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Radio-Electronics

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

ATELLITE TV
ow to receive broadcasts

ONFERENCE CALLER
asy-to-build telephone accessory

ADIO 73 YEARS AGO
he way it was in the 1900's

I-FI TURNTABLES
hey do more than spin records

DIGITAL SLOT MACHINE
Easy to build, fun to play

IDENTIFY UNMARKED IC's
Step-by-step how-to guide

TRS-80 BREADBOARD
Application circuits and programs

HOUSEHOLD ANDROIDS
Get started designing your own

A GERNSBACK PUBLICATION

EQUIPMENT REPORTS
Panasonic RF-2900 Multiband Radio
Radio ... Seven Stereo
B&K E-200D RF Sig Gen

NASA PATENT 4,052,648

Power Chopper™

A new invention by America's space agency will help all Americans save energy and make some companies very wealthy.

Exxon has it. So does about a dozen other manufacturers. And if our hunches are correct, a new space-age product invented by NASA may not only save Americans millions of dollars but make fortunes for the companies that sell it.

The new NASA invention uses the latest space-age technology to save energy. Your refrigerator for example, is a major energy user. With this new device, your refrigerator compressor will run quieter, there will be considerably less heat generated from the motor, and it will run more efficiently saving up to 30% in energy.

The invention requires no installation. Just plug it into your outlet and plug your refrigerator into the device.

OVER PRICED UNIT

But there's a catch. Most manufacturers sell the device for as much as $200. Using it with your refrigerator, it will take many years before it will pay dividends. On a powerful motor, however, the device will pay for itself much quicker.

Manufacturers who have announced their units are selling them like hot cakes. Although you may have heard a great deal of publicity about the product, you may not have seen any advertising because most manufacturers are currently sold out.

Watch for it! We predict great success for all those associated with the product. The power-saving device invented by NASA is a big hit. It will grow in popularity and save energy and make many companies very successful.

A SMALL COMPANY

There is one small company however, that is credited with improving the device and developing it for the consumer market. Called ERI (Electronic Relays, Inc.) the company has developed several models to service specific products such as a refrigerator, a washing machine, dishwasher, swimming pool and a typewriter.

This small company actually improved the NASA invention by adding its own refinements. ERI had a great deal of experience in solid state relays which use TRIACs and integrated circuits—two important elements in the NASA invention. A TRIAC is a bidirectional thyristor which controls AC from a single control input. TRIACs also produce a great deal of heat.

ERI's experience taught them how to control the TRIAC and its heat dissipation and thus they were able to reduce the device's cost through more efficient handling of the heat problem. They were already one of the nation's largest purchasers of TRIACs—thus their costs were already low.

NATIONAL PUBLICITY

They called their product a Power Factor Controller and sent a sample to a national magazine for their review. In several tests, the device out-performed even the claims made by the manufacturer and the magazine ran a glowing article on their findings.

The manufacturer felt that the product might at first be misleading. Although it does save up to 30% on energy and in many cases up to 60%, ERI felt most consumers would expect a 30% reduction in their total electric bill—which of course the product will not do. Consumers will only get up to a 30% savings on the particular appliance used with the unit.

STILL PESSIMISTIC

The manufacturer also felt that the product was primarily for the industrial market—restaurants with large banks of refrigerators. The consumer must wait a few years before the device would pay for itself. And finally, the manufacturer did not feel that the consumer would respond in great numbers to the article which ran in the July, 1979 edition of *Popular Science* magazine.

Well, the consumer did respond. So much so that the small manufacturer, with absolutely no marketing staff, was buried with mail. The president of ERI called JS&A to help him out.

TEST ONE YOURSELF

We called it the Power Chopper and agreed to offer it to the consumer market for $29.95—a major price breakthrough.

Even if Exxon lowers their prices considerably, they'll never come close to the low cost of the Power Chopper. ERI's expertise with the TRIAC and JS&A's direct-to-consumer marketing, make the new NASA invention a practical power-saving accessory for every home.

The sophisticated electronics of the Power Chopper consist of a TRIAC, two integrated circuits and several solid-state devices.

We urge you to test just the refrigerator module. Order one from JS&A on a 30-day no-obligation trial. In the meantime, while you are waiting for your unit, feel the heat generated from the bottom of your refrigerator. Listen to the sound level of your compressor.

When the Power Chopper arrives, plug it in and notice how much quieter and cooler your refrigerator runs. See how much less time the compressor must run. The compressor not only will run more efficiently but will save energy every day you use it.

AWARD WINNER

If after 30 days you are not convinced that the Power Chopper will save you energy and money while making your refrigerator run smoother, then just unplug it and send it back for a prompt and courteous refund, including the $2.50 postage and handling. But if you've definitely noticed the difference, you'll want to purchase more units for the remainder of your motor-based appliances.

JS&A feels that ERI's technology, their improved NASA design and their low manufacturing costs will catapult them to the forefront of those introducing the new NASA invention. ERI's Power Chopper is one of the nation's major new innovative products and just recently won the Industrial Research IR-100 Award.

To order your Refrigerator Power Chopper, send $29.95 for each unit plus $2.50 for postage and handling to JS&A Group, Inc., One JS&A Plaza, Northbrook, Illinois 60062. (Illinois residents please add 5% sales tax.) Credit card buyers may call our toll-free number below. We'll send your Refrigerator Power Chopper, one-year limited warranty and you'll be ready to save. If you wish to order additional units for other appliances at $29.95, you may, but we suggest you test the refrigerator module first and totally convince yourself.

GOVERNMENT REBATE

Purchase of the Power Chopper entitles you to a full 15% energy tax credit on your income tax return. It's like having the government give you a $4.50 rebate.

JS&A is America's largest single source of space-age products—further assurance that your purchase will be backed by service for years to come.

NASA technology was responsible for the development of the integrated circuit and many other space-age products. Their latest product could not have been developed at a better time. Start saving and order a Power Chopper at no obligation, today.

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Radio-Electronics®

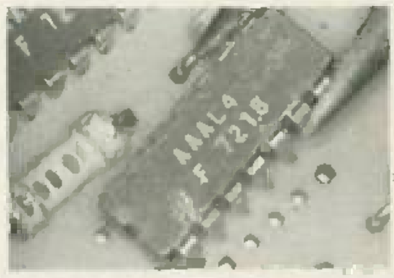
THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

Electronics publishers since 1908

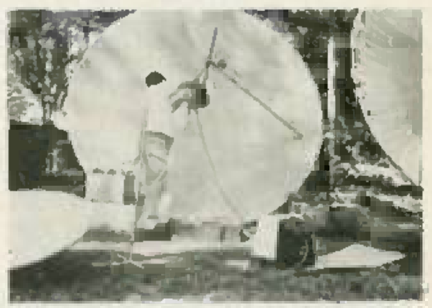
JANUARY 1980 Vol. 51 No. 1

ON THE COVER

The radio-controlled R2-D2™ robot toy manufactured by Kenner Products contains two PC boards, 3 motors, a 3-cell battery pack and even a speaker, but it has nowhere near the capability of a true android. To find out what a household android would require and how you can go about designing your own, turn to page 37.



IDENTIFYING UNMARKED IC's can be a real headache unless you know how to go about it. The full story starts on page 45.



THIS INEXPENSIVE SATELLITE ANTENNA makes backyard reception of satellite TV broadcasts a reality. If you're interested in building an inexpensive earth station, turn to page 55.

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CIRCLE 15 ON FREE INFORMATION CARD

looking ahead

Earth-station bonanza: The direct satellite-to-home market is expected to open up wide as a result of the latest FCC action—virtual "deregulation" of receive-only earth stations. This followed by two months the Commission's decision to "routinely" grant such applications (**Radio-Electronics**, November 1979). Under the new ruling, an earth station may now be built without any license and without the necessity for frequency coordination. This opens the way for the use of dishes smaller than 4.5 meters, which generally has been the minimum size the FCC would approve. It also means cheaper and faster installations.

Sidney Topol, chairman and president of Scientific-Atlanta, hailed the decision as opening the way to thousands of home receiving stations. The FCC proposed that operators who want the anti-interference protection of frequency coordination should be able to use a "self-licensing" procedure by simply notifying the Commission of their intention to build the station following frequency coordination—but amateurs aren't expected to follow that procedure. This doesn't mean that privately owned programs are now free to all. The Commission noted that copyright statutes and the Crime Control Act are adequate to take care of this problem, along with scrambling. The last-named is now being explored by companies which provide programming for pay cable.

Victory for tapists: A tapist, in my lexicon, is someone who tapes TV programs off the air ("taper" sounds too much like some kind of South American animal). Anyway, tapists won an important victory in Los Angeles District Court when Judge Warren Ferguson ruled that the home videotaping of copyrighted television programs for personal use is completely legal. In the suit brought by MCA and Walt Disney Studios against Sony and others, the judge ruled flatly: "Non-commercial home-use recording of material broadcast over public airwaves does not constitute copyright infringement." He specifically said his ruling didn't apply to pay TV, cable TV, tape-swapping or home duplication of copyright tapes because these weren't included in the suit.

High-resolution home TV: Have you often wondered why somebody hasn't developed a compatible television broadcast system with double the number of lines of today's TV to make possible high-resolution television for those who want it? Well, so have I. And we can stop wondering right now. Because such a system is under development. By the Japanese, of course—and anything they do must be taken seriously. It's too early to say much about it, but watch this space. With the development of giant-screen projection, and eventually electroluminescent TV displays, this is bound to be one of the hottest topics of the 1980's—not only in Japan, but in North America and Europe. Remember where you read this first.

Videodisc progress: The optical videodisc is gaining new adherents in Japan. Sony and Philips have agreed to cross-license videodisc and videotape developments, giving Sony access to Philips' patents on the optical disc system. Sony has already built, and is demonstrating, an optical system compatible with the Philips/MCA technique. Sharp of Japan has taken out a license to build a Philips-type disc player. And at the Japan Electronics Show, Sanyo and Toshiba also displayed optical disc systems. But all of this doesn't necessarily mean the optical technique will sweep the videodisc field. Toshiba is a licensee of the RCA capacitance disc system and has demonstrated an RCA-compatible machine. Sanyo is a licensee of the Telefunken-Decca TED mechanical system. Sony has also signed a cross-licensing pact with Matsushita and JVC covering videodisc developments. Matsushita has developed the Visc-O-Pac mechanical system and JVC developed a capacitance system. What this means is that the Japanese are keeping all their options open as they await a governmental ruling on videodisc standards. There are some who feel that the optical system will get the go-ahead as an institutional-industrial-educational and advanced consumer system, and a simpler technique will be designated for the mass market.

Heath joins Zenith: Zenith, one of America's "Big Two" television set manufacturers, is entering the small computer and consumer kit field through its recent purchase of the Heath Company. As soon as the merger was consummated, Zenith established a Data Systems Division, charged with developing Zenith-brand microcomputer products and systems in the small computer field for homes and businesses. The Zenith line will be marketed through Zenith dealers, retail computer stores and through Heath Electronic Centers and the Heath catalog. Of course, the entire Heath line will be continued and augmented under its new ownership.

Zenith has already been in the computer component field through manufacture of color monitors for Texas Instruments' new small computer. Other consumer electronics makers are eyeing computers, too. RCA's Solid-State Division has been manufacturing small computers for two years. GTE Sylvania will market the Mattel Intellivision video game, which is convertible to a computer. Magnavox's Odyssey line, now equipped with alphanumeric keyboard, is beginning to look suspiciously like a series of products that can easily be converted to a computer.

FCC on videoplayers: The FCC has modified its policy on interference so as not to discourage the growing home video field. The Commission has proposed to make it easier for manufacturers to comply with interference rules for videocassette recorders and videodisc players. It proposes to eliminate the necessity for FCC testing of such products, and to permit a fairly large increase in RF radiation from them. This, says Commission staffers, is a calculated decision. One member put it this way: "We now feel we have the responsibility to protect the neighbors of people using these devices, but not reception within the same residence."

This is the same rationale that lead to the FCC's adoption of a rule permitting the use of stand-alone RF modulators as intermediaries between home computers and TV sets (**Radio-Electronics**, December 1979). R-E

DAVE LACHENBRUCH
CONTRIBUTING EDITOR

Facts from Fluke on low-

cost digital multimeters.

	Product	Functions	Ranges	Digits	Basic DC Accuracy	Conductance	Other Special Features	U.S. Price
HANDHELD MODELS	8022A	6	24	3½	0.25%		Basic six-function DMM; lowest-priced	$129
	8020A	7	26	3½	0.1%	X	High accuracy; pioneer in conductance; exclusive two year warranty.	$169
	8024A	9	26	3½	0.1%	X	Direct temperature readings; continuity/input level detector with selectable audible signal; peak hold capability.	Available soon
BENCH/PORTABLES	8010A	7	31	3½	0.1%	X	True RMS; extra 10A range.	$239
	8012A	7	31	3½	0.1%	X	True RMS; two extra low resistance ranges	$299
	8050A	9	39	4½	0.03%	X	True RMS; selectable reference impedances with direct readouts in dBm; offset feature	$329

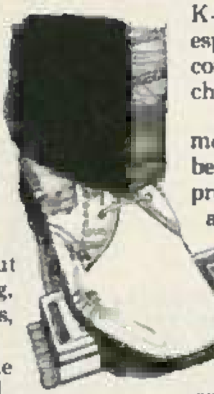
When you're looking for genuine value in a low-cost DMM you have a lot more to consider than price. You need information about ruggedness, reliability and ease of operation. Accuracy is important. And so are special measurement capabilities. But above all, you must consider the source, and that company's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

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

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

The economics of endurance.

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



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

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

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

The importance of being honest.

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

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

Special measurements: getting more from your DMM.

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

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

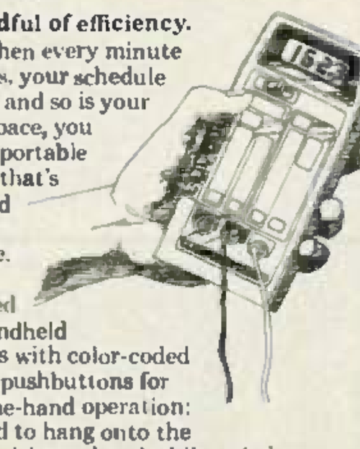
If your work involves temperature measurements, the new 8024A delivers direct temperature readings via any K-type thermocouple. This is especially useful in testing component heat rise and checking refrigeration systems.

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

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

A handful of efficiency.

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



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

A word about warranties.

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

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

Incidentally, you'll find it all at Fluke.

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

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☐ Please send the facts on Fluke low-cost DMM's—specifications, applications information, and selection considerations.

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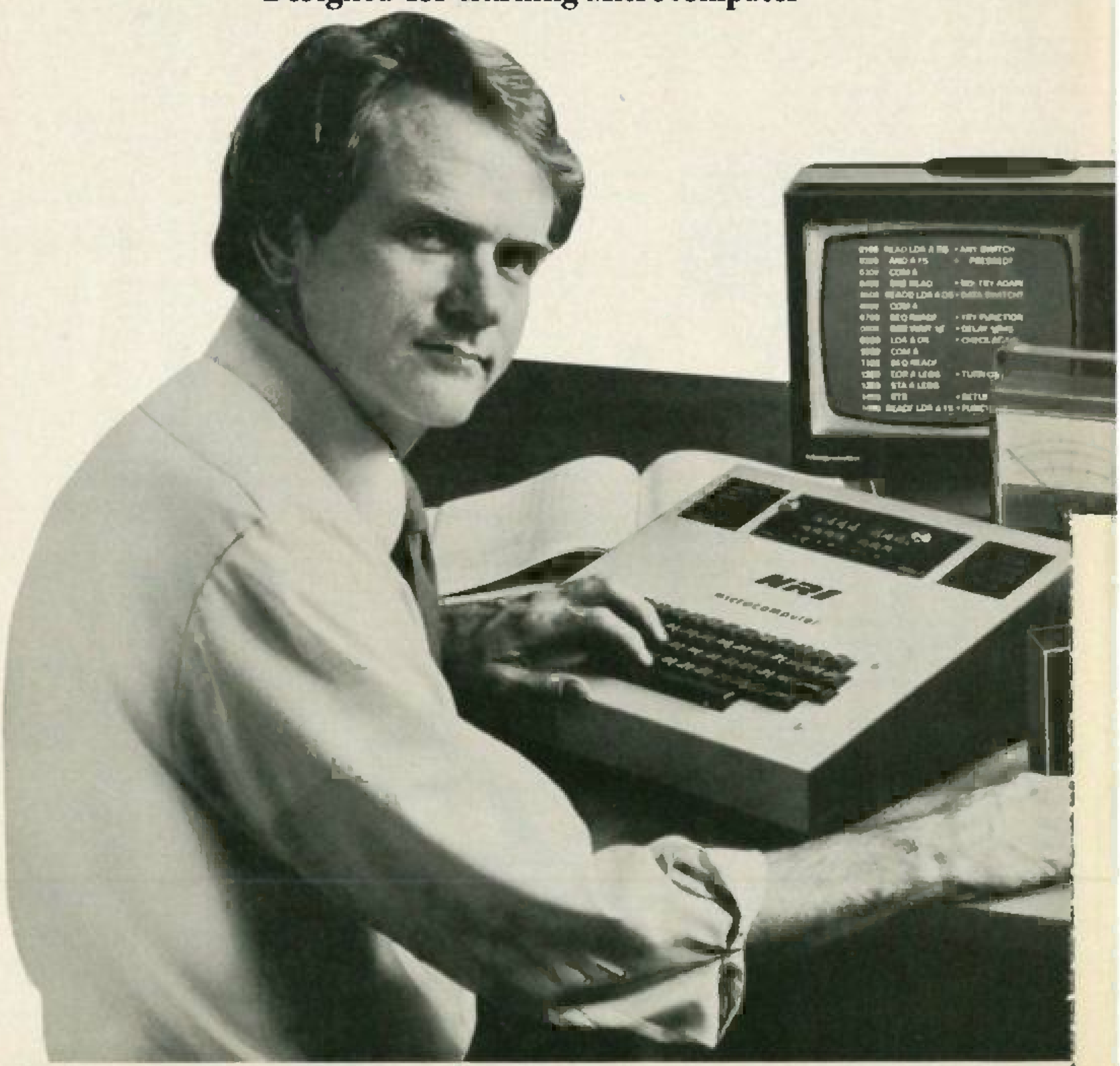

editorial

A New Decade

The decade of the 70's has come to a close, and the decade of the 80's has begun. The new electronics decade, however, is already under way and is going full blast. To get a feel for the latest technology and what the 80's will hold in store for us, let's glance at some of the happenings and some of the terms and acronyms that are presently being used in the semiconductor industry—the foundation upon which tomorrow's electronics industry is built.

Do you remember when C-MOS (complementary-MOS) was the greatest thing to happen since the invention of the light bulb? Now there's also n-MOS (N-channel MOS). This logic family has several different names, depending on who is doing the manufacturing. They include HMOS, X-MOS and S-MOS. The HMOS (high-performance n-MOS) family also has a sister (brother?) called HMOS II. On top of this, Advanced Micro Devices has a scaled-down MOS process called PolyPlanar. How about a P^2C-MOS which is a double-polysilicon process! Other logic families around include ISL (Injection Schottky Logic), STL (Schottky Transistor Logic), Isoplanar-S, and even BEST (Base-Emitter Self-Aligned Technology). Manufacturers even mix technologies within the same IC. Matshushita has an IC that combines p-channel MOS with I^2L and ion-implanted NPN transistors. One last one: we've all heard about MOSFET's, but how about a MESFET (Metal Semiconductor Field Effect Transistor).

Where is all this technology leading us? Not long ago, the jump from 4K to 16K RAM's opened many new doors. Today, semiconductor manufacturers have introduced 64K RAM's. Bubble memories were introduced in the 70's with a capacity of 256K. Two bubble memory devices were introduced in 1978, each with a capacity of 1 megabit. Now manufacturers are talking of 8-megabit capacities per device within the next few years.

Microprocessors have also come a long way. From the original 4004, through the 8008, 8080 and Z-80, we now have the Z-8000. It is a 16-bit processor that has many 32-bit attributes. In other words, it behaves like a 32-bit processor in many ways. There are also the 68000 and NS16000, both 16-bit processors. Many, many processors have been introduced, and if I were to list them, they would fill several more paragraphs. One introduction however, cannot go without mention, the analog microprocessor. Intel's 2920 is a digital microprocessor that includes D/A and A/D converters on the input and output ports. It's a digital processor that connects to analog signals.

Remember SSI (Small Scale Integration) and MSI (Medium Scale Integration)? We're now working with LSI (Large Scale Integeration) but the push is on for VLSI (Very Large Scale Integration). Oh well. I remember working with RTL (Resistor Transistor Logic) and DTL (Diode Transistor Logic). I wonder what we'll be using in 1990?

Art Kleiman

ART KLEIMAN
MANAGING EDITOR

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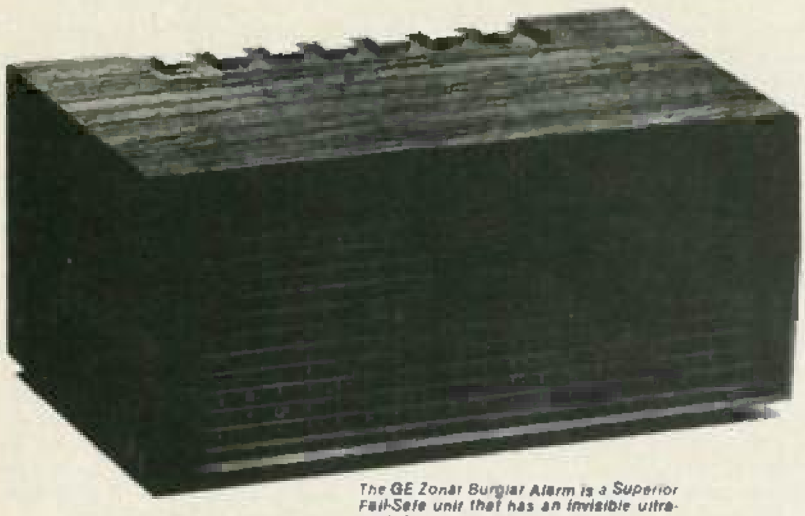
The Protectors

The two products shown below are the latest in Space-Age Electronic Home Security. Do you know which one is right for you?



The GE Zonar Burglar Alarm is a Superior Fail-Safe unit that has an invisible ultrasonic beam to detect intruders.

The Micro FM Wireless Mike has a range of over 300 ft. and transmits through any standard FM Radio.

The two new products shown in this ad are the latest in space-age electronics. The Zonar Burglar Alarm compares with similar burglar alarms selling for $200 or more. The Micro FM Wireless Mike, the worlds smallest wireless microphone, represents new technology in the field of FM Radio-Electronics.

We bought both of these products from the manufacturers and tested them under every possible condition. The following are the results of our experiments with both the Zonar Burglar Alarm and the Micro FM Wireless Mike. Please read on. The results may surprise you!

THE GE ZONAR BURGLAR ALARM

The new GE Zonar Burglar Alarm sounds a loud (85db) alarm — so loud that it can cause pain — and scare away intruders that cross the invisible ultrasonic beam.

The Zonar Burglar Alarm requires no installation and it is portable, so you can place it anywhere in your home. Operating the Zonar is as easy as turning on your television. To arm the unit, you simply press the On Instant or On Delay button. You now have 35 seconds to leave your home. When you return, you enter and you have 10 seconds to press in your secret code numbers. This will disarm your unit. The personalyzed code numbers for alarm shut-off means that only you or your family knows the code to disarm the alarm.

The Zonar Burglar Alarm looks like a handsome piece of furniture and its small unobtrusive design helps to make it less noticable. It measures only 7" X 4" X 3" and weighs less than two pounds. To help protect your home or office, it comes with warning decals for windows or doors that state, **"WARNING Protected by Electronic Surveillance Equipment"**, to help deter potential burglars.

The GE Zonar Burglar Alarm is battery operated, so even if a burglar cuts off your power, the unit will still be operational to alert you and your neighbors.

The GE Zonar Burglar Alarm comes with complete instructions and a One-Year limited warranty backed by General Electric. Should your unit ever malfunction, you may drop it off at any authorized General Electric Dealer or you may use GE's convenient service-by-mail center.

To order your unit for a 30-day test, simply send your check for $69.95 plus $2.50 postage and handling to Chandler's, One Chandler Plaza, Chantilly, Virginia 22021 (Virginia residents please add 4% sales tax.) Credit Card Buyers may call our 24-hour Toll-Free number below.

THE MICRO FM WIRELESS MIKE

The micro FM Wireless Mike is a miniature microphone that picks up your voice and transmits it through any standard FM radio.

The new Micro FM Wireless Mike measures only 1½" X ½" and weighs less than one ounce. We found that the superior electronic components put into the microphone surpass anything else on the market. It has a transmitting range of over 300 feet (the length of a football field) and its exceptional fidelity gives you clear reception with practically no interference. Unlike citizen band radios, which operate in the 27 to 29 Megahertz range, the Micro FM Wireless Mike uses the 88 to 108 Megahertz range, giving you the freedom to operate from your car radio, portable radio or home stereo.

BUT WAIT, THERE'S MUCH MORE. The Micro FM Wireless Mike is capable of more than just being a remote mike. It can be used as an intercom in both your home and office. For example, if you are in the garage and your wife or children are in the upstairs bedroom, you can turn on the mike and use it just like an intercom. Secondly, it is small and can be clipped to your jacket while in meetings or during a speech in your conference room or office. The Micro FM Wireless Mike is FCC approved for use in homes, apartments, offices or factories.

Finally, it's inexpensive — only $29.95 complete with 27" flexible antenna, carrying case, operating instructions and a fresh 1.3 volt mercury battery (which can be replaced at any hearing aid or radio-electronics store).

Your Micro Mike comes with a 90 day limited warranty backed by two substantial companies. Should a malfunction ever occur, there's a complete service-by-mail center as close as your postman.

The Micro FM Wireless Mike can be ordered by calling our 24-hour toll-free number below or by sending your check for $29.95 for one or $58.00 for two. Please add $1.25 each for postage and handling and Virginia residents add 4% sales tax.

OUR OPINION

We are convinced that both of these new products are superior in value and quality.

The Micro FM Wireless Mike and the GE Zonar Burglar Alarm are backed by two substantial American companies. MLI Industries and General Electric both have years of experience in manufacturing and design leadership. Chandler's is one of America's innovative companies specializing in bringing the American public new and unique products — additional assurance that your prudent investment is well secured.

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what's news

Second satellite seminar scheduled for Miami

Following the highly successful satellite seminar held at Oklahoma City last August, a second one will be held in Miami, February 5, 6, and 7. The three-day program will include more than two dozen technology lecture sessions by three authorities on satellite technology, as well as special sessions on marketing and selling low-cost satellite terminals.

The cost of the three-day seminar is $150. Pre-registration is mandatory. Because a large number had to be turned away at Oklahoma City, where 506 attended, facilities for a thousand or more are being obtained at Miami. Full information is available from Satellite Television Technology, P.O. Box G., Arcadia, OK (phone 405-396-2574).

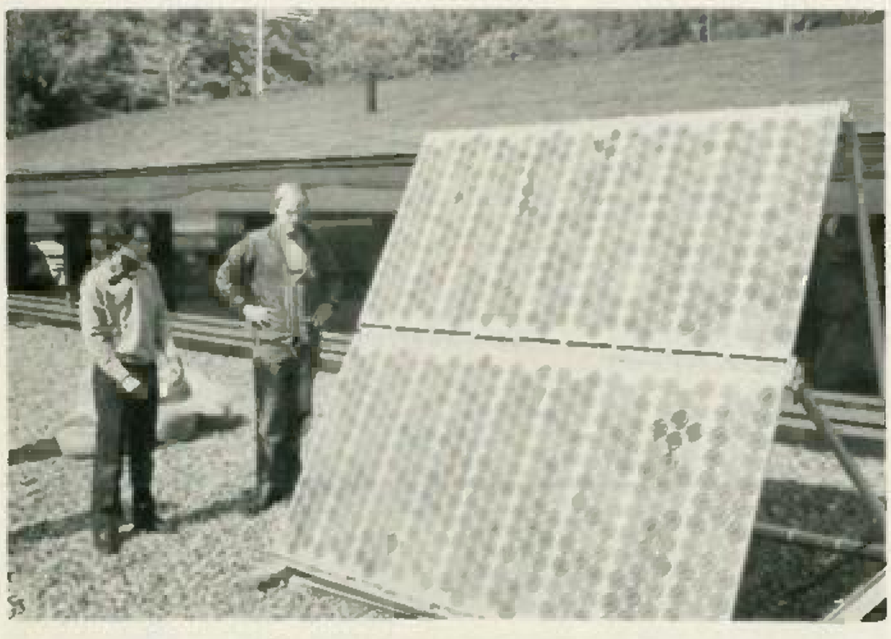
Olympic ski communications to get power from the sun

The 1980 Winter Olympics command post (Lake Placid, NY) and the top of 4,867-foot Whiteface Mountain, on which the ski events take place, will be linked by a communications system powered in part by 20 photovoltaic solar panels. Each of these panels consists of 36 three-inch single-crystal silicon cells in a weatherproof assembly. Power output of each panel averages 1.2 amperes at 16.2 volts (approximately 20 watts of peak power).

There will be two primary links and one standby system for communication between the peak of Whiteface Mountain and the base camp below. The first, a wired system, consists of 12 semi-portable telephones between the peak and base of the mountain. The second system, which acts as an intercom, uses a dozen fixed-position telephones. The standby system works with a General Electric UHF radio.

All the systems can be powered by the group of 20 large panels. Eight panels of an 18-panel array on the roof of White Mountain Ski Lodge supply 2.4 amperes at 48 volts for the first race communications system; the remaining ten can provide 6 amperes at 10 volts for the second, electrically independent intercom setup.

A two-panel array powers the emergency standby system and charges a bank of storage cells. Should the regular electric power fail completely, it will be able to supply energy for all the communications systems, as well as the lighting required for the games, for as long as two hours.



10 PANEL SOLAR ARRAY being installed on the roof of Whiteface Mountain Ski Lodge by Arthur Rudin (left) of Arco Solar, Inc., and Ronald Stewert of the State University of New York, in a project coordinated by the Northeast Solar Energy Center of Cambridge, MA. The solar array will provide power to communications systems for downhill ski events at the 1980 Winter Olympics.

New evaporated recording tape increases density ten times

A recording tape in which the magnetic recording layer is evaporated directly onto the base film surface has a density ten times that of conventional tape, states its developer, Matsushita Electric Industrial Co. This means that a 3-hour tape for microcassette recorders can be made. The new tape, called Angrom, was scheduled for test marketing in Japan this fall. No plans for export were announced.

In all ordinary tapes (including "metal" tapes) the magnetic material is mixed with resins in about a 30:70 ratio. Only 30% of the surface is actual magnetic material. The surface of the new tape is 100% magnetic. Because the adhesive material is not needed, the coating is thinner—0.3 micron instead of the usual 3 microns. This reduces bulk, making it possible to put a longer tape in a given cassette. The all-magnetic surface will record shorter waves, thus high-frequency response is improved.

The new tape was made possible by overcoming production problems in connection with applying the coating and securing its adhesion to the film base.

American scientists, German machine head search for newest particle

The elusive particle that is believed to hold all matter together—the whimsically named gluon—was discovered by a research team headed by University of Wisconsin physicists Sau Lan Wu, aided by Georg N. Sobernig, the University of Wisconsin—Madison reports. The team spent the last two years at Hamburg, working with the new electron accelerator (which is known by its German acronym PETRA), to observe events following collisions between high-energy electrons and oppositely charged positrons.

When high-energy electrons and positrons collide they convert all their energy and mass into an energy bundle called a virtual photon. From that energy bundle a quark and an antiquark are produced. These move apart in opposite directions. This causes the quark and antiquark to form a stream of particles in a narrow cone, called a jet.

One jet is formed from each of the original quark and antiquark that are produced from the virtual photon. If the energies of the colliding electrons and positrons are high enough (in this case 15 billion volts each) then one of the quark jets can radiate a gluon, which also turns into a jet of particles.

Using a method devised by Drs. Wu and Gobernig, the research team developed a computer program to analyze the data from the electron-positron annihilations, and the third jet—evidence for the gluon—was discovered. "If the 3-jet events we detected are not from the gluon," Dr. Wu told the conference in Geneva, Switzerland, last June, at which the information was first presented, "then something very

continued on page 16

continued from page 14

exciting is just around the corner."

Why is the gluon so important to physicists? Scientists since Einstein have proposed the existence of four forces, electromagnetic, gravitational, strong, and weak, each of which has elementary carriers of force. The photon is the carrier of force of electromagnetism and until now it was the only one known.

The existence of the gluon, the carrier for the strong force, is encouraging to physicists who are seeking the carriers of the gravitational and weak forces. It is the hope of many physicists to eventually combine all four forces into one grand unified theory of matter.

Marriage of sound and print in new audio-visual system

What the manufacturer, Microsonics Corp, calls a "totally new dimension in publishing" has just been introduced. It consists of a miniature handheld player, called a "Microphonograph" and a 2-inch transparent record that can be applied direct to a page of a book or to a card designed for the purpose. The record plays for a minute and a half.

HOW THE MICROPHONOGRAPH is used. The device adds sound to the information obtainable from a printed book.

The user simply places the Microphonograph on the page, locates the record and presses the "play" button. Instantly he has his own multimedia system, combining pictures, print and sound.

The system would seem especially valuable in the language field, giving even a home student practically the services of a native-speaking teacher. In other subjects the added sound can make a dry text come alive, with the author's voice commenting on the texts (in historical or biographical works, often with the voice of the subject). Special formats for combining sight and sound in training courses are already being produced by several firms.

In the card format, one side can display photos, maps or diagrams that will complement information on the record, and the back can carry additional information or instructions. The system can even be adapted to existing printed material, making it one of the least expensive of audio-visual systems.

The system—Microphonograph and records—is priced from $20 up, depending on the choice of hardware and quality and quantity of software. Updating or extending is easy, simply by adding new microrecords and cards.

Lights three times as good are forecast for year 2000

A research study just conducted by Westinghouse Electric scientists concludes that—while electric costs will triple by the year 2000—improvements in lighting will mean that the lighting part of the average user's bill will rise only slightly.

High-intensity mercury vapor, metal halide and high-pressure sodium vapor discharge lamps—already in use in industry—will make great energy savings in residential lighting. Up to 150-175 lumens per watt is attainable with such lamps, the Westinghouse scientists predict. (Standard bulbs in use today have an efficiency of only 15-20 lumens per watt—a 100-watt bulb is rated at 1710 lumens.)

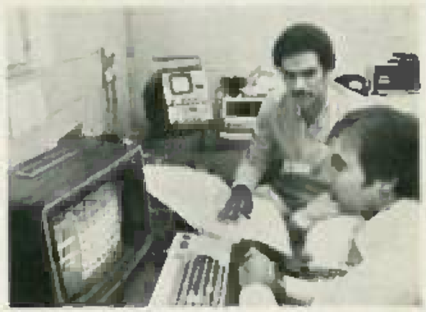
The average homeowner, the study found, pays $57 per year, or 27 percent of his total electric bill, for lighting. By the year 2000, this should decrease to about 8 percent. But—the new light bulbs will cost more, maybe $5 to $15 each. The cost of lighting will have to be calculated on the price of the bulb together with the amount of light it will give in its useful lifetime.

The fluorescent lamp—already at least four times as efficient as the tungsten bulb—will take over in the home, through color improvement and new design. Already screw-in types are being made to use in existing incandescent fittings.

Further new developments are predicted: Lighting will be used for home security; proximity sensors installed around the perimeter of a residence and activated by an intruder will turn on the inside lighting. New products will improve perception, reduce eyestrain and satisfy specific health requirements. Special lighting will be introduced for older people. A major area of research will be devoted to the psychological, behavioral and physiological effects of lighting on people.

Students do original research in summer training session

A near-unique type of industrial "student training" program is being cosponsored by GTE Laboratories and the National Science Foundation. Some 40 students, representing 19 colleges and universities, are participating in research projects at GTE facilities.



ALFREDO ARCHILLA, of the University of Puerto Rico, working with GTE staffer William Hertz on his "smart telephone" project.

Unlike many "student training" programs, this one provides the student with genuine research and real work. If they succeed in their tasks, they have the realization that they have added to the world's knowledge, technology or convenience.

For example, Alfredo Archilla of the University of Puerto Rico at Mayaguez, is working on a "smart telephone" that will not only accept voice commands but will talk back. "Right now" says Mr. Archilla, "you can tell a telephone to perform a task in your home (such as turning the oven on or off) from a remote location by touch tone. When you ask it it has finished the job, it also answers in tone. We want it to answer in words, and my job is to develop such a program."

Subscription TV stations now permitted to proliferate

The FCC voted, in a meeting late in September, to rescind the rule that permitted only one pay-TV station in a community.

The opposition to subscription television by broadcasters and movie theaters that was so marked when pay-TV was first proposed has decreased to only token opposition, FCC sources reported. It is possible that the extensive development of cable television has reduced the relative importance of over-the-air subscription systems.

There are at present only six pay-TV stations on the air. The largest, KBSC, Corona, CA, which serves the Los Angeles region, has 210,000 subscribers. The others are KNXV in Phoenix, AZ; KWHY, Los Angeles, CA; WQTV, Boston, MA; WWHT, Newark, NJ, and WXON, Detroit, MI. R-E

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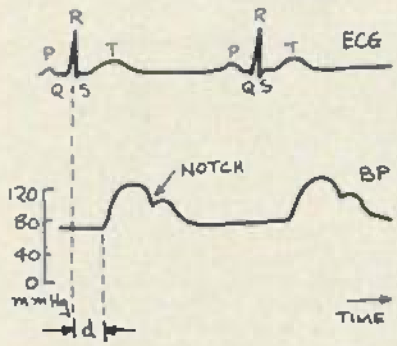
letters

HEART RATE

I am a physician, currently in my fourth year of surgical residency. In addition, I hold a Masters Degree in Electrical Engineering. Because of my background, I am naturally fascinated by articles in your magazine relating to medical applications of electronics. Such an article was Mark C. Worley's "Heart Rate Monitor" (July 1979 issue). I must, however, take exception with several points in the author's description of the device's operation.

The "heart beat waveform" depicted in the article correctly shows a typical electrocardiogram tracing. This is a recording of the electrical activity measured between a pair of electrodes in contact with the skin of the body. It corresponds to the discharge and recovery of the electric charge across the membranes of heart muscle cells, which initiates contraction of the muscle.

The device, that is described in the article is commonly referred to as an optical plethysmograph (from the Greek plethysmos, an enlargement). It measures the minute expansion and contraction of the fingertip in response to the blood pressure pulsations within its arteries. The enclosed diagram illustrates the relationship of the heart electrical activity (ECG, or electrocardiogram) and the blood pressure (BP). The R-wave, or more correctly the QRS complex, is the activity that initiates the contraction of the main pumping chambers. The T-wave is the activity that accompanies electrical recovery of the charge across the cell membranes.



