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COMPUTERS - VIDEO - STEREO - TECHNOLOGY - SERVICE

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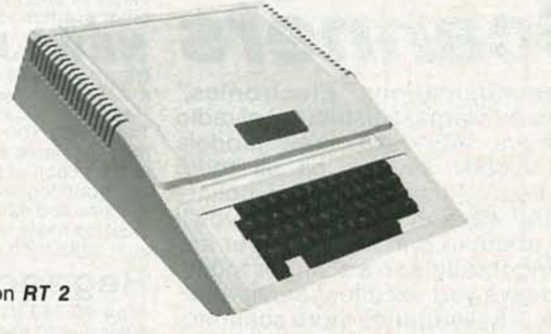

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Radio-Electronics

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

Electronics publishers since 1908

NOVEMBER 1983 Vol. 54 No. 11

ON THE COVER

When you think about the products in the various different categories of electronic products—be they video, audio, broadcast, or what have you—there are always some that shine above the rest. The reason why they are thought of as superior may be due to a sophisticated design, the use of state-of-the-art technology, better reliability or accuracy, or any one of a number of similar reasons. The same holds true, of course, for test instruments. This month we bring you a special look at the ultimate in sophisticated or unusual test instruments. The story begins on page 59.

FEW PEOPLE REALIZE that the quality of your TV sound is limited only by the quality of your TV's audio section. Unfortunately, the quality of the audio in an average set is just not very good. But there is somethng you can do about it—build the TV sound converter and get audio quality you never thought possible from your TV. The story starts on page 45.

COMING NEXT MONTH
On Sale November 17

- **Video Color Processor.** An accessory you can build for your home-video system.
- **Digital TV.** A look at this fascinating new technology.
- **Designing Analog Circuits.** Another installment in our back-to-school series.
- **And lots more!**

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VIDEO ELECTRONICS

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

HI-FI VHS

The 10 Japanese manufacturers of VHS videocassette recorders have agreed on specs for a helical-scan audio track to compete with Beta Hi-Fi. The major point of disagreement had been on noise-reduction systems, and the one finally selected is a newly developed one which is said to most closely resemble dbx. The Hi-Fi VHS system uses a process called "depth multiplex recording" and uses a supplementary pair of audio heads, unlike Beta Hi-Fi, which uses the video heads to pick up an FM signal that is multiplexed into the video information. In the VHS version, FM audio signals (on a 1.3 MHz carrier for the left, 1.7 MHz for the right) are recorded on the tape by the rotary heads, and then the video material is recorded over the audio signal on the same portion of the tape, but closer to the surface of the magnetic material. The announced specs of Hi-Fi VHS are similar to the previously announced ones of Beta Hi-Fi—80-dB dynamic range, frequency response of 20-20,000 Hz, distortion 0.3%, wow and flutter virtually nonexistent.

To preserve compatibility, the longitudinal audio track will be maintained. That track in some machines, including the new VHS Hi-Fi models, is already a stereo track, so the new units to be available here in early to mid-1984 will be capable of having four separate audio tracks as well as two stereo audio track systems. Quad VCR, anyone?

BACKTALKING VCR

Look for a VCR that talks to you among next year's introductions. A feminine synthesized voice will remind you to insert the cassette, warn you if the safety tab has been removed on the cassette you want to record, summarize the date and time for which your machine is programmed, tell you if you've goofed when you set the timer for two overlapping programs—and praise you when you've done everything right. It's already been introduced in Japan by Sony, and is on the way across the pond, we're afraid.

TV STEREO SOUND

The FCC has finally opened its long-anticipated proceeding that will end with the authorization of multi-channel sound for television, including stereo. In line with its current laissez-faire policies, the Commission proposed merely to remove all restrictions on the use of the aural subcarriers in the TV broadcast band, permitting stations to use them for virtually any purpose, paralleling a recent similar "deregulation" of FM station subcarriers. The FCC also proposed to widen TV's aural track from 75 to 120 kHz and increase permissible modulation from 25 to 75 kHz.

Mindful of the stalemate that followed the FCC's ruling on AM stereo, which established no standards, the broadcasting, set-manufacturing, and cable-TV industries have continued testing of three proposed multi-channel TV sound systems through a special industry-wide EIA committee, with the hope that the recommended system will become the *de facto* standard for stereo sound broadcasting.

The tests of multichannel sound systems developed by Electronics Industry of Japan, Telesonics Corp., and Zenith Radio Co. were nearing completion at press time, and the committee's chairman, Thomas Keller of the National Association of Broadcasters said all of the systems tested well and all were "superior in quality to FM radio." He also minimized the chances that any problems might be experienced by cable TV systems in connection with stereophonic TV sound.

Each of the three systems permits the broadcasting of stereophonic sound along with another channel of audio, so that a station or network might broadcast a simultaneous translation of the audio into another language without sacrificing stereo on the English-language soundtrack.

TV set makers, meanwhile, were preparing for the advent of stereo by developing circuits for all three proposed systems. It is believed that the earliest the FCC could finalize its ruling legitimizing multi-channel TV sound would be in February 1984—and it could take much longer if there are any legal complications. Multi-channel broadcasting could start within a few months and TV sets could be tooled, manufactured and on sale about five months after the FCC acts—meaning that stereo TV receivers could be on the market in the summer of 1984.

With a stereo-audio track and a supplementary sound channel available, it's only a matter of time before somebody adds a subsubcarrier to the supplementary channel. Quad TV, anyone? **R-E**

New Zealanders discovered that sleeping under sheep's wool induced sleep.

Sleep Sheep

We may have found a way to improve your sleep forever.

The story we are about to tell you may seem rather incredible. And indeed it is. But if you'll have an open mind, what you will learn may indeed change your life.

There is a new product manufactured in New Zealand that is selling very well. It's called the Woolrest—a bed pad made of thick wool. You simply place it over your mattress and then cover it with your bottom sheet as you normally do when you make your bed.

SLEEP INDUCING

Sheep's wool has always had an outstanding reputation for keeping you warm in winter and cool in summer. That is why wool seat covers are so popular. But wool has another property known by New Zealanders for many years. Namely—wool induces sleep.

In New Zealand, for example, a way to cure insomnia was to cover yourself with a sheepskin rug. For some very unscientific reason, the hypnotic quality of the wool encouraged sleep. Counting sheep was another technique that was often recommended. But it was the development of the Woolrest bed pad that suddenly turned an old wive's tale into fact.

DIFFERENT EXPERIENCE

Sleeping on a Woolrest is a different sleeping experience. Whether you sleep on a hard or soft mattress, the Woolrest apparently radiates a feeling of comfort and relaxation from the wool fibers which mold, massage, and conform to your entire body.

Scientific tests conducted by Dr. Peter Dickson of Ohio State University proved that the Woolrest pad indeed helped induce sleep. Testimonials from people who owned them clearly demonstrated that Woolrest not only induced sleep but also provided great relief for backaches, arthritis, and rheumatism. Its natural fibers tend to alleviate the pain and pressure caused by these illnesses and thus make sleep come easier and deeper.

Frank Thornton, a Seattle Washington dental technician, had trouble sleeping for six years. He purchased a Woolrest pad and has been able to sleep through the entire night practically every night. According to Thornton, "I felt a sensation of buoyancy from the Woolrest. I have read in literature that a person sleeps more restfully with natural fibers surrounding their body." Thornton has already purchased seven Woolrest pads for his entire family.

There are hundreds of other testimonials we could mention from the thousands who have purchased them, but one thing is clear. Using a Woolrest pad you know that the rest of your life will be spent sleeping comfortably, with a minimum amount of sleeplessness. Certainly, there will be nights when it will be difficult to go to sleep. But with the Woolrest those nights will be fewer, shorter and without the tradeoff of taking sleep-inducing drugs.

WARM IN WINTER

In the winter the Woolrest holds your body heat and thus keeps you warmer. You'd expect that. But in summer it keeps you cooler through a process of moisture absorption by absorbing up to one-third of its weight in moisture to keep your body cool and dry.

Will the Woolrest work for you? We're willing to prove it with no risk on your part. Order one for a 45-day sleep test. When you receive it, closely examine the surface. Feel the thick pure woven pile of natural New Zealand wool. Place it on your bed and then cover the pad with your regular bottom bed sheet—either fitted or plain.

JUST A FEW DAYS

That night go to sleep on it. But don't judge the effectiveness until you've slept on it for at least a full month. You should actually notice the difference in just a few days, but after a month you'll turn from being skeptical like we were, to a real enthusiastic believer. If not, we'll understand. After all it may not work for everybody. Just return it within the 45-day sleep trial and you'll receive a prompt and courteous refund including the $4 delivery charge. The Woolrest washes easily in your washing machine and has a limited five-year warranty. Complete instructions come with each pad. Sleep on a Woolrest and experience what we mean at no risk or obligation. Order one, today.

To order, credit card holders call toll free and ask for product by number below or send check plus $4 delivery for each pad ordered.

Twin Size (0025RA) **$129**
Full Size (0026RA) **179**
Queen Size (0027RA) **209**
King Size (0028RA) **269**

The New Zealand wool used exclusively in the Woolrest could be a major reason for its effectiveness. Here's why.

Most sheep are raised in countries where temperature extremes cause their wool fibers to become brittle, rigid and often cracked at the ends. In Australia sheep are often raised in the dusty outback where temperature and rainfall can vary greatly.

In New Zealand however, the sheep enjoy a year-round temperate climate and graze in lush green pastures. Their wool fibers are thick and vibrant with good shape retention .

NEW ZEALAND WOOL

The Woolrest uses only the best New Zealand wool. The fibers are actually woven onto a pure wool blanket base and thoroughly washed and tufted.

We have mentioned the importance of New Zealand wool for good reason. Just as there are several grades of sheepskin seat covers, we suspect eventually there will be several grades of wool bed pads. None will ever compare to the wool used in the Woolrest.

JS&A®

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WHAT'S NEWS

Electricity plus gas in experimental car

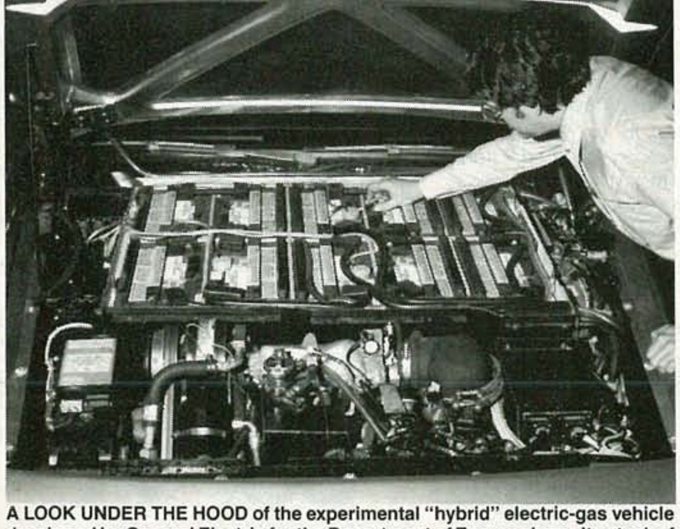
A new "hybrid" car with both an electric motor and a gasoline engine has been developed by General Electric for the U.S. Department of Energy. The new propulsion system gives the experimental vehicle the fuel savings of an electric for around-town driving, while eliminating the electric's major drawback—its limited driving range. It uses batteries for short-range driving, and can make long—even cross-country—trips with the gas engine.

The electric motor is powered by ten 12-volt lead-acid batteries that weigh a total of 750 lbs. The battery may be recharged by the gasoline engine or by wall-plug electricity. The car is also equipped with a regenerative braking system that feeds recharge energy to the batteries when the brakes are applied.

The 40-HP electric motor and the 80-HP gas engine operate separately or in parallel. Electricity is used for speeds up to 40 mph, and gas for highway driving.

The Hybrid Test Vehicle was built by a team of automotive and technology firms headed by scientists and engineers of the GE Research and Development Center, Schenectady, NY. GE developed and built the car's 40-horsepower electric motor, the electronic controls for the motor, and the microcomputer that controls the entire hybrid system, monitors the battery's state-of-charge and a variety of other parameters, and decides when to switch on the electric motor, the gasoline engine, or both.

The total cost of the development effort—including the efforts of various subcontractors—was $10 million.



A LOOK UNDER THE HOOD of the experimental "hybrid" electric-gas vehicle developed by General Electric for the Department of Energy shows its stack of lead-acid batteries. Running on electricity for in-town driving, and on gas for the road, it combines the economy and anti-pollution advantages of electric vehicles with the long-range driving advantage of the gasoline engine car.

Videodisc owners are using their discs

A survey conducted by RCA indicates that the average videodisc owner uses his player 8.5 hours every week, and watches his favorite programs repeatedly. Households with children use their players 10.3 hours a week on the average.

Cable TV does not appear to be a competitor—videodisc owners who subscribe to Home Box Office use their players 8.8 hours a week. (Persons who use two services apparently watch more video than the average.) That also seems to apply to VCR owners, who use their videodisc players an average of 7.9 hours a week.

The survey also discovered that about 80 percent of videodisc owners who also subscribe to cable TV were already on cable when they bought their videodisc players.

Ku-band satellites for direct home broadcast

Contracts are being let for a fully developed Direct Broadcast Satellite (DBS) system that will cover the United States with four operating satellites and two in-orbit spares. Larry Yermak, Director of satellite programs at RCA Astro-Electronics in Princeton, NJ, told a ku-band satellite communications conference at Washington, DC. that the system is being designed for General Telephone & Electronics (GTE) and its GSTAR program.

Each of the four satellites, transmitting in the 14/12 GHz band, will transmit data, voice, and images, to the 48 continental United States on 16 channels by shaped beam. Alaska and Hawaii will be covered by spot beams.

New component series tailored for customer

Six "firsts" are claimed by the manufacturer of a remote-controlled tuner designed to match components in a product series tailored to individual consumer needs. The firsts are in a high-technology microcomputer-controlled FM frequency synthesizer in the *B261* tuner by Revox of Switzerland.

To suit the individual purchaser, the Revox retailer will program the frequency and call letters for each of the tuner's 20-station presets. He will also program into the tuner's memory each of four modes (stereo, high blend, mono, and muting). All programmed controls will then be covered with a tinted plexiglass shield to protect the programmed settings.

Other firsts include tuning in 12.5-kHz increments, an alphanumeric liquid-crystal display with seven numbers for station frequency, and four letters or numbers for station name; memory locations for up to 20 FM station frequencies, with corresponding station identification; direct automatic memory scan through the 20 stations, or scan via remote control; optional second antenna input, with potential to assign the desired antenna to any station frequency, and a 400-Hz calibration oscillator that permits precise level setting of a connected tape recorder. Expanded use of microprocessors makes possible an infrared remote-control system that covers all switching and control functions of the tuner.

The *B261* is engineered to match Revox's new *B251* integrated amplifier. The optional remote control will operate the *B261* and the *B251* individually, and (with adapters) two turntables, a cassette recorder, and an open reel deck not in the *B200* series. The manufacturer's suggested retail price is $1,500.

New AM stereo tuners play all four systems

Two manufacturers have designed AM-stereo tuners that can receive any one of the four systems currently in use under the FCC's "let the market decide" approach to AM stereo.

The system developed by the Japanese company Sansui actually senses which of the four stereo systems is being used by the station to which it is tuned, and immediately starts decoding it.

Sansui is developing two types of tuners. One is a car radio, which the company says will be available at a price of around $200. The other, an AM/FM/stereo tabletop tuner, is expected to sell for $410. Both are based on a multisystem IC that Sansui says it may make available to other manufacturers.

The other manufacturer, Sony, is expected to have a tuner available shortly. A portable AM/FM stereo type, its price will be around $90. The Sony model uses a switch to select the competing systems—one position for Kahn AM-stereo, a second position for Magnavox, Motorola and Harris.

The new multisystem tuners are expected to speed up the adoption of AM stereo, since many potential customers now hesitate to buy a tuner that would not be able to receive some of the important stations that may go over to AM stereo in the future. Stations will also be

continued on page 8

TEK 2213/2215/2235
DUAL TRACE OSCILLOSCOPES

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Now 60 MHz or 100 MHz Tek quality is just a free phone call away!

**New lower price!
100 MHz 2235
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Tek has expanded its best-selling 2200 scope line up to 100 MHz. And brought it all as close as your phone. Tek's revolutionary, reduced-component architecture brings unprecedented quality, reliability and affordability to the 60 MHz 2213 and 2215, and now, the 100 MHz 2235.

All three of these lightweight (13.5 lb.) scopes feature 2 mV/div vertical sensitivity and 5 ns/div sweep speeds, plus a complete trigger system for stable triggering on digital, analog or video waveforms.

Scopes with a comprehensive 3-year warranty*... probes...and expert advice. One free call gets it all! You can order, or obtain literature, through the Tek National Marketing Center. Technical personnel, expert in scope applications, will answer your questions and expedite delivery. Direct orders include operating and service manuals, two 10X probes, 15-day return policy, and worldwide service back-up.

	2213	2215	2235
Bandwidth	60 MHz	60 MHz	100 MHz
No. of Channels	2	2	2 + Trigger View
Alternate Sweep	—	Yes	Yes
Vert/Trig B/W Limit	—	—	Yes—20 MHz
Single Sweep	—	—	Yes
Accuracy: Vert/Horz	3%	3%	2%
Delay Jitter	1:5,000	1:10,000	1:20,000
Trigger'g Sensitivity	0.4 div at 2 MHz	0.4 div at 2 MHz	0.3 div at 10 MHz
Input R-C	1MΩ –30pf	1MΩ –30pf	1MΩ –20pf
Variable Holdoff	4:1	4:1	10:1
Price	$1200†	$1450†	~~$1950†~~ Now $1650†

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*3-year warranty includes CRT and applies to 2000 family oscilloscopes purchased after 1/1/83.
Scopes are UL Listed, CSA and VDE approved.

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WHAT'S NEWS

continued from page 6

more ready to convert, if they know that listeners will be able to receive them, no matter which system they adopt.

The systems, however, are competing fiercely to become the "accepted" one. At the time of writing, Harris appeared to be the leader, claiming to be equipping 15 to 20 stations a month. The Kahn system has more than 30 stations on the air, Motorola six, and Magnavox 3.

First-run films to be transmitted while subscriber sleeps

In a program already in use experimentally, subscribers to a service known as TeleFirst will be able to receive first-run films transmitted by local broadcast stations direct to their home videocasette recorders.

TeleFirst, an electronic service from ABC, transmits during the early morning, usually between 3 and 5 A.M. (very few ABC stations broadcast 24 hours a day). According to an ABC official "You set your VCR before you go to bed, and when you wake up you will have a brand-new first-run film ready for you on your cassette.

The film will *not* be ready for non-subscribers to the TeleFirst service—it is in scrambled form. All subscribers receive a decoder, for a fee expected to run about $25 per month. That decoder attaches to the viewer's recorder and makes the recordings viewable.

Commercial service will begin early in 1984, with WLS, the ABC affiliate in Chicago, as the first station to transmit the films.

EIA debates system for multichannel TV sound

The Electronic Industries Association (Consumer Electronics Group) reported in August that the EIA Multichannel Sound Committee was completing the testing phase, leading to a vote on what system of multichannel TV sound to recommend to the FCC.

Testing the three proposed transmission systems at Matsushita had been finished, and testing the four proposed companding systems was practically completed. A combined transmission-companding test, scheduled for this past September, would complete the technical record.

It was expected that a complete report and industry recommendation for a single transmission and companding system would be ready to present by mid-December, to meet the FCC's schedules for decision making.

New information system keeps motorists updated

Blaupunkt reports that as of last August its Automatic Radio Information (ARI) service was covering the New York metropolitan area with four widely separated FM stations, and began serving Connecticut and Philadelphia during September. ARI is Blaupunkt's subcarrier technology that enables selected FM radio stations to provide motorists with timely traffic bulletins for specific "travel zones" within a metropolitan area.

Blaupunkt also announced that it has added to its line an adaptor, the ARI-A, which can convert any "ARI-capable" FM receiver into a functioning ARI-receiving instrument. (All Blaupunkt radios now being imported are ARI-capable.) The adaptor plugs into the back of the ARI-capable electronically tuned unit and provides pushbutton "travel-zone" selection. When the zone is selected, the radio will scan to the station for that zone, ignoring all other stations.

"Amorphous metal" for future transformers?

A new kind of core material, "amorphous metal," has the potential of eliminating more than a half-billion dollars a year energy waste in power transformers, say General Electric scientists. G. E. is now engaged—with the support of electric power organizations—in a $6.6 million program designed to make that core material commercially practical.

Amorphous metal is a fundamentally new kind of material, in which the orderly, crystalline atomic structure of metals and alloys is totally absent. The material's atoms and molecules are arranged randomly—much as they are in glass. (The material is also known as "glassy metal" or "metallic glass.")

The amorphous composition is much easier to magnetize than materials now used for transformer cores; thus core losses are reduced (by about 70 percent) resulting in great savings.

Amorphous metal is made by ultra-fast cooling. The molten iron-based alloy (at about 2,300° F) is squirted onto a cool (60° F) rapidly spinning wheel, where it hardens in about a thousandth of a second into a thin (.001-inch) ribbon. The ultra-fast action freezes the material before it has time to assume the ordered structure of metals.

The present program is aimed at accelerating the commercialization of transformers with those cores. Some major manufacturing challenges will have to be met before they can be mass-produced at low cost.

Meanwhile G.E. has produced 25 "pre-prototype" transformers, which are being installed in key utility systems as part of a long-time evaluation program. Within the next 39 months 1,000 25 KVA transformers will be delivered for field testing by sponsoring utilities.

New European satellite studies future physics

The European space satellite, EXOSAT, is ready to commence its task after a series of calibration maneuvers to fix its position in space, Marconi Space & Defense Systems reported in July. The long-term pointing accuracies, according to Marconi, who built the attitude control system, are around 1.5 arc second rms, which is about twice the accuracy capability of the observing instruments on board.

The satellite will now observe pulsars, supernovas, quasi-stellar bodies, and collapsed stars in the attempt to learn more about the laws of physics that apply under the strange conditions found in those celestial objects.

The precise timing of the launch, EXOSAT's ability to modify its own orbit, plus the low gas consumption rate of the attitude-control system, gives reason to hope that the satellite's useful life can be extended well beyond the planned two-year mission. **R-E**

Radio-Electronics

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SATELLITE/TELETEXT NEWS

GARY ARLEN
CONTRIBUTING EDITOR

DBS SERVICE IN 1984

Satellite Television Corp. has advanced its Direct Broadcasting Satellite timetable, and now intends to begin a five-channel pay-TV service in fall 1984—nearly two years ahead of the original plan. STC's first DBS transmissions will be available only in the northeast US and will be sent via a new Satellite Business Systems bird. SBS (partly owned by STC's parent company, Comsat) will modify the SBS-4 satellite now under construction to permit signals from five transponders to be concentrated in the densely populated northeastern US. STC expects that dishes as small as two-feet in diameter can be used for its DBS feeds.

NBC TRANSMISSIONS

The NBC television network is also going aloft on a specially modified Satellite Business System Ku-band bird, starting January 2. Comsat General Corp. will actually manage the service, which calls for a satellite communications system that will initially distribute programming to 24 NBC affiliate stations. The contract is seen as the first step toward a 10-year agreement by which Comsat will provide satellite network distribution to all NBC affiliates in the US. The space segment of the NBC transmission will travel on SBS Ku-band satellites, although in the future the service will be moved to RCA Americom birds operating at the same frequency.

U.S. GETS 8 DBS SLOTS

The western hemisphere satellite conference has sorted out orbital assignments for Direct Broadcasting Satellite service (12 GHz band), and the US has received eight positions with authority to transmit 32 channels from each slot. The assignments are at 175°, 166°, 157°, 148°, 119°, 110°, 101°, and 61.5° (all west longitude). The US delegation to the 23-nation Regional Administrative Radio Conference (RARC) had hoped to obtain enough slots to provide service to four areas within the continental US, roughly corresponding to time zones. As it turned out, each orbital position will reach half the US—although the official government statement on the matter is that new technical advances make it feasible for each DBS bird to cover that large a territory. Under the new international agreement, Alaska, Hawaii, Puerto Rico, and the Virgin Islands will be served by spot beams from the US orbital positions.

One major setback for the US negotiating team at RARC was the adoption of a value of −107 dB (watts-per-square-meter) for power flux-density. The US had wanted a value of −105 dB. A high-power flux density is desired for the use of small, cheap receivers that are planned by most DBS operators. The higher power level may also be needed to offer the enhanced services such as high-definition television.

AUDIO BURSTS

Nippon Television Network has revealed preliminary findings from its test of audio-accompanied vertical-blanking-interval teletext. The NTV system sends music as coded digital signals—notes that can be compressed into 0.001 to 0.005 seconds. The ongoing NTV test has sent musical performances as long as one and a half minutes (2000 bytes transmitted in one second). Data received by the teletext decoder is stored and then played back using a microprocessor that controls the number of sound-source oscillators; those oscillators can generate the sound of six instruments or up to 11 voice parts. NTV expects the integrated audio device would be offered for barely $25 above the price of non-audio teletext decoders —although commercial introduction is still several years away.

TELETEXT NEWS BITS

KSL-TV Channel 5 in Salt Lake City will become the second U.S. TV station to launch a commercial teletext service using World System Teletext format (based on the British format). Zenith will build teletext decoders, to be sold for about $300 each to TV set owners in the Salt Lake City area.

Rockwell International has teamed up with Norpak, a leading Canadian teletext/videotex equipment maker. Jointly, the two companies want to accelerate an IC production schedule that could make it possible that NABTS/NAPLPS format decoders-receivers could be built for as little as $500 by late 1984. The so-called "North American" standard has so far eluded efforts to build fairly low-cost hardware—and the involvement of Rockwell is seen as a positive sign to bring costs down. **R-E**

VIDEOGAMES

Staying power

DANNY GOODMAN

AS WE WERE THUMBING THROUGH OUR archive files on videogame software, we came upon a series of videogame-cartridge bestseller lists. For the most part those lists are based on telephone polls to dealers and distributors around the country to see each month which cartridges are doing best. Examining the results published in the first six months of 1983, it was interesting to see which games had the staying power to survive the whims of the cartridge-buying public.

The most noticeable fact is that it is the same cartridge producers who show up on the list month after month; Activision, Atari, Coleco, and Parker Brothers. made the top ten every month. Next come those publishers who appear frequently —Imagic and Mattel. Beyond that, only CBS Games ever broke into the elite club for two months, each time with a different cartridge.

For that six-month period, Coleco was the winner with the highest number of mentions in the top ten: 17, including both *Colecovision* and *2600* titles. Activision and Atari were tied for second place with 14 each. The rest straggled in: Parker Brothers with 6, Imagic with 4, Mattel with 3, and CBS with 2.

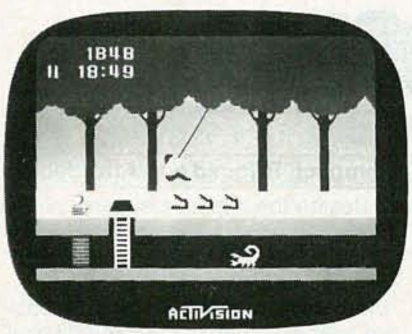


FIG. 1

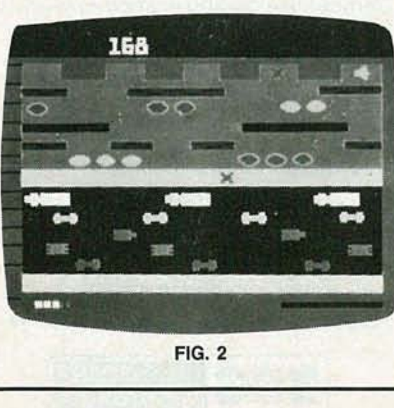


FIG. 2

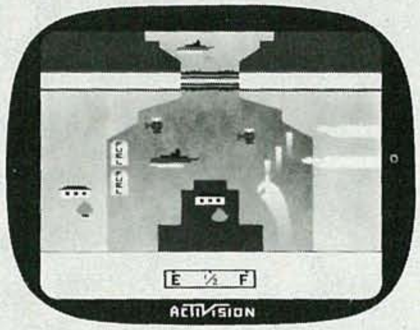


FIG. 3

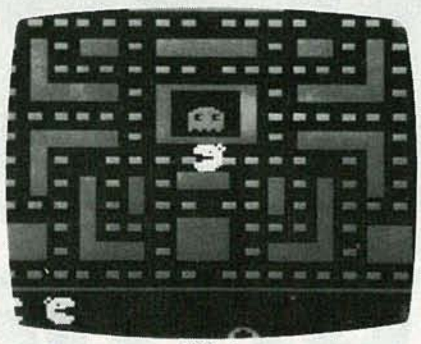


FIG. 4

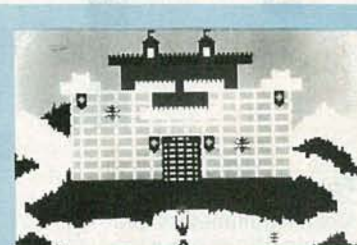
What is probably much more important, however, is that of the sixty possible top-ten slots over the period, very few titles managed to carry over for more than two months at a time. In fact, only five titles—*Pitfall, Frogger, River Raid, Ms. Pac-Man* (see Figs. 1-4), and *Donkey Kong* (for the *2600*)—made the list for four or more months. It seems then, that cartridges with staying power are extremely rare, especially when you consider the hundreds of cartridges available today.

Much more typically, a good title will gather all kinds of support for a month or two after its introduction, and then disappear into the background. For example, the celebrated *E.T.* cartridge surfaced in the January list in 7th place. The following month it inched up to 6th. But by March it was gone. *Mouse Trap* for *Colecovision* zoomed instantly to 3rd place in February, only to never be seen on the list again. Even the Activision name doesn't guarantee a long-term winner. *Sea Quest* hit the charts in April in 8th place, but that was about it.

The strongest influence on whether a cartridge becomes a long-time hit or just a shot in the dark, we believe, is word of mouth. Few home videogame players are isolated from other players of the same console—in fact most games are bought because the buyer has played someone else's initially. That informal but powerful grapevine carries over to the purchase of cartridges later on. When a new cartridge hits the stores, a good number of "pioneers" venture out and buy it if the wording on the box looks intriguing. Thereafter, a good game's reputation will spread like wildfire. An outstanding game will keep that fire burning for many months as more and more players decide that they must have it.

Undeniably, those top-selling games are good-playing games. There is no secret formula. Interesting graphics, innovative sound, and novel and ever-challenging game play—those are the basics of cartridge staying power.

Imagic's Ice Trek for Intellivision



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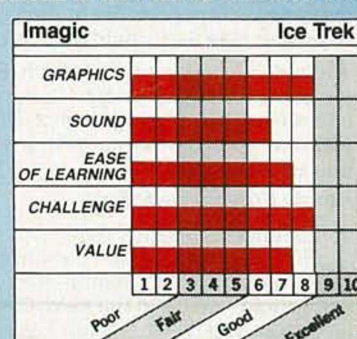

There aren't many videogame cartridges that take on the guise of a Norse saga. One exception to that is *Ice Trek*

continued on page 14

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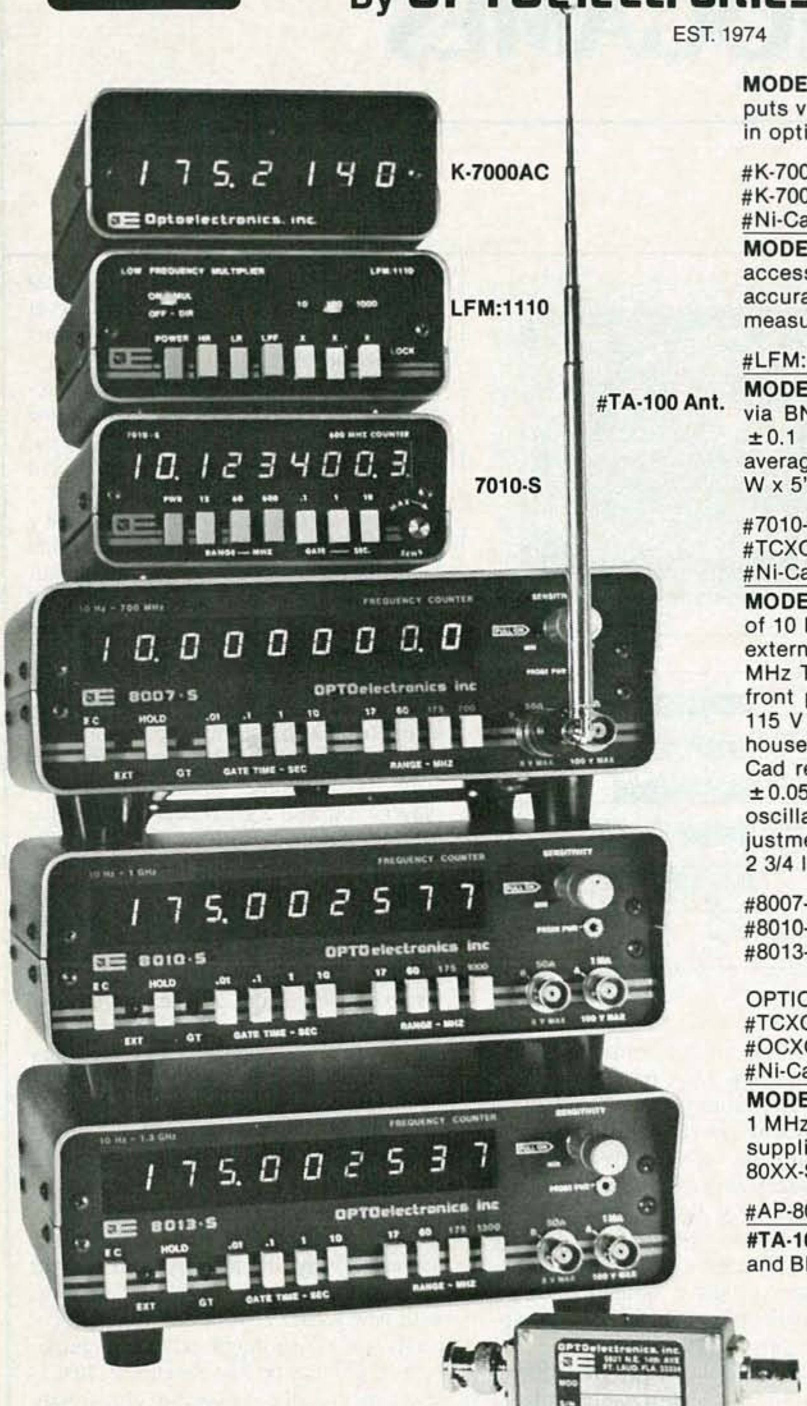

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		FREQ	STAB-DESIGN	BELOW 500 MHz	ABOVE 500 MHz		12 MHz	17 MHz	60 MHz	175 MHz	MAX FREQ				
K-7000-AC	550 MHz	5.24288	±1 PPM-RTXO	15 mV −24 DBM	N/A	(2) .1, 1 SEC	10 Hz			100 Hz		No	No	Yes	No
7010-S	600 MHz	10.0 MHz	±1 PPM-TCXO *±0.1 PPM-TCXO	10 mV −27 DBM	20 mV −21 DBM	(3) .1, 1, 10 SEC	.1 Hz	1 Hz		10 Hz		Yes	No	Yes	No
8007-S	700 MHz														
8010-S	1 GHz	10.0 MHz	±1 PPM-TCXO *±0.1 PPM-TCXO *±0.05 PPM-OCXO	10 mV −27 DBM	20 mV −21 DBM	(4) .01, .1, 1, 10 SEC	.1 Hz		1 Hz		10 Hz	Yes	Yes	Yes	Yes
8013-S	1.3 GHz														

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VIDEOGAMES

continued from page 12

from Imagic (981 University Avenue, Los Gatos, CA 95030), a modestly challenging and fun cartridge.

Ice Trek is a three-fold adventure of a character called "Vali" as he wends his way to the Ice Palace of Kalktron the Terrible. The first scene has Vali skiing across the tundra while dodging trees and stampeding caribou. If one of the antlers grabs Vali, he is dragged back to the edge of the screen and loses one life. If worse comes to worst, Vali has an axe with which he can slay one of the caribou, but doing so invokes the ire of the Wildlife Goddess, who shoots an arrow at him.

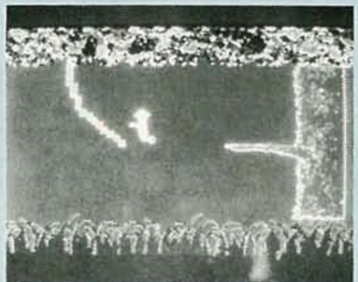
If he gets by the tundra, Vali winds up at the bank of a river loaded with floating icebergs. Using the controller buttons and aiming with the direction disk, you control Vali's hook as he tries to snare pieces of ice to build a bridge to the other side. Unfortunately, if an iceberg rams the existing bridge, Vali loses that part of the bridge, and probably ends up in the water, losing one life. To defend against that Vali has a torch with which he can melt oncoming icebergs. That game segment will be the most challenging for the beginner.

Finally, once Vali crosses the bridge, he is outside the Ice Palace. From below the palace, he must hurl torches up to several ice blocks and villains at the top, while they toss ice crystals down at Vali. If Vali is successful, the Ice Palace melts as a Wagner tune is played.

Perhaps we've been spoiled by Mattel's grandiose signalling an achievement such as that, complete with long musical renditions and sometimes special graphic displays. We were a bit disappointed, therefore, by the short and lifeless musical tribute to Vali's efforts the first time he melted the Ice Palace. Even in the rest of the game, the sound effects are not impressive; thundering caribou hooves and a flowing river signal the first two adventures. I do, however, like the sound and visual effects when an iceberg starts shaking the bridge before it breaks a piece of it off.

Atari's Jungle Hunt for Atari 2600

With the astounding success of Activision's *Pitfall*, it was only a matter of time before someone else devised a jungle-based adventure with a similar feel. And so we have *Jungle Hunt* from Atari (1265 Borregas Ave., Sunnyvale, CA 94086), a multiple-scene, horizontally scrolling game putting the human player in charge of an on-screen alter ego. Instead of guiding Pitfall Harry through an endless jungle of treasures, we guide Sir Dudley Dashly on his quest to rescue Lady Penelope from the jungle savages. Therein lies the main difference in how to approach the game, as we'll see.



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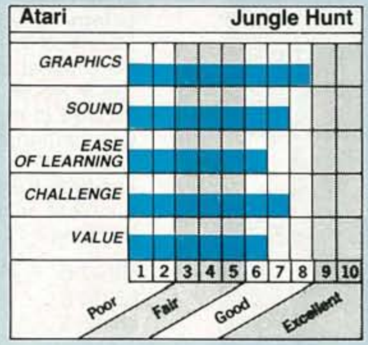


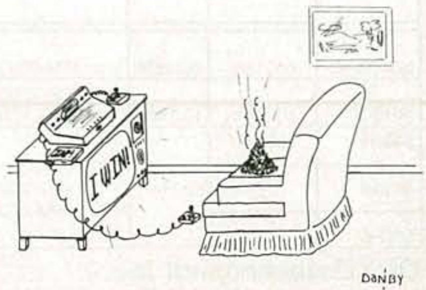
Jungle Hunt is chock full of different screen action, which helps to break up the monotony of a typical session. In the first part, Dudley must successfully swing along 11 erratically moving vines. Next he must swim through a river full of crocodiles (bonus points are available for knocking out as many crocodiles as possible, as long as his air supply holds out). Then comes a boulder field in which big and small boulders roll and bounce across the screen; Dudley must either duck or jump to avoid being hit by one. Finally, Dudley must jump over two spear-carrying guards. If he is successful, Dudley goes into the center of the village where he rescues Lady Penelope.

It's wonderful to see so many different scenes on a *2600* cartridge. Some clever designing went into coloring various background elements to make them appear to be completely different in succeeding scenes. However, it is a shame that most of the scenes appear flat, especially in comparison with David Crane's *Pitfall* from Activision.

In *Jungle Hunt* you are racing against a timer of sorts that counts down possible bonus points from the start of the round. What takes some of the excitement out of the game for us is that the adventure is finite—that is, it reaches a conclusion when you save Lady Penelope. With plenty of time left, you just restart the adventure. That doesn't seem logical to us. And once you've arrived at the scene to save Lady Penelope once, if you are like most players you lose a great deal of incentive to come back to the game again and try for a higher score.

The difference between *Pitfall* and *Jungle Hunt*, I suppose, is that in *Pitfall*, the score is the thing. You are in a constant race against the clock to try different routes to pick up more and more treasures along the way. But in *Jungle Hunt*, your attention is divided between saving Lady Penelope and the score. In your early attempts, the only thing you are going to care about is reaching Lady Penelope. Once you've done it, you've forgotten that there is even a score adding up to the top of the screen.

When you have gotten the feel of a game one way, it's awfully hard to shift gears and think about it in a new light, with new goals. If your cartridge budget limits you to one jungle-adventure game, then *Pitfall* may be a better choice. Just as in the movies, the remakes of classics are rarely as good as the originals. **R-E**



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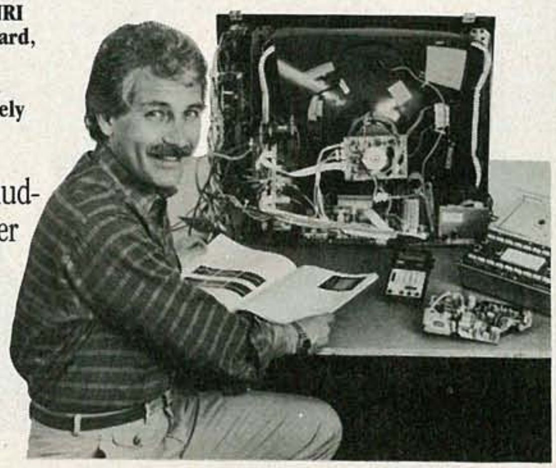

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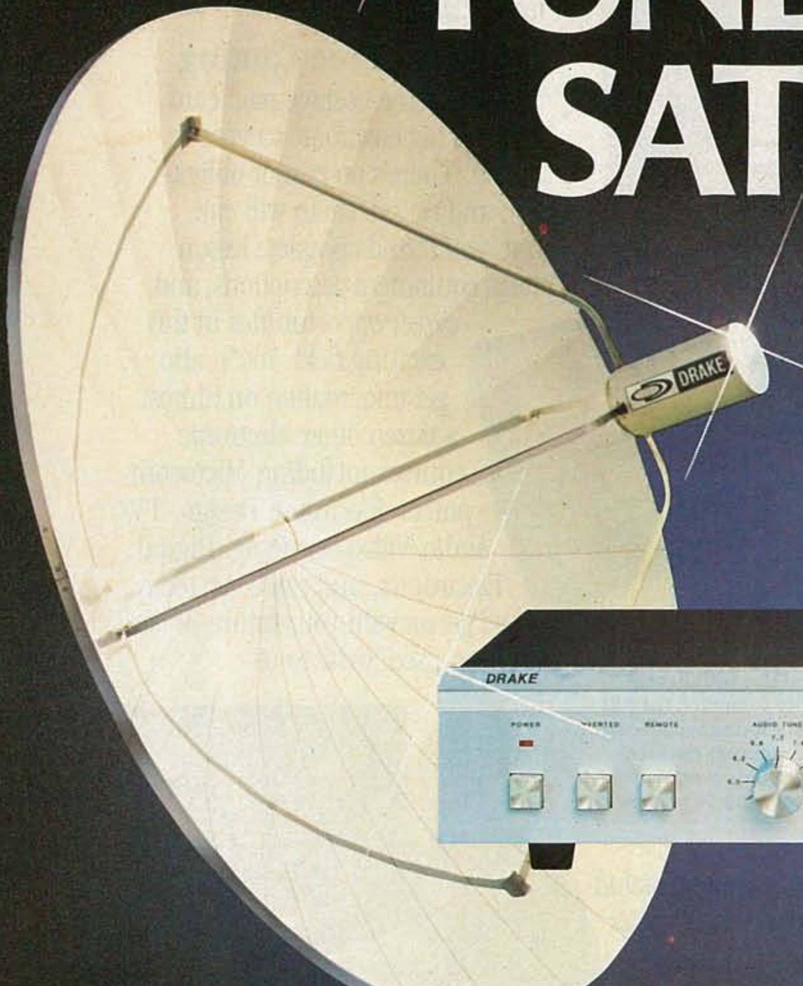

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LETTERS

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THE *KAYPRO II*

This is in reply to the review of the *Non-Linear Systems—Kaypo II* computer in the April 1983 **Radio-Electronics.** First, I have heard that the NLS unit was under development at the same time or before the Osborne unit, but underwent more revisions before actually coming to market than did the Osborne. Here are some relevant facts to the best of my knowledge.

The *Kaycomp I* was the initial prototype; it was never actually produced. That unit may have had one drive on each side of the screen. The next unit developed was that *Kaycomp II,* which had the fault of the "raster scan" or "cursor dance" that was noted in the review. Those first-production *Kaypro II's* may have had the "cursor dance," but I haven't heard about it. That, I assume, was corrected early in 1982, before the actual production of the unit. Due to the name problem, the literature was revised and the name changed to *Kaypro II* when the hardware was improved.

Early keyboards—those I will call type "A"—did have a short travel and a hard-bottoming keystroke. Other units, type "B", have a different feel—the kind that your reviewer would prefer. If the CAPS LOCK lamp cover is slightly raised and has concentric circles, it is type A; the flush cross-hatch pattern lamp cover indicates a type-B keyboard. Both types A and B appear to be out in the field. My dealer has two A units on display, but mine has a B keyboard.

Early units *did* have the drives in vertical orientation; that was changed, and the brightness control went to the rear panel. It sounds as if the review unit may actually have been a Kaycomp or a very early *Kaypro II.* The chances are that most of the 10,000 finalized units shipped in 1982 contained none of the problems noted in the review, except the RFI.

My Kaypro is quite capable of blanking my RCA XL-100 on channels 2 and 4 when residing 36 inches from its antenna. A Japanese TV set of more recent vintage gets bad interference lines some 18 feet away. That problem is aggravated by connecting a printer cable, and mostly it radiates from the coiled keyboard cable.

I know that the literature has been updated more than once, as has the software. The original bundled software pak included the word processor from Select Information Systems, instead of the Perfect Writer/Speller/Filer/Calc. Old units also came with the ProfitPlan spreadsheet, the S-BASIC compiler, and the CP/M 2.2. Now new units come with the Perfect/ProfitPlan/S-BASIC and CP/M 2.2, as well as the Microsoft M-BASIC interpreter and a second spelling checker, as well as a Pac-Man and an adventure game.

My own S-BASIC compiler never did work-

—even on the supplied demonstration programs. The irony of that is that Non-Linear Systems now wants an extra $75.00 from previous Kaypro owners for the M-BASIC, The Word Speller & Games pak that is now the "standard" bundled software. While that price certainly beats paying about $400.00 to get those things elsewhere, it displays a shameless corporate lack of tact by NLS and Kaypro toward previous *Kaypro II* owners.

All in all, however (lack of tact aside), I would say that the NLS/Kaypro deserves a "9" in the price/value category, even if the eight book-sized manuals are a lot of reading and somewhat difficult.
STEVEN L. BENDER
Queens Village, NY

DRY TRANSFERS

I was interested to see the article about dry transfers as a resist medium in the **Radio-Electronics Annual, 1983,** though of course it alluded to other brands than the one that CERES distributes here in Canada.

However, I think that your readers might be justifiably puzzled when they come upon the statement in another story in the same issue wherein dry transfers are referred to somewhat negatively, saying in particular that they are prone to wash off in the etchant.

To put the matter straight: Wash-off is simply not encountered with this medium. Our product is unconditionally guaranteed in that, as well as in other, respects; and in five years, only four sheets of transfers have ever been returned—and the reason for return was *not* "wash-off." Etching temperatures almost to the boiling point are withstood and results are exceptionally crisp and clean, thanks to the excellent adhesion and thinness of the transfer medium.

I am surprised to learn that the brands available in the US do not provide curves or corners; our line includes quite a variety of them, with various degrees of curvature and of different thickness. As we advise our customers, layout tapes *do* work, but their performance on curves is inferior to that of transfers.

One final comment: Again, I do not know whether this applies to brands sold in the US, but one of our strongest selling points is dry transfers' capability to accomplish very fine work and permit high component density. Our line allows leads to be routed between the pads of IC DIP sockets—which is very difficult to do with any other "home" medium.
JOHN COX
CERES,
866 Bloor Street West
Toronto, ONT M6G 1M5

UHF TV PREAMPLIFIER

I just finished building the UHF TV Preamplifier that was presented in the March and May 1982 issues of **Radio-Electronics,** and am very pleased with the results.

There is still an error in the parts-placement diagram that was reprinted in the May 1982 issue. The amplifier failed to work properly at first, so I compared my unit against the schematic diagram. I also noticed that the voltages on the transistors did not appear to be correct. I then found that four resistors were switched on the parts-placement diagram. Resistors R1 and R2 should be interchanged, and resistors R3 and R4 should be interchanged. That will considerably raise the voltage on transistors Q1 and Q2.

I ordered the chip capacitors by mail from MHz Electronics in Phoenix, AZ, and received them by mail in only seven days. I substituted MRF901 transistors which I got from Radio Shack (#276-2044) and found them to work very well.

After I had the amplifier assembled and working, I had one of the engineers where I work check the gain across most of the UHF band. My lowest gain was 30 dB.

I am using the amplifier at the antenna, which is the Simple Simon Electronics model *STVA-4*, and am very pleased with the results. I use the antenna system mostly to pull in some distant UHF stations.

Please keep the excellent articles coming. I am a Senior Technical Writer for The Heath Company, and have enjoyed reading your magazine for many years.
RANDY KAEDING, K8TMK
Stevensville, MI

REWINDING TRANSFORMERS

The article, "Rewinding Transformers", in your May 1983 issue caught my eye for two reasons. First, I had problems dismantling a large choke for a magnet project. Large power transformers or chokes are sometimes not only enameled but are also covered with globs of black, tarry material. After much sawing and prying at the laminations unsuccessfully, I was about to give up. My father informed me that the best way to deal with the problem was to burn the choke in a good fire. The next day, when the charcoal grill had cooled, I removed the choke and took the bolts from the laminations. It practically fell

apart in my hands.

The second reason I appreciated the article was because of the uses to which I'd put my laminations. All "E"-shaped laminations were varnished back together, and all "I" sections likewise. Mount the "E" on its back and wind 300 turns of #18 AWG Beldan enameled magnet wire around the center pole. Using that "E-I" magnet, and a few common electrical parts, you can demonstrate transformer action, a saturable reactor, resistance soldering, an electromagnet (about 1600 Gauss at center pole), AC synchronous motor, and a cute levitation trick (Lenz's law).

All those projects and more can be found in a book called *Projects in Basic Magnetism,* by John P. Shields, published by Howard W. Sams & Co., 1965. I strongly recommend it to anyone interested in applications of a versatile fundamental component in electronics. It might even make a good series for your magazine.

JOE CARR
Ft. Worth, TX

SPEED-LIMIT LAWS

In the "Letters" department, **Radio-Electronics,** March 1983 issue, Mr. Kolasinski's conclusion is that because many or most drivers exceed a given speed limit, "... it is the intent of most drivers to break the speed-limit laws."

It just might be that those speeding drivers realize that life is very short, and that time spent while driving from point A to point B is wasted time. So, in speeding, they are trying to use their lives productively and efficiently by minimizing wasted time.

Highway speed limits have little to do with fuel conservation, safety, or saving lives. They are strictly a means of allowing cops who are incapable of dealing with real criminals (murderers, robbers, rapists, drug pushers, etc.) to issue their quota of tickets easily and thus earn their keep. Any fuel savings due to the 55-mph limit vs. a 70-mph limit is too small to measure relative to the country's overall use of crude oil. If safety were a concern, the laws would allow whatever speeds are reasonable for existing conditions. Where is the sense in being allowed to drive 55 mph on a main highway in heavy, rush-hour traffic with cars very close to each other, yet being ticketed for doing 30 mph in a 25-mph zone at 2 AM when there is not a pedestrian or any other car in sight?

Yes, both in 1974 (when the 55-mph limit took effect) and 1975, about 9,300 fewer people died due to traffic accidents than those who died of the same cause in 1973. But that is largely because drivers had the skills to drive at 70 mph, so in driving at 55 mph they were overskilled, and accident rates dropped. But as the skills were lost, because of disuse the death rates have climbed to near their 1973 figures.

One should keep the number of auto deaths in perspective. In 1980, 52,411 people died in accidents related to motor vehicles. But that is only 2.72% of the total of 1,927,788 persons dying in the United States from *all* causes (National Safety Council figures). So while cutting auto-related deaths by 10,000 sounds impressive, it means only a 0.52% drop in overall number of U.S. deaths.