The pressure tracing is characterized by a sharp rise to peak (systolic) pressure, and a more gradual falloff to the (diastolic) pressure before the next contraction. The "notch" in the curve on its downslope is caused by the one way valve at the outlet of the heart snapping shut as the pressure falls. The delay, d, is a function of the response time of the muscle to the electrical stimulation, and the propagation delay of the pressure pulse down the artery.

From this discussion, it can be seen that prevention of multiple triggering is indeed necessary. However, Mr. Worley's statement "triggering on . . . R- and T-waves" is misleading.

Another inaccuracy contained in the article is the reference to the 300 ms (misprinted as 300 μs) period of trigger lockout as a Schmitt trigger. A Schmitt trigger is a circuit that has hysteresis, i.e., a different threshold for positive-going and negative-going input changes.

Finally, it must be kept in mind that the heart rate may rise over 200 beats-per-minute under stress or after heavy exercise, and that in a young, well trained athlete the resting heart rate may be as low as

35-40 beats-per-minute. Thus for some applications, it may be desirable to double R21 and R22, and readjust R24 to make the meter range 30-230 beats-per-minute. It is also necessary to reduce R13 to 22K (trigger lockout period 240 ms) to permit heart rates over 200 beats-per-minute to register. Of course, the meter scale would have to be redrawn.

In spite of the above criticisms, I enjoyed the article very much. I am looking forward to more projects along this line. The use of electronics and computers in medicine is rapidly expanding, and I feel that many of your readers would jump at the chance of becoming familiar with some of the technology and principles involved.

EDWARD B. BORDEN, M.D.
Bronx, NY

ETCHANT DISPOSAL

James Temple's "How to Make Your Own PC Boards" (July 1979 issue) was interesting and I am looking forward to future articles.

With regard to disposal of ferric chloride etchants, the following comments are based partially on my own experience and partially on an excellent reference book, "Printed Circuits Handbook," C.F. Coombs, Jr., Editor, McGraw-Hill Book Co., 1967.

Disposal of expended etchants via a scavenger service is probably the only method that is both completely safe and legal in all communities, but scavenger services are not likely to be interested in handling individual hobbyists' quantities. Perhaps an organized group, such as an electronics club, could find a way to pool their waste chemicals.

Spent ferric chloride etchant can be made safer by neutralizing the acid with sodium carbonate. Sodium carbonate is sold in grocery stores as "sal soda" or "washing soda." Immediately after the etchant is expended, pour it into a plastic container large enough to allow for foaming. Rinse the tray with fresh water and pour that into the container. Slowly add the sodium carbonate neutralizer, while stirring with a wood or plastic utensil, until foaming ceases.

Disposal of waste chemicals in public sewers is forbidden in many communities, and for valid reasons. In the case of PC etchants, copper dissolved from the boards may upset the role of bacteria required for sewage breakdown and may destroy plants and fish if it ends up in natural waters. Small amounts of etchant would become extremely diluted by the large volume of water in a public sewer and probably would do no harm. On the other hand, hobbyists in rural areas who rely upon a single-dwelling sewage system (septic tank) may have cause for concern if they process a large number of boards.

Direct burial is an inexpensive and frequently used (but not necessarily legal) method of disposal. A disposal sump can be made by filling a hole several feet deep with coarse gravel. Neutralized etchant is poured into the gravel and washed down with fresh water to further dilute and disperse the chemicals. R-E

L. SCOTT HOFER
Federal Way, WA

equipment reports

Panasonic Model RF-2900 Portable Multiband Radio

ONE OF THE MOST ATTRACTIVE MULTIBAND portable radios on the market is the *model RF-2900* from Panasonic Corporation. While definitely not of communications quality, it does perform well for its intended applications.

Housed in an attractive black military-type case with chrome accents, the radio has a bright digital fluorescent display that provides an accuracy of 1 kHz through 30 MHz, and 100 kHz on FM.

The circuit is a double-conversion type for good selectivity. The frequency ranges are: 525 Hz–1605 kHz and 3.2 Hz–30 MHz (AM/CW/SSB) and 88 Hz–108 MHz (FM). Power is supplied by a 120 VAC source or by internal batteries (six D-cell batteries, which are not included). A dual-speed main tuning dial handles fine adjustment on all ranges. During battery operation, the dial lights and frequency display can be switched off to conserve power. An integral telescoping whip antenna enhances the receiver's portability; and external antenna terminals are on the back of the case.

CIRCLE 101 ON FREE INFORMATION CARD

An S-meter acts as a tuning aid and often doubles as a battery tester. An adjustable BFO (beat-frequency oscillator) control permits the manual selection of CW (continuous-wave) pitch or LSB/USB reception.

Front-panel jacks are provided for an external speaker (or headphones), a tape recorder output and an audio input to the receiver amplifier. In addition, a detachable sun shade for the frequency display and a carrying strap are included.

Testing the unit, we found the FM reception to be entirely adequate. The audio was clean, and the automatic frequency control was very effective for drift cancellation. The digital frequency display proved to be quite accurate in locating stations.

On the AM broadcast band the unit's selectivity was good. Images were undetectable through most of the tuning range; display accuracy was within 2 kHz; and the audio quality was found very good.

When the unit was used in the shortwave mode, high sensitivity brought in weak signals using only the whip antenna. A front-panel trimmer allows close frequency calibration. A wideband/narrowband selectivity switch provides sharp adjacent-channel rejection in any mode. The receiver displayed good mechanical stability.

It must be remembered that the *model RF-*

continued on page 26

CIRCLE 75 ON FREE INFORMATION CARD

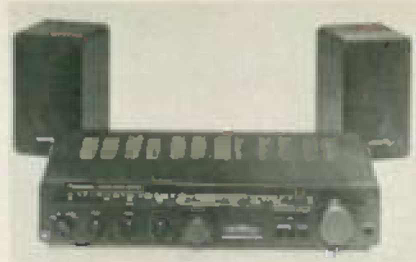
2900 is not designed as a communications receiver. It is primarily a portable radio with shortwave coverage. Serious single-sideband (SSB) or continuous-wave (CW) reception is difficult because of constant oscillator drift. Spurious signals were present throughout the shortwave tuning range. Dial backlash is quite noticeable on the higher frequency ranges. Frequency tuning is rapid, making fine adjustment difficult. Noise-limiter circuitry is not included, making the receiver vulnerable to an electrically noisy environment.

In spite of the receiver's problems with shortwave reception, it performs well for the AM/FM listener who wants good sound, portability, an accurate frequency readout and access to shortwave broadcasts.

The *model RF-2900* multiband portable radio sells for $299.95 and is manufactured by Panasonic Corporation, One Panasonic Way, Secaucus, NJ 07094. **R-E**

Radio Shack System Seven Stereo

GOOD THINGS COME IN SMALL PACKAGES! THIS familiar saying could well apply to the Radio Shack (500 One Tandy Center, Fort Worth, TX 7610) *System Seven* stereo. Although we all have a tendency to take manufacturer's specifications with a grain of salt, it appears that in this case, the manufacturer's good press is well deserved.



CIRCLE 102 ON FREE INFORMATION CARD

System Seven's matching *Minimus-7* speakers (No. 40-2030) are reminiscent of the popular *Maximus* bookshelf speakers of more than a decade ago and perhaps even better. The speakers produce an astonishing bass and smooth, silky highs. Measuring only 7 × 4½ × 4½ inches, the cabinets are made of heavy metal casting, each enclosing a 4-inch high-compliance woofer and a 1-inch dome tweeter. Careful placement is one secret means of achieving maximum performance from these miniature dynamos!

The receiver (*model STA-7*) is handsomely designed. It is enclosed in a low-profile (16½ × 3½ × 12-inch) black-satin-finish metal cabinet. The blackout dial and tuning meter are attractively edge-lighted when the receiver is switched on.

The amplifier specifications are excellent: 15 Hz-30 kHz ±2 dB; under 0.5% THD from 20-20,000 Hz into 8 ohms and a full 10-watt output.

The amplifier can accommodate several front-panel switch-selectable inputs. The rear apron houses an array of jacks in order to allow wide amplifier flexibility. A rear apron switch provides 6.5-dB bass enchancement for the matching speakers.

The AM/FM tuner stages are equally impressive: FM sensitivity (IHF) is typically 2.2 µV; limiting sensitivity (−3 dB) is 3.2 µV; S/N ratio (1 mV) is 60 dB; total harmonic distortion (stereo) is 0.6%; stereo separation (at 1 kHz) is 34 dB; image rejection is 50 dB; IF rejection is 80 dB; and selectivity is 45 dB.

A built-in ferrite loop is provided for AM reception, and line-cord coupling can be used for metropolitan FM listening. External antenna terminals are provided on the rear apron for both AM and FM reception.

Power requirement is either 120 VAC or 240 VAC.

Our test

Initial hookup and installation were easy; we followed the suggestions outlined in the literature that accompanies the system. Our advice: DO READ the instructions. Speaker placement is critical for optimum performance. You need speaker hookup wire; and use color-coded zip cord of adequate gauge in order to insure proper phasing and efficient power transfer.

The tuning dial markings are well-spaced and easy to read, and the flywheel tuning knob has a professional feel. FM stability is excellent, with warm-up drift undetectable. The bass and treble controls have detent stops, giving the impression of incremental steps; similarly, the balance control has a center-position detent stop. We liked these features. Although the quality of sound from the *System Seven* would merit using the most expensive stereo headphones, we selected a set of Realistic's new *model PRO-20* headphones ($24.95) to see how well they would perform with the receiver. The results were quite satis-

continued on page 32

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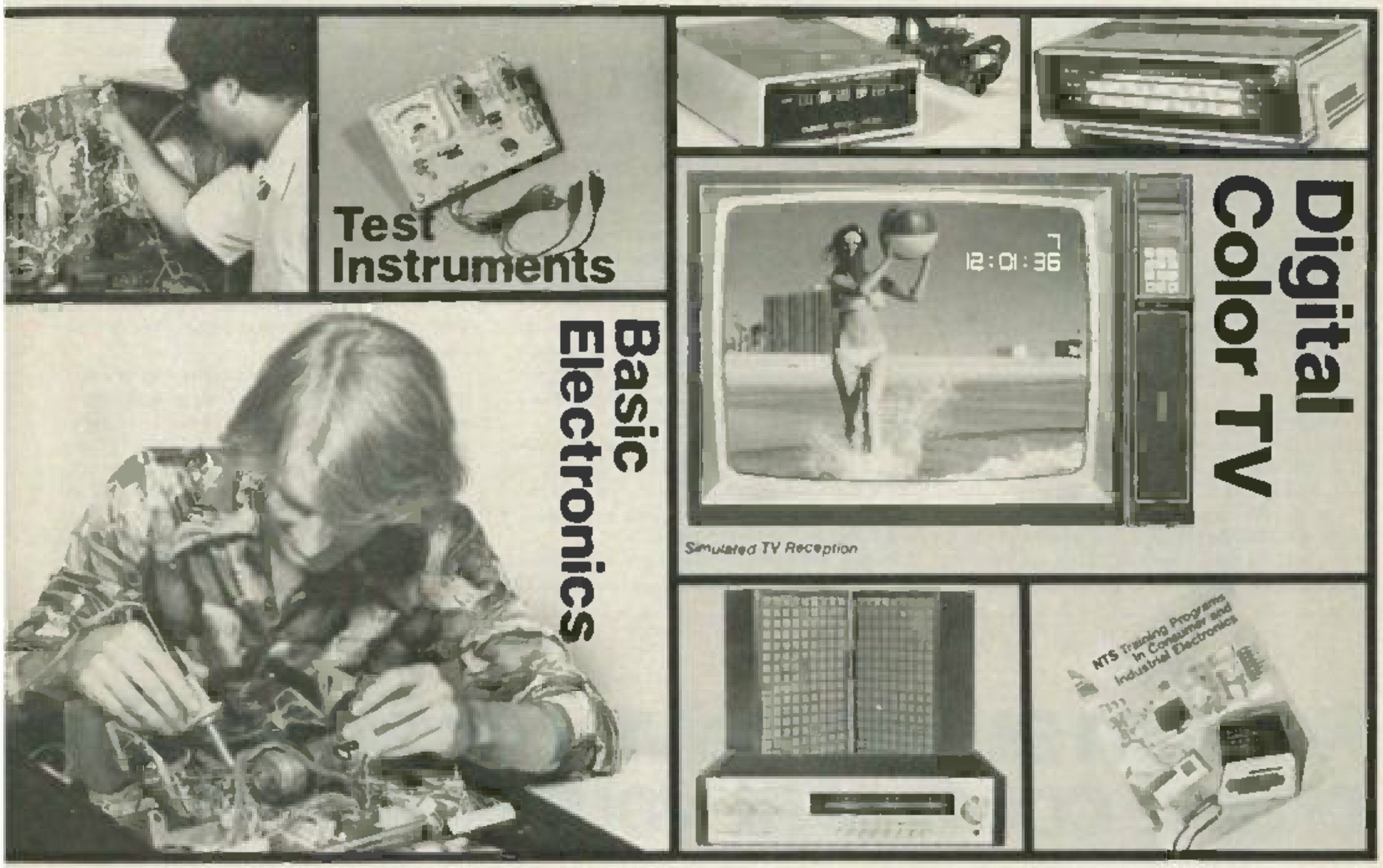

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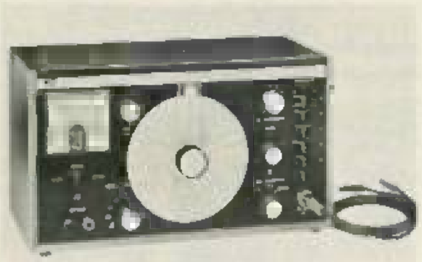
EQUIPMENT REPORTS

continued from page 26

factory; these low-cost phones are a good choice in matching economy stereo headphones for noncritical requirements.

Clearly, the *System Seven* is a product for other manufacturers to reckon with; it should become a standard of comparison among low-cost, high-performance component music systems. The Radio Shack *System Seven* sells for $219.95. **R-E**

B & K Model E-200D RF Signal Generator



CIRCLE 103 ON FREE INFORMATION CARD

A REASONABLY-PRICED, METERED-OUTPUT signal generator is a difficult item to find. B & K's model *E-200D* RF Signal Generator helps fill that void.

The *E-200D* is a handsome, husky compact generator featuring straightforward operation. Functions are very clearly marked, and familiarization comes quickly. The accompanying owner's manual is well written, and very flexible in its subject matter. The usual circuit descriptions and control identifications are provided, but several other text subjects are included. A handy dB-to-microvolt conversion table is provided and is very helpful for sensitivity measurements. Alignment procedures for AM radios, FM receivers, and TV sets are given step-by-step.

The *E-200D* measures 12¼ × 7¼ × 8 inches, and weighs 14 pounds. It is securely enclosed in a steel cabinet, AC powered through a 3-wire grounded cord.

Fundamental frequency generation ranges from 100 kHz through 54 MHz, with calibrated harmonics usable through 216 MHz (TV Channel 13). Frequency accuracy is advertised as being ± 1.5% of highest frequency on any band, usable to 0.1% with internal calibrator. The calibrator is heterodyned against the signal generator frequency, producing an audio beat note that can be heard from an internal speaker.

RF signal voltage output (maximum) varies from 3 volts (lowest frequencies) to 0.3 volt (highest frequencies). Using the calibrated attenuator and level control, the output level may be selectively adjusted from −106 dB (.5μV) to +2 dB (216,000 μV) at 50 ohms. Accuracy throughout the entire fundamental frequency range is specified as being within 2 dB.

Modulation is provided by an internal 400 Hz (± 20%) bridged-T oscillator. Level is set at 1V RMS for 50% modulation. External and internal sources of modulation are both continuously adjustable and metered.

Both a block diagram and circuit schematic are included for servicing the generator, and to make internal calibration easier. The subject of calibration needs to be mentioned. While it is possible to bring the *E-200D* into specified accuracy, the unit that we evaluated was considerably off in its dial reading. On several lower-frequency segments, (between 100 kHz and 9 MHz) the adjustable hairline could not be offset far enough to coincide with the actual output frequency. Nonlinearity in the dial ranges aggravates the problem. Although we made no attempt to align the unit, our feeling is that it could probably be brought within specifications.

To assist with calibration accuracy, two internal reference oscillators are included. The 1-MHz crystal oscillator is very accurate and stable. It is usable up to about 33 MHz. The 100-kHz oscillator is an L-C unit, and had strayed considerably off frequency. Adjustment of the 100-kHz calibrator is easily accomplished by aligning the slug of the oscillator coil, readily accessible through a small hole in the shielded RF section.

Shielding and mechanical stability are two vital areas in any signal generator design. We were pleased at the RF isolation provided by the extensive copper-plated steel shielding. The cabinet cover is also interlocked to discourage stray radiation.

One of the most serious drawbacks in using inexpensive hobby-type RF signal generators comes with low signal levels. When it is important that very low output signals (in the microvolt region) must be used to measure maximum sensitivities of radio receiving equipment, stray radiation will wreak havoc! These leakage paths may occur between cabinet/panel cracks, or with poor cable shielding, poor

continued on page 34

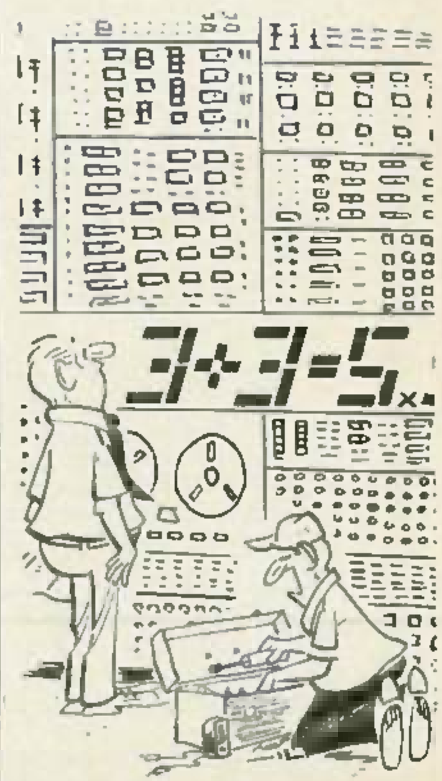
continued from page 32

ground strapping, AC line radiation, or even loose panel hardware. The *E-200D* seems to have much lower stray radiation than most other low-cost competitive signal generators. That condition must be attributed in large part to the heavy shielding around the internal oscillator section.

While the shielding made the unit relatively RF tight, mechanical instability is still apparent, especially at higher frequencies. A gentle tap on the cabinet will cause severe detuning on the upper ranges. Above 5 MHz, the frequency dial tuning becomes increasingly rubbery, making close adjustment virtually impossible on close tolerance alignment. Thermal drift, however, is minimal with this solid-state instrument.

Considerable frequency pulling occurs from the attenuator control. With the dial set at some useful frequency, rotating the fine attenuator control results in extensive frequency change. Even though the attenuator pot is isolated by a buffer stage, interaction with the oscillator is still quite prevalent. Some loading effect on frequency is also noted when the output of the generator is connected to its injection point in the circuit to be checked.

Metering in any unit is desirable. Obviously, absolute accuracy cannot be expected except in generators costing considerably more than the *E-200D*, but used as a relative reference, it can be very useful. For most applications, and non-demanding test bench use, the *E-200D* is loaded with useful features. The *E-200D* RF signal generator sells for $300. Available from B & K-Precision, Dynascan Corp., 6460 W. Cortland St., Chicago, IL 60635. R-E



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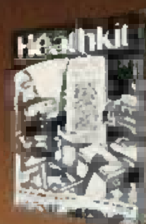

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Do not be fooled by the low prices, these brand new lab quality frequency counters have important advantages over instruments costing much more. The models 7010 and 8010 are not old counters repackaged but 100% new designs using the latest LSI state-of-the-art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

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

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

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

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

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

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MODEL 7010 600 MHz

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- STATE-OF-THE-ART LSI DESIGNS
- COMPREHENSIVE USER MANUAL PROVIDED
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MODEL	$ PRICE	RANGE 10Hz to	LED DIGITS	SENSITIVITY 50 OHM INPUT 25-250 MHz	250-450 MHz	450 MHz-1GHz	HI-Z INPUT 10Hz - 60 MHz	GATE TIMES	RESOLUTION 12 MHz	60 MHz	MAX FREQ	TCXO TIME BASE 20°-40°C	FREQ.	EXT CLOCK INPUT	NI-CAD BATT PACK
7010 *7010.1	145.00 225.00	600 MHz	9	5-20 mV	10-30 mV	20-40 mV to 600 MHz	1-10 mV	(3) .1, 1, 10 SEC	.1 Hz	1 Hz	10 Hz 600 MHz	1 PPM 0.1 PPM	10 MHz	YES OPTION $25.	YES OPTION $15
8010 *8010.1	325.00 405.00	1 GHz	9	1-10 mV	5-20 mV	10-25 mV	1-10 mV	(8) .01-20 SEC	.1 Hz	1 Hz	10 Hz 1 GHz	1 PPM 0.1 PPM	10 MHz	YES STD	YES OPTION $30.

* Has precision 0.1 PPM TCXO time base.

MODEL 7010

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

OPTIONS

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

MODEL 8010

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

OPTIONS

- #Ni-Cad-801 Ni-Cad Battery Pack & charging circuitry Installs inside unit $ 39.00
- #CC-80 Carry Case, Padded Black Vinyl $ 9.95

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DESIGN YOUR OWN ANDROID

No doubt many of you have dreamed of the day when you will have an android at your beck and call. Well, that day is not yet here but you can get an early start by designing your own android. Here are the basics.

MARTIN BRADLEY WEINSTEIN

THERE ARE AT LEAST HALF A DOZEN INDIviduals in America who have designed and built their own working robots, and at least two companies now offer robot plans and kits as commercial products. The day when almost anyone can go to his hobby workshop and emerge with a home-built robot is more than near; it's arrived.

But that isn't the kind of project to go into with a headlong plunge. There are many important decisions to be made at the outset. And a complex, interwoven electronic/mechanical/human engineering task to be accomplished.

What is offered here is not a set of plans, nor the final word in design; it is a thought-out attempt at organizing and recording one man's decisions on how to approach that design task. You will have to make your own judgments as to whether or not these decisions apply to the robot or android *you* build.

The first step: defining terms

To avoid confusion—but not necessarily to define these terms for anyone but ourselves—let's sort out what we mean by terms like *robot*, *android*, and so on.

The key considerations are mobility, control, independence, and the ability to learn by experience and adaptability.

A *robot* is a mechanism, fixed or mobile, possessing the ability to manipulate objects external to itself under the constant control of a human being, a computer, or some other external intelligence.

An *automaton* is a mechanism, fixed or mobile, possessing the ability to manipulate objects external to itself under the constant control of a programming routine previously supplied by an external intelligence.

An *android* is a mobile mechanism possessing the ability to manipulate objects external to itself under the constant control of *its own* resident intelligence, operating within guidelines initially established and occasionally updated by a human being, a computer, or some other external intelligence.

A *cyborg* (or "cybernetic organism") is an android capable of heuristic (learning by experience) updating of its own resident intelligence.

A *mandroid* is an android or cyborg in the shape, size, and likeness of a human being. Mandroids might be used, for example, to pilot aircraft or ground vehicles, initially designed for human operation, through dangerous or humanly unsurvivable conditions.

Philosophical aspects

Frankly, my decision to build an android was an emotional impulse. I knew that the necessary technology existed, and I knew I *could* build one. So I decided to do it before I decided just what my creature should do.

When I announced my intention to several friends and colleagues—who have been enthusiastic and supportive—I found that the almost universal response to my announcement "I've decided to build a robot" was the understandable question "What will it do?" This article is, in part, my attempt to answer that question.

With a bow to Dr. Isaac Asimov (whose science fiction classic *I, Robot* introduced the "Laws of Robotics"), here are the criteria for our tentative first steps at android design that comprise our own "laws of robotics."

First, our creations should not be destructive to any part of their environment, including living cohabitants, walls and furniture, the breathableness of the air, radiation levels, or anything else.

Second, our creations should not be destructive to themselves. We need to include adequate hardware and software protection to assure self-preservation, except where that violates our first "law."

Third, we must design in an instinct for survival, meaning here self-continuance of operation, except where that would violate the first two laws. The most immediate manifestation of the survival trait, for example, would be a mechanism to assure that low batteries would be recharged before failure. (Throughout our text, the term "mechanism" will be used to identify any means—hardware, software, human cooperation, whatever—by which an end, or design goal, may be achieved.)

Obstacles in the human environment

If our robots and androids are to "live" with us, they must be capable of maneuvering through our individual environments. To better appreciate the difficulties that entails, join us in a little mental scenario for a fast experimental demonstration.

Imagine that you have a remote-controlled motorized toy, and that you want to drive it on a tour of your house. As you do so, make a list of the goals you are setting for yourself, and be sure to list the specific obstacles that make your task more difficult.

Figure 1 shows a typical (for the sake of this discussion, anyway) upstairs floorplan for a Colonial home. Even with no furniture to contend with, we can quickly identify a number of obstacles: stairs, narrow hallways, doors, and closets.

Figure 2 takes us into a sparsely furnished room, where furniture, cords, and so on begin taking a significant role.

While the detail of your imaginary excursion might vary from ours, you will notice that the goals and obstacles listed in Table 1 offer a good, fairly general, starting point for our design.

That gives us some of our first requirements for our robot or android: obstacle recognition, collision avoidance, and obstacle manipulation.

One example of that might be recognizing a closed door and not colliding with it, but opening it, then proceeding.

Stairways

A vehicle with wheels of the same order of size magnitude as a step cannot negotiate the step in a controlled manner.

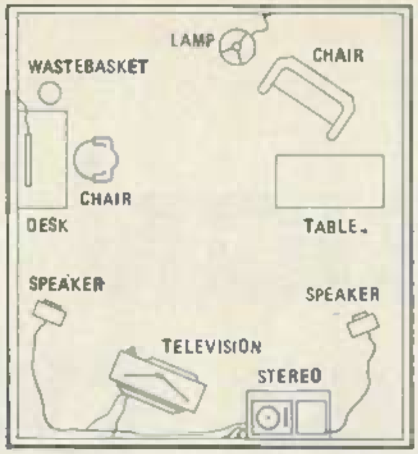


FIG. 2—FURNISHED ROOM presents many obstacles to an android.

In other words, you might be able to ride a bicycle up and down a stairway—but you wouldn't want to try it in a go-cart.

So large wheels are one possible answer to the problem of negotiating stairs.

Another solution, which you may have seen back in the 60's in artists' renderings of proposed lunar vehicles, approximates the action of a single large wheel by using a triangular array of three wheels: both the array and each individual wheel may be driven.

Walking—the approach favored by humans and animals—presents problems in balance and locomotion that are best left alone at present, considering the technology available to us.

Still another possible answer is to use the principle of a tracked vehicle. A vehicle with twin tracks and two reversible motors not only solves the problem of forward and reverse motion, even over stairways and uneven terrain; it also makes turning easier to accomplish, especially within a small radius.

However, when such a vehicle begins climbing or descending the stairs, the tendency to topple must be overcome. That tendency can be reduced by first designing the vehicle with a low center of gravity. That means keeping the more massive components as close to the ground as possible, keeping the height of the machine reasonable as opposed to the geometry of its base, and keeping the higher parts of the machine as lightweight as possible.

Also, we ought to consider a mechanism for keeping the main body of the machine upright no matter what the attitude of its base. (That's angular attitude, not emotional attitude—though at times it can seem that way.)

TABLE 1

GOALS
- Steer away from walls
- Steer around and between furniture
- Avoid wires and cords
- Follow long, straight clear paths
- Continue forward, avoid reverse

OBSTACLES
- Closed doors
- Stairs
- Carpets and high-drag surfaces
- Transitions between floorings
- Hanging items extending from walls
- Shelves
- People and pets
- Clutter on floors
- Wires and cords
- Closets and cabinets
- Narrow hallways
- Fireplaces

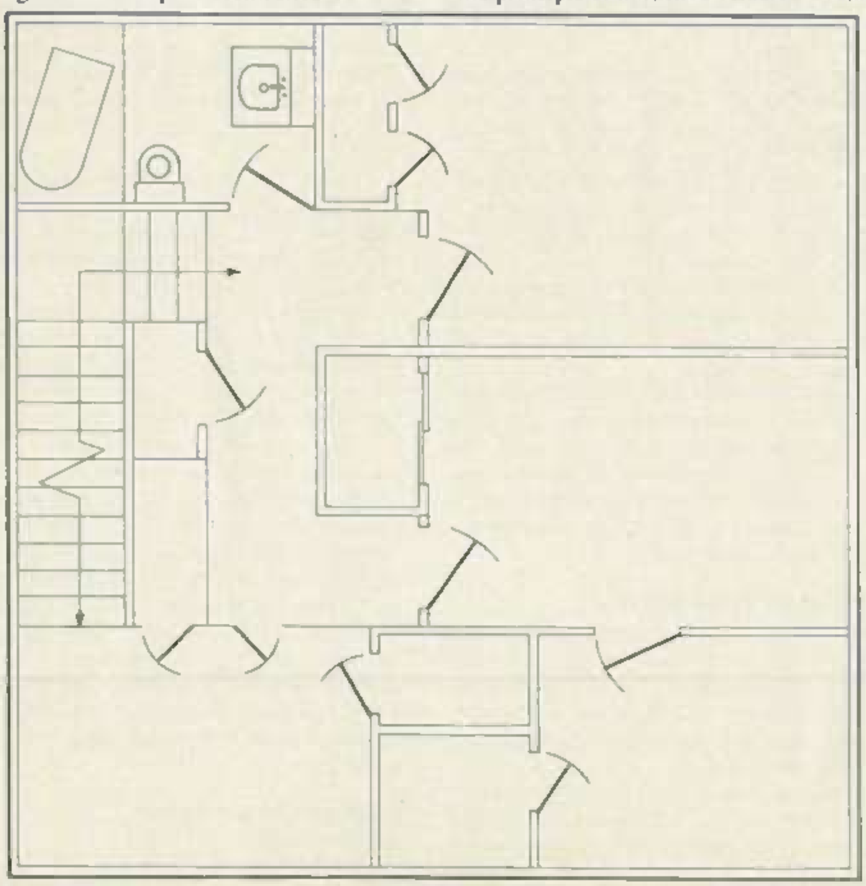


FIG. 1—UPSTAIRS FLOORPLAN of a typical Colonial-style house without the furniture.

Physical aspects

You've probably heard that a woman's high heel exerts more force per unit area than an elephant or a jumbo jet. While you probably haven't been considering having an elephant or a jumbo jet walking around your house, you don't have too many fears of a woman in high heels doing the floor in.

No, we're not suggesting an android in high heels. What we are suggesting is that placing reasonable limits on the size, shape, and weight of your machine *before* it's built can save you and your property needless grief afterwards.

First, decide what temperatures your machine should be prepared to endure, then choose your materials carefully to meet or somewhat exceed those conditions.

A house android, for example, that will never leave the comfort of a heated/air conditioned "room temperature" home, can be built out of the handiest, cheapest materials that will handle the mechanical and electronic design goals. But if you, for example, take an NMOS or PMOS android outside when it's snowing, you can count on him "forgetting himself" as his electronics will stop functioning. Battery performance is likely to suffer, too, as is mechanical and lubricant performance.

A more generalized machine will be designed for, say, −10°F to 100°F, depending on your geographic location. CMOS electronics work well to −40°F (= −40°C) and in quite a bit more heat than we can withstand. Those same temperature ranges are readily available for relays, discrete components, motors, lubricants, plastics, adhesives, and most of the other materials we'll need.

Size and weight

The size and weight of your machine depend very much on the size and weight of your machine; this design loop requires that you force yourself to make some initial assumptions.

For reasons we'll discuss later, practical power and motor design options reduce to electric rechargeable batteries and electric motors. The biggest current requirement for the batteries—by far—is the motor drive. The current required is a function of the power required from the motors, which is a function of the *product* of load and speed.

Obviously, the same amount of power is required to move a machine half as heavy twice as fast as is needed to move a machine twice as heavy half as fast.

So first we must decide on the total load we would ever want to carry and the minimum speed we would settle for; or we could consider the top speed we wish to attain and settle on the minimum load we want to carry at that speed.

We will present the math later; right now, a few examples are in order.

A machine with a design weight, unloaded, of 100 pounds, designed to travel at a top speed of 20 miles per hour, or to carry a 300 pound load at 5 mph, requires 5½ horsepower or 4500 Watts. That means 375 amps of stall current from a 12-volt battery.

A reasonable battery configuration, permitting several hours of operation be-

SOURCES

The following is a list of places to go for more information about robots, androids, and some of the hardware discussed in the article:

Tab Books (Blue Ridge Summit, PA 17214) offers two books of interest. *Build Your Own Working Robot* by David L. Heiserman (Tab No. 841, $5.95) details the construction of a small, wheeled self-controlling vehicle. *The Complete Handbook of Robotics* by Edward L. Safford, Jr. (Tab No. 1071, $7.95) includes excellent discussions of batteries, motors, sensors and more.

Hayden Books (50 Essex Street, Rochelle Park, NJ 07662) offers *How to Build a Computer Controlled Robot* by Tod Loofbourrow (No. 5681-8, $7.95), which details the hardware and software design of Tod's small robot, "Mike." Hayden also offers the accompanying KIM 6502 software on cassette.

The International Institute for Robotics (PO Box 615, Pelahatchie, MS 39145) publishes a newsletter and offers a home study course, which includes a microcomputer and parts for a small machine. The basic course costs $890. Subscriptions to the newsletter are $8 annually. Contact Director T. Dale Cowsert for information.

The United States Robotics Society (PO Box 26484, Albuquerque, NM 87125) acts as a clearinghouse for robotics information and irregularly publishes a very worthwhile newsletter. Membership is $14 a year. Contact Director Glenn Norris for information.

Gallaher Research (PO Box 10767, Salem Station, Winston-Salem, NC 27108), or GRI, are the people who introduced the "Grivet" robot arm. They have a three-ring binder (with *Robotics* in big letters on the front and spine) full of sketches and specifications of manipulator systems. That binder, available for $10, serves as the company catalog of plans, kits and components for manipulator assemblies and machined parts. Contact John K. Gallaher, Jr.

Lour Control (1822 Largo Court, Schaumburg, IL 60194) offers a manual for $15 which details construction of a small wheeled vehicle, sans intelligence. A kit version is available for $375, an assembled version for $495, and an assembled control interface for $35.

Micro Works (PO Box 1110, Del Mar, CA 92014) offers a series of video digitizers that make standard camera video inputs X-Y addressable and extractable for S-100, S-50, and Apple systems.

Semionics Associates (41 Tunnel Road, Berkeley, CA 94705) offer content-addressable add-in associative memory (CAM) for the S-100 bus, very useful for pattern recognition.

Computalker Consultants (1730 21st Street, Santa Monica, CA 90404) offers speech synthesis hardware and software, and is rumored to be close to introducing speech recognition products.

Telesensory Systems, Inc. (3408 Hillview Avenue, P.O. Box 10099, Palo Alto, CA 94304) offers some limited-vocabulary speech synthesis hardware.

Votrax (500 Stephenson Highway, Troy, MI 48084) is another manufacturer of software-variable electronically synthesized human speech hardware. Their newest version, VS-6.4, is supposed to represent several improvements over earlier offerings.

Texas Instruments (Consumer Specialty Products Division, Lubbock, TX) offers Speak & Spell™, an extraordinary talking toy (about $55 in department stores), and has recently announced a talking language translator. The enterprising experimenter who isn't afraid to cannibalize a Speak & Spell can find a thorough explanation of the operation of that chip in the article "Speech Synthesis with Linear Predictive Coding" written by TI's Larry Brantingham and appearing in the June, 1979 issue of *Interface Age*.

National Semiconductor is rumored to be working on a single-chip speech synthesizer but details are not yet available.

Terrapin, Inc. (33 Edinborough Street, 6th Floor, Boston, MA 02111) offers a small, externally controllable vehicle it calls a "Turtle" robot as a $400 kit or a $600 assembly, with an S-100 interface also available.

Superior Electric (383 Middle Street, Bristol, CT 06010) offers two 15-minute audio cassette courses for $5 each. Tape No. 1 is "Stepping Motor Controls;" the other, unnumbered, is "Stepping Motor Technology." The company has a great deal of excellent literature available concerning DC stepping motors.

Intersil (10710 North Tantau Avenue, Cupertino, CA 95014) has a number of applicable products. Foremost among those are their CMOS RAM's, EPROM's, and processors, including upcoming CMOS equivalents of the 8048, 8748, 8031 family. Also noteworthy is their IH8510/8520/8530 family of power amplifier, motor and actuator drivers. Application/data sheets and a list of distributors should be available on request.

Robert Bosch Corporation (2800 South 25th Ave., Broadview, IL 60153) offers Mini-Giants®, a line of small-size low-voltage relays with up to 30-amp contact ratings.

Globe-Union (5757 North Green Bay Avenue, Milwaukee, WI 53201) has an excellent brochure available describing their Gel/Cell® rechargeable batteries and chargers.

Of all the small computer system-oriented publications, *Byte* (70 Main Street, Peterborough, NH 03458) has had the consistently best coverage of robotics. Here's just a sampling: *Designing a Robot from Nature; A Hobbyist Robot Arm; A Stepping Motor Primer; A Model of the Brain for Robot Control; The Nature of Robots; Talk to a TURTLE;* and *Artificial Intelligence and Entropy*. All from three selected 1979 issues.

Arctic Cat may be a reasonable source for track drive components. Detail *exactly* what you have in mind in a letter to Peg Kirk, Product Distribution, Arctic Cat Division, Box 635, Thief River Falls, MN 56701. We will try to coordinate a standard kit of components for the kind of track drive described in the text, but that may take a while or forever to define and determine a price for. If and when we're successful, it will be announced in the pages of **Radio-Electronics**.

You may also find useful components in the pages of the **Edmund Scientific** catalog. For a copy, write to them at 7977 Edscorp Building, Barrington, NJ 08007.

tween recharges, involves four 17-pound batteries. But once we add in the weight of motors, mechanics, housings, etc., we can see that we've exceeded our 100-pound weight criterion.

So what must give way? Probably the top unloaded speed and the load carrying requirements. If we cut the top speed to 10 mph and the top loaded weight to 200 pounds (100 pound machine + 100 pound load), we eliminate two batteries, saving 34 pounds—plus trimming weight from the motors, supports, on-board charger, and more. We also lighten up the current requirements for the control electronics.

So by sacrificing the capability of giving us a ride around the block, we see we can build quite a lot of more important capability into a 50-150 pound machine.

But before continuing with our discussion of the physical attributes of our machine, let's go back to a definition of what we want it to do.

The manipulative imperative

There is a toy on the market, a "Radio-Controlled *R2-D2*." It's cute, and you really can remote control its motion and direction. Indeed, a number of hobby computer enthusiasts have taken to using their computers to push the buttons. But that toy, on however grand a scale, fails to meet our definition for robot or android because it cannot "manipulate objects external to itself."

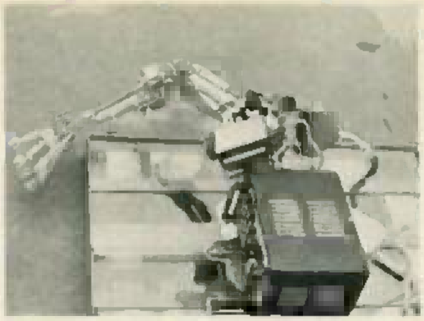
That requirement also means that our machine must be designed to *reach* those "objects external to itself" with some sort of mechanical arm. In theory, this mechanical arm requires only three *degrees of freedom*, along the X, Y, and Z perpendicular axes. In practice, however, our rule that the machine must not destroy things in its environment demands the ability to reach around obstacles; that means we must have five or six degrees of freedom.

We get the number of those "degrees of freedom" by counting each "axis of movement"—more simply, each joint. For example, in a human being, the wrist represents one such axis (rotational), the elbow two (both rotational and hinge), the shoulder two. If you add in the hand-wrist hinge action, and all the degrees of freedom in the fingers, you can begin to appreciate the complexity of following an anthropomorphic design.

Another available degree of freedom is telescopic, as is found in the large industrial robots.

A great deal of work has gone into the design of manipulator arms. Those used in industry are out of our scope because of size and cost. But there are others.

Most notable of those is the "Grivet," once (but no longer) offered by Gallaher Research Incorporated for something around four hundred dollars. It used six DC motors and a wealth of machined parts. But it wasn't very sturdy, nor nimble, nor strong. Gallaher is still in business, though, offering optimistic plans, kits, and parts for a number of other manipulators with varying sizes and degrees of freedom. Their catalog, which includes some plans, comes in a handsome 3-ring binder that reads "Robotics 1979" for $10 (send to GRI at PO Box 10767, Salem Station, Winston-Salem, North Carolina 27108).



MANIPULATOR ARM, called NELOC, is an innovative design by Andy Filo of Akron, OH.

Arm design problems

Some sort of position information will need to be sent back to the controlling intelligence, as well as contact information for the "fingertips"; that requires additional components—at the minimum, a potentiometer for each motor and pressure sensors for the fingertips.

As the weight of the arm rises, so does the necessity of providing counterbalancing weights at each axis, as well as the requirement for structural sturdiness.

Yet, for all of its required strength, the arm has to be able to "give" if it is to survive the shock of a substantial load, suddenly applied. Even the task of catching a football can destroy a too-rigid arm; shock-absorbers must be built in.

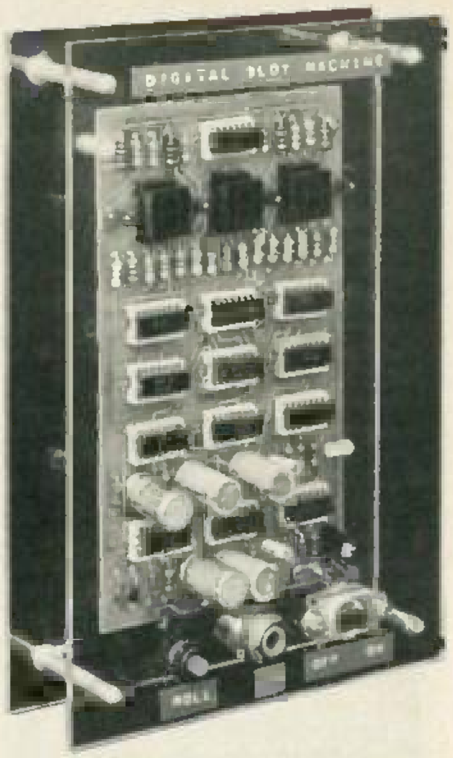
Then there's the problem of knowing *where* the arm is, both in relationship to the body of the machine and in relationship to the object that's to be manipulated.

One special task we can anticipate requiring the arm to accomplish involves inserting the on-board battery charger plug into an available wall socket. While the on-board memory can recall the relative position of the plug as a head start, and while the on-board intelligence may have mapped the particular room the machine is in, giving the locations of available outlets, there still remains the problem of lining the plug up exactly with the socket and inserting it—without pushing it through the wall or applying 110 Volts to the shell of the machine.

For that task, there is no substitute for vision.

Next month we will continue this absorbing story with discussions of how an android sees, how it gets about and how it overcomes such obstacles as stairways and tight corners. **R-E**

BUILD THIS



FRED BLECHMAN, K6UGT and DAVID MCDONALD

"ONE-ARMED BANDITS" ARE THE MAINstay of gambling centers wherever games of chance are allowed. Go to any hotel lobby in Las Vegas or Reno, for example, and people are pulling the slot machine handles all night. The typical mechanical devices, with three or more rolling drums that randomly stop, are being replaced with microprocessor based video units that feature color graphics and highly sophisticated scoring.

This unit is not that involved. It is an all-electronic design using TTL digital logic, with a set of four LED's programmed to flash on and off when all three characters are the same, indicating a jackpot!

When the power is first applied to the unit, all three displays (usually) light up with the letter "C" (for Cherry), and four discrete LED's flash on and off. (If the LED's don't flash, it's because the three displays did not start up the same—usually they do, but sometimes they don't.) Now press the ROLL pushbutton. The digits will "roll", looking something like a blinking 8, until you release the pushbutton. Now the left-most digit stops, followed shortly thereafter by the center digit, then the last digit. Each digit will display either a "C" for Cherry, an "L" for Lemon, an "O" for Orange or an "A" for Apple. If all three displays stop with the same letter, the LED's flash.

DIGITAL SLOT MACHINE

Games of chance and mechanical gambling devices were with us for years, then came electric and now electronic games. Here is a simple electronic version of the one-armed-bandit that you can build.

The odds of getting all three displays with any of the four same letters are 1 in 16 tries. For any two displays to have the same letter in selected locations, the odds are also 1 in 16. The odds of getting the same selected letter in all three displays is one chance in 64.

How it works

This explanation will assume you have some knowledge of digital circuitry. Figure 1 is a block diagram of the Digital Slot Machine and Fig. 2 shows the schematic. Each display has its own logic section that is clocked by a separate oscillator. The WIN logic section monitors the state of each display, and when all three are the same, it commands the LED's to flash on and off at a rate determined by the WIN oscillator.

Let's describe how display 1 is operated, since the same technique is used for display 2 and display 3 (with small differences described later).

Clocking

Inverters IC13-a and IC13-b, together with resistors R22 and R23 and paralleled capacitors C1, C2 and C3, form the oscillator 1 circuit. The output of this oscillator is applied to one input (pin 10) of NAND Schmitt trigger IC12-a.

When pushbutton switch S1 is depressed, capacitor C4 immediately charges through blocking diode D1, and a positive voltage appears on pin 9 of the Schmitt trigger IC12-a. Now whenever the output of oscillator 1 (IC13-a & IC13-b) is HI, pin 8 of IC12-a, which is normally HI, snaps LO and clocks flip-flop IC5-b at its pin-5 input. The Q and $\overline{Q}$ outputs of IC5-b, pins 8 and 9, change state each time a LO clock pulse comes from IC12-a.

When S1 is released, C4 discharges through resistor R24 until the input to IC12-a at pin 9 falls below threshold to a LO, so the output of IC12-a is held HI and no further clocking occurs, even though oscillator 1 is still running.

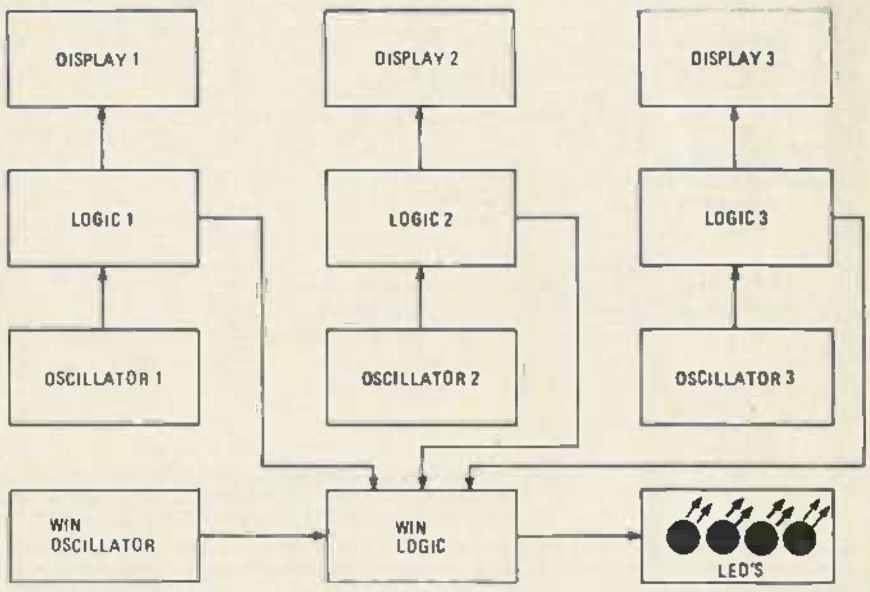


FIG. 1—BLOCK DIAGRAM of the digital slot machine. Each display is "rolled" by a separate oscillator. The "win" oscillator blinks the four LED's when the three displays are identical.

The snap-action Schmitt trigger is used here rather than a normal NAND gate so the slow decay time of C4/R24 doesn't cause erratic operation and false triggering.

Display Logic

When power switch S2 is closed, flip-flops IC5-a and IC5-b usually come up to voltage with a logic LO on the Q output of IC5-a, and a logic HI on the Q output of IC5-b. Figure 3 shows the logic states at the inputs and outputs of each

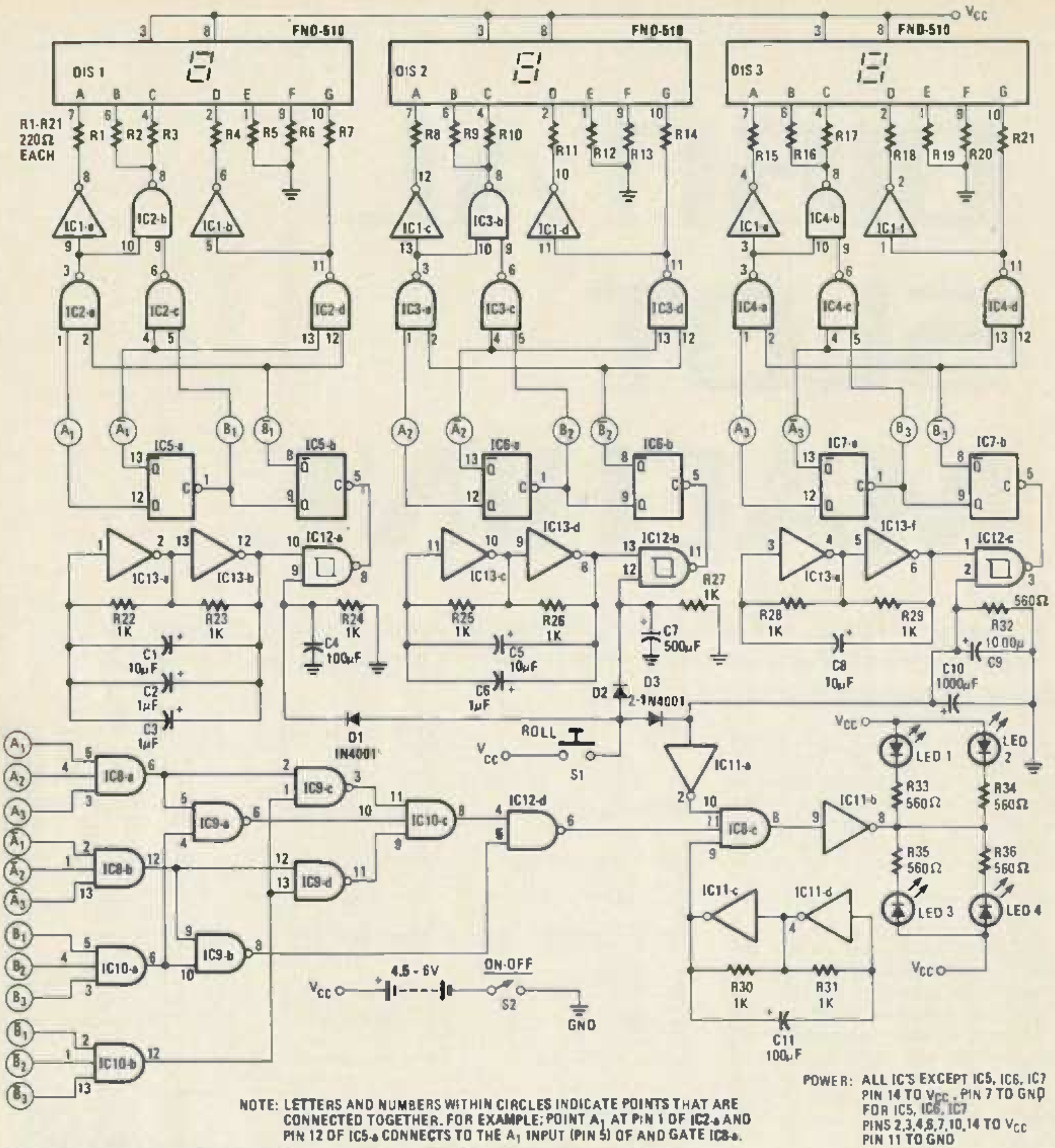


FIG. 2—SCHEMATIC DIAGRAM of the digital electronic slot machine. Each of the three displays will show a random selection of the letters A, C, L and O; representing apple, cherry, lemon and orange, respectively.

logic element. This results in a display of the letter "C". All display segments have a series resistor to prevent burnout, since these are LED displays. Display segments E and F are always lighted since they are wired to ground through their resistors R5 and R6. A logic LO at the output of inverter IC1-a allows segment A to light, and the LO at the output of inverter IC1-b lights segment D. The logic HI at the output of NAND gate IC2-b keeps segments B and C off, while the HI at the output of IC2-d keeps segment G off.

When the pushbutton switch is depressed and the first LO clocking pulse arrives at the input of flip-flop IC5-b, its outputs change state: Q goes LO and $\overline{Q}$ goes HI. As the Q output of IC5-b goes LO, this also clocks flip-flop IC5-a, driving its output HI and the $\overline{Q}$ output LO. If you follow the changes through the display logic network, you'll find only one segment is effected; segment A goes off, so the "C" becomes an "L".

When the next LO arrives from the oscillator, flip-flop IC5-b outputs change state again. Output Q goes HI, and output $\overline{Q}$ goes LO. However—and this is important—flip-flop IC5-a does NOT change state, since it needs a logic LO at its clock input, and it just received a HI! Thus, flip-flop IC5-a is counting in binary, only changing state with every *second* cycle of the oscillator. This is the way binary counters operate.

The display changes from "C" to "L" to "O" to "A" and then repeats as long as S1 is pressed. When S1 is released the decay time of C4/R24 allows the display to keep changing for a short time, finally stopping at one of the four letters.

The logic networks for the other two

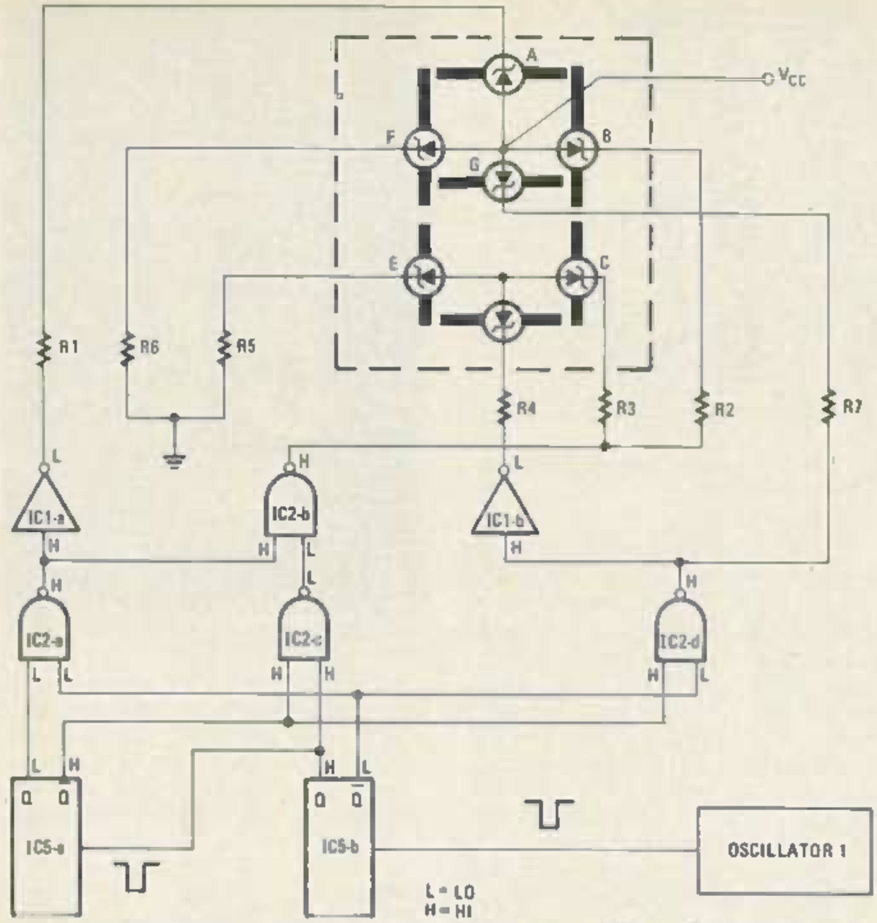


FIG. 3—DISPLAY LOGIC DIAGRAM shows the existing states of pertinent points when the letter C—for Cherry, is displayed.

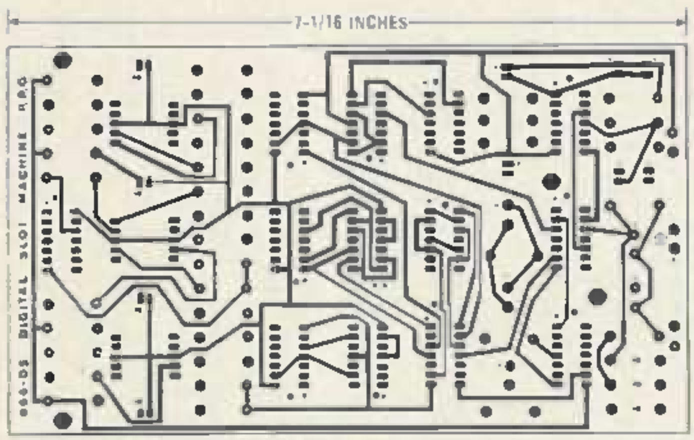


FIG. 4—FOIL PATTERN for the top surface of the PC board. The double-sided feature calls for precise alignment of the top and bottom foil patterns.

letter displays are identical. The oscillator speeds are slightly different. Oscillator 1 has a total of 12μF (C1 plus C2 plus C3) while oscillator 2 has 11μF (C5 plus C6) and oscillator 3 has 10μF (C8). The lower the capacitance the higher the output frequency and the faster the display changes letters. This speed difference provides a more random result to the displays. Also, each display has a different stopping time. The oscillator for each display can only feed pulses through the Schmitt trigger to the flip-flop as long as the voltage on one trigger input pin is held HI (pin 9 of IC12-a, for example). For display 1 this is controlled, after the release of S1, by C4 and R24 with a relatively short time constant. For display 2, however, C7 is five times the value of C4, and for display 3 the combination of C9 and C10 is four times greater than C7. Even though bleeder resistor R32 is a lower value than R24 or R27, the results are that display 1 stops almost immediately after S1 is released, followed shortly by display 2, and then display 3 a little bit later. This creates suspense and virtually guarantees a random combination.

WIN Logic

When each display is identical, the output states of each pair of flip-flops (IC5-a and -b, IC6-a and -b, IC7-a and -b) are also identical. The schematic shows each of the flip-flop outputs are designated A1, $\overline{A1}$, B1, $\overline{B1}$, etc. If all three displays are *not* identical, the logic network composed of IC8-a, IC8-b, IC10-a, IC10-b, IC9-a, IC9-b, IC9-c, IC9-d and IC10-c holds output pin 6 of Schmitt trigger IC12-d LO. However, whenever any of the 4 possible combinations of identical outputs appears at each flip-flop set, the output of IC12-d goes HI.

Looking at AND gate IC8-c, we see three inputs. One input (pin 11) is from IC12-d, pin 6 as just described. Another input (pin 9) is from pin 6 of inverter IC11-a. Inverters IC11-c and -d, together with R30, R31, and C11, form an oscillator running at a slow speed—about 4 Hz. This is the "WIN" oscillator. The third input to IC8-c at pin 10, is from inverter IC11-a. Obviously, whenever pushbutton switch S1 is pressed, a HI appears at input pin 1 to IC11-a, through blocking diode D3. However, when S1 is released, the HI at pin 1 of IC11-a is maintained by the decaying voltage across the parallel combination of C9 and C10, with bleeder resistor R32 controlling the decay time. When this voltage falls below threshold, Schmitt trigger IC12-c no longer enables oscillator 3 pulses, so the display "freezes." Also, the input to IC11-a is now LO, so its output goes HI. This tells AND gate IC8-c that the last display has stopped, and thus prevents the four WIN LED's from flashing spuriously anytime the displays happen to be identical.

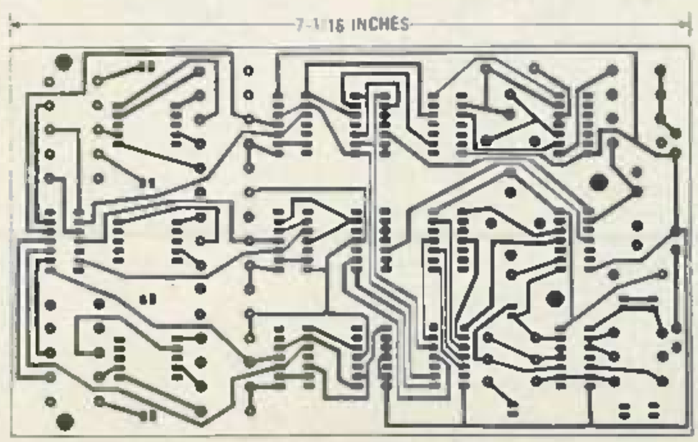


FIG. 5—PATTERN for the bottom of the PC board. See text on the plated-through holes.

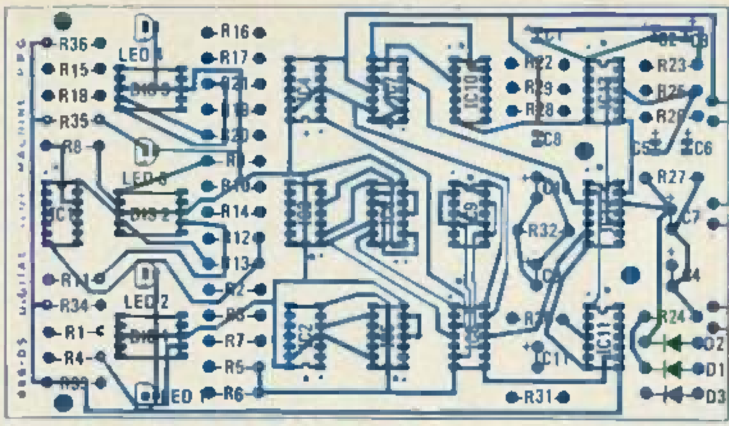
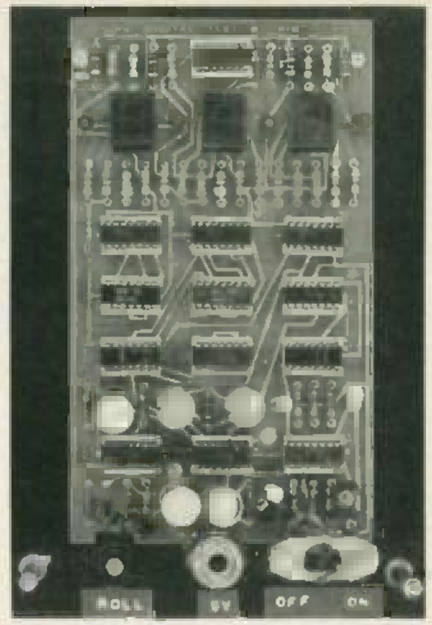


FIG. 6—NOW PARTS ARE positioned on the PC board. Note the polarity of the capacitors and diodes. IC's 2-7 are inserted facing down while IC's 1 through 13 face up.



FRONT VIEW of the slot machine. Clear plastic panel makes all parts visible.

Now we can see that three conditions must exist for pin 8 of AND gate IC8-c to output a HI: (1) the three displays must be the same (IC12-d's output HI); (2) the WIN oscillator must be providing a HI and (3) S1 must be open and the last display stopped.

When these three conditions exist, the output of AND gate IC8-c is HI and the input to inverter IC11-b is HI. The output of IC11-b goes LO and the cathodes of all four LED's see a path to ground and light. As the WIN oscillator output goes LO, AND gate IC8-c output goes LO, the output of IC11-b goes HI and the LED's go off. This sequence continues at a rate of about 4 times per second (WIN oscillator frequency) until either S1 is pressed again, or power is turned off.

PARTS LIST

All capacitors 10 volts or higher rating; all resistors ¼ watt carbon 10%

R1—R21 220 ohms
R22—R31 1000 ohms
R32—R36 560 ohms
C1,C5,C8 10µF electrolytic
C2,C3,C6 1µF electrolytic
C4,C11 100µF electrolytic
C7 500µF electrolytic
C9,C10 1000µF electrolytic
D1,D2,D3 1N4001 or equiv. (1A, 50 PIV)
LED1—LED4 Jumbo red LED
DIS1—DIS3 Fairchild FND 510 .5 inch common-anode 7-segment display
IC1,IC11,IC13 7404 hex inverter
IC2,IC3,IC4,IC9 7400 quad 2-input NAND gates
IC5,IC6,IC7 7473 dual J-K flip-flop
IC8,IC10 7411 triple 3-input AND gate
IC12 74132 quad 2-input NAND Schmitt trigger
S1 SPST normally-open pushbutton switch
S2 SPST slide switch

A complete kit of all parts above, plus a double-sided drilled printed-circuit board with plated-through holes, is available for $29.95. The PC board alone is $10.95. Add $1 for shipping (USA) and handling. California residents add 6% sales tax. Order from:
PPG Electronics Co., Inc. Dept. RE
14725 Oxnard St.,
Van Nuys, CA 91401

Construction

The Parts List shows that this design uses a lot of parts, including 13 integrated circuits. While you could certainly wire this on a perforated board, it is far easier and less troublesome to use a printed circuit board. Figures 4 and 5 show the top and bottom of a two-sided PC board design. If you make this board yourself, be certain that the top and bottom traces are aligned very closely. Since you probably won't have the equipment to plate through the holes after you drill them, be sure to solder each component on both the top and bottom of the board wherever traces would feed through. This might mean using Molex pins instead of sockets for the IC's since the pins can be soldered to both the top and bottom of the board, while regular IC sockets can only be soldered to the bottom of the board.

The actual construction is very simple if you use the PC layout shown, with only a few precautions. Insert all parts into the top of the board in the positions shown in Fig. 6. Use sockets for all IC's—just in case you insert the IC's backwards (see Fig. 7 for orientation), or if an IC ever needs to be replaced for any reason. Be sure all capacitors are inserted into the board with the proper polarity; the same is true for the diodes and LED's. For the diode, the banded end is your guide; for the LED, look for a flat spot or notch at the base. Be particularly careful to note that the top edge of the displays have 4 notches along that side. Be very careful to put the right valued resistor in each location.

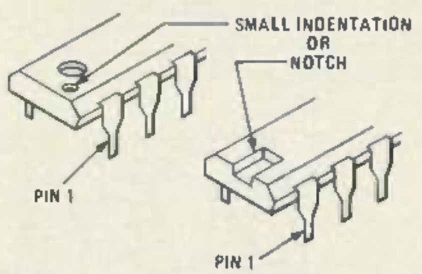


FIG. 7—HOW PIN 1 IS IDENTIFIED on an IC housed in a DIP package.

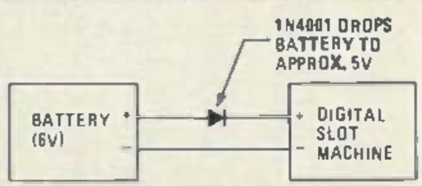


FIG. 8—DROPPING DIODE protects against reversed polarity.

Testing

Use either 4 "D" cells, a 6-volt lantern battery or a 5-volt regulated supply for power. DO NOT reverse polarity or you'll probably zap the IC's! It would be wise, actually, to add a diode (1N4001 or equivalent) in series with the power supply lead (see Fig. 8), especially if you're using batteries. With the diode, the 6 volts from the lantern battery is dropped closer to the ideal 5 volts for TTL circuitry. (If the display is dim or erratic, jumper or remove the diode you added.)

Turn on S2. The displays should all light. If all three are the same, the four LED's should flash. Troubles can usually be traced to (1) poor soldering (2) parts in backwards, for those requiring proper orientation, (3) component values in wrong locations. Actually, the *least* likely problem is defective parts, so check (1) to (3) above before blaming the parts.

Press S1 and watch the action!

Modifications and packaging

The entire unit could be packaged in a large box, but my model is sandwiched between sheets of clear Plexiglas with screws and spacers, with the switches and power jack mounted on the upper panel.

You might want to increase the stopping time of the displays, to add to the suspense. This is most easily done by adding capacitance to each display's slowdown circuit–C4, C7 or C9/C10.

While the Digital Slot Machine won't allow you to go home with a pocket full of silver dollars, at least you'll still have the shirt on your back! R-E

Identify Unmarked IC's

How to identify those surplus and salvageable IC's and reduce the cost of your next digital construction project.

KIRTLAND H. OLSON, P.E. & ANN L. ZEVNIK*

SOME TIME OR OTHER, EVERY ELECTRONics buff gets hooked on at least one super deal for unmarked components. Though I generally shy away from such "bargains" as too time-consuming, I fell into this one by making an all-too-common mistake.

It began when a neighbor introduced me to a new surplus outlet operated by a local manufacturer. On my first visit, I looked at many circuit boards, filled with IC's, and marveled at the low prices. Memorizing a few numbers and codes, I resolved to see if any data sheets in my files would reveal information on those boards.

Success! Some numbers seemed familiar — 911, 914, 912 seemed to belong to a resistor-transistor logic family (RTL) introduced some years ago by Fairchild. Symbols that I remembered from the packages told me that Fairchild, Motorola, and Transitron had manufactured those circuits. Although I had no specific data sheets, my collection revealed that RTL had been made in dual-inline packages (DIP's) like those I'd seen.

I resolved to buy some boards on my next visit, and parted with a few dollars for several. Hedging my bet, I chose those containing discrete components as well as integrated circuits. That way, if the IC's were valueless, I could at least salvage a reasonable number of resistors and capacitors. Tucking my prize behind the seat, I drove home, elated.

*Kirtland H. Olson, P.E., provides technical and management assistance to business and government. Ann L. Zevnik writes, lectures and manages seminars for The Harvard Group.

After several days of poring over data sheets, and back issues of **Radio-Electronics**, my collection of diagrams, pin-connections, and type numbers filled several sheets of notes; but discrepancies began to arise. Some numbers had four digits that didn't appear in any logic family; other numbers suggested linear circuits.

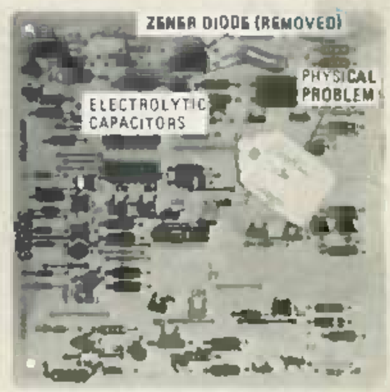
Such was my introduction to *date codes*: The numbers that guided my purchase turned out to be manufacturing dates. Crushed, I put the boards aside for several months. From time to time I contemplated attempts at identification.

Now almost a year after my original purchase, I wanted some IC gates and decided to try to identify some of those unmarked units experimentally. Although I ultimately succeeded, frustrating failures dogged my path. However, each failure taught me valuable lessons from which I derived a scheme for identifying unmarked digital IC's.

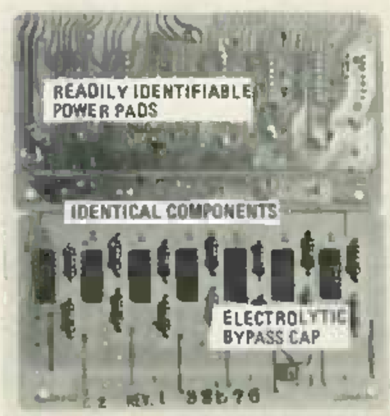
Hooking up the power supply

I started by trying to identify IC elements that would clearly indicate a logic family. Still believing that the DIP's contained RTL, I expected to use a 3.6-volt power supply; but I still needed to know which pins to try. Several pin-pairs commonly serve as power and ground — 7 and 14 often serve TTL DIP's — but RTL uses 4 and 11.

For most digital logic families, you can connect any pin to a positive supply or ground without damage. However, *some* power gates would not survive that, if you



BEST BUY BOARD. This single-sided board contains both IC's and discrete components. Electrolytic capacitors indicate voltage limits and polarity. The Zener diode also tells us the voltage and polarity.



ANOTHER GOOD BOARD CHOICE. Electrolytic bypass capacitor tells us polarity and maximum power line voltage.

happened to connect a collector directly to the supply while the transistor was turned on; and RTL NOR gates might also be damaged. I put 500- to 1000-ohm protective resistors in series with test probes to each side of the supply. Of course, I couldn't put such resistors in series with the power supply, but I was using a diode string (see Fig 1) that could deliver only 50 mA anyway.

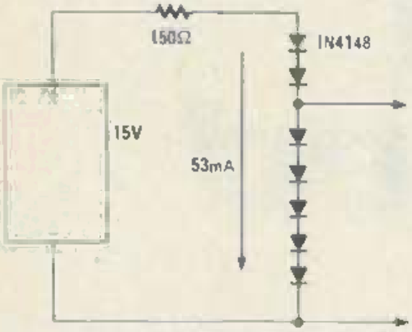


FIG. 1—DIODE STRING in series with resistor acts as a voltage divider. Each diode develops a fixed voltage drop across its junction.

Using printed circuit traces as clues, I saw that pin 4 of all packages connected to a common point. What I took to be pin 11 also returned to a common bus. As leads didn't always go directly, I patiently traced back to the common point on the board. Using RTL specs as a guide, I applied about 4 volts to one DIP after removing it from the board.

Missed again! First, the voltage across the IC was only millivolts and I suspected that the supply was backward. Reversing the leads raised the voltages to more reasonable levels. Past experience told me that I should find gate outputs at definite logic levels, and that inputs would not be so precise.

I began to measure voltages at each pin. The strange results puzzled me; few pins showed anything sensible. I shut down the supply and turned to my notes to check my work.

Idly picking up a board, I checked the pinout again. As I counted the pins, I realized that it was pin 10, not 11, that was common to many IC's. On turning the board over, I spotted an electrolytic bypass cap, clearly marked with + and —. Now I knew the power pins *and* the correct polarity.

Identifying the gates

Quickly soldering the power leads to the proper pins, I began to repeat my measurements. As the numbers filled my chart, the gate structure began to reveal itself. On those IC's, some strange voltages appeared. I recorded them without understanding, hoping to find an explanation later. Clearly, however, those voltages didn't look like RTL. Many terminals were near 1.5 volts, suggesting internal pull-up resistors for a current-sinking form of logic.

With the chart filled in, I checked the components near the place I'd removed the IC from the circuit board. Small capacitors connected the terminals with oddball voltages to others. A cursory check revealed that the circuit boards contained many such caps, connected between pins on the various DIP's.

Two pins showed values essentially equal to the supply voltage, and I took those to be outputs. Since gates are the most common functions, I also assumed that the DIP contained one or more gates of an unknown kind. Deducing that I would most likely find a NAND gate, I put the meter on the output terminal and began to ground each unidentified pin in turn.

I soon discovered four pins that made the assumed output pin go low, when any one was grounded. Moving the meter probe, I found that the pin with the strange voltage behaved logically opposite to the output — but varied between 0.4 and 0.8 volts, rather than between zero and supply. Moving on, I tried the other high voltage pin and found a similar gate structure.

At that point, I wondered how I would identify the proper supply voltage. Capacitor ratings of 15 and 35 volts certainly set an upper limit. Most logic families use five volts, but how could I be certain? Luckily, I found one card with a Zener diode on it, clearly connected to supply the IC's.

CERAMIC BYPASS CAPACITOR does not indicate polarity or voltage, but does identify power busses.

Measuring the Zener voltage, I verified that those IC's required 5 volts. Remembering my previous mistakes, I decided not to use my 5-volt 1-amp lab supply, but rather to use my + or —, 15-volt 200-mA supply with a dropping resistor to limit available current to 50 mA. I used the Zener removed from the board to provide 5 volts.

Rewiring my setup, I re-measured voltages at various IC pins and tested gate-functions thoroughly. Testing all 32,768 combinations of 16 pins would take 9 hours at 1 second per test, so I was glad to have developed some clues first. As a result, even trying to hold five probes at once, I could prove within a half hour that the IC contained two positive logic AND gates, each with four inputs.

Celebrating my victory over a cup of coffee, I reflected on how lucky I had been so far. But luck helps those who are ready: I had balanced my mistakes with

CHECKLIST FOR TESTING SURPLUS DIGITAL IC'S

1. **Use circuit clues** to identify power pins, polarity, and voltage, if possible.
2. **Sketch the circuit connections** to an IC before removing it from the board. Record pins that are grounded, tied to plus, tied together, or left open. That procedure reduces the number of combinations you need to try. Also record the presence of pin-to-pin resistors or capacitors: they often give valuable clues.
3. **Measure the supply voltage** *at the IC pins* immediately after firing up the test circuit.
4. **Use your voltmeter** and grounding probe to group gate inputs together. The open-circuit voltage at one input to a gate drops mV when you ground another input to the same gate.
5. **Test one IC at a time** until you can identify it.
6. **Use a power supply** that can only deliver a few mA when shorted.
7. **Use a socket mounted to a breadboard.** Molex pins on drilled breadboards, or the upside-down socket type, will accept soldered pins.
8. **If you don't know the voltage,** start at 3.6 to 4 volts. This way you won't kill RTL but will operate DTL/TTL.
9. **Make a simple clock pulser** so you know you get one clock pulse per actuation.
10. **Use 470 ohms to 1k ohms** in series, with probes to connect inputs to plus or ground.
11. **Once you identify one function,** test another mystery IC that has identical markings to see if it is the same function. Then test another with some (*not all*) markings different. Establish which marks relate to function.
    - *Outputs tend to take* either the highest or lowest voltages, second only to the power and ground connections.
    - *Clock inputs may appear* to be grounds when left floating.
    - *Normal gate inputs* for current sinking logic are 2 to 3 diode drops above ground — that is, 1.2 to 1.8 volts when floating.
    - *Voltages differing* from the standard logic levels usually indicate nodes, expanders, or special inputs for external components.

good moves. Choosing boards with discrete components gave me clues (like the Zener voltage) that would otherwise have been missing. Using a current-limited supply meant that my mistakes in connecting power were not fatal to the IC, and provided both information and a second chance to use it. Buying IC's on boards gave me circuit clues not available in "by the bagful" specials.