RAYMOND KOSTANTY
Wood-Ridge, NJ

HOLOGRAPHIC DISPLAYS

Having just received the June 1983 issue of **Radio-Electronics,** the first thing I did was to read the regular columns, and on reading the editorial (videogames, etc.), I was amazed to find reference to holographic displays. The reason why I was amazed is that I have made arrangements with TI on just such an item. Without going in to construction details, I will state that it is closer than you think, and is compatible with normal color-TV signals, as well as monochromatic material. The display is, of course, solid state, and requires comparatively little power. It is conceivable to get reductions in the power-consumption figures as the learning curve is progressed.

Good thinking on your part even to consider such a device as a possibility.

It is also to be noted that there is a chance of production agreements on the following items also: a method of receiving wide-band signals at zero bandwidth (compatible), and a method of transmitting and receiving wide-band signals at zero bandwidth,

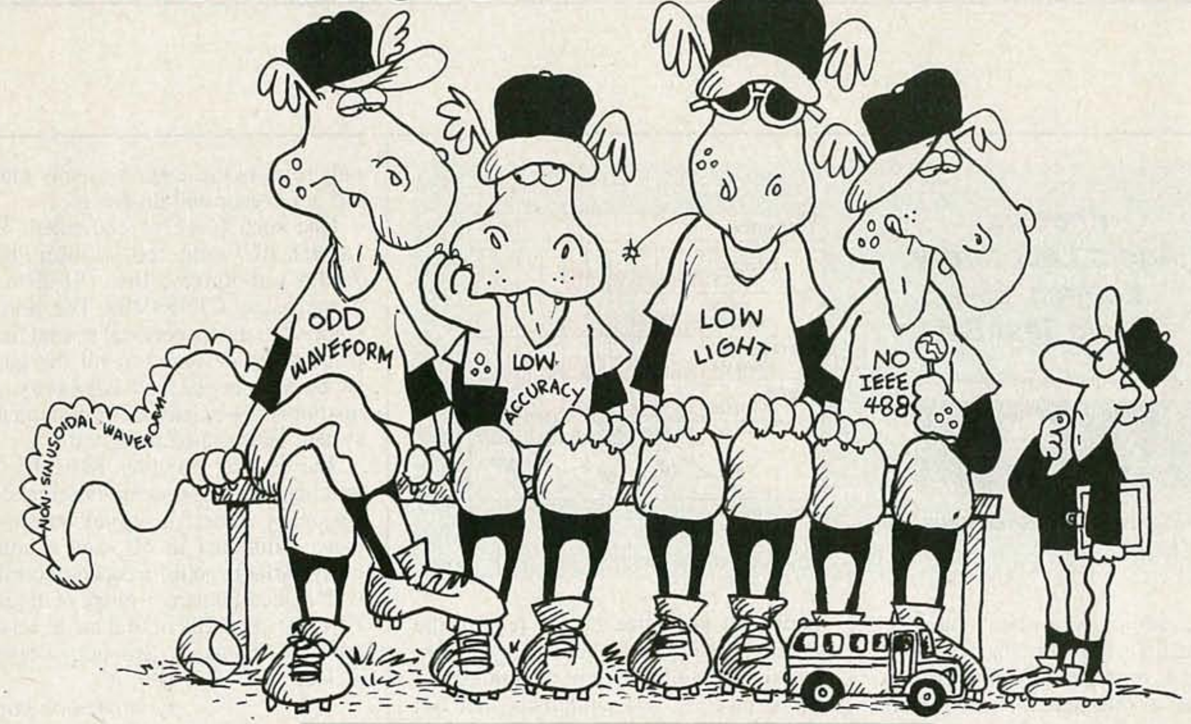
T.E. DEAGLE, Inventor
State Farm, VA

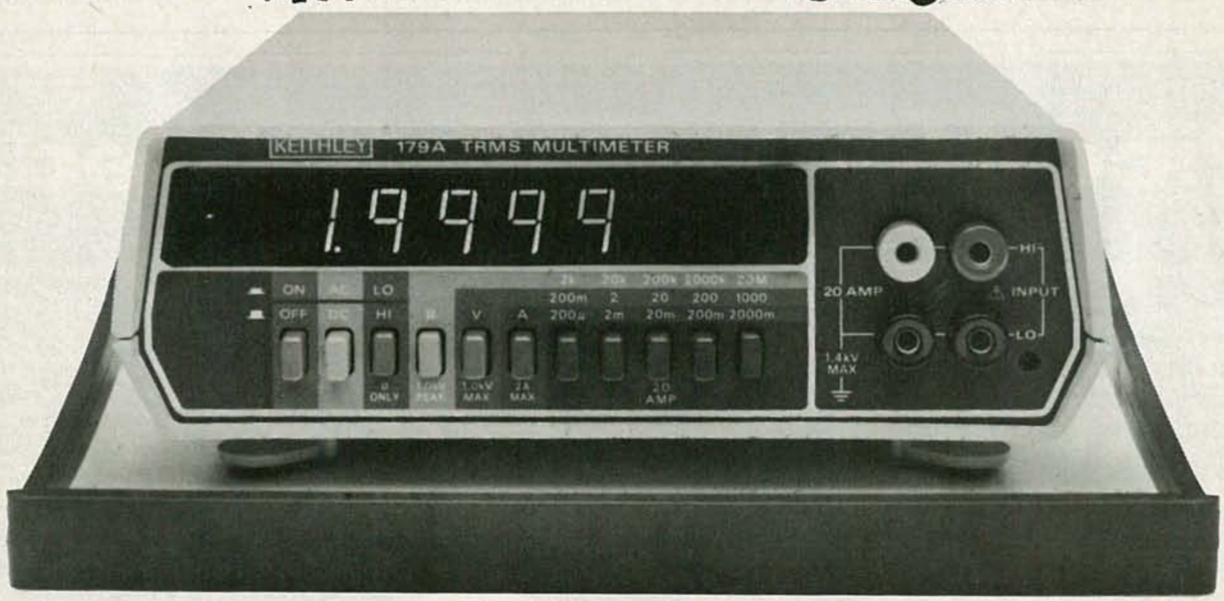
COMMENDATIONS

I wish to commend authors Marc Stern and Herb Friedman on their well-written, very informative articles on computers, hardware, and software in the April 1983 **Radio-Electronics.** That is must reading for anyone wishing to replace his ignorance about this explosive field, and especially so for the first-time computer buyer. I give your special section four stars. **R-E**

WELLINGTON LEE
Chicago, IL

A bench full of dragons and no relief?





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EQUIPMENT REPORTS

Phoenix Audio Laboratory Loftech TS-1 Audio Test Set

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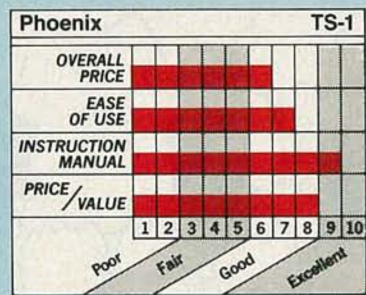

WHEN SERVICING, ALIGNING, OR CALibrating quality audio systems, including such things as professional taping systems or communications gear, there are a great number of tasks that do not require the precision of expensive laboratory-quality test instruments. Often a moderately priced piece of test equipment that has only some of the features usually found in lab-grade gear will do nicely

One such piece of equipment is the Loftech *TS-1* audio test set from Phoenix Audio Laboratory, Inc. (91 Elm ST., Manchester, CT 06040). The unit is a somewhat unconventional test set that appears to be designed to fill the gap between the service and laboratory grade instruments—at least for communication-system and tape-recorder tests.

The test set provides basically three functions: An automatic-ranging digital frequency meter; a digital output-level meter calibrated in dB, and a continuously variable audio-frequency oscillator with a rated frequency range of at least 15 Hz to 30 kHz. The digital meter serves as both the frequency and output-level indicator.

continued on page 32

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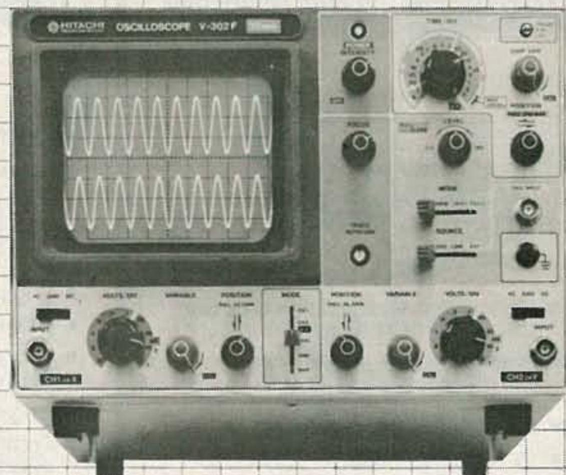

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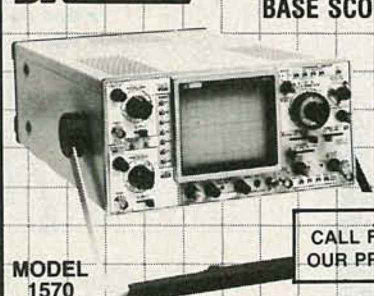

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☐ *I can't afford any more education.*

☐ *I have a family now.*

☐ *I'm here. You're there. I've never learned that way before. I'm not sure it will work for me.*

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Be honest with yourself. Are the reasons really excuses? You already know enough about electronics to be interested in reading this magazine. So why not learn more? If you need encouragement, read on and see how excuses can be turned into results.

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EQUIPMENT REPORTS

continued from page 32

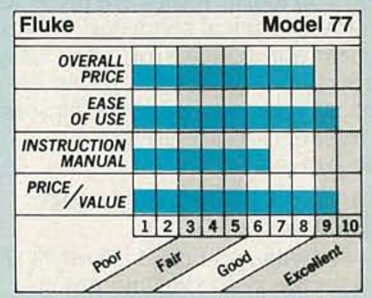
tle tricky because just a light touch on the control knob can produce a substantial shift in frequency. That is typical of just about every kind of signal generator or oscillator with a 1000:1 frequency adjustment, but it does lead to a more serious complaint, the semi-automatic meter-function selection.

To describe the semi-automatic meter switching as inconvenient is an understatement. If there is any question about the oscillator's level or frequency, or it is necessary to readjust either the oscillator's level or frequency, pulling the plug connected to the meter's test leads is not the easiest nor most convenient way to do it. There should be an input/output meter-selector switch on the front panel; a push-switch isn't all that expensive.

But inconveniences notwithstanding, the Loftech *TS-1* can often prove the best low-cost way to do a job easily and with the least fuss. While the test set is not a "full-function" instrument, in most instances it does permit notably quick and accurate frequency checks and adjustments to audio systems, equalizers, and communications lines. Most important, its readings and adjustments can be trusted. It sells for $299.00 **R-E**

Fluke Model 77 DMM

CIRCLE 104 ON FREE INFORMATION CARD



WHEN SHOPPING FOR A PORTABLE DMM there are several things you should look for. Those are reliability, ease of use, and ruggedness; it would also be nice if the unit sold for a reasonable price. We recently had a chance to examine a device that meets all of those criteria; it is the Fluke (PO Box C9090, Everett, WA, 98206) model 77 DMM. In addition, however, that meter is packed with a variety of features, including autoranging, automatic display blanking (to prolong battery life), both digital and analog readouts, and a touch-hold function that locks in a reading on the display. Considering all of that, this is quite an extraordinary instrument; we would like to tell you more about it.

The model 77 is an attractive, compact device. It measures 1.12 × 2.95 × 6.55 inches and weighs 10 ounces. The front panel is simplicity itself, consisting of just the display, a single rotary switch, a RANGE switch (more on that later), and four test lead jacks. The jacks are of the type in which there is no exposed metal; that greatly reduces the chance of an accidental shock. The rotary switch is used to turn the unit on and off, and to select the function desired; the RANGE button is located at the center of that switch.

Specifications

Let's look at the meter's specifications. It will measure DC voltage over five

ranges; those are 320-millivolts and 3.2-, 32-, 320-, and 1000-volts full scale. Claimed sensitivity is 0.1 millivolt (320-millivolt range) and accuracy in the worst case (1000-volt range) is 0.4% + 1 digit. AC voltage is measured over four ranges—3.2-, 32-, 320-, and 750-volts full scale. Sensitivity is claimed to be 1 millivolt, and the accuracy is 2% + 1 digit. AC and DC current is read over three ranges—32-milliamps, 320-milliamps, and 10-amps full scale. The sensitivity is as high as 0.1 milliamp, and the accuracy is between 1.5% + 2 digits to 3% + 2 digits, depending on the range. Finally, resistance is measured over six ranges. Those are 320-, 3200-, 32,000-, and 320,000-ohms, and 3.2- and 32-megohms. Sensitivity is claimed to be 0.1 ohm (320-ohm range), and the accuracy is better than 2% + 1 digit.

There is also a diode-test/continuity-test function. For continuity testing, a tone sounds whenever the measured resistance is less than 150 ohms. For the diode test, the meter displays the measured forward voltage drop (up to 2 volts) and beeps briefly for one diode drop (.7 volts). If a continuous tone sounds, the diode is either reverse biased or open.

If you've been paying attention, you've probably noticed something strange about the ranges we've described. In most 3½-digit DMM's the typical range will be from 0 to 1999 (with appropriate placement of the decimal point). Here, many of the ranges run from 0 to *3200* (again with appropriate placement of the decimal). What that means is that the meter has greater resolution per range. In fact, the resolution rivals that of much more expensive 4½-digit DMM's. As a result, if the measurement is, say, 24.05 volts, that's what you'll see, not 24.0 as would be typical.

Use

It's hard to imagine a DMM that's easier to use than the model 77 To operate, all you have to do is select a function with the rotary switch and perform the test. You don't even need to worry about the polarity of the measurement or zeroing the probes—that is taken care of by the meter. In addition, range selection is not necessary as the unit is an autoranging one. If you wish, the autoranging can be defeated by a touch of the RANGE switch. Pressing that switch repeatedly steps the meter through the ranges, including proper placement of the decimal point. When a range is selected, all further measurements are made on it. To return to autoranging, the rotary switch is turned to another function and then back.

When the unit is first turned on (again with the rotary switch) the meter goes through a quick two-second self-test sequence. During that time all critical functions, the battery, and the display, including all annunciators, are tested. If everything is OK, the meter chirps and you are set to go.

Readout

We've already mentioned one way in which the readout on this meter differs from the norm—its ability to display values greater than 1999. It differs in another way, however, that is even more significant. As nice as DMM's are, there's one thing you can't do with them that you can with an analog meter: peak or null a circuit. The chief reason for that is the slow response time of a typical DMM—often a second or more. That drawback has been nicely done away with in this meter through the inclusion of an analog bargraph display. That display, located at the bottom of the readout, responds almost instantly to any changes in the measured values.

In addition to the above, the readout contains many of the features we've come to expect in modern meters. A full complement of annunciators includes function, range (indicates when the RANGE button has been pressed) polarity, and low battery.

Touch-hold

If you ever have had to make a measurement in a tight area, especially when working with high-voltage or delicate circuitry, you know how critical probe placement can be. The last thing you need is to

have to keep a watch on your meter's readout at the same time. Well, with the model 77 you don't have to. That meter's touch-hold function "captures" a reading and displays it until you have a chance to look at it. That allows you to place all your attention on placing the probes. When you here the meter beep, you know that the reading has been captured by the meter. You can then withdraw the probes and examine the reading at your leisure.

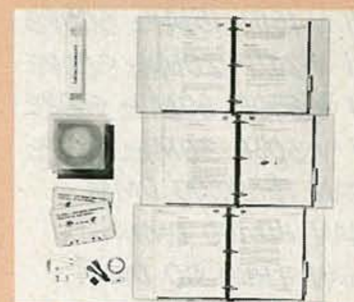
The touch-hold function is activated with the RANGE switch. To turn it on, the RANGE switch is held in as the rotary switch is turned to the desired function. The RANGE annunciator on the readout lets you know that the function has been activated. To deactivate the function, the meter must be turned off.

The meter comes complete with a multipurpose holder. It serves as a shock absorber for rough handling, it holds and stores test leads, it includes a tilt stand, a belt hook for easy carrying, and a neck strap for easy viewing while using the test probes.

The only thing that was the least bit disappointing about the meter was the instruction manual. It offered little more than a brief summary of meter's operation. There's also an operator maintenance section that shows how to test the fuse, perform some simple calibration procedures, replace the fuse and the nine-volt battery that the meter uses for power (estimated battery life is claimed to be two years), and it gives an abbreviated parts list. In all, the manual covers the material it was intended to well, but it would have been nice to see more information for the technically inclined.

The manual aside, this is a really nice piece of equipment. And to top everything off, it sells for $125.00, a reasonable price considering that this meter offers just about every feature one would want in a portable DMM. If you are in the market for a DMM, be sure to keep the model 77 in mind. **R-E**

Heathkit EE3104 Electronics Circuits Course



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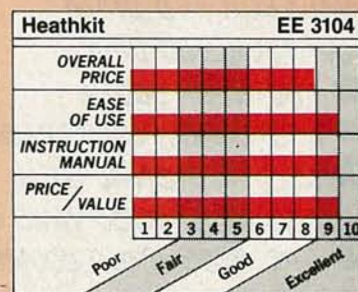

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continued on page 119

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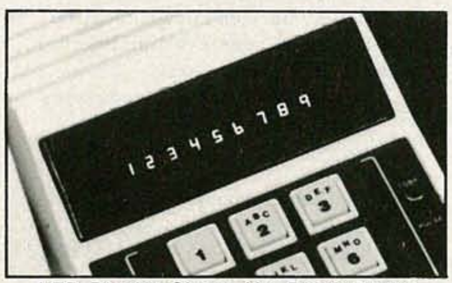

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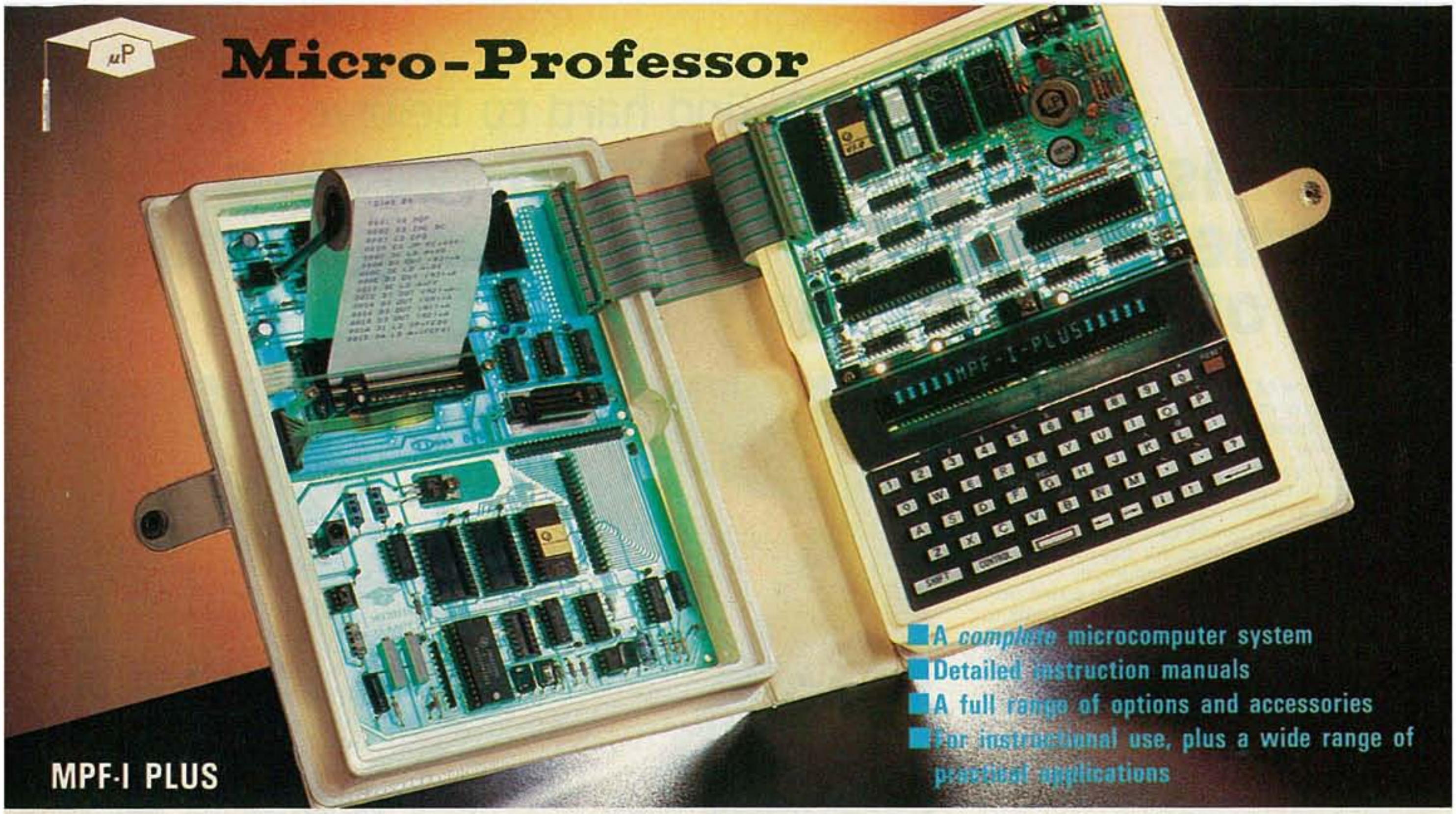

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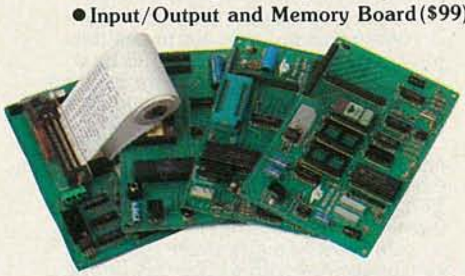

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HI-FI Sound Converter For Your TV

GARY McCLELLAN

You don't have to settle for poor sound quality from your TV set any more. This easy-to-build project will get great sound from any set—and no internal modifications are required!

OVER THE PAST FEW YEARS SOME EXCITing things have happened to TV that have dramatically improved the medium. For example, cable/pay TV has brought quality movies and sports into the home, making your couch "the best seat in the house." Furthermore, television receivers themselves have been undergoing numerous improvements, and picture quality is noticeably better on some of the latest sets. Those improvements are making TV viewing better than ever, and are inducing people to watch TV more often.

Unfortunately, a TV set's sound system is usually its most overlooked area, and that is sad. With the exception of a few of the latest sets, the average TV has a four-inch speaker, a one-watt audio amplifier, and no tone controls. The result is sound quality that's good enough for the news, but that can't do justice to musical programs or feature movies. Combine that low-quality sound with a good picture, and you lose half of your potential viewing pleasure! But don't despair—now you can do something about it!

That's where our TV Sound Converter comes in. It's designed to correct the deficiencies of most TV sound-systems and to improve the sound quality to match that of the picture produced by the best sets. The project features a separate high-quality FM detector; treble and bass tone-controls; a loudness-compensated volume control, and an audio power-amplifier. Connect the TV Sound Converter to a good speaker system, and you'll be amazed at how good TV sound can be!

There are no solder connections or modifications required at the TV receiver. That eliminates a potential shock hazard, and is sure to be appreciated by people who don't want to tear into their TV's. Other features of the converter include a sound input for your videocassette recorder (VCR), so you can improve the sound from that source, too. A muting circuit (which suppresses the between-station noise that you get when you change channels) is also included. And, on top of that, the converter can be used with any TV, whether it's a tube-, transistor-, or IC-type receiver.

The TV Sound Converter is moderately priced and easy to build. To keep the cost to a minimum, a special effort was made to use as many commonly available parts as possible. (Check the ads in **Radio-Electronics.**) Most of the circuitry—three IC's, two power transistors, and an assortment of inexpensive and readily available passive components—is contained on a hand-sized PC board. It cost us about $45 to build, but that figure might be higher if you don't have a well-stocked junkbox. Construction is straightforward and is pretty much limited to stuffing the printed-circuit board with parts, and to connecting the external controls, input jack, and power transformer to the board. One potential area of concern is the three coils used in this project. But don't worry about having to wind them; you can buy them prewound. The only coil winding that you'll have to do is to wind five turns of wire around one of the prewound coils. That's a job that anyone can handle, even someone who's never wound a coil before! So if you are concerned about ease of construction, don't worry—this project is not bad at all!

How it works

There are many ways to improve the sound quality of your TV receiver, and each has its advantages and disadvantages. Let's discuss some of the methods briefly, because it will help you to appreciate the circuitry used here. The cheapest and simplest way to improve the sound is to disconnect the set's internal speaker, and substitute a quality speaker-system. While the cost is low, the drawbacks include impedance-matching problems (many new sets use 32–45 ohm

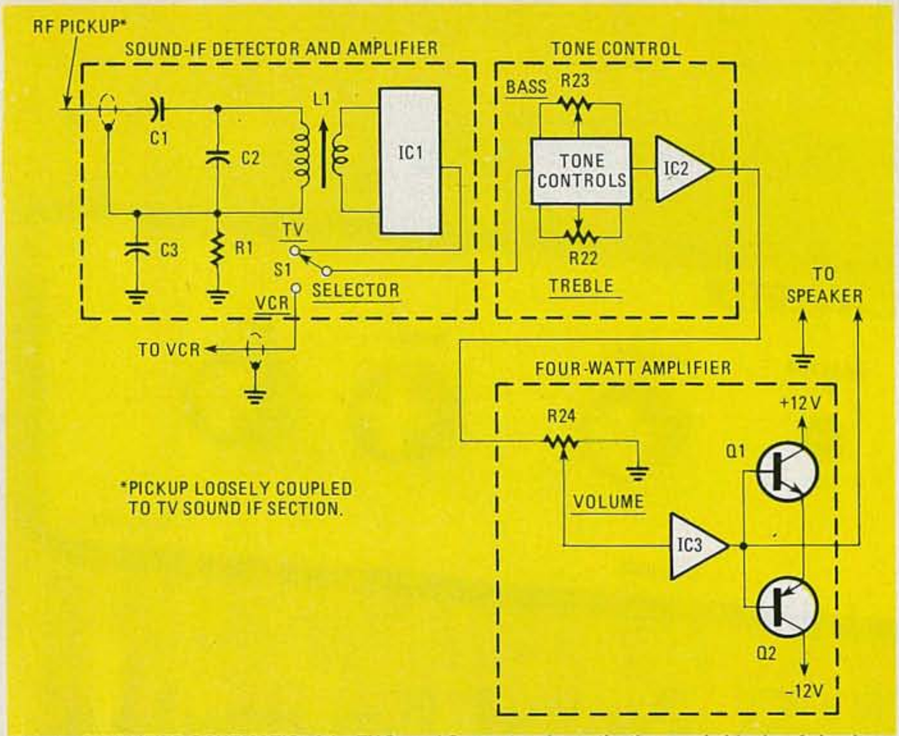


FIG. 1—SIMPLIFIED SCHEMATIC of the TV Sound Converter shows the three main blocks of circuitry: the sound-IF detector/amplifier, the tone-control section, and the audio power-amplifier.

speakers), excessive hum and distortion, and a severe shock hazard. You should know that power transformers have quietly disappeared from recent TV's, and that can make adding an external speaker a dangerous proposition. Another approach is simply to connect an external audio-amplifier across the TV's volume control. That costs more, and it requires modifications to your TV. It will eliminate the other problems mentioned earlier—except for the shock hazard. A serious drawback, however, is that many new TV's use a DC control-voltage to control the volume and, as a result, there is no audio signal at the volume control. That's why that approach is often ruled out.

That leads us to the TV Sound Converter, which uses a different (and better) approach. The device uses a complete sound-IF amplifier plus an audio amplifier to do the job. Careful design results in the best possible sound quality, and the elimination of the shock hazard. While cost might be considered a disadvantage to this method, the build-it-yourself nature of the converter keeps that under control.

The TV Sound Converter contains three "blocks" of circuitry. Figure 1 shows those blocks in a simplified schematic of the converter. The first block is a complete sound-IF amplifier and detector. Its circuitry is preceded by a special input-network made up of C1, C2, C3, L1, and R1. (Switch S1 bypasses this IF amplifier section for VCR inputs.) The combination of C2 and L1 is tuned to the TV-sound frequency (4.5 MHz) and rejects other frequencies that could interfere. The secondary winding of L1 is an impedance-matching device. It provides the IC with the low impedance that it needs to see at its input. Capacitor C3 and resistor R1 are included to provide an RF ground for the input, and to minimize a shock hazard. That is important in case the input cable should somehow short itself to live TV-circuitry. The gain of the circuit is so high that simply placing the input cable *near* the TV-sound section will make it work. No electrical connections are required. In fact, with some TV's, the input cable can be placed on the outside of the rear cover with excellent results!

The second block is the tone-control section. That is nothing more than the usual treble and bass controls, plus an amplifier to make up for losses in that section. Finally, the third block is an four-watt power amplifier. Four watts is more enough power to drive a set of quality speakers to good volume with low distortion.

Now let's look at the circuitry in more detail, referring to the schematic in Fig. 2. The TV sound-IF signal is picked up by a "probe" that is loosely coupled to the sound-IF section of the TV. The signal is fed to the IF IN terminals of the converter. Capacitor C2 and coil L1 are resonant at 4.5 MHz, providing selectivity for the IF amplifier. The IF signal is transformer-coupled into the IF amplifier via pin 1 of IC1. It is amplified by a factor of about 80 dB, and appears at pin 8 of the IC. Coil L2 reduces the signal level to about 150 millivolts, which is necessary for proper muting-circuit operation. The 150-millivolt signal appears at pin 9 of IC1 and goes to two places.

First, it drives a quadrature-type detector contained inside the IC. That works in conjunction with C9, L3, and R3 to produce a demodulated audio signal. That signal goes to an internal amplifier, and ultimately to pin 6, the output of IC1.

At the same time, the signal from pin 9 drives an internal level-detector circuit that generates the muting function. The output of the level detector appears at pin 12 of IC1. The output is divided by R4, R5, and R6, and filtered by C12. Potentiometer R5 sets the muting threshold. The voltage applied to pin 5 of IC1 controls an amplifier inside the IC that switches audio to pin 6 when there is a signal of sufficient strength present. Finally, the detected audio appears at pin 6 of IC1. A simple de-emphasis network made up of C13 and R7 restores its proper-high frequency response. The audio appears at the AF OUT terminals and goes to a switch, S1, that determines whether the rest of the circuit (the tone-control and amplifier blocks) will act on that audio or the audio from your VCR.

The tone-control section consists of a standard bass and treble network and an amplifier. Audio coming from S1 (the switch that selects IC1 or the VCR as the signal source) is applied to the AF IN terminals. A simple bass-control circuit made up of C15, C16, R9, R10, and R23 boosts or cuts the bass frequencies. The treble frequencies are handled by a simple boost/cut circuit made up of C17, C18, and R22. Resistor R11 is included to minimize interaction between the bass and treble controls. The signal output from the tone controls is taken from the slider of the TREBLE potentiometer, and drives op-amp IC2. That device is a simple non-inverting amplifier with a gain of 50—enough to overcome the losses that take place in the tone-control circuitry. The amplified signal from IC2 drives an external volume control, which features loudness compensation (bass frequencies are boosted and the treble reduced slightly at low volume-levels) to improve the audio quality. The loudness compensation-circuit is made up of C29 and R25, which are connected to a tap on the volume control.

From that point, the audio signal goes to IC3, an LM377 two-watt audio amplifier IC. That's a rather unusual application for that IC, which is intended for lower-power applications. The circuit was abstracted from the 1980 edition of the National Semiconductor *Audio Handbook*. The output of the IC drives the speaker through R20. At low levels (below about 100 mW) the IC provides all power. But as the output rises, the voltage drop across R20 also rises, and that causes transistors Q1 and Q2 to turn on. They act as emitter followers and boost the power level. As a result, it is possible to get more than four watts of power from a two-watt IC. The technique is simple, low cost, and effective. Resistors R17 and R18 set the gain of the circuit, while

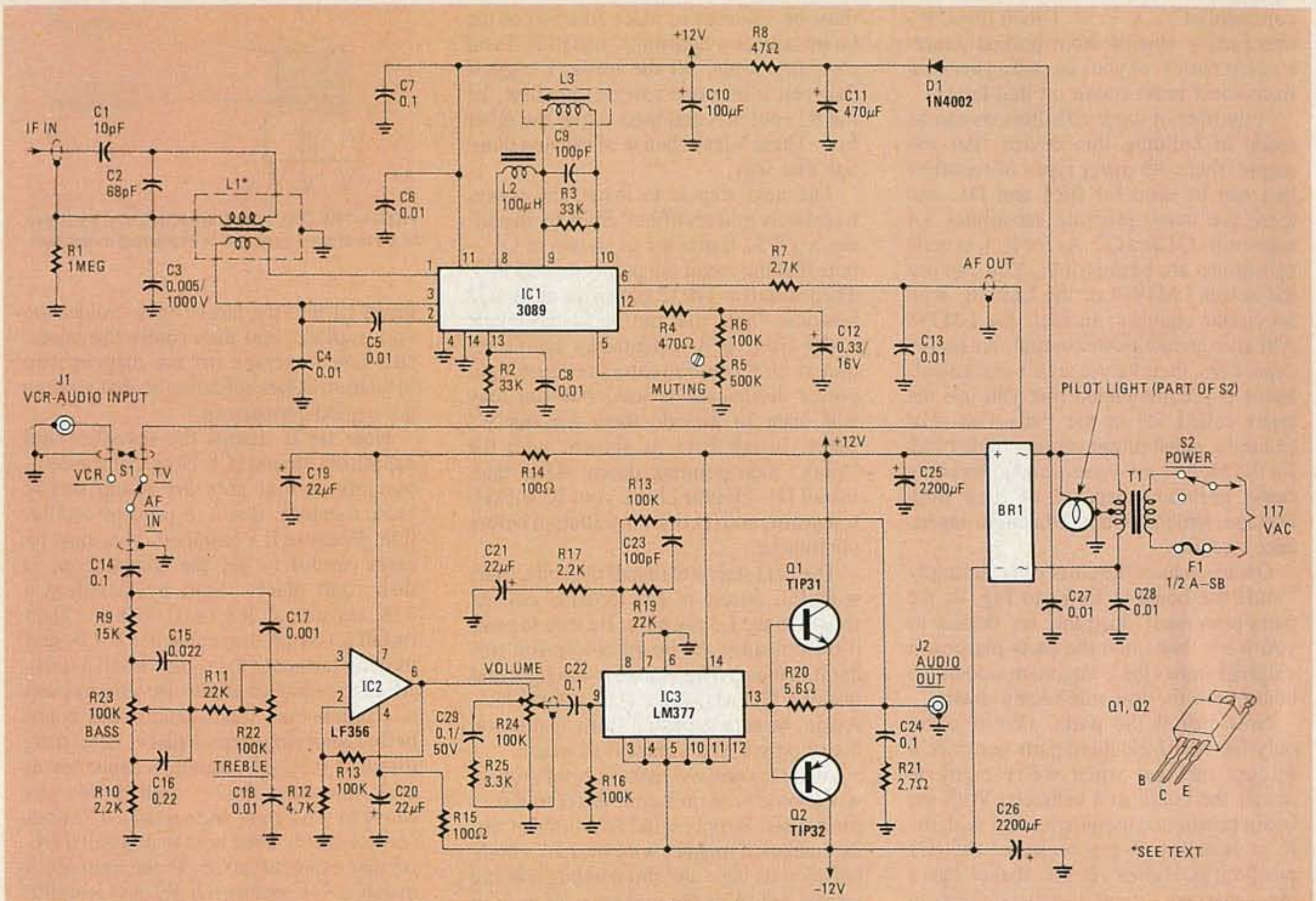


FIG. 2—THE PILOT LIGHT SHOWN is optional. It was part of the power switch (S2) used by the author. Note that R18 (connected between C23 and R19) is incorrectly labelled R13.

C21, C23, and R19 shape the frequency response.

All that's left are the power supplies (+12 and −12 volts). The amplifier section uses a conventional ± 12-volt supply, made up of T1, BR1, C25, and C26. The IF section has its own 12-volt power supply: D1, C11, C10, and R8. A separate supply is needed for that section because it was found that powering it from the same supply used by the amplifier generated noticeable hum.

Construction

The first step in building the TV Sound Converter is to obtain or make a PC board. You can make your own board—the full-size foil pattern is shown in Fig. 3. A pre-etched and drilled board is available (from the supplier indicated in the Parts List). Whichever you choose, you should note that, because of the high sensitivity of the IF amplifier, a PC board is a necessity for this project. If you try to breadboard the device, the chances are that it will oscillate and do other strange things. Play it safe and use a PC board!

Once you have a board, the next step is to obtain the parts. Generally, they should be available from many sources. As for the Miller coils, they should be available from larger parts-distributors. Shields are required for those coils—you can use

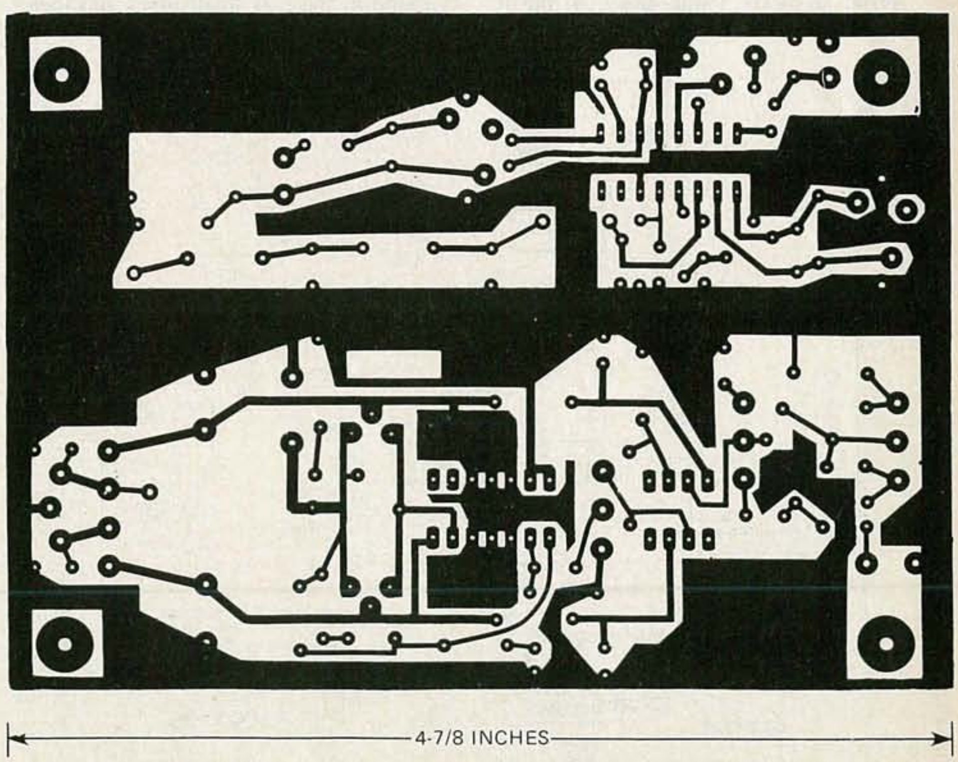


FIG. 3—YOU MUST USE A PC board for the converter. If you don't, the chances are that the circuit will oscillate.

commercial ½ × ½ × 1-inch ones, IF-transformer shields from junked American car radios, or you can make your own from sheet brass (more on that later).

A number of parts substitutions can be made in building this device. For example, there are many types of rectifiers that can be used for BR1 and D1, and there are many possible substitutes for transistors Q1 and Q2. As for IC3, several substitutes are permissible: You can use the newer LM1877 or the LM378, with no circuit changes. In fact, the LM378 will give greater power output. As for the capacitors, their values aren't too critical, but it is recommended that you use the types called for in the Parts List. For example, substituting ceramic-disc types for the Mylar tone-control capacitors may cause problems because of their high leakage, which can upset the high-impedance circuitry.

Once you have the parts you can simply "stuff the board." Refer to Fig. 4, the parts-placement diagram, for details as you work. Note that the parts-placement diagram shows the component side of the board with the foil side facing down.

Now install the parts. (We'll cover only the board-mounted parts here; we'll discuss the rest when we're ready to mount the board in a cabinet.) With the board positioned as shown, start with the IC's: Install a 16-pin socket at the IC1 position as shown. If the socket has a pin-1 marking, orient it so that it points to your right. Then go to the IC2 position and install an 8-pin socket. Be sure to orient any pin-1 marking as shown. Do not install either IC1 or IC2 until you are told to do so. Move on to IC3. *Do not* install a socket at this position; the IC must be soldered in place (the foil of the board acts as a heatsink). Install IC3 and carefully solder all the leads. I suggest that you solder one row of pins first, let the IC cool off, and then solder the other row. There's less chance of causing damage that way.

The next step is to install the power transistors and rectifiers. Start by installing a TIP31 transistor as shown at Q1—note that the metal tab points toward IC3. Then install a TIP32 transistor at the Q2 position—note that the metal tab points *away* from IC3. (Heatsinks aren't required on those transistors because their power dissipation is low, but you may still want to include them for safety's sake). Install BR1 as shown, with the "plus" side pointing down. After that, install D1. Double check your IC socket, transistor, and rectifier installation before continuing.

The next step is to install the coils. Start with L3. Insert a 23A155RPC coil as shown in the L3 position. Be sure to push it flush against the board before you solder it in place. Then move to the right and install a 100 μH choke (L2) against IC1. Again, be sure to push it flush against the board before you solder it in place.

At this point we make a brief stop to wind some wire on a coil. Refer to Fig. 5 for details. Simply wind five turns of no. 28 enameled magnet wire over L1's body between its base and the windings, being careful not to let the magnet wire overlap the existing winding. Then twist the free ends of the new winding once to hold them in place. Now refer back to Fig. 4. You are going to install the coil at the L1 position. Insert the wires of the coil you wound in the two small holes and then

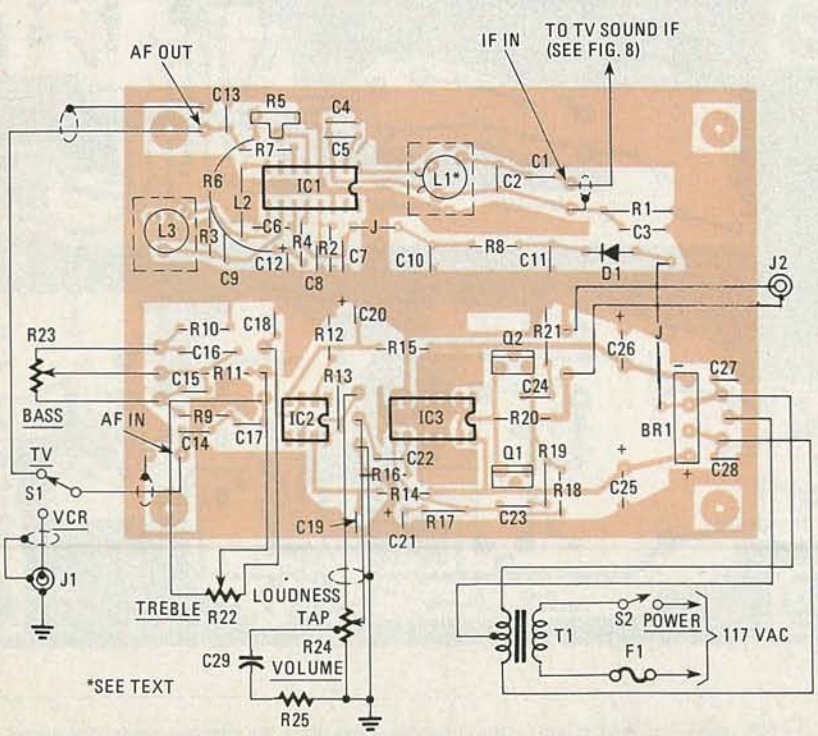


FIG. 4—PARTS-PLACEMENT DIAGRAM. Both on-board and off-board connections are shown.

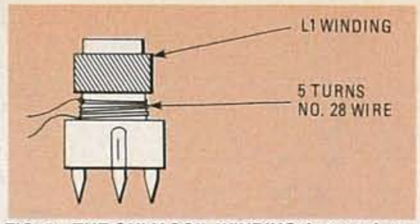


FIG. 5—THE ONLY COIL WINDING that you have to do is shown here and is explained in the text.

insert L1 into the larger ones. Solder the coil in place, and then solder the wires. (Be sure to scrape off the magnet-wire insulation before soldering so that you can get a good connection.)

Now we'll install the resistors and capacitors around IC1. Note that the components in that area are intentionally close together; that's to prevent oscillation. Because it's cramped, you must be extra careful to get the components in their right places. Start by installing a 33K resistor at R3 (next to L3). Then install a 100-pF disc capacitor at C9, and moving farther to the right, install a 0.01-μF disc capacitor at C6. Be sure to push all components flush against the board before soldering them in place. After that, install a 0.33-μF tantalum capacitor at C12; note that the + sign points up. Move to your right and install a 470-ohm resistor at R4. Then next to it install 0.01-μF disc capacitor at C8. To the right of C8 install a 33K resistor at R2 and install a 0.1-μF disc capacitor at C7. Finish up work in this area by installing a wire jumper at "J." A piece of leftover resistor-lead will work fine. Now, stop and examine your work, and correct any mistakes you may find before going on.

Continuing with the IC1 components, install a 0.01-μF disc capacitor at C13 and a 2.7K resistor at R7. Next to it, at R5, install a 500,000-ohm trimmer potentiometer. Move to the right and install 0.01-μF disc capacitors at C4 and C5. Finish up the circuitry around IC1 by installing a 100,000-ohm resistor at R6 as shown. Note that R6 is installed about an inch over the top of the IC. Place short lengths of insulated tubing over the leads and then install them in the places shown. That takes care of IC1; on to the less-critical circuitry!

The remaining resistors are installed next, starting at the left-hand side of the board and working toward the right. Begin by installing a 2.2K resistor at R10 and a 22K resistor below it at R11. Move down a bit and install a 15K resistor at R9 and then jump over to IC2 and install a 4,700 ohm resistor at R12, and a 100K resistor at R13. After that, install a 100-ohm resistor at R15, above IC3. On the other side of IC3 install a 100K resistor at R16 and, next to it, install a 100-ohm resistor at R14. After that, install a 2.2K resistor at R17. Move up to the center of the board and install a 47-ohm resistor at R8. Move up still farther and install a

1 megohm, ½-watt resistor at R1 and a 2.7-ohm resistor at R21. Note that it may be necessary to pre-form the leads before installation; the holes are spaced widely apart. Continue by installing a 5.6-ohm resistor at R20. If you can't find the half-watt (R20) resistor, simply use two 10-ohm, ¼-watt resistors in parallel. Move down and install a 22K resistor at R19, next to Q1. Finish up the resistors (finally!) by installing a 100K resistor at R18 as shown. Check your resistor installation carefully before continuing and correct any mistakes now before you forget about them.

Install the capacitors next. Again, work from left to right. Install a 0.22-μF Mylar capacitor at C16 and a 0.022-μF Mylar at C15. After that install a 0.1-μF Mylar capacitor at C14, and a 0.001-μF Mylar at C17. (Incidentally, a good source of those capacitors is junked imported radios and other similar equipment.) Continue by installing a 0.01-μF Mylar capacitor at C18. Now for a few electrolytics—watch the polarities any time you install electrolytics! Install 22-μF electrolytics at C19, C20, and C21. After that, install a 0.1-μF Mylar capacitor at C22, next to IC3. Moving up, install a 100-μF electrolytic at C11. Make sure the capacitors are installed properly before continuing.

Now install a 68-pF disc capacitor at C2, and a 10-pF disc capacitor at C1. Moving on, install a 0.005-μF, 1-kV disc capacitor at C3. After that, install 2200-μF capacitors at C26 and C25. Make sure those capacitors are installed properly before continuing. Then install a 0.1-μF Mylar capacitor at C24 and a 100-pF disc at C23 (at the lower edge of the board.) Finish up the capacitor installation with 0.01-μF discs at C27 and C28, next to BR1. Check your work and correct any errors before you continue.

All that's left to do on the board is to install a jumper and the coil shields. The jumper comes first. Cut a 2-inch piece of insulated hookup wire, strip the ends, and connect it at the holes near BR1 and D1.

Before you install the coil shields, wrap pieces of plastic electrical tape over the terminals of L1 and L3. That helps to prevent shorts. Then snap the coil shields into place and solder them to the board.

If you don't have access to commercial shields, or to a junked American-made car radio for the shields from its IF transformers, you can make them yourself. Here's how: Cut a strip of sheet brass (available from hobby shops) into two 1¾ × 1-inch pieces. Then roll each strip into two ½-inch (diameter) by 1-inch (high) cylinders. Solder the edges to keep the metal in place. Then solder pieces of solid wire to the edges of the cylinders. Those are the mounting terminals. Insert your new coil shields into the board and solder them in place. That completes the construction of the board. And if you're done things correctly, the completed board should look like that shown in Fig. 6.

PARTS LIST

All resistors ¼-watt, 5% unless otherwise specified
R1—1 megohm, ½ watt
R2, R3—33,000 ohms
R4—470 ohms
R5—500,000 ohms, trimmer potentiometer
R6, R13, R16, R18—100,000 ohms
R7—2700 ohms
R8—47 ohms
R9—15,000 ohms
R10, R17—2200 ohms
R11, R19—22,000 ohms
R12—4700 ohms
R14, R15—100 ohms
R20—5.6 ohms, ½ watt (see text)
R21—2.7 ohms
R22, R23—100,000 ohms, potentiometer, audio-taper
R24—100,000 ohms, potentiometer, audio-taper with loudness tap (Radio Shack 271-1723 or equivalent)
R25—3300 ohms

Capacitors
C1—10 pF, 1000 volts, ceramic disc
C2—68 pF, 1000 volts, ceramic disc
C3—0.005 μF, 1000 volts, ceramic disc
C4, C5, C6, C8, C13, C27, C28—0.01 μF, 50 volts, ceramic disc
C7—0.1 μF, 16 volts, ceramic disc
C9, C23—100 pF, 1000 volts, ceramic disc
C10—100 μF, 16 volts, radial-lead electrolytic
C11—470 μF, 16 volts, radial-lead electrolytic
C12—0.33 μF, 16 volt, tantalum
C14, C22, C24, C29—0.1 μF, 50 volts, Mylar
C15—0.22 μF, 50 volts, Mylar
C16—0.22 μF, 50 volts, Mylar
C17—0.001 μF, 50 volts, Mylar
C18—0.01 μF, 50 volts, Mylar
C19, C20, C21—22 μF, 16 volts, radial-lead electrolytic
C25, C26—2200 μF, 16 volts, radial-lead electrolytic

Semiconductors
IC1—LM3089 FM receiver IF system
IC2—LF356N monolithic JFET op-amp or TL081 general purpose BIFET op-amp
IC3—LM377 dual 2 watt audio amplifier or LM1877 dual audio-power amplifier
Q1—TIP31 NPN power transistor
Q2—TIP32 PNP power transistor
D1—1N4002
BR1—full-wave bridge rectifier, 1 amp, 50 volts
T1—18 volts, 2 amps, center tapped
L1, L3—10-19 μH adjustable coils, J.W. Miller 23A155RPC
L2—100 μH RF choke, J.W. Miller 9210-76
F1—½ amp slow-blow fuse
J1—RCA phono jack
J2—Two-contact connector
S1—SPST toggle switch
S2—SPST power switch (with optional 16-volt pilot lamp)

Miscellaneous: 5 feet RG-174 coaxial cable, 6 inches no. 28 enameled wire, one 16-pin IC socket, one 8-pin IC socket, coil shields, cabinet, hardware, 3 knobs, AC line cord with plug, fuse holder, etc.

The following is available from Mendakota Products, PO BOX 20 HC, Orangehurst, Fullerton, CA. 92633: AUD-1 printed-circuit board, $12.00. California residents add 6% sales tax. Non-USA residents include an additional $3.50 for first-class postage and handling. Coils L1-L3 can be ordered from: Circuit Specialists, Box 3047, Scottsdale, AZ 85257. Price is $7.95 postpaid; please specify J.W. Miller part numbers when ordering; Arizona residents add 4% sales tax.

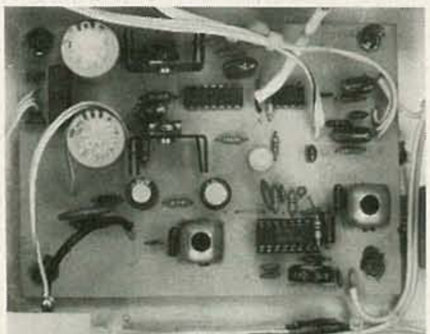


FIG. 6—THE ONLY CRAMPED AREA on the board is around IC1. That is intentional; it prevents unwanted oscillation.

Installing the converter

The next phase of construction is to install the board in a cabinet, and to wire the controls and power transformer to it. Let's start by discussing the cabinet. The converter is designed to be installed in almost any type of cabinet, plastic or metal. So, if you have a particular type of cabinet in mind, and there is room for the parts, go ahead and use it. In fact, you may even be able to mount the board inside your TV receiver and dispense with the cabinet entirely! However, if you decide to install the board inside the TV, remember to mount it well away from any heat-producing circuitry, and away from the TV's horizontal-output stage. The latter can introduce a buzz into your audio if the board is too close to it.