Getting the first IC off the board had been a chore. Lifted pads and bent leads gave mute evidence of trouble to come. Unfortunately, the pads lifted easily from those boards (some kind of paper epoxy, not glass). The manufacturer had bent the IC leads over on the circuit side of the PC board, making removal difficult.

Then I had an inspiration! Realizing that there was no real reason to save the useless board, I decided to cut the traces next to the pads and deliberately lift the pads individually with my soldering iron.

Using a small hobby grinder, I cut each trace as close to the pad as possible. (If you don't have a grinder, use a razor blade or sharp knife to cut the circuit.) Heating the pad until it lifted, I slid the pad off the bent IC pin. With longnose pliers, I straightened each lead and the DIP's fell off the board into my waiting hand.

Sorting the IC's

Near the date code, the IC's I bought bore cryptic markings consisting of four letters and one number. For example, the first IC I tried was labelled AAAL4. Finding another DIP marked AAAL4 with a different date code, I removed it from the board and proceeded to test the circuit, *assuming* it would be the same. Within minutes, my assumption was proven correct.

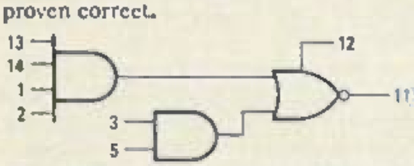


FIG. 2—DEVICE had 2-input and 4-input AND gates feeding a 2-input NOR gate.

Excited by success, I sought a new challenge. A DIP marked AAVL1 seemed less formidable than one marked AAFA1 — suppose that meant "full adder!" Removing the AAVL1 IC, I still marveled at how easily I could remove the circuit trace from the package, rather than trying to wrest the package from the board.

By now I knew that the circuit contained many valuable clues. Accordingly, I made notes to show where the small capacitors connected; which pins were grounded; which connected together, and which had no connection. This time I quickly verified that one of the pins connected to the capacitor was an output, and there were two of them.

Figure 2 shows the diagram as I derived it. Because pin 11 presents a NOR function, I needed more time to determine its operation. I found it easiest to define those functions for positive logic, since the gate inputs normally assume the high state. Thus, pin 11 of AAVL1 normally stays low if all inputs are open. Grounding 3 or 5, or both, raises 11 *only* if 13, 14, 1, or 2 is also grounded. Later, I learned a way to tell which pins were in the same gate input, but at this point, logic alone sufficed.

Since a V in the identifying numbering sequence occurred when I encountered a NOR function, I resolved to see if AAAL5 numbered device would be only AND gates. Again using circuit board clues, I made my sketch (see Fig 3). The outputs were high and did not respond rapidly to grounding single input pins. Clearly those were not simple AND gates.

Using the meter and the grounding probe, I discovered that some inputs affected others. If the DVM read 1.483

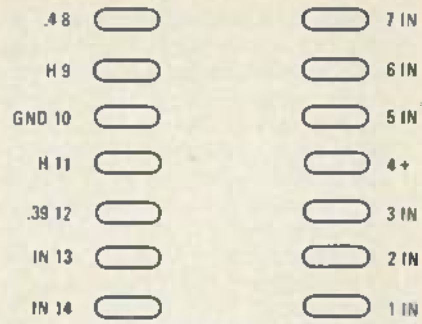


FIG. 3—DEVICE PIN-OUT with identified leads and their functions.

on one input, grounding any one of several other inputs reduced the reading to between 0.9 and 1.1 volts. I had found a way to deduce which inputs entered the same gate! External pin measurements reveal close internal connections. Knowing which inputs comprise the same gates provides the key to unscrambling complicated IC's.

REMOVING IC's FROM SURPLUS CIRCUIT BOARDS

Although many manufacturers offer devices to ease IC removal, most of those tools are designed to try and preserve the circuit board. If you recognize that the surplus board is worthless, except to carry home your IC's, there's an easier way to remove DIP's from cards.

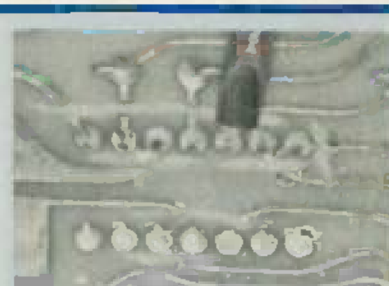
The trick is to do the job in steps:

1. Cut the circuit traces, so each pad can be removed separately.

2. Heat the pad with your soldering iron until you can slide it over the bent IC pin.

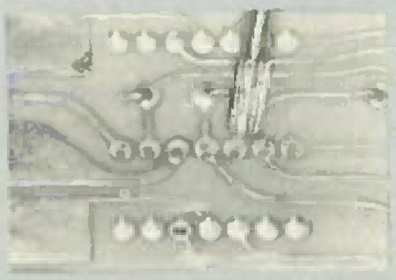
3. Straighten the IC pins, one by one, so the DIP drops off the board.

That procedure wrecks the board, but separates the de-soldering operation from mechanically removing the IC. DIP's come off easily, with straight, clean pins that will still fit a socket.

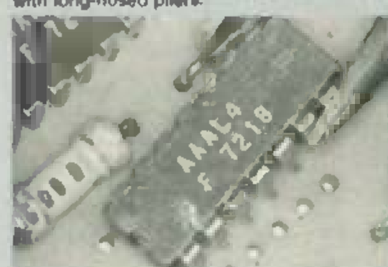


Heat pad with soldering iron, slide off in direction of bent pin.

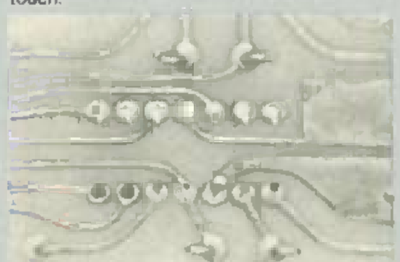
After removing all pads, straighten each pin with long-nosed pliers.



Hobby grinder cutting traces requires light touch.



Board is destroyed, but IC drops out with straight, usable pins.



IC before removal, traces and pads intact.

Hopelessly difficult to remove, this IC is entirely grounded.

Rapidly checking each pin against the others, I found four input pairs. Deducing that those pairs further combined inside the gate, I strapped them together and to ground in various combinations until a sensible pattern emerged. In a short while I derived the diagram shown in Fig. 4. That DIP contains two pairs of two-input AND gates followed by the OR INVERT sections. As I'll show you later, you can connect each of those to make an exclusive OR.

My assumption that "V" signified NOR was clearly down the drain. Testing several units of each type, I could verify that the alphanumeric code uniquely identified the device, but still could not deduce the meanings.

On to other IC's

Confident that I could attack more complex functions, I tried an AAFL1.

CHECKLIST FOR BUYING SURPLUS DIGITAL IC'S

1. **Avoid multilayer boards.** They make it hard to get the IC's off without special equipment. (You can tell multilayer boards by holding them up to a light. If you see circuit traces that aren't on either side of the board, it's a multilayer type.)
2. **Pick singlesided PC boards** whenever possible.
3. **Next choose double-sided boards.**
4. **Choose boards with physical defects** (bad solder or cracks) over those with burn marks or other obvious warnings. You are more likely to get good, new materials.
5. **Get boards with discrete components**—especially Zeners or filter caps—to give you clues to IC voltages and pinout. That way, if the IC's turn out badly, at least you'll salvage some components.
6. **Pick boards that have repetitive patterns** and many IC's of one kind. They will help you find clock lines, power pins, and essential control lines.
7. **Prefer boards with straight IC pins.**
8. **Pick boards that have the smallest pads** around IC pins, making it easier to lift them with a soldering iron. Big solid blocks of circuit are hard to lift.
9. **Avoid glass epoxy boards.** They hold their pads better, so you must work harder to get the IC's off.
10. **Remember that numbers like 911 or 7222** are likely to be date codes unless you see the complete manufacturer's number.

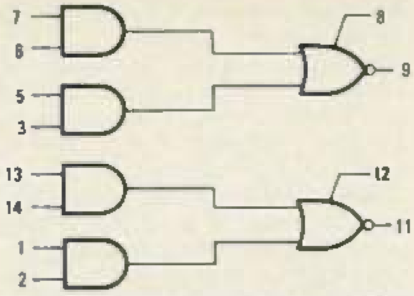


FIG. 4—THIS DEVICE was found to contain two pairs of 2-input AND gates. Each AND-gate pair fed into a 2-input NOR gate.

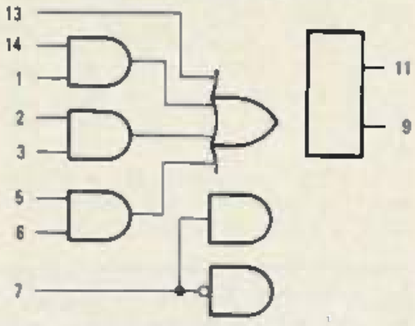


FIG. 5—LOGIC DIAGRAM of the IC before all lead connections and functions had been identified and labeled.

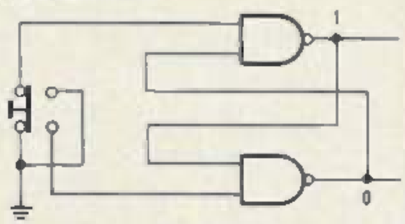


FIG. 6—TWO NAND GATES connected as a switch-operated clock that produces a single pulse each time switch is pressed.

Once again I found two outputs, and established the pairs of gates. As I measured one output, grounding inputs in turn, I got very confusing results. I could swear that the output state changed, but repeating the test showed no result.

After going through several such sequences, I began to measure both outputs after each test. Suddenly it was clear — feedback points always changed in synchronism. That revelation opened new possibilities to explore. Although more complex functions could give the observed changes, I deduced that AAFL1 contained flip-flops.

Checking that assumption, I found that pin 7 on AAFL1 seemed to be connected to ground internally; it always remained within a few milivolts of ground. I decided to seek circuit board clues. Finding a board containing only AAFL1 devices, I discovered that all pins 7 were bussed to conductors that left the board. Furthermore, by examining the other connections around AAFL1 devices, I surmised that of the inputs, only pins 13 and 1 could not be simply tied to ground.

Let's review the situation, because flip-flops are a little harder than simple gates. Figure 5 shows what I knew before using circuit board clues. Bussing of pin 7 indicates some common purpose, and its normally low voltage (when unconnected) sets it apart from common gate inputs. Of the remaining terminals, 9 and 11 are outputs; 8 and 12 are the corresponding feedback points for capacitors; 4 is the positive supply, and 10 is ground. Circuit board traces always take 13 and 1 to the connector; 14 is sometimes used and sometimes open, and 2, 3, 5, and 6 connect to ground.

Piecing all that together, I opted to strap 2, 3, 5, and 6 to ground, leave 14 open, work with 13 and 1, and assume that 7 was the clock. At first, I tried clocking the flip-flop with a probe, connecting alternately to +5 and ground. That set-up turned out to be unreliable, as the imperfect contact generates an unknown number of pulses. Figure 6 shows a simple, switch-operated clock that produces a single clock pulse each time we operate the snap-action switch.

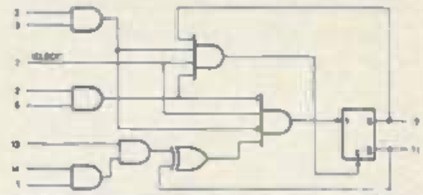


FIG. 7—EXCLUSIVE-OR made from two AND gates and NOR gate in half of AAALS.

Using a similar clock generator, I could cycle the clock line for varying combinations of logical inputs to pins 13 and 1.

Tables of inputs & outputs

By reducing the number of terminals to be tested, I generated simple tables relating the logical inputs and outputs before clocking to the logic outputs after a clock cycle. Having then a guide to operation, I could alter the state of pins 2, 3, 5, and 6 in various combinations and derive a logic representation of the flip-flop.

Using the functional diagrams I developed, I built a seven-stage feedback shift register that generates 125 of all 127 possible sequences of 7 bits. In essence it makes digital noise. I used an AAAL5 as an exclusive OR (Fig. 7) to feed back signals from the last two stages of the shift register to the first.

As you can see from Fig. 7, the AND gates form the functions A.B' and B.A' before being OR'ed and inverted. Thus they provide an output only if *one* flip-flop is high and *not* when both are high. That generates the exclusive OR function.

Now, I realize that your unmarked or house-numbered IC's will be coded differently from the ones I bought. But with simple equipment and careful measurements, you can identify digital IC's precisely enough to use them for many projects. Buying carefully will help you to gain many hints for the solution of your particular puzzle.

Use the three checklists on buying and testing surplus digital IC's to help yourself to bargain components. R-E

CONFERENCE CALL Telephone Accessory

Have you ever wished that you could converse via telephone with two separate parties at the same time? If so, it is possible that you can do it using this inexpensive and easy-to-build telephone adapter.

JULES H. GILDER

WOULD YOU LIKE TO BE ABLE TO TALK TO your Aunt Bessie in Florida and your sister Eileen in New York at the same time? You could ask the telephone operator who (for a special fee) could probably arrange such a round-robin conversation, commonly referred to as a conference call. Or, if you may be lucky enough to live in an area where the telephone company offers its subscribers a special conference-call service for an additional monthly fee.

If neither of these solutions appears practical, then just rummage through your junk box for a handful of parts, or buy everything you need from your nearest electronic parts dealer to make a conference-calling device for less than $5. All you need is two 1-μF nonpolar capacitors and a double-pole-single-throw (DPST) switch. If you want your project to look nice and make it simple to hook up, you can also buy a 3 × 2 × 1-inch plastic box and a telephone jack and plug.

One more important thing: To use this device, you must have two separate phone lines (i.e., two different phone numbers). Also, since this project is directly connected to the phone line, you should check with your local telephone company to see if it has any objection to your using this device.

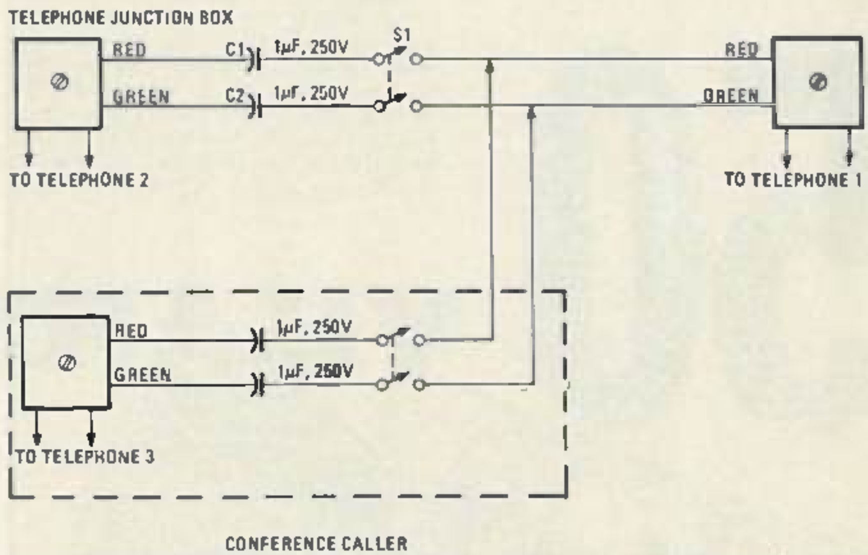
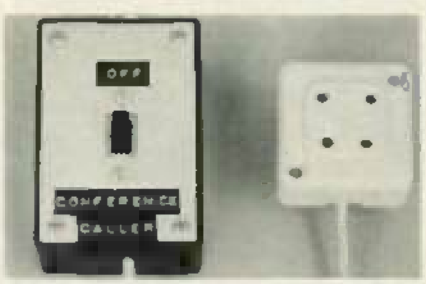


FIG. 1—WITH TWO SEPARATE TELEPHONE LINES brought to your desk or other convenient point, you can use this simple circuit to initiate conference calls.

About the circuit

Talk about simple circuits . . . there aren't many simpler than this one. All the circuit consists of is two capacitors and a switch; even a novice electronics hobbyist should have no problem assembling this handy telephone accessory.



THE CONFERENCE CALLER accessory and the jack-in-a-plug that makes it easy to connect to and disconnect from the phone lines.

PARTS LIST

C1—1-μF 100 VDC, nonpolar capacitor
C2—1-μF 100 VDC, nonpolar capacitor
SW—DPST switch

Basically, the circuit couples two telephone lines together without interfering with the operation of either line. It does this by letting the audio signals pass from one line to the other and preventing the DC control signal of the telephone network from passing through.

One way to accomplish this is to use a specially wound isolation transformer that has windings of equal impedance. A simpler and less costly method is to simply place a 1-μF capacitor in series with the connections between the two telephones as shown in Fig. 1. The switch merely makes it possible for you to decide when to connect the second line in and when to cut it off.

continued on page 71

50 YEARS OF

By HUGO GERNSBACK

A half-century ago, the first radio for the public's use and enjoyment was marketed. Differing vastly from today's radios in construction and function, it opened the field of radio for private interest and amusement rather than commercial communications use.

THE year 1955 marked the 50th anniversary of the first home radio sold to the public anywhere in the world.

It was not radio as we know it today because in 1905 there was no commercial broadcasting. But wireless had been going strong for several years and amateur radio too had just begun. Marconi and other pioneers were transmitting intelligence by the dot-and-dash method; indeed wireless in those days was rapidly forging ahead.

The public at large knew little or nothing about wireless before 1905, except what they read in the papers and in magazines. As for owning a wireless *home set*, it had not as yet been born.

Previous to 1905, in 1903-04, the writer had been working on a small portable transmitter and receiving outfit which he felt could be sold to the public. It took several years to perfect it and make it foolproof so it would work under practically all conditions. It had to be low in cost so everyone could buy the outfit.

This ambition was realized some time in 1905. After making a number of models the writer began to market the first home or private radio set ever sold to the public.

As there were few wireless stations in the country, it became necessary to sell a transmitter, too, so amateurs could set up a transmitter and receiver at home. Then while one person was transmitting signals, the other could receive them. Or the transmitter could be set up in one room and the receiver would ring a bell in the other room without any intervening wires whatsoever.

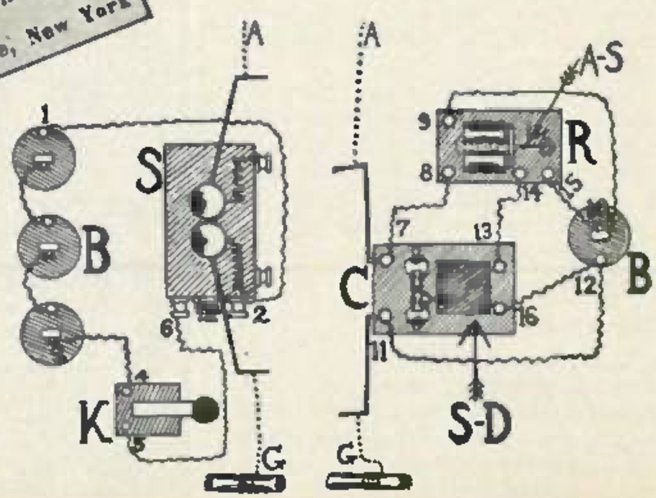
The outfit that accomplished all this was known as the TELIMCO Wireless Telegraph Outfit. TELIMCO is a contraction of the first letters of the writer's old pioneer firm, The Electro Importing Company (E. I. Co.), which became famous between 1904 and 1915 as the first radio mail-order house in the world. Only comparatively few sets were sold in 1905. But in 1906 the little outfit went into quantity production and was sold through many large outlets, including such famous stores as Macy's, Gimbel's and F. A. O. Schwarz, the country's largest toy establishment.

Incidentally, it was first advertised in the magazine *Scientific American* in the issue of Jan. 13, 1906. *This was the first home radio set advertisement to appear in print anywhere.*

The writer well remembers the incredulous looks of many of the store owners when they were first approached to buy "wireless sets." It was necessary to make a demonstration in each case before anyone would stock them.

The complete set, both receiver and transmitter, at first was marketed for \$7.50. This was raised later on to \$10, at which price most of them were sold.

The photograph shows an exact replica of the original outfit, built by the writer, to commemorate the 50th anniversary of the first home radio set. The transmitter, with the three dry cells and key, was composed of a 1-inch spark coil. The "1-inch" here means that the coil threw a 1-inch spark through free air, between wire points.



Above—Advertisement for the first radio set offered the public. It appeared in *Scientific American*, Jan. 13, 1906. Right—Picture diagram of layout, drawn by Hugo Gernsback in the 1900's: A, G, antenna, ground; S, spark coil; B, batteries; K, key; AS, relay adjusting spring; SD, coherer—Connections: 9, 8, to relay electromagnets; 7, 11, coherer; 13, 16, decoherer; 14, 15, relay contacts.

Mounted on the spark coil, on two metal standards, were two brass oscillator balls between which a small blue spark jumped the ⅛-inch gap. The spark coil had a fast vibrator so that every time you depressed the key a spark would jump between the two balls. Depressing the key for a short period would give a dot, a longer period would give a dash.

The receiver was a 75-ohm "pony" relay which had to be so sensitive that if you blew your breath slightly against the armature its contacts would close. There was also a single dry cell and the all-important *coherer*. It was simply constructed of two large, double binding posts through the bottom holes of which passed two silver-plated brass rods. A glass tube, placed between the two binding posts, was slipped over the two brass rods. These silver-plated ⅛-inch metal rods fitted the glass so that there was extremely little or no play. The two rods were separated about 3/16 inch, forming a gap. This gap was filled with the "soul of the set"—the coherer filings, composed of 90% coarse iron and 10% coarse silver filings. By shaking the mixture well it was ready to be used. The filings had always to be loose, *never packed tight*.

The decoherer—an ordinary house bell—was mounted so that the clapper of the bell would strike against the glass tube of the coherer at the exact spot where the filings were. If the diagram is studied, it will be seen that every time the relay closes its contacts, the bell will ring through the single cell.

Now, if you depress the key at the transmitter, the two aerials (aerial and counterpoise) will emit radio waves. Curiously enough, the waves which the writer used 50 years ago were of the very short variety (above 30 megacycles) to which modern radio has come back. The two aerial wires of the transmitter measured less than 1⅓ feet.

Inasmuch as the coherer is directly in the receiver aerial circuit, the filings offer a very high resistance. But under the onslaught of the radio waves they instantly become an excellent conductor —as if they now were a solid conductor. The relay, in the same circuit, now goes into action, attracting the armature which closes its contacts. This sets off the decoherer bell which rings and shakes up the coherer filings. These now fly apart—*they decohere*—and the coherer becomes nonoperative until the next wavetrain comes along.

Thus every time you press the transmitter key, the bell at the receiver rings. It rings as long as you hold the key down. A long ring is a dash, a short one a dot.

You can pick up the receiver and walk to the next room, yet the bell sounds without any visible connection. Even through thick walls, signals still come in.

One of the things that bedeviled us in the early days was sparking at the relay contacts. This would set up electromagnetic waves and often the outfit gave no clear signals; sometimes the bell would ring for seconds *after* the signal. This was overcome by putting a 5-μf capacitor across the relay points.

The range of the TELIMCO Wireless Telegraph Outfit was between 300 to 500 feet when used without ground connections. By using an elevated aerial 50 to 100 feet in length and by grounding one side of both transmitter and receiver to a water or gas pipe, the range was easily increased to one mile. Indeed, hundreds of people who bought the outfit at the time reported excellent reception even over greater distances, but these, of course, were exceptions. Note that this set used *no tuning whatsoever*.

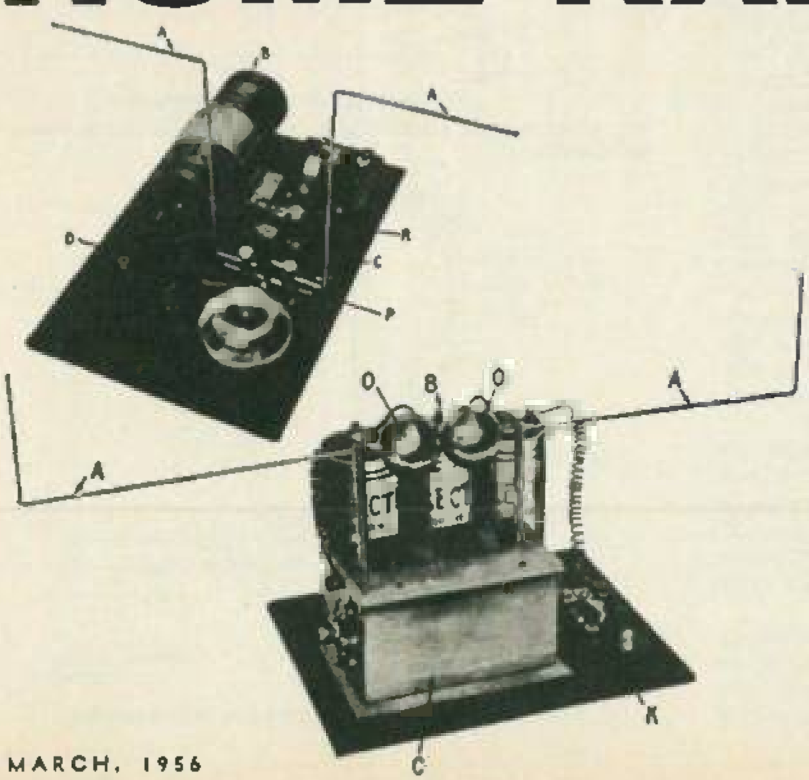
A curious thing about this little outfit today is its strange effect on radio people who never heard of the ancient spark coil and coherer sets. Young radiomen, who have never seen one of these outfits, are usually very much perturbed and astonished when the writer demonstrates it. The reason of course is that people have difficulty realizing that with a little three-dry-cell transmitter it is possible to ring a bell through intervening walls while the novice holding the receiver.

Radiomen today think of devices which operate relays as being relatively large and find it hard to believe that such a small portable transmitter and receiver could do the work.

It is conceivable that some time in the future these same instrumentalities may still find a use in modern radio and electronics which may not be apparent today.

The TELIMCO outfit here described has recently been acquired by the Henry Ford Museum of Dearborn, Mich. It was donated by the writer. It will be permanently exhibited in the radio section of the museum. END

HOME RADIO



Replicas of the original transmitter and receiver, soon being sent to the Ford Museum at Dearborn. Left—the receiver: A, antenna system; B, dry cell; C, coherer; D, decoherer; P, adjustable coherer rods; R, 75-ohm relay. Right—the transmitter: A, antenna and counterpoise; B, dry-cell power supply; C, 1-inch spark coil; O, spark-ball oscillators; K, transmitter key.

BUILD THIS

TRS-80 BREADBOARD

Part 3—Build this breadboarding device that serves as an interface between the TRS-80 microcomputer and circuits you are designing. Here are some experiments that show how the device can be used.

JON TITUS, CHRIS TITUS, and DAVID LARSEN

IN THE LAST TWO ISSUES WE COVERED THE DEVELOPMENT AND construction of this interfacing breadboard that lets you connect external devices to your TRS-80. Now, let's see how to use it.

Experiments you can do

A simple traffic light controller: In this experiment, you will construct a traffic light simulator so that various light patterns may be experimented with, under the control of programs in the *TRS-80* computer. The first step is to construct the "traffic light" using individual colored LED's, and the second step is to develop the necessary software that can be used to control the needed lamp patterns. Wire the output port shown in Fig. 16. Make the necessary connections between the two SN7475 latches and the data bus. Remember that each of the latch IC's requires a power and ground connection for proper operation. Individual LED's have been used to simulate the traffic light's lamps. You will find that colored LED's make the patterns easy to recognize. Individual 220-ohm current-limiting resistors have been used with each LED. The SN7475 latch outputs have been used to directly drive each LED. In this configuration, a logic zero at a latch output will turn the corresponding LED on, while a logic one will turn the LED off. The latch enable input may be obtained from the NOR gate circuit shown in Fig. 15.

If this circuit is not wired on your solderless breadboard, you may wish to wire it at this time. Remember to connect +5 volts and ground to the SN7402 NOR gate. In this configuration, the latches will only be activated to accept information from the *TRS-80* when an OUT 6,X instruction is executed. Of course, X must be defined in the program so that the computer knows what is to be output to the latches.

Once the LED's have been wired to the latch IC's, and the latch IC's have been interfaced to the *TRS-80* through the interface breadboard, you should try and test each of the LED's. First, to be sure that all of the LED's have been turned off,

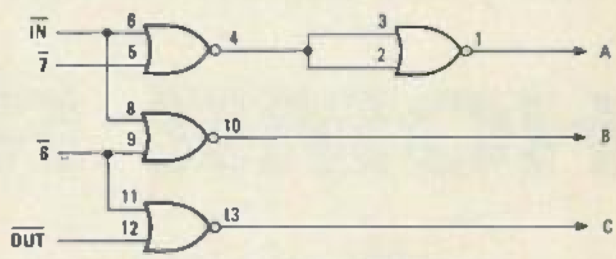


FIG. 15—SCHEMATIC DIAGRAM of the NOR gate circuit used for testing the breadboard.

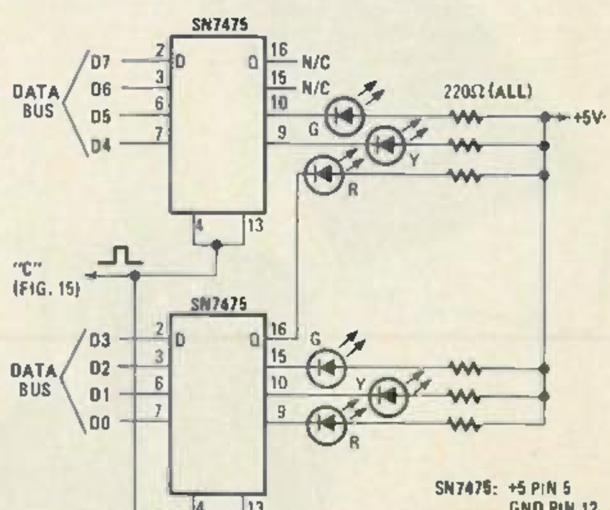


FIG. 16—A SIMPLE traffic-light simulator. See text for program.

execute an OUT 6,255 command. Now, with the following LED configuration:

Bit	LED	
D0	Red	
D1	Yellow	ELM Street
D2	Green	
D3	Red	
D4	Yellow	MAIN Street
D5	Green	

determine what patterns of logic ones and logic zeros are needed to control each of the individual LED's.

Since the latches can drive the LED's directly, the following bit patterns were assigned to each of the LED positions:

ELM	Red	254_{10}	11111110_2
ELM	Yellow	253	11111101
ELM	Green	251	11111011
MAIN	Red	247_{10}	11110111_2
MAIN	Yellow	239	1101111
MAIN	Green	223	11011111

Once you have compared these individual patterns with the ones you have determined, test them using your computer and your interface. You should be able to use statements such as OUT 6,251 to test each LED.

When all of the LED's have been tested, write a short program that will flash the yellow lamp on Main Street, while flashing the red lamp on Elm Street. Both of the lamps may flash at the same time, or they may alternate. Use a 2-second flash period; that is, 2 seconds on, 2 seconds off, and so on. The following program may be used to flash the lights at the same time:

```
10 OUT 6,255
20 FOR T=0 TO 300:NEXT T
30 OUT 6,238
40 FOR T=0 TO 300:NEXT T
50 GOTO 10
```

Two time-delay statements have been used, one at line 20, and the other at line 40, to create one second delays in the program. Since two of the LED's are to be turned on and off at the same time, the bit pattern is 11101110, or 238. We will leave it up to you to write the program that could alternate the flashing LED's, rather than flashing them at the same time.

To actually simulate a traffic light, you must first figure out what lamp patterns are required at an intersection. We suggest that you try and do this before you go on. You can then compare your answers with ours. Actually, only four different patterns are required, which may seem to be fewer than you expected. These patterns are noted below:

1. Red on Elm, Green on Main 222
2. Red on Elm, Yellow on Main 238
3. Green on Elm, Red on Main 243
4. Yellow on Elm, Red on Main 245

The decimal equivalent for each pattern has also been determined.

Now, the program to control the traffic light must be developed. You should assume a 2-second yellow period, with a 6-second green period for Elm Street, and a 10-second green period on Main Street. Once the lamp patterns have been determined, the program is rather simple. The following program may be used:

```
10 M=10:E=6
20 DATA 222, 238, 243, 245
30 READ L
40 OUT 6,L
50 FOR I=0 TO M
60 FOR T=0 TO 300:NEXT T
70 NEXT I
80 READ L
90 OUT 6,L
100 GOSUB 1000
110 READ L
120 OUT 6,L
130 FOR I=0 TO E
140 FOR T=0 TO 300:NEXT T
150 NEXT I
160 READ L
170 OUT 6,L
180 GOSUB 1000
190 RESTORE
200 GOTO 30

1000 FOR I=0 TO 2
1010 FOR T=0 TO 300:NEXT T
1020 NEXT I
1030 RETURN
```

While this program worked quite well, there are a number of simplifications that can be made to make the program more compact and more efficient. Can you suggest some changes that could be made?

In the second traffic light controller program, an array has been set up for the traffic light lamp patterns, and also for the periods for which they are to be activated. Now, a generalized control program can be used, rather than the long sequencing program used previously. Some statements have also been added so that you may enter the periods needed for Elm and Main green times (in seconds).

```
10 A(1)=222:A(2)=238:A(3)=243:A(4)=245
20 M(1)=0:M(2)=2:M(3)=0:M(4)=2
30 INPUT "MAIN";M(1)
40 INPUT "ELM";M(3)
50 FOR Q=1 TO 4
60 OUT 6,A(Q)
70 FOR I=0 TO M(Q)
80 FOR T=0 TO 300:NEXT T
90 NEXT I
100 NEXT Q
110 GOTO 50
```

So far, the computer has been used merely as a sequencer, since it has only performed simple sequencing functions, with fixed times between each lamp pattern. There are probably many situations in which this type of sequencing might be useful. Just think of the many tasks that you perform time after time, with little or no variation. Let's now consider expanding the traffic light program so that it will respond to changing traffic patterns. We will assume that two sensors on Elm street (one for cars going in either direction), and two sensors on Main Street have been OR'ed together so that cars are readily detected by the computer. Assume that the E and M keys on the computer are used for the car sensing functions.

Develop a program that will normally have the traffic light in the Elm Street—Red and Main Street—Green situation. After thirty seconds of "green on Main Street" have elapsed, the computer will start to sense cars on Elm Street. If cars are sensed after this initial 30-second period, then Elm Street will

KIT INFORMATION

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

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

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

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

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

Connecticut residents add state and local taxes as applicable.

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

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

be cycles through a 30-second (or less) green period. Since it will irritate drivers on Main Street when a single car actuates the Elm Street green period for 30 seconds, the program must also count the cars sensed on Main Street, when the Elm Street green period has started. When a certain number of cars, say five, are sensed on Main Street, then a new green period on Main Street will be started. Of course, each "switch" in the light patterns must go through the normal green-yellow-red sequence. Try and develop this program to control the traffic light. With some variations in timing, we used the program that follows. Shortened time periods were used to speed the testing of the program:

```
10 A=0
15 REM RED ON ELM, GREEN ON MAIN
20 OUT 6,222
30 FOR I=0 TO 10
40 FOR T=0 TO 300:NEXT T
50 NEXT I
60 A$=INKEY$
65 REM E KEY PRESSED AFTER 10 SECONDS
70 IF A$="E" THEN 80 ELSE 60
75 REM RED ON ELM, YELLOW ON MAIN
80 OUT 6,238
90 FOR I=0 TO 2
100 FOR T=0 TO 300:NEXT T
110 NEXT I
115 REM GREEN ON ELM, RED ON MAIN
120 OUT 6,243
130 FOR I=0 TO 10
140 FOR T=0 TO 150
150 B$=INKEY$
160 IF B$="M" THEN 190
170 NEXT T:NEXT I
180 GOTO 210
190 A=A+1
200 IF A=5 THEN 210 ELSE 170
205 REM YELLOW ON ELM, RED ON MAIN
210 OUT 6,245
220 FOR I=0 TO 2
230 FOR T=0 TO 300:NEXT T
240 NEXT I
250 GOTO 10
```

Controlling an analog voltage:

There are many situations in which a variable analog voltage is required. Controlling such a voltage by using the TRS-80 computer and some simple software provides a great deal of flexibility that can not be obtained in other ways. Probably the easiest way to have a small computer generate an analog voltage is through the use of a digital-to-analog converter (D/A). These devices are available in many configurations, but they can be briefly explained by stating that they can produce a voltage within a known range, say zero to +10 volts.

The actual voltage produced is proportional to the binary value provided to the converter by the computer. Thus, for an eight-bit D/A converter, a binary value of zero would cause the converter to output zero volts, while an input of 255 (11111111) would cause the converter to generate the full 10-volt output. A binary value between these limits would cause the converter to generate a proportional voltage, for example, 10000000, or 128, would generate a +5-volt output. For additional information on D/A converters and other interesting converter devices, we refer you to: *Microcomputer-Analog Converter Software & Hardware Interfacing*, Howard W. Sams and Co., Inc., 1978.

In this experiment, a Signetics NE5018 eight-bit D/A converter IC has been used. Other similar eight-bit converters may also be used, providing similar results, but the NE5018 has some nice features that make it easy to use in computer systems. These features include a built-in eight-bit output port latch, an on-chip reference and an on-chip buffer amplifier. The NE5018 is wired as shown in Fig. 17. An SN7402 NOR gate chip has also been used to generate the required Latch Enable ($\overline{LE}$) signal that will control the flow of eight bits of information to the latch, and thus to the D/A converter.

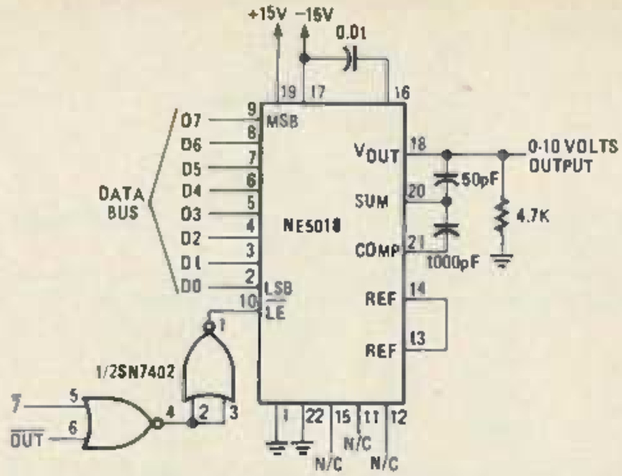


FIG. 17—A SIMPLE 9-BIT digital-to-analog interface.