We built our version in the cabinet of a discarded UHF converter; the chassis and front panel came from an old aluminum chassis-box. All that was required was a little work to make the cabinet components presentable, and the cost was zero. No doubt you can find a suitable cabinet if you raid your junkbox or shop around a bit.

Once you have a cabinet, you can drill all the mounting holes for the parts. The photograph shown in Fig. 7 should give you an idea of where to place them. The board itself is mounted on the bottom of the cabinet using ¼-inch spacers. Drill the holes, clean up the cabinet, and paint

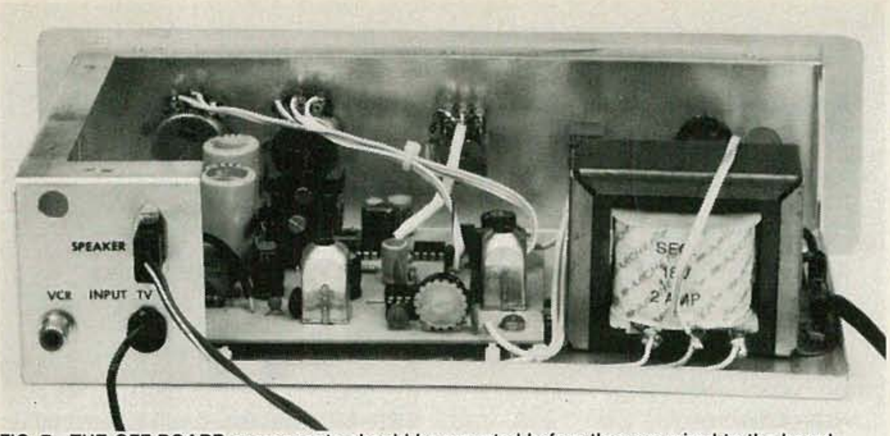


FIG. 7—THE OFF-BOARD components should be mounted before they are wired to the board.

it if necessary. Label the controls with the press-on letters that are available from many electronics supply houses and art-supply stores. Then install the controls, connectors, and the power transformer. By this time you are ready for the final wiring.

All that is left to do is to connect the cabinet-mounted components to the board. Refer again to Fig. 4, the parts-placement diagram, for details. Start by stripping both ends of a 3-foot piece of RG-174 coax cable as shown in Fig. 8. Separate the shield braid on one end and twist it to form a separate lead. That end will be connected to the board shortly. As for the other end, strip off 1 inch of the insulation, but leave the center conductor untouched. Then cut the shield braid all of the way back to the insulation. Place a piece of ¼-inch heat-shrink tubing over the cable, positioning it so that it overlaps both the end of the center conductor and the braid, and then shrink it in place. That end of the cable is the RF pickup for the converter. It will be placed near the sound-IF section of your TV. Refer to Fig. 4 for the remaining connections. Connect the other end of the RG-174 cable to the IF pads on the board. Note that the shield goes to the pad that connects to C3/R1.

Now for some other shielded-cable connections. Conventional microphone cable can be used for those. Cut two short lengths (about 6 inches), and strip one end of each cable. Install one cable at the AF OUT (the output of the sound-IF detectors) connections, and the other at the AF IN pads. Cut another short length (about 6 inches) of dual-conductor shielded cable for the volume control. Note that if you don't have such cable, two pieces of regular, single-conductor shielded cable will do fine. Strip one end and connect it to the VOLUME pads as shown. That takes care of the shielded-cable connections.

The remaining connections can be made with conventional hookup-wire or ribbon cable. We used ribbon cable for a neater appearance. Start with the bass and treble controls. Cut short lengths of wire and install them as shown. If you used hookup wire, twist the bass-control wires together, and the treble-control wires together, so that they won't be confused. Then continue with the speaker leads. Cut two short lengths of wire, and install them as shown. Finally, cut three short lengths of wire for the power transformer, and install them as indicated in Fig. 4. That takes care of the board cable connections. Install the board in your cabinet and get ready to complete the wiring.

We still have to wire the POWER switch, S1. Route the cables to the switch, cut them to size, and connect them to the switch. Then connect J1. The shell of that jack is the only part of the converter circuit connected to ground that goes to the "outside world." Be absolutely certain that it does not come into contact with the TV set's chassis! (That also means that, if you are using a metal enclosure, that the jack should make good electrical contact with that enclosure.) Make the cable ground connections exactly as shown—that will minimize hum pickup.

The controls come next. Start with the bass control. Route the wires from the board over to the control and cut them to size. Connect the wires to the control as indicated. After that, connect the treble control in the same manner. The volume control (with the loudness tap) comes next. But first, install the loudness components. Connect a 33K resistor in series with an 0.1 μF capacitor and wire them to the volume control as shown in Fig. 4. Route the volume cable over to the control, cut it to size, and connect as has been indicated.

The next step is to connect the speaker wires. When routing them to J2, be sure to position them well away from the bass and treble cables. After that, connect the power transfomer. Connect the wires to T1 as shown, after routing them well away from all other wires. If your power switch has a built-in pilot light, connect it now: otherwise disregard that step. Finally, wire up F1 and S2. With that you have finished assembly, except for installing IC1 and IC2. You can do that after you have applied power to the board and verified that the proper supply-voltages are present at the IC sockets—+12 volts at pin 11 of IC1, and pin 7 of IC2, and −12 volts at pin 4 of IC2. (There should also be +12 volts at pin 14 of IC3 and −12 volts at pins 3–5 and pins 10–12 of IC3.)

Adjustments

One of the nice features of this device is that, although adjustments are required, no test equipment is necessary to make them. All you need is a TV receiver in good condition, and a plastic hex alignment-tool.

Start by presetting the adjustable components and checking the operation of the unit. Set the slugs of L1 and L3 to mid position. Then turn potentiomenter R5 fully clockwise. Connect a speaker, and apply power to the board. Set S1 to its VCR position, and connect a tuner or other high-output-level device to J1. At this point, the project should perform like any other high quality audio amplifier. If not, check your wiring, and correct any errors. Set S1 to the TV position. You should hear a roar of noise. If not, turn the potentiometer in the other direction. If you then hear the roar, you've wired the control backwards. Reverse the wiring (if necessary) and you are ready to try the converter with your TV.

Modern TV's can pose a serious shock hazard when operated with the back cover removed. Do not touch any components while the set is plugged in.

Remove the rear cover of your TV, and locate the sound section. Often that circuitry will be identified by a module or tube placement, or by a sticker inside the set. Once you have found the sound section, connect the power to the set and turn it on. Tune in a strong station and adjust the fine tuning for the best sound quality. Place the RG-174 cable from the converter near the sound-IF tube, transistor, or sound-detector IC. With some IC-type sets you can jam the pickup lead directly into the sound coil for a strong signal. You should now hear weak sound or per-

continued on page 100

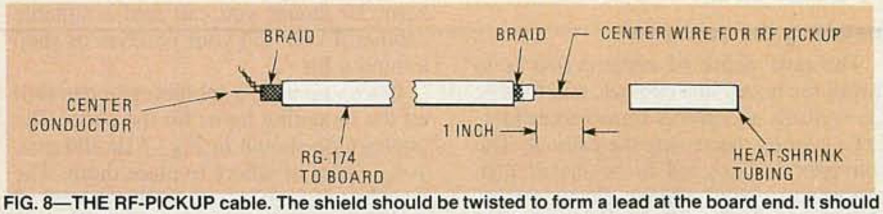


FIG. 8—THE RF-PICKUP cable. The shield should be twisted to form a lead at the board end. It should be cut off at the other end, and the center conductor and a bit of the braid and outer insulation covered with heat-shrink tubing.

INNOVATIONS IN ELECTRONICS

Gee-whiz products from tomorrow that you can buy today—all possible thanks to the wonders of modern electronics

WARREN ROY

ELECTRONICS! THE WONDERFUL WORLD OF ELECTRONICS! IT seems to be behind evey new product to brighten our life. Some of these products are truly significant. Others are conveniences, and still another group are just fun. But all are exciting to those of us in the know; those who can understand and appreciate what the product really does, how it does it, and why that makes it innovative.

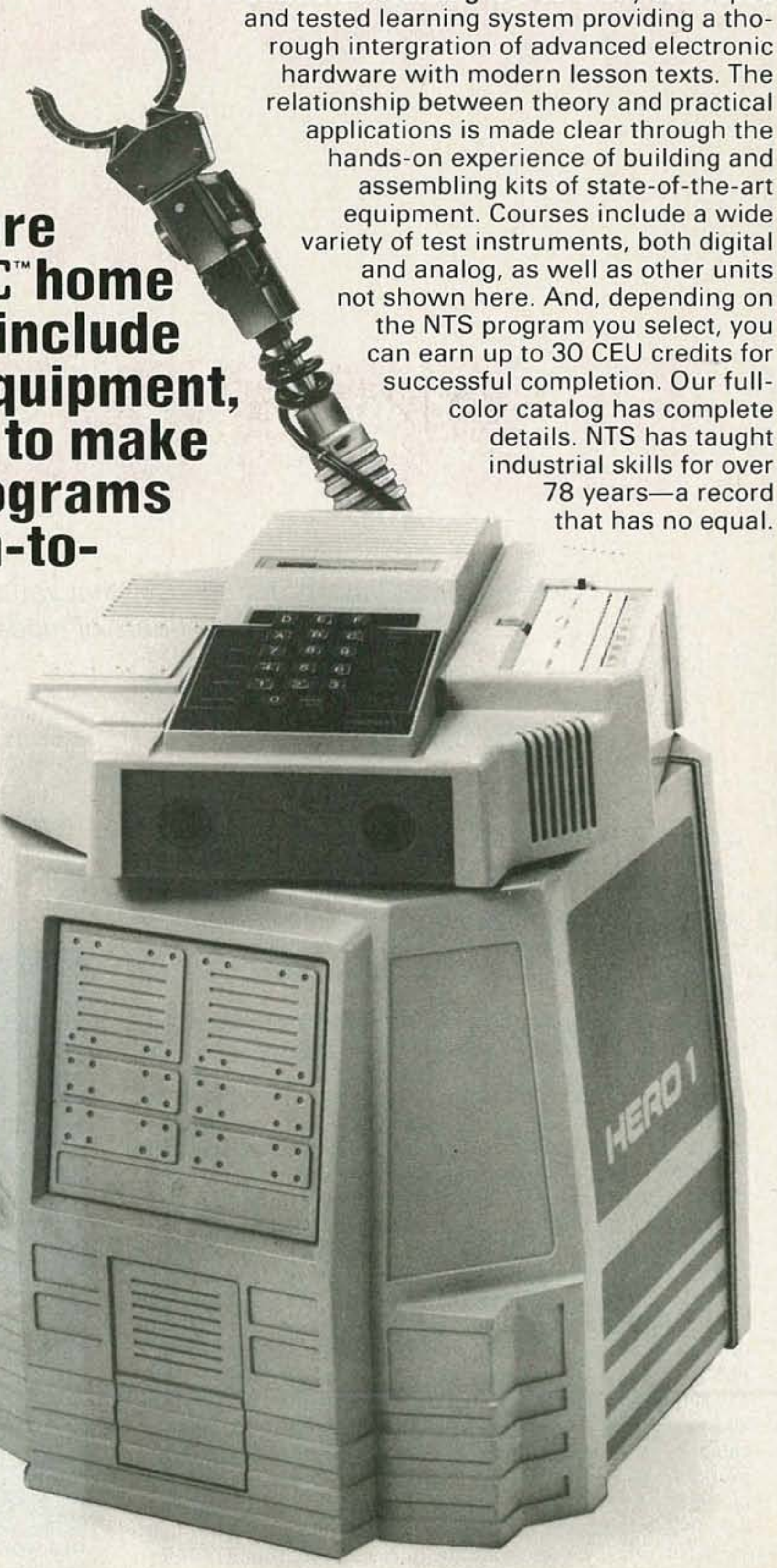
As we have all seen, the price tag of a new automobile has moved from $2,000 to $10,000. In the same period of time the price of a small computer has dropped from several thousands of dollars to less than $800 for a complete system with plenty of memory and a disk drive. That is the kind of movement electronics has made possible, and the kind of excitement that electronics generates in all of our lives. In a time of rising prices, the the features of modern electronics continues to drop and only technological development has made that possible.

The idea behind this article comes from the dozens of electronics catalogs filling our mailboxes—each one crammed with the latest examples of products delivered thanks to electronic technology. The editors of **Radio-Electronics** asked me to look through those pages, select examples of the technology and present a variety of selections for you, our readers. That's what any author would consider a fun asignment—pick what you like and write about it. And so I have. You may not agree with my choices or with my reasons behind my selections. I may have overlooked a significant item. I picked the items I liked—that doesn't mean that they are the best selling, or the most innovative. It does mean that when I looked, these were the items that stood out. OK. Now you know the rules. Let's find out if my idea of electronics innovations—1984, is the same as yours.

Robots, ROBOTS, robots

If you've ever wanted to know what it felt like to control the robot arm that inserts and removes radioactive fuel rods into and out of the core of a nuclear reactor, here's an easy way to find out. A Japanese firm, called Armatron, has devised a working replica of an industrial robot arm. It's designed to work just like the ones used in ultra-modern factories and laboratories. Quoting right from the *Sharper Image* catalog offering this device gives a bit

THIS WORKING REPLICA of an industrial-robot arm is manufactured by Armatron, a Japanese firm. It is available in this country from sharper image.


HERO 1

THE SOPHISTICATED HERO ROBOT from Heath is available both in kit form and fully assembled.

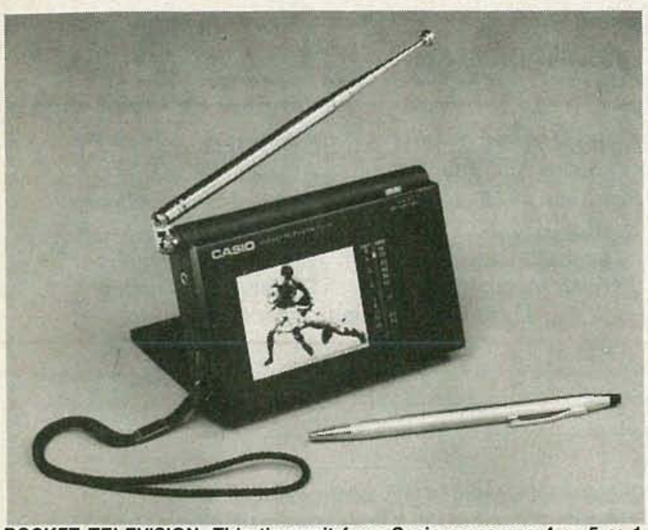
more information on what it will do. "Drop an olive in your martini, play a game of robot chess, pass hors d'oeuvres to startled party guests." The unit comes with a variety of accessories that let you practice and polish your skills. It's made of high-impact plastic, weighs 2½ pounds and measures 6×9×8 inches. The arm assembly is 15½ inches long and the non-slip gripper jaws open to 2 inches.

At a more sophisticated level is *Hero*, the now-famous robot produced by the Heath company as both a kit and an assembled ready-to-go-to-work robot. *Hero* is a complete, mobile, machine with its own on-board computer, a voice, and lots of other goodies. I'm in the process of assembling a *Hero* of my own and that's become a challange in itself. About 15 more hours of work and I'll be ready to switch it on and start enjoying the jobs I have scheduled for it.

By the way, robots aren't new to regular readers of **Radio-Electronics;** we showed you how you could build your own, in a series of articles that started in the August 1980 issue.

Television—always something new

Radio-Electronics first told you about a portable flat-screen TV more than two years ago. It was a cover story on the October 1981 issue. It was the announcement, at that time, that Sincalir had shown a flat-screen TV receiver. And today, if you have $300 to spare, you can buy one for yourself. It's the Casio large-screen (large for a portable set) liquid-crystal display, flat, pocket-size



POCKET TELEVISION. This tiny unit from Casio measures 4 × 5 × 1 inches and features a 2¾-inch LCD "screen."

TV. The LCD screen delivers a great picture on the 2¾-inch screen and the entire set measures a miniature 4 × 5 inches and is just about 1 inch thick. All the features you might expect are built right in, a high-performance VHF-UHF tuner, a speaker, of course, and a 4-way power system that guarantees complete portability. Also, an external antenna terminal is included for use when its convenient for you to stay in one place. As it says in the *Markline* catalog listing this set "It's the TV of the future for people who need information and entertainment to go!"

OK, you want a portable set; but you want color, too. Then your choice in TV receivers might be the Panasonic *CT-3311* Micro Color TV. It measures a mere 2.6 inches diagonally, weighs only 3.3 pounds and cost a few pennies under $500.

THIS SMALL COLOR PORTABLE from Panasonic has no channel selector dial. Instead, it features an electronic auto-search tuner.

There's no tuning dial to turn either, thanks to the electronic magic of Auto-Search. At the press of a button, the electronic tuner searches for the channel you want—UHF or VHF—finds it, and locks it in. The receiver is also handy as a portable monitor for your video camera.

I know you've already heard of Seiko's wristwatch TV and I have deliberately not included it here. Since you can't go out and buy one today it doesn't fit into the scope of this article. But how about being able to turn on your TV by pushing a button on your digital wristwatch? No! we're not kidding. That product is available right now for only $69.95. Of course, since what pushing that watch button does is to active a remote module, you can also control any electically-powered device up to 300 watts. And since there are two channels you can control two different devices in the same room. It's an infra-red remote control, so the signals are kept within the one room and as a result you can have additional "watch-controlled" devices all over your home.

Talking about watches

The modern digital watch is an amazing phenonomon. They come in every variety you can imagaine; some that you can't imagine and some that you can't figure out why they bothered to make in the first place. Calculator watches are one example of unusual watches. I find that all those little pushbuttons on the front are a pain. It's bad enough that they are so tiny that if you don't have little fingers (I don't) you can't use them, but the buttons take up so much room that the average calculator watch is big, ugly and cumbersome. Well, Casio has come up with a solution to that problem, too. Their new *Touch Sensor* watch is a calculator watch that doesn't have a bunch of keys on the front panel. No! You don't use ESP to operate the calculator. When this watch is in the calculator mode, the liquid-crystal display indicates the keys on the transparant face of the watch and that face then becomes a pressure-sensitive keyboard. Neat! If I do say so myself.

Then of course there are watches that monitor your pulse rate,

INSTEAD OF KEYS, this calculator/wristwatch from Casio uses a touch sensitive watch face.

that have analog and digital displays, lifetime calendars, sing you a song when it's time to get up, and even tell you the temperature (in both Celsius and Fahrenheit). If you can think of some feature that isn't yet available, look for it; it will be there next week.

Musical greeting cards

That's not new. I've bought those through the years. They come with little mechanical music boxes. True, but that's not the kind I'm talking about. I mean greeting cards that look like plain ordinary greeting cards until you open them and they start to play. That's when you either send for the men in white jackets or for a tool kit to find out what's inside. When you've finally heard enough and are ready to dig in to see what's inside, you're going to be suprised. It's only an IC, a flat battery, and a flat ceramic transducer. They're not inexpensive. You'll have to spring for $24.95 for a set of four cards. That's one to take apart and three to send to important friends and relatives. What a way to impress that new special person in your life. Send them the card that plays "Let Me Call You Sweetheart."

This calculator draws graphs

Some calculators add and subtract and multiply and divide. Some offer scientific functions. Others have memories and are programmable. Here is one that does all of those things but also draws graphs and draws them in an array of colors. I'm talking about the Sharp *EL-7050* calculator. The input procedures are simple; there's no new programming language to learn. Just enter the data needed to draw up your chart, select the type of graph, the color, and the shading. Using this calaculator you can generate bar graphs to show relative value or quantity; or circle

THIS SHARP *EL-7050* calculator can generate a variety of graphs and print them out in an array of colors.

graphs to show distribution of parts of a whole; or broken line graphs for trends and transitions; or band graphs for a combined effect. You also have your choice of four colors and various shadings to add contrast or emphasis. The last word in pocket calculators? Probably not. Just wait till the mailman delivers your next catalog.

Electronic typewritters for everyone

Revolution has struck the typewriter. That old dependable machine is not what it used to be. If you don't know what I'm talking about, let me direct you to look at two new typewriters from Brother. First is the *EP-20*. This portable machine weighs less than 5 pounds, is battery powered, and..... Well, let's start all over again. The *EP-20* is small enough to fit into your briefcase with plenty of room to spare. In fact, its thickest point (at the paper feed) is a thin 1½ inches. This is a full-function, correcting, electronic typewriter. The dot-matrix printer operates with a 16-character delay. Those first 16 characters appear on the liquid-crystal display at the top center of the keyboard before they are printed so you can read and correct as you go along. If error-free copy is not necessary you can override the delay.

The keyboard provides you with the same widely spaced keys and characters found on most standard typewriter keyboards. And there's a second shift feature that lets you access 44 international-language and arithmetic symbols. Complete tab functions, automatic paper feed, self-repeat for all keys—even a four-function calculator (printing or non-printing) are built right in.

If you need a machine that's a bit more elaborate step up to the Brother *CE-60*. This one is a 17½-pound portable that has many features of office machines and can, by connecting a simple interface module, become a computer printer. As a typewriter the *CE-60* includes automatic underlining, centering, and correction (it remembers what you have typed—automatically correcting up to one entire line with a single keystroke). Then there's a relocation key that returns you to where you left off before you made that correction. When you reach the end of a line you don't have to hit the carriage return. The typewriter will do it for you. Once you establish your right-hand margin, the carriage returns automatically—without breaking a word—and continues to print on the next line. I guess some time soon, Brother will add a microprocessor, 64k of memory and turn this unit into a full computer/printer.

Telephones and computers do mix

Take a telephone, add a 10-number automatic dialer, mix in an LCD clock, an AM/FM radio, and top it off with the convenience of a speakerphone. Now put all that into one attractive, tomorrow-styled package and you've got the *Electra*. It's just one example of what's happening in electronic telephones. While this one is visually exciting, there are many other similar combinations that look just like an ordinary bedside clock/radio. And, of course, dialers with extensive memories and telephones with their own built-in memories are commonplace. At the last Consumer Electronics Show there must have been more than 100 displays of all types of telephone equipment. Probably at the top end of the home telephone scale is the *Sensorphone*. Made by Gulf & Western, it turns your phone ito an "electronic caretaker". It is so smart that it even talks to you in plain English while you program it. In fact, at every single command, *Sensorphone* will tell you what you've done. So what does it do?

It monitors your AC power line to tell if it is on. It monitors room temperature. It even checks for any unusual loud sounds such as those from a smoke or burglar alarm. If it discovers that AC power is off for more than five minutes, it will call you and tell you. If the temperature it is monitoring drops below the limit you have preset it will let you know. If your smoke or burglar alarm goes off and continues for more than 10 seconds, *Sensorphone* calls you, tells you and lets you listen to noise for 15 seconds. In fact, it will call you at a series of four different numbers until it reaches you. It can't be tricked either, because will keep right on calling until *you tell it to stop*. It's also a telephone dialer. What will they think of next?

Portable record player is really portable

Taking along a record player for 12-inch LP's wasn't an easy chore until very recently. At best it was a matter of gathering together a semi-portable compact stereo system and carting it to where you were going. Now, an interesting and practical option is available. From Audio-Technica comes *Mister Disc*. It's a completely self-contained, high-quality, portable stereo phono system that plays both LP's and 45's. This unique player mea-

THOUGH NOT QUITE POCKET SIZED, this turntable from Audio-Technica measures just 11.4 × 4 × 2.5 inches but can play full-sized LP's.

sures 11.4 × 4 × 2.5 inches, weighs 2.5 pounds, and is battery powered. It comes with an Audio-Technica vector-aligned dual magnetic cartridge with a diamond stylus and a dynamically balanced pickup arm that doesn't need leveling. For private listening there's a set of lightweight headphones that deliver great stereo sound.

Electronics and your lifeline

Consumer medical monitoring equipment will do wonders for you. It will measure your pulse, your blood pressure, your weight. It can check you out while you exercise. And while it is not a substitue for your doctor, you can use this gear to check yourself out during the span between visits. There are also special accessories like a *Compucal* scale that Sharper Image calls a "Truth-In-Food Computer." What does it do? Simple!

WHERE CAN I GET MINE

Listed here are the names and addresses of companies that issue catalogs, containing the types of equipmentment described in this article. If you want one of their catalogs use the reader-service number below their name and address. This list probably does not list every catalog house. If you know of one that is not shown here, please let us know, so we can add it to future listings.

DAK Industries Inc
10845 Vanowen Street
North Hollywood CA 91605

Circle 131 for catalog

Robert Edmund Co.
300 Edscorp Building
Barrington NJ 08007

Circle 132 for catalog

JS&A
One JS&A Plaza
Northbrook IL 60062

Circle 133 for catalog

Markline
P.O. Box C-5
Belmont MA 02178

Circle 134 for catalog

New Horizons
5 - 31 50th Avenue
Long Island City NY 11101

Circle 135 for catalog

The Sharper Image
406 Jackson Street
San Francisco CA 94111
(800) 344-4444

Circle 136 for catalog

The Shelburne Company
110 Painters Mill Road
Owings Mills MD 21117

Circle 138 for catalog

Dietary statistics for more than 700 generic and name-brand foods are stored in its main memory—even Big Macs and Oreo cookies. Simply place the portion of food you are about to eat on the scale, enter the code for the type of food being weighed, and *Compucal* displays the number of calories in that portion. Push another button or two and you'll know the sodium, carbohydrate, fat, and cholesterol content, too. And separate user memories let up to nine people keep track of their total dietary intakes by the day, week, or month.

On a more serious note, Sharper Image shows an automatic blood-pressure monitor developed by Digitronic. It prints out your blood pressure—both systolic and diastolic pressures—your pulse rate, and both the time and date that you took the measurement. You can't even make a mistake, because once you wrap the pressure cuff around your arm, the machine takes over. It automatically inflates and deflates the cuff and takes all the necessary measurements at just the right time.

What else is new?

Obviously, I've only been able to spotlight the many new and exciting electronic innovations that are invading our lifestyle. If you have found this article interesting, why don't you drop us a line and tell us about some new, exciting electronic device you have seen? Just tell us about it; clip a photo or catalog listing, tell us where it can be purchased, and we'll see if we can't present it to our readers in a future issue. Send your electronic innovation to Electronic Innovations, c/o **Radio-Electronics,** 200 Park Avenue South, New York, NY 10003. And don't forget to include your full name and address, in case we need more information.

In looking over the items we have described here, we're left with the thought that our readers might like to be able to look inside these products—get to see some of the circuitry that makes them work. If this is your feeling, tell us so and we will do our best to bring the information to you. **R-E**

UNIQUE TEST EQUIPMENT

CHESTER H. LAWRENCE

A look at what's new, what's sophisticated, and what's unusual in test equipment today.

ELECTRONIC TEST EQUIPMENT ARE THE POTS AND PANS OF AN electronics lab. Without the meters, scopes, generators and all the other devices we use to measure, examine and regulate the electronic equipment that surrounds us in today's world we would soon drown in a maze of very beautiful and sophisticated, but inoperative electronics hardware.

But what is test equipment? The answer to that simple question is complicated. It depends on who you are and what you do. To some, a multimeter is test equipment. In fact, it may be the only test equipment they need, own or use. To others it's a scope, or a function generator, or an RF signal generator. Most of us have used a digital multimeter, scope, generator, and various component testers. But have you ever used a logic analyzer; a network analyzer; or a portable oscilloscope that has a liquid-crystal display and also sports a memory? These are just some of the very sophisticated and unusual electronic test equipment that can be found in labs around the world. Let's take a look at some of these special instruments and see what they do, how they work and why we use them.

LCD digital storage scope multimeter

On the front cover of this issue is one of the most fascinating pieces of test equipment that I have seen lately. It's a simple portable oscilloscope. But that's where the simple ends and the exciting new technology begins. Note the liquid-crystal display and the memory. Take a measurement, carry the instrument away and the measurement is still there in the scope's memory.

The *M 2050* from BBC Metrawatt is a unique combination of a low-frequency digital oscilloscope, a 3½ digit multimeter and a transient recorder with two independent memories tucked into one neat portable package. An expensive oscilloscope if you compare it to conventional equipment, but if you look at the kinds of special jobs it can perform you will soon agree that the price is fully justified.

If there is any disadvantage to the unit it is in its frequency range. Because of the limitations imposed by the display, top frequency is 50 kHz. The price of this unit is $1795.

First take a look at how small this instrument is—a mere 257mm × 169mm × 88mm when folded, and it weighs only 1.95 kg. Since the display is an LCD device it draws very little power and the battery-powered unit runs other battery-powered scopes into the ground. Thanks to the memory you can capture a waveform while working in a cramped corner, then walk away and examine that pattern and compare it with the ones in your service data later. All-in-all a great example of what technology can do.

NEW FLAT-PANEL OSCILLOSCOPE, model M 2050, from BBC-Metrawatt/Goerz combines the functions of a digital oscilloscope, a 3½-digit multimeter, and a transient recorder into a single, portable instrument.

When using the instrument, measurements can be evaluated more accurately because the scope and multimeter operate simultaneously. For example, while the scope portion of the display is used to evaluate signal characteristics, the DMM portion can be used to display the true RMS value of the signal. Because the inputs were designed with the voltage- and current-handling characteristics of a digital multimeter in mind, the Digital Scope Multimeter can be used directly for high-voltage measurements. Up to 500 volts can be applied to the 200-mV range without damaging the instrument. On all other voltage ranges 780-volt overload protection is provided.

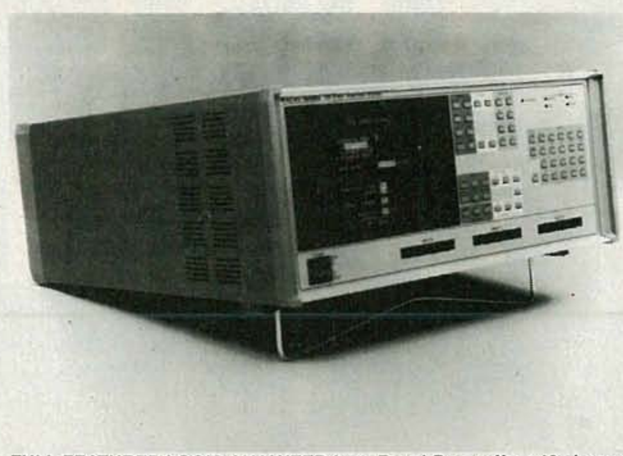
Operating as a scope, the *M 2050* digitizes analog signals at a 500 kHz rate. At 10 samples per cycle, the effective bandwidth is 50 kHz. The transient recording capability of the instrument enables the operator to use two independent 0.5K × 8-bit memories to record data. It can capture events as brief as 2 ms. Once recorded, data from either memory can be recalled and displayed for analysis. Waveforms can be retained in memory for months. An analog output makes it possible to make a hard copy of the data when connected to a strip recorder.

Logic analyzer

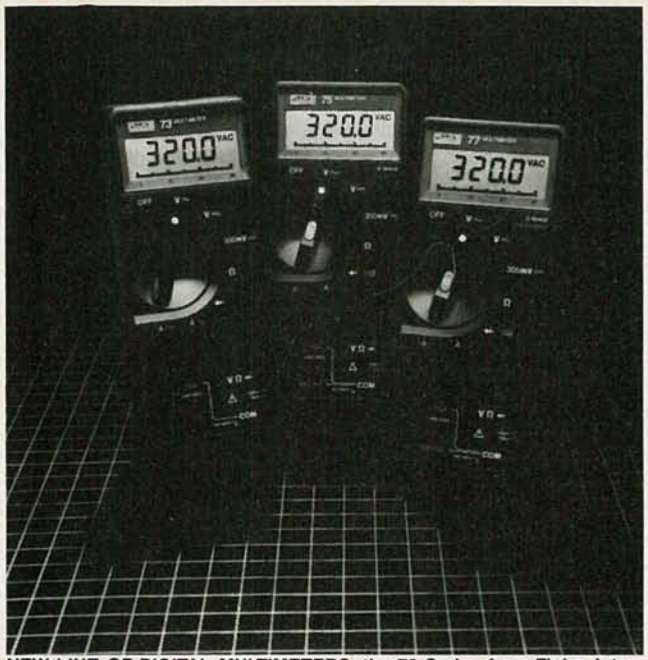
As stated in the latest Hewlett-Packard catalog, logic analyzers are powerful measurement tools for today's complex digital systems. They are essential during the critical phase of integrating hardware and software. Costly design errors can be avoided.

When digital products are in production or operational, a logic analyzer is the instrument that quickly isolates a problem and decreases downtime. In a new line of logic analyzers recently introduced by Racal-Dana a new dimension is added to this instrument's capability—a fast, easy-to-use, effective software debugging tool. The model *205*, an example of a top-of-the-line instrument, is priced at $6995. It offers 48 channels of state analysis and 16 channels of waveform plus many significant features, including a 16-channel word generator, 12K bytes of non-volatile memory and a GPIB (*G*eneral *P*urpose *I*nterface *B*us) interface. A more detailed discussion of the GPIB appears later in this article.

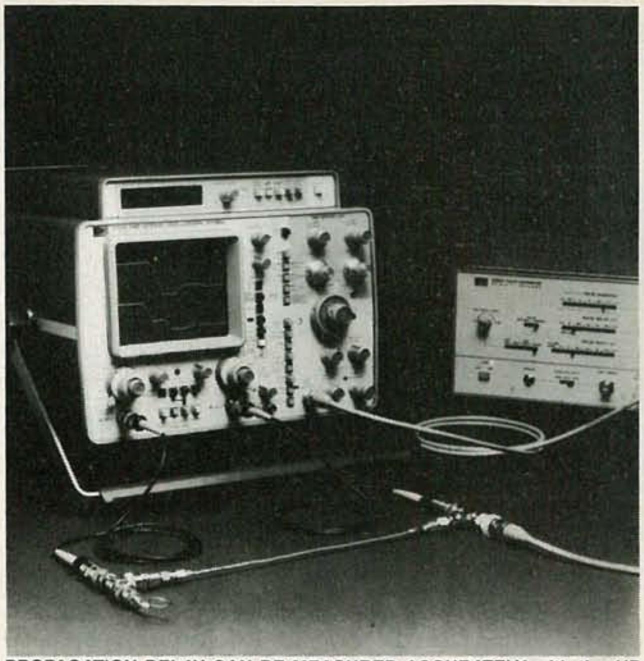
Applications for logic analyzers are not limited to the laboratory. Data and information gathered by using these instruments during design and development does not have to be put up on a shelf leaving the people in production, testing, quality control, and service to rediscover facts already known. With good planning and design, physical connections and simple routines for logic analyzers can be built right into the equipment the instrument has helped to design. This will provide for quick troubleshooting and efficient maintenance even after the product is in use.



FULL-FEATURED LOGIC ANALYZER from Racal-Dana offers 48 channels of state analysis and 16 channels of waveform. The model *205* also includes a 16-channel word generator, 12K bytes of non-volatile memory and a GPIB interface standard.



NEW LINE OF DIGITAL MULTIMETERS, the 70 Series from Fluke, introduces some significant changes in DMM technology. The bar pattern across the bottom of the digital display is an analog display that greatly enhances the capabilites of the instruments.



PROPAGATION DELAY CAN BE MEASURED ACCURATELY with the *HP 1726A* time-interval oscilloscope. In this photo a 10-inch length of semirigid coax cable has a delay of -1.43 ns. The minus sign indicates that the channel A signal occurs later than the channel b signal.

Digital multimeters

If you want to look at extremes, here are two instruments, both with the same name, but each at opposite ends of the DMM spectrum. The John Fluke Manufacturing Company is a major manufacturer of digital multimeters. At the top end of the spectrum they produce their model *8506A*, a unit that they claim delivers performance at the edge of technology. I must agree. This instrument has 7½ digits of resolution, a 24-hour accuracy of 120-parts-per million from 40 Hz to 20 kHz and a stability of 30 parts-per-million. The instrument's top notch accuracy is attributed to the use of a thermal-RMS detection technique based on the heat dissipated by a resistor. As a result the instrument's response is relatively independent of the input signal's waveform and full accuracy can be guaranteed for a wide range of input signals.

The only problem with this instrument is that it represents drastic overkill for most digital-multimeter applications. It's a lot like hiring a Greyhound bus to take one person from place to place instead of using a taxi.

At the other end of the spectrum is Fluke's newest and least expensive digital multimeters, a line of three instruments in the *70 Series*. Starting at $85 and packed with a variety of high-priced features, including an analog liquid-crystal display for reading peaks, I think that this meter represents a new standard for the test-equipment industry and fortells the future of portable-multimeter technology. For more details on this instrument see the Equipment Report elsewhere in this issue.

Synthesized signal generator

Over its entire range of 80 kHz to 520 MHz, all you need do is punch out the frequency, the modulation and the RF level of the desired signal on the front-panel keyboard and you have it at the output. Designed by Marconi Instruments to test transmitters and transceivers, frequency resolution is within 10 Hz at all frequencies. RF output up to +13 dBm is available at all frequencies and microprocessor control provides operating simplicity and speeds up routine measurements. A non-volatile memory stores up to 10 generator settings and a further 40 carrier-frequency values. The memory also stores calibration information. Microprocessor-aided fault diagnosis lets the user, from the front panel of the instrument, pinpoint the section of this instrument that is not functioning properly.

Time-interval oscilloscope

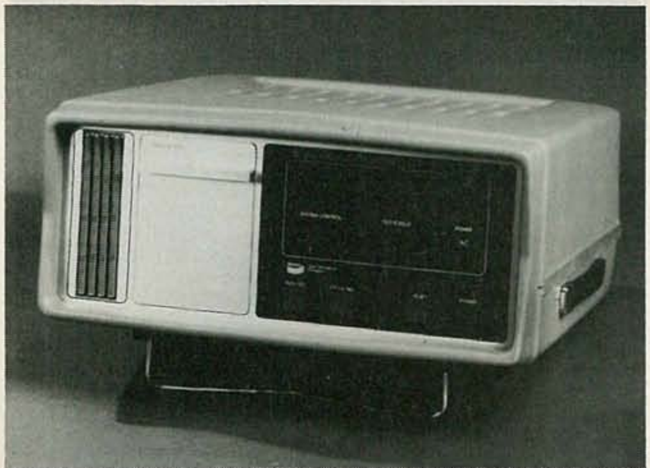
Offering 50-picosecond accuracy and 10-picosecond resolution the new Hewlett Packard *HP 1726* scope makes fast, reliable timing measurements on complex repetitive signals. The instrument combines counter and oscilloscope technologies. It has the viewing and measuring capabilities of a 275-MHz scope and the ease of use of a time-interval counter. That is particularly useful to those making frequent timing measurements.

Designed to make precise timing measurements, the *HP 1726* uses a crystal-referenced time base in conjunction with a CRT and stable triggering circuits. This combination makes it possible for the instrument to display the signal being tested as well as to measure the designated interval with up to 50-picosecond accuracy. At $7,675, the *HP 1726* is far from cheap, but for the high-technology and high-performance portion of the electronics industry it meets the requirement found in fundamental areas of research-and-development labs, production, and service. As a diagnostic tool the unit is excellent for characterizing designs, processes and entire test systems.

Digital module tester

The most advanced automatic test equipment technology in a compact 28-pound package is the way Bendix introduces its model *9070* digital module tester. The primary purpose of this instrument is to separate bad circuit-card assemblies from good ones. It can handle GO/NOGO screening and fault isolation diagnostics on everything from a simple circuit card to a complex system. It works in the field, on the bench, or on the production line. The highly sophisticated instrument tells the operator what to do—step by step; it signals when a fault is detected and displays test results instantly.

In the field, the portability of the *9070* makes it possible to take the tester to the problem and find the fault there. This does away with board swapping and cuts down on the number of boards in the service pipeline. Good boards stay on the job. Obviously this is not used in simple systems or where the boards being tested are relatively inexpensive. In those instances, simple board swapping is more efficient and less expensive. At the repair shop the unit finds faults that need repair in bad boards quickly and automatically, delivering the kind of quick turnaround and throughput that is needed for an efficient shop testing operation.



DIGITAL MODULE TESTER does its job by applying input signals at designated input pins and certifying predicted responses at designated output pins. This tester is the Bendix Model *9070*.

To do its job the *9070* applies input signals at designated input pins and verifies predicted responses at designated output pins. Any sequence or combination of the following input signals may be used for each individual test:

- Input logic pattern
- Change of state at one pin or simultaneous change of state at multiple pins
- Sequential change of state at selected pins
- Single or multiple clock pulses at individual or group of pins

Output response may be verified by any of the following methods:

- Full output go pattern
- Change in output at single or multiple pins from prior test
- Specific logic level at single or multiple pins

Maximum system capability is 256 active input/output pins. All pins are programmable; no dedicated adapter is required.

Universal disturbance analyzer

Anomolies on the AC power lines can affect computers and other senisitive microprocessor-based instruments. To counter this problem is the Dranetz Technologies *Series 626—Universal Disturbance Analyzer*. This is a modular, portable microprocessor-based instrument made up of a mainframe and up to five individual plug-in modules. By choosing the appropriate plug-ins the user can monitor single-phase AC, 3-phase AC, DC voltages, common-mode AC voltages, and logic event changes-of-state.

TOGETHER WITH SOME OF ITS INPUT MODULES is the Series *626* Universal Disturbance Analyzer from Dranetz. This unit can spot and record anomalies that affect computers and other sensitive microprocessor-based instruments.

The *Universal Disturbance Analyzer* is specifically designed for use in the computer field-service industry and continuous on-site monitoring of computer operations. Voltage disturbances are printed out in industry-standard terms of sags, surges, and impulses (including impulse duration). In addition, the *626* will have applications in the analysis of power problems associated with telecommunications systems, industrial process-control systems, medical instrumentation and, of course, the entire range of microprocessor-based equipment.

Testing cellular-radio receivers

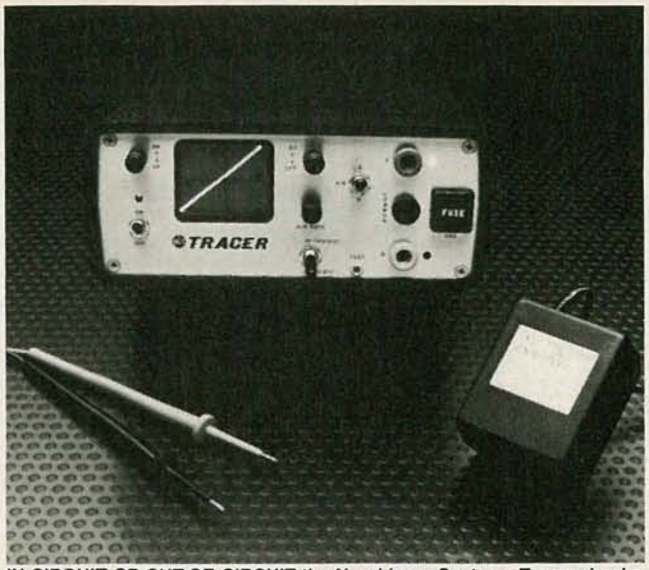
What do you use to test these state-of-the-art receivers? Boonton Electronics says try their model *1021* programmable RF signal generator. It has a frequency range to 1.08 GHz and covers all of the requirements for high-speed testing of cellular receivers. Switching time between channels is 50 ms. Output levels to +16 dBm, SSB noise of less than −113 dBm, residual FM below 12 Hz at 900 MHz, and FM distortion of 0.05%. In addition, the low-distortion, internal, modulation oscillator can be used as an audio oscillator with programmable frequency and level. The generator can be controlled manually, automatic via GPIB, or preset to recall up to 250 complete panel setups from an integral non-volatile memory. Oh, about the price....a mere $16,950.

IF YOU'RE SERVICING CELLULAR RADIO equipment, a programmable RF signal generator like the Boonton Electronics model *1021* is what you need. The special feature is that it covers the requirements for high-speed testing of cellular receivers.

Component and circuit tester

The *TR-1 Tracer* from Non-Linear Systems is not an expensive instrument, but it is a fascinating one because of the wide range of tests it will perform. How does one describe it? Well it is an in-circuit and out-of-circuit tester of components and networks. Signature analysis patterns provide the key to rapid fault finding. The unit tests all parameters simultaneously of circuit boards or individual components without power-up. Dual inputs make it snap to compare a known good component with a suspect.

When testing equipment the *TR-1* locates shorts, opens, and wrong parts in a minimum of time. Since the unit works equally well in or out-of-circuit it can also be used in receiving inspection for qualitatively checking a variety of components. Because the unit conducts dynamic testing rather than static testing it can detect faulty parts suffering from defects such as noise leakage, temperature instability and intermittent deficiencies that might go undetected using other methods. You are sure to find many additional applications for this device. Battery powered and easily portable, it's a handy companion in the field.



IN-CIRCUIT OR OUT-OF-CIRCUIT the Non-Linear Systems Tracer checks out and troubleshoots circuits, subassemblies and components rapidly and accurately. All tests can be performed without powering-up the circuit being checked.

Inexpensive frequency counter

Not all good things must be expensive. Here's a frequency counter than ranges from 5 Hz to 1 GHz, yet costs only $575. It's the Global Specialties model *6002*. It also measures period from 1 μS to 200 ms. Also, there are three selectable resolutions with LED indicators and simple push-button control. A 10-MHz crystal oven oscillator time-base assures ± 0.5 ppm, ± 1 ppm/year stability.

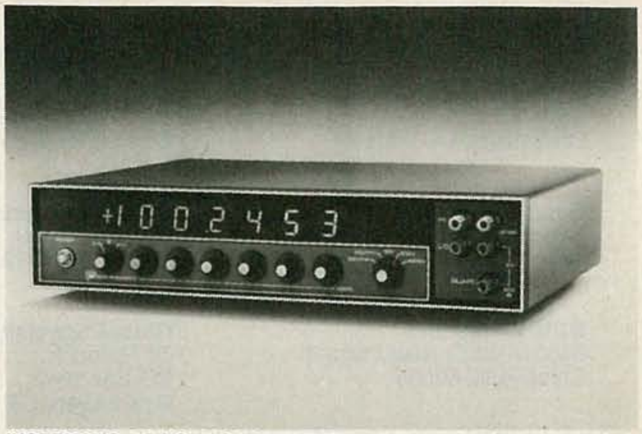
The unit is intended for use for audio/VHF in communications, data processing, process control, RF design, digital design, quality control, and maintenance. There's an 8½-digit display featuring leading-zero blanking, 0.43-inch tall characters and a contrast-enhancement filter.

ARE 8½ DIGITS ENOUGH in a frequency-counter display? The model *6000* frequency counter from Global Specialties provides that display of the frequencies it measures.

Calibration standard

DC voltage/current portable calibration standard that's NBS (*N*ational *B*ureau of *S*tandards) traceable is a handy instrument to have around. And the Data Precision model *8200* delivers higher effective resolution, higher stability, exceptional accuracy and great flexibility in a unique new way. This instrument is an extremely accurate microcomputer-based, remotely programmable, line-powered portable standard for the transfer of NBS reference values to instrumentation and equipment in a broad range of working environments—in the lab, in the quality-acceptance quality-control department, and on the production floor.

When operating in the manual mode, the *8200*'s 6-digit control network is controlled by setting its associated rotary switches to any reading between 000000 and 1048575 plus polarity indication, with appropriate decimal point location. (The internal microcomputer translates from binary to BCD, so you read the output in decimal values.) The desired values appear above the rotary switches displayed on a set of LED's. The unusual *Incrematic Control Feature* enables the operator, using any one rotary switch to control not only that particular decade, but all of the successive significant digits.



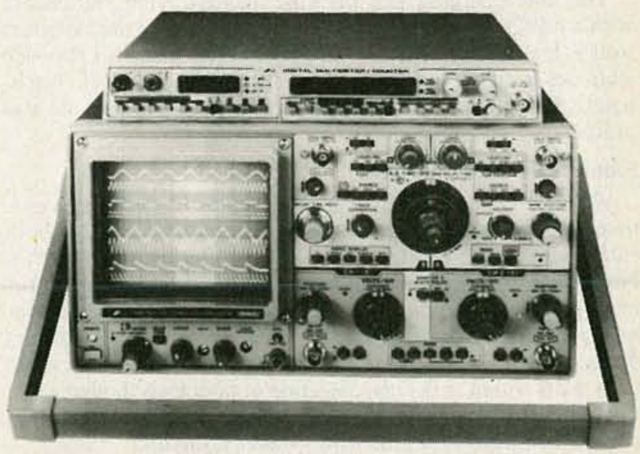
INCREMATIC DC VOLTAGE/CURRENT portable calibration standard allows unlimited use of any one decade with full borrow/carry to and from all more significant digits. This instrument is the model *8200* from Data Precision.

Thus external instruments can be exercised down to any resolution, step after step, using only one knob for a particular test-run resolution. This feature is extremely useful when measuring linearity of D/A and A/D converters, as well as the transfer function and linearity of analog function modules such as multipliers and dividers.

Arbitrary waveform generator

So you want to generate custom waveforms. The Wavetek model *175* will do that job for you. It lets you tailor your own waveform. Any waveform that can be drawn can be entered into this versatile instrument and then generated as an output.

This unusual device stores waveforms as digital points on a 256 × 255 data grid. These points are sampled by a crystal-controlled clock at selectable times up to 200 nanoseconds. Amplitude can be varied a full 20 volts peak-to-peak with 3-digit resolution. Waveform shape data is entered in any one of four RAM memories through the front-panel keyboard or the GPIB. You enter the data for each change-of-slope location and the internal microprocessor connects these points. In addition, plug-in sockets are provided for four PROM's so you can create a permanent library of your most used waveforms. One place that this instrument is invaluable is in medical electronics where we can create the many irregular waveforms that are often required.



THE MODEL *SS-5711D* four-input, eight-trace, portable oscilloscope from Iwatsu. It also features a digital multimeter.

MANUFACTURER LIST

BBC-Metrawatt/Goerz
6901 West 117 Avenue
Broomfield, CO 80020

Bendix Corporation
Test Systems Division
Teterboro, NJ 07608

B&K Precision
6460 West Cortland Street
Chicago, IL 60635

Boonton Electronics
499 Pomeroy Rd.
Parsippany, NJ 07054

Data Precision Corp.
Elect Avenue
Danvers Indl Pk
Danvers, MA 01923

Dranetz Engineering Labs
1000 New Durham Road
Edison, NJ 08817

John Fluke Manufacturing Co.
PO Box C9090
Everett, WA 98206

Global Specialties Corp.
70 Fulton Tr.
PO Box 1942
New Haven, CT 06509

Hewlett-Packard
3000 Hanover St.
Palo Alto, CA 94304

Iwatsu Instruments
120 Commerce Rd.
Carlstadt, NJ 07072

Marconi Instruments
100 Stonehurst Ct.
Northville, NJ 07647

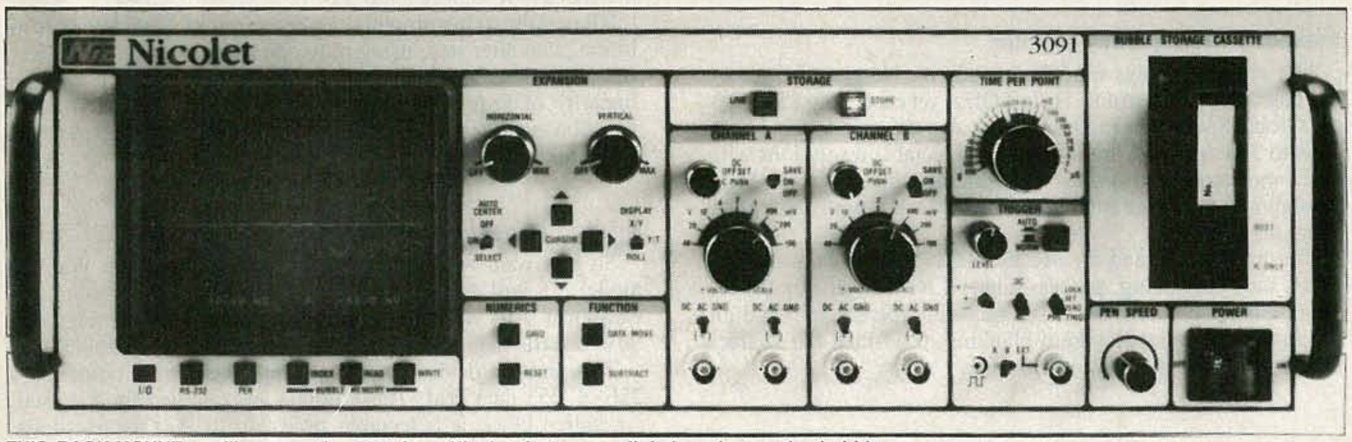
Nicolet Instrument Corp.
5225 Verona Rd.
Madison, WI 53711

Non-Linear Systems
533 Stevens Avenue
Solana Beaach, CA 92075

Racal-Dana
4 Goodyear St.
PO Box C-19541
Irvine, CA 92713

Tektronix
PO Box 1700
Beaverton, OR 97075

Wavetek Inc.
9045 Balboa Avenue
San Deigo, CA 92123



THIS RACK-MOUNT oscilloscope, the *3901* from Nicolet, features a digital readout and a bubble memory for storage.

NTSC Color-Bar Generator

With all the attention that video gets these days, thanks to the VCR, videodisc player and video cameras, a good NTSC generator is increasingly valuable. One moderately-priced, yet quality unit is the model *1250* made by B&K. It is a cost-effective unit for broadcast, CATV, and industrial television applications. It's also useful for aligning and troubleshooting VCR's.

This unit accurately generates the standard NTSC bar pattern with an IWQ signal occupying the lower quarter of the pattern as well as the full-screen color-bar pattern. There's also a five-step staircase pattern with selectable chroma levels. Dot, cross-hatch, dot-hatch, center-cross patterns, and color raster are also available.

Fiber-optic cable tester

With the importance of fiber-optic cables in electronic communications constantly growing an electronic device to test these cables was sure to be close behind. Enter the Tektronix *OF150* Fiber Optic TDR. This high-performance, easy to use instrument performs repeatable, accurate distance and loss measurements on multi-mode optical cables. Typical applications include: splice measurement though a one-way cable loss of up to 21.5 dB within ± 0.1 dB; detection of fiber ends though a one way cable loss of up to 42.5 dB; and measuring distance to discontinuities to 19.9 km, with 1-meter resolution.

The *OM150* delivers direct LCD readout of results. A built-in chart recorder provides a permanent record of the waveform.

GPIB compatability

The General Purpose Interface Bus (GPIB) was established in 1975. Three years later, in 1978 the IEEE standard defining this bus was further refined, defining an interfacing system that has become a widely accepted instrument industry standard. The major areas it specifies are:

Mechanical—the interface connector and cable.
Electrical—the logic signal levels and how the signals are sent and received.
Functional—the tasks an instrument's interface may perform (such as sending data, receiving data, triggering the instrument) and the protocols to be used.

Today, a wide variety of instruments include interfaces conforming to this mechanical, electrical and functional standard. With GPIB compatibility, measurement capability can be chosen off-the-shelf and simply cabled with standard bus cables in either a linear or star configuration.

Some closing comments

Obviously an article of this nature cannot include every exciting new instrument, nor can we possibly mention every manufacturer of quality test equipment. Please don't think that the instruments and manufacturers mentioned in this article are the only ones that we have seen. Scores of new instruments are announced each month and what we have tried to do here is bring you a sampling and cross-section of those that have interesting and sometimes different features. **R-E**

ALL ABOUT

ECL LOGIC CIRCUITS

TJ BYERS

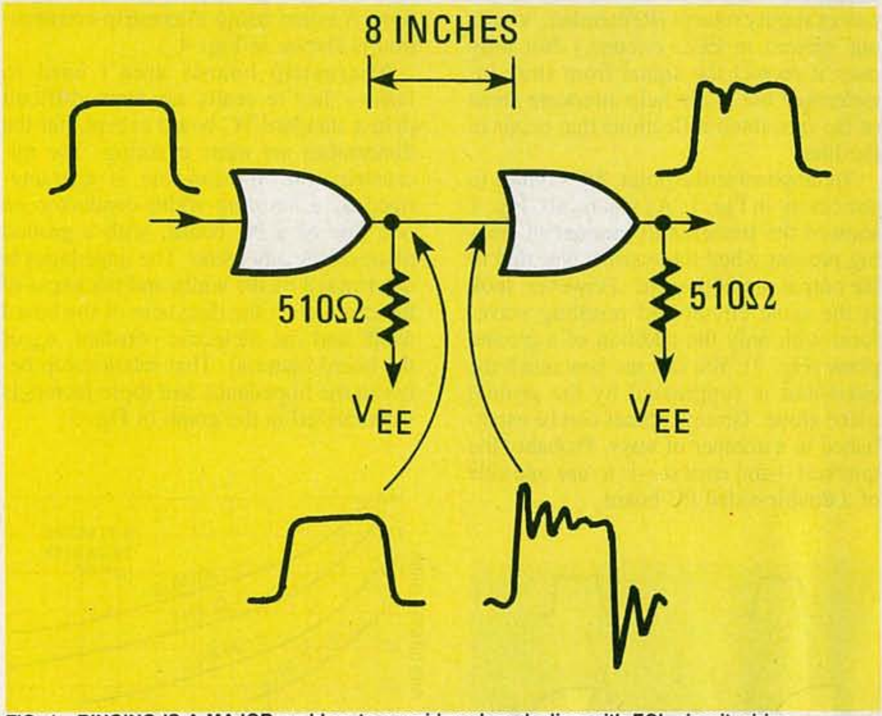


FIG. 1—RINGING IS A MAJOR problem to consider when dealing with ECL-circuit wiring.

Because of the high operating speed of emitter-coupled logic, standard wiring procedures cannot be used. Here we will look at the solution to the circuit-wiring problem.

Part 2 IF YOU READ THE FIRST installment in this series, then you have a general understanding of ECL (*E*mitter-*C*oupled *L*ogic) and its capabilities. However, to use ECL IC's, you have to understand more then the ECL gate. You have to pay close attention to the interconnections between devices. This month we'll investigate just that.

Wiring ECL gates

The application of ECL is identical to any other form of logic and, as with any other logic, the output of one gate must be connected to the input of the following gate. Normally, that is a routine kind of thing, and you simply run a wire from one to the other, just as we have done in Fig. 1. (Notice that, in compliance with the rules of ECL loading, a pulldown resistor is connected to the output pin of each gate.)

Before going any further, we should explain that at high frequencies, any wire connecting any two points (gate output to gate input, in our case) can be considered to be a transmission line. A transmission line has certain amounts of resistance, inductance, capacitance, and a time delay—all of which influence the signal traveling through it. We must also remember that if the transmission line is not terminated by its characteristic impedance, a portion of a signal flowing through the line will be reflected when it reaches the line's termination. Those reflections add to (or subtract from) the signal voltage. Reflections are present even at low frequencies, but in that case, they are usually masked by the relatively slow risetime of the pulse. However, when the delay time in the wire is longer than the risetime of the input pulse, the reflected power causes a *ringing* inside the line that affects the pulse. (If the ringing is limited to the risetime of the pulse it is not usually a problem, because the IC's are clocked after the steady-state levels have been reached.) For example, the lead length specified for our example in Fig. 1 would give a delay that is longer than the risetimes commonly encountered when using ECL gates. The result is shown—notice that a clean pulse enters the line from the gate output. But by the time it reaches the following input, it is distorted by ringing. The ringing is due to the reflected waves present in the transmission line.

ECL is forgiving to a certain extent, and some ringing is permissible. However, ringing on the input line does reduce the noise "safety" margin considerably and in some cases will even produce false triggering. Typically, an ECL gate will tolerate up to 35% overshoot and 15% undershoot. That's not a wide margin to work within!

Fortunately, there is a simple way to reduce ringing. By placing the load resistor at the end of the connecting lead—instead of at the gate output—the overshoot is attenuated. Instead of feeding a pulse down an open wire, the output circuit now sees a terminated low-impedance transmission line.

As shown in Fig. 2, that simple procedure gives us cleaner output waveforms. It now becomes apparent why the ECL-IC designers opted for an open-emitter driver and did not include a load resistor on the chip.

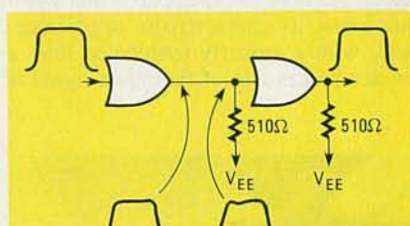


FIG. 2—CONNECTING THE OUTPUT RESISTOR at the end of the connecting lead can help to reduce ringing.

Ground planes

At higher frequencies, the noise picked up by an unshielded wire is prohibitive. One way to provide shielding, without using coaxial cables and the like, is to place the lead alongside a ground plane.

A ground plane is nothing more than a sheet of metal that is placed close to the interconnecting wire and is tied to the power supply return. (Remember, V_{CC} is our ground in ECL circuits.) Not only does it protect the signal from stray interference but it can help attenuate some of the unwanted reflections that occur in the line.

To emphasize the point, let's return to our circuit in Fig. 1. As you recall, Fig. 1 showed the tremendous amount of ringing present when the resistor was tied to the output pin of the gate. However, look at the same circuit and resulting waveform with only the addition of a ground plane (Fig. 3). You can see how much the overshoot is suppressed by the ground plane alone. Ground planes can be established in a number of ways. Probably the quickest—and easiest—is to use one side of a double-sided PC board.

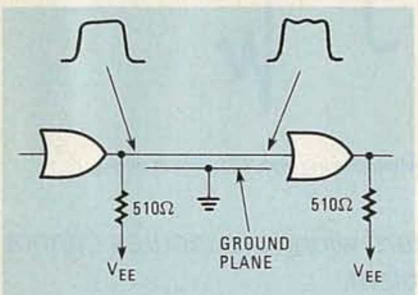


FIG. 3—USING A GROUND PLANE is another way to reduce overshoot and ringing.

Microstrip construction

A logical extension of the ground plane concept is microstrip construction. Microstrip design goes one step beyond the simple ground plane by allowing you to give a specific impedance to every line. In the ground-plane approach previously reviewed, no effort was taken to make sure that the impedance was constant. There are several advantages to being able to tailor the impedance of the transmission line. For one thing, it is much easier to match the load resistance to a line when you know its characteristic impedance. And, with a properly terminated line, a greater percentage of the input signal is seen at the other end. Thus, a wider margin for error is obtained. Moreover, it provides the highest possible noise rejection. A board using microstrip construction is shown in Fig. 4.

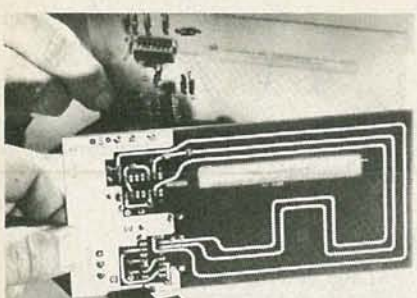


FIG. 4—THIS BOARD (an 83-MHz ring counter) uses 12-inch microstrip delay lines and a ground plane (seen in mirror).

Microstrip boards aren't hard to make—they're really no more difficult than a standard PC board except that the dimensions are more exacting. The microstrip transmission-line is characterized by a constant-width conductor on one side of a PC board, with a ground plane on the other side. The impedance is determined by the width and thickness of the conductor, the thickness of the board itself, and the dielectric constant, e_r, of the board material. That relationship between the impedance and those factors is summarized in the graph in Fig. 5.

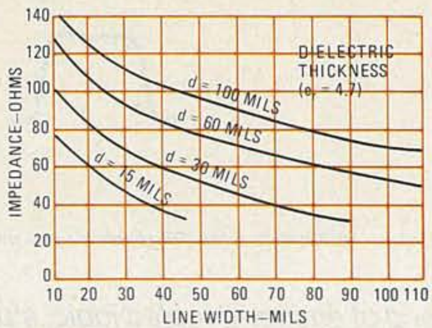


FIG. 5—THIS GRAPH SHOWS microstrip impedances for double-clad 1-ounce copper board; copper thickness = 0.0015 inches.

When laying out a microstrip board, certain precautions must be observed. First, there should be no squared corners in your leads—sharp bends should be avoided. For best performance, all bends should be given a radius no smaller than one-fourth the wavelength. Also, to minimize crosstalk, as much spacing as possible should be left between parallel lines. If you have no choice and have to separate two lines by less than 150 mils (0.15 inches), then a ground lead must be run between them.

For practical reasons, the characteristic impedance of the microstrip lines falls between 50 and 150 ohms. To achieve impedances greater than 150 ohms, the line width becomes prohibitively narrow; not that their construction isn't possible, but small imperfections in the etching process become more critical. That restriction, however, falls within the guidelines of good circuit design. As impedance increases, propagation time also increases. So, as far as speed is concerned, low-impedance lines are preferred. However, low-impedance lines require a low-value terminating resistance, which must—as we discussed last month—dissipate more power. An impedance of 68 ohms usually yields the best trade-off between power dissipation and speed—and happens to fall in the middle range of board construction. Of course, you are not restricted to using 68-ohm lines exclusively. You can use any impedance you deem necessary for the job. You can even mix the impedances on a board to tailor the performance for specific results, as we shall see shortly.

Line terminations

Anytime a transmission line is longer than the signal wavelength, termination of the line is a necessity. By using constant-impedance transmission lines, though, it becomes possible to terminate the line in more than one way and still achieve a good match with reduced overshoot.

We have already seen one—the use of a terminating resistor at the end of the line. That is called parallel terminations. It provides the highest speed while reducing the capacitance effect on the output of the gate. When one output drives several loads, however, there are a couple of variations to the parallel termination.

The first approach is to lump all the loads at the end of one transmission line, as seen in Fig. 6. Although that slows the risetimes and falltimes somewhat, because of the increased capacitance, it is desirable when all the inputs involved are located on a single IC. Notice that only one load resistor is used for all the inputs.

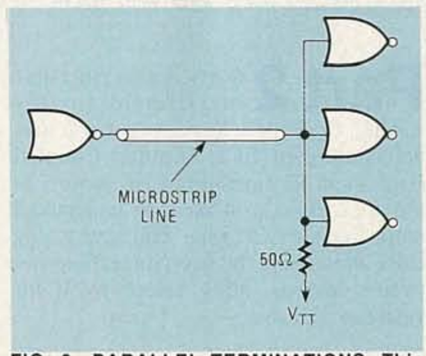


FIG. 6—PARALLEL TERMINATIONS. This approach uses only one load resistor.

An attractive benefit of a parallel-terminated line is the fact that the impedance is constant along its entire length. This makes it possible to tap the signal from any location along that length, as shown in Fig. 7. For proper distribution, though, the taps should be evenly spaced along the length of the line. You must keep in mind, however, that as the pulse progresses down the line, the delay increases. In other words, the first gate will receive its signal before the end gate.

A variation of the single line is the multiple-line mode. A representation of this method is shown in Fig. 8. Notice that the path to each input is through a separate transmission line. When the loads are scattered throughout the card, it is better to use that arrangement. You'll

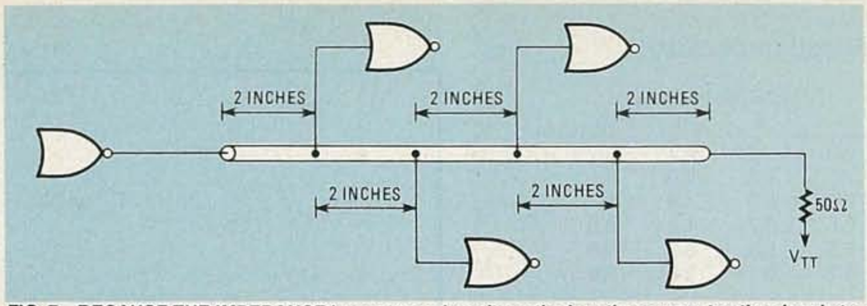


FIG. 7—BECAUSE THE IMPEDANCE is constant along its entire length, you can tap the signal at any point on the coaxial line.

also notice that each line is terminated by its characteristic resistance, which means that the power dissipation of the output gate increases as the number of lines increases. Therefore, it is best to use high-impedance lines so that the total lumped resistance doesn't exceed the DC limits of the output circuit. For instance, if we take the example in Fig. 8, the wise choice would be to run three 150-ohm lines to the inputs. In that way, the total load seen by the output will be 50 ohms—well within its operating parameters.

An obvious consequence of mixing impedances on a card, however, is that each impedance displays a different propagation time; delays increase as the impedance increases. Depending on the lengths involved, it's possible that pulse skewing could result even though you may have taken care to match wire *lengths*.

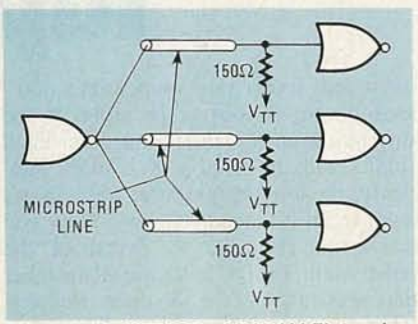


FIG. 8—THIS METHOD of PARALLEL termination uses multiple microstrip lines. The total impedance seen by the gate is 50 ohms.

Series terminations

The alternative to parallel terminations is series termination. Series termination is achieved by inserting a resistor in series with the transmission line, as shown in Fig. 9. The value of the series resistor is equal to the impedance of the line, less the output impedance of the gate. The typical output impedance of an ECL gate is 7 ohms; therefore, the proper series resistor for a 50-ohm line is 43 ohms. By placing the resistor in series with the line at the input, only half the voltage swing is transferred down the transmission line. When the signal reaches the end, however, high-frequency reflections bouncing back and forth in the line combine to double the output voltage, thus re-establishing the original logic level.

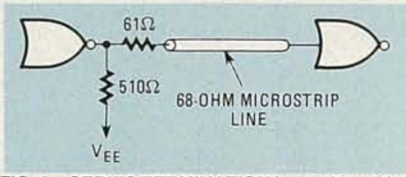


FIG. 9—SERIES TERMINATION is an alternative to parallel termination.

To maintain clean wavefronts, though, the input impedance of the gate must be several times greater than the characteristic impedance of the transmission line. This requirement lends itself well to ECL circuits. Since the signal voltage is reinforced at the point of exit, it is possible to have more than one load on the output and still maintain proper voltage levels. However, the capacitance of the extra inputs has a greater effect on the rise and fall times than it does with parallel terminations. That is due in large part to the series resistor.

Some of the problem can be alleviated by decreasing the size of the series resistor, thus decreasing the R-C time constant. Unfortunately, less resistance means more ringing. Therefore, the series resistance must not go below the point where the ringing exceeds the limits imposed by the input. That approach is known as series damping, and a chart of the lowest acceptable resistor values can be found in Table 1.

A single load on a line doesn't present that problem. Therefore, it is better to run parallel lines to each input as shown in Fig. 10, instead of clustering them on one line. That is an excellent way to distribute a signal over a card without the increased power dissipation that's associated with multiple parallel-terminated lines. As before, the value of the series resistor for each line is equal to the impedance of the line.

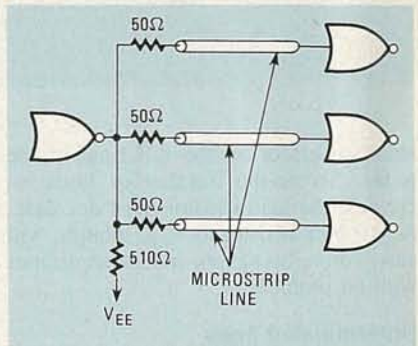


FIG. 10—SERIES TERMINATION using multiple microstrip lines helps to keep power dissipation down.

The size of the pulldown resistor, however, is affected by the number of lines the output must drive. If the value of the load resistor is too high, the output transistor will turn off during its transition from the high to the low state, creating a

TABLE 1—Minimum Series Resistance

Rise Time	Line impedance ohms	Series resistance ohms	Gate output impedance (ohms)
3.5 ns	50	9	15
"	68	18	"
"	75	21	"
"	82	25	"
"	90	29	"
"	100	34	"
"	120	43	"
"	140	53	"
"	160	63	"
"	180	72	"
1.1 ns	50	18	6
"	68	27	"
"	75	30	"
"	82	34	"
"	90	38	"
"	100	43	"
"	120	52	"
"	140	62	"
"	160	72	"
"	180	81	"

TABLE 2—MAXIMUM UNTERMINATED-LINE LENGTH

Rise Time	Line impedance (ohms)	FANOUT =	LENGTH (inches) 1	2	4	8
3.5 ns	50		8.3	7.5	6.7	5.7
"	68		7.0	6.2	5.0	4.0
"	75		6.9	5.9	4.6	3.6
"	82		6.6	5.7	4.2	3.3
"	90		6.5	5.4	3.9	3.0
"	100		6.3	5.1	3.6	2.6
2.0 ns	50		3.5	2.8	1.9	1.2
"	68		3.2	2.3	1.5	0.8
"	75		3.0	2.2	1.3	0.7
"	82		2.9	2.0	1.2	0.6
"	90		2.8	1.9	1.0	0.5
"	100		2.6	1.8	0.9	0.4
1.1ns	50		1.6	1.1	0.7	0.6
"	68		1.4	0.8	0.5	0.4
"	75		1.3	0.8	0.4	0.3
"	82		1.2	0.7	0.4	0.2
"	90		1.1	0.6	0.3	0.2
"	100		1.0	0.5	0.2	0.1

staircase effect on the fall time of the pulse. So as the number of lines increases, the load resistor must decrease. A 510-ohm resistor to V_{EE}, though, will easily drive up to four independent lines with no problem.

Unterminated lines

If the length of the transmission line—or wire, for that matter—is shorter than the wavelength of the input signal, the signal will pass through the conductor virtually unaffected by the reflections. Since many of the connections within a circuit are short and direct, they can be made with unterminated lines.

In a pulse circuit, the dominant frequency is determined not by the pulse repetition rate, but by the rise time of the pulse. The signal undershoot, which is the most critical of the two parameters, is held to about 15% if the travel time for a two-way trip through the conductor is less than the risetime. However, the propagation time through the line is determined by more than one factor. Involved are the length of the conductor, the dielectric constant of the board, the capacitance of the load, and impedance of the line. Those factors are often interrelated and variable, but Table 2 ties them together. With that table you can determine, at a glance, the longest unterminated line that you can use in a given situation.

As you can see, the shortest runs occur with those ECL IC's that have the fastest risetime. It is for that reason that a separate family of ECL IC's, the 10000 series, was developed. With deliberately slowed risetimes, they are able to take advantage of longer unterminated connections, thus easing circuit constraints. Unfortunately, their slower response time may not meet your system requirements in all cases.

System interconnections

In larger systems, more than one card is often involved. In that case, of course, connections between cards must be made. That presents a unique situation in that we must use all the transmission-line knowledge we have discussed so far. Furthermore, the parameters we discussed become more critical—and a new one comes to light.

This new parameter is attenuation. At the single-board level, attenuation is seldom a problem. But it must be taken into consideration when interconnections between modules and cabinets are made. Let's first take a look at the options open to us.

Although the mother-board arrangements can be used for tying cards together under special circumstances, it is better to use point-to-point wiring since few edge-connectors perform well at the frequencies involved. Single wires can be used if you respect their limitations. To begin with, they fall under the restrictions imposed by the rise-time versus lead-length rule. A practical example here would be a wire no more than 15-inches long, loaded with fewer than four gates. To prevent objectionable ringing, however, a ferrite bead must be placed at the end of the wire. To improve the signal somewhat, a 100- or 120-ohm resistor can be placed at the line ending and returned to the V_{TT} source. That resistance more or less matches the impedance of the line and thereby reduces some of the overshoot.

An open lead, unfortunately, is prone to pick up noise along the way, making it undesirable for many applications (particularly clocking pulses). A better approach is to make interconnections with coaxial cable. Not only does the

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Voice-Operated Switch for your Tape

WITH ONE HAND YOU DELICATELY BALance the tip of your scope probe on the tiny pin of an IC while your other hand fiddles with the scope's sync knob. Suddenly, the long-sought-after trace shows itself in all it's detailed glory! Now you can see the rise time, the overshoot, the pulse width, the DC level and all the other data needed to get the job done. But now what do you do? The notebook is across the room and you'll never remember all those precious numbers if you go get it.

You could dictate the readings to your secretary—if you had one. You could also lock the trace in your storage scope—if you had one. There has to be a better way. Let's see, your hands are full so you can't write—but you can talk! What's needed is cheap, hands-off recording gadget that would only record when spoken to, and would shut down during those long periods of utter silence when you are completely baffled by the peculiarities of your designs.

The answer is a voice-operated switch for a cassette tape recorder built from parts from your junkbox!

That is actually how the project came about. There was a real need to improve

JAMES P. REED

If you've ever found your hands "tied" when you needed to record an important piece of data, you'll appreciate the usefulness of this simple device.

Recorder

efficiency while doing design work and troubleshooting; in those instances stopping to write down data is usually inefficient or impossible. After a little reflection, it's easy to see that a voice-operated switch could be useful in a number of other situations such as taking verbal notes while studying, unattended monitoring of CB or ham receivers, etc.

For about $20.00, providing you have a well-stocked junkbox, you can build a voice-activated switch that will detect speech and turn a recorder on in response to it. It will also turn the recorder off in response to periods of silence that last over three seconds. That three-second interval is provided to allow for the pauses in normal speech.

No modification of the recorder or its microphone is required. The voice-operated switch simply takes the place of the ON-OFF switch found on most recorder's mikes.

Operating the device is quite simple. Simply plug the cassette recorder's microphone into the jacks on the automatic switch's front panel, set the microphone's ON-OFF switch to the OFF position, plug the automatic switch's cable into the recorder, and set the recorder up to RECORD. The only other thing you need to do is to set the switch's RANGE control so that it will be triggered by your speech, but not by random noises. At highest sensitivity the author's unit would trigger on noises as far as 10 feet from the mike.

Due to the start-up time of the tape transport, sometimes the first syllable of a message may be lost. That does not usually cause any serious problems, but if it bothers you, preface your comments with something like "hey" or some nonsense syllable.

Circuit operation

The device, whose schematic is shown in Fig. 1, is designed around a LM324N quad op-amp. Housed in a 14-pin package, that op-amp requires but one supply voltage and is especially useful for battery-powered circuits.

One of the op-amps in the device (IC1-a) is configured as a very high-gain amplifier. With the values shown for R1 and R3, the gain of the amplifier is about 1000. Capacitor C1 couples the audio signal to the op-amp's inverting input while blocking any DC that might be present at the recorder's mike input. Resistors R2 and R4 bias the non-inverting input so that the DC output of the op-amp is set to approximately ½ of the supply voltage. Capacitor C2 bypasses any AC that might appear at the inverting input. That is important here due to the extremely high-gain of the amplifier. If it were not done, AC signals at the inverting input would show up in the amplifier's output and cause oscillation.

The amplified audio signal is coupled to the second stage through C3 and is applied to the inverting input of IC1-b. Resistors R6 and R10 bias that stage so that, with no signal input, the output from the amplifier is zero. Resistors R5 and R9, and potentiometer R8, allow us to set a DC voltage at the non-inverting input to which the audio signal at the inverting input can be compared.

The biasing of IC1-b is arranged so that only the negative-going half-cycles of the audio signal are detected. By adjusting the RANGE control (R8), we can set the detection level of the amplifier. Resistor R7 is used to limit the gain of that stage.

The presence of an audio signal produces positive pulse-like signals at the output of IC1-b that are coupled through R11 to the base of Q1. The collector of that transistor is tied to a time-constant circuit formed by R13 and C4. When Q1 conducts due to the signal from IC1-b, C4 is discharged through D1 and the transistor. That causes the inverting input of IC1-c to go more negative than the non-inverting input (the positive input of IC1-c is held at a reference level by resistors R14 and R15) and the amplifier's output goes positive. That positive output op-

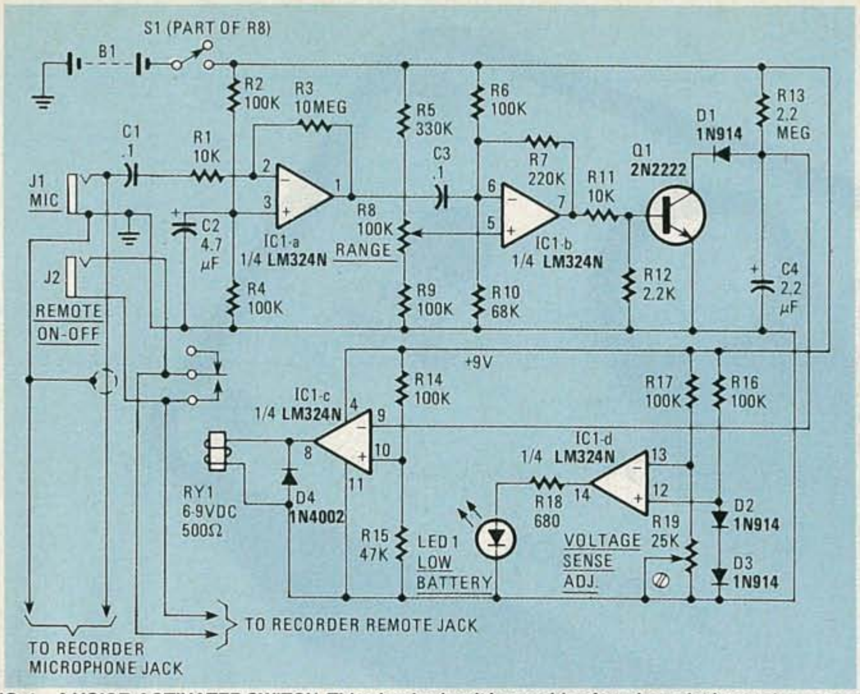

FIG. 1—A VOICE-ACTIVATED SWITCH. This simple circuit is capable of turning a device such as a tape recorder on and off in response to your voice.

FIG. 2—THE PROJECT IS HOUSED in a small project box with an aluminum front panel. Note the lead to the recorder at the right; it was taken from a defective microphone (see text).

erates relay RY1 and it's contacts close, turning the recorder on. Diode D4 protects the amplifier's output stage from being damaged by inductive kickback when the relay coil is de-energized. As long as audio signals are being detected, Q1 continues to discharge C4 and the relay is held in.

If no audio signals are detected by IC1-b, the R-C time-constant circuit charges up and the voltage at the inverting input to IC1-C goes more positive than the reference input. That drives the output to zero, de-energizing RY1 and turning the recorder off. With the values used in the prototype, the delay is about 3 seconds.

The fourth op-amp, IC1-d, is used as a low-battery-voltage detector. Configured as a comparator, IC1-d will light an LED on the front panel when the battery voltage falls to a selectable limit (more on that in a moment). Taking advantage of the relatively constant voltage drop across a forward-biased diode, we develop our reference voltage via R16, D2, and D3. The reference voltage is applied to the non-inverting input of IC1-d while a portion of the battery voltage, as determined by voltage divider R17 and R19, is tied to the inverting input. When the battery has discharged enough to allow the inverting input to fall below the non-inverting (reference) input, the output of the op-amp goes positive and drives the LED on through current-limiting resistor R18. Resistor R19 allows us to adjust the trip point of the low-voltage detector; that point should be set at around 7.5-volts DC.

Construction

Building the switch should make a nice two-evening project. The author's unit

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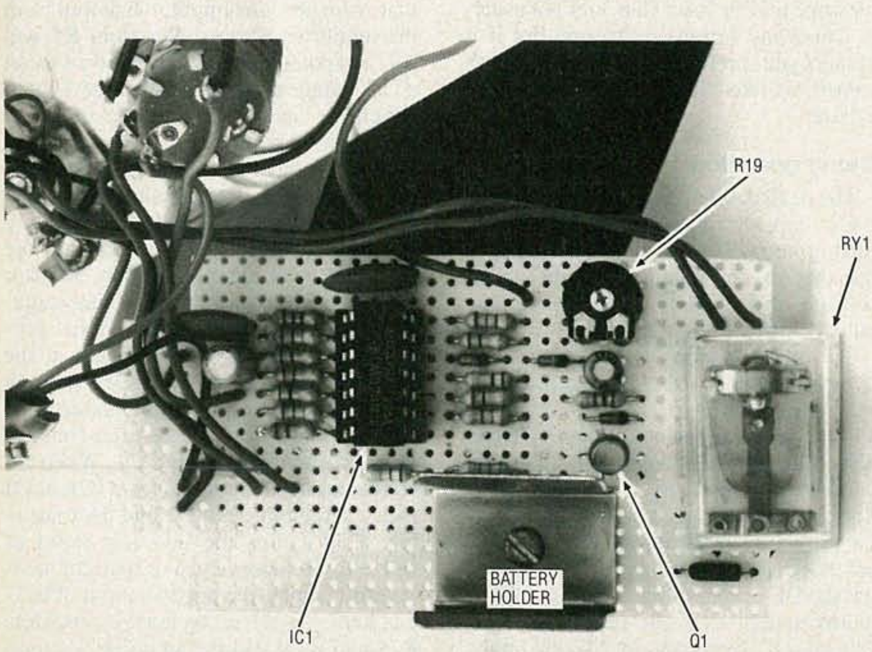


FIG. 3—MOST OF THE CIRCUIT can be mounted on a small piece of perforated construction board.

PARTS LIST

All resistors ¼-watt, 5%, unless otherwise specified
R1, R11—10,000 ohms
R2, R4, R6, R9, R14, R16, R17—100,000 ohms
R3—10 megohms
R5—330,000 ohms
R7—220,000 ohms
R8—100,000 ohms, potentiometer, audio taper
R10—68,000 ohms
R12—2200 ohms
R13—2.2 megohms
R15—47,000 ohms
R18—680 ohms
R19—25,000 ohms, trimmer potentiometer

Capacitors
C1, C3—0.1µF, 50 volts, ceramic disc
C2—4.7µF, 35 volts, electrolytic
C4—2.2µF, 35 volts, low-leakage electrolytic, Radio Shack 272-1420 or equivalent

Semiconductors
IC1—LM324N quad op-amp
Q1—2N2222 NPN transistor
D1–D3—1N914
D4—1N4002
LED1—Red LED with snap-in holder, Radio Shack 276-018 or equivalent
S1—SPDT switch (part of R8)
J1—miniature phone jack
J2—subminiature phone jack
RY1—miniature relay, 6–9-volts DC, 500 ohms, Radio Shack 275-004 or equivalent
B1—9-volt battery

Miscellaneous: Perforated construction board, project box, battery holder and clip, IC socket, wire, cable, solder, etc.

mini player-piano

ROBERT GROSSBLATT

Build the Pianomatic and make beautiful music—electronically.

Part 3 This month we'll conclude our look at the pianomatic. Figure 17, the interconnection diagram that was discussed last time, appears on the following page.

The voltage regulator

Although voltage regulator IC13 is designed to output five volts, we can change that and make it provide 7.3 volts, a good operating voltage for the Pianomatic. By raising the ground terminal, pin 2 (C in Fig. 4, September issue) above system ground, we trick the regulator into putting out a higher voltage. Whenever you need a voltage slightly different than you can get from a standard series-regulator, that little trick can save you all sorts of design problems. Nothing is without a price, however. Certain circuit conditions, such as operating the regulator near the limit of its current capability, can cause the resistor at the ground terminal, R34 here, to overheat, change value, and change the regulated voltage. So make sure you heat-sink the regulator and use a resistor of the proper wattage.

The maximum current-draw of the Pianomatic is about 100 mA at 7.3 volts, so it's not unreasonable to use batteries as a power supply. Remember though, that the voltage regulator, IC13, is a series regulator, and is not anywhere near 100% efficient. Although it will provide a steady output voltage, it requires an input voltage at least 2.5 volts higher than the desired regulated output. In the case of the Pianomatic, some elementary arithmetic tells us that we need at least 7.3 + 2.5 = 9.8 volts for B1–B8. Eight alkaline cells provide us with 1.5 × 8 =

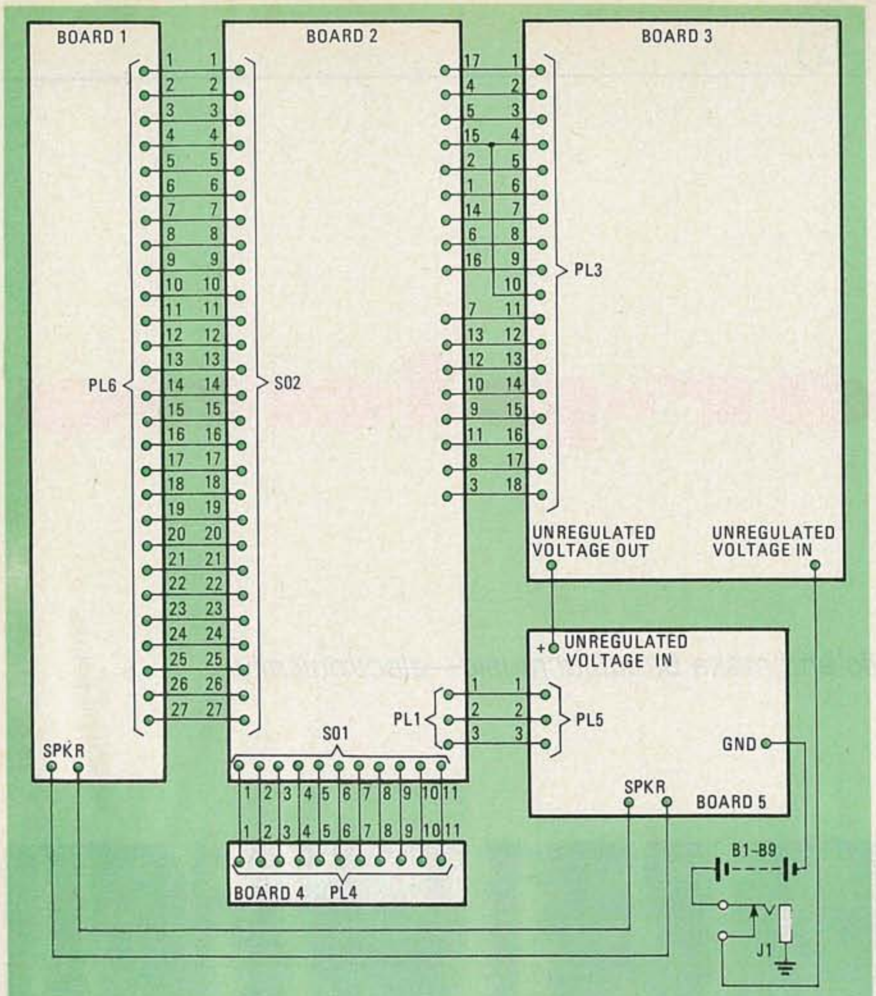


FIG. 17—HOW THE FIVE boards are interconnected. The connections between Boards 2 and 3 are also listed in Table 2.

12 volts nominally, and are a good choice. Since the current required is a maximum of 100 mA, "AA"-size cells are the smallest you should use. The inclusion of J1 in the circuit also makes it possible to power the Pianomatic from an external source such as a wall-plug transformer with a DC output.

FIG. 18—BATTERIES B9-B11 should be button-cell types with solder lugs. Those batteries can then be soldered together, covered with heat-shrink tubing, and mounted directly on board 1 as shown.

If you decide to make a little nickel-cadmium pack for B9–B11, it's a great help to get button cells, or whatever, with solder lugs on them. Solder the cells together in series and then cover the package with a piece of heat-shrink tubing of the proper size as shown in Fig. 18. The PC pattern has space for three button cells with small pigtails of wire at the end to connect them to the board. If you use different cells, other provisions for mounting them will have to be made.

Troubleshooting

In a system as complex as the Pianomatic, there are no simple ways to troubleshoot the circuit. If you make PC boards using the foil patterns provided, you won't have any electronic problems. Check for all the usual things—look for broken traces, unetched copper between the traces, bad solder joints or solder bridges, etc. If you suspect an electronic problem, do all the standard tests—are the clocks clocking, have I overlooked something incredibly basic, have I forgotten to apply power to the circuit, and so on. Check the polarities of the diodes and IC's against the placement diagrams. The last thing to check, the very last thing, are the IC's. Chances are that if an IC hasn't committed suicide and fried, there's nothing wrong with it. Wayward operation of an electronic circuit is usually due to a normal IC being fed schizophrenic data and doing its best to cope.

The connectors from board to board are male and female header strips made by AP, Sprague, and others. They come with standard 0.1-inch spacing, can be cut to any length you want, and are nice and cheap. One other nice thing about them is that they don't have to be mounted right on the edge of the board. That is a real advantage because digital boards are often topological nightmares. The male headers come either straight or right-angled, and both types are used in the construction of the Pianomatic. If you're really into saving money or don't ever expect to take the boards apart, you could hard-wire the boards together, but that is really a false saving. If you do use the connectors, be aware that they can be put

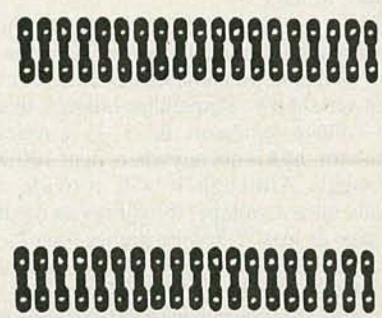


FIG. 19—FOIL PATTERN FOR HEADER STRIPS. The length of the board can be made as long or short as needed.

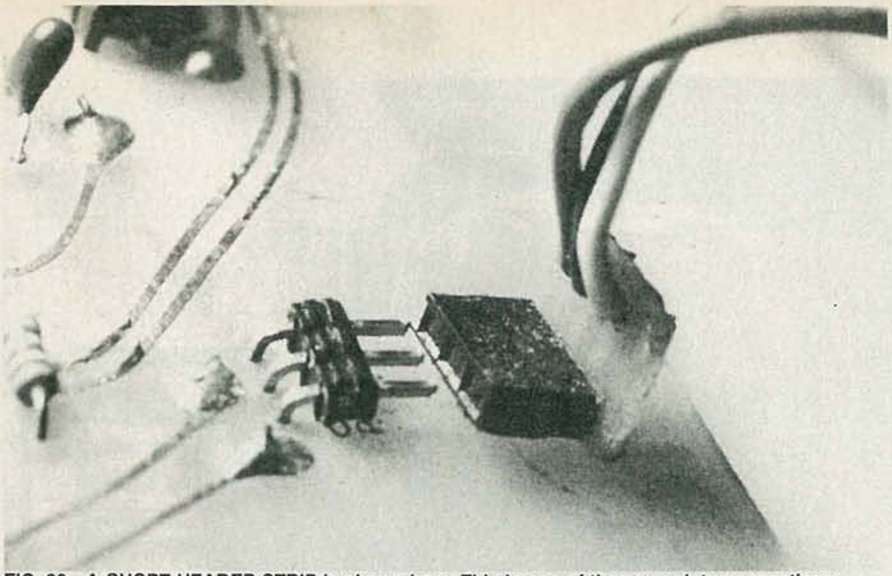


FIG. 20—A SHORT HEADER STRIP is shown here. This is one of the power interconnections.

at the end of a length of multi-conductor cable by making a small circuit board for them. A foil pattern for that is shown in Fig. 19 and you can see the construction in Fig. 20. The PC board can be made as long as you want depending on your need, and comes in handy when you have to deal with an oddball number of connections.

Calibration

The only calibration needed by the Pianomatic is the setting of the low-battery-warning trip point. Connect the Pianomatic to a variable power supply set to about 12 volts. Verify that the output of the voltage regulator, IC13, is 7.3 volts. If it's not, you'll have to change the value of R34. Raising the value will raise the voltage, and vice versa. Once you have the correct regulated voltage, lower the input voltage to 9.8 volts. Adjust R41 until the decimal points light in the display. If your decimal points lit when you supplied the twelve volts, disconnect the power and move the wiper of R41 closer to ground. When you turn the power back on, the decimal points will be out and you can then calibrate the trip point of the circuit.

One point about those displays. You'll note that they have 10 pins, but that there are only 9 mounting pads on the PC board for each. The reason for that is that pin 1 is a second common-cathode connection and is not needed. Thus, that pin can be unused without affecting operation. To keep things simple, it is cut off, eliminating the need for one of the mounting pads.

Use

The Pianomatic is very easy to use. With the control switches set to WRITE, MANUAL, and MEMORY, the display counter should be all zeros. Every time you press a key, you will hear the corresponding note and the LED in the key will light. When you release the key, the display counter will increment by one to show you which note position you are programming next and the LED corresponding to the next note in memory will light up. If you make a mistake in programming, don't worry because the Pianomatic is very easy to correct later on. After you've programmed the entire tune, push the RESET button, S6, to get back to the beginning of the page. Put the READ/WRITE switch, S2, in the READ position, and single step through the tune in MANUAL playback. If you come across an error, put S2 in WRITE and program the correct note—that's all there is to it.

There are 16 switches on the keyboard. Switches S10–S22 are used to program notes. To program a rest, S9 is used. Switch S23 is used to program a half rest (binary 14). Finally, S24 is used to enter a binary 15 (tune end) on the bus.

It's a good idea to program in a rest for the first note in a tune (the note that occupies the position shown in the note-counter display as 000), since the Pianomatic will automatically reset to that position when you are playing back a tune in AUTOMATIC. Remember that the last thing you have to program in a tune is a binary 15 (tune end). The Pianomatic will decode that and stop playing.

The Pianomatic doesn't understand the difference between a quarter, half, or whole note. If the tune you are programming requires a note to be held for three beats, you'll have to program it in three successive addresses in the memory. Although you will be playing back three notes, the transition between them is so smooth that you won't hear any interruption. Likewise, because of that smooth transition, if you want a fresh attack on a note, you'll have to program in a half rest (binary 14) before it.

The blanking of the displays and the counter resetting is handled automatically by the circuitry in the Pianomatic. If you feel that you want to change any of it, you'll have to rewire some of the switches (for the display blanking), or remove some components (for resetting the counters). For instance, the Pianomatic resets the counters to zero when you switch from WRITE to READ. If you wanted to defeat that you would have to remove D2 and C6. If you find that you want to eliminate any of the automatic control functions of the Pianomatic, study the schematic, locate the relevant parts, and take them off the board.

Table 1 (in the September issue) describes the control functions of the switches and gives you a good idea how to go about changing anything you want. Remember that none of those functions are sacrosanct. The circuit and its operation are interesting enough to teach you a lot of things if you're willing to spend the time playing "What if?"

Before you go about changing things, however, make sure your Pianomatic is working, and that you understand the information in Table 1. The effects of the switches are all interrelated and putting the Pianomatic in any particular mode of operation may require the throwing of several switches. As you can see from Table 1, the keyboard is disabled in AUTOMATIC playback. This means that if you want to use the keyboard, switch S3 must be in the MANUAL position. That is true regardless of how the other switches are set. The same sort of reasoning applies to the other functions of the Pianomatic. If you go over Table 1—carefully—you'll see what has to be done to change any of those things.

Case

A plastic piano-shaped case was built for the Pianomatic; the control switches (board 3) were located in the bench and B1–B8 were located in the wood box on which everything else was mounted (see Fig. 21). Obviously that isn't necessary—the Pianomatic can be put in any standard box large enough to accommodate the boards, batteries, etc. If you decide to make a fancy case for your Pianomatic, or even just a piano-like keyboard, here is some straight-from-the-shoulder advice—try to find a toy electronic piano that has a keyboard of the right size, cannibalize the toy, and use the keyboard. The prototype was built using microswitches for switches S9–S24, and it was an extraordinary amount of work. If you use a toy piano, the only alteration you'll probably have to make is to drill the holes in the keys for the LED's.

As you can see from the foil pattern for Board 5 (Fig. 11), the board was designed to fit in the rear of the piano-shaped case. The speaker was mounted on the rear of the board and small lengths of wire were used to connect it to the speaker terminals on Board 1. If you decide to go that route, drill a hole in the rear of Board 5 and

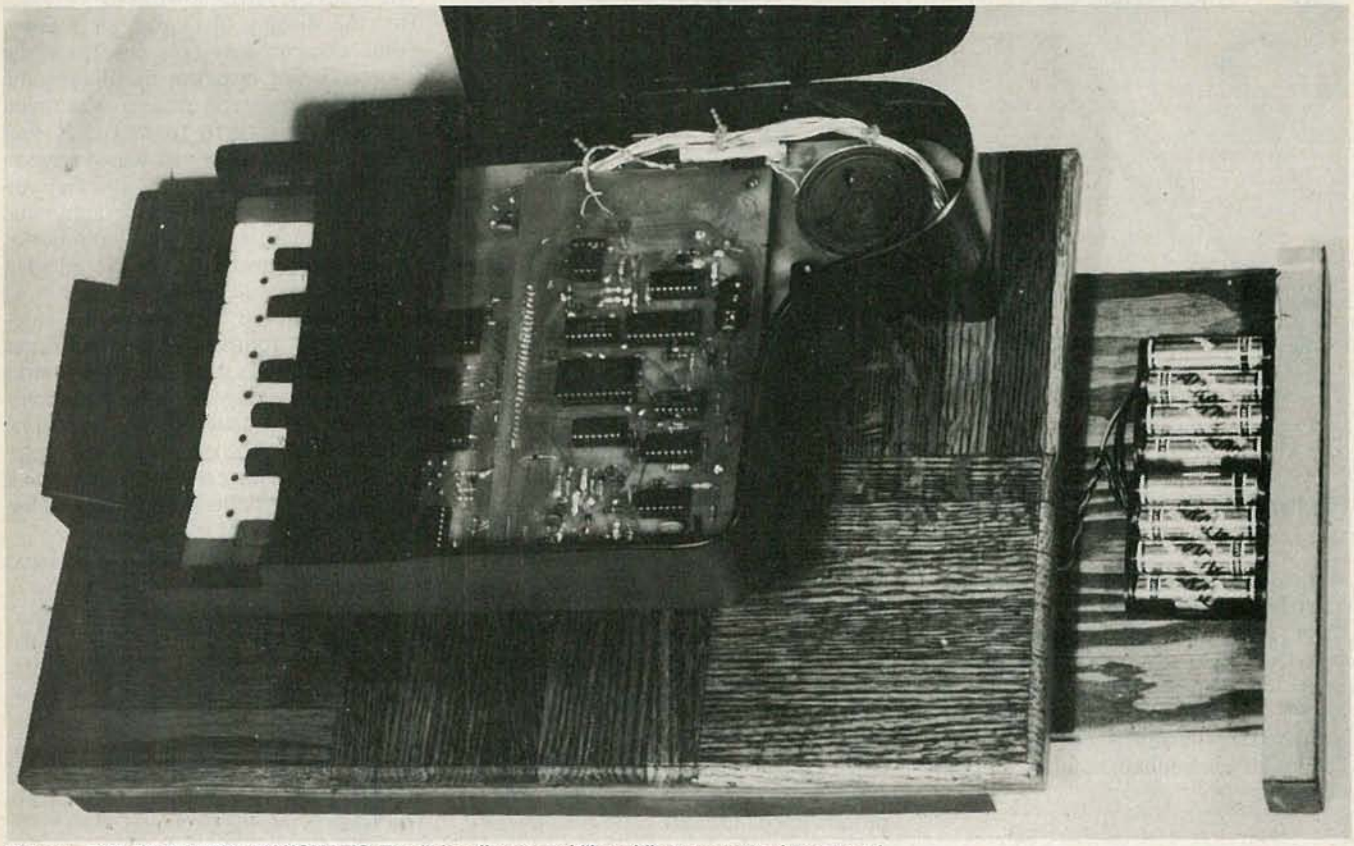


FIG. 21—THE COMPLETED PIANOMATIC. The "piano" case and "bench" were mounted on a wood base in the author's prototype shown here.

slowly enlarge it until the speaker's magnet housing fits snugly in the hole.

The note-counter display board, Board 4, is laid out so that the display digits will sit in the middle of the keyboard. Right-angled male headers on Board 4 are used as the connectors and the entire board plugs into the appropriate strip of female headers on Board 2.

Just as an aside, some of you might wonder why a 4514 was used for IC1 and a 4515 for IC6. The difference between them is only in the polarity of their outputs—otherwise they're pin-for-pin identical. The answer is very simple—one of each was on hand so they were used. The reason had more to do with inertia than anything else.

Expansion

The Pianomatic is designed to play a total of 256 notes, and only one note at a time. If you want to expand on those things, you'll have to expand the memory. If you want longer tunes, you'll have to have a memory that can handle more words. If you want to increase the range of the Pianomatic you're going to have to increase the amount of data in each word—you'll need a wider bus.

One extra bit on the data bus will enable you to insert a programmable divide-by-two network between the note generator and its clock. By doing that you can add an entire octave to the range of the Pianomatic—two extra bits and you'll get four octaves, and so on. All that's necessary to shift an octave is to divide the frequency going into the clock input of IC7. If you want to be able to play more than one note at a time, you're going to need a separate bit for each note in the octave. That means you'll need a data bus at least thirteen bits wide—a sixteen-bit bus would give you all the notes playing individually, four or more octaves, and still leave room for programmable voicing, tremolo, and so on. The only change you'll have to make in the circuitry, other than the memory, is to have a separate 50240 for each octave and a separate analog switch for each note. The last word of caution is to remember that the outputs of the note generator, IC7, cannot be connected directly together. You will have to sum them with resistors and then feed the common legs of the resistors to the input of the amplifier.

Although the Pianomatic was designed as a programmable music box, it can be used as a doorbell, alarm, telephone ringer, or anything else you can think of. By replacing the START switch, S4, with a small relay, just about any type of signal can make it play. A little bit of ingenuity on your part will easily produce a substitute for the tune selector so that different signals (doorbells on different doors, for example) will trigger different tunes. The range of applications is limitless.