Actually, the D/A converter does not generate a continuously varying voltage, since only 256 different voltages may be produced, one per eight-bit value. This means that in a converter with a zero to 10-volt range, the individual voltages will be approximately 39 millivolts from the one on either "side" of it. With the interface shown in Fig. 17 connected to your interface breadboard, try and write short programs that will 1) generate a positive-going voltage ramp over and over again, 2) do the same thing for a negative-going voltage ramp, and 3) generate a slowly increasing and then slowly decreasing voltage outputs to generate a triangular output. These programs are listed below:

1) Program for a Positive Ramp

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

2) Program for a Negative Ramp

```
10 FOR I=255 TO 0 STEP -1
20 OUT 6,I
30 NEXT I
40 GOTO 10
```

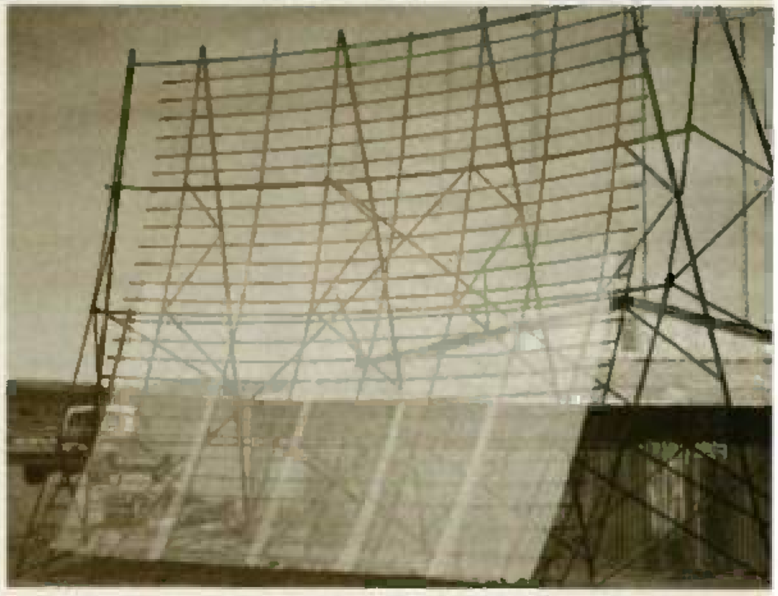
3) Program for a Triangular Voltage Output

```
10 FOR I=0 TO 255
20 OUT 6,I
30 NEXT I
40 FOR I=254 TO 1 STEP -1
50 OUT 6,I
60 NEXT I
70 GOTO 10
```

There are many applications in which D/A converters are useful, and in fact, some computer systems have a number of D/A converters interfaced to them. Some possible applications include the control of X–Y plotters so that graphic displays of information may be produced, the control of servo motors for positioning solar detectors/collectors, the sweeping of frequency generators to generate computer music, the control of filters to filter out various types of electrical noise, and even the generation of known voltages that may be compared against unknown voltages to determine their value.

There are many, many other digital devices that may be interfaced to your TRS-80 computer through the interface breadboard: UART's and USART's for serial communications, 20 mA RS-232C loops for teletypewriter and terminal control, advanced programmable controller chips, analog-to-digital converter chips for measurements, and even other microcomputers. In fact, we have interfaced our TRS-80 computer to an MMD-1 computer (Dyna-Micro, **Radio-Electronics**, May, June & July 1976), so that programs may be listed on a teletypewriter. **R-E**

Home Reception Using Backyard Satellite TV Receivers



SWAN SPHERICAL ANTENNA is effective in receiving satellite transmissions and can be built relatively inexpensively.

Part 4—In this installment of a series, we will go into more technical details on receiver characteristics and specifications and will show how some satellite receivers have been built at comparatively low cost.

ROBERT B. COOPER, JR.

IN PARTS ONE, TWO, AND THREE OF THIS multiple-part series (appearing in the August, September, and October 1979, issues of **Radio-Electronics**) we learned how the geo-stationary satellite system is designed, what it is intended to do and what a private individual, living someplace south of the 80th north parallel, north of Venezuela, and east-west between Bermuda and Hawaii can anticipate being able to receive with a private, backyard satellite television terminal. Satellite television is the next "generation" of television service in America and throughout wide areas of the world. Because of the mechanics of the service, it is virtually immune to interference and signal degradation, is not adversely affected by weather, and holds the potential to provide every home in North America with several hundred direct-access television channels!

Receiving system

Having determined that the basic system consists of an antenna, a low-noise amplifier (LNA) and a receiver-demodulator, let's look at what it is that goes into each of these three major component modules to make up the operating system.

The antenna system has been adequately covered in previous portions of this series. Basically, in order to achieve the kind of gain necessary (38 to 45 dBi) a parabolic reflector is the best antenna choice. This parabolic reflector has a single focal point where all of the energy intercepted by the reflective antenna surface is re-directed and focused. There are several acceptable members of the antenna family known as parabolics that can be pressed into this service; prime focus parabolics, Cassegrain parabolics and spherical parabolics are included. For as long as the (limited) supply holds out, surplus (as in no longer used in commercial or military service) parabolic (or "dish") antennas larger than 8 feet in diameter provide very economical "reflector surfaces" for most portions of North America. The exception to this is in New England where anything smaller than a twelve-foot reflector surface would be a mistake. Beyond that, one of the least expensive antenna surfaces for this service has been developed by a fellow in Arizona named Oliver Swan. Using aluminum window screening as a reflector surface, and stock square aluminum or steel tubing as reflector frame material, Swan has developed a spherical antenna system that can be constructed in virtually any size from 10 feet by 10 feet to 20 feet by 20 feet for as low as approximately $500 for the ten-foot by ten-foot version. It is inevitable that some commercial firm will soon begin marketing antenna "kits" in this area, perhaps copying the Swan developed spherical antenna and that from this will spring a whole new family of "backyard decorative pieces."

Because we are dealing with a low-power transmitter source (the typical satellite has a 5-watt peak power transmitter) and a fairly high loss between the "bird" and your receiving location (196 to 200 dB is typical at 4 GHz), not very much signal power arrives at your antenna. Fortunately, the signal received is very constant (variations of ± 0.7 dB over a full year are typical limits) and this allows us to design the system for peak performance and forget it rather than be concerned with wide-range AGC systems to cope with large signal fluctuations.

To make the most of the weak signal, we have to place a very high gain, and extremely low noise (figure) signal amplifier (or booster in TV terms) right at the antenna. Since the reflector surface on the parabolic is merely a focusing tool, the actual "pickup antenna" is really separate and distinct from the reflector. This receiving antenna, directed backwards away from the satellite and towards the focused energy coming from the reflector surface, is called a "focal point" or feed-point antenna.

The most efficient feed antenna is one that looks at the reflector surface in such a way that the "pattern" on the feed antenna is down 10 dB at the out-

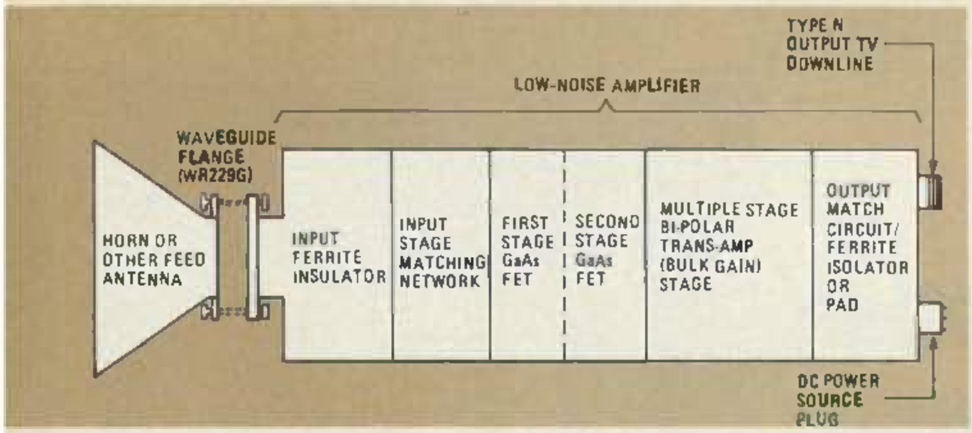


FIG. 1—MOST COMMERCIAL FEED-ANTENNA LOW NOISE AMPLIFIERS consist of a feed antenna (often a horn as shown for a prime-focus feed) which is equipped with a waveguide flange that bolts it directly to the input flange on the LNA (*Low Noise Amplifier*). The LNA has an input (ferrite) isolator both for frequency selectivity and as an impedance matching device for the first stage of the amplifier itself. The extremely low-noise amplifiers develop their superior operating characteristics because of extreme care taken in matching the first stage to the input source impedance and by carefully hand selecting the expensive GaAs-FET (Gallium Arsenide Field Effect) transistors. GaAs-FET devices are chosen for the first two stages. Once the noise figure is "established" by these two stages, less costly bipolar transistors are used in 3-4 additional stages for "bulk" gain. The output, to the low-loss downline coaxial cable, is through another ferrite isolator device or through a "loss pad" inserted to force an impedance match.

side edges of the reflector's surface area. A horn-feed antenna, properly designed, handles this function. Look closely at Fig. 1. Note that the horn-feed antenna is flanged or bolted directly to the low-noise amplifier itself; the energy from the horn feed-point antenna couples through the waveguide flange into the input circuit on the low-noise amplifier, a section that has a piece of ferrite (rod) in it as an isolator.

Low-noise amplifiers

This commercial style low-noise amplifier is the state-of-the-art high-dollar approach to the low-noise amplification aspect of the system. There are less expensive ways to go as we shall see in subsequent portions of this series. The purpose of the ferrite isolator is primarily to insure that the input circuit to the first active (transistor) amplifier stage sees a constant impedance or load. This is done to insure that the transistor used in the first stage, a GaAs-FET (for *G*allium *A*rsenide *F*ield-*E*ffect *T*ransistor), is noise-figure matched at the 4 GHz operating frequency. Most of the high-dollar GaAs-FET's available for this service have two separate peak operating points; maximum gain does not coincide with best (i.e. lowest) noise-figure performance. In this case, gain is backed off in the first couple of stages as a trade off for lowest noise figure since noise generated in the early preamplifier stages is impossible to eliminate later on in the system.

Most of the commercial LNA units employ a pair of ultra-low-noise GaAs-FET's in the first two stages, and then follow that up with between three and five less expensive (typically bipolar as opposed to GaAs-FET) amplifier stages. Once the noise figure for the LNA is established by the first couple of stages, less expensive (and higher noise figure) bipolar stages can make up the remainder of the LNA system gain required.

Noise figure is measured in both dB and by the Kelvin noise temperature scale. Most of the commercial data sheets will specify Kelvin temperature only and most commercial installations are using amplifiers with 120-degree Kelvin (or 1.5 dB noise figure) specs.

State-of-the-art has been catching on quickly in this field; in late 1976 the price for a 120-degree Kelvin LNA was in the $3,500 region. By late 1978 you could find the same amplifier for around $1,800. Today the price is down in the $1,000 region and many expect it to drop down close to $500 by this time next year. That still may be high for your pocketbook and there are other options.

As previously discussed in this series, you can get a raw signal input to the receiver by one of two techniques; use a big antenna and an LNA with not such hot specs, or, use a smaller antenna and a hot-spec LNA. If you set out to build your own antenna system, rather than buying commercially, you might be better off in this fast-changing technology time to invest in a little more steel and mesh and build a larger antenna going in, especially if you plan on having to purchase your LNA.

As recently as early in the past summer anyone who wanted to build his own LNA was pretty much stuck with working with 300-degree Kelvin type bipolar transistors. The belief was that any home constructor attempting to work with the touchy, and hard-to-make-work GaAs-FET amplifiers was probably asking for a quick way to lose a $100 bill: that being the going price for the GaAs-FET transistors these days from Hewlett-Packard (HFET 2201). However, during the recently completed Satellite Private Terminal Seminar this past August 14-16 in Oklahoma City, several home terminal builders demonstrated two- and three-stage GaAs-FET amplifiers they had constructed for between $225 and $350 that gave an excellent account of themselves against commercial amplifiers costing three to four times as much. This major achievement has changed the name of the private or backyard terminal game for the home constructor.

Well now: if a chap in Arizona can build a 10-foot by 10-foot spherical reflector and feed for $500 or less, and you can build your own GaAs-FET low-noise amplifier on the kitchen table for $350 or less, that starts to get the home-constructed terminal down to an affordable price does it not? What about the receiver?

Receivers

In 1976 the first satellite video receivers around came into the cable television field via the Intelsat or international satellite marketplace. They cost upwards of $10,000 and were literally hand wired and hand aligned.

By early 1978 the price for essentially the same receiver was down to about half that; perhaps $5,000. But there had been only minor changes in the original design. The price reductions were largely due to slightly more volume production, and of course competition.

Needless to say many people were working on bringing the cost down; way down. Most however were involved in the cable TV, broadcast TV and other commercial market areas where nobody really expected receiver prices to drop much below say $3,000 for many years to come. Outside of these broadcast related industries other engineers with a totally different set of markets in mind were quietly doing their own developmental work. Their goal was a *$3,000 complete terminal;* including the antenna and the LNA.

By mid-1979 some inter-receiver marrying had taken place. Commercial receivers are available in two formats; some tune only one channel and to change channels you have to either change crystals or go through some sequence of screwdriver adjustments, or both. Not exactly what the home viewer accustomed to detent tuning has in mind. The other commercial receiver format is called "frequency agile" and that means you push buttons or twirl a knob and the full set of 12 (or 24) satellite channels flips by in front of you. By mid-1979 some of the commercial receivers in the single channel format were down under $2500 list price while the tuneable versions were just a tad above $3,000.

Let's stop for a minute and study Fig. 2. To appreciate what is involved in a satellite television receiver, we ought to understand what it has to do.

In a commercial installation the LNA (which mounts at the antenna, usually married to the feed-horn or focal-point antenna) has to develop sufficient RF signal voltage gain, at 4 GHz, to (1) drive the microwave signal through the interconnecting coaxial cable and into the receiver, and, (2) provide sufficient signal gain to establish the noise figure of the LNA as the noise figure for the whole receiving system.

The typical satellite TV receiver has a relatively high noise figure; 10-12 dB is not uncommon. To attempt to use such a high "front-end" noise figure to receive the weak satellite signals would be a mistake. To lower the noise figure to a more usable level (such as under 2 dB) requires not only a low-noise LNA but sufficient gain in the LNA stages to override the noise contribution by the 10-12 dB noise figure of the receiver. As a rough rule of thumb you need between 2.5 and 3 times as much voltage gain (in dB) as the noise figure (also in dB) to establish the new, lower noise figure of the LNA as the noise figure of the system as a whole.

Back now to Fig. 2. To keep unwanted energy out of the receiver (and there is plenty of unwanted or off-frequency energy floating around microwaves these days) the typical commercial receiver has a pre-selector (either totally passive or active plus passive) at the input. This is followed by a "high frequency-mixer" that combines the incoming (3.7 to 4.2 GHz) signals with a local oscillator signal source generated within the receiver to produce a new lower frequency (IF) output. Gain is then applied at the high-frequency IF and then the signal goes through yet a second mixer that further down-converts the high IF to yet a lower IF. This lower IF is often 70 MHz although there are some variations to this rule in commercial receivers. When we finally reach the lower IF, we have gone through a pair of down conversions each employing a high-quality mixer and a high-quality local oscillator. If this is a frequency-agile (i.e. tuneable) receiver the first mixer is driven by a tuneable local oscillator source while the second mixer is driven by a fixed local oscillator source. Just for dollar reference, we are looking at using $75 to $100 mixers in these applications and the local oscillators are priced in about the same range. If this suggests that microwave components or modules are not cheap, you read the message correctly.

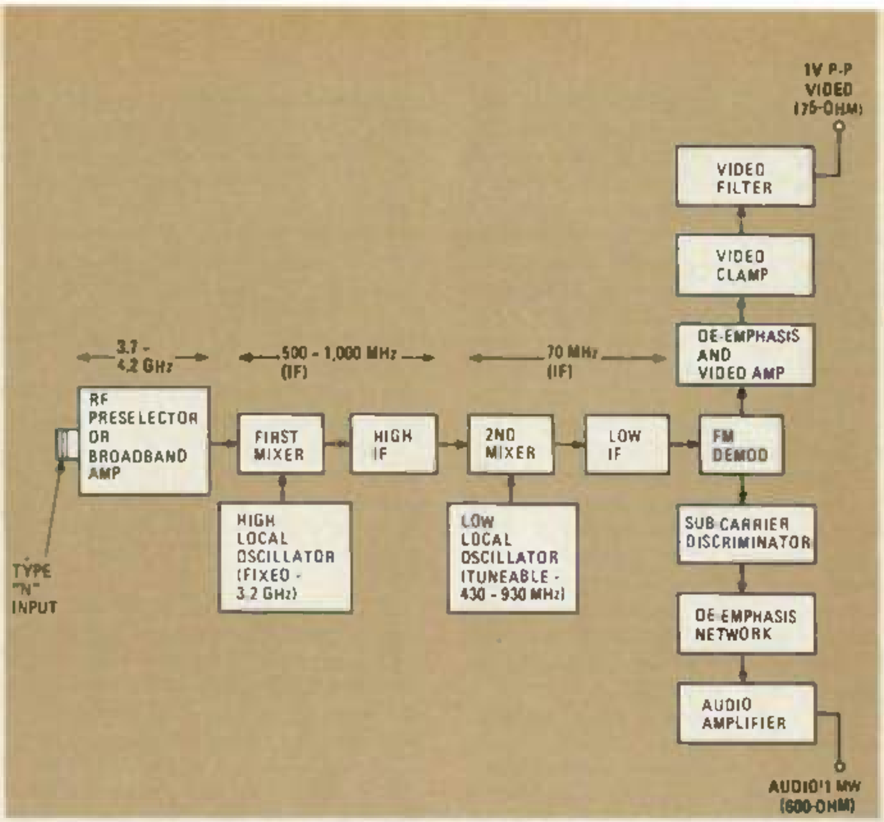


FIG. 2—MOST COMMERCIAL RECEIVERS use high-gain (50 dB) LNA's mounted at the antenna capable of driving 4-GHz region signals through several hundred feet of 7/8ths inch line to the indoor receiver. Typical receiver has either double conversion (approach shown here) or single conversion directly to IF. In receiver design shown, a 3.7- to 4.2-GHz preselector often has enough gain to bring the input RF level up to an adequate voltage to drive the first mixer. Relatively high-level high-frequency local oscillator (3.2 GHz is shown in example) may measure +10 dBm or more. With local oscillator on low side, high IF of 500-1,000 MHz is attained to drive second mixer that down converts to 70-MHz low IF. Oscillator for second local oscillator is voltage- or capacitive-tuned to produce 70-MHz low IF with inputs over full 500-1,000 MHz range. FM demodulator (discriminator) produces basic baseband signal that processes up for video to a de-emphasis circuit and video amp, then to a video clamp to eliminate the 30-Hz energy dispersal waveform, and then to a filter circuit. Audio processes down through separate (6.8 MHz) discriminator, de-emphasis network and audio amplifier.

HORN ANTENNA/LNA combination points directly towards the dish antenna. Coaxial cable is used to connect the LNA to the receiver.

Once at the low IF we are ready to go to work on the modulation itself. Gain at a relatively low IF such as 70 MHz is inexpensive these days and 40-50 dB of gain in this range is typical. When the twice-down-converted signal is built up to a sufficient voltage level, it is ready to be demodulated. Remember that the video is frequency modulated onto the carrier, and the audio coming along with the video is further frequency modulated as a sub-carrier. This says that we use discriminators to demodulate the video and the audio in our detection system.

By removing the video signal out of the IF signal with a detector, we end up with what is called baseband; that means pure video in this case. Only because the audio is carried along as a 6.2- or 6.8-MHz add-on or subcarrier, when we demodulate to baseband video we also have a aural subcarrier in the baseband output. By using a low-pass filter for the video and a high-pass filter for the aural subcarrier, we can then separate the video into one chain for further processing and the audio into another.

The video is preemphasized at the uplink transmitter site as a means of increasing the system performance and at the receiver we need to deemphasize to establish the original baseband video characteristics. The deemphasis network is strictly an L-C network and is not complicated. Next in line for the video is a video clamp circuit that may mystify you if you are accustomed to normal video techniques.

Video at the uplink site is "frequency-dithered" or dispersed at a 30-Hz rate as a means of reducing potential interference between strictly terrestrial 4 GHz video circuits (such as the telephone companies employ) and the satellite service. The easiest way to clean up the dispersal waveform is to shove the video through a clamping circuit. If you clamp something like this *hard* enough, the 30-Hz waveform simply goes away. Finally a bit of passive video filtering and you are in business with baseband video (typically 1 volt peak-to-peak).

Over on the audio side, after passing the 6.2 or 6.8 MHz aural subcarrier through a frequency filter that eliminates the video baseband information, the signal is fed into yet another discriminator (detector) that recovers the audio. From here it goes through yet another deemphasis network (this one for the audio) and finally an audio amplifer. Most commercial receivers release the audio across a 600-ohm balanced output line.

If you are engaged in the television receiver servicing industry, you may be asking yourself why this should cost between $2500 and $3500 a pop. If you are new to receivers in general, you probably have the opposite reaction.

As we shall see in the next part of this series of articles, several experimental or private terminal builders have asked themselves the same thing. One terminal builder, Taylor Howard of California, has managed to assemble the LNA (a bipolar unit in his case) *and* the receiver for around $1,000. He did this back in 1976-77 when parts were considerably more expensive and we estimate you can do it today for under $700.

Assuming you don't want (or need) to start off with a bag full of new parts, and can assemble some equipment from other services into a satellite TV receiver, just how simple can it really be? Well, a man in South Carolina by the name of Robert Coleman has put together a 10-foot dish, a two-stage GaAs-GET LNA and a complete receiver for around $500! His "secret," if you can call it that, is that he is a sharp attendee of Hamfests and other outlets where *surplus* electronic equipment is brought out for sale at often just a few pennies on the original dollar value. The Coleman approach is a good one, but it requires being able to trace down surplus parts, modules and components that may not be a good supply because of limited production runs many years (or decades) ago. Still, if this approach does interest you and you are not afraid to go into the surplus market to look for parts, there is help available for you in this specialized area.

Suppose you wanted to try a cross between building a complete terminal receiver from scratch and assembling one from surplus equipment? Well, that is an approach many people have followed, largely patterned after the work done by English satellite TV experimenter/pioneer Steve Birkill (amateur G8AKQ). The Birkill receiver is similar to that shown in Fig. 3. The LNA is a bipolar system of three to five stages using Hewlett-Packard HXTR (6102 and 6101) transistors. For those who want to investigate this particular approach, Hewlett-Packard Application Note No. 967 tells how to build a stage of this amplifier at 4 GHz (a multiple stage-device is simply several separate stages cascaded together).

The Birkill Receiver places the LNA stages at the feed antenna, follows that with a double-balanced mixer (also located at or near the feed) and the mixer is driven by both the input 4 GHz range signal(s) plus a "free-running" oscillator operating at around 3,200 MHz. There are several ways to derive the local oscillator injection signal; one of the easiest is to use a completely self-contained oscillator. One of the 8360-family of oscillators manufactured by Avantek, Inc., 3175 Bowers Ave., Santa Clara, CA 95051 will do the job nicely. This TO-8 packaged device has four pins on it: one for the positive operating voltage, another for a ground, a third for the RF output in the gigahertz region and a fourth for a tuning voltage that allows you to run the oscillator through a 500-MHz span. Most homebrew (from

LEARNING MORE ABOUT SATELLITE TV

Readers with an interest in pursuing further the details of the Home Satellite TV Reception system may be interested in the following reference materials available:

Satellite Study Package—includes a 72-page "Handbook" describing the complete home satellite TV receiving system, how the satellites operate, where to locate equipment and what services are available via satellite, written by Bob Cooper. Also includes 22-by-35 inch four-color two-sided wall chart depicting each of the geostationary TV satellites in operation and explaining the technical equations of the satellite TV system. Satellite Study Package is excellent "starter set" towards a full understanding of the system and getting your own system underway. Price is $15 via first class mail (U.S. and Canada in U.S. funds) or $20 elsewhere from Satellite Television Technology, P.O. Box 2476, Napa, CA 94558.

Home Satellite Construction Manuals—three separate manuals available describing construction details (parts lists, sources for parts, schematics where applicable) of two separate receiver systems, low-cost low noise amplifiers and the unique new *Swan Spherical* TVRO antenna. The *Coleman TD-2 Manual* describes conversion of surplus microwave equipment to TVRO terminal plus showing latest low-cost methods of amplifying and converting 4-GHz signals to 70-MHz IF; the original Coleman system cost under $500 to build. The *Howard Terminal Manual* describes a 24-channel frequency-agile (tuneable) receiver plus bipolar LNA using off-the-shelf new parts that can be duplicated for under $800. Taylor Howard, a professor at Stanford, has had this system operational since 1976. The *Swan Spherical TVRO Antenna Manual* describes construction of a unique multi-satellite reflector surface plus a unique feed-horn; inventor Oliver Swan shows how a 10- to 12 foot-size antenna can be assembled with common hardware for under $300. Price of each manual is $30 or all three for $80 from: Satellite Television Technology, P.O. Box G, Arcadia, OK 73007.

Satellite Private Terminal Seminar—this past August more than 500 satellite TV enthusiasts attended first-ever "international seminar" as more than a dozen instructors (including Taylor Howard, Robert Coleman, Oliver Swan, and Paul Shuch) taught in classroom sessions the latest in low-cost satellite TV circuit technology. SPTS '80 will be held in Miami, Florida on February 5, 6 and 7 with special emphasis on how to market and install private low-cost terminals throughout North, Central and South America. There will be exhibits, five-satellite systems demonstrations, and course study books. Registration is $150 per person; advance registration required. For full information write: SPTS '80/Miami, P.O. Box G, Arcadia, OK 73007 or call (405) 396-2574.

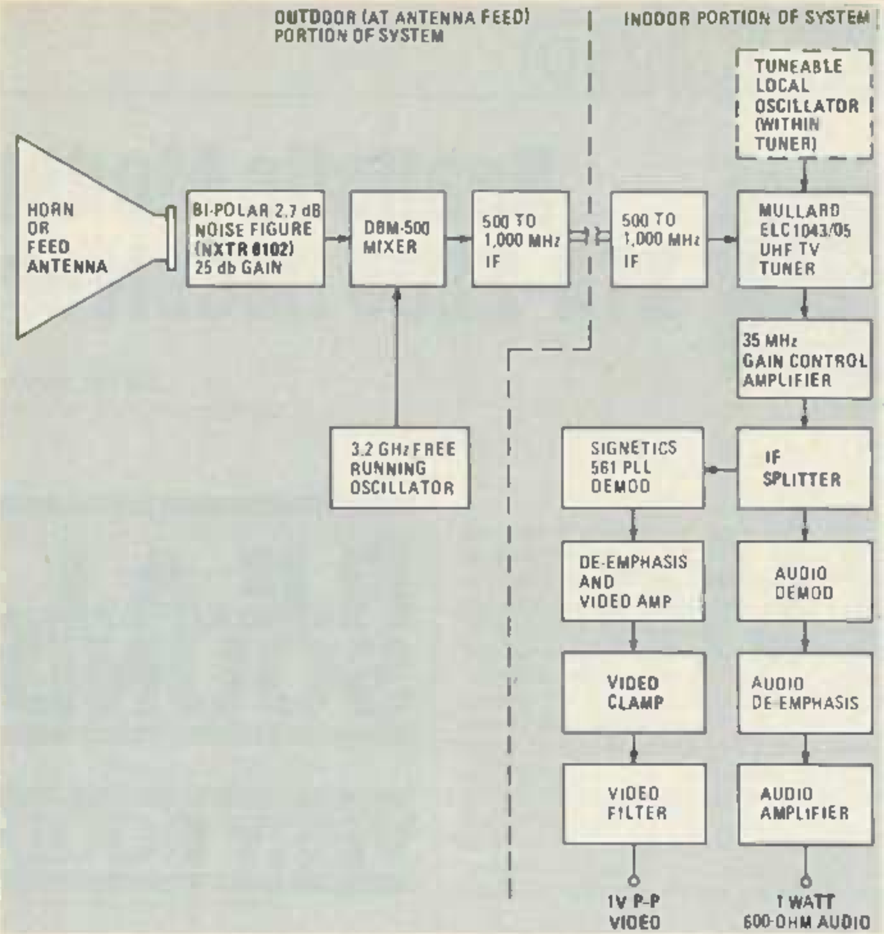


FIG. 3—MOST HOMEBREW TERMINALS place a lower grade LNA stage plus first mixer, local oscillator source and an IF stage or two at the feed antenna, coming down to the baseband demodulator through lower-cost 50-ohm cable at the high-IF (500-1,000 MHz) region. In this version, essentially patterned after English experimenter Steve Birkill, a Mullard ELC1043/05 (European) TV tuner is slightly modified as combination oscillator and mixer to translate high IF range down to 35-MHz region low IF. Birkill processes his 35-MHz IF to video through a Signetics 561 phase-locked-loop demodulator; a system that offers advantages for weak input level signals. Full block diagram is not shown at this time.

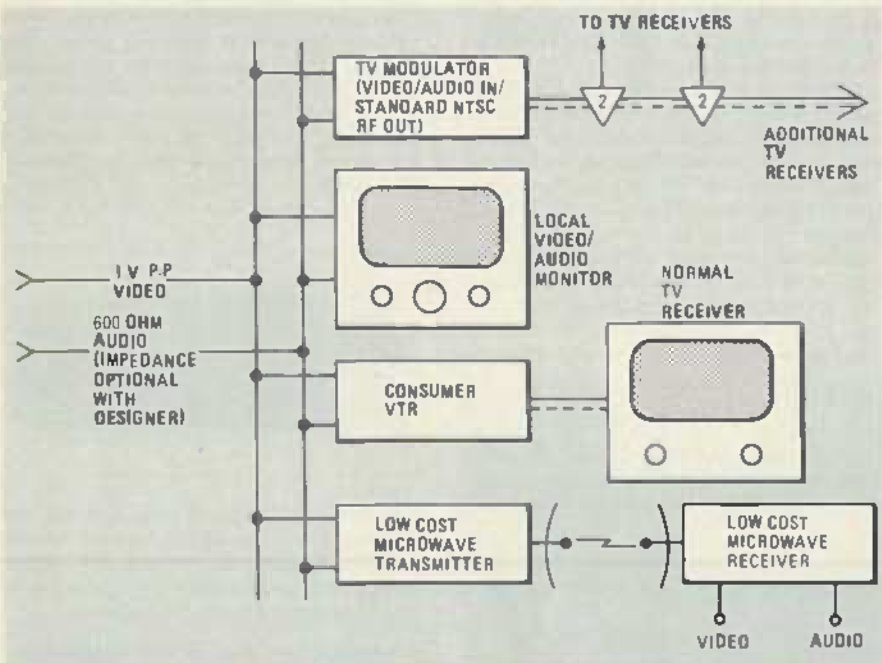


FIG. 4—VARIOUS METHODS OF DISPLAYING BASEBAND (i.e. demodulated) video and audio. Typical receiver produces 1VP-P video and some usable level of audio (often at 600-ohms balanced although that is design decision of builder). Baseband signals will directly drive TV channel RF modulator, a high-quality video monitor (with audio display system built-in or separate), a consumer VTR (for recording or as loop-thru to use RF modulator), or low-cost (private) microwave system.

scratch) satellite TV receiver builders are using this approach because it eliminates all work at microwave frequencies in deriving the high local oscillator signal.

The Birkill Receiver approach, modified slightly, is shown in Fig. 3. As you can see, the LNA, the high-frequency local oscillator and mixer, plus a bulk gain stage operating in the 500-to-1,000 MHz region is mounted outside at the antenna. This simply means that what you feed "downstairs" to the remainder of the receiver, through coaxial cable, is (relatively speaking) low-frequency signals; in the 500-to-1,000 MHz region in this case. If the run is 100 feet or less, you can get by at these frequencies with RG-8 type coaxial cables whereas a similar run at 4 GHz requires ⅞-inch air-dielectric cable and special fittings.

Once indoors, the Birkill Receiver approach treats the signals contained in the 500-to-1,000 MHz IF bandwidth as a "group" and tunes them separately with a slightly modified (English, Mullard) UHF television tuner. The TVRO signals are 36 MHz wide (and of course still FM) and we need to convert them again (in frequency) down to a low enough IF where they can be detected. Experimenter Steve Birkill has found that an English Mullard type ELC1043/05 UHF TV tuner makes a dandy tunable second conversion system with only minor modifications. Unlike U.S. (of Canadian or Japanese, etc) UHF tuners designed for the American NTSC signals, the English (Mullard) tuner is capable of passing the full 36 MHz wide TVRO signal with only very minor modification. All American tuners checked have a 3 dB passband of not more than 10 to 11 MHz which simply means that they are not wide enough (even if modified) to handle the extra modulation/carrier width of the TVRO signal. Another advantage of the (European) UHF tuner, in this application, is that it has 20 dB of RF (500-1,000 MHz) gain and a quite respectable noise figure of under 5 dB. American market UHF tuners lack RF amplifier stages and consequently their front end noise figures are in the 12 dB and up region.

Birkill takes his low IF out at 35 MHz which allows him to use a Signetics 561 phase-locked-loop as a demodulator. Many of the commercial receivers also use phase-locked-loop demodulators, but Birkill's approach is unique since it allows the system user to change the effective bandwidth of the total system by varying the way the 561 is driven. This allows you to capture (that is, see) signals that are far weaker than would register on a standard 30- to 36-MHz wide IF satellite receiver; although admittedly the quality does suffer in the process. However, in his case, Steve Birkill has been able to produce very

continued on page 65

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CIRCLE 106 ON FREE INFORMATION CARD

Realistic Model STA-2200 Receiver

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

REALISTIC AUDIO PRODUCTS ARE SOLD exclusively by the thousands of Radio Shack stores located throughout the United States and through their mail-order catalogs. The company has its own engineering staff, located in Fort Worth, Texas, to design the products which are then manufactured for them overseas. Their most sophisticated stereo receiver to date is the *model STA-2200* shown in Fig. 1.

The gold-colored front panel has no conventional dial scale or pointer. Instead, a large, highly visible digital display indicates the frequencies selected. The display reads-out in 200-kHz increments for FM and in 10-kHz increments for AM and is associated with a true frequency-synthesis tuning scheme. The display also serves as a real-time digital clock, indicating the time of day (including "AM" or "PM" notations) when non-radio program sources are being heard, or even in the AM and FM mode when a CLOCK pushbutton located behind a cleverly arranged sliding door panel is depressed. Program functions, such as phono and auxiliary, are also designated by alphabetic notations in the display area, as in reception of stereo FM signals.

Sliding up the aforementioned panel (located at the left of the display) reveals additional buttons for setting the hour and the minute of the digital clock display, for dimming the intensity of the display, for turning off output-power and signal-strength LED displays and for activating the "station-memory" feature. When the MEMORY-SET button is pushed, you have five seconds in which to enter the tuned-to frequency of six AM or six FM stations (a total of twelve) by depressing one of six buttons located beneath the digital readout area. Just to the left of the sliding panel are tape monitor and dubbing lever switches for operation of two connected tape decks for dubbing from one to the other.

The upper right of the panel is equipped with several tuning option buttons. Pressing the auto-tuning UP or DOWN buttons makes the tuner scan in the desired direction until the next usable signal is reached. A second pair of buttons (equipped with arrows, like the first pair) can be used for manual tuning. (The tuner continues to move up or down in frequency so long as the button is held down.) Just below those, a SCAN button, when depressed, makes the tuner scan to each of the memorized station frequencies in sequence, stopping for five seconds at each station for auditioning. If you want to stop the scan sequence, press the HOLD button during the 5-second interval. A POWER on/off button is also located at this end of the panel.

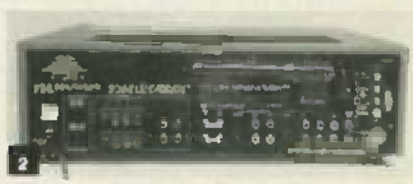
The center of the lower section of the front panel contains two banks of LED's (10 LED's per bank), which serve as power-output meters. These LED's are calibrated in watts, referred to 8-ohm loads. Calibration is either 100 watts or 10 watts per channel maximum, depending upon the setting of a pushbutton. Additional pushbuttons in that cluster include a mute button for FM, A and B speaker selector buttons, a tone control defeat button, mono/stereo switch, an MPX high-blend filter switch, and a loudness switch.

Concentric volume and balance controls are located at the lower right corner of the panel, as is the usual headphone connection jack. To the left of the power LED display are bass and treble tone controls, and between them are a pair of pushbutton switches that determine the frequency at which the tone controls begin to boost or cut (150 Hz or 300 Hz for the bass, 3 kHz or 6 kHz for the treble). A program selector switch is located at the extreme left of the panel and, in addition to its expected settings (phono, AM, FM and aux), also has a setting for Dolby FM. The receiver is equipped with a complete Dolby FM decoder circuit.

RADIO-ELECTRONICS AUDIO LAB
R.E.A.L. SOUND
RATES
REALISTIC STA-2200
VERY GOOD

The rear panel of the *STA-2200* is shown in Fig. 2. A line fuseholder and switched and unswitched AC receptacles are at the left. Nearby are spring-loaded color-coded speaker terminals for the two pairs of speakers. There are also RCA-type phono jacks for use when your speakers are equipped with permanent cables terminating in matching phono plugs. Preamp-out/main-amp-in jacks are interconnected by a pair of removeable wire jumpers.

Two sets of tape-out/tape-in jacks are augmented by European type DIN multi-contact connectors. Other inputs (auxiliary and magnetic phono) are at the lower right of the panel, far removed from any AC hum fields, and a chassis ground terminal is located near the phono input jacks. Antenna screw terminals for AM, 75-ohm and 300-ohm FM antenna connections are provided along with a pivotable AM loopstick ferrite bar antenna.



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Construction and circuit highlights

An internal view of the STA-2200 chassis is shown in Fig. 3. The FM front-end uses a dual-gate MOS FET and is tuned by variable-capacitance diodes, controlled by a microprocessor. The FM IF section uses 3 IC's and three

MANUFACTURER'S PUBLISHED SPECIFICATIONS:

FM TUNER SECTION:
Usable Sensitivity: mono, 1.8 μV (10.3 dBf). **Signal-to-Noise Ratio:** mono, 68 dB. **Image Rejection:** 75 dB. **Capture Ratio:** 1.5 dB. **IF Rejection:** 95 dB. **AM Suppression:** 55 dB. **Harmonic Distortion:** mono, 0.2%; stereo, 0.3%. **Stereo Separation, 1 kHz:** 48 dB.

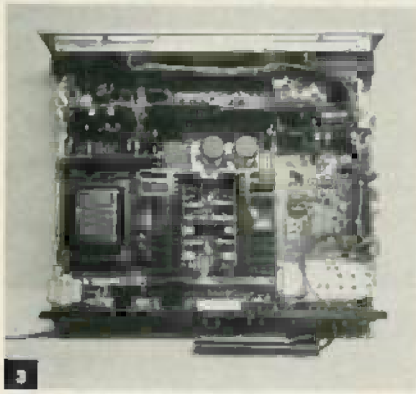
AM TUNER SECTION:
Sensitivity: 10 μV. **Distortion:** 1.0%. **Image Rejection:** 45 dB. **IF Rejection:** 47 dB. **AM Fidelity:** 40 Hz to 3,000 Hz, ±6 dB.