A set of the five PC boards, etched and drilled, but not plated through, is available from Hal-Tronix, PO Box 1101, Southgate, MI 48195. The price is $39.95. Please add $2.00 for shipping and handling. MI residents add 4% tax.

Any construction project should also serve as a learning experience, and the Pianomatic has a lot to teach you. It uses circuit techniques that can be adopted for your own designs. It should make you think of variations in applying the principles of operation so your own projects become more and more sophisticated. Low-power memory retention and keyboard encoding are only a few of the things you can learn by understanding the operation of the Pianomatic. **R-E**

"There's something wrong with this digital readout. It's nothing but a bunch of numbers."

A user's first software purchase is often a word-processing program. Confused? We'll help you out.

Word Processing

HERB FRIEDMAN

NO ONE HAS REALLY COUNTED, BUT THERE IS PROBABLY MORE word-processing software for personal computers than any other kind of non-game program. And for good reason. Because once you get away from the classroom, the educators, and the "computer schools"—all of whom push BASIC programming as computer literacy—most personal computers are used to do things: to prepare letters, documents and reports; keep records; process mailing lists; handle bookeeping; plot the stock market, any of a thousand things. None of these require a knowledge of programming because the software you need already exists and is generally available...at the very least, for the most popular computer systems.

Since much of what you do with your computer will eventually end up in some form of report or document, word-processing software is one of the first serious software purchases.

Another reason for the importance of word-processing software is that much of the budget-priced software for low-cost desktop computers works through the word-processing environment.

Now "word-processing environment" is a mouthful that we should explain before we go any farther. There are two aspects to the word-processing environment. First, it is often used to hold down the cost of other software. For example, a lot of the time spent developing and debugging database software—which simply means electronic files or a mailing list—goes into allowing the user to enter the desired data in simple English words or phrases. If the user can use his existing word-processing software to prepare the database records, a good part of the database's development time and effort is eliminated. The database that might have cost, perhaps, $150, can be sold for $80, or $60 or less. In this instance the database comes with a patch that automatically modifies the user's word-processing software so it can be used to prepare the database records. This is called "using the existing word-processing environment." When the user must prepare data records he calls up the specially modified version of the word processor.

The second aspect of the word-processing environment modifies what is already an integrated database package to work with some other—commonly used—software, usually a word processor. For example, *MicroMailer* or *MicroVenture*, one of the finest low-cost mailing list systems, can modify itself so its mailing list records can be integrated into the *MailMerge* (MicroPro, 33 San Pablo Ave., San Rafael, CA 94903) program that runs under *WordStar* (MicroPro). This might not seem earth-shaking at the moment, but if you have to prepare form letters using the *WordStar* word-processing program, it's a lot easier to integrate *MicroMailer*'s address files than to retype the whole thing in *WordStar* format.

In both of these examples, the cost of the software or the user's time and effort is reduced by making it a part of the word-processing environment. The savings in time and money are substantial—easily $100 or more in software costs—so it's easy to understand the importance of the word processor, and why it is so popular.

In and out of memory

There are two basic forms of word processors: In Memory and Disk Overlay. An in-memory word-processor is always entirely within the computer's memory and includes the printer driver. That's the software routine that outputs the created document or text to the printer. Whatever RAM is not used by the software (which includes the driver) is available for text storage. In-memory word-processor software can originate from tape or disk. It makes no difference because a mirror-image of the software on the tape or disk is created in memory. Once the program and printer driver are in memory the storage media isn't important. For example, the superb *Telewriter-64* (Cognitec, 704 Nob Ave., Del Mar, CA 92014) software that converts the Radio Shack *Color Computer* into a professional-quality word-processor, is supplied on tape or disk, as is Radio Shack's own

Scripsit. On the other hand, the disk-based *Typitall*, from Howe Software (14 Lexington Rd., New City, NY 10956), which is perhaps the most convenient and powerful word processor for the Radio Shack *Models I, III,* and *4*, has extensive "help" screens that are too large to put in memory. They remain as a disk overlay even though the main program itself and the commonly-used screen prompts are entirely in-memory. Yet even with the entire program within memory, out of 48K of available RAM, *Typitall* leaves 32K available for the document. That's more than 5000 words before the memory becomes full and requires a save to disk or tape.

TYPITALL'S HELP SCREEN shows you a representation of the keyboard that shows control and function keys and special characters.

One major advantage of the in-memory software is that it will instantly reformat the text displayed on the screen. Also, it easily accommodates different printers because you can have several versions of the software on the same tape or disk. Since the printer driver is independent, an in-memory word-processor easily accommodates several printers without the need for manual patching of the program for each printer. This probably sounds confusing so let's untangle it by giving a specific example.

Imagine that you have a high-speed matrix line printer for general use and a daisy-wheel printer for letter-quality documents. It is more than likely they use different commands for the underscore. For example, the Epson printer might take a special software routine for an underscore that is activated with a control-U, while a Smith-Corona *TP-l* daisy-wheel requires the "EM" command to turn the underscore on and off. If you use an in-memory word-processor such as *Typitall*, you prepare two versions, one with the key you select to represent the underscore command providing the correct command for the Epson, another with the key representing the "EM" command for the *TP-l*. Now it doesn't matter which version you use to prepare the document. When you decide to print, you load the version for a particular printer and the software automatically corrects the underscore command to the correct sequence for the printer. This is a tremendous convenience that can only be appreciated if you normally use two or more different printers. I use three printers, an Epson, a *TP-l*, and an IBM *Selectric*. My document can be printed by any of the three by simply loading the desired version of *Typitall*. I don't have to go through the hassle of correcting the printer codes within the document or patching each document for a specific printer.

Keep in mind, however, that not all in-memory word-processor software permits easy interchange of printer drivers. Radio Shack's own *Scripsit* has no provisions at all for different printers. Only specially-modified versions of *Scripsit*, using third-party software, provides the underscore and additional printer drivers for *Scripsit*.

Another unsung advantage of in-memory software is that you can often print the work you have created, or just part of it, before it's stored. You get a chance to see how it will be formatted by the printer. If you don't like how it looks you can either revise the document or instantly reformat the text. (In-memory software, however, doesn't let you see how the printed output will appear on the screen–you have to print it out. We'll see shortly that some disk-overlay software does.)

For example, you set the screen width so it exactly conforms to the selected printer width. You look at the display and you don't like it. You are set for 60-column width and you will end up printing a double spaced document in 26 lines; 25 lines on Page 1, and one line on Page 2. You want it all on one page; so you set your screen width for 63 columns and instantly the screen reformats. Now you find this produces 25 lines on Page 1, and one single word on Page 2. So you reformat again, to 64 columns wide, and zap, everything fits on 25 lines. Great! Just what you wanted! You set the printer format for 64 columns and what you see is what you get—25 lines on one page.

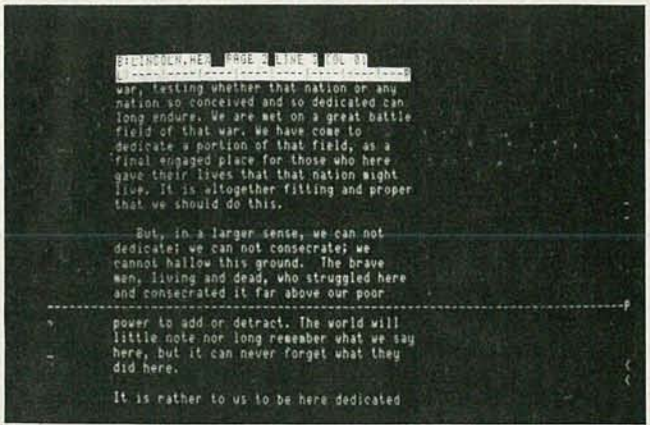
But you still don't care for the way it looks. So you touch a couple of keys and the screen format changes to 64 columns justified; meaning straight left and right margins. Aha! That looks even better, so you set the printer driver for 64 columns justified, and you print what you see.

Now virtually all decent word-processor software will reformat on the screen, but not instantly. Of the major word-processor software, only the in-memory systems are instantaneous—the others take a lot of fussing, particularly if you then use a spelling checker or dictionary.

Before we leave in-memory formatting, keep in mind that only the screen width is usually accurate. I'm assuming you have a "commercial-width" screen, which means 64 columns minimum, preferably 80 column. Anything less than 64 columns causes more problems than it's worth so we will not even consider anything less than 64 columns So how come we mentioned the Radio Shack's *Color Computer*, with its 32-column screen? Because *Telewriter-64* generates a 64-column screen by creating characters with graphics. (Must be seen to be believed.) While the column width is displayed accurately, few programs show precisely how the printed page will appear with multiple line spacing. Even *Typitall* forces the user out of the create (edit) mode into a special viewing mode to check how the hardcopy will format. Most in-memory systems don't even permit this.

In-memory queing

A major limitation of the in-memory software is the way it integrates pre-written blocks of text. Assume you have prepared four stock paragraphs that you will use for "boilerplating"; meaning, you create a document using "stock" blocks (paragraphs) of text that have been saved on a cassette tape or floppy disk. You have created a document using blocks No. 3 and 1, and you decide to plug block No. 2 in between blocks 3 and 1. This usually can't be done. In-memory systems, chain (append) blocks at the end of the document being prepared. In other words, block 2 will chain in after block 1. But once it's in (on the screen) you will have to use a block move (or paragraph move) command to move block 2 into position between blocks 3 and 1.



A PAGE BREAK is indciated by a dashed line in *WordStar*. At the top of the screen, the page, line, and column numbers are indicated.

Radio-Electronics YOUR OWN Software 1983 — Word Processing

It sounds easy enough, but it gets out of hand when you're moving several blocks into a rather large document—you tend to lose track of what is moving where.

The general rule of thumb for blocks and in-memory word-processing is: if the blocks are already in memory you can move them around in any order with almost lightning speed. If the blocks are being read in from disk or tape they chain to the end of the working document...then you can move them around in any order.

Disk overlay

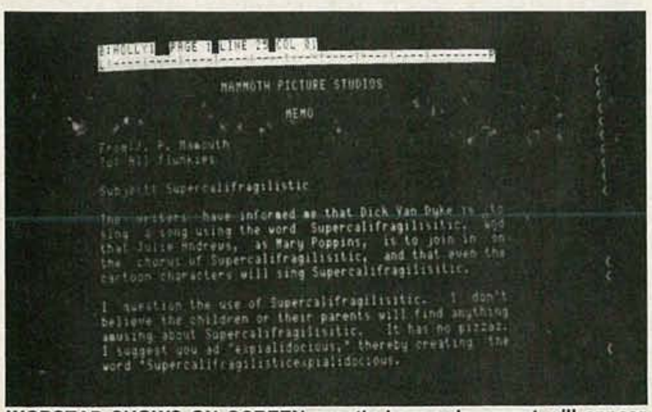
The most complex and therefore the most powerful word-processors—of which *WordStar* is the best known—are so large that the entire program is rarely in memory because it would either exceed the memory of a 64K RAM computer, or the amount of free RAM would be too small to store complete multi-page documents. To free up as much RAM as possible, the software routines that are used infrequently and the "help" prompts are not moved from disk to RAM, they are called into RAM only when needed. Also, the printer routine often resides on the disk—not in RAM—as a separate program, making it impossible to produce an instantaneous hardcopy of the working document.

For example, assume you have created a document that is a nasty letter to the local utility. You open with "Dear Rat Finks:". Somehow, you don't believe this will look good on paper and you would like to make a quick print. No way! *WordStar* and many other similar programs cannot easily make a print of a document, or a partial document until it has been saved on disk. Then the printer routine is called up and it uses the disk file to make a hardcopy. (Sometimes you can just scream in frustration.)

If hardcopy is possible only from documents already stored as disk files, it follows that if you store the document on disk but leave it on-screen and make further additions and changes to the screen version, a PRINT command will make a copy of the version on disk, not the version in the computer. Again the new version must be saved and then printed. (Yes, you again scream in frustration.)

One disadvantage of disk-overlay word-processing programs is that they are often slow—sometimes intolerably so. However, using a memory disk (RAM configured as a disk drive), speeds things up considerably.

Though disk overlay word-processors tend to have some unusual characteristics, they most closely approximate the dedicated word processors. A dedicated word processor such as a Lanier, a Wang, IBM, Xerox, or whatever, is made to do one job: prepare documents. To this end they are jam-packed with string-handling features. They will align decimals in columns of numbers and then stack the columns side by side. They allow the user to call in a reference document for on-screen comparisons or evaluations. They can call up a spelling checker or dictionary from within the word-processing program. And in particular, dedicated machines usually have separate, well-labeled keys for the most-used functions, such as DELETE, INSERT, LINE DELETE, BLOCK MOVE, EXECUTE, PRINT, etc.



WORSTAR SHOWS ON SCREEN exactly how a document will appear when it is printed out.

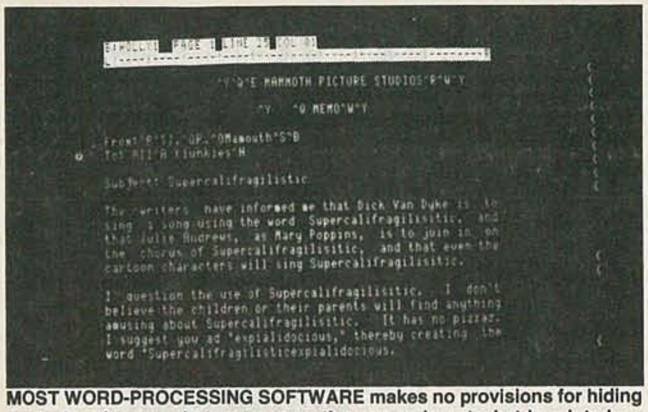
In general, the word-processing software for microcomputers only approximate the most important features of a dedicated word-processor machine. Essentially, we end up with a computer trying to function like a word processor. A really good word-processor program for microcomputers, such as *WordStar*, does a rather thorough approximation of a dedicated word processor. There are other word-processor programs that are also effective, but they don't do quite as thorough an approximation as *WordStar*.

In terms of professional features, *WordStar* is the one to which all others are compared, even by *WordStar*'s own competitors. Well...at least this is true for 8-bit machines where 64K of RAM is the general rule. *WordStar* is memory-efficient, and through the use of disk overlays packs a lot of features into 64K of RAM. With the new 16-bit machines the programmmers have lots of memory to literally waste, and there is advance information to the effect that some new 16-bit word-processors will actually out-perform *WordStar*. But this is comparing apples (8-bit) with oranges (16-bit). What happens when *WordStar* gets completely re-written for 16-bits?

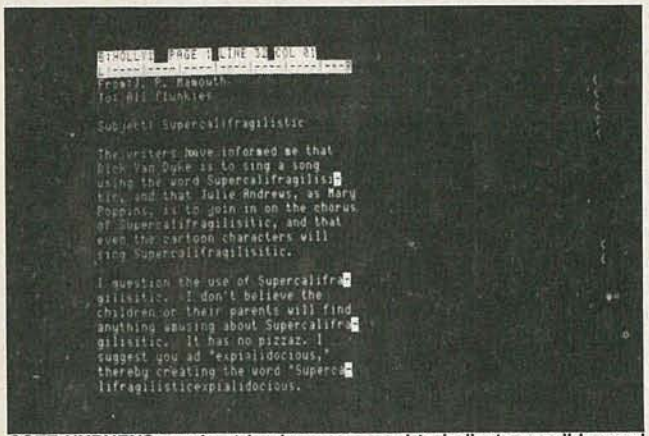
It is true that *WordStar* is a bit of a pain, particularly if it's not used every day. It has 149 direct commands, and with one or two exceptions none have any logical order. For example, in most systems the letter "D" represents DELETE. In *WordStar* it's the letter "Y". While either "I" or "V" is usually used for INSERT, *WordStar* uses "V" for insert under one condition, and as part of the command for a movement of the cursor under another condition. But more important, *WordStar* does not have automatic formatting. If you change the line width you must reformat each and every paragraph. If you have formatted and then found a misspelled word that was short a few letters, inserting the letters destroys the format for that line, and the user must manually reformat the line. In another powerful type of overlay word-processor, such as *Peachtext* (Peachtree Software Inc., 3445 Peachtree Rd., N.E., 8th Floor, Atlanta, GA 30326), inserting extra characters would automatically produce a reformat to maintain the user-established line width.

Part of *WordStar*'s formatting deficiency (if it can be called a deficiency) is caused by its absolutely accurate screen representation of the final printout—and only *WordStar* among the better-known, high-performance programs has this accuracy. A *WordStar* screen display can be user-set to precisely represent the printout, including multi-line spacing and the page break, which is a dashed horizontal line across the page. An information line across the top of the screen always indicates the page number being viewed.

It is difficult to understand the importance of a precise screen representation of the printout if you have never had need for it. As a magazine writer, I generally have no use for it. The instant automatic format, advanced insert and overwrite and multi-printer driver features of *Typitall* are more important to me when



MOST WORD-PROCESSING SOFTWARE makes no provisions for hiding control codes, so what you see on the screen is not what is printed.



SOFT HYPHENS or ghost hyphens are used to indicate possible word breaks. If the text is reformatted, the words are restored if possible.

preparing an article. But when I am creating a document that requires precise positioning of columnar material, or preparing advanced "boilerplating" where I must combine single and double line spacing with multiple paragraph widths, there is simply no substitute for complete screen/printer formatting; it literally saves hours of work.

If you require precise, or even moderately accurate screen display of the printout, you must use a program that will conceal the printer control characters. If the printer control characters are displayed they throw the screen out of true orientation because each control character, which will not be printed, is shown on the screen.

But *WordStar*...again *WordStar*...can conceal the characters so the screen shows exactly how the document will print. As shown in the illustrations, the screen display of the control characters can be turned on and off at will.

Simply because *WordStar* is so commonly used—it is the de-facto standard for word-processor software. There are many third-party enhancements that either modify *WordStar*, or work in conjunction with *WordStar*. For example, *WordStar* accommodates only four user-programmed printer control codes. If you need more than four, or if you want to use any control code that the printer can handle, then you need an enhancement known as *HexPrintR* by C.I. Software. *HexPrintR* not only allows the user to send any printer code from within *WordStar*, it allows graphic creations if an Epson *MX-80* type printer is used. (You can print those cute "Have A Nice Day" faces.).

Then there's an enhancement called Math from *Force Two, Ltd.* It imbeds a four-function calculator mode within *WordStar*. If you list a column of numbers, Math will automatically add the column if desired, just as it will do subtraction, multiplication and division.

Into heavy textbook preparation, or preparing a college thesis for one of those stuffy professors to whom style is more important than content? Then you might want the enhancement called *Footnote* from Pro/Tem that does exactly what it says...prepares footnotes for documents.

Do you need an index or table of contents for a *WordStar*-prepared document? You could muck your way through all the references and compile the information by hand, but another enhancement, called *Documate/Plus* from the Orthocode Corp. (1435 Twenty Second Ave., San Francisco, CA 94122) will create it for you from a *WordStar* prepared document.

It is unfortunate that this is beginning to sound like a plug for *WordStar* because that is not the intention. (I, for one, prefer to use an in-memory processor for general use because of its speed-of response). The simple truth is that *WordStar* has so many features that it is the one to which others are compared, and the one for which enhancements are usually written first, and the one for which accessory programs, such as low-cost but very effective data bases, are usually written first. (And this will probably bring in at least 50 letters detailing numerous exceptions.)

Keep in mind that every word processor is certain to be hailed as "...another breakthrough in the state of the programming art;" or crowned as "..the leading word-processing software for the year 19xx" (you fill in the x's). Regardless of which word-processor software you're interested in and regardless of its cost, if it doesn't have the most-needed very specific functions you want, you will never be satisfied (and replacement word-processing software usually doesn't come cheap).

It is a general rule of thumb when selecting a word processor that you look for the things it doesn't have. All have character and word insert, all have overwrite, all have some form of a block move, and all have a hundred other "state of the art" features. But does it have what you truly need? If you run a service or parts business where you must prepare bids and quotes on many different items, "boilerplating" from pre-written, "stock" paragraphs is one of the very most important features. If you run a small service business using the mails for direct advertising, does the word processor integrate easily with your present multi-selector mailing list software? If you are a student, does the word processor support the superscripts needed to mark footnotes?; does it support footnotes? If you publish a newsletter, does it support columnar screen and printer formats (side-by-side columns)? If you're into *VisiCalc* and *SuperCalc* spreadsheets, does the word processor integrate them directly into your document? Most important of all, is the word processor easy to use? If you need frequent printouts from selected paragraphs, or the screen, or a line of text or a block, can you do it easily without getting tangled in relatively complex printing routines?

Consider how frequently you will use the word processor. Many have complex and confusing commands, that are no problem if you prepare documents daily—it's easy to remember what you use frequently. But if you do only occasional word-processing, remembering more than a hundred control codes can be a real problem, and you might end up spending most of your time thumbing through the manual trying to discover how to do things. Perhaps the best arrangement for infrequent users is the "label set" supplied with Radio Shack's *Scripsit*, which consists of a set of self-adhering labels that affix to the front of the keys used for commands and control. Instead of remembering that control-D is DELETE and control-C is the paragraph marker with automatic indent, the user simply presses the keys with the actual words: CONTROL, DELETE, PARA., etc. It's a shame the other word processors don't provide labels—at most the set costs less than $1 and is one of the most convenient operating features.

Finally, if you need word processing for anything other than preparing a standard letter, try to get a demonstration that emphasizes the unusual or uncommon word-processing features of primary interest to you. If you're considering software that's available only through the mail, try to get a demonstration from someone in your area who already has it. As with most purchases, it's the only way to determine if it will meet your specific needs. **R-E**

Audio Tapes
How Different Are They?

Some people say that all cassette tapes are the same—you can't tell one from the other. We'll examine some different brands and different types of tape to see if that's true.

HERB FRIEDMAN

MANY THINGS GO INTO GETTING HI-FI PERformance from cassette tape. Among the most important are high-frequency *tape saturation* and *bias*. We'll be looking at the saturation points of two different types of three well-known brands of cassette tape to see how they compare. We'll also look at how different bias levels affect recordings made on those tapes.

As you probably know, cassette tapes tend to attenuate high frequencies. The frequency at which the tape's response is down 3-dB from the maximum is called the high-frequency saturation point. We'll take a closer look at that shortly.

Bias is a high-frequency signal that is applied to the recording head along with the AF (*A*udio *F*requency) signal. The bias signal preconditions the tape's magnetic coating to sharply reduce (almost eliminate) the natural distortion caused by the hysteresis effect of magnetic materials. Without the preconditioning, low-distortion tape recording could only be made at extremely low volume levels, and the tape noise would be almost as loud as the signal.

A rule of thumb is that the slower the tape speed, the greater the tape's sensitivity to variations in applied bias level. When dealing with the speeds associated with the reel-to-reel recorder, such as 15, 7.5, and 3.75 ips (*i*nches-*p*er-*s*econd), a bias value way outside the ballpark will still produce a decent recording. But at the (slow) 1⅞-ips speed of cassette tape, bias level becomes a critical factor in overall performance—more than anything else, it determines whether a listener accepts the recording as high-fidelity.

There are several reasons for that. Among them is the fact that the modern cassette tape has been improved to the point where, within a given price range, the output level (sensitivity) and tape noise (inherent noise level) of different tapes are similar. The same is true with the tapes' overload level, headroom (we'll discuss this shortly), and just about everything else—except modulation noise (which is a subject for the future). On any given day, one tape will slightly outperform any other tape of the same type and price range—it all depends on the particular production run and the direction you tilt your head when you read the test instrument.

The two most obvious characteristics that differ between tapes of the same class is the high-frequency response and the high-frequency saturation at standard record level (0-VU). In the final analysis, it's those two characteristics that determine whether a listener accepts the recorded sound quality as high fidelity.

I know we just said it was the bias level that did that. But that's because the bias level sharply determines the high-frequency response, and, to a lesser degree, the distortion. Within a range of bias-level values that produce low distortion, the resultant high-frequency response can range from peaked to dull (meaning attenuated highs). Until recently—because tape characteristics varied widely—to get the distortion characteristics where the manufacturer wanted them, it was not uncommon for the optimum bias value for one brand or type of tape to have no relationship to any other brand or type. So many hi-fi cassette decks had adjustable bias-systems that were keyed to equal output between a midrange and a high-frequency—usually about 1000 and 12,000 Hz. There was the time when most "quality" cassette decks had at least one, possibly multiple, bias adjustments for all four types of tape. Cassette recorders were quickly starting to resemble a jet's instrument panel.

Today, however, there are many decent cassette decks available at budget prices because the adjustable bias systems and their associated metering circuits have been eliminated. So how is the tape biased for best performance? By simply turning the tape selector to the appropriate tape type. The fancy trimmers and tweakers aren't really needed because most of the recent high-performance tapes use the same bias values. In fact, the remainder of their performance is so similar it's hard to tell whose tape you're using. You'll probably come out a winner no matter whose tape you use.

Our tests and results

To avoid drowning you in a sea of statistics, we have selected three of the most popular tape brands and types—tape recognized by many as "high-fidelity tape." There are other brands that are equally good, and we are not trying to recommend that you limit yourself to those shown. We

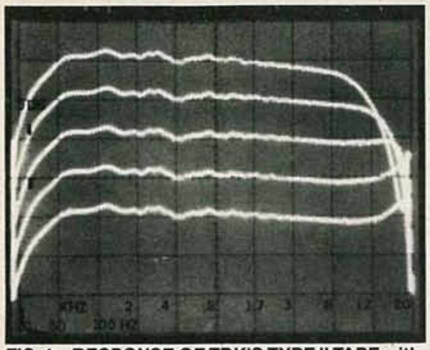


FIG. 1—RESPONSE OF TDK'S TYPE II TAPE with the recorder set to the T-M BIAS level.

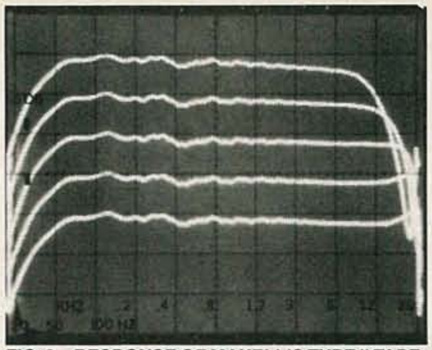


FIG. 2—RESPONSE OF MAXELL'S TYPE II TAPE with the recorder set to the T-M BIAS level.

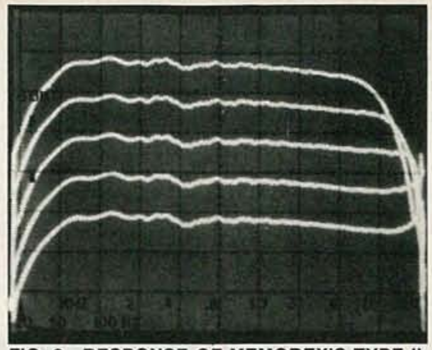


FIG. 3—RESPONSE OF MEMOREX'S TYPE II tape with the recorder set to the T-M BIAS level.

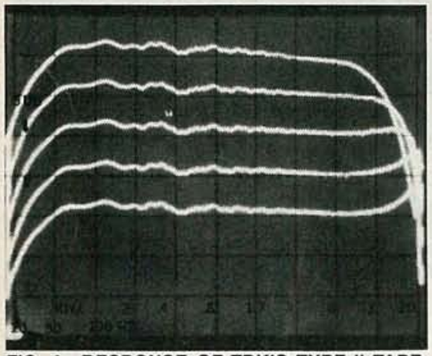


FIG. 4—RESPONSE OF TDK'S TYPE II TAPE with the recorder set to the MEM BIAS level.

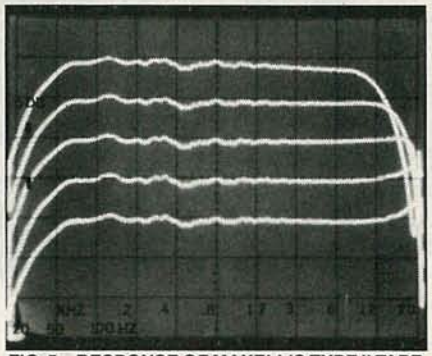


FIG. 5—RESPONSE OF MAXELL'S TYPE II TAPE with the recorder set to the MEM BIAS level.

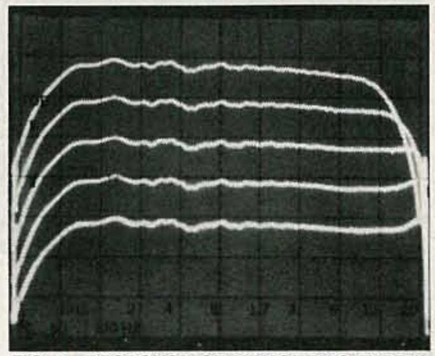


FIG. 6—RESPONSE OF MEMOREX'S TYPE II tape with the recorder set to the MEM BIAS level.

have simply selected three of the best known brands: Maxell UDII/S, TDK SA/X, and Memorex HBII. All are high-bias (Type II or chrome-type) tape. We also looked at metal tape (Type IV) from the same three manufacturers.

To avoid throwing a bunch of numbers at you, we have included many illustrations—instead of tables—that describe the tapes' performance.

The test recorder we used was Radio Shack's *3100*—a moderate-cost high-performance three-head model. Its quality is typical of what is found in popularly priced decks. Its internal metering system indicated that modern TDK and Maxell (Type II) tape use the same bias value (at least on the test recorder) so that's what we used. (The deck has a two-tone generator that helps you correctly adjust the bias value.) We'll call that bias value T-M BIAS. The machine's optimum bias for Memorex type II was slightly less than for TDK and Maxell tapes, so its value (MEM BIAS) was also used.

Figures 1 through 6 show the effect of the two bias values on all three (Type II) tapes. Figures 1 through 3 show the performance of the tapes using the T-M BIAS value. Figures 4 through 6 show what we get from the same three tapes with MEM BIAS.

In each figure, the top trace represents the output level corresponding to a 0-VU record level; the lower traces are the outputs produced by reducing the input level in steps of 5 dB until we reach the bottom trace, which is 20 dB down. That's the "standard" test level for cassette tape—you'll see why in a moment.

First, notice that the top trace in each figure shows high-frequency attenuation. While the lower traces actually rise at 20 kHz, the top traces are down about 3 dB somewhere around 8 or 9 kHz (the *corner frequency*). The attenuation is produced by high-frequency tape saturation. Beginning at about 8 kHz there will be no further increase in tape output regardless how much input is applied. The midrange can accept additional input—the so-called "headroom measurement," but it will have no affect on the high end where the saturation level remains as shown in the figures.

Notice that the high-frequency response "extends" as the input level is decreased (in 5-dB steps). It really doesn't extend—we simply are reducing the saturation caused by the input signal. At −20 dB we get a great response, which is why −20 dB is the reference level for cassette machines—at this level even junk looks good.

It is the high-frequency saturation that makes high-level high-frequency signals appear dull and lifeless. If you push the level too high, everything above 8 kHz or 9 kHz heads for the basement. At 12 kHz the response is 5 dB down, and at 15 kHz almost 15 dB down. That's not exactly "sparkling sound quality." To avoid high-frequency saturation, the record level must peak considerably below 0-VU if the program material has substantial high-frequency content.

It's interesting that in terms of frequency response and saturation level the performance from these three brands, which are in competition with each other, are very similar even when the bias levels are mismatched. That's why many hi-fi enthusiasts aren't too fussy about brands and why their tape purchase is often determined more by selling price than "sound quality." (Want to bet that this statement brings in mail from some manufacturer claiming that the shell, or rollers, or slip sheet, or whatever is more important than sound quality?)

Give or take a dB or two in signal-to-noise ratio and output level, the variations between different well-known brands of recent Type II (chrome bias) tape is slight, and overall performance is notably good. Even better performance requires moving up to metal tape, which provides both extended high-frequency response and resistance to high-level tape saturation.

Metal tape

Of all the metal tape attributes, from a listening viewpoint, the most important characteristic is reduced high-frequency saturation. That can be seen by comparing Fig. 7 to the traces for Type II tape. Figure 7 shows the output of the three brands of metal tape at two different recording levels. (Maxell, Memorex, and TDK metal tapes all appear to use the same bias values.) The upper group of traces show the output level produced by a 0-VU record level. The lower group shows the output level resulting from a

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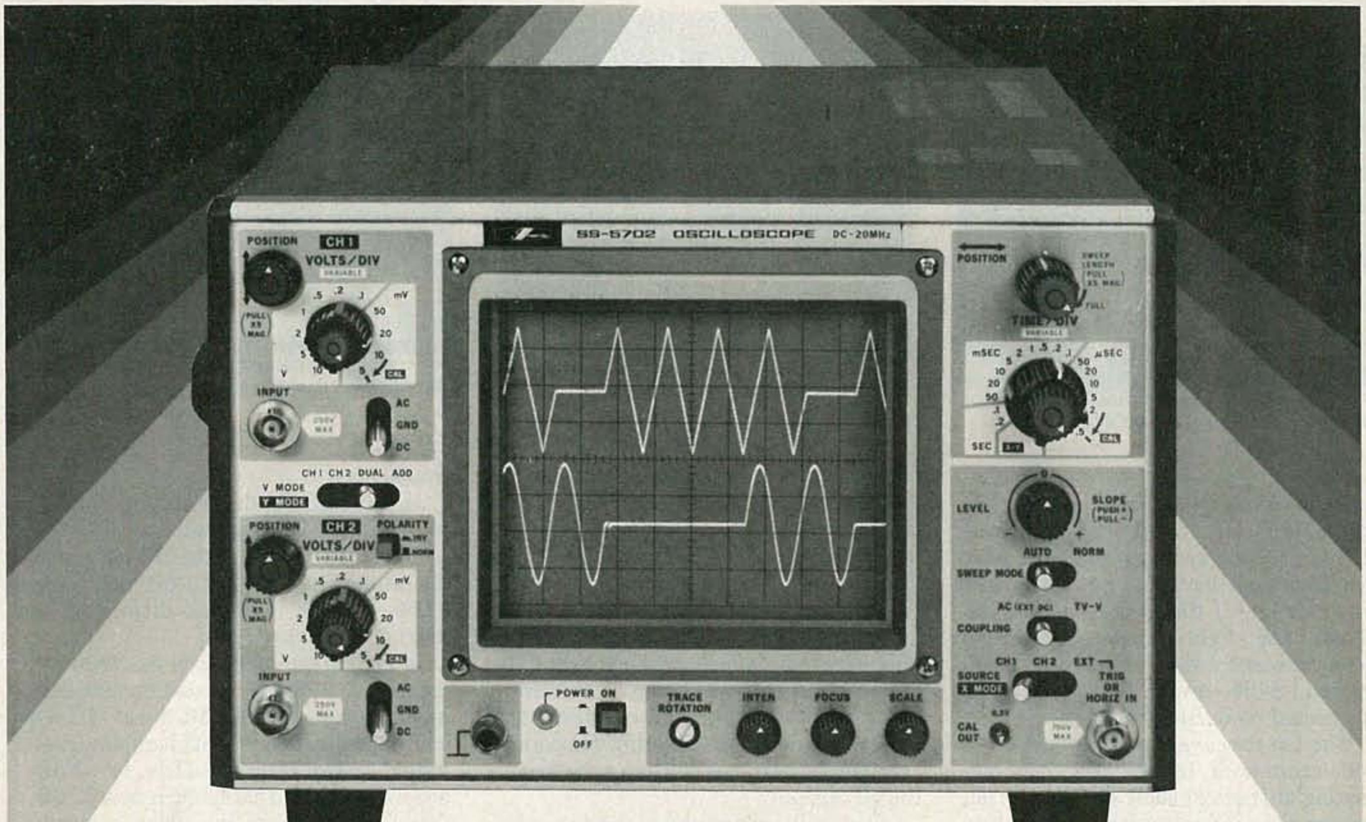

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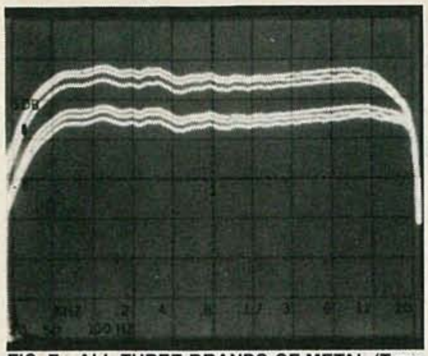

FIG. 7—ALL THREE BRANDS OF METAL (Type IV) tape. The top group shows the output with a 0-VU record level, the bottom group shows the output due to a −5-dB record level.

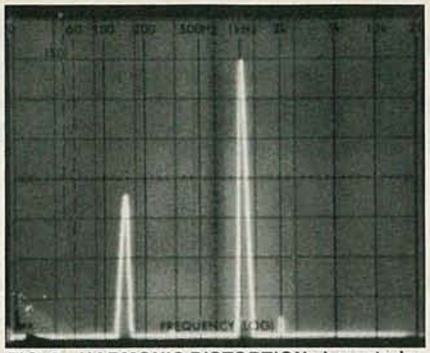

FIG. 8—HARMONIC DISTORTION characteristics of the test system.

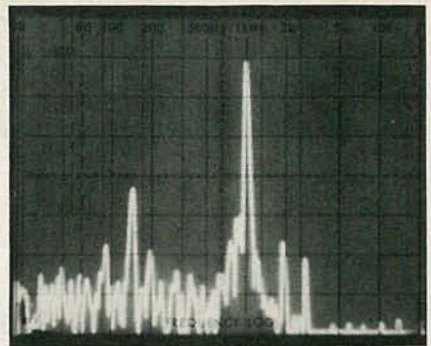

FIG. 9—DISTORTION CHARACTERISTICS for Maxell's metal tape at a 0-VU record level.

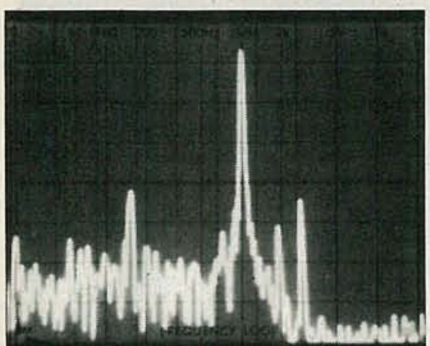

FIG. 10—DISTORTION CHARACTERISTICS for Maxell's metal tape at a +6-VU record level.

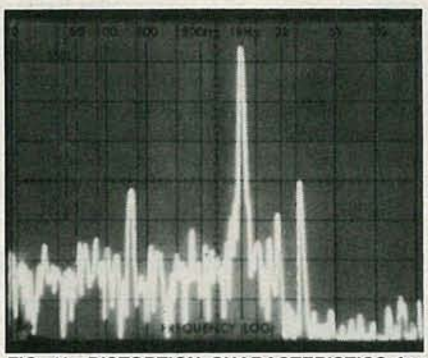

FIG. 11—DISTORTION CHARACTERISTICS for Maxell's metal tape at a +8-VU record level.

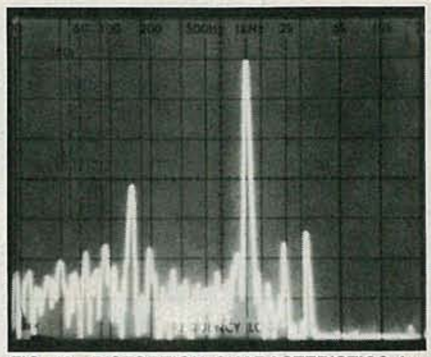

FIG. 12—DISTORTION CHARACTERISTICS for Maxell's Type II tape at a 0-VU record level.

−5-dB record level. First, note that the characteristics are almost identical. They're so similar that if the tapes were not identified, we could not know with any certainty if they were, in fact, different. The slight difference in output level between the three brands is no greater than 1.5 dB—a value that can easily be a standard production-variation.

The top traces in Fig. 7 represent a 0-VU record level. Instead of the tape saturating at approximately 8 kHz, the saturation point (or corner frequency) is now at about 13 kHz, It is this "extended" 5-kHz range that provides the brilliance when reproducing music. If you attenuate the highs above 8 kHz, the reproduction appears to be dull and lifeless. Extend the range to 13 kHz and the brilliance is restored even at maximum recording level. Considering the frequency limitations of the typical moderate-price recorder, few listeners would know or realize there was a roll-off (due to the tape) at 13 kHz.

Now look at the lower set of traces in Fig. 7—the output level from metal tape produced by a −5-dB record level. The response goes out to 20 kHz, a level of performance not attained from Type II (chrome-bias) tape until the input level is almost 15 dB down. It is this 10-dB advantage of metal tape that provides a noticeable naturalness (brilliance) to recordings made at high or maximum recording levels.

Another characteristic of metal tape is somewhat greater midband headroom. That requires some explanation. Back in the early days of cassette tape tests it became somewhat fashionable to measure the difference between the input level that produced a 0-VU record level meter reading and the level that produced 3% THD (*T*otal *H*armonic *D*istortion) at midband frequencies. Somehow, this nebulous measurement of "headroom" was intended to imply some favorable characteristic; actually, it meant the metering was poorly designed (this is how you turn a mistake to an advantage).

Eventually, metering was standardized, but improved tape characteristics—particularly from Type II and IV tape—actually permit higher recording levels than 0-VU because the reference level that drives the tape to the 3% THD standard reference level is greater than 0 VU. The effect of the higher level, or headroom, is shown in Figs. 8 through 13, where each major vertical division represents 10 dB. Since for a given tape type the performance is similar, to keep things simple only one brand of tape is used for the illustrations.

Figure 8 shows the distortion characteristics of the test system—all the associated hardware except the tape itself. The test signal is 1 kHz, whose peak represents the output level for a 0-VU record level. The small peak at 2 kHz is the 2nd-harmonic distortion, which is 65 dB down. It represents about 0.05% THD. The pulse between 100 and 200 Hz is a special low-frequency pulse to give an on-screen check of the system calibration. Ignore it; it has no relevance to our measurements.

Figure 9 shows the distortion characteristics for Maxell metal tape at 0-VU record level. Note that the 3rd-harmonic distortion (3 kHz) is 50 dB down, or 0.3%. Second harmonic distortion (2 kHz) is 48 dB down.

In Fig. 10 the input level has been increased by 6 dB. Note, that the 3rd harmonic distortion is 34 dB down (2.2%) and is greater than the 2nd harmonic distortion. In Fig. 11 the input level is +8 dB and we see the 3rd harmonic is now 32 dB down (2.5%). Note that there is not a corresponding increase in output level—the tape is saturated.

In comparison, to those three figures, examine Figs. 12 through 14, which show the same input-level conditions for Maxell Type II (chrome-bias) tape. Note that at 0-VU record level (Fig. 12) the 2nd and 3rd harmonic distortion is similar to that of metal tape. But with a +6-dB input (Fig. 13) the 3rd harmonic increases dramatically—it is only 24 dB down (6.1%), while with a +8-dB input (Fig. 14) the 3rd harmonic is 23 dB down (6.5%) with considerable increase in the 5th harmonic. In fact, we can, for the first time, begin to distinguish the 5th harmonic from the "noise floor." Its effect will be barely (if at all) noticeable because it is more than 6 dB down from the 3rd harmonic. Any further "overload" of the tape will sharply increase the 5th harmonic component.

As you can see, the bias/frequency response characteristics show that some of

continued on page 88

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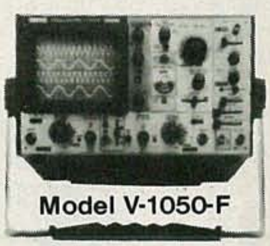

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AUDIO TAPES

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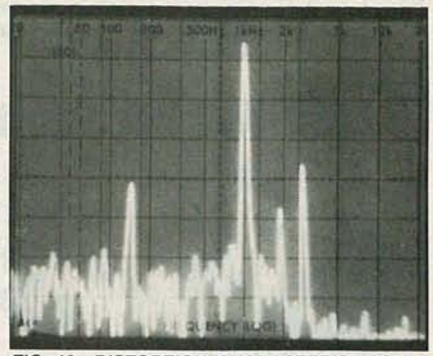

FIG. 13—DISTORTION CHARACTERISTICS for Maxell's Type II tape at a +6-VU record level.

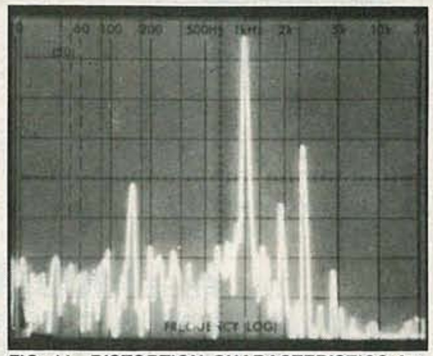

FIG. 14—DISTORTION CHARACTERISTICS for Maxell's Type II tape at a +8-VU record level.

the best known brands of Type II tapes are similar with regard to their frequency response and bias requirements. The metal tapes are so much alike that they appear to have come from the same source (though that's very unlikely).

Overload tests clearly illustrate the increased maximum-level high-frequency response and the increased "headroom" capacity of Type IV (metal) tape when compared to Type II tape.

What it all comes down to is that well-known tape brands have a reputation they deserve, and if you keep recording levels from "pinning the meter" you don't have to pay the extra cost of Type IV tape—Type II can work just fine. **R-E**

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ECL LOGIC CIRCUITS

continued from page 68

coax represent a well-defined impedance that is easily terminated, but it also provides good protection against cross-talk and noise.

There are several types of coax available for the job: RG58U, RG59U, etc. However, coax suffers from a noticeable attenuation of signal as the frequency increases. In other words, that type of connecting cable may not be suitable for all your interfacing, especially if the frequency is high and distances are long. The graph in Fig. 11 illustrates the point by showing you the maximum length of the coax as a function of input frequency

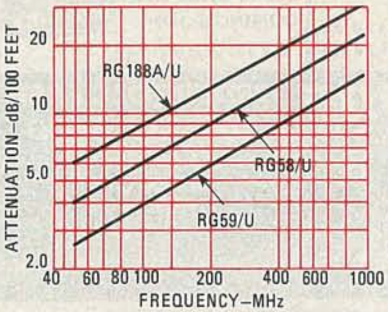

FIG. 11—ATTENUATION BECOMES A problem at high frequencies when using coaxial cable.

for three popular types.

Moreover, because of reactive loading, the fanout of a coaxial cable must be considered at high frequencies. For example, at 300 MHz it should be limited to no more than four. This is one of those situations where the logic tree comes in handy.

Unfortunately, both the open wire and the coaxial cable are afflicted by the shortcomings of a single-ended line. Things like ground loops, power-supply variations, and DC shifting from temperature differences must all be taken into account. Fortunately, there is another way to interface ECL IC's.

It will be easily understood if you first remember that an ECL gate is a differential amplifier. And because it is a differential amp, it has many of the desirable characteristics associated with differential design, including high common-mode rejection. As you recall, most ECL gates provide both OR and its complementary (NOR) output. Since the two outputs are always in mutual opposition, it presents the perfect opportunity to exploit the common-mode-rejection properties of an ECL IC. Making use of those properties allows us to connect two functions with nothing more than a twisted pair of wires.

The twisted pair is wired to both the OR and NOR outputs and connected to the input of an ECL line receiver. A line receiver is really nothing more than an ECL gate that has both inputs of the amplifier available to the user. Any noise that the twisted leads may pick up along the way will be induced in both wires equally; that is, the noise will have the same amplitude and polarity in both lines. This signal is then input into the line receiver and, as is the nature of differential inputs, the noise is cancelled out. That leaves us with only the digital information, which, of course, is what we desire.

Terminating twisted pairs

Thanks to differential design, twisted pairs provide the maximum noise immunity for any transmission line. As a result of this noise-free input, other parameters can be relaxed, including line terminations.

For reliable operation, the outputs of the driving gate must be terminated. The pull-down resistor is normally located right at the output pin, and more often returns to the -5.2-volt V_{EE} line, thus eliminating the additional V_{TT} supply, as we see in Fig. 12. You'll notice that both outputs are terminated similarly so that the driving source is balanced. Next, the twisted pair must be terminated at the receiving end. That is not a critical step, in contrast to the pains we took to assure proper termination of a single-ended transmission line.

The actual impedance of the line will vary depending on the wire gauge, insulation thickness and dielectric constant, and tightness of the twist. A 100-ohm resistor across the receiver inputs will usually be more than adequate. Any mismatch that may occur here is virtually ignored by the receiver.

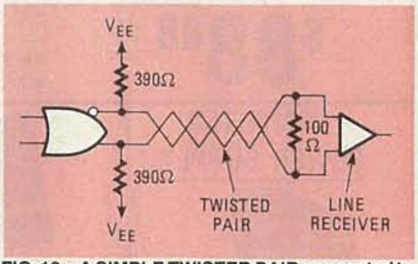

FIG. 12—A SIMPLE TWISTED PAIR connected to a line receiver can reduce common-mode noise.

And there you have it—a short course in ECL design. We must admit, though, that we have only touched on the subject. An interesting aspect of understanding microstrip theory and design, apart from its ECL applications, is that it is so applicable to many of the newer high-speed devices becoming available to the experimenter. Circuits like downlinks and ultraband communications rely almost exclusively on microstrip techniques, and are currently within the realm of practical experimentation. **R-E**

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VOICE OPERATED SWITCH

continued from page 70

was built into a 4×2×1½-inch plastic "experimenter's box" with an aluminum front-panel (see Fig. 2), but any enclosure will do. The box we chose was, admittedly, almost too small, so positioning the battery, relay, and RANGE control had to be done with care.

Most of the components were mounted on a piece of perforated construction-board as shown in Fig. 3 and point-to-point wiring was used. A small piece of foam rubber was glued to the backside of the front panel so that it would press against the battery when the panel was screwed down. That was sufficient to hold the circuit board in place.

There is one thing you must watch for if you use a metal panel. You *MUST* insulate J2 from the panel. For most cassette recorders, remote switching is done in the positive supply, making both terminals of J2 "hot." Thus, if you do not insulate J2, you will cause a direct short across the recorder's supply. Of course, the easiest way to solve the problem would be to mount J2 somewhere on the plastic part of the box.

Little about the wiring is critical, with the exception bringing the output leads to the recorder. As you can see in Fig. 2, we used the cable from a defective mike for that. As an alternative, you can make up a couple of cables and terminate them with the appropriate miniature and subminiature plugs. That should work just as well provided that you use shielded cable for the mike lead.

You can, of course, modify the unit to suit your particular needs. For instance, you could mount a microphone cartridge directly in the box, making the whole thing even more compact unit. If your cassette recorder does not have a remote jack, you can easily add one by mounting a closed-circuit subminiature jack in a convenient place in the recorder's case and wiring it in series with the positive battery lead. **R-E**

HI-FI SOUND CONVERTER

continued from page 50

haps the buzz of video from the project. Adjust coil L1 for maximum volume and then adjust L3 for the cleanest sound quality. Note that L3's tuning may be quite broad, and that the best results will be obtained over a range of several turns. That's normal, and all you need do is to center the adjustment. Repeat the adjustments several times for best results.

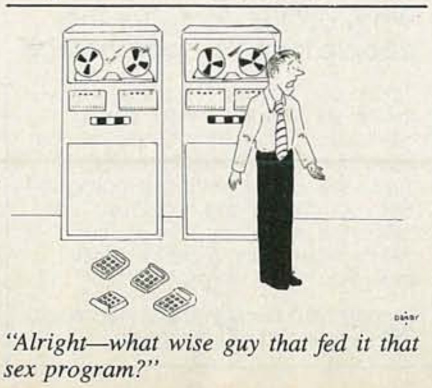
Try moving the RG-174 cable around, noting the volume of the sound. With some sets you will get great results with the cable taped onto the outside of the cabinet. With others you may have to leave the cable very near the sound section. Once you have found a convenient location, turn off the TV, unplug it, and secure the cable in place. A dab of RTV (silicone bathtub-sealer) is ideal for that. Replace the back cover of the TV.

Turn your TV set back on and tune to an unused channel. Adjust the fine tuning knob so that all you hear from the converter is noise. Adjust potentiometer R5 so that the noise is muted. Then turn back to the active channel and the sound should return. Note that this adjustment is also not too critical; the muting circuit doesn't have a sharp threshold like the one in a CB receiver.

Using the converter

Using the TV Sound Converter is a snap—once it is set up, no more attention is required. Turn on your TV and carefully adjust its fine-tuning control for the best possible sound and picture quality for each station in your area. Tune to unused channels, and adjust the fine tuning so that no sound from adjacent channels can be heard. That ensures that the converter's muting function will work properly. Then adjust the bass, treble, and volume controls to suit your taste. That's all there is to it!

You're now all set to enjoy great sound! With a good quality 8- or 16-ohm speaker attached, you'll probably be amazed at how good TV can sound, whether you're watching a movie, a sporting event, a musical feature, or even playing a videogame. And you'll probably wonder why you didn't hear about anything like this converter sooner! **R-E**



"Alright—what wise guy that fed it that sex program?"