AMPLIFIER SECTION:
Power Output: 60 watts per channel into 8 ohms, 20 Hz to 20 kHz. **Rated Harmonic Distortion:** 0.02%. **Input Sensitivity, for full output:** phono, 2.2 mV; high level, 160 mV. **Phono Overload:** 200 mV. **Signal-to-Noise Ratio:** phono, 65 dB; high level, 75 dB. **Bass Control Range:** ± 10 dB at 50 Hz or 100 Hz. **Treble Control Range:** ± 10 dB at 10 kHz or 20 kHz.

linear-phase ceramic filters. Quadrature detection is used to recover the FM composite audio signal which is then fed to a phase-locked-loop stereo decoder. The digital tuning is controlled by a phase-lock-loop CMOS IC. MOS FET's are also used in the power amplifier section. Automatic protection circuitry protects against voltage surges, overloads, speaker shorts, and thermal overheating.

FM performance measurements

Table 1 summarizes performance measurements made for the FM section of the receiver. Frequency response in mono and stereo FM was extrememely flat, with very little evidence of the roll-off often encountered at around 15 kHz (the upper limit of FM transmission) in many tuners and receivers. Signal-to-noise and distortion in mono and stereo FM were not as good as are usually encountered with conventionally-tuned FM tuner sections, however. Figure 4 illustrates the frequency response of the FM section, as well as the stereo FM separation characteristics of the multiplex decoder without the use of the blend filter (lower trace) and with the MPX blend filter activated (center trace). Figure 5 is a composite spectrum-analyzer sweep photo used to illustrate the nature of the cross-talk fed into the unmodulated channel from the modulated one when a 5-kHz signal is used to modulate one channel. The desired 5-kHz output from the modulated channel is the tall peak at the left of the display. (The display is linear from 0 Hz to 50 kHz with 5 kHz per horizontal division.) Contained within this peak is the second peak, at lower amplitude, which represents the 5-kHz component observed at the output of the unmodulated channel, while to the right of this are distortion components as well as the expected 19- and 38-kHz subcarrier components.



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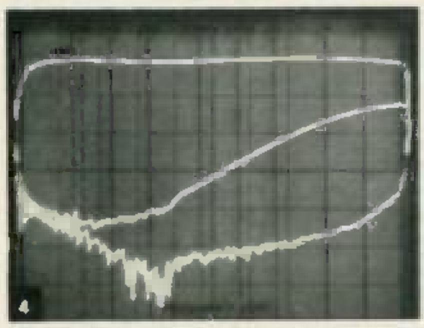

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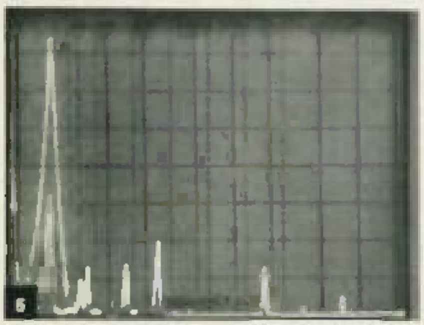

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RADIO-ELECTRONICS PRODUCT TEST REPORT

TABLE I

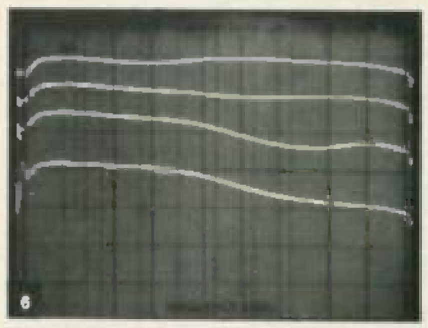
Manufacturer: Realistic (Radio Shack) — Model: STA-2200

FM PERFORMANCE MEASUREMENTS

SENSITIVITY, NOISE AND FREEDOM FROM INTERFERENCE	R-E Measurement	R-E Evaluation
Inl sensitivity, mono: (μV) (dBf)	1.8 (10.3)	Very good
Sensitivity, stereo (μV) (dBf)	7.0 (22.1)	Good
50 dB quieting signal, mono (μV)	3.0 (14.7)	Very good
50 dB quieting signal, stereo (μV)	47.0 (38.6)	Fair
Maximum S/N ratio, mono (dB)	68	Fair
Maximum S/N Ratio, stereo (dB)	65.5	Good
Capture ratio (dB)	1.5	Very good
AM suppression (dB)	56	Good
Image rejection (dB)	75 dB	Good
I-F rejection (dB)	97 dB	Good
Spurious rejection (dB)	83 dB	Good
Alternate channel selectivity (dB)	75 dB	Very good
FIDELITY AND DISTORTION MEASUREMENTS		
Frequency response, 50Hz to 15 kHz (± dB)	0.5	Excellent
Harmonic distortion, 1 kHz, mono (%)	0.12	Very good
Harmonic distortion, 1 kHz, stereo (%)	0.15	Very good
Harmonic distortion, 100 Hz, mono (%)	0.14	Excellent
Harmonic distortion, 100 Hz, stereo (%)	0.26	Good
Harmonic distortion, 6 kHz, mono (%)	0.11	Excellent
Harmonic distortion, 6 kHz, stereo (%)	0.23	Very good
Distortion at 50 dB quieting, mono (%)	0.37	Excellent
Distortion at 50 dB quieting, stereo (%)	0.30	Very good
STEREO PERFORMANCE MEASUREMENTS		
Stereo threshold (μV)	7.0 (22.1)	Very good
Separation, 1 kHz (dB)	51.0	Superb
Separation, 100 Hz (dB)	46.0	Excellent
Separation, 10 kHz (dB)	36.0	Very good
MISCELLANEOUS MEASUREMENTS		
Muting threshold (μV)	7.0 (22.1)	Good
Dial calibration accuracy (± kHz at MHz)	Perfect	Superb
EVALUATION OF CONTROLS, DESIGN, CONSTRUCTION		
Control layout		Excellent
Ease of tuning		Superb
Accuracy of meters or other tuning aids		Superb
Usefulness of other controls		Very good
Construction and internal layout		Very good
Ease of servicing		Good
Evaluation of extra features, if any		Excellent
OVERALL FM PERFORMANCE RATING		Very good

The action of the Dolby FM decoder circuitry is best illustrated by Fig. 6. Each sweep (logarithmic, from 20 Hz to 20 kHz) was made at a different level of modulation and, as expected, the upper sweep is vitually flat while correspondingly lower level sweeps show the Dolby high-frequency attenuation required to restore flat response at those lower levels to signals that had been conversely boosted during transmission. The FM generator was set for 25 microsecond pre-emphasis in making these plots.

Frequency response in AM was remarkably good compared with the AM sections of many stereo receivers that we have tested in the past. As can be seen from the response plot of Fig. 7, the −6-dB points occurred at approximately 30 Hz and 4 kHz which, though hardly "hi fi" compares very favorably with the usual 2.5- to 3-kHz roll-off normally found on AM tuners built into high-fidelity receivers.



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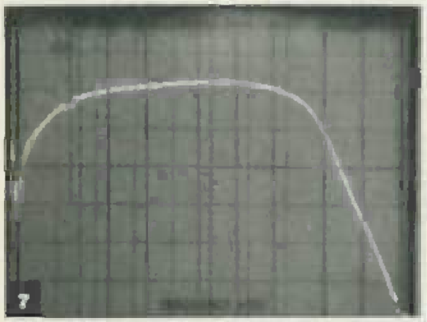
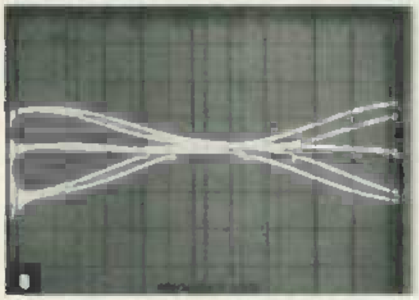
Amplifier and preamplifier section measurements

Table 2 is a summary of measurements made for the power amplifier and preamplifier sections of the *STA-2200* Receiver. The unit seems quite conservatively rated in terms of power output, as well as rated distortion, delivering a clean 72 watts per channel at mid-frequencies and just under 70 watts per channel at the 20 Hz and 20 kHz frequency extremes for its rated harmonic distortion of 0.02%. Since no ratings were provided for 4-ohm loads, we did not measure maximum output for this load condition. We did, however, operate the amplifier for long periods into 4-ohm speaker systems without encountering any thermal or shut-down problems.

While our signal-to-noise measurements for both phono and high-level inputs are made in accordance with the new IHF Amplifier Measurement Standards (and cannot therefore be compared with Radio Shack's published specifications), the 77-dB S/N measurement in





phono and the 81-dB measurement for the high-level inputs (both A-weighted and referred to 1-watt output) compare very favorably with measurements obtained for other receivers in this, or even higher-priced categories. Phono overload capability exceeded Radio Shack's claimed figure of 200 mV by a wide margin and there is absolutely no danger of overdriving the first stages of the phono equalizer section of the receiver.

Range of the variable-turnover bass and treble controls is illustrated in the spectrum analyzer sweep photo of Fig. 8. Sensitivity of the analyzer was 10 dB of amplitude between horizontal lines and sweep is logarithmic from 20 Hz to 20 kHz.

Summary

Our overall product analysis of the Realistic *STA-2200* will be found in Table 3. On the whole, the receiver embodies a great many innovative design features, most of them concerned with ease of use and convenience of accurate tuning. In our bench and listening tests, the receiver ran very cool under all listening conditions, including extended periods when it was operated near its clipping point.

The purist audiophile may not think much of the fancy tuning schemes, the digital and LED displays and the time clock, but we suspect that the music enthusiast who wants ease of use and welcomes a "conversation piece" such as the built-in digital clock will find the *STA-2200* appealing. The less-than-spectacular signal-to-noise performance of the FM section, will probably *not* prove to be a limiting factor in FM listening. Few stations we know of actually *transmit* a signal-to-noise or dynamic range ratio much above 60 dB. For all of these reasons, and because of its clever design and pleasing layout, we have assigned a VERY GOOD R.E.A.L. rating to the Realistic *STA-2200*. R-E

RADIO ELECTRONICS PRODUCT TEST REPORT

TABLE 2

Manufacturer: **Realistic (Radio Shack)** Model: **STA-2200**

AMPLIFIER PERFORMANCE MEASUREMENTS

	R-E Measurement	R-E Evaluation
POWER OUTPUT CAPABILITY		
RMS power/channel, 8-ohms, 1 kHz (watts)	72.0	Excellent
RMS power/channel, 8-ohms, 20 Hz (watts)	69.0	Very good
RMS power/channel, 8-ohms, 20 kHz (watts)	69.0	Very good
RMS power/channel, 4-ohms, 1 kHz (watts)	N/A	N/A
RMS power/channel, 4-ohms, 20 Hz (watts)	N/A	N/A
RMS power/channel, 4-ohms, 20 kHz (watts)	N/A	N/A
Frequency limits for rated output (HzOkHz)	10-30	Excellent
Dynamic headroom (dB)	1.2	Non-rated
DISTORTION MEASUREMENTS		
Harmonic distortion at rated output, 1 kHz (%)	0.014	Very good
Intermodulation distortion, rated output (%)	0.035	Very good
Harmonic distortion at 1-watt output, 1kHz (%)	0.017	Very good
Intermodulation distortion at 1-watt output (%)	0.018	Good
DAMPING FACTOR AT 8 OHMS, *50 Hz*	67	Very good
Phono preamplifier measurements		
Frequency response (RIAA ± dB)	0.5	Good
Maximum input before overload (mV)	235	Excellent
Hum/noise, A-weighted, referenced to 1-watt or 0.5-volt output, for 5 mV input (dB)	77	Very good
High level input measurements		
Frequency response (Hz-kHz, ± dB)	12-30, 1.0	Very good
Hum/noise, A-weighted, referenced to 1-watt or 0.5-volt output, 0.5-volt input (dB)	81	Excellent
Residual noise, A-weighted minimum volume, referenced to 1-watt output (dB)	82	Very good
TONAL COMPENSATION MEASUREMENTS		
Action of bass and treble controls	See Fig. 9	Excellent
Action of secondary tone controls	N/A	N/A
Action of high and low cut filters	N/A	N/A
COMPONENT MATCHING MEASUREMENTS		
Input sensitivity, phono 1/phono 2, referenced to 1-watt or 0.5-volt output (mV)	0.37	
Input sensitivity, high level referenced to 1-watt or 0.5-volt (mV)	18	
Output level, tape outputs, at rated output (mV)	160	
Output level, headphone jack, at rated output (mV or mW)	307mV/8 ohms	
EVALUATION OF CONTROLS, CONSTRUCTION AND DESIGN		
Adequacy of program source and monitor switching		Excellent
Adequacy of input facilities		Very good
Front panel layout		Excellent
Action of controls and switches		Superb
Design and construction		Excellent
Ease of servicing		Good
OVERALL AMPLIFIER PERFORMANCE		Very good

TABLE 3

OVERALL PRODUCT ANALYSIS

Retail price	$599.95
Price category	Medium
Price/performance ratio	Very good
Styling and appearance	Excellent
Sound quality	Very good
Mechanical performance	Excellent

Comments: Last year, Radio Shack's most expensive model sold for the same price as the *STA-2200*, $599.95. It was a 120-watt-per-channel model, with conventional tuning. This year, their top model has given up power in favor of a very sophisticated FM and AM tuning system, known as frequency synthesis. This tuning method guarantees center-of-channel tuning that is fully as accurate as the tuning of the broadcast station.

The digital display, the 12-station memory (6 for FM, 6 for AM), the use of the display as a time clock plus its alphabetic designations of program source, stereo FM signal reception, and the like all add to the cost of the unit, so that, in effect, Radio Shack has traded power for convenience features and ease of tuning. The *STA-2200* is a joy to use. The LED power "meters," and LED signal-strength indicators, are far more accurate and easier to interpret than are mechanical tuning and power output meters.

Some small sacrifices result from the frequency synthesis approach. The maximum signal-to-noise ratio in mono FM is less than 70 dB. Varactor tuning simply does not yield the same signal-to-noise performance as variable capacitor tuning. The *Realistic STA-2200* delivers clean, natural sound in phono and tape reproduction. Tone controls are well designed and the variable turnover feature is a welcome one. A sub-sonic filter would have been a welcome addition, however. A word of commendation is in order for the excellent AM section which had surprisingly good frequency response.

BETTER Pick-up Arm PERFORMANCE

The design of the phonograph pickup arm plays an important part in the overall performance of a high-fidelity system. Len gives details on the Thorens approach to pickup arm design.

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

A RECENT TRIP TO SWITZERLAND INCLUDed a visit to the well-known Thorens Company, a few miles outside of Zurich. There, several audio experts and I, were treated to a seminar that explored many of the myths associated with turntable design and performance. Admittedly, any manufacturer is going to make a strong point for his own design approaches to a product, but much of what we learned was backed up by solid theory. In any record playing system, we deal with two major elements: the turntable with its drive system, and the pickup arm and cartridge combination. In this article, we will discuss some of the design considerations involved in insuring optimum pickup arm/cartridge interface. In a future article we will discuss design approaches for the turntable and its drive system.

In recent years we have seen significant improvements in both turntable designs (to reduce rumble, improve speed precision and to minimize speed variations known as wow-and-flutter) and cartridge designs (to improve frequency response, lower tracking distortion and reduce mass). While design improvements of turntable and cartridges can be considered independently of each other, design improvements in pickup arms cannot be analyzed without considering the total playback system.

Tracking characteristics of an arm at very low frequencies (below 20 Hz) are influenced primarily by arm resonance and record warp. Arm resonance is the vibration of the arm/cartridge assembly that results while the stylus tracks the record. Record warp can affect arm tracking by altering instantaneous stylus pressure, as shown in Fig. 1. As the stylus rides up the record warp, the inertia of the arm mass causes the downward stylus force to increase. Conversely, when the pickup rides down the warp, the inertia of the pickup arm mass causes the downward stylus force to decrease. This varying stylus force, especially when the stylus rides down the warp, often results in mistracking and increased distortion as the stylus loses intimate contact with the record groove. Reducing the effective pickup arm mass would lower the inertial forces affecting stylus force as warped records are tracked and would, therefore, improve tracking and provide for lower distortion when playing warped records.

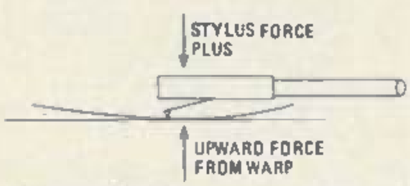


FIG. 1—RECORD WARP affects stylus pressure—increasing it as stylus rides up and decreasing it as stylus rides down the warp.

Messrs. Happ and Karlov, in a paper titled "Record Warps and System Playback Performance", analyzed the velocity spectrum of record warp using a representative sampling of records. The results of their work are shown in Fig. 2. From this graph we see that the velocity of record warp is greatest between 0.5 Hz and 7 Hz. To minimize pickup arm mistracking caused by record warp, the arm-resonance frequency should be between 10 Hz and 12 Hz, or *above* the frequencies that cause maximum record warp velocities. However, arm resonance must be below the 20-Hz lower limit of audio modulation on the record.

The chief factors that influence the resonant frequency of an arm/cartridge combination are the weight of the cartridge, the effective mass of the pickup arm, and the compliance of the cantilever arm of the pickup cartridge. The way these factors affect arm resonant frequency is illustrated in Fig. 3. The curves

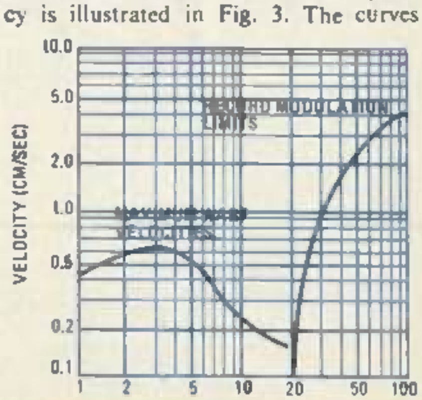
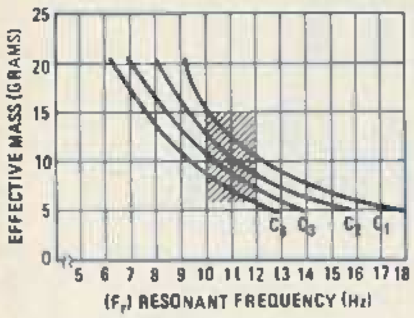


FIG. 2—RECORD WARP velocities peak at around 0.6 cm/sec at about 3.5 Hz.

show how arm resonant frequency changes with respect to the effective mass of the pickup arm and with the compliance of the cartridge used. Note that the resonant frequency varies inversely with effective mass and with compliance. Increasing *either of these two parameters* decreases the resonant frequency of the arm.

For example, if we have an arm with an effective mass of 15 grams and add a lightweight cartridge that weighs only 3 grams it has a compliance of 30 x 10^{-6} cm/dyne. As shown in Fig. 4, the effective mass of this arm/cartridge combination would be 18 grams (15 grams for the arm plus 3 grams: the weight of the cartridge). The resonant frequency of this



C = CARTRIDGE COMPLIANCE (CM/DYNE)

$C_1 = 15 \times 10^{-6}$
$C_2 = 20 \times 10^{-6}$
$C_3 = 25 \times 10^{-6}$
$C_4 = 30 \times 10^{-6}$

$$F_r = \frac{1}{2\pi(MC)^{\frac{1}{2}}}$$

FIG. 3—RESONANT FREQUENCY of arm and cartridge are affected by three factors.

arm/cartridge combination would be 7.5 Hz. This frequency borders on the range of greatest velocity caused by record warp (as previously shown in Fig. 2).

Three grams is a rather light weight for a cartridge, so suppose we increase its weight to 7 grams. Total effective mass of the combination would now be 22 grams (see Fig. 5), and the new resonant frequency of the arm/cartridge combination would be 6.3 Hz, or very close to the maximum velocity of record warps.

Most popular phono pickup cartridges do weigh between 3 and 7 grams and ideally, if we are dealing with cartridges whose compliance ranges between 15 and 30 x 10^{-6} cm/dyne (also typical) the effective mass of a pickup arm that would keep resonant frequencies in the range

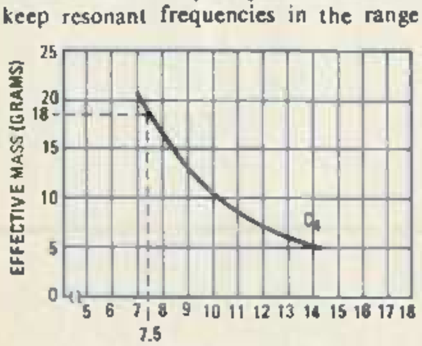


FIG. 4—RESONANT FREQUENCY varies with arm mass and cartridge compliance.

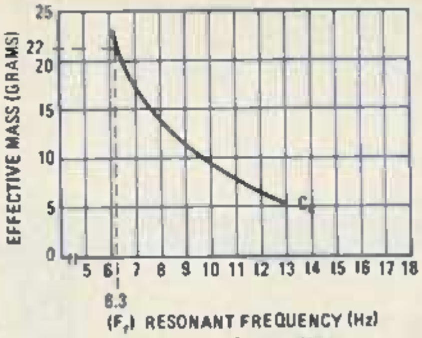
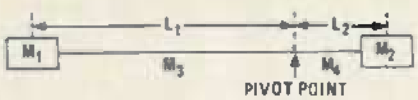


FIG. 5—HOW INCREASING CARTRIDGE weight affects arm mass and frequency.

from 7.6 Hz to 12 Hz is between 6 and 10 grams (not including the weight of the cartridge).

To keep the effective mass of a pickup arm within this specified range, only certain factors in the arm design may be altered, while others must remain constant. The various dimensions and masses involved are illustrated in Fig. 6. For example, the length of the pickup arm tube from stylus tip to pivot center (L1) is fixed by the record diameter and the overall dimensions of the turntable system. The mass of the pickup cartridge, one of the factors determining the value of M1 in Fig. 6, is determined by the cartridge manufacturer and, as we have stated, generally ranges from 3 to 7 grams. The remaining factors that lend themselves to redesign are the mass of the headshell assembly (part of M1), the



$$M_{EFF} = \frac{M_1 L_1^2 + M_2 L_2^2 + M_3 (L_1/2)^2 + M_4 (L_2/2)^2}{L_1^2}$$

L_1 = STYLUS TIP TO PIVOT CENTER DISTANCE
L_2 = PIVOT CENTER TO COUNTERWEIGHT MASS CENTER DISTANCE
M_1 = MASS OF HEADSHELL PLUS CARTRIDGE
M_2 = MASS OF COUNTERWEIGHT ASSEMBLY
M_3 = MASS OF PICKUP ARM TUBE
M_4 = MASS OF COUNTERWEIGHT TUBE

FIG. 6—THE SIX FACTORS involved in the design of a pickup arm.

mass of the pickup arm tube (M3), the mass of the counterweight tube (M4) and its length (L2), and the mass of the counterweight itself, (M2).

The degree to which the mass of the counterweight may be altered and, to some extent, the degree to which the length of the counterweight tube may be altered, is limited by the weight range of popular pickup cartridges. The counterweight, after all, serves the primary function of balancing out the weight of the cartridge, shell and forward part of the pickup arm. The only elements of the structure, then, that may be dealt with in attempting to lower effective mass are that portion of M1 represented by the headshell and the mass of the pickup arm itself (M3).

For example, the headshell mass can be reduced by using a light material and eliminating the screw collar that normally secures the headshell to the pickup arm tube. That approach, however, makes it difficult to interchange pickup cartridges.

An alternate solution (and one that Thorens eventually adopted) is to move the screw collar closer to the pivot point of the arm. By doing so, the mass is moved closer to the pivot point. In effect, because the formula for effective mass includes the term M3 $(L1/2)^2$, and since L1 is now shorter, there is a significant decrease in overall effective mass. Since the mass of the pickup arm has been decreased, the mass of the balancing counterweight can also be decreased, further reducing the effective pickup arm mass (see Fig. 7).

The pickup cartridge must, of course, be rigidly connected to the pivot assembly. The material of the arm must be rigid but also light in weight. According to

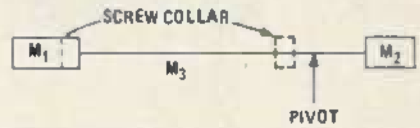


FIG. 7—EFFECTIVE MASS of pickup arm is lowered in new Thorens design by moving the screw collar closer to the pivot point.

Thorens (and more and more turntable manufacturers seem to be coming to the same conclusion of late), a straight pickup-arm tube design provides maximum stiffness and also lowest mass. Furthermore, in a straight tube design the rotational force caused by mass displacement about the vertical pivot points need not be compensated for with additional counterweight lateral balancers, as is done with some S-shaped pickup arms.

Thorens' new pickup arms ("Isotrack" arms), have been designed with all of the foregoing in mind. A thin-wall, straight anodized aluminum tube is used and the screw collar is located close to the pivot point. Instead of removing the head-shell to interchange cartridges, the user purchases as many forward tube portions as he or she wishes, mounting each cartridge in a separate unitized forward tube structure.

The arm's effective mass turns out to be approximately 7.5 grams (exclusive of the cartridge used). Figure 8 compares the range of arm resonance that might be expected from a typical arm with an effective mass of 15 grams when used with cartridges weighing between 3 and 7 grams and having compliances of between 15 and 30 x 10^{-6} cm/dynes with the resonance range that will result if those same cartridges are used in the Thorens Isotrack arm. For the typical higher-mass arm, resonant frequencies range from 6.3 Hz to 9.5 Hz, after adding in the weight of the cartridge to the effective arm mass. For the Isotrack arm, resonance falls between 7.6 Hz and 12 Hz, thanks to its lower effective mass.

In addition to its lower mass, the Thorens Isotrack arm has a low 25-milligram (maximum) pivot friction in both the vertical and horizontal planes. Anti-skating is applied through a magnet arrangement that has the advantage over the familiar spring or weight arrangement that tends to introduce additional and variable friction components as the arm traverses the record.

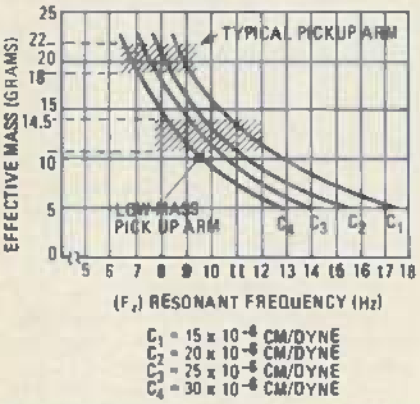


FIG. 8—A COMPARISON OF RESONANCES of two pickup arms of different weights.

According to Thorens, there is one additional advantage to be gained through the use of a low-mass arm. That is, lower susceptibility to vibration and shock from outside sources.

There is one other important consideration that should be discussed in any analysis of pickup arm design. That is the configuration of the bearing assembly and the length of the arm itself. Because so many of the records we play are warped, the bearing pivot point should ideally lie in the same plane as the playing surface. With such positioning, the longitudinal displacements caused by record warp are kept to a minimum, and the resulting wow-and-flutter components are lower. We are not discussing the wow-and-flutter that is inherent in the turntable drive system itself (that will be discussed next month). Rather, we are discussing that wow-and-flutter component that is generated entirely by vertical motion of the cartridge stylus as it is lifted and lowered by a warped record. Figure 9 illustrates this effect as it occurs with a pickup arm of normal length. The closer the pivot point is to the level of the record surface, the lower the wow and flutter produced by warped records. Extremely high levels of wow-and-flutter occur with short-arm designs that have a relatively high bearing-pivot point. Some of the so-called tangentially tracking arms that are available today have short arms, simply because tracking-angle error (the main reason for attempting a tangential-tracking arm in the first place) is eliminated in such designs. (The arm and cartridge cantilever assembly are always tangent to the groove being played). After investigating this approach, Thorens concluded that while tangential arms are certainly feasible, the additional drive requirements for such arms make them too complicated to be practical.

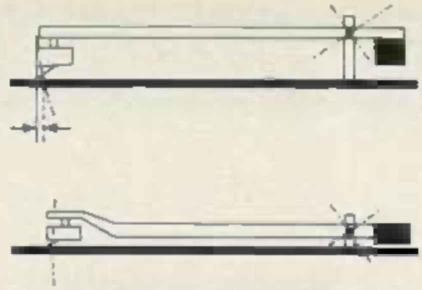


FIG. 9—WOW AND FLUTTER caused by record warp depends on height of pivot above record. Bottom design shows lower pivot.

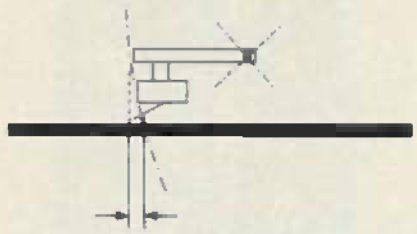


FIG. 10—RECORD-INDUCED WOW-AND-FLUTTER can be reduced in designs that have the arm pivot moved closer to the cartridge head.

In any case, referring once more to the wow-and-flutter problem inherent in short-arm designs (including the tangentially tracking ones currently available), consider the short, 4-cm arm constructed as shown in Fig. 10. The wow-and-flutter added by a warped record to that inherent in the turntable drive system itself works out to be:

TOTAL WARP EXCURSION	ADDED WOW-AND-FLUTTER
1 mm	0.12%
2 mm	0.24%
3 mm	0.36%

If we assume that a high-quality turntable exhibits its own basic wow and flutter component of around 0.05%, then with a 1 millimeter record warp the total wow-and-flutter will rise to 0.17%. A quick survey of your own records will show that you have very few that have less than 1 millimeter of warpage!

It is clear that the design of a complete turntable system involves many diverse factors, not the least of which is the fact that most phonogrpah records are less-than-perfect. To design a record playing system on the premise that records that will be played on it are perfectly flat, have completely concentric holes, and will be played in an environment that is totally free of outside vibration or noise is to ignore the real-world situation. In the next installment, we will talk about rumble, wow-and-flutter, mounting suspensions, and other factors relating to the turntable platter itself and its drive system. We will also try to show why one manufacturer's turntable, that has a −70 dB rumble figure, may, in fact, produce more rumble than another turntable that has a −50 dB rumble figure. **R-E**

TV RECEIVERS

continued from page 59

high quality reception from the Russian stationary series of satellite transponders although he is working with signals 7-9 dB weaker than we have available here from North American domestic satellites, and he has acceptable (if not high quality) pictures from the much weaker Intelsat satellites (they run from 12 to 15 dB weaker than our domestic satellites). The balance of his receiver approach is pretty standard since once you have baseband video and audio there is only about one way to process it for conversion back to RF as an AM format signal.

To some people, being at baseband with the signal may seem like ending up at the wrong place. To view baseband directly, you feed the video and audio signals into a video "monitor" and a speaker. Not everyone has a video monitor of course and some means of getting the baseband signal back to a standard NTSC television channel (with the video portion amplitude modulated) is required.

A word about viewing the signal(s) at pure baseband; i.e. into and through a video monitor. This is the ultimate (high class) viewing technique since the baseband signals are of very high quality (48- to 54-dB signal to noise) and purity. However, this generally limits you to viewing the signals on a single monitor since video monitors tend to be expensive.

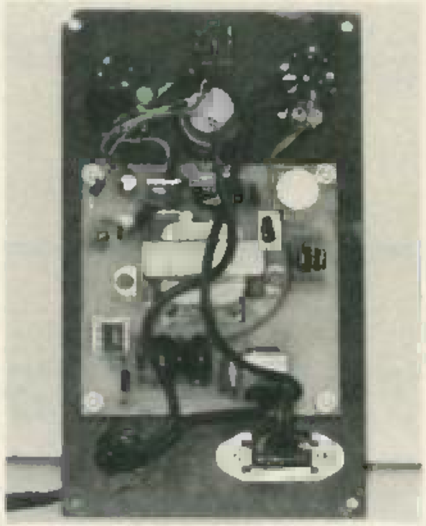
In Fig. 4 we have several methods suggested to get the baseband back to an RF channel. Clearly the baseband video and audio must be used to modulate a TV channel modulator device. Numerous circuits for these devices have appeared in **Radio-Electronics** through the years. One of the easiest ways to modulate back to RF is to use a LM1889 IC which is a complete (TV channel 3 or 4) RF carrier generator/modulator intended for TV games and home VTR's. If you already have a home VTR, you can simply loop the baseband video and audio to the home VTR's "camera" and "audio" inputs. This turns the VTR into a modulator for you and you can then watch the satellite TV signals on multiple TV receivers, connected to the VTR modulator through 75-ohm coaxial cable (as in a miniature TV distribution system). **R-E**

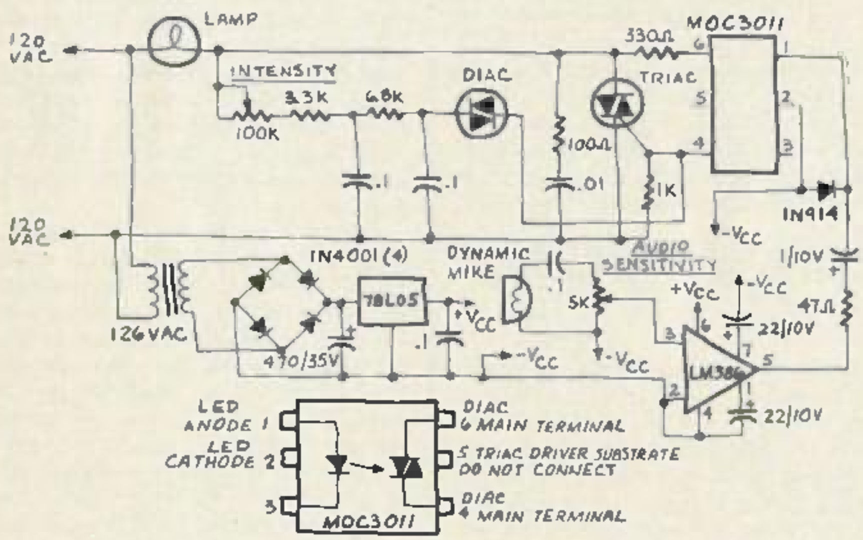
new ideas

SOUND-ACTIVATED LAMP DIMMER

MY NEW IDEA CONCERNS THE USE OF Motorola's MOC3011 opto-isolated triac driver. The triac driver consists of a LED and an optically coupled bilateral switch (better known as a DIAC). This device permits low-voltage control signals to control high-voltage, high-power loads. It essentially allows the user to create a solid-state relay for a fraction of the cost.

I wanted to make a simple and inexpensive device capable of sound modulating the intensity of a light source using a microphone built into the case. The device that I designed employs a conventional light dimmer circuit in addition to the sound activation circuit. The light dimmer may be used either independently of or in conjunction with the sound circuit. When used separately, the AUDIO SENSITIVITY control is set to minimum and the light dimmer is used in the conventional manner. When the light dimmer is activated by sound the 100K pot sets the minimum intensity that will remain in the absence of sound and return to after it has been triggered to full intensity by the sound section. This feature is made possible by the MOC3011. The signal that controls the triac in the light dimmer is so low that it does not harm the bilateral switch in the MOC3011. Furthermore, when the bilateral switch in the MOC3011 triac driver is triggered by the LED, it causes the triac to conduct fully and override the preset light dimmer setting.





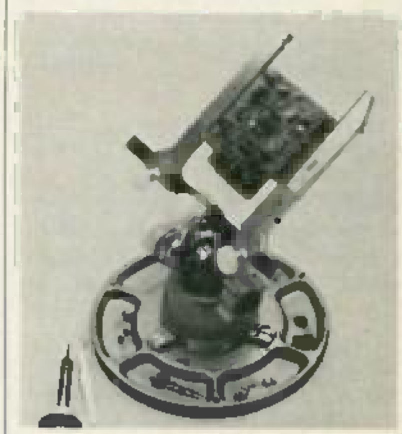
The construction of the control unit is simple and straightforward. If circuit assembly is done using point-to-point wiring rather than a circuit board. Use extreme caution when wiring that portion of the circuit which is connected to the 120-volt power line. Be sure that during the wiring of the triac driver (MOC3011), no connection of any kind is made to pin 5. Set the microphone element into a hole drilled in the top of the case and secure it with a silicon rubber compound. The audio gain and light dimmer controls were placed near the microphone element to allow adequate separation between the low-voltage section and the 120-volt power control section. A chassis-mounted power socket was used as a convenient way to make the device flexible in use. If a high-power load is anticipated, be sure that adequate heat sinking is provided for the triac.

In addition to using this unit to produce scary effects for Halloween and cause your Christmas tree lights to dance with the Christmas music, you can also use this device to produce unique DISCO lighting effects with just about any lamp in the house. Several units placed around the room create a wild effect and there is no required connection to a sound source.—**David L. Holmes**

NEW IDEAS

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

All published entries, upon publication, will earn $25 plus a Circuit Board Holder, Standard Base and Tray Base Mount from Panavise Products, Inc. (See photo below.) Selections will be made at the sole discretion of the editorial staff of **Radio-Electronics**.



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An easy-to-build circuit that monitors sound level and lets you know when it rises above or falls below a predetermined point, plus a nifty new solder station.

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

THERE ARE TIMES WHEN ONE WISHES TO know when and if a sound level exceeds a certain point. It may be machinery that requires adjustment when its noise reaches a given level. It may be children (yours or the ones you babysit) who need to be reminded *automatically* when they get too noisy. Among other possibilities are your school or summer camp lunchroom or, even, your neighbor's stereo.

Of course, you could get an audio level meter, but have you priced one of those lately? And, besides, you have to watch the meter. Well, if all you want to know is when the level reaches a certain point, this simple project is what you have been looking for. As an added bonus, it can be set up to tell you if the noise falls *below* the setting—that is, if things get too quiet!

The heart of the loudness detector is a common 555 IC wired as a Schmitt trigger. As shown in Fig. 1, the output changes state—from high to low—whenever the input crosses a certain voltage. That threshold voltage is established by the setting of pot R4.

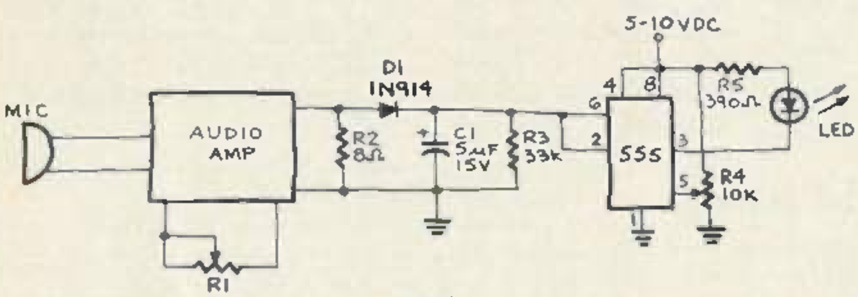

FIG. 1

The prototype circuit uses a LED in the output. As wired, it turns ON to indicate a higher voltage (noise). Obviously, if the LED and its associated resistor R5 were wired between pin 3 and ground, it would turn OFF to indicate that same condition.