NEW IDEAS

Low-battery warning

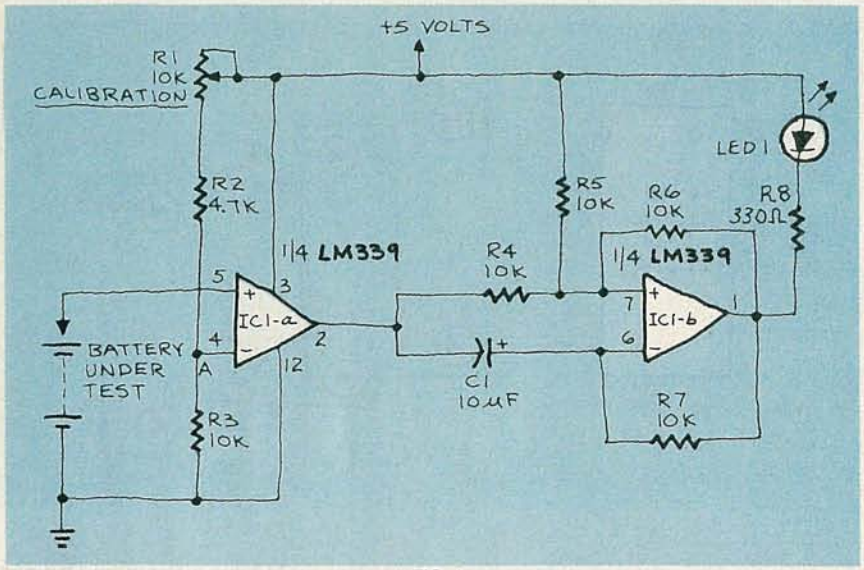


FIG. 1

WHEN WORKING WITH LOW-POWER DEvices, the use of a battery back-up becomes practical, and in some instances important. Nowhere is that more true than in the case of non-volatile RAM (*R*andom *A*ccess *M*emory). But batteries have a limited life span and their failure, if not detected, could have catastrophic results in the event that the main power source is disconnected from a memory device. After all, without some source of power the contents of the memory will be lost forever.

The circuit discussed here, and shown in Fig. 1, was designed to help prevent such an occurence. It constantly monitors the condition of the batteries and signals if their voltage falls below a certain preset value. Use of a circuit such as this is especially important if carbon, alkaline, or nickel-cadmium batteries are used. Those devices have a relatively short shelf-life. What's more, they discharge relatively quickly.

Turning to the circuit itself, a voltage divider consisting of R1, R2, and R3 is used to set the input reference voltage below which the batteries are to be replaced. That reference voltage, at point A, is varied by R1. With the voltage divider shown in Fig. 1, a range of 2 to 3.5 volts is possible.

When the battery voltage drops below that at point A, the output of IC1-a, ¼ of a LM339 quad comparator, switches from high to low. That triggers IC1-b, which is configured as an astable multivibrator.

Feedback resistors R6 and R7, coupled with capacitor C1, determine the time constant of the multivibrator. The output from IC1-b is connected to LED1 through dropping resistor R8. With the circuit values as shown, the LED will flash at a rate of 3 Hz.

Although this circuit was designed specifically to monitor RAM back-up batteries, it can of course be modified for use in just about any application where the condition of a battery must be found.—*William T. Surgeson*

"I had my home computer do my taxes. It cheated the government out of ten thousand bucks and set me up as the fall guy."

NEW IDEAS

This column is devoted to new ideas, circuits, device applications, construction techniques, helpful hints, etc.

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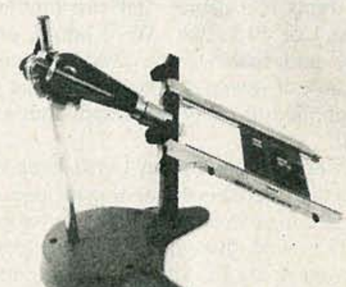

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HOBBY CORNER

Lotto device

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

STATE-RUN LOTTO-TYPE LOTTERIES have become very popular over the last several years. In those games the player picks six lucky numbers between 1 and 40. If those numbers are also selected in the weekly drawing, the player wins all or part of a "jackpot." Some of those jackpots can be quite large; recently a Pennsylvania man won 7-million dollars in that state's game. Of course if the numbers are not chosen the state keeps the player's wager.

The reason we're bringing all of that up is that we recently received a letter from George Rates (NY), who wants a device to help him pick his lucky numbers. What he wants is a device that will randomly light 1 of 40 LED's. We'll devote some time and space to the task this month because it illustrates procedures that can be applied to many other applications as well.

Even if you don't play Lotto, keep your eyes open because the same principles can be used to control any practical number of LED's. Here, though, we'll build a device to control 40 LED's, which we've chosen to think of in terms of four sets of ten each. Of course, you can arrange the LED's in any straight or mixed pattern you desire.

Figure 1 shows a 74145 BCD-to-decimal decoder IC. It has ten output lines that go low sequentially as it is addressed from zero to nine. (Only the first and last lines are shown but the other 8 are connected the same way.) Note that each output line is connected to 4 LED's. In addition, one LED in each set is connected to a line (labeled A, B, C, and D).

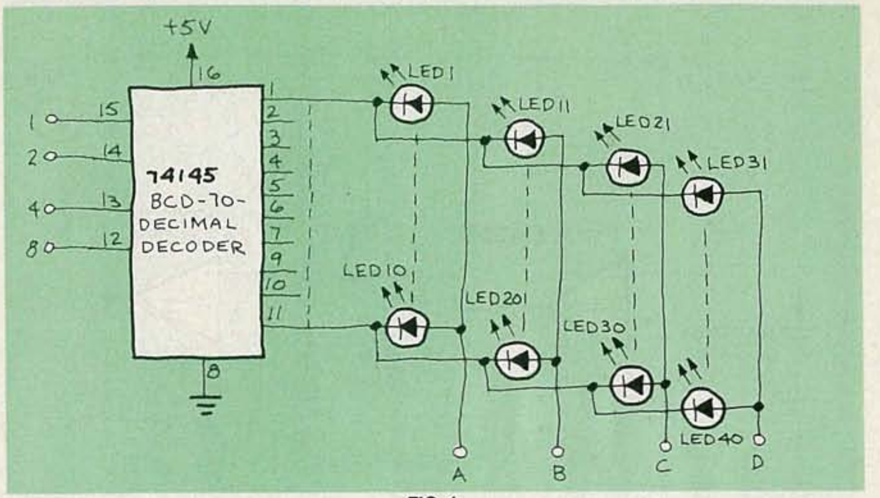

FIG. 1

Now, if we put +5-volts DC on line A, any of the ten LED's on that line will light when the address line to it from the 74145 goes low. The same applies to the LED's attached to lines B, C, and D.

So far, so good; but we need something to provide the addresses to that 74145. That is taken care of in Fig. 2. It is nothing more than a 555 oscillator driving a 7490 decade counter. Open S1 and the 555 outputs pulses at pin 3. In turn, the 7490 counts those pulses in groups of ten and outputs repeated counts of one to ten (in BCD, of course).

Now, let's test what we have. Connect the output of the 7490 to the input of the 74145. Apply 5 volts to line A and press S1. You should not see anything happening; the values of R1, R2, and C1 were chosen to produce fast pulses and the LED's will be flashing so fast you don't see them. As soon as you release the switch, however, the flashing stops and one of the LED's remains on.

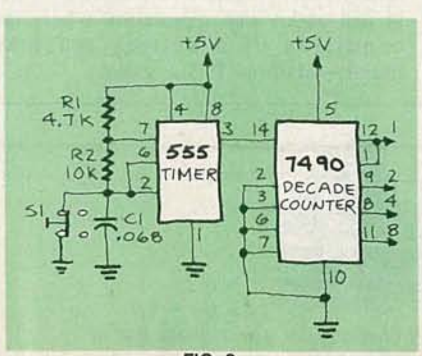

FIG. 2

You can slow the rate of the flashes to see what's happening by substituting a larger capacitor for C1. If you do so, be sure not to leave it there permanently because the "random" LED that remains lighted is only random when the LED's flash so fast that you can't stop it where you wish.

Let's stop for a moment and see where we stand. We have one set of ten LED's that flash sequentially so fast that you can't predict which will be on when you release the switch. That's fine, but we're not finished; we must get the other 30 LED's into the act.

Using all 40 LED's is only a matter of switching the 5 volts from line to line. Of course, the switching must be timed just right in order to energize a line as soon as the previous line has finished flashing. There are many ways that can be done, but we're going to use the method shown in Fig. 3.

Note in Fig. 3 that pins 2 and 3 of the 7404 are tied together to pin 8. We want only a count of four and doing that resets the counter to zero when it reaches four. If you are wondering why it resets at four when you need four counts, remember that the count does not start at one, but at zero instead.

AN INVITATION

To better meet your needs, "Hobby Corner" has undergone a change in direction. It has been changed to a question-and-answer form. You are invited to send us questions about general electronics and its applications. We'll do what we can to come up with an answer or, at least, suggest where you might find one.

If you need a basic circuit for some purpose, or want to know how or why one works, let us know. We'll print those of greatest interest here in "Hobby Corner." Please keep in mind that we cannot become a circuit-design service for esoteric applications; circuits must be as general and as simple as possible. Please address your correspondence to:

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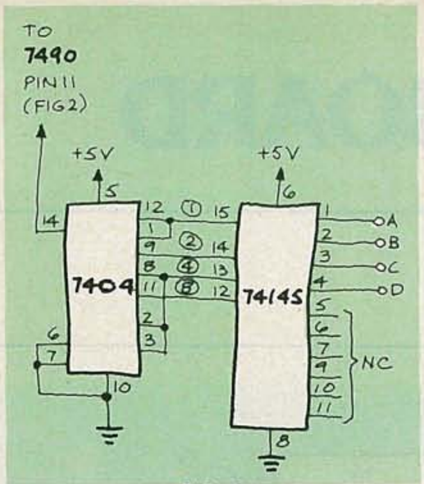


FIG. 3

For the same reason, we are using only the first four output pins of the 74145. In order to synchronize the lines with the LED's, be sure that you drive the 7404 with a signal from pin 11 of the 7490, as shown in Fig. 3.

Now we are all set but for one thing: The output of the 74145 takes the selected line to ground and we want it taken high (remember that we want a positive voltage on the LED lines). That is the reason for the 7404, a hex inverter. It changes the high's to low's and vice-versa. So, we have the selected line going high as we need.

Connect the A, B, C, and D lines from the 7404 to the like-labeled lines from the LED's and that's all there is to it. The flashes run through the first ten LED's, then the second ten, and so on, returning, of course, to the first set of ten after the fourth.

Well, George, get started building. When you are through, each push of the switch will leave a randomly selected LED lighted. Don't forget that you can arrange the LED's in whatever order best suits your needs or whims. R-E

"It shouldn't take you long to repair it. Elmo has already laid out all the groundwork for you."

THE DRAWING BOARD

Working with counters

ROBERT GROSSBLATT

IC-FABRICATION TECHNOLOGY HAS COME a long way since the first IC rolled off the production line a mere twenty or so years ago. Component density has gone from four transistors on the early chips to over four hundred thousand transistors on current ones. These mind boggling numbers have led to all sorts of good things—from five-dollar microprocessors to blister-packed digital watches sold next to the canned soup in the supermarket. The result of all this on someone (like me) who occasionally likes to re-invent the wheel to solve circuit problems has been quite extraordinary.

I've had to re-define the wheel.

What is new, expensive, and exotic today is most definitely cheap and ho-hum tomorrow. I can remember using loads of power-gobbling gates and flip-flops to build counters. Today that approach to a circuit design would be ridiculous because the array of features in available MSI (*M*edium *S*cale *I*ntegration) counters can take care of any design problem you can imagine. Counters have to be considered a basic building block of digital design—in other words, a one IC addition to a circuit.

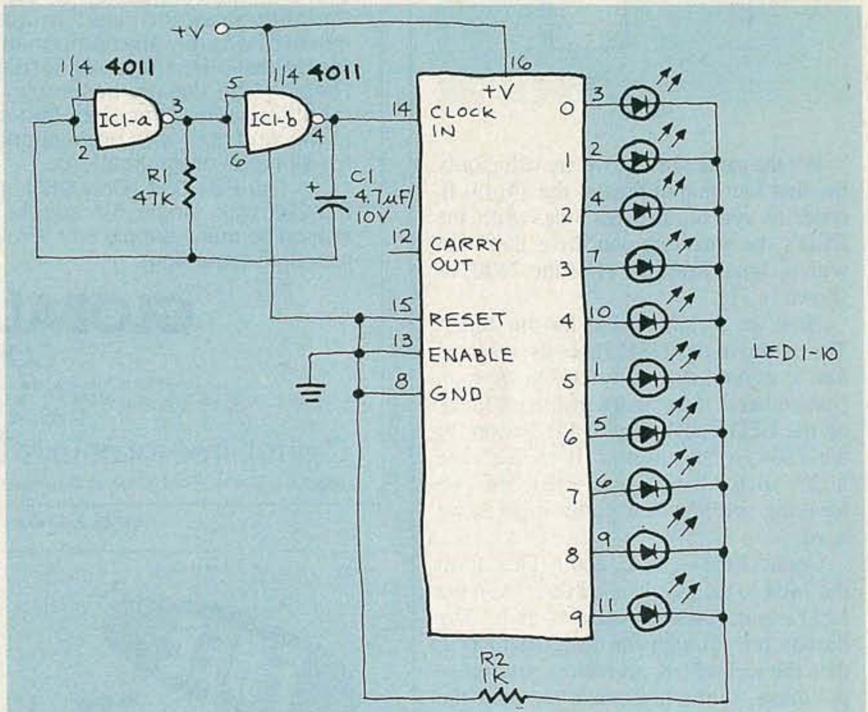


FIG. 1

Now, the word "counter" takes in a lot of territory—anything that does first one thing and then another in a pre-arranged sequence can be called a counter. Just about the only thing they have in common is that they need a power supply and some sort of clock. There are lots of ways you could divide them up but since we're calling them a basic building block, we'll make a basic two divisions—counters with a one-and-only-one type of output and those with encoded outputs.

Every logic family has its own array of counters and for our purposes, anything we say about the counters in one family will be more or less true of the counters in any other family. We'll restrict our discussion to CMOS counters since we're more interested in finding out how to use them than in chopping the top off the package and looking at the silicon.

The 4017 is a good example of a counter that has only one output decoded at a time. It has ten outputs and they go high one at a time in fixed sequence as long as the ENABLE and RESET pins are held at ground. A high on the ENABLE pin will disable the clock input and the counter will ignore incoming clock pulses. A high on the RESET pin will make the "0" output go high; it will stay that way until the RESET pin is grounded again. There's also a "carry" output that divides the input clock by ten—it's high for counts zero through four and low for counts five through nine. This IC is really a shift register with a few added bells and whistles. There are, however, some interesting things we can learn from it and some extremely useful things that it can do when we put it to work for us

First of all, this is a synchronous counter. That means that all the internal flip-flops are triggered by the incoming clock at the same time. The other possible arrangement is called a ripple counter, meaning that the internal clocking takes place like a row of dominoes—each stage triggers the next stage. Ripple counters are cheaper to make; but they're much slower than synchronous ones since stage changes happen in serial, rather than parallel, fashion. They will also temporarily output incorrect counts while the dominoes are still falling. That glitchy period is euphemistically called the "settling time" but it would be more accurate to call it the time when the output of the counter was just plain wrong. Since the speed at which CMOS operates is a function of, among other things, the supply voltage, lower voltages can lead to delays many microseconds long. During those microseconds the counter output is not exactly something you'd want to take to the bank.

The one-and-only-one type of counter can come in really handy when you have to solve certain design problems. The keyboard data encoder we designed showed two of the many possible uses for this type of counter. We used it there to select a particular switch at the keyboard and also as a sequencer to control the order in which data was latched onto the

TABLE 1

Operation	Propagation Delay	Pulse Width	Transition Time
Decoded output	500 nanoseconds	200 nanoseconds	300 nanoseconds
Reset	450 nanoseconds	200 nanoseconds	250 nanoseconds

bus. That is, of course, by no means all it's good for.

The best way to understand how the IC is used is, naturally enough, to actually use it. Since the 4017 has outputs that sequence one after another, probably the most basic circuit we can build is the sequencer shown in Fig. 1. We're using one half of a 4011 to make a simple clock we can use to drive the 4017. Any other oscillator would be just as good. The frequency of the 4011 clock follows the form F = 1/1.4RC. Since we want to be able to see the 4017 outputs in action, we'll pick values for the clock components that slow it down enough for us to watch things happen. The values shown will give a clock frequency of about 3 Hz—a nice compromise between visibility and impatience.

Everything else in the circuit is straightforward. By tying both the ENABLE and RESET pins to ground, the 4017 will count from zero to nine over and over again. Now, that isn't the most exciting thing I've ever seen but even this circuit has some important real-world uses. What you're looking at is a one-IC method of delaying clock pulses by a time period exactly equal to N clock pulses. All you have to do is route your clock to the input of the 4017 and pick off whichever phase-shifted output you want. Of course your input clock will have to be running ten times faster than the frequency you want to see at the output, but that's not much of a problem.

We can spice things up even more by using the ENABLE and RESET pins. Tying the ENABLE pin to a particular output means that the 4017 will count to a certain number and then stop. Doing the same thing with the RESET pin will give you a really down-and-dirty method of frequency division. Since the IC will reset to zero whenever the selected output goes high, any of the chip's outputs in sequence before the selected one will go high at a rate equal to f/N where f is the input clock frequency and N is the number you're dividing by.

Someone once said that there's no such thing as a free lunch and that applies here as well as anywhere. While it's obviously true that you can divide a clock down this way, it's also unfortunately true that you're paying a price for simplicity. First, the duty cycle of the output will be something like 1/N. This makes sense because the outputs go high for one full cycle of the input clock and remain low for the rest of the time. I said "something like 1/N" because there's a certain amount of uncertainty that's caused by the weirdness that goes on when the selected output goes high and the IC resets. That leads to the second price we have to pay.

When you operate the IC at 5 volts, the propagation delay (the time it takes for the IC to change to a new state) from one output to the next is about 500 nanoseconds. This means that there will be a 500-nanosecond delay between the time an input pulse is detected and the IC puts a high on the next output in sequence. Let's assume we have the RESET pin tied to output 4 and output 3 is high. Along comes the next input clock pulse—it's detected and the internal machinery of the IC starts to decode it. When that operation is finished it simultaneously turns off output 3 and turns on output 4 (remember that this is a synchronous counter). So far so good.

When output 4 goes high, it brings the RESET pin high and causes the IC to turn off output 4 and put a high on pin 3—the first output in its sequence. The problem crops up because the 4017 features asynchronous reset. That means that reset takes place whenever the RESET pin is brought high. In an IC with synchronous reset, the reset operation wouldn't happen until the next clock pulse arrived at the input. The 4017 is counting as a synchronous counter but reset is happening in a ripple fashion. Our problem is that the IC ignores incoming clock pulses when the RESET pin is high as well as during the entire reset operation. A quick look at Table 1—which shows us the characteristic operational times for a 4017 operating from 5 volts—illustrates exactly what the problem is.

In the best of all possible worlds, therefore, there's a built-in period of almost 1 microsecond (500 + 450 nanoseconds) during which the 4017 is performing its reset operation. We have to wait for the selected output to be decoded and then twiddle our thumbs while the reset operation is carried out. Since the clock input is disabled half this entire time (during reset), we'd better make sure that no clock pulses show up at the input because they're going to be ignored. The price, therefore, that we're paying for down-and-dirty frequency division is a cutback in the maximum input frequency we can have and the possibility of glitches in the count.

Next month we'll see how to add synchronous reset and take care of these other problems by a little creative gating. We'll also start designing a circuit that will not only divide frequencies by any number we want, but is keyboard-programmable as well. **R-E**

STATE OF SOLID STATE

Power transistor driver/amplifier

ROBERT F. SCOTT, SEMICONDUCTOR EDITOR

WHENEVER HI-FI EXPERIMENTERS OR AUDIO engineers begin a high-power audio amplifier, they are immediately faced with the question of how to interface the op-amp or low-level discrete voltage-amplifier devices to the power amplifier. The 741 or a similar op-amp—operating from power supplies of ±6 to ±12 volts and delivering a maximum of around 5 mA—cannot drive power transistors and Darlington configured devices. In a 50-watt RMS amplifier operating from a ±35-volt supply, those devices require 50 mA or more of drive.

Most approaches to the problem have used two or more discrete driver stages—each with its own power-supply requirements, SOA (*S*afe *O*perating *A*rea) protection, and short-circuit protection.

Intersil has taken another approach—they have developed a dedicated IC that is the total solution to the problem of driving almost all power transistors with breakdown voltages up to 70 volts. The device—the ICL8063—is a monolithic power-transistor driver and amplifier. It is intended primarily for complementary-symmetry outputs in an audio amplifier and as a driver for linear or rotary actuators, and servo and stepping motors. It is compatible with most op-amps and dedicated devices such as preamps and compandors; taking output levels in the order of ±11 volts and boosting them to ±30 volts at 100 mA to drive power transistors. For example, Intersil used 2N3055 (NPN) and 2N3791 (PNP) as the output transistors in their data-sheet circuits. The ICL8063 includes built-in ±13-volt regulated outputs to power op-amps or other external devices. Therefore, only ±30-volt supplies are needed for a complete power amplifier.

Using the ICL3068, we can build a power amplifier delivering ±2 amps at ±25 volts with only three additional discrete devices (a pre-driver and two power transistors) and as few as eight passive components. The slew rate of the power amplifier is the same as that of the 741 pre-driver by itself; except that the output current can slew up to 2 amps at 1V/μs. Other factors such as common-mode rejection ratio (CMRR), input current, voltage offset and power-supply rejection ratio (PSRR) are also the same as for the 741 op-amp. Typically three 1000-pF (.001 μF) compensating capacitors are used to insure good stability down to unity gain. The circuit will drive a 1000-pF load (as might be represented by 30 feet of RG-58 coaxial cable) in line-drive application, without problems. Quiescent current is only 30 mA from a ±30-volt power supply.

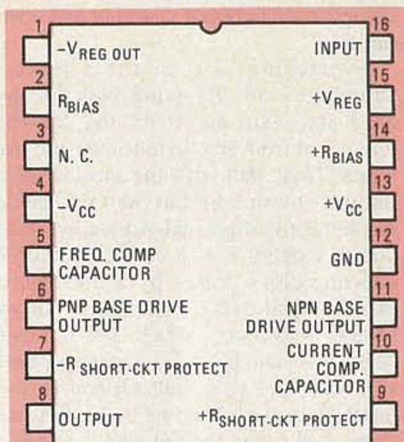


FIG. 2

A $20-per-channel 50-watt amplifier

Figure 1 is the schematic of a power amplifier using the ICL8063 to drive 2N3055 and 2N3791 power transistors to 50 watts into an 8-ohm load. (The pinout of the ICL8063 is shown in Fig. 2.) The first 741 is a preamp for FM tuner and phonograph inputs. The phono input has RIAA (*R*ecording *I*ndustry *A*ssociation of *A*merica) equalization. The second 741 is a pre-driver for the ICL8063. The complementary-symmetry-output transistor stage delivers 56 volts P-P (50 watts RMS) into an 8-ohm speaker. Distortion is less than 0.1% up to about 100 Hz and increases to about 1% at 20 kHz.

The 0.4-ohm resistors limit the maximum output current that can be drawn. The 1-megohm biasing resistors (between pins 2 and 4 and 13 and 14) are based on $V_{CC} = \pm 30$ volts and guarantee adequate performance when driving DC motors, programmable power supplies, and power DAC's. You can decrease V_{CC} from ±30 to ±5 volts in 5-volt steps by using 1 megohm, 680K, 500K, 300K, 150K, and 62K biasing resistors.

When selecting the output transistors for the amplifier, make sure that their beta (hfe) does not exceed 150 at I_C = 20 mA and V_{CE} = 30 mV. The output terminal can be shorted to ground for an indefinite period as long as the transistors have adequate heat sinks.

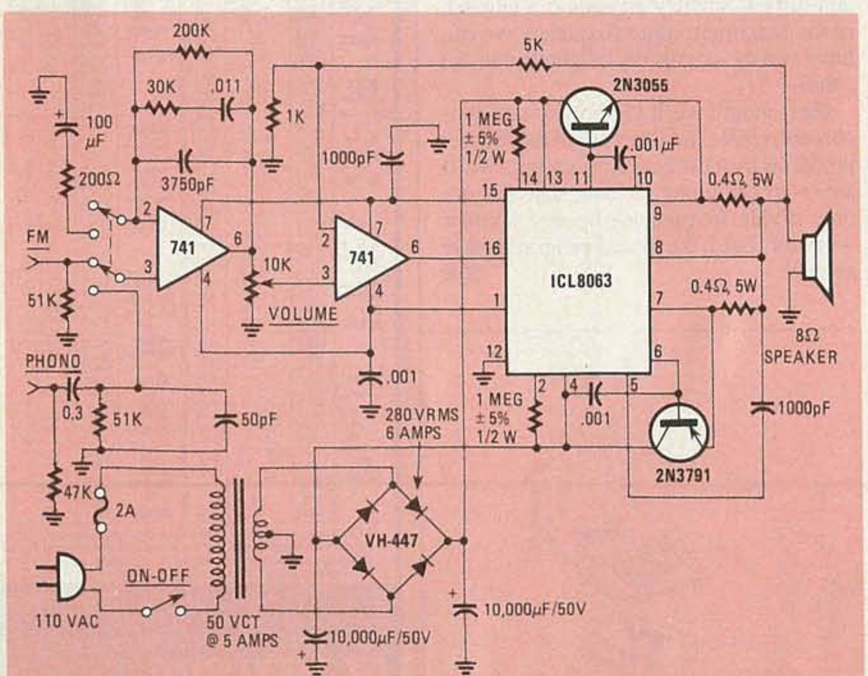


FIG. 1

Dual high-speed rectifiers

The RUR-D1610, -D1615, -D1620 series is a new family of RCA ultra-high-speed dual-chip rectifiers intended as output rectifiers and fly-wheel diodes in high-frequency pulse-width-modulated power supplies and switching regulators. The devices feature a current-carrying capacity of 16 amps per diode and a recovery time of less than 35 ns. Maximum forward voltage drop (at 25°C and full rated current) is 0.95V.

The low stored-charge and fast recovery of the RUR series minimizes electrical noise and, in many circuits, reduces the turn-on power dissipation of associated switching transistors. Breakdown voltages for the RUR-D1610, -D1615, and -D1620 are 100, 150, and 200 volts, respectively. The devices are in steel TO-204M packages. **RCA,** Box 4200, Somerville, NJ 08876.

New Voltage regulators

Motorola has introduced a series of three-terminal negative-voltage regulators capable of supplying in excess of 1.5 amps over an output-voltage range adjustable from −1.2 to −37 volts. These voltage regulators—the LM137/237/337—are easy to use and require only two external resistors to set the desired output voltage. Added features found in the new series include internal current limiting, thermal shutdown, and safe-area compensation.

The LM337T, 337H, and 337K are packaged in TO-220, TO-39 and TO3 housings, respectively. Their temperature range is 0°C to +125°C. Prices range from $1.35 to $3.60 each in 100—999 lots. The LM237 and LM237K are in TO-39 and TO-3 packages, respectively and are developed to operate in the −25°C to +125°C range. The LM137H and LM137K operate over a −55°C to +150°C temperature range and are in TO-39 and TO-3 packages, respectively. **Motorola Semiconductor Products, Inc.**, PO Box 20912, Phoenix, AZ 85036.

Memory design kit

The TMS4500-Kit from Texas Instruments is the firm's new *MOS Memory Design Kit* that comes with enough devices and supporting literature to permit you to design a 32K byte memory system. The kit contains four TMS4416's—the firm's newest DRAM (*D*ynamic *R*andom *A*ccess *M*emory)—and the new TMS4500A DRAM controller featuring an address multiplexer, refresh counter, timing and control circuits, and logic for microprocessor acess and memory-refresh sequences. The kit, available through authorized TI distributors, carries a suggested sale price of $50.00. **Texas Instruments**, Semiconductor Group, PO Box 401560, Dallas, TX 75240. **R-E**

COMPUTER CORNER

Computer graphics

LES SPINDLE*

THE GRAPHICS CAPABILITIES OF PERsonal computers have long been familiar to game enthusiasts, who follow the exploits of their favorite arcade characters in vibrant, living color. And, as the use of computer graphics has become more widespread (take Disney's *Tron*, for example), more people have become aware of what computers can do in this area. But there are many important graphics applications besides entertainment. We'll examine some of them and then we'll review a few equipment-purchase considerations.

Charts and graphs

In a business environment, charts and graphs are the most popular media used to present information. That's because they can show complex data and trends in an easy-to-follow *visual* format. (Remember the saying: A picture's worth a thousand words.) That makes graphs and charts ideal for a group meeting. And it makes their production the most popular application for the graphics capabilities of business computers.

Often, especially with a small group of people, the computer's CRT screen can be used to view the graphics. However, for presenting information to a larger group, another method, namely producing hard (paper) copy, has to be used. We'll discuss some of the ways that can be done shortly.

Many professions use computer graphics for a wide variety of applications. For example, engineers and technicians want to produce flow charts, schematics, and various types of line drawings. With some highly sophisticated systems, images can be drawn in three dimensions, and an image—a bridge perhaps—can be rotated so that you can view it from various angles. That makes the graphics-capable computer ideal for architects and mechanical engineers.

What equipment must a hobbyist or small-business owner have in order to begin making reasonably efficient use of graphics? The terminal that is used is a very important part of the system. One graphics-capable terminal from Columbia Data Products is shown in Fig. 1. We discussed many terminal-buying considerations in a previous column, but a few words on the graphics capabilities of terminals would be appropriate here.

FIG. 1

The "standard" business microcomputer or terminal has a monochrome, raster-scanned display that is satisfactory for many applications. However, multicolor capability is often more desirable. That's because if the color capabilities of a computer are used properly, the information contained in graphical form can be made clearer.

A screen format of 48 lines by 80 characters (alphanumeric; 484-by-512 pixels—picture elements—graphic) is adequate for most applications. In general, you want a terminal with a bit-mapped display. That means that each pixel is represented by at least one bit of memory. Allotting more bits per pixel increases the terminal's graphics capability because each pixel can take on various shades or colors instead of being limited to just being on or off. The maximum number of colors that can be displayed on the screen *simultaneously* is limited by the number of bits assigned per pixel. You can expect to pay anywhere from $2000 up to $15,000 for a business-quality graphics terminal.

Printers and plotters

If you need to have a printed copy of your screen graphics, you will want a graphics printer, or—for more specialized applications—a graphics plotter.

A graphics-capable impact dot-matrix printer is the least expensive way to obtain hard copy of graphic computer-output. Graphics printers can produce alphanumeric output as well as graphic output accompanied by alphanumerics. When producing graphics, the printer's character generator is bypassed. Some printers can produce color output, although better color definition is usually achieved with the use of a plotter.

The principal reason for selecting a printer instead of a plotter is for speed. However, a problem with using a dot-matrix printer for graphics is that if a large area has to be filled in, the printhead can easily overheat. Other types of graphics printers (such as ink-jet printers) don't suffer from that problem.

A plotter will be required if you require detailed graphic output. Plotters can produce a variety of drawings, charts, diagrams and graphic copy—usually with better resolution than the impact graphics printer.

A *flatbed* plotter holds a flat sheet of paper in place, while a pen moves back-and-forth and up-and-down across the paper. The size of the drawing is restricted on this type of plotter. Only very large (sometimes cumbersome) units will accommodate large drawings.

The *drum* plotter advances the paper on a rotating cylinder. A pen is moved back and forth across the paper as the page rolls by. These plotters usually use a roll of paper, not individual pages. Therefore, the size of the output is limited in the horizontal direction, but not in the vertical direction.

An *electrostatic* plotter is limited to one color and requires a complicated programming method in order to generate the line-by-line point rasters. The paper is guided in one direction, and the impressions are made by a group of styli. Special paper must be used to convert the electrostatic charges into a series of dots. A character generator can be added, allowing the unit to perform double duty as a printer and a plotter. Very detailed work is possible with these units, and they are good at handling both graphics and text material.

You can expect to pay from $800 up to about $8000 for a good graphics-output device.

Software

Of course all of the hardware we have discussed is useless without some type of graphics-software package. Most software is designed specifically for only one type of system.

An important consideration in select-

**Managing Editor, *Interface Age* magazine

ing the graphics software is its ability to interface with other software that you may be using. For example, you would want your spreadsheet program to be compatible with your graphics program.

Among other useful features to look for as you shop are: the ability to scale charts up and down, label axes, and integrate text; curve-smoothing; moving averages; and the ability to spot trends through the use of regressions. There is a wide range of features to support various systems. Take the time to view thorough product demonstrations from your dealer when you are looking for the best package for your needs.

Among all computer products, graphics hardware and software provide the widest range of features from product to product. A rule that you should follow when shopping for any computer equipment holds true here also: Be sure to define your requirements carefully before you begin to shop. Making the right selection may take a little effort, but the benefits will be well worthwhile. **R-E**

SERVICE CLINIC

Full-wave bridge rectifiers

JACK DARR, SERVICE EDITOR

THE FULL-WAVE SOLID-STATE BRIDGE rectifier is certainly common. It's also a useful and simple circuit to understand. I say that, even though it took me about a year to learn how to draw one and get all the diodes going in the right direction! (Just to show you that I really do know how, I've included one in Fig. 1.) Many late-model TV sets use a full-wave bridge connected right across the AC line. That saves using a power transformer, *but* it has one disadvantage—for the technicians working on it. You **must** use an isolation transformer when servicing it. That's because, as shown in Fig. 1, the chassis is always at least 60 volts-AC above ground. I ran into such a set a long time ago. I plugged it in, touched the chassis and *Wham!*. I said a few appropriate things and reversed the line plug but, of course, obtained the same result. I was doing things the hard way. It stung all the worse because I had an isolation transformer on the bench all the time! If you're not careful you can damage line-connected test equipment, such as your scope. (If you use a little battery-powered VOM, you might not notice it at all. But while you won't damage the the meter, you will probably damage yourself.)

When compared to a half-wave type, the full-wave rectifier output has the advantage of being easier to filter. That's because there is less ripple—both halves of the cycle are used. Remember that; it can be a valuable clue. If you have filter problems that cause the familiar floating hum-bar on the raster, you'll see two bars instead of the usual one. That one is almost always caused by a low-value filter capacitor. Scope the ripple voltage to be sure.

There are peculiarities, of course. (Every circuit has 'em.) A shorted diode anywhere in the bridge will blow the fuse or trip the circuit breaker. That's easy to find with an ohmmeter. However, if one of the diodes should open, you'll get some odd reactions. Remember these—they've popped up lately in several sets. If a diode opens, the DC output voltage will not be affected very much—at least not enough drop to be a definite clue. However, the ripple voltage will always go up, and the ripple frequency will change. That can cause some problems in some sensitive circuits.

The ripple will not have two even peaks

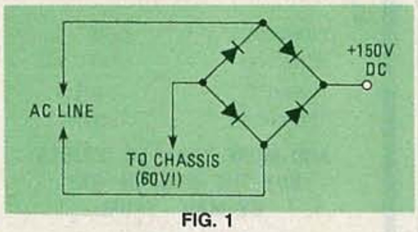


FIG. 1

(120 Hz) as it should. You may see one high peak and one low peak, or maybe only one peak at 60 Hz. Here's one example of a problem we ran into. In a fairly old set from General-Electric with separate diodes in the bridge, the sync was affected. That caused some sort of spike voltage that got into the sync circuits and made them false-trigger.

Another, and more baffling, case showed up in a Midland model *16-032*. That little import job came in for lightning damage. One diode and a capacitor, plus the regulator transistor, were replaced; and it played—for a while. It developed an intermittent condition. Human-bar floated up the picture and a horizontal pull showed up in the middle of the raster. Turning it off and back on stopped that, and it worked for a short time. After some wheel-spinning, we scoped the ripple. When the fault showed up, the normal 120-Hz ripple disappeared, and a 60-Hz waveform came on. It was a bit higher than normal, but didn't look too big.

We were scoping through the 11-volt regulator. When the fault occurred, a definite 60-Hz spike showed up in the output! (If this circuit worked as it should, that shouldn't have gotten through the regulator.) We found that one diode in the bridge (separate) got warm when the fault appeared; that pointed to excessive current; the other diode in that leg was cold. Replacing the cold one cleared up the problem.

Some time back, I made a memorable goof; I said, positively: "Silicon diodes never open; they always short." Less than two weeks later that problem came in and I stood in my shop and looked at an open silicon diode! (I got a correction out as soon as possible). I would have said "Silicon diodes are never intermittent," but something told me to keep my mouth shut. Sure enough, the problem we just discussed was really the first time I'd run into a definitely intermittent silicon diode, but I had a feeling all along that they were there somewhere. Moral: In this business, *never* say anything is impossible. If you do, it'll come back to haunt you.

This is a memo to fellows who write to the Clinic for help. *Please* guys; do *not* send mail to Boulder, Colorado! That's our subscription department; they have to send letters all the way back to New York before I can get 'em. That means that it takes a couple of weeks longer to get an answer back.

Here's one more, and more important memo. When you write in, remember to put your name and address in the letter! Even though that sounds silly, I've had quite a few letters in the last few months with no address at all. That's very frustrating—for some reason, those letters always ask questions that I know the answer to! If I can't find you I can't answer you.

Finally, here's a note for the "Help! Help!" department. If anyone out there has an 1LD5 octal tube, let Kelly Peters, Box 215, Alsen ND 58311 know about it. He needs one for an old Zenith he's restoring. *Don't* write me; tell *him* about it!

R-E

SERVICE QUESTIONS

DRIVE PROBLEMS

I read your column on horizontal sweep circuits and I'd like to argue a few points. In sets with the common problem of a hot horizontal-output transistor, check the amplitude *and* the waveform of the drive. If the drive is too *low*, the transistor will run hot!

In one case, the set had a good picture and good everything else, but the horizontal output transistor got very hot. I've found an open electrolytic bypass capacitor. The waveform was about half of drive.

In another case, a set had good picture and good sweep, but poor brightness regulation and the horizontal output transistor again ran hot. The cause of that was a resistor in the base of the horizontal-output transistor that increased in value. Another symptom I saw was that the output transistor and the driver transistor both got hot. The waveform out of the oscillator was good, however. The cure was to add a 0.1μF capacitor across the 560-ohm resistor in the base of the driver. That makes it turn off and on completely, as it should—Eugene Spooner, Charlotte, NC.

ODDBALL CURE

I wrote to you about a TS915 Quasar with a strange problem. Blobs of different colors would creep up the screen three or four times a minute. You suggested checking the filter capacitors, etc. I did that, but it didn't help. After going around in circles a couple of days, I found out that the problem was with the degaussing coil. It was turned on all the time! The quick cure was to disconnect it.

Thanks to Leonard Pochop of Ontario, CA for that one. He used my favorite cure for degaussing-coil trouble!

COMPUTER-VIDEO PROBLEMS

In the May issue, there was a question from E.L.G. about a problem with a *TRS-80* microcomputer with an intermittent video output. I had the same problem on my *Model III*. It turned out to be a poor contact on the CPU socket. It fooled me for a while because it seemed to be thermally sensitive. The cure is simply to clean all the pins and socket. *A.K.?*

I'd like to know who to thank for that, but I can't read his signature!

HANDY HINTS

I'm a technician who services G-E televisions. In the June "Clinic," a man wrote that he had a problem with cold solder joints in a 17AC 602. The SCR he mentioned, Q980 is a start-up SCR; when he put the jumper wire in he got a dark blob. The reason for that is that the SCR is now gated on! Take the jumper out.

It seems that a lot of people are having problems servicing the AB and AC chassis. What I did was to make up a chart of the connections that should be suspected. Following the chart, you can do some point-to-point wiring to find the problem. Be sure to use a low-wattage iron when soldering on those boards. If anyone wants information on how to get the chart, send me a note and a SASE—Douglas Stalker, Box 35A, East Chatham, NY 12060.

VERTICAL SWEEP PROBLEM

The raster is about 4-inches high in this RCA CTC-63XP. If I unhook the 47K resistor that goes to Q102, the horizontal-disable SCR, the raster comes back. Cooling the SCR brought the problem back again, as does cooling CR203, a zener diode. I'm completely stumped, have you got any ideas?—D.V. Hollandale, MN

I'd try a new SCR and zener. Check for voltage across the zener to see if it's working normally. In this chassis, the connection from the disable circuit goes to the vertical circuit! Frankly, I don't know why. So, any problem here could upset the vertical sweep.

(Feedback: The new SCR brought in a jumping raster. I ordered a new hold-down control, R107, adjusted it, and that cleared up the problem entirely.I found that if R110 or R105 changes value, you will have the same problem. Dave Veldman, Hollandale, MN

CREEPING HIGH VOLTAGE

I've been using a trick for several years on CTC-51 -2-3-4-5 sets to cure a high-voltage creep. (It was discussed on page 99 in the July "Clinic.") I connect an 800-volt or 1-KV diode from the control grid to ground, with the cathode going to ground. With that, the grid cannot go more than 0.7 volts positive. It's saved a few tubes for me!—A.S., Willodale, Ontario.

Well, that should work. However, I still prefer replacement of the faulty tube; you may have to try two or three to find one, but it works. The control grid shouldn't go zero or positive, but even if it only "goes in a positive direction" it's enough to cause excessive current in the output tube. You pay your money, and you take your choice.

NO AC SWITCH?

When poking around into some AC/DC devices I've noted that many manufacturers leave the AC supply in an always-on condition when the unit is plugged in. When the unit is turned off, only the DC side of the supply is disconnected. Is that considered a safe practice? Of course the transformer/rectifier doesn't use much power, but couldn't it possibly cause trouble if the device is left plugged in with the switch off? Instructions never seem to include a caution to remove the AC plug.—M.W., Mt. Dora, FL

I think that the answer to that is a 5-letter word (cheap). When the DC is turned off, the set draws no measurable current. So it's cheaper to use an SPST than a DPST switch.

CONVERGENCE DRIFT PROBLEM

I worked on this Zenith 12A8C14 for quite a while on a problem of convergence drift. You told me to warm up the diode assembly. That did not help. I finally decided to take it out; I replaced it with three 300-volt 1-amp diodes. Presto! No convergence drift even after many hours. Thanks for pointing me in the right direction!

Thanks to Jerry McAulliff of Lincoln, Nebraska for that feedback. R-E

NEW PRODUCTS

For more details use the free information card inside the back cover

HOT-AIR PENCIL, model *AG700,* has a built-in, electronically controlled air-supply pump and flow-heating system. It is designed for micro-electronic soldering and desoldering operations.

CIRCLE 111 ON FREE INFORMATION CARD

Measuring approximately 10 × 9 × 5 inches, the unit includes a 24-volt/50-watt output pen, adjustable from 50°C to 450°C, a 10-position air-capacity regulator, and a detachable chip tweezer. The model *AG700* is priced at $1,177.85. — **Weller,** The Cooper Group, PO Box 728, Apex, NC 27502.

CIRCLE 000 ON FREE INFORMATION CARD

CB RADIO SYSTEM, the *K-40,* consists of the K-40 speech processor microphone, the *K-40* CB radio, and the *K-40* magnetic-mount antenna.

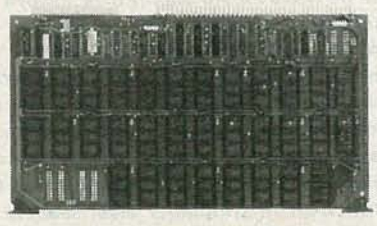
The transceiver is 1¼ inches high, 4¼ inches wide, and 6¾ inches deep, and will fit into many jacket or suitcoat pockets. It includes a frequency-synthesizer circuit, and heat-resistant transistors are used in all critical circuits.

CIRCLE 112 ON FREE INFORMATION CARD

The receiver is a dual-conversion superhetrodyne type with automatic noise limitation in the audio stages. The microphone has auto-sensitive amplifier circuits that adjust to voice levels from two inches to two feet away. There is also a tone-control switch to provide high-pitched transmissions during congested traffic conditions, or to switch down to a mellow tone. It can be clamped on to any metal surface; no microphone hook is needed.

The antenna is manufactured to tolerances that assures ±.0005″ accuracy of coil spacings. The *K40 CB Radio System* is priced at $199.00.—**American Antenna,** 1500 Executive Drive, Elgin, IL 60120.

EPROM BOARD, model *M60155,* can support up to 512 kilobytes of EPROM programming when fully loaded with 27128's. Alternatively, it can be loaded with 2764's or 2732's for a maximum storage of 256 kilobytes or 128 kilobytes, respectively. The board can decode a full 24-bit address, and be jumpered to decode only 20 bits, if so desired.



CIRCLE 113 ON FREE INFORMATION CARD

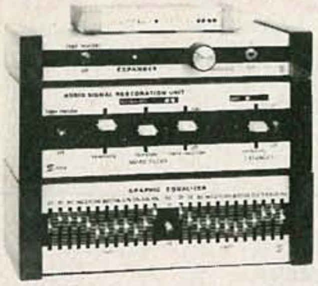
The memory can be accessed either as 16-bit words or 8-bit bytes with full Multibus byte swapping. The 2764's are supported on standard boards. The use of either 2732's or 2718's is a factory option.

The model *M60155* is priced at $525.00 — **TSD Display Products, Inc.,** 35 Orville Drive, Bohemia, NY 11716.

CORDLESS-TELEPHONE ANTENNA. *The Long Ranger Plus,* increases cordless-telephone range without the use of ground radials. Designed for do-it-yourself installation, no potentially warranty-voiding connections or modifications to the phone base station are required. *The Long Ranger Plus* is supplied complete with cable and all hardware necessary for mast mounting; or it may be mounted indoors with utility clips or

continued on page 117

Radio-Electronics mini-ADS



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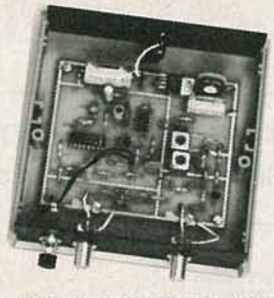

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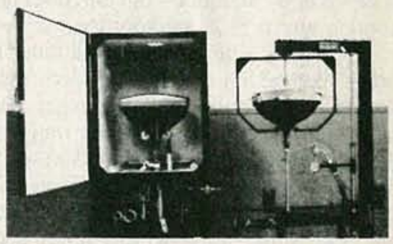

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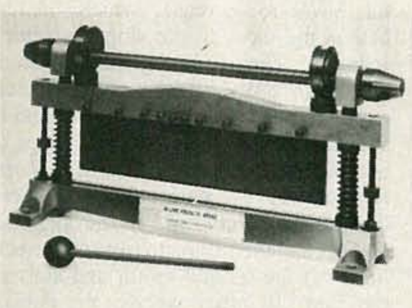

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COMMUNICATIONS CORNER

A computer-controlled antenna tuner

HERB FRIEDMAN, COMMUNICATIONS EDITOR

BECAUSE OF THE SOMEWHAT EXTENSIVE, if not excessive, attention given microprocessors by newspapers, magazines, and even TV news programs, it's not uncommon to find that to many persons outside the computer industry the term computer is synonymous with microprocessor. Actually, the two don't necessarily have a relationship. We'll look at an example of that this month: an automatic antenna tuner, the J.W. Miller (19070 Reyes Avenue, PO Box 5825, Compton, CA 90224) model *AT2500*. While that tuner (shown in Fig. 1) uses a computer, it is an *analog* computer—the unit does not contain any type of microprocessor.

The Miller automatic antenna tuner is much like the average high-performance non-automatic tuner. Among other features, it's rated for a frequency range of 3.0 to 30 MHz at better than 2500 watts PEP for sideband; it will match its 50-ohm input to an output between 10 ohms and 300 ohms, and it will accommodate longwire and coaxially fed antennas. The tuner also has a built in output-power meter and a remote directional coupler for an SWR meter; and there are several protection devices—such as automatic drop-out of the linear amplifier or reduced output power through the transmitter's ALC (*A*utomatic *L*evel *C*ontrol)—in case the SWR is excessively high.

Now all this sounds, or at least reads, familiar—just another feature-loaded antenna tuner. To some extent that is true. Both the loading coil (the "band selector") and the tuning capacitors have knobs and can be manually adjusted for minimum SWR (or best match, whichever term you prefer). But in this instance manual "tuning" is mostly used for tweaking the tuner.

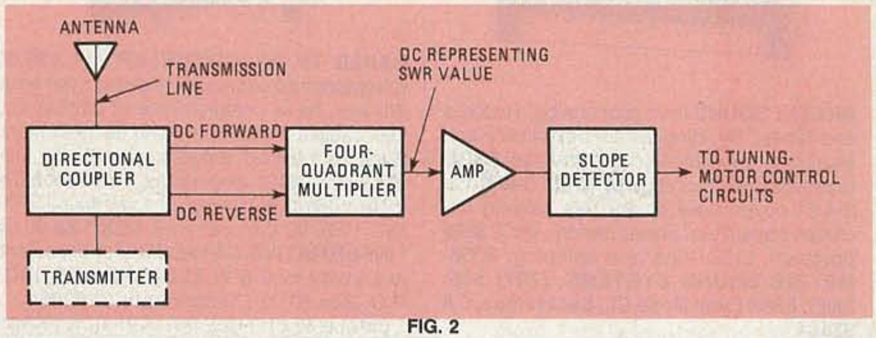

FIG. 2

In the Miller tuner the "bull" work is done by a computer. The instant the transmitter is keyed, the tuner samples the conditions on the transmission line and feeds the information to a computer that controls small motors attached to the tuning capacitors. If the computer senses an SWR that exceeds a minimum value (selected by the user), the tuning motors automatically adjust the capacitors for continuously decreasing SWR. (The loading coil is pre-set by the user for a specific operating band or frequency range.) When the computer senses that the SWR is below the user-selected minimum SWR value it makes no further tuning adjustments. The average computer-controlled tune-up takes about 15 seconds.

The computer itself consists of the remote SWR detector, a slope detector that senses increasing or decreasing SWR, and motor-drive circuits (fed by the slope detector) that control the motors attached to the tuning capacitors. (See Fig. 2.) The forward and reverse DC outputs from the remote directional coupler—which can be connected directly at the transmitter's output (where it really belongs)—is fed to a four-quadrant multiplier. There, the SWR is calculated from the two DC voltages sent by the remote coupler. The SWR value is represented by a DC voltage that is fed to an operational amplifier and on to a slope detector.

How it works

At the first instant of operation, one tuning motor steps. Assume that causes the SWR to increase, which, in turn, causes the input to the slope detector to increase. That is recognized as an increase in SWR so the slope detector causes the first motor to turn off and the second to start. As long as the slope detector senses a decreasing slope, representing decreasing SWR, it keeps the second motor on. If the slope decreases and then starts to rise, the detector turns off the second motor and activates the first. In other words, the detector alternately steps the tuning motors so that the slope tends to decrease.

At some point the motors must be stopped or they will constantly "hunt" for a lower SWR. That is accomplished through a front-panel TUNE SWR selector that is set by the user to the minimum acceptable SWR. Let's assume the selector is set for 2:1. When the SWR is reduced below the selected value—in this

continued on page 117

FIG. 1

NEW PRODUCTS

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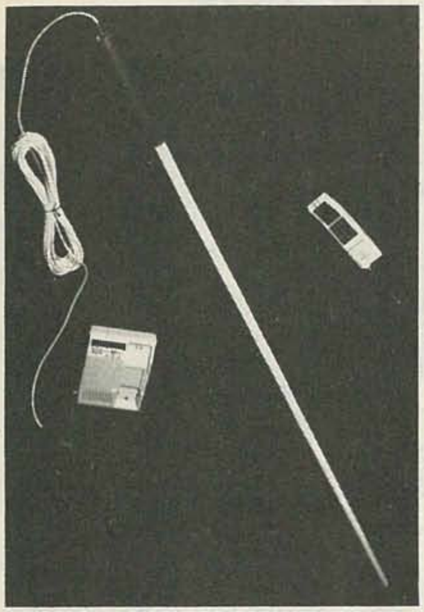
double-back tape (not supplied). It has been designed to meet the CPSC (Consumer Product Safety Commission) shock-hazard



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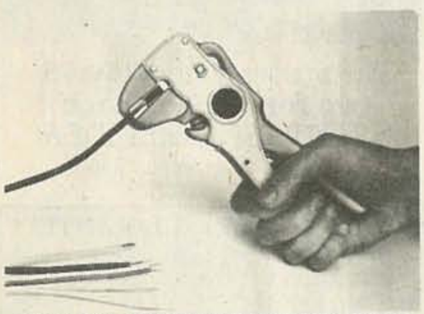
standards to 14,500 volts. It is priced at $59.95. — **Shakespeare Company,** RFD #3, PO Box 733, Newberry, SC 29108.

STRIPPING TOOL, model *PTS-3,* is a lightweight, multi-purpose hand tool that will strip wires of sizes between 10 AWG and 26 AWG and, in the case of multi-core cables, those with diameters up to 0.350 inch.