The 555 control (input pins 2 and 6) voltage originates from a small audio amplifier. The amplifier output is fed to R2 which develops an AC voltage proportional to the sound level at the microphone. That voltage is rectified by D1 and filtered by C1 and R3. The gain of the audio amplifier is controlled by potentiometer R1.

The amplitude of the voltage out of the filter is dependent upon the sound level. The greater the sound level, the greater the voltage.

When that voltage exceeds the threshold set by R4, the 555 output changes state and the LED turns ON. There you have it—a loudness detector! But a few details remain.

The audio amplifier can be whatever you happen to have on hand as long as it will output 150 mW or so. You may want to build a simple transistor or IC amplifier or you can use a commercial module. My loudness detector was first tested by running the output of a "shirt-pocket" radio across R2.

The LED can be replaced by a relay with a DC voltage rating appropriate to the supply voltage you apply to pin 8. The hook-up is shown in Fig. 2. Do not omit the diode. The back EMF from the relay is likely to ruin the 555. By using a relay, you can cause a bell to ring, a bright light to turn on or, even, the offending machine to cut off!

Use of the loudness detector requires proper setting of R1 (amplifier volume) and R4 (trigger threshold). I recommend that R4 be set to provide a reasonable range with the particular amplifier used. Then the sensitivity for different uses can be set on R1 alone. The control can then be calibrated in some arbitrary scale to permit resetting to a given level.

Of course, you can use the pots in the reverse manner but that will give you less latitude in sensitivity. However, the important thing is to have only one control as the normally used variable—otherwise it will be difficult to reset the trigger level.

There are two other minor factors which you will discover as you use the detector. First, it is somewhat frequency sensitive. How much so depends partly on the microphone and amplifier used, but compensation is not worth the trouble except in critical applications.

Second, the detector displays hysteresis; that is, the cut-off level is lower than the cut-on level. You will find this to be an advantage in many uses. The actual

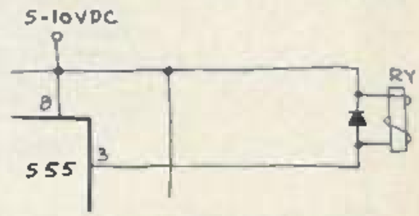

FIG. 2

difference between the two voltages varies with the setting of R4.

Certainly there are other uses to which you can put the basic 555 circuit. A variable voltage from any source will cause the light or other alarm to activate. All you have to do is to apply that voltage to pins 2 and 6 of the 555. Be sure, however, that the voltage on pins 2 and 6 does *not* exceed the applied voltage on pin 8 or the 555 will be damaged. In cases where this is a possibility, you should use a voltage divider or a Zener diode to prevent it.

Please hold

I would like to pause to give a bit of gentle (?) advice to some advertisers of parts and equipment. It is very nice of you fellows to provide your telephone numbers, especially if you have a toll-free line.

You must know, however, that it is quite disconcerting to be placed on "hold" before the caller has a chance to say a word. It is *more* than disconcerting if the number is not toll-free and the caller is left paying to listen to a dead line.

Accordingly, I trust that all you good guys will review your procedures. If your establishment suffers from this malady, a correction will benefit both your customers *and you*. After all, other folks sell the same items.

A suggestion: if you can't handle it right then, don't answer it. We'll be glad to call back in a few minutes.

continued on page 70

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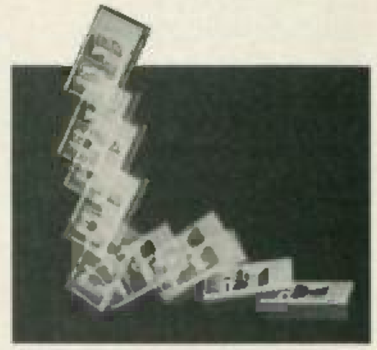

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LX 303 SPECIFICATIONS

DC Volts (5 RANGES): 200mV to 1000V full scale. RESOLUTION 0.1mV ACCURACY: ±(0.5% rdg + 0.5% f.s.): **INPUT IMPENDANCE:** 10MΩ: OVERLOAD PROTECTION, 1000VDC or peak AC all ranges. **AC VOLTS (40 Hz to 5kHz):** 200V to 600V full scale: RESOLUTION: 0.1V: ACCURACY: ±(1.0% rdg – 0.5% f.s.) 2.0 db at 5kHz OVERLOAD PROTECTION: 600VDC or rms **RESISTANCE (6 RANGES, LOW POWER):** 200Ω to 20MΩ full scale: RESOLUTION: 0.1Ω; ACCURACY: ±(0.5% rdg + 0.5% f.s.) ±(1.5% rdg + 0.5% f.s.) on 20MΩ range. OVERLOAD PROTECTION 120VDC or rms all ranges, 240V rms for 30 sec. **DC CURRENT (6 RANGES):** 20 nA to 200 mA full scale. ACCURACY: ±(0.5% rdg + 0.5% f.s.); OVERLOAD PROTECTION 60V on 10 nA to 10 μA ranges, 25 mA on 100 μA range and 500 mA on 100 mA range. **GENERAL:** DIMENSIONS: 5¾ x 3⅜ x 1¾" (14.7 x 8.5 x 4.3cm); WEIGHT: 12 oz (0.33kg). POWER 9V battery (not incl.) or Hickok AC Adapter. BATTERY LIFE: Alkaline. 300 hours typical READ RATE: 3/sec.; TEMPERATURE: 0 C to 50 C operating. −35 C to +60 C storage.

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CIRCLE 55 ON FREE INFORMATION CARD

HOBBY CORNER

continued from page 68

Solder station

PanaVise (2850 29th St., Long Beach, CA 90806) has come out with a neat and effective solder station. It consists of a holder for spools of solder and/or wire and a holder for your iron. Also provided are two sponge tip cleaners. The holders can be used separately or fastened together (bolts provided) as a single unit for either right or left hand use. (See Fig. 3)

The station can be mounted on your workbench, on the wall, or you can put it on a movable base. One or both holders, separately or as a unit, also may be mounted on PanaVise's holders for boards/parts (and you already know how great I think they are).

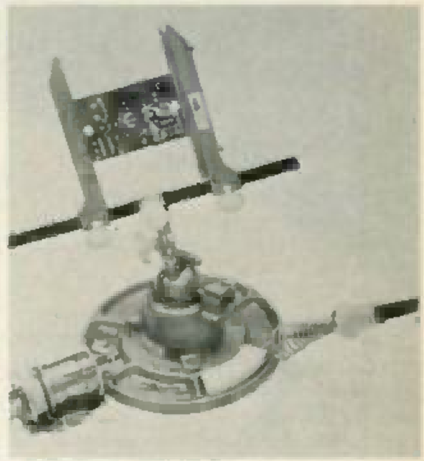
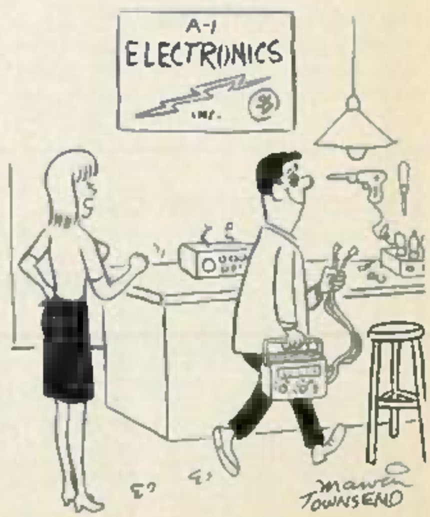


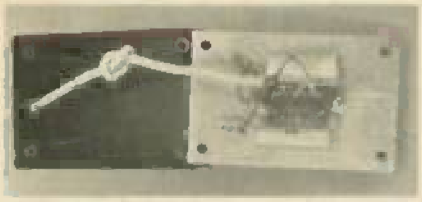
FIG. 3

If you aren't using a solder station, consider the convenience of having an iron, solder, and wire right where you need them. You may not be as careless as I, but it is good to have a place to put your iron so it isn't lying around waiting to burn your hand! The *model 371* solder station sells for about $5. R-E



"Next time you check resistance ranges around here, leave me out of it!"

CONFERENCE CALLER
continued from page 49



INTERIOR VIEW of the Conference Caller. The two non-polarized isolating capacitors are wired directly to the switch.

Construction and installation

Construction is simple and wiring is not at all critical. The components can be mounted directly to the switch. When you connect the conference caller to your telephone lines make sure only the green wires go to the green terminals, and the red wires to the red terminals.

C1 and C2 must be nonpolar (*not* electrolytic) capacitors rated at more than 100 volts. If you want to expand your conference caller to use three or more telephones, simply add two more capacitors and a switch for each additional line (see the dashed box in Fig. 1).

To test this device, have a friend call one of the numbers connected to it. Next, call someone else, using the other phone. Now, close the switch and all three of you should be able to talk together. **R-E**

communications corner

A phonograph record that tells all about shortwave listening, plus a tri-band monitor antenna.

HERB FRIEDMAN, COMMUNICATIONS EDITOR

THE CHINESE PHILOSOPHER CONFUCIUS once said: "A picture is worth a thousand words." Had he lived in our time he might have added: ". . . but one good LP recording is worth all the words and all the pictures."

For more than a quarter century I have been reading about one of my favorite hobbies, shortwave listening—or SWL'ing as it is more commonly known—and in all that time I have yet to find a book on the subject that was not deadly dull. One of the problems with modern books is that a publisher usually contracts for a specific length. The writer has to fill so many pages; and an exciting subject, such as SWL'ing, can easily get buried in excess verbiage, sure to put one to sleep by the twentieth page. (It takes five pages just to thank all those who helped the author.)

If you'd like to get the real flavor of SWL'ing, or if there's some youngster who you think would enjoy getting into it, the pathway to this little known but widely practiced hobby is through a 12-inch LP record that goes by the rather insipid title of *Long Live Shortwave!* (exclamation mark and all). Put together and narrated by Mitch Murray, one of Great Britain's leading songwriters, who is also an avid SWL (*S*hort-*W*ave *L*istener), the record is an obvious labor of love. (See Fig. 1.) Side A tells us about SWL'ing: what it is, the frequencies in use during different time periods, antenna tips . . . just about everything a new SWL would want to know. For example, there are actual samples of the sounds of RTTY, SSTV and satellite signals.

There isn't a wasted word on the whole side, which runs about 22 minutes. One subject flows into the next, and the youngsters—and a few old-timers—we played the record for were left sitting on the edges of their seats waiting to hear what Mitch would cover next.

A small booklet, actually a piece of paper about 8 × 13 inches that is folded in thirds, contains the artwork that Mitch refers to. Some of the pictures are antenna designs; others are charts, such as the SINPO code and frequency conversion. (SINPO is a method of reporting reception quality—*Editor*)

On that one side of an LP, Mitch Murray covers SWL'ing better than does any book I've read.

FIG. 1

The flip side of the record is still more fun. It contains the station identification, or *signatures*, of SW stations around the globe: from the "Blue Danube" cimbalon signature of Austrian Radio to some exotic bird of New Zealand. You can tell who is broadcasting, even if you don't know the language, by these "signatures."

One really big extra provided with the record is a listing of the major DX clubs around the world, including addresses. In many instances those are "umbrella" clubs that can supply you with the address of any DX club that is in your local area.

Long Life Shortwave! is available from Trans-Island Productions Ltd., P.O. Box 24, Douglas, Isle of Man, British Isles, for $6.95 including postage. Specify either record or cassette format.

Raising the antenna current

As to mobile CB antennas, there are two "rules" that determine how far your signal travels: 1—For a given antenna design (base-loaded, center-loaded, etc.), the longer the overall antenna length, the greater the radiation. 2—For a given antenna length, the higher the loading coil (if any), the greater the radiated signal. Since each antenna type has its advantages and disadvantages you usually select the best compromise for your own personal needs. However, if you're presently using certain base-loaded mobile antennas and would like to switch to one of the continuously-loaded, or top-loaded designs, you can do so without going through the expense of a complete antenna system. A small metal gadget from Anixter-Mark, the model HWA-1 CB Antenna Adapter, screws on in place of some base-loading coils and provides a standard ⅜ inch-24 thread for standard and loaded whips, quick-connectors, and light-duty springs.

Presently, the model HWA-1 can be used on the following antenna mounts: A/S model M-125; Royce model 2-205; Antenna Inc. model 17610, and a host of imported models. Your best bet is to go down to your local Anixter-Mark antenna dealer and make sure the adaptor will fit your mount.

The primary advantage of using an antenna with a high loading coil is shown in Fig. 2. Note that radiation is from the area of maximum current, which is near the base of the antenna. The closer the loading coil is to the base the more the radiating current area gets *squished* towards the groundplane. Maximum current—hence, maximum radiation—for a given antenna length is provided by top loading; but top loading gets very "hairy." It has a narrow bandwidth and

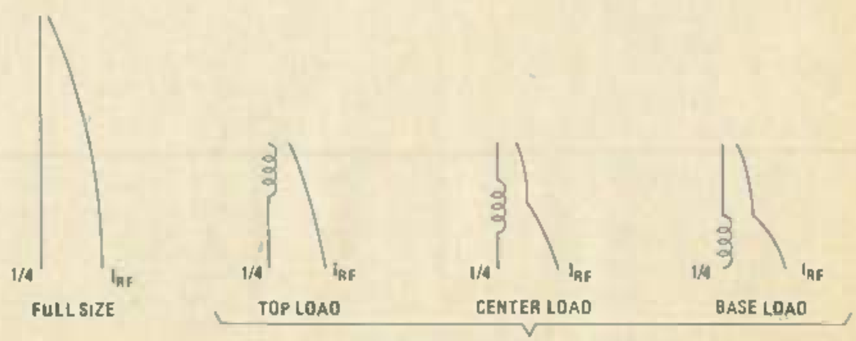


FIG. 2

requires really precise tuning for lowest SWR. Nontuneable models positively require a broad groundplane under them, such as the roof of a car or RV, or the *center* of a trunk.

Tri-band monitor antenna.

Our final item this time falls into the "Why didn't I think of it?" category. It's the magnetic mounted mobile low/high VHF and UHF monitor antenna, Hustler model MOM, covering the 30-50, 150-174, and 450-512 MHz bands. Basically, it consists of a magnetic mount with an antenna approximately 34 inches long. The whip antenna has a loading coil in the approximate center that "tunes" the whip to the low (30-50) VHF band. On the high VHF band the coil functions as an "isolator," or trap, so signals are received by the lower part of the antenna that functions as a ¼-wave whip at the high-VHF frequencies. On the UHF band the lower part of the antenna appears to function as a ⅝-wave whip. (The sizes are only approximate. The antenna is for receiving only; not for transmitting.)

The supplied 17-foot coax cable has Motorola-type plugs on both ends since it plugs into a matching connector on the magnetic base.

Why a plug-in connector? That is where the "Why didn't I think of it?" comes in. The magnetic base has two slots cut in the rear. A small metal bracket supplied with the antenna is attached to the edge of the trunk lip behind the rear window. The bracket is similar to those used for "standard" trunk-lip antennas except for two small hooks that protrude upward. If you intend to barrel down the highway at speeds that might tear a magnetic mount loose (and contrary to what anyone says it *does* happen), you simply engage the slots in the mount with the hooks when you install the antenna and it will stay put under any driving condition. Between the hooks and the magnets that antenna doesn't come loose.

To remove the antenna you simply unplug the coax at the mount and lift the antenna off the hooks. A weatherproof cap is provided for the coax plug in case you want to leave it out for possible instant use.

One other bit about the Hustler MOM: It makes a great "indoor" VHF/UHF antenna if your monitoradio has a metal cabinet. Simply place it on top of the cabinet; the magnet locks it in place. **R-E**

service clinic

The "Christmas tree" pattern reveals itself once again.

JACK DARR, SERVICE EDITOR

A LONG TIME AGO, THERE WERE MANY TV sets. These were black-and-white sets, and they all had their problems (You'll note that this tendency is still around!) One of the most annoying of these was a peculiar instability in the horizontal oscillator. Because of the unmistakable pattern it made on the TV screen, it was easy to recognize, but could be very hard to find. That is the "Christmas tree" (Fig. 1) and is one of the places where the "big scope" (TV screen) actually gave you the diagnosis!

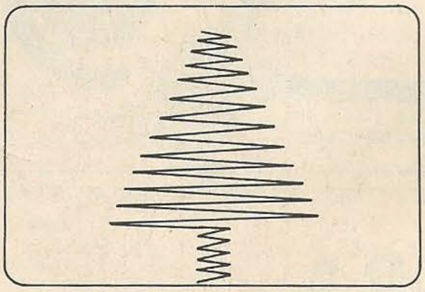


FIG. 1

Analyzing this, you can see that the horizontal oscillator starts to sweep only a wee bit, and slowly, at the top of the screen. Gradually, this gets wider and wider. When the trace gets to the bottom of the screen, it abruptly collapses and the whole sequence starts over again. The horizontal oscillator is *trying* to work. When it reaches a certain amplitude, it collapses. The reason is that something is upsetting the *feedback*. No feedback means no oscillation, in any kind of oscillator circuit.

The major cause of this is something is getting into the normal feedback loop of the oscillator, and preventing it from going into normal oscillation. Probably caused by cancellation of pulses, etc. Eventually, we found that the main cause of this was a bad filter capacitor, usually in the B+ line that fed both horizontal oscillator and horizontal output stage. Pulses were being fed back through the B+, and got to the wrong place at exactly the right time, to kill the oscillation. Incidentally, you'll notice that there is also a 60-Hz ripple involved in this! The tree pattern is steady! So, the oscillator is being gradually 'killed' at a 60-Hz rate. A bad capacitor allows increase in this ripple, and lets 15,750 Hz. pulses in.

The exception to this rule is in sets with the popular *Synchroguide* oscillator circuit. By carefully setting this up exactly wrong, you could find a combination of adjustments to the two coils that would let it Christmas tree.

With later model sets, we haven't seen the Christmas tree pattern for a long time. The other day, I saw one! Real dandy, too. Same unmistakable pattern, but a double; there were two trees, top to bottom, complete in every detail. (Fig. 2) This was in a Sylvania E06-02 chassis. Original complaint was loss of height. Replacing the vertical driver/amplifier IC cleared this up, and the set went home. Back in a few days, with complaint of "lines in the picture and makes funny noise at turn-on". On the bench, it played very well for quite a while.

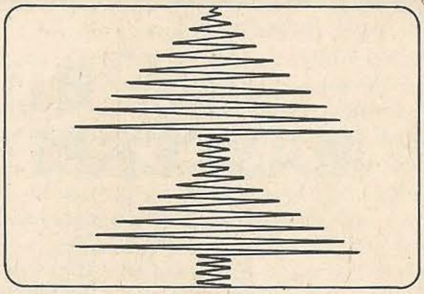


FIG. 2

Finally, it began to show horizontal pulling at a 2-3 second rate, then went into the new Christmas tree pattern. From force of habit, I scope the B+ line feeding the horizontal oscillator! The scope showed pulses here. DC Voltage readings were low, and the B+ boost line, +170 V was also low and showed pulses. A bad filter was suspected. Turned out to be a 100 μF 250 V capacitor on the +170 V boost line. This is a flyback-derived voltage and could be expected to be low with the odd drive waveform from the oscillator. However, it was the culprit; the open filter was allowing high pulse voltages to develop on the +170 V line, and this was managing to get into the B+ line feeding the horizontal oscillator, in amplitude great enough to cause the incorrect feedback and Christmas tree pattern. However, the old concept seems to be valid still; the major cause *was* a bad filter capacitor and the proof of the pudding was the presence of pulses on the B+ lines. Replacing this capacitor cleared up the problem.

So: if you start seeing Christmas trees in the middle of the summer, up scope and look first on your B+ lines feeding the horizontal oscillator. As far as I *know*, it is not possible for a normally-operating horizontal oscillator of the modern type to be misadjusted in such a way that it will Christmas tree. In the Synchroguides, the two coils made it fairly easy to find a setting that would cause this. Some used to call this "squegging". A fascinating word, and I've never yet been able to find out where it came from or what it meant! Sounds like one that was invented to describe something, and in that way, I guess it's OK! **R-E**

service questions

HORIZONTAL PROBLEM

I have a problem with a model 1872 XAM color set. It came in with sound and no raster. I changed the output, the high-voltage rectifier and the damper. The picture came back, but now it runs horizontally. Adjusting the hold control finally produced three pictures side by side, vertically locked. I've checked everything I can think of. Any ideas? I used a solid-state high-voltage rectifier. Could this be causing it?—J.G., Brooklyn, NY.

This is a horizontal-frequency problem, and I doubt that the high-voltage rectifier would affect it at all. Try this to see if it works: Shunt out the horizontal AFC and see if you can adjust the horizontal-hold control, etc., to get ONE straight-sided floating picture.

If you can't, then there's a part off-tolerance somewhere in the frequency-determining section of the oscillator—either the coil or the capacitors across it. Check C261, C262 and the resistance of the coil, both sides of the tap. Be sure to use exact replacements for these parts; they are critical.

VERTICAL SHRINK, POOR SYNC

Here's one that fooled me for a while. The picture on this GE KC chassis shrank up from the bottom, and had very poor vertical sync. After checking a few things with no luck, I finally pulled the deflection yoke and found that the little thermistor in series with the bottom half of the yoke was bad. Apparently this also caused the sync problem. Please pass this along.

Sure will, and thanks to Bob Stevens, TV Rebuild Service, for this tip.

MAGNAVOX HEAD NEEDED

I need a play-record head for a Magnavox model 2TR200S reel-to-reel tape recorder. The factory says it's not available any more. Do you have any information on this?—L.T., Wartburg, TN.

The Nortronics Company (8101 Tenth Ave. North, Minneapolis, MN 55427) does list this Magnavox part number. They list their type 1002 as a replacement for the Magnavox 76149043 head. I hope this helps.

BRIGHTNESS PROBLEM

Don Black, service manager for Sony of Canada, Ltd., sends along this note about the raster shading problem in the Sony *model KV-1910* mentioned in the January 1979 issue. He says that it is apt to be caused by filter capacitor C707, (4.7 μF, 250V) on board T. This is a filter in the collector supply circuit to the R–G–B output transistors. Thanks to Mr. Black for his help.

BAD FLYBACK

I'm a teacher's aid in a vocational school radio-TV repair class. We have a problem with an RCA model KCS-153B. The high voltage is very low; there is severe blooming and not enough width. I found that the high-voltage winding of the flyback read 15,000 ohms. (The diagram shows this should read 590 ohms.) The transformer shows continuity, but also shows "short." Do you think this flyback is bad?—L.L., LaGrange, KY.

Yes. It has probably overheated and shorted a few turns in the high-voltage winding. This will cause all of the symptoms you describe.

SCOPE POSITIONING PROBLEM

Your crystal ball hit it right on the nose in a horizontal positioning problem in my Sylvania *model 400* scope. The voltages on the 7C5's were the same, but on the horizontal internal/external switch, one voltage was OK and the other way up. The 0.1-μF coupling capacitor, C37, was shorted! I replaced C37 with a new capacitor and bingo! Thanks.—Roger Williams, New Orleans, LA.

HIGH-VOLTAGE PROBLEM

This Admiral model 3K19 is showing several odd symptoms. The cathode current in the 26LW6 is way up, and the high voltage is way down. The boost voltage is just about right at 875 volts. Any ideas you might have would be welcome.—J.C., Berlin, NY.

I have one idea: If your boost voltage is normal, this tells you that the horizontal-output stage, deflection yoke and flyback

continued on page 76

SERVICE QUESTIONS

continued from page 75

are OK. Since you have a high-voltage problem, try a new high-voltage tripler; that would be a more likely cause.

(Feedback: Yes, it was indeed a very "bad tripler!")

SHORT TUBE LIFE

This Penncrest model CB233 TV has a 16A8 tube that lasts only about 4 or 5 days to a week! I've monitored all the voltages on it, but can't see anything wrong. I have another model of this make with the same problem!—V.S., Burlington, WI.

There is one thing shown on the schematic diagram that might be causing this problem. A dropping diode is used in the heater string; result—reduced power. If this diode is leaky or shorted, it places the full sinewave AC on it and overloads the tubes. Check the diode for leakage, or replace it. Incidentally, a sinewave AC voltmeter will *not* measure the heater voltage correctly because this voltage is a half-wave pulsating AC. Take note that Sams shows only 10 volts across the 16A8 tube!

HINT ON MAD MODULES

RCA is now enclosing a note in its shipments of MAD modules that reads:

"When using Module Stock No. 139685 as a replacement for Modules MAD001A-1H, 1J, 1P or 1R, it may be necessary to solder the pixtube socket leads to the external terminals of the module." This might be helpful.

LUCK OR GENIUS?

Your crystal ball must have been really working in the April 1976 issue! A neighbor to the east of me had the intermittent-start horizontal oscillator problem; the neighbor to the west had the Zenith high-voltage regulator trouble! How do you do it?—L.H., Rochester, NY.

There are two distinct schools of thought on this; one group favors genius, the other seems to lean more toward pure luck. As far as I can see, the second group has a slight edge—something like 97.3%. However, if it works take it!

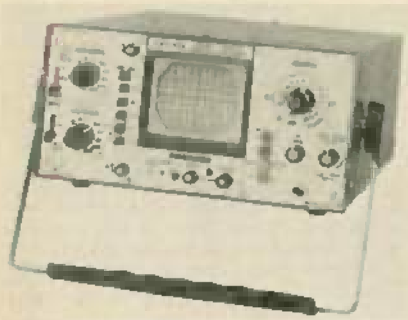
SHUTDOWN TROUBLE

Thanks to your help, "we" finally found what was causing this model 19TS-949 Quasar to shut down after about 15–30 seconds! You said that it would shut down on both low and high voltages. I found that the 25-ohm, 20-watt resistor, R815, was *cracked* right under the metal clamp that holds it in place. The center wire wasn't broken, but the resistance was close. I replaced it and all system were go! I figure that the loose wire in the cracked insulator heated more at turn-on and was upsetting the anode voltage on the SCR, causing it to trip.—L.F., Fulton, MO. R-E

new products

More information on new products is available. Use the Free Information Card inside the back cover.

DUAL-TRACE, 20-MHZ OSCILLOSCOPE, *model LBO-308,* is a 3-inch portable scope designed for field and lab applications, with power supplied



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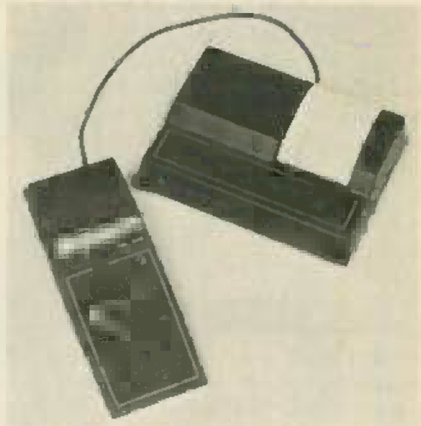
from AC/DC source or optional rechargeable battery pack. Specifications include a 2 mV-per-division sensitivity over 12 measurement ranges, a 17.5-ns risetime, X5 magnification, and a maximum sweep speed range of 0.1 µs-per-division. The unit also has triggers for both channels and X-Y operation. The *model LBO-308* comes with probes; carrying case is optional. Suggested retail price: $950.—**Leader Instruments Corp.,** 151 Dupont St., Plainview, NY 11803.

CALCULATOR, *Model HP-41C,* has an alphanumeric LCD display and contains 130 preprogrammed scientific and mathematical functions. In addition, it can perform other calculations through programs written by the user or from applications software. Peripheral devices can be plugged into calculator for added capabilities; these include 4 memory modules to increase program memory, a card reader to enter and record programs, a thermal printer for output, a wand that enters programs optically, and 16 applications modules for solving problems in specific areas.

Other features of the calculator include editing powers, comparing data and results, word messages indicating calculation errors, keyboard overlays, labels for addressing parts of programs, and a continuous memory that retains programs



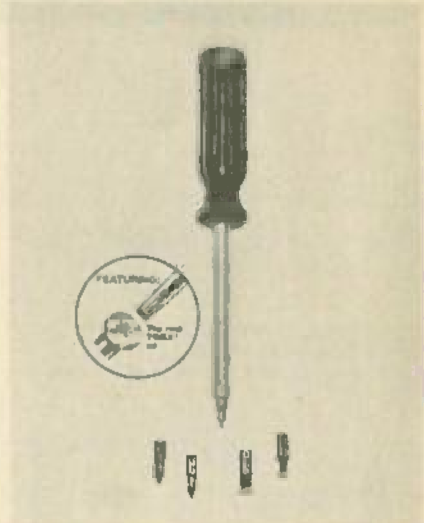
CIRCLE 152 ON FREE INFORMATION CARD

and data even when power is shut off. Price is $295.00. Plug-in devices sold separately.—**Hewlett Packard,** 1501 Page Mill Rd., Palo Alto, CA 94304.

MAGNETIC 5-IN-1 SCREWDRIVER, *model 70425,* is designed for use in home, shop, garage or factory applications. A built-in magnet in the shank holds extra bits and the screw. The *Com-*

NEW PRODUCTS

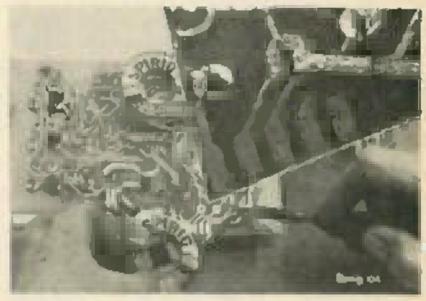
continued from page 77



CIRCLE 153 ON FREE INFORMATION CARD

Tordome handle features a removable dome cap that stores the 4 extra bits inside the shaft while the fifth bit is in use. The bits include the *Torx T15*, a $\frac{5}{32}$-in. and a $\frac{1}{4}$-in. regular, plus No. 1 and No. 2 Phillips bits.—**Vaco Products Co.**, 1510 Skokie Blvd., Northbrook, IL 60062.

DESOLDERING WICK, *3S-Wick*, comes in spools containing a 5-foot, 5-inch length and costs $.49 each for OEM quantities of 5000. Each spool is



CIRCLE 154 ON FREE INFORMATION CARD

worth about 250 desoldering operations.—**Solder Absorbing Technology, Inc.**, 357 Cottage St., Springfield, MA 01104.

MODULE REBUILDING SERVICE accepts all makes of remote control transmitters for rebuilding, including Admiral, GE, Magnavox, Quasar, RCA, GTE-Sylvania, Zenith, Packard Bell, Advent, Sanyo and Truetone. Information on specific transmitter and module numbers, etc., can be obtained by writing the company.—**PTS Electronics, Inc.**, 5233 S. Highway 37, Bloomington, IN 47401. R-E

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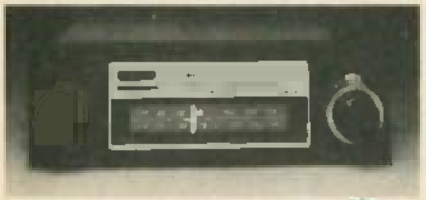
stereo products

More information on stereo products is available. Use the Free Information Card inside the back cover

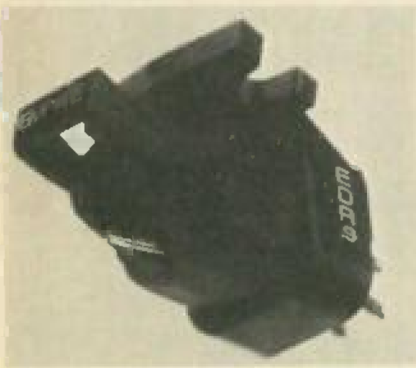
CAR STEREO EQUIPMENT LINE, 20 models (*model SR2100* shown) ranging from under-dash 8-track and cassette units to 8-track/cassette AM/FM stereo radio combinations, several with



CIRCLE 131 ON FREE INFORMATION CARD

digital displays. Many units feature loudness, muting, high-filter and AM/FM controls; LED indicators; audio-reverse cassette; and automatic key-off reject. Suggested retail price for the *model SR2100*, $219.95.—Sparkomatic Corp., Milford, PA 18337.

EXTENDED-RESPONSE PHONO CARTRIDGE, *model EDR.9*, has an aluminum cantilever with a nude-mounted diamond stylus. The stylus has a 0.3 by 3.0-mil radius. Other specifications: frequency response, 10 Hz–50 kHz, 20 Hz–35 kHz ±1¾ dB; tracking force range, ¾–1¼ grams;



CIRCLE 132 ON FREE INFORMATION CARD

separation, 20 dB at 20 Hz–5 kHz; compliance, 28 $\times 10^{-6}$ cm-per-dyne; power output, 4.5 mV at 5 cm-per-second. The cartridge weighs 5.2 grams, and sells for a suggested retail price of $199.—Empire Scientific Corp., 1055 Stewart Ave., Garden City, NY 11530.

LOUDSPEAKER SYSTEMS, *models XP20, XP40, XP60, XP80,* are acoustic suspension high-fidelity systems. The *model XP20* is a two-way coaxial system with a frequency response of 65 Hz–18 kHz, ±3 dB, a sensitivity of 88 dB at 1 watt 1 meter, and can handle up to 30 watts input. The speaker measures 14 H × 9.7 W × 8.7 inches D. The *model XP40* has an 8-inch woofer and a ¾-inch midrange/tweeter; provides a frequency response of 63 Hz–20 kHz, ±3 dB, an 88-dB sensitivity at 1 watt 1 meter, and a maximum input of 35 watts. The unit measures 16.7 H × 9.7 W × 9.4 inches D. The *model XP60* (shown) is a three-way system with a sensitivity of 87 dB at 1 watt 1

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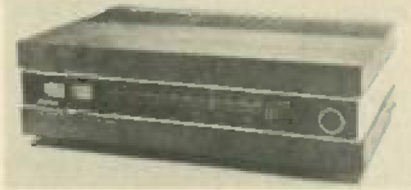
meter and a power-handling capability of 40 watts. It features a ¾-inch tweeter, a 4-inch midrange driver and an 8-inch woofer. The unit measures 18.7 H × 10.4 W × 9.4 inches D. The *model XP80* uses a 10-inch woofer to provide a low bass response. It has a sensitivity rating of 86 dB 1 watt 1 meter, and a maximum power-handling capability of 50 watts; it measures 22.2 H × 12 W × 10.4 inches D. All speaker enclosures are teak or walnut veneer with a brown grille cloth and come in pairs. Suggested retail prices: *XP20*, $90; *XP40*, $115; *XP60*, $160; *XP80*, $210.—Rank Hi Fi Inc., 20 Bushes Lane, Elmwood Park, NJ 07407.

AM/FM STEREO RECEIVER, *Spatial Control* receiver, provides 100 watts-per-channel, contains four amplifiers and features a spatial slide control. Slide control is used in conjunction with the



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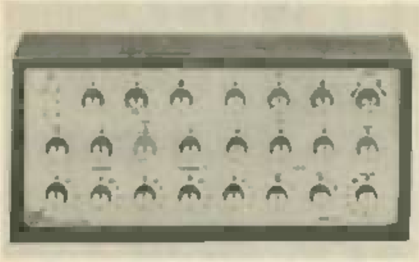
model 901 Direct-Reflecting loudspeakers to narrow or widen the aural image. Also available is a 40-watt stereo receiver, the *model 550*. Suggested retail prices: the *Spatial Control* receiver, $799; the *model 550*, $349.—Bose Corp., 100 The Mountain Rd., Framingham, MA 01701.

SOUND/SPEAKER CONTROL SYSTEMS, *Series CD*. Audio control systems provide simultaneous tape recorder playback, dubbing, record, mixing and monitoring capabilities using single patchcord. The *model CD-5* system controls three tape

STEREO PRODUCTS
continued from page 79



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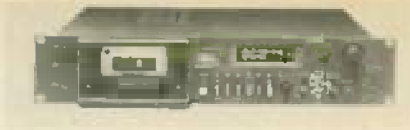
recorders plus an amplifier/receiver and contains a fade control. The *model CD-10* monitors six tape recorders (reel-to-reel, cassette or 8-track units), an amplifier/receiver and signal processors; it also features a fade control and 10-position switch. The *model CD-35* (shown) handles five tape recorders plus an amplifier/receiver and signal processors; it contains a 12-position switch and auxiliary control to monitor a sixth tape recorder. The speaker control system (the *model CD-25*) can accommodate up to four sets of speakers, contains 10-position control switch and can handle 20 watts-per-channel. Suggested retail prices: *model CD-5*, $99.95; *model CD-10*, $149.95; *model CD-35*, $399.95; *model CD-25*, $189.95.—**Dubie Corp.**, 1725 Ladera Trail, Dayton, OH 45459.

CASSETTE DECK, *model RS-M65*, uses a built-in frequency generator servomotor, providing a 0.3% tape speed deviation and 0.035% WRMS wow-and-flutter. The *model RS-M65* is rack-mountable, and offers the following features: a removable tape compartment door, a muting



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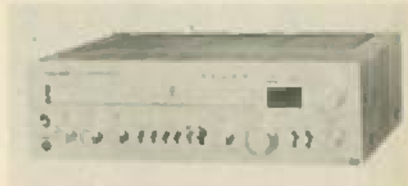
switch, timer controls, a PAUSE control, a 3-position bias and equalization selector control, a MEMORY REWIND switch, Dolby with multiplex filter, input/output selector switches, mike jacks, left and right input/output level controls, a fluorescent meter, and a tape counter. Suggested retail price: $550.—**Technics**, One Panasonic Way, Secaucus, NJ 07094.

STEREO RECEIVER, *model STA-240*, delivers 60 watts-per-channel RMS minimum into 8 ohms, 20 Hz–20 kHz, with no more than 0.15% THD, and provides a sensitivity of 1.9 μV and a capture ratio of 1.5 dB. The receiver's features include automatic AM bandwidth control; digital frequency readout plus slide-rule tuning dial; *Auto-Magic*



CIRCLE 137 ON FREE INFORMATION CARD

FM tuning; tape dubbing and monitor switches; 5-point LED signal-strength indicator; high-cut and low-cut filter switches; a 25-75-μs de-emphasis switch; and input/output jacks. The *model STA-240* is housed in a walnut veneer wood cabinet, and carries a suggested retail price of $429.95.—**Radio Shack**, 1400 One Tandy Center, Fort Worth, TX 76102. **R-E**

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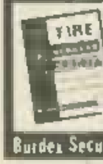

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Easily adaptable on most 1802 systems. Requires 12K RAM minimum for Basic and user programs. Cassette version in stock now. ROM versions coming soon with exchange privilege allowing some credit for cassette version.

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RCA Cosmac Super Elf Computer $106.95

Compare features before you decide to buy any other computer. There is no other computer on the market today that has all the desirable benefits of the Super Elf for so little money. The Super Elf is a small single board computer that does many big things. It is an excellent computer for training and for learning programming with its machine language and yet it is easily expanded with additional memory, Full Basic, ASCII Keyboards, video character generation, etc.

Before you buy another small computer, see if it includes the following features: ROM monitor; State and Mode displays; Single step; Optional address displays; Power Supply; Audio Amplifier and Speaker; Fully socketed for all IC's; Real cost of in warranty repairs; Full documentation.