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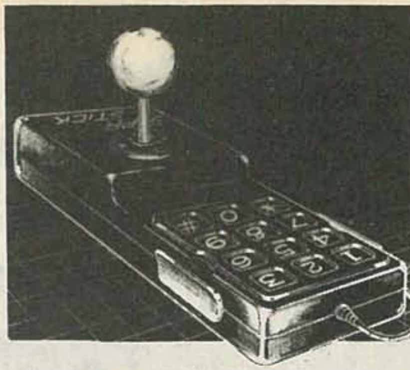
With a single squeeze of the handles, the insulation on the wire is severed and the slug automatically removed. The blades are self-adjusting and a tension-setting device is incorporated in the tool for extremely critical applications.

A wire cutter, for cutting wires to length, is incorporated in the tool, and all cutting and stripping blades are easily replaced. The tool is 7 ¼ ounces, and measures 6 ¾ × 3 inches; it is manufactured from a combination of hardened steel and polypropylene plastic.

The model *PTS-3* is priced at $44.00. — **The Eraser Company, Inc.,** PO Box 4961/ Oliva Drive, Syracuse, NY 13221.

JOYSTICKS, *Supr-Stick DeLux, Supr-Stick CC* (shown), and *Supr-Stik Xtra Lite,* all have



CIRCLE 116 ON FREE INFORMATION CARD

arcade components and microswitches. All components are replaceable, and the action button on each is located centrally to accommodate both left-handed and right-handed players.

Supr-Stick Delux includes suction feet and an automatic fire control; it is compatible with all Atari-type games and computers, and is priced at $39.95.

Supr-Stick CC (Colecovision Controller) has the same quality full microswitch and features a full keypad with slot for overlays, and two oversize action buttons; it is priced at $34.50.

Supr-Stick Xtra Lite uses smaller components and a smaller base; it does not include suction feet or auto-fire control, but as with the other two models, there is a one-year warranty. It is priced at $19.95.—**D-Zyne Video Products, Inc.** 64 Dayton Road, Waterford, CT 06385.

SOLDERING/DESOLDERING SYSTEM, model *MP-1,* is self-contained and so portable that it can be used anywhere that electronics equipment needs to be repaired — in depot, in mobile vans, in remote field-service centers, or on-site. It operates from AC and 12-volt DC sources.

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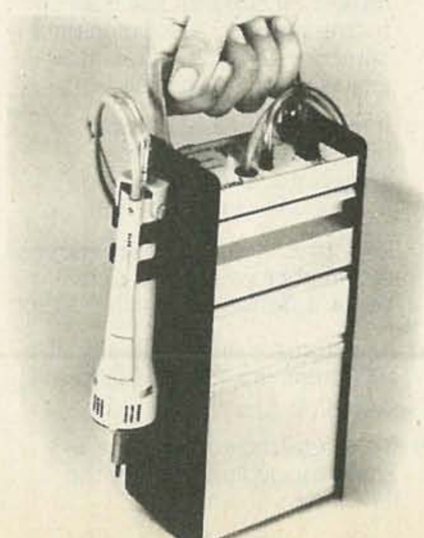

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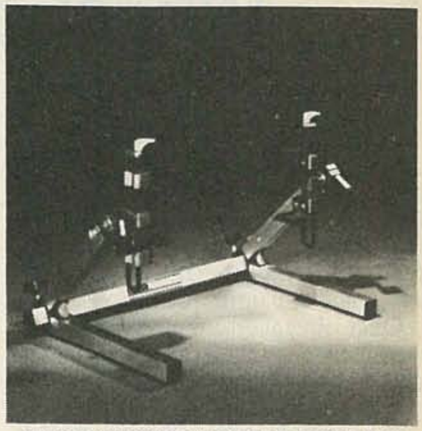
CHASSIS MOUNT, model *601* and model *602* (shown) offers a load capacity of a full 100 pounds and a width capacity of up to 18 inches. The upright arms, legs, and crossbars are made of ⅛-inch and 1¼-inch square tubing and provide a pivot-center height of 9 inches from work surface. For



CIRCLE 118 ON FREE INFORMATION CARD

safety, a positive lock detent is visible while rotating the chassis, and a visual indicator shows when the safety latch is engaged or disengaged. An all-metal friction brake allows for either left or right hand operation, and is located at a natural angle for a seated operator.

The model *601* has scissors clamp; the model *602* has self-centering heads; both are priced at $199.95.—**PanaVise,** 14024 Sylvan St., Van Nuys, CA 91401. **R-E**

COMMUNICATIONS CORNER

continued from page 114

instance 2:1—a STOP command is issued by internal logic circuits and the motor-drive circuit is turned off. At that point the operator can manually tweak the controls if an even lower SWR is desired (assuming the SWR can be further reduced).

If the transmitter frequency is changed, causing the SWR to rise, the motor drive circuits will be reactivated when the SWR exceeds the TUNE SWR reference value.

Note that while there is no microprocessor of any kind, the tuner is truly computerized—it makes a decision based on the transmission-line variables (the input from the directional coupler) and the limiting variable (minimum acceptable SWR) specified by the user.

If you were to ask why the same idea or techniques could not be applied to tuning of the transmitter's final RF amplifier, the answer is, of course, that it is entirely possible. There is not much difference in sensing the slope of a DC voltage that represents SWR or the slope that represents input current to the final amplifier. Doing it for SWR is a little easier and a good starting point. With some refinement of the technique and a reduction in the cost of the components, automatic tuning will probably make its appearance in ham gear very soon. **R-E**

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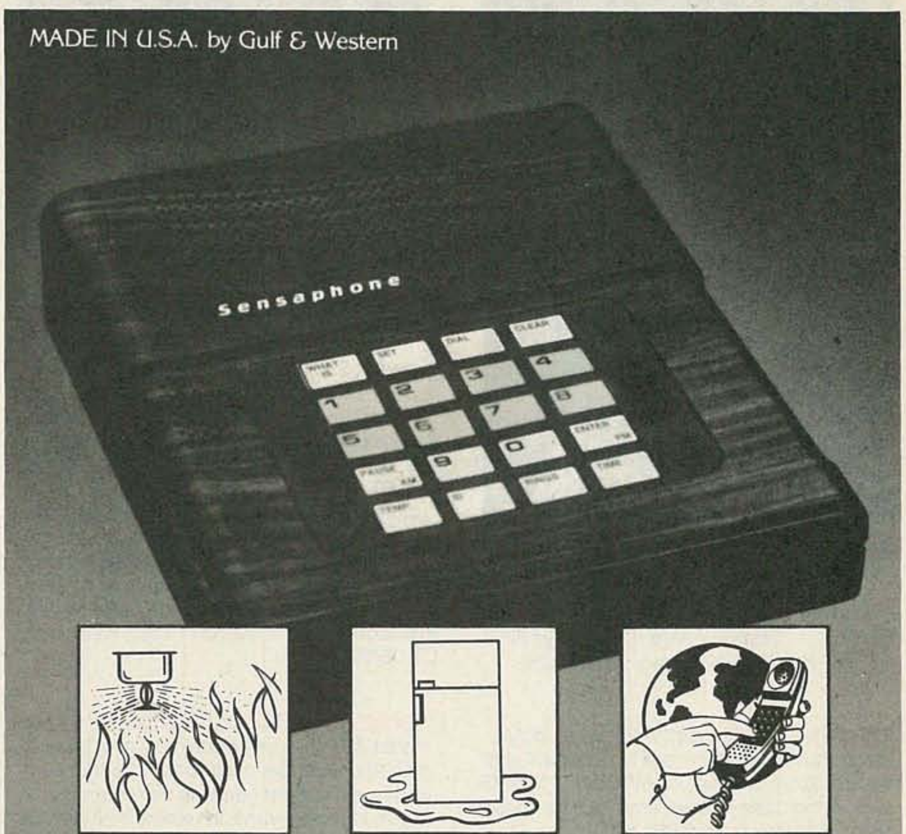

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EQUIPMENT REPORTS

continued from page 42

sortment of half-watt resistors; two linear potentiometers; ceramic, electrolytic, and mylar capacitors; three inductors; an audio transformer; a variety of diodes and transistors; a 5741 operational amplifier, and a 555 timer. Also included are such miscellaneous items as solder, 22-gauge wire, a three-inch speaker, a 3579.545 kHz crystal, a small lamp, an alignment tool, and a small parts container.

As is usual with Heathkit educational products, the electronic circuits manual, which is packaged in a three ring binder, is clearly written, features informative, easy-to-understand graphics, and is printed on high-quality paper. Also included in the package is a series of six instructional records that are keyed to the text; they provide reinforcement and help speed the learning process.

It is important to realize that a good portion of the instruction involves hands-on circuit experimentation, which is very valuable. It greatly reinforces the material in the text, and helps assure that the material learned will be retained. But because there is so much experimetation certain test equipment, including an oscilloscope, a DMM, and the Heathkit *ET-3100B* trainer, are extremely helpful. The trainer, which is also used in the three previous courses in the sequence, is available as a stand-alone device for $99.95 as a kit and $169.95 fully assembled. It is also offered in a package with the course for $144.95. The course alone sells for $64.95.

What's covered

The first unit of the course concentrates on amplifier basics and explains the importance of those circuits. That module takes you through the basic types of amplifiers and their theory of operation. It completely discusses such topics as gain and biasing techniques. By the end of the chapter, you are designing basic common-emitter amplifiers and determining the class of operation for various amplifier circuits. Finally, you are led through amplifier-coupling techniques. The chapter also discusses such factors as thermal stability.

Unit two takes what you have learned in unit one and applies it to specific applications so that you gain a greater understanding of amplifier functions in different situations. It begins with circuits used to amplify DC and low-frequency AC signals and then progresses through a discussion of IF amplifiers, RF amplifiers, and video amplifiers. Also included are audio, and power amplifiers.

As you go through the unit, you learn about such things as a Darlington circuit and how a basic differential amplifier can be used to amplify a single input, as well as why it offers a degree of temperature stability. You also learn the differences in amplifier types and about amplifier bandwidth. You also learn about the importance of neutralization and how a frequency multiplier works.

Unit three covers operational amplifiers. In it you will learn about common-mode rejection ratio, input resistance, output resistance, offset current, bias current, slew rate, and other factors that determine op-amp performance. The unit also will teach you about op-amp circuits such as comparitors and simple inverting and noninverting amplifiers. Also covered are voltage followers, summing amplifiers, and differential amplifiers. The unit is rounded out with a discussion of lowpass, highpass, and bandpass active filters that use op-amps.

For many, the material presented in unit four will be old hat; that unit covers power supplies. That information is essential, however, to the beginner in electronics. In that unit the characteristics of half-wave, full-wave, and bridge rectifiers are discussed. You also learn about the effect of filter capacitors on output voltage, ripple voltage, and a diode's peak inverse voltage. After that, you'll find out about the characteristics of capacitor, resistor-capacitor, and inductor-capacitor filters, as well as the operation of half-wave and full-

continued on page 124

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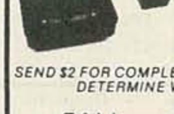

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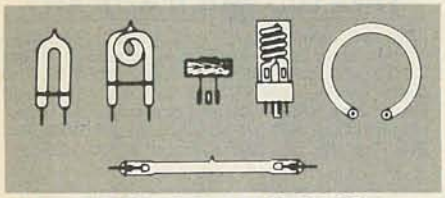

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EQUIPMENT REPORTS

continued from page 119

wave voltage multipliers. Regulators, including simple zener regulators; emitter-follower regulators; simple series-feedback regulators, which use op-amps, and series and shunt regulators are also covered. The unit wraps up with an explanation of protective circuits and devices.

Unit five is an in-depth look at oscillators. Included here is a discussion of the three general classes of oscillators, as well as a look at the operation of Hartley and Colpitts oscillators. You are also exposed to crystal, phase-shift, and Wien-bridge oscillators.

By the end of the unit, you will be building basic Hartley and Colpitts oscillators, as well as modifying the Colpitts oscillator so it becomes a crystal oscillator. Finally, you build an op-amp Wien-bridge oscillator and add an automatic gain-control circuit to simplify oscillator adjustment.

Unit six studies digital circuits and pulse waveforms. In it you will learn the difference between time-domain and frequency-domain analysis, as well as the difference between periodic and aperidodic waveforms. In addition, you will be able to identify the sinewave components in squarewaves, sawtooth waves, and triangular waves, and will have an understanding of such concepts as frequency, period, pulse width, and duty cycle. Moving on, the chapter takes you through an analysis of the effect on waveforms of such devices as diode clippers, clampers, and transistor clippers, and looks at how square- and sinewaves are affected by R-C integrators. You will also learn about the operation of astable, monostable, and bistable multivibrators. This unit concludes with an explanation of the Schmitt trigger, how a 555 timer can be connected as an astable or monostable multivibrator, a look at how an op-amp can be made to produce a linear ramp. and the operation of a transistor sawtooth generator.

Unit seven introduces you to the principles of modulation and demodulation. In it, you study not only FM but also AM and single-sideband modulation.

To help insure that you remember what you have learned, the course includes periodic reviews as well as a final examination. Further, the experiments are geared to put the knowledge obtained to practical use to reinforce what you've learned.

Overall, this is a very good effort. It will serve as an excellent refresher course for someone who's been exposed to this material in the past, and it will help a newcomer develop a sound introduction to basic circuit design and theory. Though you'll certainly not be able to go out and repair large mainframe computers or complex communications transceivers when you are finished, who knows where this solid start might lead. **R-E**

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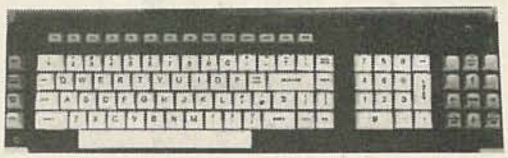

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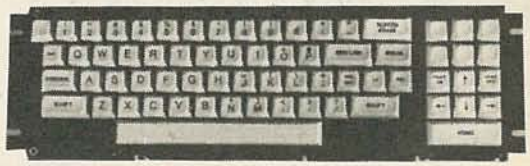

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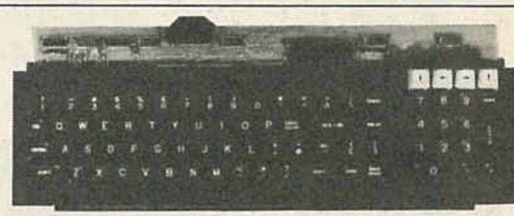

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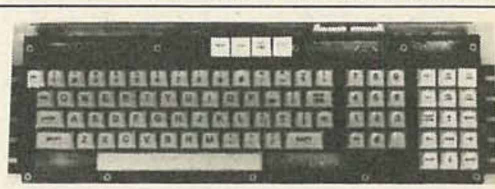

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SN7454N	14	.19	SN74152N	14	.59	SN74367N	16	.55
SN7459N	14	.25	SN74153N	16	.55	SN74368N	16	.55
SN7460N	14	.39	SN74154N	24	1.25	SN74390N	16	1.49
SN7470N	14	.29	SN74155N	16	.59	SN74393N	14	1.49

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74LS01	14	.25	74LS93	14	.55	74LS193	16	.79
74LS02	14	.29	74LS95	14	.79	74LS194	16	.69
74LS03	14	.29	74LS96	16	.89	74LS195	16	.69
74LS04	14	.29	74LS107	14	.39	74LS197	14	.79
74LS05	14	.29	74LS109	16	.39	74LS221	16	.89
74LS08	14	.29	74LS112	16	.39	74LS240	20	1.09
74LS09	14	.29	74LS113	14	.39	74LS241	20	1.09
74LS10	14	.29	74LS114	14	.39	74LS242	14	1.09
74LS11	14	.35	74LS122	14	.49	74LS243	14	1.09
74LS12	14	.35	74LS123	16	.79	74LS244	20	1.09
74LS13	14	.39	74LS125	14	.49	74LS245	20	1.49
74LS14	14	.59	74LS126	14	.49	74LS247	16	1.09
74LS15	14	.35	74LS132	14	.59	74LS248	16	1.09
74LS20	14	.29	74LS133	16	.59	74LS249	16	1.09
74LS21	14	.29	74LS136	14	.39	74LS251	16	.59
74LS22	14	.29	74LS138	16	.59	74LS253	16	.59
74LS26	14	.29	74LS139	16	.59	74LS257	16	.59
74LS27	14	.29	74LS151	16	.59	74LS258	16	.59
74LS28	14	.35	74LS153	16	.59	74LS260	14	.59
74LS30	14	.25	74LS154	24	.99	74LS266	14	.59
74LS32	14	.29	74LS155	16	.69	74LS273	20	1.49
74LS33	14	.55	74LS156	16	.69	74LS279	16	.49
74LS37	14	.35	74LS157	16	.69	74LS283	16	.69
74LS38	14	.35	74LS158	16	.59	74LS290	14	.89
74LS40	14	.29	74LS160	16	.69	74LS293	14	.89
74LS42	16	.55	74LS161	16	.69	74LS298	16	.89
74LS47	16	.75	74LS162	16	.69	74LS352	16	1.29
74LS48	16	.75	74LS163	16	.69	74LS353	16	1.29
74LS49	14	.75	74LS164	14	.69	74LS365	16	.49
74LS51	14	.25	74LS165	16	1.19	74LS366	16	.49
74LS54	14	.29	74LS168	16	1.19	74LS367	16	.49
74LS55	14	.29	74LS169	16	1.19	74LS368	16	.49
74LS73	14	.39	74LS170	16	1.49	74LS373	20	1.29
74LS74	14	.39	74LS173	16	.69	74LS374	20	1.29
74LS75	16	.39	74LS174	16	.69	74LS375	16	.69
74LS76	16	.39	74LS175	16	.69	74LS377	20	1.49
74LS78	14	.39	74LS181	24	2.95	74LS393	14	1.19
74LS83	16	.65	74LS190	16	.89	74LS399	16	1.49
74LS85	16	.79	74LS191	16	.89	74LS670	16	1.49
74LS86	14	.39				81LS95	20	1.49
74LS90	14	.55				81LS97	20	1.49

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74S02	14	.35	74S133	16	.45	74S244	20	2.49
74S03	14	.35	74S134	16	.50	74S251	16	1.19
74S04	14	.45	74S135	16	.69	74S253	16	1.19
74S05	14	.45	74S136	14	1.39	74S257	16	1.19
74S08	14	.39	74S138	16	.89	74S258	16	1.19
74S09	14	.39	74S139	16	.89	74S260	14	1.19
74S10	14	.35	74S140	14	.55	74S280	14	1.95
74S11	14	.35	74S151	16	.99	74S287*	16	1.95
74S15	14	.35	74S153	16	.99	74S288*	16	1.95
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74S22	14	.35	74S158	16	.99	74S374	20	2.49
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74S65	14	.39	74S196	14	1.49	74S570*	16	2.95
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74S85	16	2.49	74S241	20	2.25	74S572*	18	4.95
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CD4009	16	.59	CD4046	16	1.19	CD4511	16	1.19
CD4010	16	.59	CD4047	14	1.29	CD4512	16	1.19
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CD4012	14	.29	CD4049	16	.39	CD4515	24	2.49
CD4013	14	.39	CD4050	16	.39	CD4516	16	1.19
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CD4021	16	1.19	CD4068	14	.39	CD4562	14	5.95
CD4022	16	1.19	CD4069	14	.29	CD4566	16	1.39
CD4023	14	.29	CD4070	14	.39	CD4583	16	2.49
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CD4025	14	.23	CD4072	14	.29	CD4723	16	1.19
CD4026	16	2.49	CD4073	14	.29	CD4724	16	1.19
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MICROPROCESSOR CHIPS

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MC6802CP	40	MPU w/Clock and RAM	7.95
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INS8039N	40	CPU-Sgl. chip 8-bit (128 bits. Ram)	5.95
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Z80A-CTC	28	Counter Timer Circuit	4.95
Z80A-DART	40	Dual Asynchronous Rec./Trans.	9.95
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Z80A-SIO/1	40	Serial I/O (Lacks DTRB)	12.95
Z80A-SIO/2	40	Serial I/O (Lacks SYNCB)	12.95
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82S25	16	16x4 (50ns) O.C. (74S289)	2.25

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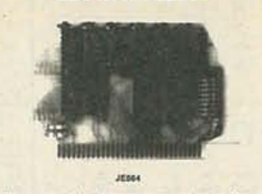

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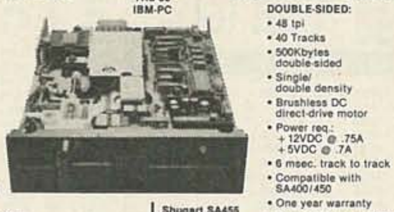
- Weight: 3 lbs. 5 oz.

FD55A $249.95



Shugart SA455

SHUGART SA455

DOUBLE-SIDED:
- 48 tpi
- 40 Tracks
- 500Kbytes double-sided
- Single/double density
- Brushless DC direct-drive motor
- Power req.: +12VDC @ .75A, +5VDC @ .7A
- 6 msec. track to track
- Compatible with SA400/450
- One year warranty
- Size: 5.75"W × 1.63"H × 8"D
- Weight: 3.3 lbs.

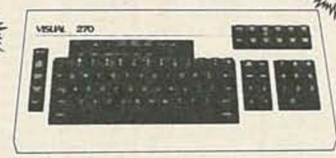
SA455 . . . . $259.95

Keytronics 90-Key Keyboard

WITH SECURITY KEYLOCK SWITCH

250 Available! — BRAND NEW!!

- RFI shielded
- Cursor controls
- Numeric keyboard
- 8-bit Parallel
- Solid state switches
- 10 user-programmable keys
- Positive TTL Logic
- Size: 17"L × 8¼"W × 2¾"H



Made for Visual Technology, this keyboard features: a security keylock (includes two keys) to guard against unauthorized use; an 11-key numeric keypad; cursor controls; and 10 user-programmable keys. Electrical requirements: +5VDC. Color (case): White. Color (keycaps): Black. Complete with case, keyboard assembly, 40-inch interface cable, and schematics. Weight: 7 lbs.

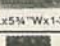
Part No. KB270 .... $79.95 each

23"Lx5¾"Wx1-3/8"H

MICRO SWITCH 85-KEY KEYBOARD

Word Processing Keyboard, 26 Pin Edge Card Connection. Supply Voltage +5VDC. Main Keyboard is QWERTY. Additional Key Pads for Cursor and word processing functions.

Part No. 85SD18-1 .... $29.95 each

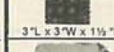


3"L x 3"W x 1½"H

HI-TEK 14-KEY NUMERIC KEYPAD

SPST switching. Charcoal grey keycaps. Mounted on printed circuit board.

Part No. K-14 .... $9.95 each



POWER SUPPLY +5VDC @ 1 AMP REGULATED — *Transaction Tech*

Output +5VDC @ 1A (also +30VDC) reg. Input 115VAC 60Hz. 2-tone (black/beige) self-enclosed case. 6 ft., 3 cond. black power cord. 6½"W x 7"D x 2¼"H. Wt. 3 lbs. Data sheet incl.

Part No. PS51194S .... $14.95 each

POWER SUPPLY +5VDC @ 3 AMP REGULATED — *Deltron*

Input: 115VAC, 47-440Hz. Output: 5VDC Adjustable @ 3 amp, 6VDC @ 2.5 amp. Adjustable current limit, Ripple & Noise: 1MV rms, 5MV p-p — 2 mounting surfaces. UL recognized. Size: 4"W x 4½"L x 2-7/16"H - wt. 2 lbs. Data sheet included.

Part No. QPS-1 .... $29.95 each

POWER SUPPLY +5VDC @ 7.5 AMP, 12VDC @ 1.5 AMP SWITCHING

Input: 115VAC, 50-60Hz @ 3 amp/230VAC, 50Hz @ 1.6 amp. Fan volt./power supply select switches (115/230VAC). Output: 5VDC @ 7.6 amp, 12VDC @ 1.6 amp. 8 ft. blk. pow. cord. 11½"W x 13¾"D x 3¾"H. Wt. 6 lbs.

Part No. PS94V0S .... $39.95 each

POWER SUPPLY 4-Channel Switching - Apple Compatible

FOR USE AS AN EXTERNAL POWER SUPPLY FOR APPLE

Microprocessor, mini-computer, terminal, medical equipment and process control applications. Input: 90-130VAC 47-440Hz. Output: +5VDC @ 5A, -5VDC @ 1A; +12VDC @ 1A, -12VDC @ 1A. Line reg.: ±0.2%. Ripple: 30mV p-p. Load reg.: ±1%. Overcurrent protection. Adj: 5V main output±10%. 6-3/8"L x 1-7/8"W x 4-15/16"H. Wt. 1½ lbs.

Part No. FCS-604A .... $69.95 each

$10.00 Minimum Order — U.S. Funds Only
California Residents Add 6½% Sales Tax
Shipping — Add 5% plus $1.50 Insurance
Send S.A.S.E. for Monthly Sales Flyer!

Spec Sheets — 30¢ each
Send $1.00 Postage for your *FREE 1984 JAMECO CATALOG*
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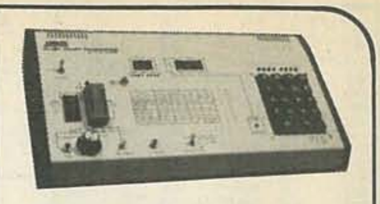


JE664 EPROM PROGRAMMER

8K TO 64K EPROMS — 24 AND 28 PIN PACKAGES

• Programs, validates, and checks for properly erased EPROMs • Emulates PROMs or EPROMs • RS232C Computer Interface for editing/program loading • Loads data into RAM by keyboard • Changes data in RAM by keyboard • Loads RAM from an EPROM • Compares EPROMs for content differences • Copies EPROMs • Power Input: 115VAC, 60Hz, ≈ 10W power consumption • Enclosure: Color-coordinated, light tan panels w/molded mocha brown end pieces • Size: 15-5/8"L x 8⅞"D x 3⅝"H • Wt.: 5¾ lbs.

JE664-A EPROM Programmer $995.00
Assembled & Tested (Includes JM16A Module)

JE665 — RS232C INTERFACE OPTION — The JE665 RS232C Interface Option implements computer access to the JE664's RAM. Sample software written in BASIC provided for TRS-80® Model I, Level II Computer. Baud rate: 9600. Word lgth: 8 bits - odd parity. Stop bits: 2. Option may be adapted to other computers. The JE665 can be interfaced to any computer with an RS232 port. Information is also provided for interfacing to any CP/M system with an RS232 port.

JE664-ARS EPROM Programmer w/JE665 Option $1195.00
Assembled and Tested (Includes JM16A Module)

EPROM JUMPER MODULES - The JE664's JUMPER MODULE (Personality Module) is a plug-in Module that pre-sets JE664 for proper programming pulses to the EPROM & configures EPROM socket connections for that particular EPROM.

P/N	EPROM	EPROM MANUFACTURER	PRICE
JM08A	2708	AMD, Motorola, National, Intel, TI (25V)	$14.95
JM16A	2716, TMS2516	Intel, Motorola, National, NEC, TI, (25V)	$14.95
JM16B	TMS2716	Motorola, TI (+5, -5, +12)	$14.95
JM32A	TMS2532	Motorola, TI (25V)	$14.95
JM32B	2732	AMD, Fujitsu, NEC, Hitachi, Intel (25V)	$14.95
JM32C	2732A (21V)	Fujitsu, Intel (21V)	$14.95
JM64A	MCM68764, MCM68L764	Motorola (21V)	$14.95
JM64B	2764	Intel (21V)	$14.95
JM64C	TMS2564	TI (25V)	$14.95
JM64D	HN482764G-4	Hitachi (21V)	$14.95

UV-EPROM Eraser

Erases 2708, 2716, 2732, 2764, 2516, 2532, 2564. Erases up to 8 chips within 51 minutes (1 chip in 37 minutes). Maintains constant exposure distance of one inch. Special conductive foam liner eliminates static build-up. Built-in safety lock to prevent UV exposure. Compact — only 9.00" x 3.70" x 2.60". Complete with holding tray for 8 chips.

DE-4 UV-EPROM Eraser . . . $79.95
UVS-11EL Replacement Bulb $16.95

IBM MEMORY EXPANSION KIT

SAVE HUNDREDS OF $$$ BY UPGRADING MEMORY BOARDS YOURSELF!

Most of the popular memory boards allow you to add an additional 64K, 128K, 192K, or 256K. The IBM64K Kit will populate these boards in 64K byte increments. The kit is simple to install — just insert the nine 64K RAM chips in the provided sockets and set the two groups of switches. Directions are included.

IBM64K (Nine 200ns 64K RAMs) $49.95

EXPAND YOUR MEMORY

TRS-80 to 16K, 32K, or 48K

**Model 1 = From 4K to 16K Requires (1) One Kit
Model 3 = From 4K to 48K Requires (3) Three Kits
Color = From 4K to 16K Requires (1) One Kit

**Model 1 equipped with Expansion Board up to 48K Two Kits Required — One Kit Required for each 16K of Expansion —

TRS-16K3 *200ns for Color & Model III $12.95
TRS-16K4 *250ns for Model I $10.95

TRS-80 Color 32K or 64K Conversion Kit

Easy to install kit comes complete with 8 ea. 4164-2 (200ns) 64K dynamic RAMs & conversion documentation. Converts TRS-80 color computers with E circuit boards, & all new color computers to 32K. Minor modifications of 32K memory will allow the use of all the 64K of the dynamic RAM providing you have a FLEX DOS operating system.

TRS-64K2 .... $44.95

5¼" Mini-Floppy Disk Drive

Pertec Computer Corp.

FOR TRS-80 MODEL I - COLOR COMPUTER

Features single or double density. Recording mode: FM single, MFM double density. Seek time: 25msec. track to track. Power: +12VDC (±0.6V) 1.6A max., +5VDC (±0.25V) 0.8A max. Unit as pic. at right does not incl. case, power supply, cables). 30-pg. data book incl. Wt. 3½ lbs. Size: 5¾"W x 8"D x 3¼"H.

Part No.	*Limited Quantity!*	Price
FD200	Single-sided, 40 tracks, 250K bytes capacity	$179.95
FD250	Double-sided, 35 tracks, 438K bytes capacity	$199.95

8" FLOPPY DISK DRIVE

Siemens

- Shugart 801R compatible
- Single-Sided
- 77 Tracks
- 400/800K Bytes Capacity
- Industry Standard

The **FDD100-8 8" Floppy Disk Drive** (Industry Standard) features single or double density. Recording mode: FM single, MFM double density. Transfer rate: 250K bits/sec. single density; 500K bits/sec. double density. The FDD100-8 is designed to work with the single-sided soft sectored IBM Diskette I, or eq. disk cartridge. Power: 115VAC @ 50-60Hz, +24VDC @ 1.7 amps max., +5VDC @ 1.2 amps max. Unit as pictured above (does not include case, power supply, or cables). Size: 8.55"W x 14"L x 4.5"H. Weighs 12 lbs. Incl. 96-pg. manual.

Part No.	Price
FDD100-8	**$169.95 ea.**

CIRCLE 41 ON FREE INFORMATION CARD

FORMULA INTERNATIONAL INC.

12603 Crenshaw Blvd., Dept. B, Hawthorne, CA 90250

For information (213) 973-1921 • Orders Only (outside Calif.) (800) 672-8758

POCKET LIGHT

Complete with 5" flourescent tube, powerful bulb and handy strap. Runs on 3 pcs 1.5V "C" size batteries (not included). It's a practical, convenient, powerful spotlight and flourescent light. Its superior quality is ideal for indoor or outdoor use.

LOW PRICE $6.50

SANYO UHF VARACTOR TUNER

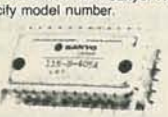
FOR UHF CHANNELS 14-83

Tuning voltage +1 to +28VDC. Input impedance 75Ω. IF band width 7-16MHz. Size 2⅝" x 1¼" x ¾". Supply voltage 15VDC.

Model 115-B-403A, Video IF 45.0MHz
Model 115-B-405A, Video IF 62.5MHz

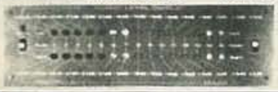
$19.95

Tuner is the most important part of the circuit. Don't let those $19.00 tuners fool you.
All units are brand new from Sanyo. When ordering please specify model number.



MARK IV — 15 STEP LED POWER LEVEL INDICATOR KIT

This new stereo indicator kit consists of 36 4-color LED's (15 per channel) to indicate the sound level output of your amplifier from −36dB to +3dB. Comes with a well designed silk screen printed plastic panel and has a selector switch to allow floating or gradual output indicating. Power supply is 6-12VDC 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's, all electronic components, PC Board and front panel. **MARK IV KIT $31.50**



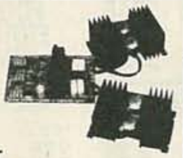
FLOURESCENT AUDIO LEVEL MONITOR

This is the kind of VU monitor that is being used by most amplifier manufacturers. IC's are used to simplify circuit layout. Easy to assemble and can be used with all power level amplifiers. Power requirement 12VDC.

TE-221 KIT For Just $28.50 (Limited Stock)

TA-1000 KIT $51.95

Power Transformer $24.00 ea.



100W CLASS A POWER AMP KIT

Dynamic Bias Class "A" circuit design makes this unit unique in its class. Crystal clear, 100 watts power output will satisfy the most picky fans. A perfect combination with the TA-1020 low TIM stereo pre-amp.

Specifications • Output power 100W RMS into 8Ω. 125W RMS into 4Ω • Frequency response 10Hz-100KHz • THD less than 0.01% • S/N ratio better than 80dB • Input sensitivity 1V max. • Power supply ±40V at 5A.

1 WATT AUDIO AMP

All parts are pre-assembled on a mini PC Board. Supply voltage 6-9VDC . . . . **Special Price $1.95**

6W AUDIO AMP KIT

TBA810 with Volume Control. Power Supply 6-18VDC **Only $7.50 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 ±16VDC (not included). Voltage gain 33dB, 20Hz-20KHz.

Super Buy Only $18.50

LASER SUPER LATERN

Brilliant flourescent lantern with 9" 6 watt flourescent tube. Features include: Powerful direct beam spotlight with 9V pre-focus bulb; Buzzer horn - either constant or time intervals of sonic alarm; Twin blinker - red amber flashing or red & amber flashing on time intervals; Fully adjustable nylon strap. Operates from D size batteries or plugs into vehicle cigar lighter socket.

SPECIAL $11.95

6-WAY A/C ADAPTOR

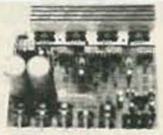
Input: 110VAC. Output: 3V, 4.5V, 6V, 7.5V and 12VDC. Current: 300mA.

OUR LOW PRICE $5.50 ea.

CRYSTAL CONTROLLED WIRELESS MICROPHONE SYSTEM

No FCC License Required
OUR PRICE $49.50
Additional Microphone (Transmitter) Available at $28.00 ea.
MURA WMS-49

Transmitter: FET mic for flat 30Hz-18KHz response. X'tal controlled 49MHz AM Band for drift-free performance. 100mW output (range approx. ¼ mile) for reliable long range transmission. Powered by a 9V radio battery.
Receiver: X'tal controlled locks on 49MHz transmitter signal. On panel VU meter, monitors the signal strength from the microphone. Standard phone jack outlet connection to a P.A. or other phone input. 9V battery included. This professional set is ideal for on stage, in field, church, in house or outdoor use.



A GOOD BUY at $65.00 TA-800

120W PURE DC POWER STEREO AMP KIT

Getting power hungry from your small amp? Here's a good solution! The TA-800 is a pure DC amplifier with a built-in pre-amp. All coupling capacitors are eliminated to give you a true reproduction of the music. On board tone and volume controls combined with built-in power supply make the TA-800 the most compact stereo amp available. Specifications: 60W x 2 into 8Ω. Freq Range: 0Hz-100KHz±3dB. THD: .01% or better. S/N Ratio: 80dB. Sensitivity: 3mV into 47K. Power Requirement: ±24-40 Volts.

WHISTLE ACTIVATED SWITCH BOARD

All boards are pre-assembled and tested. You whistle to its FET condenser microphone from a distance, as far as 30 feet away (sensitivity can be easily adjusted), and it will turn the switch on. If you whistle again it will turn off. Ideal for remote control toys, electrical appliance such as lights, coffee pots, TV, Hi-Fi, radio or other projects. Unit works on 9VDC.

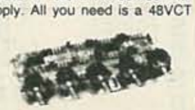
Model 968 . . . .$2.50 ea.

LOW TIM DC STEREO PRE-AMP KIT TA-1020

Incorporates brand-new DC design that gives a frequency response from 0-100KHz ±0.5dB. Added features like tone defeat and loudness control let you tailor your own frequency supplies to eliminate power fluctuations!

Specifications: • THD/TIM less than .005% • Frequency response DC to 100KHz ±0.5dB • RIAA deviation ±0.2dB • S/N ratio better than 70dB • Sensitivity; Phone 2mV 47KΩ, Aux 100mV 100KΩ • Output level 1.3V • Max output 15V • Tone controls; Bass ±10dB @ 50Hz, Treble ±10dB @ 15Hz • Power supply ±24VDC @ 0.5A. Kit comes with regulated power supply. All you need is a 48VCT transformer @ 0.5A.

Only $44.50 Transformer $4.50 ea.



UNIVERSAL NI-CD BATTERY CHARGER MW-398

Charges 9V, AA, C or D size Ni-CD batteries all at one time.

Part No. 050-0190 $11.50 ea.

SUPER FM WIRELESS MIC KIT

This new designed circuit uses high FREQ FET transistors with 2 stage pre-amp. Transmits FM range (88-120MHz) up to 2 blocks away and with the ultra sensitive condenser microphone that comes with the kit allows you to pick up any sound within 15 ft. away. Kit includes all electronic parts, OSC coils and PC Board. Power supply 9VDC.

FMC-105 $11.50 per Kit

PROFESSIONAL FM WIRELESS MICROPHONE

Made by one of the leading Japanese manufacturers. This factory assembled FM wireless microphone is powered by two AA size batteries. It transmits in the range of 88-108MHz. Element is built in a plastic tube type case with an omni-directional electronic condenser microphone unit. By using a standard FM radio, signal can be heard anywhere on a one acre lot. Sound quality was judged "very good." MODEL WEM-36 was $16.50.

ON SALE $8.25 ea.

HEAVY DUTY 500mA MULTIPLE AC-DC ADAPTOR

For all battery operated electronic equipment up to 500mA with LED indicator.

Input: 117/220VAC, 50/60Hz

Output: 3, 4.5, 6, 7.5, 9 and 12VDC.

Model SA-8112A $25.00 ea.

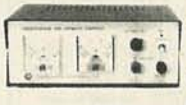
SANYO ANTENNA SIGNAL BOOSTER

This Booster is specially designed for UHF Channels (14-83). After installing (between the antenna input cable and the UHF tuner), this unit will provide a minimum of 10dB gain, that is approximately 2 times better than you are seeing now. Ideal for those who live in apartments that can not put up an outdoor antenna. Small in size, only 2" x 1½" x 1". Supply voltage is 15 VDC.

Model 001-0076 $12.50

PROFESSIONAL REGULATED VARIBLE DC POWER SUPPLY KIT

All solid state circuitry with high efficiency power transistor 2SD388 and IC voltage regulator MC1733. Output voltage can be adjusted from 0-30V at 1A current limited or 0-15V at 2A current limited. Internal resistance is less than 0.005Ω, ripple and noise less than 1mV, dual on panel meters for voltage and current reading, also with on board LED and audible over load indicator. Kit comes with pre-drilled PC Board, instructions, all necessary electronic components, transformer and a professional looking metal cabinet. The best project for school and the most useful instrument for repairmen. Build one today!



Model TR88A 0-15VDC @ 2A

Model TR88B 0-30VDC @ 1A

$59.50 per Kit

★ SPECIAL ★ Excellent Price!

Model 001-0034 $29.50 per Kit

Transformer $10.50 ea.

TA-322 30 WATTS TOTAL 15W + 15W STEREO AMP KIT

This is a solid state all transistor circuitry with on board stereo pre-amp for most microphone or phone input. Power output employs a heavy duty Power Hybrid IC. Four built on board controls for, volume, balance, treble and bass. Power supply requires 48VCT 2.5A transformer. THD of less than 0.1% between 100Hz-10KHz at full power (15 Watts + 15 Watts loaded into 8Ω).

LOW T.I.M. TRANSISTORS 100W + 100W

• Employs Hitachi low noise I.C. for pre-amp • Max. output 16 V P-P (non distortion) • With hi-low filter, and tone defeat circuit • Rear power amp with short circuit protection • Giant heat sink for maximum results • Tone controls ±14dB • All components (except pots for volume, and tone controls) are pre-assembled, the quality is guaranteed. • Power supply DC±35V-50V

MODEL: SA802C
Part #370-0340 . . . . . $85.00
POWER TRANSFORMER (68V-80V CT 6 AMP)
Part #670-0220 . . . . . $24.50

60W + 60W O.T.L. AMP

Stereo pre-amp + tone control + power amp. All in on unit, fully assembled! Compact in size: 7"x4¾"x2½". Can be fitted into most cabinets. Power transistors using 25C1667 X 4 to give a max output of 60W + 60W (8Ω)

• Frequency response: 20Hz~85KHz(−1dB) • Total harmonic distortion: 0.02% (1KHz) • Signal/Noise Ratio: 88 dB (open loop) • Tone control: 100 Hz±16 dB 10 KHz±14dB • Dynamic range: 60 dB • Power Supply: 48V~70V 5 Amp. • Filter Capacitor: 4700 µ 75V or better.

MODEL: SA-4520
Part #370-0350 . . . . . $39.95 ea.
1 Transformer Part #670-0230 . . . $22.50 ea.
2 Filter Capacitor 4700µF 70V $6.50 ea.

MAGNETIC HEAD EQUALIZER

• Standard RIAA curve for all kinds of magnetic heads • 3 stages crossover circuit for best results • Output voltage guaranteed to be stable without any oscillation • Power Supply: 24 V.D.C.

MODEL: MA-142
Part #370-370 . . . . . $6.95 ea.

STEREO MIC. AND ECHO MIXER FOR STEREO AMPLIFIER SYSTEM

The circuitry employs all integrated circuits, BBD type echo circuit, echo time can be adjusted (max. .30 Msec.) Also with a microphone preamp on the board. Fully assembled.

MODEL: MX205
Part #370-0360 . . . . . $29.95 ea.

20 STEPS BAR/DOT AUDIO LEVEL DISPLAY KIT

This new designed audio level display unit is using a new integrated circuit from National Semiconductor to drive 20 pieces of color LEDs (green, yellow and red) on each channel. It provides two types of display methods for selection 'bar' or 'dot'. The display range is from −57dB to 0dB. Kit is good for any amplifier from 2 watt to 200 watts! Power supply requires 12V AC or DC. So it is great for cars as well! Kit comes with printer circuit board, all LEDs, electronic components, switches, and silk screen printed professional front panel.

MODEL: TY-45
Part #370-0280 . . . . . $38.50

SEND ONE DOLLAR FOR OUR DETAIL CATALOG

Shipping & Handling Charges	Under $50.00 Purchase	Over $50.00 Purchase
Inside California	10%	5%
Outside Calif. (incl. Mexico & Canada)	15%	10%
Overseas	25%	20%

Minimum Order $10.00/Calif. Residents add 6.5% Sales Tax. Phone Orders Accepted on VISA or MC ONLY. NO C.O.D.'s. Prices subject to change without notice.

STORE HOURS MON-FRI—10-7 SAT—10-6

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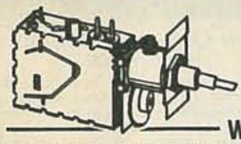
CIRCLE 76 ON FREE INFORMATION CARD

MORE GAIN
Than a Varactor UHF Tuner



$15.00 **SATISFACTION GUARANTEED**
Frequency Range 470-899 MHz Channels 14-83. Output Channel 3. Ch 2 or 4 Avail.

PART #B20 . . . . **$15.00**

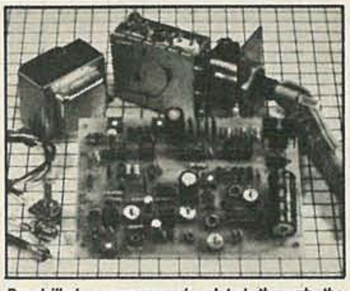
WHAT'S IN IT?

To make a regular UHF tuner into a **GILCO HIGH GAIN TUNER**, each and every one of the following steps is painstakingly taken by a certified technician:
1. The first thing GILCO does is change the standard diode to a **hot carrier diode**.
2. The tuner's output is then measured on our JERROLD field strength meter and compared to a computer derived chart from which we determine the correct value coil to add across the IF output for ***maximum pre-peaked gain***.
3. The tuner is then fed a standard 10db 300 ohm antenna input and while monitoring the output on our HEWLETT PACKARD spectrum analyzer, the tuner is tuned to the desired channel and its oscillator is offset for the desired output frequency as follows:
Channel 2: 58 Mhz, Channel 3: 63 Mhz, Channel 4: 68 Hhz
We call this step peaking because the tuner's output looks like a peak on our spectrum analyzer and the highest point of that peak is actually adjusted for the desired output.
4. The last step is one more measurement on the field strength meter which is again compared to our performance chart to calculate the correct value of the second coil which is added to the tuners internal connections.

This procedure was developed by GILCO and it is our computer derived performance charts that make our tuner better, that's because ***almost every tuner gets a different value coil*** before it's peaked and again a different value coil after it's peaked. The combinations are endless and ***the way we determine the values is our secret...***

GILCO PARTS KIT & PRINTED CIRCUIT BOARD

- **Use with GILCO High Gain Tuner**
- **Requires NO Modification to Your Television**
- ***Individually Packaged and Labeled Parts Save Guesswork***
- The only tools required for assembly are: screwdriver, soldering iron, voltmeter. No drilling is required to the P/C board.
- This kit was designed to take advantage of the GILCO high gain tuner which means its circuitry is ***simpler and more efficient*** than those circuits that require inferior varactor tuners.



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The CT-90 is the most versatile, feature packed counter available for less than $300.00! Advanced design features include; three selectable gate times, nine digits, gate indicator and a unique display hold function which holds the displayed count after the input signal is removed! Also, a 10mHz TCXO time base is used which enables easy zero beat calibration checks against WWV. Optionally, an internal nicad battery pack, external time base input and Micro-power high stability crystal oven time base are available. The CT-90, performance you can count on!

SPECIFICATIONS:

Range:	20 Hz to 600 MHz
Sensitivity:	Less than 10 MV to 150 MHz Less than 50 MV to 500 MHz
Resolution:	0.1 Hz (10 MHz range) 1.0 Hz (60 MHz range) 10.0 Hz (600 MHz range)
Display:	9 digits 0.4" LED
Time base:	Standard-10.000 mHz, 1.0 ppm 20-40°C. Optional Micro-power oven-0.1 ppm 20-40°C
Power:	8-15 VAC @ 250 ma

7 DIGITS 525 MHz $99.95 WIRED

SPECIFICATIONS:

Range:	20 Hz to 525 MHz
Sensitivity:	Less than 50 MV to 150 MHz Less than 150 MV to 500 MHz
Resolution:	1.0 Hz (5 MHz range) 10.0 Hz (50 MHz range) 100.0 Hz (500 MHz range)
Display:	7 digits 0.4" LED
Time base:	1.0 ppm TCXO 20-40°C
Power:	12 VAC @ 250 ma

The CT-70 breaks the price barrier on lab quality frequency counters. Deluxe features such as; three frequency ranges - each with pre-amplification, dual selectable gate times, and gate activity indication make measurements a snap. The wide frequency range enables you to accurately measure signals from audio thru UHF with 1.0 ppm accuracy - that's .0001%! The CT-70 is the answer to all your measurement needs, in the field, lab or ham shack.

PRICES:

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CT-70 Kit, 90 day parts warranty	84.95
AC-1 AC adapter	3.95
BP-1 Nicad pack + AC adapter/charger	12.95

7 DIGITS 500 MHz $79.95 WIRED

PRICES:

MINI-100 wired, 1 year warranty	$79.95
AC-Z Ac adapter for MINI-100	3.95
BP-Z Nicad pack and AC adapter/charger	12.95

Here's a handy, general purpose counter that provides most counter functions at an unbelievable price. The MINI-100 doesn't have the full frequency range or input impedance qualities found in higher price units, but for basic RF signal measurements, it can't be beat! Accurate measurements can be made from 1 MHz all the way up to 500 MHz with excellent sensitivity throughout the range, and the two gate times let you select the resolution desired. Add the nicad pack option and the MINI-100 makes an ideal addition to your tool box for "in-the-field" frequency checks and repairs.

SPECIFICATIONS:

Range:	1 MHz to 500 MHz
Sensitivity:	Less than 25 MV
Resolution:	100 Hz (slow gate) 1.0 KHz (fast gate)
Display:	7 digits, 0.4" LED
Time base:	2.0 ppm 20-40°C
Power:	5 VDC @ 200 ma

8 DIGITS 600 MHz $159.95 WIRED

NEW READ RECEIVER FREQUENCY

SPECIFICATIONS:

Range:	20 Hz to 600 MHz
Sensitivity:	Less than 25 mv to 150 MHz Less than 150 mv to 600 MHz
Resolution:	1.0 Hz (60 MHz range) 10.0 Hz (600 MHz range)
Display:	8 digits 0.4" LED
Time base:	2.0 ppm 20-40°C
Power:	110 VAC or 12 VDC

The CT-50 is a versatile lab bench counter that will measure up to 600 MHz with 8 digit precision. And, one of its best features is the Receive Frequency Adapter, which turns the CT-50 into a digital readout for any receiver. The adapter is easily programmed for any receiver and a simple connection to the receiver's VFO is all that is required for use. Adding the receiver adapter in no way limits the operation of the CT-50, the adapter can be conveniently switched on or off. The CT-50, a counter that can work double-duty!

PRICES:

CT-50 wired, 1 year warranty	$159.95
CT-50 Kit, 90 day parts warranty	119.95
RA-1, receiver adapter kit	14.95
RA-1 wired and pre-programmed (send copy of receiver schematic)	29.95

DIGITAL MULTIMETER $99.95 WIRED

PRICES:

DM-700 wired, 1 year warranty	$99.95
DM-700 Kit, 90 day parts warranty	79.95
AC-1, AC adaptor	3.95
BP-3, Nicad pack +AC adapter/charger	19.95
MP-1, Probe kit	2.95

The DM-700 offers professional quality performance at a hobbyist price. Features include; 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 LED readout with automatic decimal placement, automatic polarity, overrange indication and overload protection up to 1250 volts on all ranges, making it virtually goof-proof! The DM-700 looks great, a handsome, jet black, rugged ABS case with convenient retractable tilt bail makes it an ideal addition to any shop.

SPECIFICATIONS:

DC/AC volts:	100uV to 1 KV, 5 ranges
DC/AC current:	0.1uA to 2.0 Amps, 5 ranges
Resistance:	0.1 ohms to 20 Megohms, 6 ranges
Input impedance:	10 Megohms, DC/AC volts
Accuracy:	0.1% basic DC volts
Power:	4 'C' cells

AUDIO SCALER

For high resolution audio measurements, multiplies UP in frequency.

- Great for PL tones
- Multiplies by 10 or 100
- 0.01 Hz resolution!

$29.95 Kit $39.95 Wired

ACCESSORIES

Telescopic whip antenna - BNC plug	$ 7.95
High impedance probe, light loading	15.95
Low pass probe, for audio measurements	15.95
Direct probe, general purpose usage	12.95
Tilt bail, for CT 70, 90, MINI-100	3.95
Color burst calibration unit, calibrates counter against color TV signal	14.95

COUNTER PREAMP

For measuring extremely weak signals from 10 to 1,000 MHz. Small size, powered by plug transformer-included.

- Flat 25 db gain
- BNC Connectors
- Great for sniffing RF with pick-up loop

$34.95 Kit $44.95 Wired

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3 AMP SILICON RECTIFIER

RECTIFIERS

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1N5249B	19 V 5% 500mW Zener	.24	1.80
1N5250B	20 V 5% 500mW Zener (1N968B equiv.)	.24	1.80
1N5251B	22 V 5% 500mW Zener (1N969B equiv.)	.24	1.80
1N5252B	24 V 5% 500mW Zener (1N970B equiv.)	.24	1.80
1N5253B	25 V 5% 500mW Zener	.24	1.80
1N5254B	27 V 5% 500mW Zener (1N971B equiv.)	.24	1.80
1N5255B	28 V 5% 500mW Zener	.24	1.80
1N5256B	30 V 5% 500mW Zener (1N972B equiv.)	.24	1.80
1N5257B	33 V 5% 500mW Zener (1N973B equiv.)	.24	1.80

Littlefuse Fuses

3AG "NORMAL-BLO" FUSES

DIGI-KEY Part No.	Amp. Rtg.	Price 5	100	1,000
F100-ND	.010	13.70	206.00	826.00/M
F101-ND	.031	11.00	165.00	741.00/M
F102-ND	.062	4.00	60.00	270.00/M
F103-ND	.100	4.00	60.00	270.00/M
F104-ND	.125	4.00	60.00	270.00/M
F105-ND	.150	4.00	60.00	270.00/M
F106-ND	.175	4.00	60.00	270.00/M
F107-ND	.187	4.00	60.00	270.00/M
F108-ND	.200	4.00	60.00	270.00/M
F109-ND	.250	2.42	36.30	163.00/M
F110-ND	.300	2.42	36.30	163.00/M
F111-ND	.375	2.42	36.30	163.00/M
F112-ND	.500	2.42	36.30	163.00/M
F113-ND	.600	2.42	36.30	163.00/M
F114-ND	.750	2.42	36.30	163.00/M
F115-ND	1	1.24	18.60	84.00/M
F116-ND	1.250	1.24	18.60	84.00/M
F117-ND	1.500	1.24	18.60	84.00/M
F118-ND	1.600	1.24	18.60	84.00/M
F119-ND	2	1.24	18.60	84.00/M
F120-ND	2.500	1.24	18.60	84.00/M
F121-ND	3	1.24	18.60	84.00/M
F122-ND	4	1.98	29.70	134.00/M
F123-ND	5	1.98	29.70	134.00/M
F124-ND	6	1.98	29.70	134.00/M
F125-ND	7	2.14	42.80	321.00/M
F126-ND	8	2.74	41.10	185.00/M
F127-ND	10	2.74	41.10	185.00/M

3AG "SLO-BLO" FUSES

DIGI-KEY Part No.	Amp. Rtg.	Price 5	100	1,000
F300-ND	.010	6.90	104.00	467.00/M
F301-ND	.031	6.90	104.00	467.00/M
F302-ND	.040	6.90	104.00	467.00/M
F303-ND	.062	4.86	72.90	328.00/M
F304-ND	.100	4.86	72.90	328.00/M
F305-ND	.125	4.86	72.90	328.00/M
F306-ND	.150	4.86	72.90	328.00/M
F307-ND	.175	4.86	72.90	328.00/M
F308-ND	.187	4.86	72.90	328.00/M
F309-ND	.200	4.86	72.90	328.00/M
F310-ND	.250	4.86	72.90	328.00/M
F311-ND	.300	4.86	72.90	328.00/M
F312-ND	.375	4.86	72.90	328.00/M
F313-ND	.400	4.86	72.90	328.00/M
F314-ND	.500	4.86	72.90	328.00/M
F315-ND	.600	4.86	72.90	328.00/M
F316-ND	.700	4.86	72.90	328.00/M
F317-ND	.750	4.86	72.90	328.00/M

3AG PANEL FUSEHOLDER

Black phenolic conforming to MIL-M-14, type CFG. Rated at 20 amps for any voltage to 250. Includes neoprene washer, hex nut, and lock washer.

Part No.	Price 1	10	100
F004-ND	1.89	15.00	94.50

MA1026 Time-Temp. Clock Module

"Programmable" Clock Modules

.5" 4-Digit LCD Clock

DIGI-CLOCK KIT

- 12 VDC — Ideal for Car, Van or Boat!

Part No. 5001K ONLY $17.95

LED's — Red, Green, Amber, Orange

3 mm, 4 mm, 5 mm; Round, Rectangular, Arrow

Color	Part No.	Price 10	100	Size MM	Shape
Red Diffused	P300	2.20	19.50	5	Round
Red Clear	P301	2.20	19.50	5	Round
Green Clear	P302	2.20	19.50	5	Round
Green Diffused	P303	2.20	19.50	5	Round
Amber Clear	P304	2.20	19.50	5	Round
Orange Clear	P305	2.20	19.50	5	Round
Amber Diffused	P306	2.20	19.50	5	Round
Orange Diffused	P307	2.20	19.50	5	Round
Red Clear	P308	2.20	19.50	3	Round
Green Clear	P309	2.20	19.50	3	Round
Amber Clear	P310	2.20	19.50	3	Round
Red Clear	P311	2.20	19.50	4	Round
Green Clear	P312	2.20	19.50	4	Round
Amber Diffused	P314	2.20	19.50	4	Round
Red Diffused	P315	2.20	19.50	3x5	Rectangle
Green Diffused	P316	3.12	26.00	3x5	Rectangle
Amber Diffused	P317	3.12	26.00	3x5	Rectangle
Red Diffused	P318	2.20	19.5[illegible]	4x4.5	Arrow
Green Diffused	P319	3.12	26.00	4x4.5	Arrow
Amber Diffused	P320	3.12	26.00	4x4.5	Arrow

Panasonic LED Numeric Displays

Red, Green, Amber and Orange Colors — Direct Drive

Part No. Comm. Anode	Comm. Cath.	Digits	Color	Size In.	Price 1	10	100
P322	P343	8	Red	.3	1.26	11.60	105.00
P323	P344	8	Green	.3	1.58	14.50	132.00
P324	P345	8	Amber	.3	1.93	17.70	162.00
P325	P346	8	Orange	.3	1.93	17.70	162.00
P326	P347	8	Red	.43	1.45	13.30	122.00
P327	P348	8	Green	.43	1.78	16.30	149.00
P328	P349	8	Amber	.43	1.93	17.70	162.00
P329	P350	8	Orange	.43	2.10	19.32	176.00
P330	P351	8	Red	.57	1.58	14.50	132.00
P331	P352	8	Green	.57	1.90	17.50	159.00
P332	P353	8	Amber	.57	1.93	17.70	162.00
P333	P354	8	Orange	.57	2.25	20.70	188.00
P334	P355	88	Red	.43	2.10	19.30	175.00
P335	P356	88	Green	.43	2.45	22.50	205.00
P336	P357	88	Amber	.43	3.08	28.30	257.00
P337	P358	88	Red	.57	2.10	19.30	175.00
P338	P359	88	Green	.57	2.45	22.50	205.00
P339	P360	88	Amber	.57	3.58	32.90	299.00
P340*	P361*	8888	Red	.28	5.36	49.20	448.00
P341*	P362*	8888	Green	.28	6.15	56.60	515.00

* Multiplexed Display

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1% Metal Film Resistors

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In order to receive the pricing below, the resistor part number must be followed by a "-ND" (i.e., 10KQ-ND) and ordered in multiples of 1,000 only.

Price /1000	1M	10M	50M	100M	500M	1000M
¼W	8.10/M	7.20/M	5.80/M	5.40/M	4.50/M	4.00/M
½W	12.25/M	10.25/M	8.50/M	8.90/M	7.40/M	6.65/M

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DIP Jumper Cable Assembly — Standard Assembly Styles

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D-Subminiature Connectors

HD9-ND	9 Pin Hood	1.62	13.50	108.00	810.00
HD15-ND	15 Pin Hood	1.62	13.50	108.00	810.00
HD25-ND	25 Pin Hood	1.62	13.50	108.00	810.00
HD37-ND	37 Pin Hood	1.80	15.00	120.00	900.00
HD50-ND	50 Pin Hood	2.01	16.75	134.00	1005.00

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$ 50.00-$99.99	Add $0.25	$ 500.00-$999.99	Less 20%
$100.00 & Up	No Charge	$1000.00 & Up	Less 25%

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It's like no other magazine in the world!

Between the covers of this special annual publication are carefully selected articles on scientific developments, recent technical advances, consumer products trends, development of services, exotic communications advances, design information, hobbying tips, and "what's new" material compiled for your reading pleasure and information. Each article was specifically chosen and prepared for publication by the editorial staff of *Radio-Electronics* magazine, updated to the moment it went on press and printed. Here's what you will read about in the 1984 edition:

VIDEO ENTERTAINMENT—It couldn't be said all in one article so we compiled a 16-page special section covering the changing and growing field of entertainment in the home: new video components with screens from the gigantic to the tiny postage-stamp size, accessories that didn't exist last year, and tips on getting the most from what you own or plan to buy.

SATELLITE TV—The countryside is strewn with parabolic tracking dishes installed by home owners to pull-in the countless television channels transmitted back to earth by satellites poised in space in geosynchronous orbits. You, too, can enjoy the programming selection—and much of it is commercial-free, too!

MOBILE TELEPHONES—What was once a status symbol for the idle rich is quickly becoming a working tool for the common man. Cellular technology promises more channels with a little help from applied computer technology.

DIGITAL AUDIO DISCS—Laser rays are bringing new noise-free, pulse-encoded audio programming to your stereo system embedded in a plastic disc immune to strawberry jam, sandpaper, and desert heat.

MAIL ORDER BUYING—You've heard the bad points, including the myths. Now, here are the facts and economics of buying mail order that will be an asset to your business or hobby.

PLUS—There's so much more, we have space only to mention an electronic guitar tuning project, theory on digital filters, how to make inexpensive computer cables, build a programmable home thermostat, tips on buying pocket-size shortwave receivers, stereo audio for TV, all about VLF active antennas, news on pagers, how to restore antique radios, and....

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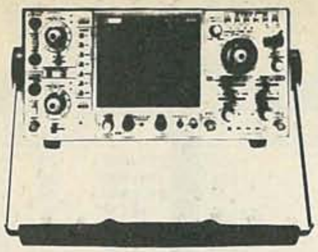

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1477	15 MHz	595.00	499.95
1479B	30 MHz	795.00	619.95
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1540	40 MHz	950.00	809.95
1560	60 MHz	1150.00	979.95
1570	70 MHz	1395.00	1095.00
1590	100 MHz	1995.00	1695.00

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MODEL		REG. PRICE	OUR PRICE
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V-422	40 MHz	895.00	760.75
V-650	60 MHz	1195.00	995.00
V-1050	100 MHz	1995.00	1690.00
V-209	20 MHz PORTABLE	950.00	790.95

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8022B	TROUBLESHOOTER DIGITAL MULTIMETER	144.00
8024B	INVESTIGATOR DIGITAL MULTIMETER	249.00
8026B	3 1/2 DIGITAL MULTIMETER	219.00
8060A	4 1/2 DIGITAL HANDHELD METER	349.00
8062B	4 1/2 DIGITAL HANDHELD METER	279.00
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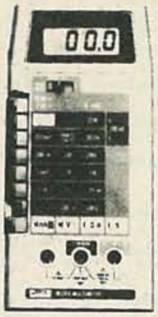
8050A	4 1/2 DIGIT MULTIMETER BENCH OR FIELD	389.00
8050A-01	3 1/2 DIGIT MULTIMETER BENCH OR FIELD	439.00



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TECH 310UL	3 1/2 DIGIT MULTIMETER	150.00
TECH 320B	3 1/2 DIGIT MULTIMETER	170.00
TECH 330	3 1/2 DIGIT MULTIMETER	209.00
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HD-110	PORTABLE DIGITAL MULTIMETER	180.00
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DM-15	3 1/2 DIGIT MULTIMETER	$59.95
DM-20	3 1/2 DIGIT MULTIMETER	64.95
DM-25	3 1/2 DIGIT MULTIMETER	79.95
DM-40	3 1/2 DIGIT MULTIMETER	69.95
DM-45	3 1/2 DIGIT MULTIMETER	89.95

Weller

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EC-2000	SOLDERING STATION	144.95
DS-600	PORTABLE DESOLDERING STATION	325.00
DS-500	DESOLDERING STATION	399.95
DS-100	DESOLDERING STATION	69.95

UNGAR

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9000	SOLDERING STATION	135.00
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HOT VAC 4000	DESOLDERING STATION	349.95

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260-6XL	VOM EXTRA FEATURES	120.00
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360-3	PORTABLE DIGITAL VOM	234.95
461-2	AVERAGE SENSING DMM	175.00
462	AUTORANGING DMM	219.95
463	DMM	175.00
470	HANDHELD DMM	124.95
467E	TRUE RMS DMM	191.25
467	"DIGALOG" DMM	229.50
380	MICROWAVE LEAK TESTER	325.00

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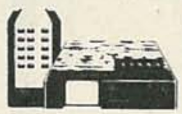
LCC-91	91 CHANNEL CORDLESS TV CONVERTER	119.95
TECKNIKA 6301	WIRELESS REMOTE CONTROL TV TUNER	110.00
BP 5746	46 CHANNEL / UHF CONVERTER FOR TV AND VTR	29.95



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SK 3303 / 522	11.95 each
SK 3307 / 529	17.75 each 5 & Up 16.50 each
SK 3305 / 534	12.50 each
SK 3900 / 536	24.95 each
SK 3309 / 539	12.50 each
800-616 ZENITH FOCUS DIVIDER	4.50 each

Xcelite

MODEL	REG.	OUR PRICE
TC-100/ST	$499.95	$349.95
TC-150/ST	379.95	289.95
TC-200/ST	236.17	179.95

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PART No. GE	PART No. MAGNAVOX	PART No. ZENITH
EP 25X55	250663-11	800-860
EP 25X60	250663-13	
EP 25X75	250663-17	PART No. SEARS
EP 25X78	250663-19	20-887-1
EP 25X69		
EP 25X79	ANY ASSORTMENT OF 5 for $17.50	

NAME BRAND TRANSISTORS

MODEL		OUR PRICE	MODEL		OUR PRICE	MODEL		OUR PRICE
108	10 FOR	$ 5.50	157	10 FOR	$10.00	125	100 FOR	$ 9.95
123A	10 FOR	3.95	159	10 FOR	5.50	177	20 FOR	9.95
152	10 FOR	8.00	196	10 FOR	10.00	506	10 FOR	8.00
153	10 FOR	8.00	197	10 FOR	10.00	712	5 FOR	10.00
154	10 FOR	12.00	198	10 FOR	12.50	SPECIAL 238	10 FOR	26.00

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BP SOLDER	.031 DIAMETER	10.95 each 3 For 30.00
SOLDER WICK	1/8 DIAMETER	10 For 9.95

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COPPER BRAID	54.95	1,000 FEET

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TMM2016 2KX8 STATIC 200 NS $4.15

STATIC RAMS

2101	256 x 4 (450ns)	1.95
5101	256 x 4 (450ns) (cmos)	3.95
2102-1	1024 x 1 (450ns)	.89
2102L-4	1024 x 1 (450ns) (LP)	.99
2102L-2	1024 x 1 (250ns) (LP)	1.49
2111	256 x 4 (450ns)	2.49
2112	256 x 4 (450ns)	2.99
2114	1024 x 4 (450ns)	8/9.95
2114-25	1024 x 4 (250ns)	8/10.95
2114L-4	1024 x 4 (450ns) (LP)	8/12.95
2114L-3	1024 x 4 (300ns) (LP)	8/13.45
2114L-2	1024 x 4 (200ns) (LP)	8/13.95
2147	4096 x 1 (55ns)	4.95
TMS4044-4	4096 x 1 (450ns)	3.49
TMS4044-3	4096 x 1 (300ns)	3.99
TMS4044-2	4096 x 1 (200ns)	4.49
MK4118	1024 x 8 (250ns)	9.95
TMM2016-200	2048 x 8 (200ns)	4.15
TMM2016-150	2048 x 8 (150ns)	4.95
TMM2016-100	2048 x 8 (100ns)	6.15
HM6116-4	2048 x 8 (200ns) (cmos)	4.75
HM6116-3	2048 x 8 (150ns) (cmos)	4.95
HM6116-2	2048 x 8 (120ns) (cmos)	8.95
HM6116LP-4	2048 x 8 (200ns) (cmos)(LP)	5.95
HM6116LP-3	2048 x 8 (150ns) (cmos)(LP)	6.95
HM6116LP-2	2048 x 8 (120ns) (cmos)(LP)	10.95
Z-6132	4096 x 8 (300ns) (Qstat)	34.95

LP = Low Power   Qstat = Quasi-Static

DYNAMIC RAMS

TMS4027	4096 x 1 (250ns)	1.99
UPD411	4096 x 1 (300ns)	3.00
MM5280	4096 x 1 (300ns)	3.00
MK4108	8192 x 1 (200ns)	1.95
MM5298	8192 x 1 (250ns)	1.85
4116-300	16384 x 1 (300ns)	8/11.75
4116-250	16384 x 1 (250ns)	8/11.95
4116-200	16384 x 1 (200ns)	8/12.95
4116-150	16384 x 1 (150ns)	8/14.95
4116-120	16384 x 1 (120ns)	8/29.95
2118	16384 x 1 (150ns) (5v)	4.95
4164-200	65536 x 1 (200ns) (5v)	5.95
4164-150	65536 x 1 (150ns) (5v)	6.95

5V = single 5 volt supply

EPROMS

1702	256 x 8 (1us)	4.50
2708	1024 x 8 (450ns)	3.95
2758	1024 x 8 (450ns) (5v)	5.95
2716	2048 x 8 (450ns) (5v)	3.95
2716-1	2048 x 8 (350ns) (5v)	5.95
TMS2516	2048 x 8 (450ns) (5v)	5.50
TMS2716	2048 x 8 (450ns)	7.95
TMS2532	4096 x 8 (450ns) (5v)	5.95
2732	4096 x 8 (450ns) (5v)	4.95
2732-250	4096 x 8 (250ns) (5v)	8.95
2732-200	4096 x 8 (200ns) (5v)	11.95
2764	8192 x 8 (450ns) (5v)	9.95
2764-250	8192 x 8 (250ns) (5v)	14.95
2764-200	8192 x 8 (200ns) (5v)	24.95
TMS2564	8192 x 8 (450ns) (5v)	17.95
MC68764	8192 x 8 (450ns) (5v)(24 pin)	39.95
27128	16384x8 Call	Call

5v = Single 5 Volt Supply

EPROM ERASERS

	Timer	Capacity Chip	Intensity (uW/Cm²)	
PE-14		6	5,200	83.00
PE-14T	X	6	5,200	119.00
PE-24T	X	9	6,700	175.00
PL-265T	X	20	6,700	255.00
PR-125T	X	16	15,000	349.00
PR-320	X	32	15,000	595.00

Z-80

2.5 Mhz

Z80-CPU	3.95
Z80-CTC	4.49
Z80-DART	10.95
Z80-DMA	14.95
Z80-PIO	4.49
Z80-SIO/0	16.95
Z80-SIO/1	16.95
Z80-SIO/2	16.95
Z80-SIO/9	16.95

4.0 Mhz

Z80A-CPU	4.95
Z80A-CTC	4.95
Z80A-DART	11.95
Z80A-DMA	16.95
Z80A-PIO	4.95
Z80A-SIO/0	16.95
Z80A-SIO/1	16.95
Z80A-SIO/2	16.95
Z80A-SIO/9	16.95

6.0 Mhz

Z80B-CPU	11.95
Z80B-CTC	13.95
Z80B-PIO	13.95
Z80B-DART	19.95

ZILOG

Z6132	34.95
Z8671	39.95

CRYSTALS

32.768 khz	1.95
1.0 mhz	4.95
1.8432	4.95
2.0	3.95
2.097152	3.95
2.4576	3.95
3.2768	3.95
3.579535	3.95
4.0	3.95
5.0	3.95
5.0688	3.95
5.185	3.95
5.7143	3.95
6.0	3.95
6.144	3.95
6.5536	3.95
8.0	3.95
10.0	3.95
10.738635	3.95
14.31818	3.95
15.0	3.95
16.0	3.95
17.430	3.95
18.0	3.95
18.432	3.95
20.0	3.95
22.1184	3.95
32.0	3.95

CRT CONTROLLERS

6845	14.95
68B45	19.95
HD46505SP	15.95
6847	11.95
MC1372	6.95
68047	24.95
8275	29.95
7220	99.95
CRT5027	39.95
CRT5037	49.95
TMS9918A	39.95
DP8350	49.95

KEYBOARD CHIPS

AY5-2376	11.95
AY5-3600	11.95
AY5-3600 PRO	11.95

8000

8035	5.95
8039	6.95
INS-8060	17.95
INS-8073	24.95
8080	3.95
8085	5.95
8085A-2	11.95
8086	29.95
8087	CALL
8088	39.95
8089	89.95
8155	6.95
8155-2	7.95
8156	6.95
8185	29.95
8185-2	39.95
8741	39.95
8748	24.95
8755	24.95

8200

8202	24.95
8203	39.95
8205	3.50
8212	1.80
8214	3.85
8216	1.75
8224	2.25
8226	1.80
8228	3.49
8237	19.95
8237-5	21.95
8238	4.49
8243	4.45
8250	10.95
8251	4.49
8253	6.95
8253-5	7.95
8255	4.49
8255-5	5.25
8257	7.95
8257-5	8.95
8259	6.90
8259-5	7.50
8271	39.95
8272	39.95
8275	29.95
8279	8.95
8279-5	10.00
8282	6.50
8283	6.50
8284	5.50
8286	6.50
8287	6.50
8288	25.00
8289	49.95

DISC CONTROLLERS

1771	16.95
1791	24.95
1793	26.95
1795	49.95
1797	49.95
2791	54.95
2793	54.95
2795	59.95
2797	59.95
6843	34.95
8272	39.95
UPD765	39.95
MB8876	29.95
MB8877	34.95
1691	17.95
2143	18.95

CONNECTORS

RS232 MALE	2.50
RS232 FEMALE	3.25
RS232 HOOD	1.25
S-100 ST	3.95

6800

68000	59.95
6800	3.95
6802	7.95
6808	13.90
6809E	19.95
6809	11.95
6810	2.95
6820	4.35
6821	3.25
6828	14.95
6840	12.95
6843	34.95
6844	25.95
6845	14.95
6847	11.95
6850	3.25
6852	5.75
6860	9.95
6862	11.95
6875	6.95
6880	2.25
6883	22.95
68047	24.95
68488	19.95

6800 = 1MHZ

68B00	10.95
68B02	22.25
68B09E	29.95
68B09	29.95
68B10	6.95
68B21	6.95
68B45	19.95
68B50	5.95

68B00 = 2 MHZ

6500

1 MHZ

6502	4.95
6504	6.95
6505	8.95
6507	9.95
6520	4.35
6522	7.95
6532	9.95
6545	22.50
6551	11.85

2 MHZ

6502A	6.95
6522A	9.95
6532A	11.95
6545A	27.95
6551A	11.95

3 MHZ

6502B	14.95

UARTS

AY3-1014	6.95
AY5-1013	3.95
AY3-1015	6.95
PT1472	9.95
TR1602	3.95
2350	9.95
2651	8.95
TMS6011	5.95
IM6402	7.95
IM6403	8.95
INS8250	10.95

GENERATORS

BIT-RATE

MC14411	11.95
BR1941	11.95
4702	12.95
COM5016	16.95
COM8116	10.95
MM5307	10.95

FUNCTION

MC4024	3.95
LM566	1.49
XR2206	3.75
8038	3.95

74LS00

74LS00	.24	74LS173	.
74LS01	.25	74LS174	.
74LS02	.25	74LS175	.
74LS03	.25	74LS181	2.
74LS04	.24	74LS189	8.
74LS05	.25	74LS190	.
74LS08	.28	74LS191	.
74LS09	.29	74LS192	.
74LS10	.25	74LS193	.
74LS11	.35	74LS194	.
74LS12	.35	74LS195	.
74LS13	.45	74LS196	.
74LS14	.59	74LS197	.
74LS15	.35	74LS221	.
74LS20	.25	74LS240	.
74LS21	.29	74LS241	.
74LS22	.25	74LS242	.
74LS26	.29	74LS243	.
74LS27	.29	74LS244	1.
74LS28	.35	74LS245	1.
74LS30	.25	74LS247	.
74LS32	.29	74LS248	.
74LS33	.55	74LS249	.
74LS37	.35	74LS251	.
74LS38	.35	74LS253	.
74LS40	.25	74LS257	.
74LS42	.49	74LS258	.
74LS47	.75	74LS259	2.
74LS48	.75	74LS260	.
74LS49	.75	74LS266	.
74LS51	.25	74LS273	1.
74LS54	.29	74LS275	3.
74LS55	.29	74LS279	.
74LS63	1.25	74LS280	1.
74LS73	.39	74LS283	.
74LS74	.35	74LS290	.
74LS75	.39	74LS293	.
74LS76	.39	74LS295	.
74LS78	.49	74LS298	.
74LS83	.60	74LS299	1.
74LS85	.69	74LS323	3.
74LS86	.39	74LS324	1.
74LS90	.55	74LS352	1.
74LS91	.89	74LS353	1.
74LS92	.55	74LS363	1.
74LS93	.55	74LS364	1.
74LS95	.75	74LS365	.
74LS96	.89	74LS366	.
74LS107	.39	74LS367	.
74LS109	.39	74LS368	.
74LS112	.39	74LS373	1.
74LS113	.39	74LS374	1.
74LS114	.39	74LS377	1.
74LS122	.45	74LS378	1.
74LS123	.79	74LS379	1.
74LS124	2.90	74LS385	1.
74LS125	.49	74LS386	.
74LS126	.49	74LS390	1.
74LS132	.59	74LS393	1.
74LS133	.59	74LS395	1.
74LS136	.39	74LS399	1.
74LS137	.99	74LS424	2.
74LS138	.55	74LS447	.
74LS139	.55	74LS490	1.
74LS145	1.20	74LS624	3.
74LS147	2.49	74LS640	2.
74LS148	1.35	74LS645	2.
74LS151	.55	74LS668	1.
74LS153	.55	74LS669	1.
74LS154	1.90	74LS670	1.
74LS155	.69	74LS674	9.
74LS156	.69	74LS682	3.
74LS157	.65	74LS683	3.
74LS158	.59	74LS684	3.
74LS160	.69	74LS685	3.
74LS161	.65	74LS688	2.
74LS162	.69	74LS689	3.
74LS163	.65	74LS783	24.
74LS164	.69	81LS95	1.
74LS165	.95	81LS96	1.
74LS166	1.95	81LS97	1.
74LS168	1.75	81LS98	1.
74LS169	1.75	25LS2521	2.
74LS170	1.49	25LS2569	4.

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7400

	.19	74132	.45
	.19	74136	.50
	.19	74141	.65
	.19	74142	2.95
	.19	74143	2.95
	.25	74145	.60
	.29	74147	1.75
	.29	74148	1.20
	.24	74150	1.35
	.19	74151	.55
	.19	74152	.65
	.25	74153	.55
	.30	74154	1.25
	.35	74155	.75
	.49	74156	.65
	.25	74157	.55
	.25	74159	1.65
	.19	74160	.85
	.35	74161	.69
	.35	74162	.85
	.29	74163	.69
	.29	74164	.85
	.29	74165	.85
	.29	74166	1.00
	.45	74167	2.95
	.19	74170	1.65
	.29	74172	5.95
	.45	74173	.75
	.29	74174	.89
	.29	74175	.89
	.19	74176	.89
	.49	74177	.75
	.65	74178	1.15
	.69	74179	1.75
	.69	74180	.75
	.69	74181	2.25
	.69	74182	.75
	.69	74184	2.00
	.19	74185	2.00
	.23	74190	1.15
	.23	74191	1.15
	.23	74192	.79
	.23	74193	.79
	.35	74194	.85
	.29	74195	.85
	.34	74196	.79
	.33	74197	.75
	.45	74198	1.35
	.35	74199	1.35
	.59	74221	1.35
	1.10	74246	1.35
	.95	74247	1.25
	.50	74248	1.85
	.59	74249	1.95
	.35	74251	.75
	2.15	74259	2.25
	.35	74265	1.35
	.40	74273	1.95
	.50	74276	1.25
	.35	74279	.75
	.65	74283	2.00
	.55	74284	3.75
	.70	74285	3.75
	2.75	74290	.95
0	1.75	74293	.75
7	.30	74298	.85
9	.45	74351	2.25
0	.45	74365	.65
1	.55	74366	.65
6	1.55	74367	.65
0	1.20	74368	.65
1	.29	74376	2.20
2	.45	74390	1.75
3	.49	74393	1.35
5	.45	74425	3.15
6	.45	74426	.85
8	.55	74490	2.55

LINEAR

LM301	.34	LM340 (see 7800)		LM566	1.49	LM1800	2.37
LM301H	.79	LM348	.99	LM567	.89	LM1812	8.25
LM307	.45	LM350K	4.95	NE570	3.95	LM1830	3.50
LM308	.69	LM350T	4.60	NE571	2.95	LM1871	5.49
LM308H	1.15	LM358	.69	NE592	2.75	LM1872	5.49
LM309H	1.95	LM359	1.79	LM709	.59	LM1877	3.25
LM309K	1.25	LM376	3.75	LM710	.75	LM1889	1.95
LM310	1.75	LM377	1.95	LM711	.79	LM1896	1.75
LM311	.64	LM378	2.50	LM723	.49	ULN2003	2.49
LM311H	.89	LM379	4.50	LM723H	.55	LM2877	2.05
LM312H	1.75	LM380	.89	LM733	.98	LM2878	2.25
LM317K	3.95	LM380N-8	1.10	LM741	.35	LM2900	.85
LM317T	1.19	LM381	1.60	LM741N-14	.35	LM2901	1.00
LM318	1.49	LM382	1.60	LM741H	.40	LM3900	.59
LM318H	1.59	LM383	1.95	LM747	.69	LM3905	1.25
LM319H	1.90	LM384	1.95	LM748	.59	LM3909	.98
LM319	1.25	LM386	.89	LM1014	1.19	LM3911	2.25
LM320 (see 7900)		LM387	1.40	LM1303	1.95	LM3914	3.95
LM322	1.65	LM389	1.35	LM1310	1.49	LM3915	3.95
LM323K	4.95	LM390	1.95	MC1330	1.69	LM3916	3.95
LM324	.59	LM392	.69	MC1349	1.89	MC4024	3.95
LM329	.65	LM394H	4.60	MC1350	1.19	MC4044	4.50
LM331	3.95	LM399H	5.00	MC1358	1.69	RC4136	1.25
LM334	1.19	NE531	2.95	MC1372	6.95	RC4151	3.95
LM335	1.40	NE555	.34	LM1414	1.59	LM4250	1.75
LM336	1.75	NE556	.65	LM1458	.59	LM4500	3.25
LM337K	3.95	NE558	1.50	LM1488	.69	RC4558	.69
LM337T	1.95	NE561	24.95	LM1489	.69	LM13080	1.29
LM338K	6.95	NE564	2.95	LM1496	.85	LM13600	1.49
LM339	.99	LM565	.99	LM1558H	3.10	LM13700	1.49

H = TO-5 CAN T = TO-220 K = TO-3

RCA

CA 3023	2.75	CA 3082	1.65
CA 3039	1.29	CA 3083	1.55
CA 3046	1.25	CA 3086	.80
CA 3059	2.90	CA 3089	2.99
CA 3060	2.90	CA 3096	3.49
CA 3065	1.75	CA 3130	1.30
CA 3080	1.10	CA 3140	1.15
CA 3081	1.65	CA 3146	1.85
CA 3160	1.19		

TI

TL494	4.20	75365	1.95
TL496	1.65	75450	.59
TL497	3.25	75451	.39
75107	1.49	75452	.39
75110	1.95	75453	.39
75150	1.95	75454	.39
75154	1.95	75491	.79
75188	1.25	75492	.79
75189	1.25	75493	.89
75494	.89		

BI FET

TL071	.79	TL084	2.19
TL072	1.19	LF347	2.19
TL074	2.19	LF351	.60
TL081	.79	LF353	1.00
TL082	1.19	LF355	1.10
TL083	1.19	LF356	1.10
LF357	1.40		

CMOS

4000	.29	4527	1.95
4001	.25	4528	1.19
4002	.25	4531	.95
4006	.89	4532	1.95
4007	.29	4538	1.95
4008	.95	4539	1.95
4009	.39	4541	2.64
4010	.45	4543	1.19
4011	.25	4553	5.79
4012	.25	4555	.95
4013	.38	4556	.95
4014	.79	4581	1.95
4015	.39	4582	1.95
4016	.39	4584	.75
4017	.69	4585	.75
4018	.79	4702	12.95
4019	.39	74C00	.35
4020	.75	74C02	.35
4021	.79	74C04	.35
4022	.79	74C08	.35
4023	.29	74C10	.35
4024	.65	74C14	.59
4025	.29	74C20	.35
4026	1.65	74C30	.35
4027	.45	74C32	.39
4028	.69	74C42	1.29
4029	.79	74C48	1.99
4030	.39	74C73	.65
4034	1.95	74C74	.65
4035	.85	74C76	.80
4040	.75	74C83	1.95
4041	.75	74C85	1.95
4042	.69	74C86	.39
4043	.85	74C89	4.50
4044	.79	74C90	1.19
4046	.85	74C93	1.75
4047	.95	74C95	.99
4049	.35	74C107	.89
4050	.35	74C150	5.75
4051	.79	74C151	2.25
4053	.79	74C154	3.25
4060	.89	74C157	1.75
4066	.39	74C160	1.19
4068	.39	74C161	1.19
4069	.29	74C162	1.19
4070	.35	74C163	1.19
4071	.29	74C164	1.39
4072	.29	74C165	2.00
4073	.29	74C173	.79
4075	.29	74C174	1.19
4076	.79	74C175	1.19
4078	.29	74C192	1.49
4081	.29	74C193	1.49
4082	.29	74C195	1.39
4085	.95	74C200	5.75
4086	.95	74C221	1.75
4093	.49	74C373	2.45
4098	2.49	74C374	2.45
4099	1.95	74C901	.39
14409	12.95	74C902	.85
14410	12.95	74C903	.85
14411	11.95	74C905	10.95
14412	12.95	74C906	.95
14419	7.95	74C907	1.00
14433	4.18	74C908	2.00
4502	.95	74C909	2.75
4503	.65	74C910	9.95
4508	1.95	74C911	8.95
4510	.85	74C912	8.95
4511	.85	74C914	1.95
4512	.85	74C915	1.19
4514	1.25	74C918	2.75
4515	1.79	74C920	17.95
4516	1.55	74C921	15.95
4518	.89	74C922	4.49
4519	.39	74C923	4.95
4520	.79	74C925	5.95
4522	1.25	74C926	7.95
4526	1.25	74C928	7.95
		74C929	19.95

74S00

74S00	.32	74S163	1.95
74S02	.35	74S168	3.95
74S03	.35	74S169	3.95
74S04	.35	74S174	.95
74S05	.35	74S175	.95
74S08	.35	74S181	3.95
74S09	.40	74S182	2.95
74S10	.35	74S188	1.95
74S11	.35	74S189	6.95
74S15	.35	74S194	1.49
74S20	.35	74S195	1.49
74S22	.35	74S196	1.49
74S30	.35	74S197	1.49
74S32	.40	74S201	6.95
74S37	.88	74S225	7.95
74S38	.85	74S240	2.20
74S40	.35	74S241	2.20
74S51	.35	74S244	2.20
74S64	.40	74S251	.95
74S65	.40	74S253	.95
74S74	.50	74S257	.95
74S85	1.99	74S258	.95
74S86	.50	74S260	.79
74S112	.50	74S274	19.95
74S113	.50	74S275	19.95
74S114	.55	74S280	1.95
74S124	2.75	74S287	1.90
74S132	1.24	74S288	1.90
74S133	.45	74S289	6.89
74S134	.50	74S301	6.95
74S135	.89	74S373	2.45
74S138	.85	74S374	2.45
74S139	.85	74S381	7.95
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74S153	.95	74S471	4.95
74S157	.95	74S472	4.95
74S158	.95	74S474	4.95
74S161	1.95	74S482	15.25
74S162	1.95	74S570	2.95
		74S571	2.95

IC SOCKETS

	1-99	100
8 pin ST	.13	.11
14 pin ST	.15	.12
16 pin ST	.17	.13
18 pin ST	.20	.18
20 pin ST	.29	.27
22 pin ST	.30	.27
24 pin ST	.30	.27
28 pin ST	.40	.32
40 pin ST	.49	.39
64 pin ST	4.25	call

ST = SOLDERTAIL

8 pin WW	.59	.49
14 pin WW	.69	.52
16 pin WW	.69	.58
18 pin WW	.99	.90
20 pin WW	1.09	.98
22 pin WW	1.39	1.28
24 pin WW	1.49	1.35
28 pin WW	1.69	1.49
40 pin WW	1.99	1.80

WW = WIREWRAP

16 pin ZIF	6.75	call
24 pin ZIF	9.95	call
28 pin ZIF	10.95	call

ZIF = TEXTOOL (Zero Insertion Force)

VOLTAGE REGULATORS

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78MO5C	.35	7908T	.85
7808T	.75	7912T	.85
7812T	.75	7915T	.85
7815T	.75	7924T	.85
7824T	.75		
7805K	1.39	7905K	1.49
7812K	1.39	7912K	1.49
7815K	1.39	7915K	1.49
7824K	1.39	7924K	1.49
78L05	.69	79L05	.79
78L12	.69	79L12	.79
78L15	.69	79L15	.79
		LM323K	4.95
78H05K	9.95	UA78S40	1.95
78H12K	9.95		

C, T = TO-220 K = TO-3 L = TO-92

DIP SWITCHES

4 POSITION	.85
5 POSITION	.90
6 POSITION	.90
7 POSITION	.95
8 POSITION	.95

INTERFACE

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8T28	1.89
8T95	.89
8T96	.89
8T97	.89
8T98	.89
DM8131	2.95
DP8304	2.29
DS8835	1.99
DS8836	.99

MISC.

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3242	7.95
3341	4.95
MC3470	4.95
MC3480	9.00
11C90	13.95
95H90	7.95
2513-001 UP	9.95
2513-002 LOW	9.95

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Green	.18	.15
Yellow	.18	.15

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MAN 72	.3"	CA	.99
MAN 74	.3"	CC	.99
FND-357 (359)	.375"	CC	1.25
FND-500 (503)	.5"	CC	1.49
FND-507 (510)	.5"	CA	1.49

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375	4.95
8167	8.95
8174	11.95
5832	6.95

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ICL7107	12.95
ICL7660	2.95
ICL8038	3.95
ICM7207A	5.59
ICM7208	15.95

9000

9316	1.00
9334	2.50
9368	3.95
9401	9.95
9601	.75
9602	1.50
96S02	1.95

EXAR

XR 2206	3.75
XR 2207	3.75
XR 2208	3.75
XR 2211	5.25
XR 2240	3.25

DATA ACQUISITION

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ADC0804	3.49	DAC1020	8.25
ADC0809	4.49	DAC1022	5.95
ADC0817	9.95	MC1408L6	1.95
DAC0800	4.95	MC1408L8	2.95

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RS232 FEMALE	3.25
RS232 FEMALE RIGHT ANGLE	5.25
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S-100 WW	4.95
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2N2102	.70	2N3903	.25
2N2218	.50	2N3904	.10
2N2218A	.50	2N3906	.10
2N2219	.50	2N4122	.25
2N2219A	.50	2N4123	.25
2N2222	.25	2N4249	.25
PN2222	.10	2N4304	.75
MPS2369	.25	2N4401	.25
2N2484	.25	2N4402	.25
2N2905	.50	2N4403	.25
2N2907	.25	2N4857	1.00
PN2907	.125	PN4916	.25
2N3055	.79	2N5086	.25
3055T	.69	PN5129	.25
2N3393	.30	PN5139	.25
2N3414	.25	2N5209	.25
2N3563	.40	2N6028	.35
2N3565	.40	2N6043	1.75
PN3565	.25	2N6045	1.75
MPS3638	.25	MPS-A05	.25
MPS3640	.25	MPS-A06	.25
PN3643	.25	MPS-A55	.25
PN3644	.25	TIP29	.65
MPS3704	.15	TIP31	.75
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MCA-7	4.25
MCA-255	1.75
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KBP04	400PIV 1.5amp bridge	.55
VM48	Dip-Bridge	.35

D-SUBMINIATURE

DESCRIPTION	SOLDER CUP		RIGHT ANGLE PC SOLDER		IDC RIBBON CABLE		HOODS	
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	BLACK	GREY
ORDER BY	DBxxP	DBxxS	DBxxPR	DBxxSR	IDBxxP	IDBxxS	HOOD-B	HOOD
CONTACTS 9	2.08	2.66	1.65	2.18	3.37	3.69	---	1.60
15	2.69	3.63	2.20	3.03	4.70	5.13	---	1.60
25	2.50	3.25	3.00	4.42	6.23	6.84	1.25	1.25
37	4.80	7.11	4.83	6.19	9.22	10.08	---	2.95
50	6.06	9.24	---	---	---	---	---	3.50

For order instructions see "IDC Connectors" below.

CALL FOR MOUNTING HARDWARE

RIBBON CABLE

CONTACTS	SINGLE COLOR		COLOR CODED	
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10	.50	4.40	.83	7.30
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20	.65	5.70	1.25	11.00
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26	.75	6.60	1.32	11.60
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50	1.38	12.10	2.50	22.00

IDC CONNECTORS

DESCRIPTION	SOLDER HEADER	RIGHT ANGLE SOLDER HEADER	WW HEADER	RIGHT ANGLE WW HEADER	RIBBON HEADER SOCKET	RIBBON HEADER	RIBBON EDGE CARD
ORDER BY	IDHxxS	IDHxxSR	IDHxxW	IDHxxWR	IDSxx	IDMxx	IDExx
CONTACTS 10	.82	.85	1.86	2.05	1.15	---	2.25
20	1.29	1.35	2.98	3.28	1.86	5.50	2.36
26	1.68	1.76	3.84	4.22	2.43	6.25	2.65
34	2.20	2.31	4.50	4.45	3.15	7.00	3.25
40	2.58	2.72	5.28	4.80	3.73	7.50	3.80
50	3.24	3.39	6.63	7.30	4.65	8.50	4.74

ORDERING INSTRUCTIONS: Insert the number of contacts in the position marked "**xx**" of the "order by" part number listed. **Example:** A 10 pin right angle solder style header would be IDH**10**SR.

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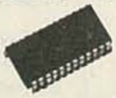

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14 pin LP	20	19	18
16 pin LP	22	21	20
18 pin LP	29	28	27
20 pin LP	34	32	30
22 pin LP	29	27	24
24 pin LP	38	37	36
28 pin LP	45	44	43
40 pin LP	60	59	58

3L WIREWRAP SOCKETS (GOLD)

	1-24	25-49	50-100
8 pin WW	55	54	49
10 pin WW (Tin)	65	63	58
14 pin WW	75	73	67
16 pin WW	80	77	70
18 pin WW	95	90	81
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22 pin WW	1.45	1.35	1.23
24 pin WW	1.35	1.26	1.14
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74S04	.52	74S135	1.15	74S257	1.29
74S05	.52	74S136	1.69	74S258	1.29
74S08	.49	74S138	1.29	74S260	.75
74S09	.49	74S139	1.29	74S280	2.79
74S10	.42	74S140	.73	74S287	2.99
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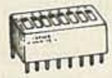

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7412	.29	7493	.45	74176	.75
7413	.39	7494	.69	74177	.75
7414	.59	7495	.65	74179	1.34
7416	.29	7496	.69	74180	.75
7417	.29	7497	2.90	74181	1.75
7420	.22	74100	2.90	74182	.75
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7430	.23	74126	.44	74193	.85
7432	.29	74128	.59	74194	.85
7437	.25	74132	.69	74195	.68
7438	.29	74136	.75	74196	.85
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7440	.19	74141	.79	74198	1.39
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7470	.29	74158	1.65	74368	.68
7472	.29	74159	2.49	74390	1.45
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74LS04	.35	74LS124	1.35	74LS251	1.40
74LS05	.28	74LS125	.89	74LS253	1.40
74LS08	.28	74LS126	.52	74LS257	.85
74LS09	.35	74LS132	.79	74LS258	.98
74LS10	.28	74LS136	.49	74LS259	2.95
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74LS40	.26	74LS165	.89	74LS363	1.49
74LS42	.79	74LS166	2.48	74LS365	.69
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74LS54	.29	74LS173	.89	74LS373	1.89
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74LS73	.45	74LS175	.89	74LS375	.69
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74LS85	1.19	74LS194	1.15	74LS395	1.70
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74LS96	.98	74LS242	1.69	81LS96	1.69
74LS107	.45	74LS243	1.69	81LS97	1.69
74LS109	.45	74LS244	1.49	81LS98	1.69
74LS112	.43				

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4023	.29	4070	.49	4512	1.39
4024	.75	4071	.35	4515	2.75
4025	.25	4072	.35	4516	1.45
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COMPLETE GUIDE TO VIDEOCASSETTE RECORDER OPERATION AND SERVICE, by John D. Lenk; Prentice-Hall, Inc., Englewood Cliffs, N.J. 07632; 365 pp. including index; 6¼ × 9¼ inches; hardcover; $22.95.

This is a simplified, practical system of operation and service for a cross-section of VCR's, both Beta and VHS. The author concentrates on a basic service and trouble-shooting approach, based on the techniques used in his other books. He describes TV and magnetic recording basics as they apply to VCR's. Descriptions include many examples of the special tools and fixtures required for service of each VCR model.

Electronics and mechanical theory, complete for both Beta and VHS, applies to practical service applications: input, output, test point, adjustment controls, typical signals, etc. There are many clear schematics.

CIRCLE 121 ON FREE INFORMATION CARD

TRS-80 MODELS I, III, & COLOR COMPUTER INTERFACING PROJECTS, by William Barden, Jr. Howard W. Sams & Co., Inc., 4300 West 62nd St., Indianapolis, IN 46268; 272 pp, 5¼ × 8½ inches, softcover, $14.95.

This book shows how the Radio Shack *TRS-80* models *I* and *III* computers, and the *Color Computer*, can be interfaced easily and inexpensively to "real world" devices such as telephones, audio inputs, temperature- and pressure-sensors, clock timers, and wind-speed instruments. Some of the projects described require implementation of some special-purpose hardware that connects to the computer input/output ports; but in other projects, no special hardware will be required, because the computers' systems themselves provide everything that will be needed.

Many of the projects can be assembled with two or three integrated circuits, mounted on a simple project board. The projects described include voice input and synthesizers, light detectors, thermometers, pressure sensor, musical note generator, anemometer (for measuring wind speed), tachometer "wand," serial-out driver for cassette port, data-communications plugboard, half-year clock, and joysticks for model *I* and model *III*.

There are many diagrams and charts, and step-by-step instructions are provided for each project—the list of them is far longer than what has been mentioned above.

CIRCLE 122 ON FREE INFORMATION CARD

34 NEW ELECTRONIC PROJECTS FOR MODEL RAILROADERS, by Peter J. Thorne; Kalmbach Publishing Co., 1027 North Seventh Street, Milwaukee, WI 53233; 80 pp; 8¼ × 11¼ inches, softcover; $10.95.

Despite the low number of pages, this is a big book, containing more than 225 photos and drawings, many in color. Each project includes an explanation of its circuitry, step-by-step wiring instructions, schematic diagrams, printed-circuit patterns, and, where applicable, trouble-shooting information.

The object of the book is to introduce model railroaders to new circuits and other electronics devices that can add to the enjoyment of their hobby. Each project has been fully tested and uses readily available components, such as integrated circuits and optoelectronic devices to simplify construction and ensure reliable operation.

The projects include throttles, sound and lighting devices, and signalling systems. There is also information about radio control, computers, and command-control systems such as the CTC-16 and Hornby Zero 1. The book has been designed so that even inexperienced hobbyists will be able to construct some of the projects, while the complicated projects will challenge those with electronics experience.

CIRCLE 123 ON FREE INFORMATION CARD

THE CB PLL DATA BOOK (International Edition), by Lou Franklin; CB City International, PO Box 31500, Phoenix, AZ 85046; 108 pp; 7 × 10 inches; softcover; $14.95.

Here is a thorough international reference guide to CB PLL circuits for both the layman and professional serviceman. The emphasis is on how the PLL provides signal mixing and channel generation, and how it can be modified for such things as CB-to-Ham band conversions. The book includes non-technical discussions of binary, BCD, and ROM channel programming. There is pinout data of nearly every PLL device ever used, as well as data on radio models using the device.

CIRCLE 124 ON FREE INFORMATION CARD

THE TIMEX-SINCLAIR 1983 DIRECTORY, E. Arthur Brown Company, 1702 Oak Knoll Drive, Alexandria, MN 56308; 90 pages; 8½ × 5½ inches; softcover; $5.00.

Here is a book that lists, describes, and provides photographs of the available peripherals and software for the TIMEX-Sinclair computer.

The directory covers such topics as: Where to find disk drives, RAM extensions, printers, modems, keyboards, interfaces, books, periodicals, programming aids, etc. It describes special applications like control circuitry, enhanced graphics, voice generation, music snythesis, video inversion, light pens, joysticks, etc. The software section includes everything from spreadsheets, word processors, data banks, engineering and design, to arcade and adventure games.

CIRCLE 125 ON FREE INFORMATION CARD

MODERN ELECTRONIC COMMUNICATION (second edition), by Gary M. Miller; Prentice-Hall, Inc., Englewood Cliffs, NJ 07632; 578 pp including index; 9½ × 7¼ inches; hardcover; $26.95.

So much has happened in the electronics field since 1978, when the first edition of this book was published, that a new edition was needed.

This new edition includes new sections that are devoted to LC circuit basics and oscillators; major updating to the digital communications material, and greatly expanded coverage of fiber optic communications. Those elements account for major revisions and expansions in chapters 1, 9, and 13. But every other chapter has also been revised and improved.

There are also more end-of-chapter problems of a quantitive nature, and problems in that category have been added and integrated in all chapters throughout the book.

After a chapter of introductory topics, covering noise, LC circuits, and oscillators, the following subjects are discussed in detail: amplitude modulation: transmission; amplitude modulation: reception; single-side-band communications; frequency modulation: transmission; frequency modulation: reception; television; communications techniques; digital communications; transmission lines, wave propagation, antennas; waveguides, radar, fiber optics, and microwaves and lasers. There are also many photos, charts, and diagrams.

CIRCLE 126 ON FREE INFORMATION CARD

NETWORK SYNTHESIS, by Charles A. Vergers; TAB Books, Inc., Blue Ridge Summit, PA 17214; 231 pages, including index; 8¼ × 5 inches; softcover, $7.95.

Informally written, this handbook treats the subject of network synthesis thoroughly, beginning with a comparison of analysis and synthesis. That is followed by a series of basic synthesis problems and a discussion of transfer functions. The author deals with the problem of recognizing transfer functions from their equations as well as frequency response. When that is mastered, the reader is ready to learn the procedures for impedance and frequency scaling.

The Butterworth and Chebyshev lowpass-filter derivation is explained, and the reader will learn the procedure for evaluating impedance and admittance equations. And for those situations where a filter-induced loss is not acceptable, there's a section showing how to synthesize active networks.

This book is profusely illustrated, and various experiments are included at the end to help the reader get hands-on experience at a comfortable pace; the experiments can be performed with a minimum of equipment. **R-E**

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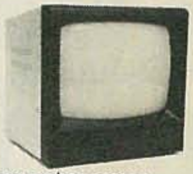

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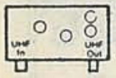

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...mbine both audio and video output onto ...annel 3 or 4 of your T.V. set. ...gle J.C. chip (MC 1374) makes for quick ...d easy assembly. Single adjustment ...ntrol! A must for every video recording or ...nputer enthusiast.

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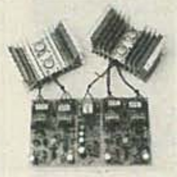
TA-802 160 WATT TOTAL 80W + 80W STEREO AMP KIT

This is a solid state all transistor circuitry on board stereo amplifier. Power output employs 2 pairs of matching Darlington transistors. T.H.D. less than .05% between DC to 200 KHz. Pwr supply requires 30 VCT 2 amp × FMR.

TA-802
$39.95



Transformer (optional)
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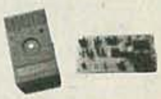
INFRA-RED REMOTE CONTROL SWITCH KIT



Infra-red Remote Control switch can be used to control appliances up to 500 W. The TK-41 has effective control up to 10 meters. No antenna needed. Features latest IC controller which excludes interferences from light or AC pulse signal.

TK-41 Kit $24.95

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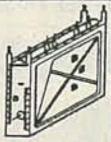

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...CIFICATIONS: • Freq. Range: 470-899 ... • Output: Channel: 3 • Input: 75 ohm ...ain: 18 dB

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Only $44.50

XFMR
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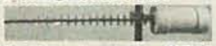
AMATEUR MICROWAVE RECEIVER KIT 1.9-2.5 GHZ



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Includes an LED Reverb Level display. Kit comes with all electronic components, transformer and instructions, and 19" rack mount cabinet.

Model TA-2400 .... $89.95

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CM-8 .... $89.95

TY-45

20 STEP LED

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TY-45 KIT
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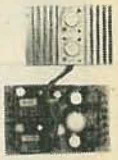

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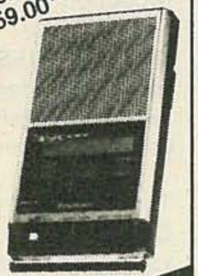

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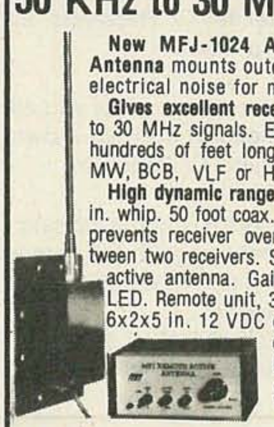

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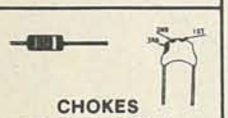

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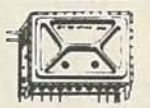

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