The Super Elf includes a ROM monitor for program loading, editing and execution with SINGLE STEP for program debugging which is not included in others at the same price. With SINGLE STEP you can see the microprocessor chip operating with the unique Quest address and data bus displays before, during and after executing instructions. Also, CPU mode and instruction cycle are decoded and displayed on 8 LED indicators.

An RCA 1861 video graphics chip allows you to connect to your own TV with an inexpensive video modulator to do graphics and games. There is a speaker system included for writing your own music or using many music programs already written. The speaker amplifier may also be used to drive relays for control purposes.

A 24 key HEX keyboard includes 16 HEX keys plus load, reset, run, wait, input, memory protect, monitor select and single step. Large, on board displays provide output and optional high and low address. There is a 44 pin standard connector slot for PC cards and a 50 pin connector slot for the Quest Super Expansion Board. Power supply and sockets for all IC's are included in the price plus a detailed 127 pg. instruction manual which now includes over 40 pgs. of software info. including a series of lessons to help get you started and a music program and graphics target game.

Many schools and universities are using the Super Elf as a course of study. OEM's use it for training and research and development.

Remember, other computers only offer Super Elf features at additional cost or not at all. Compare before you buy. **Super Elf Kit $106.95. High address option $8.95. Low address option $9.95.** Custom Cabinet with drilled and labelled plexiglass front panel $24.95. Expansion Cabinet with room for 4 S-100 boards $41.00. NiCad Battery Memory Saver Kit $6.95. All kits and options also completely assembled and tested.

Questdata, a 12 page monthly software publication for 1802 computer users is available by subscription for $12.00 per year.

Tiny Basic Cassette $10.00, on ROM $38.00, original Elf kit board $14.95. 1802 software: Moews Video Graphics $3.50. Games and Music $3.00. Chip 8 interpreter $5.50.

Super Expansion Board with Cassette Interface $89.95

This is truly an astounding value! This board has been designed to allow you to decide how you want it optioned. **The Super Expansion Board comes with 4K of low power RAM** fully addressable anywhere in 64K with built-in memory protect and a cassette interface. Provisions have been made for all other options on the same board and it fits neatly into the hardwood cabinet alongside the Super Elf. The board includes slots for up to 6K of EPROM (2708, 2758, 2716 or Ti 2716) and is fully socketed. EPROM can be used for the monitor and Tiny Basic or other purposes.

A 1K Super ROM Monitor $19.95 is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader/editor and error checking multi file cassette read/write software, (relocatible cassette file) another exclusive from Quest. It includes register save and readout, block move capability and video graphics driver with blinking cursor. Break points can be used with the register save feature to isolate program bugs quickly, then follow with single step. The Super Monitor is written with subroutines allowing users to take advantage of monitor functions simply by calling them up. Improvements and revisions are easily done with the monitor. If you have the Super Expansion Board and Super Monitor the monitor is up and running at the push of a button.

Other on board options include **Parallel Input and Output Ports with full handshake.** They allow easy connection of an ASCII keyboard to the input port. RS 232 and 20 ma Current Loop for teletype or other device are on board and if you need more memory there are two S-100 slots for static RAM or video boards. Also a 1K Super Monitor version 2 with video driver for full capability display with Tiny Basic and a video interface board. **Parallel I/O Ports $9.85, RS 232 $4.50, TTY 20 ma I/F $1.95, S-100 $4.50.** A 50 pin connector set with ribbon cable is available at $12.50 for easy connection between the Super Elf and the Super Expansion Board.

Power Supply Kit for the complete system (see Multi-volt Power Supply below).

Multi-volt Computer Power Supply

8v 5 amp, ±18v .5 amp, 5v 1.5 amp, −5v .5 amp, 12v .5 amp, −12 option. ±5v, ±12v are regulated. Kit $29.95. Kit with punched frame $37.45, $4.00 shipping. Woodgrain case $10.00, $1.50 shipping.

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6502 based single board with full ASCII keyboard and 20 column thermal printer. 20 char. alphanumeric display, ROM monitor, fully expandable. $375.00. 4K version $450.00. 4K Assembler $85.00. 8K Basic Interpreter $100.00. Power supply assy. in case $60.00. AIM 65 in thin briefcase with power supply $485.00.

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Includes everything except case. 2-PC boards. 6-.50" LED Displays. 5314 clock chip, transformer, all components and full instructions. Orange displays also avail. Same kit w/.80" displays. Red only. $21.95 Case $11.75

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Convert your TV set into a high quality monitor without affecting normal usage. Complete kit with full instructions.

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RT300 .... **$7.95**

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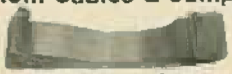

DB 25 Series Cables

Part No.	Cable Length	Connectors	Price
DB25P-4-P	4 ft	2-DP25P	$15.95 ea
DB25P-4-S	4 ft	1-DP25P/1-25S	$16.95 ea
DB25S-4-S	4 ft	2-DP25S	$17.95 ea

Dip Jumpers

DJ14-1	1 ft.	1-14 Pin	$1.59 ea
DJ16-1	1 ft.	1-16 Pin	1.79 ea
DJ24-1	1 ft.	1-24 Pin	2.79 ea
DJ14-1-14	1 ft.	2-14 Pin	2.79 ea
DJ16-1-16	1 ft.	2-16 Pin	3.19 ea
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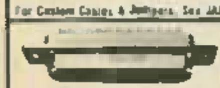
25 PIN-D SUBMINIATURE CONNECTORS

(Meets RS232)



PART NO.	DESCRIPTION	PRICE
DB25P	PLUG (as Pictured)	$2.95
DB25S	SOCKET	3.50
DB51226-1	CABLE COVER for DB25P or DB25S	1.75
DB25P-RJI	PLUG – Right Angle – P.C. Mount	4.90
DB25S-RJI	SOCKET – Right Angle – P.C. Mount	5.25

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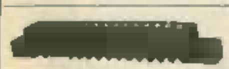

.156 Spacing–Tin–Double Read-Out
Bifurcated Contacts
Fits .054 to .070 P.C. Boards

PART NO.	DESCRIPTION	PRICE
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18/36 SE	18/36 Contacts – solder eyelet	2.49
22/44 SE	22/44 Contacts – solder eyelet	2.95
22/44 WW	22/44 Contacts – wire wrap	3.95
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Jumbo 6-Digit Clock Kit

- Four .630" ht. and two .300" ht. common anode displays
- Uses MM5314 clock chip
- Switches for hours, minutes and hold functions
- Hours easily viewable to 30 feet
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hour operation
- Includes all components, case and wall transformer
- Size: 6¾ x 3⅛ x 1¾

JE747 .... **$29.95**

- Bright .300 ht. comm. cath ode display
- Uses MM5314 clock chip
- Switches for hours, minutes and hold modes
- Hrs. easily viewable to 20 ft.
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hr. operation
- Incl. all components, case & wall transformer
- Size: 6¾" x 3-1/8" x 1¾"

JE701

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Uses LM309K. Heat sink provided. PC board construction. Provides a solid 1 amp @ 5 volts. Can supply up to ±5V, ±9V and ±12V with JE205 Adapter. Includes components, hardware and instructions. Size: 3½" x 5" x 2"H

JE200 .... **$14.95**

ADAPTER BOARD —Adapts to JE200— ±5V, ±9V and ±12V

DC/DC converter with +5V input. Toriodal high speed switching XMFR. Short circuit protection. PC board construction. Piggy-back to JE 200 board. Size: 3½" x 2" x 9/16"H

JE205 .... **$12.95**

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES

8080A	CPU	$ [illegible]
8212	8 Bit Input/Output	3.25
8214	Priority Interrupt Control	8.95
8216	Bi-Directional Bus Driver	3.49
8224	Clock Generator Driver	3.95
8226	Bus Driver	3.49
8228	System Controller/Bus Driver	4.[illegible]
8238	System Controller	5.95
8251	Prog. Comm. I/O (USART)	7.[illegible]
8253	Prog. Interval Timer	14.95
8255	Prog. Periph. I/O (PPI)	[illegible]
8257	Prog. DMA Control	1[illegible]
8259	Prog. Interrupt Control	[illegible].95

6800/6800 SUPPORT DEVICES

MC6800	MPU	$14.[illegible]
MC6802CP	MPU with Clock and Ram	24.95
MC6810AP1	128X8 Static Ram	6.95
MC6821	Periph. Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	12.[illegible]
MC6830L8	1024X8 Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	7.[illegible]
MC6852	Synchronous Serial Data Adapt	[illegible]
MC6860	0-600 bps Digital MODEM	12.[illegible]
MC6862	2400 bps Modulator	14.95
MC8T26A	Quad 3-State Bus. Transc. (MC6T26)	2.[illegible]

MICROPROCESSOR CHIPS—MISCELLANEOUS

Z80(780C1)	CPU	$14.[illegible]
Z80A(780-1)	CPU	16.95
CDP1802	CPU	1[illegible]
2650	MPU	1[illegible]
6502	CPU	11.95
8035	8-Bit MPU w/clock, RAM, I/O lines	19.95
P8085	CPU	[illegible]
TMS9900JL	16-Bit MPU w/hardware, multiply & divide	49.95

SHIFT REGISTERS

MM500H	Dual 25 Bit Dynamic	$ .50
MM503H	Dual 50 Bit Dynamic	.50
MM504H	Dual 16 Bit Static	.50
MM506H	Dual 100 Bit Static	.[illegible]
MM510H	Dual 64 Bit Accumulator	.50
MM5016H	500/512 Bit Dynamic	.[illegible]
2504T	1024 Dynamic	[illegible]
2518	Hex 32 Bit Static	4.95
2522	Dual 132 Bit Static	2.95
2524	512 Static	.[illegible]
2525	1024 Dynamic	2.[illegible]
2527	Dual 256 Bit Static	2.95
2528	Dual 250 Static	4.[illegible]
2529	Dual 240 Bit Static	4.00
2532	Quad 80 Bit Static	2.[illegible]
3341	Fifo	[illegible]
74LS670	4X4 Register File (Tri-State)	2.49

UART'S

AY-5-1013	30K BAUD	$.95

MICROPROCESSOR MANUALS

M-Z80	User Manual	$7.[illegible]
M-CDP1802	User Manual	7.50
M-2650	User Manual	[illegible]

ROM'S

2513(2140)	Character Generator(upper case)	$1.95
2513(3021)	Character Generator(lower case)	[illegible]
2516	Character Generator	10.95
MM5230N	2048-Bit Read Only Memory	1.95

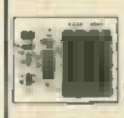
RAM'S

1101	256X1	Static	$1.49
1103	1024X1	Dynamic	.[illegible]
2101(8101)	256X4	Static	[illegible]
2102	1024X1	Static	1.[illegible]
21L02	1024X1	Static	1.95
2111(8111)	256X4	Static	3.[illegible]
2112	256X4	Static MOS	4.95
2114	1024X4	Static 450ns	7.[illegible]
2114L	1024X4	Static 450ns low power	10.95
2114-3	1024X4	Static 300ns	[illegible]
2114L-3	1024X4	Static 300ns low power	11.95
5101	256X4	Static	7.95
5280/2107	4096X1	Dynamic	4.[illegible]
7489	16X4	Static	1.75
74S200	256X1	Static Tri-state	4.[illegible]
93421	256X1	Static	2.95
UPD414 (MK4027)	4K	Dynamic 16 pin	4.95
UPD416 (MK4116)	16K	Dynamic 16 pin 250ns	[illegible]
TMS4044 (4045)	4K	Static	14.[illegible]
TMS4045	1024X4	Static	14.95
2118	16,384X1	Dynamic 200ns (5 volt single supply)	[illegible]
MM5262	2KX1	Dynamic	[illegible]

PROM'S

1702A	2048	FAMOS	$5.95
2716(INTEL)	16K*	EPROM	[illegible]
TMS2516	16K*	EPROM	49.95
(2716)	*Requires single + 5V power supply		
TMS2532	4KX8	EPROM	[illegible]
2708	8K	EPROM	[illegible]
2716 T.I.	16K**	EPROM	29.95
	**Requires 3 voltages: −5V, +5V, +12V		
5203	2048	FAMOS	14.95
6301-1(7611)	1024	Tri-state Bipolar	3.49
6330-1(7602)	256	Open C Bipolar	2.95
82S23	32X8	Open Collector	[illegible]
82S115	4096	Bipolar	19.95
82S123	32X8	Tri-state	[illegible]
74186	512	TTL Open Collector	9.95
74188	256	TTL Open Collector	[illegible]
74S287	1024	Static	2.95

JE600 HEXADECIMAL ENCODER KIT



FEATURES:
- Full 8 bit latched output for microprocessor use
- 3 User Define keys with one being bi-stable operation
- Debounce circuit provided for all 19 keys
- LED readout to verify entries
- Easy interfacing with standard 16 pin IC connector
- Only +5VDC required for operation

FULL 8 BIT LATCHED OUTPUT—19 KEYBOARD

The JE600 Encoder Keyboard provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8 bit microprocessor or 8 bit memory circuits. Three (3) additional keys are provided for user applications with one having a bi-stable output available. The outputs are latched and monitored with LED readouts. Also included is a key entry strobe.

JE600 .... **$59.95**
Hexadecimal Keypad only $14.95

DIGITAL THERMOMETER KIT

- Dual sensors—switching control for indoor/outdoor or dual monitoring
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- Range: −40°F to 199°F / −40°C to 100°C
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- Simulated walnut case - AC wall adapter incl.
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JE300 .... **$39.95**

62-Key ASCII Encoder Keyboard Kit

The JE610 62-Key ASCII Encoder Keyboard Kit can be interfaced into most any computer system. The JE610 Kit comes complete with an industrial grade keyboard switch assembly (62 keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and −12V @ 10mA for operation.

FEATURES:
- 60 Keys generate the full 128 characters, upper and lower case ASCII set
- Fully buffered
- 2 user define keys provided for custom applications
- Caps lock for upper case only alpha characters
- Utilizes a 2376 (40 pin) encoder read only memory chip
- Outputs directly compatible with TTL/DTL or MOS logic arrays
- Easy interfacing with a 16-pin dip or 18-pin edge connector

JE610 ..... **$79.95**

62-Key Keyboard only . . $34.95

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LX303 Digital Multimeter **$74.95**

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VP-40	40kV DC PROBE	39.95
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Data Transmission Method	Frequency Shift Keying, full duplex (half-duplex selectable)
Maximum Data Rate	300 Baud
Data Format	Asynchronous Serial (return to mark level required between each character)
Receive Channel Frequencies	2025 Hz for space; 2225 Hz for mark
Transmit Channel Frequencies	Switch selectable: Low (normal) – 1070 space, 1270 mark; High – 2025 space, 2225 mark
Receive Sensitivity	−46 dbm acceptable signal
Transmit Level	−15 dbm nominal; Adjustable from −6 dbm to −20 dbm
Receive Frequency Tolerance	Frequency tolerance automatically adjusts to align for operation between 1800 Hz and 2400 Hz
Digital Data Interface	EIA RS-232C or 20 ma current loop (receiver is optoisolated and non-polar)
Power Requirements	120 VAC, single phase, 10 Watts
Physical	All components mount on a single 5" by 9" printed circuit board. All components included.

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

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Expand your 4K TRS-80 System to 16K.
Kit comes complete with:
- 8 each UPD416-1 (16K Dynamic Rams) 250NS
- Documentation for conversion

TRS-16K **$75.00**

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JUST WRAP™ Replacement Wire

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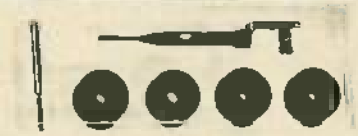

JUST WRAP™ Kit

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- Unwrapping Tool

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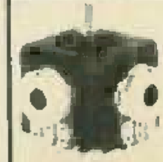
- Complete with holding tray for 4 chips

UVS-11E **$69.95**

Micro-Miniature Joystick



- 2 each 100K pots (Linear Taper)
- Printed Circuit Board Mount
- Size: 1" x 1-3/16" x 1-3/16"

Micro-Miniature Joystick . . . **$4.95**

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30pc.-HEAT SHRINK, thermo-fit, useful asst. of sizes, shrinks 50% (#3240)	1.29	60 for 1.30
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15 HUMBUCKER CONTROLS, assorted values, manufacturers dump, (#3007)	1.29	30 for 1.30
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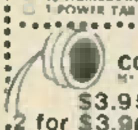

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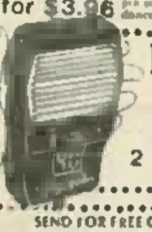

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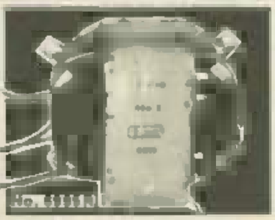

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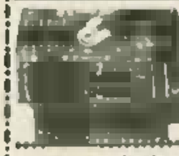

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TYPE	25 UP	10-24	1-9
2SA 473	45	55	60
2SA 483	2.00	2.20	2.50
2SA 484	1.50	1.75	1.95
2SA 485	1.40	1.60	1.80
2SA 489	1.10	1.25	1.40
2SA 490	70	80	90
2SA 493	45	53	59
2SA 495	30	35	40
2SA 496	50	64	70
2SA 497	1.00	1.20	1.30
2SA 505	50	64	70
2SA 509	30	35	40
2SA 525	50	64	70
2SA 530	1.50	1.70	1.90
2SA 537A	1.50	1.70	1.90
2SA 539	40	45	50
2SA 545	45	53	59
2SA 561	30	35	40
2SA 562	30	35	40
2SA 564A	20	27	30
2SA 565	70	80	90
2SA 566	2.50	2.70	3.00
2SA 606	1.00	1.20	1.30
2SA 607	1.10	1.25	1.40
2SA 624	70	80	90
2SA 627	3.10	3.30	3.60
2SA 628	30	35	40
2SA 634	40	45	50
2SA 640	30	35	40
2SA 642	30	35	40
2SA 643	30	40	45
2SA 653	1.90	2.10	2.40
2SA 659	35	40	45
2SA 661	50	.64	70
2SA 663	3.65	3.80	4.20
2SA 666	35	40	65
2SA 671	80	90	1.00
2SA 672	30	35	40
2SA 673	35	40	45
2SA 678	35	40	45
2SA 679	4.20	4.40	4.90
2SA 680	4.20	4.40	4.90
2SA 682	80	90	1.00
2SA 683	30	35	40
2SA 684	35	40	45
2SA 695	40	[illegible]	59
2SA 697	40	53	59
2SA 699A	50	64	70
2SA 705	40	53	59
2SA 706	85	1.00	1.10
2SA 715	80	70	80
2SA 719	30	35	40
2SA 720	30	35	40
2SA 721	30	35	40
2SA 725	30	35	40
2SA 726	30	35	40
2SA 733	20	27	30
2SA 738	40	53	59
2SA 740	1.50	1.70	1.90
2SA 743A	85	1.00	1.10
2SA 744	4.20	4.40	4.90
2SA 745R	3.80	4.00	4.40
2SA 747	4.20	4.40	4.90
2SA 748	70	80	90
2SA 750	35	40	45
2SA 755	80	90	1.00
2SA 756	2.30	2.80	2.65
2SA 758	3.40	3.55	3.90
2SA 764	3.80	4.00	4.40
2SA 765	3.10	3.30	3.60
2SA 774	40	45	50
2SA 777	50	[illegible]	70
2SA 794A	60	70	80
2SA 798	50	55	60
2SA 814	70	80	90
2SA 815	60	70	80
2SA 818	50	64	70
2SA 819	70	80	90
2SA 837R	2.50	2.70	2.90
2SA 839Y	1.30	1.45	1.60
2SA 908	8.60	8.80	9.40
2SA 913	70	80	90
2SB 22	30	35	40
2SB 54	20	27	30
2SB 55	40	53	59
2SB 75	35	40	45
2SB 77	35	40	45
2SB 173	30	35	40
2SB 175	20	27	30
2SB 176	30	35	40
2SB 178	35	40	45
2SB 186	20	27	30
2SB 187	20	27	30
2SB 202	1.10	1.20	1.30
2SB 220	90	1.10	1.20
2SB 303	30	35	40
2SB 324	30	35	40
2SB 337	70	80	90

TYPE	25 UP	10-24	1-9
2SB 346	30	35	40
2SB 367	1.10	1.25	1.40
2SB 368B	1.80	2.00	2.25
2SB 370	70	80	90
2SB 381	30	35	40
2SB 400	30	35	40
2SB 405	30	35	40
2SB 407	30	90	1.00
2SB 415	30	35	80
2SB 434	80	90	1.00
2SB 435	90	1.10	[illegible]
2SB 440	40	53	[illegible]
2SB 448	1.30	1.45	1.60
2SB 461	90	[illegible]	1.20
2SB 463	90	1.10	1.20
2SB 471	1.10	1.25	1.40
2SB 472	[illegible]	2.50	2.80
2SB 473	[illegible]	90	1.00
2SB [illegible]	70	80	90
2SB [illegible]	90	1.10	1.20
2SB [illegible]	60	70	80
2SB [illegible]	80	90	1.00
2SB 509	1.10	1.20	1.30
2SB 511	.70	80	90
2SB 514	.70	80	90
2SB 523	70	80	90
2SB 526C	70	80	90
2SB 527	90	1.10	1.20
2SB 528D	70	[illegible]	90
2SB 529	[illegible]	[illegible]	90
2SB 530	3.20	3.40	3.70
2SB 531	1.80	2.00	2.25
2SB [illegible]	1.00	1.20	1.30
2SB [illegible]	1.00	1.20	1.30
2SB [illegible]	3.20	3.40	3.70
2SB 541	3.20	3.40	3.70
2SB 554	6.00	6.00	6.60
2SB 556	[illegible]	3.40	3.70
2SB 557	[illegible]	2.50	2.80
2SB 561B	[illegible]	[illegible]	45
2SB 564	40	[illegible]	[illegible]
2SB 595	1.10	[illegible]	1.50
2SB 596	1.10	[illegible]	1.50
2SB 600	[illegible]	[illegible]	[illegible]
2SC 183	[illegible]	[illegible]	59
2SC 184	[illegible]	[illegible]	59
2SC 281	[illegible]	35	40
2SC 283	[illegible]	[illegible]	[illegible]
2SC 284	80	90	1.00
2SC 317	40	53	59
2SC 352A	2.00	2.20	2.50
2SC 353A	1.60	1.80	[illegible]
2SC 367	[illegible]	[illegible]	40
2SC 369	[illegible]	[illegible]	40
2SC 370	30	27	30
2SC 371	30	35	40
2SC 372	20	27	30
2SC 373	20	27	30
2SC 374	30	35	40
2SC 375	[illegible]	[illegible]	[illegible]
2SC 377	[illegible]	[illegible]	40
2SC 380	[illegible]	[illegible]	30
2SC 381	20	27	30
2SC 382	35	40	45
2SC 383	35	40	45
2SC 387A	40	[illegible]	45
2SC 388A	40	53	59
2SC 394	[illegible]	27	30
2SC [illegible]	30	35	40
2SC 430	[illegible]	64	70
2SC 454	35	40	[illegible]
2SC 458	35	27	30
2SC 460	[illegible]	[illegible]	45
2SC 461	35	40	45
2SC 478	[illegible]	[illegible]	[illegible]
2SC 481	40	[illegible]	[illegible]
2SC 482	[illegible]	1.25	[illegible]
2SC 484	1.30	1.40	[illegible]
2SC 485	1.30	1.40	1.50
2SC 486	1.30	1.40	1.50
2SC 493	3.00	[illegible]	[illegible]
2SC 495	45	55	60
2SC 496	45	55	60
2SC 497	[illegible]	1.25	1.40
2SC 509	[illegible]	35	45
2SC 510	[illegible]	1.40	1.50
2SC 515A	[illegible]	[illegible]	[illegible]
2SC 517	2.50	2.70	3.00
2SC 535	30	35	40
2SC 536	30	35	40
2SC 537	30	35	40
2SC 627	1.30	1.45	[illegible]
2SC 631	35	40	45
2SC 632A	35	40	45
2SC 634A	35	40	45
2SC 680	1.90	2.10	2.40
2SC 681A	3.00	3.25	3.50
2SC 684	80	90	1.00

TYPE	25 UP	10-24	1-9
2SC 693F	20	27	30
2SC 696	1.00	1.20	1.30
2SC 708	1.30	1.45	1.60
2SC 710	20	27	30
2SC 711	20	27	30
2SC 712	20	27	30
2SC [illegible]	30	35	40
2SC [illegible]	35	40	45
2SC [illegible]	1.80	1.20	1.30
2SC 730	3.00	3.20	3.40
2SC 731	2.50	2.70	2.90
2SC 732	20	27	30
2SC 733	20	27	30
2SC 734	20	27	30
2SC 735	20	27	30
2SC [illegible]	20	[illegible]	30
2SC [illegible]	1.50	1.80	2.00
2SC [illegible]	1.50	1.80	[illegible]
2SC [illegible]	35	40	45
2SC [illegible]	35	35	40
2SC 773	35	40	45
2SC 774	1.00	1.20	1.30
2SC 775	1.40	1.60	1.80
2SC 776	2.00	2.20	2.50
2SC 777	3.00	3.25	3.50
2SC 778	3.00	3.20	3.40
2SC 781	1.90	2.10	2.40
2SC 783	2.10	[illegible]	[illegible]
2SC 784	30	35	40
2SC 785	36	40	45
2SC 789	[illegible]	90	1.00
2SC 790	80	90	1.00
2SC 793	2.00	2.70	2.50
2SC 799	[illegible]	2.20	2.50
2SC [illegible]	[illegible]	[illegible]	30
2SC [illegible]	[illegible]	[illegible]	30
2SC 830H	2.50	2.70	3.00
2SC 838	35	40	45
2SC 839	30	35	40
2SC 853	70	80	90
2SC 867	3.20	[illegible]	2.70
2SC 867A	3.20	[illegible]	3.70
2SC 870	[illegible]	[illegible]	45
2SC 871	[illegible]	[illegible]	45
2SC 895	4.20	4.40	4.90
2SC 897	2.00	2.20	2.50
2SC 898	2.60	2.70	3.00
2SC 900	[illegible]	27	30
2SC 923	[illegible]	27	30
2SC 929	20	27	30
2SC 930	[illegible]	27	30
2SC 941	[illegible]	27	30
2SC 943	35	40	45
2SC 945	.20	27	30
2SC 959	1.00	1.20	1.30
2SC 971	70	80	90
2SC 982	70	80	90
2SC 983	70	80	[illegible]
2SC 984	[illegible]	[illegible]	70
2SC 1000	35	40	45
2SC 1012	[illegible]	1.40	1.50
2SC 1013	[illegible]	64	70
2SC 1014	[illegible]	64	70
2SC 1017	80	90	1.00
2SC 1018	80	[illegible]	[illegible]
2SC 1030	1.80	2.10	2.40
2SC 1047	35	40	45
2SC 1051	3.40	3.55	3.90
2SC 1060	70	80	90
2SC 1061	70	80	90
2SC 1076	30.00	[illegible]	[illegible]
2SC 1079	3.40	3.55	3.90
2SC 1080	[illegible]	[illegible]	3.90
2SC 1096	[illegible]	55	60
2SC 1098	50	64	70
2SC 1111	2.10	2.50	2.80
2SC 1114	4.20	4.40	4.90
2SC 1115	2.50	2.70	3.00
2SC 1116	3.20	3.40	3.70
2SC 1116A	3.40	3.55	[illegible]
2SC 1124	[illegible]	90	1.00
2SC 1127	80	90	1.00
2SC 1161	1.30	1.45	1.60
2SC 1162	70	80	90
2SC 1166	20	.27	30
2SC 1167	3.60	4.00	4.40
2SC 1170B	3.60	4.00	4.40
2SC 1172B	3.20	3.60	3.95
2SC 1173	50	55	60
2SC 1175	35	40	45
2SC 1177	11.00	12.60	14.00
2SC [illegible]	1.00	1.10	1.20
2SC 1209	30	35	40
2SC 1211D	30	35	40
2SC 1212A	80	90	1.00
2SC 1213	30	35	40
2SC 1215	35	40	45
2SC 1222	20	27	30
2SC 1226	50	55	80

TYPE	25-UP	10 24	1 9
2SC 1226A	50	55	60
2SC 1237	1.80	2.00	2.25
2SC 1239	2.20	2.70	2.90
2SC 1279	50	55	[illegible]
2SC 1306	1.30	1.45	[illegible]
2SC 1307	1.90	2.10	2.40
2SC 1310	20	27	30
2SC 1312	20	27	30
2SC [illegible]	20	27	30
2SC [illegible]	4.20	[illegible]	4.90
2SC [illegible]	[illegible]	27	30
2SC [illegible]	[illegible]	40	45
2SC [illegible]A	[illegible]	[illegible]	7.60
2SC [illegible]	20	27	30
2SC [illegible]	50	55	60
2SC [illegible]	50	55	60
2SC [illegible]	45	53	59
2SC [illegible]	45	53	59
2SC [illegible]	4.20	[illegible]	4.90
2SC [illegible]	30	35	40
2SC [illegible]	50	[illegible]	[illegible]
2SC [illegible]	35	[illegible]	45
2SC [illegible]	35	40	45
2SC [illegible]	3.20	[illegible]	3.70
2SC [illegible]	30	[illegible]	40
2SC [illegible]	35	[illegible]	45
2SC [illegible]	45	53	59
2SC [illegible]	.70	[illegible]	90
2SC 1400	[illegible]	40	45
2SC 1402	[illegible]	[illegible]	[illegible]
2SC 1403	[illegible]	3.40	3.70
2SC 1407	[illegible]	55	[illegible]
2SC 1418	[illegible]	70	[illegible]
2SC [illegible]	[illegible]	1.80	2.00
2SC [illegible]	2.50	[illegible]	2.80
2SC 1447	[illegible]	70	[illegible]
2SC 1448	[illegible]	[illegible]	[illegible]
2SC 1449	60	70	[illegible]
2SC 1451	[illegible]	[illegible]	1.20
2SC 1454	3.20	[illegible]	[illegible]
2SC 1475	80	90	1.00
2SC 1474	50	[illegible]	[illegible]
2SC 1509	40	[illegible]	[illegible]
2SC 1587	40	.70	[illegible]
2SC 1567A	60	.70	[illegible]
2SC 1564	8.00	8.30	[illegible]
2SC 1586	[illegible]	[illegible]	[illegible]
2SC 1624	[illegible]	70	[illegible]
2SC 1626	[illegible]	.70	[illegible]
2SC 1628	[illegible]	.70	[illegible]
2SC [illegible]	.70	.80	[illegible]
2SC 1667	[illegible]	3.20	[illegible]
2SC 1669	[illegible]	1.00	1.10
2SC 1674	[illegible]	35	40
2SC 1675	[illegible]	27	30
2SC 1678	1.10	1.25	1.40
2SC 1679	3.00	3.20	3.40
2SC [illegible]	.30	35	40
2SC [illegible]	30	[illegible]	40
2SC 1684	30	[illegible]	40
2SC 1687	40	45	50
2SC [illegible]	35	.40	45
2SC 1706	.30	35	40
2SC 1728	.70	[illegible]	90
2SC 1730	.45	53	59
2SC 1756	.50	55	60
2SC 1760	70	[illegible]	.90
2SC 1816	1.50	1.75	1.95
2SC 1856	45	53	.59
2SC 1885	45	.53	59
2SC 1908	30	35	40
2SC 1909	1.80	2.00	2.25
2SC 164	4.50	5.00	5.60
2SC 1957	60	.70	80
2SC 1969	3.60	4.00	4.40
2SC 1973	70	80	90
2SC [illegible]	1.30	1.70	1.90
2SC [illegible]	5.40	6.00	6.60
2SC [illegible]	.50	64	70
2SC [illegible]	1.50	1.80	2.00
2SC [illegible]	80	90	1.00
2SC [illegible]	50	64	70
2SC [illegible]	90	1.10	1.20
2SC 2092	1.80	2.00	2.25
2SC 2098	3.20	3.40	3.70
2SC 2166	1.40	1.60	1.80
2SD 72	50	64	70
2SD 77	35	40	.45
2SD 90	1.30	1.45	1.60
2SD 91	1.30	1.45	1.60
2SD 92	1.30	1.45	1.60
2SD 93	1.60	1.80	2.00
2SD 118	2.90	3.20	3.40
2SD 130	1.10	1.25	1.40
2SD 187	.35	40	45
2SD 201	2.30	2.40	2.65
2SD 202	3.40	3.55	3.90
2SD 218	2.50	2.70	3.00

TYPE	25-UP	10-24	1-9
2SD 234	60	70	80
2SD 235	60	70	80
2SD 261	35	40	45
2SD 287	2.50	2.70	2.90
2SD 300	4.50	5.00	5.60
2SD 313	60	70	80
2SD 315	60	70	80
2SD 325	60	70	80
2SD 330	60	70	80
2SD 350	3.60	4.00	4.40
2SD 380	5.20	5.40	5.95
2SD 381	.85	1.00	1.10
2SD 424	3.80	4.00	4.40
2SD 425	2.90	3.20	3.40
2SD 426	3.10	3.30	3.60
2SD 427	1.80	2.00	2.25
2SD 525	90	1.10	1.20
2SD 526	60	70	80
2SK 19BL	50	35	60
3SK 22Y	1.40	1.60	1.80
3SK 39	90	1.10	1.20
3SK 40	90	1.10	1.20
3SK 41	1.30	1.45	1.60
3SK 45	1.30	1.45	1.60
AN 203	1.40	1.60	1.80
AN 214Q	1.50	1.70	1.90
AN 239	4.20	4.40	4.90
AN 247	2.50	2.70	3.00
AN 274	1.50	1.75	1.95
AN 313	3.00	3.20	3.40
AN 315	1.80	2.00	2.25
BA 511A	1.80	2.00	2.25
BA 521	1.90	2.10	2.40
HA 1151	1.50	1.75	1.95
HA 1156W	1.80	1.80	2.00
HA 1306W	2.00	2.20	2.50
HA 1339	2.50	2.70	3.00
HA 1339A	2.50	2.70	3.00
HA 1342A	2.50	2.70	3.00
HA 1366W	2.50	2.70	3.00
HA 1366WR	2.50	2.70	3.00
LA 4031P	1.80	2.00	2.25
LA 4032P	1.80	2.00	2.25
LA 4051P	1.80	2.00	2.25
LA 4400	1.90	2.10	2.40
LA 4400Y	2.00	2.20	2.50
LA 4420	2.00	2.20	2.50
LD 3001	2.00	2.20	2.50
M5 1513L	2.00	2.20	2.50
STK 011	3.80	4.00	4.40
STK 013	7.60	8.00	8.80
STK 015	4.20	4.40	4.90
STK 435	4.50	5.00	5.60
STK 439	7.90	8.00	8.80
TA 7045M	2.00	2.20	2.50
TA 7055P	2.00	2.20	2.50
TA 7061AP	90	1.10	1.20
TA 7062P	1.10	1.25	1.40
TA 7203P	2.50	2.70	2.90
TA 7204P	2.00	2.20	2.50
TA 7205P	1.60	1.80	2.00
TA 7222P	3.40	3.55	3.90
TA 7310P	1.30	1.45	1.60
TBA 810SH	1.90	2.10	2.40
TC 5080P	5.00	5.20	5.60
TC 5081P	3.00	3.20	3.40
TC 5082P	3.40	3.55	3.90
UHIC 001	4.20	4.40	4.90
UHIC 002	4.20	4.40	4.90
UHIC 003	4.20	4.40	4.90
UHIC 004	4.20	4.40	4.90
UHIC 005	4.20	4.40	4.90
uPC 20C	2.10	2.50	2.80
uPC 563	1.90	2.10	2.40
uPC 575C2	1.30	1.45	1.60
uPC 576	1.90	2.10	2.40
uPC 592H	70	80	90
uPC 1001H	1.90	2.10	2.40
uPC 1008C	4.20	4.40	4.90
uPC 1020H	1.90	2.10	2.40
uPC 1025	1.90	2.10	2.40
uPC 1154	2.00	2.20	2.50
uPC 1155	2.00	2.20	2.50
uPC 1156	1.80	2.10	2.40
uPD 861	8.00	8.40	9.50
uPD 457	8.00	8.40	9.50
uPD 858	6.00	6.30	7.00
PLL 01A	3.00	4.20	4.60
PLL 02A	5.00	5.20	5.90
PLL 03A	7.60	8.00	8.80
C-3001	1.30	1.45	1.60
2SC F8	2.20	2.70	2.90
4004	1.90	2.10	2.40
4005	2.00	2.20	2.50
SG 613	5.20	5.40	5.95
78L05	90	1.00	1.10
MPS U31	1.50	1.70	1.90
SN 7400	15	.17	19

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AY3-8910 PROGRAMMABLE SOUND GENERATOR

The AY3-8910 is a 40 pin LSI chip with three oscillators, three amplitude controls, programmable noise generator, three mixers, an envelope generator, and three D/A converters that are controlled by 8 BIT WORDS. No external pots or caps required. This chip hooked to an 8 bit microprocessor chip or Buss (8080, Z80, 6800 etc.) can be software controlled to produce almost any sound. It will play three note chords, make bangs, whistles, sirens, gunshots, explosions, bleets, whines, or grunts. In addition, it has provisions to control its own memory chips with two IO ports. The chip requires +5V @ 75ma and a standard TTL clock oscillator. A truly incredible circuit.

$14.95 W/Basic Spec Sheet (4 pages)
60 page manual with S-100 interface instructions and several programming examples. $3.00 extra

4 DIGIT ½ INCH CHARACTER LED DISPLAY

Bowmar readout stick with colons. COMMON CATHODE ONLY. 100% Prime. All segments and colons brought out to edge pads. With pinout. LIMIT 5 PER CUSTOMER

SPECIAL **$1.90**

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

ZENER GRAB BAG

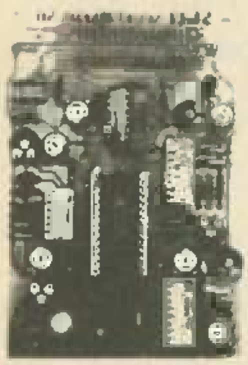
A very nice assortment of ¼, ½ & 1W zeners. Voltage ranges are from 2.7 to 30 VDC. Most have house # but we provide a cross over list to standard numbers. A great buy for any shop. 12 different types.

.50 ea.

SE-01 SOUND EFFECTS KIT

• 76477 CHIP IS INCLUDED. EXTRA CHIPS $2.95 EACH

$16.95 LESS SPEAKER & BATTERY

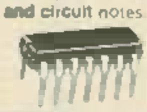


The SE-01 is a complete kit that contains all the parts to build a programmable sound effects generator. Designed around the new **Texas Instruments SN76477 Sound Chip**, the board provides banks of MINI DIP switches and pots to program the various combinations of the SLF Oscillator, VCO, Noise, One Shot, and Envelope Controls. A Quad Op Amp IC is used to implement an Adjustable Pulse Generator, Level Comperator and Multiplex Oscillator for even more versatility. The 3¼" x 5" PC Board features a prototype area to allow for your added circuitry. Easily programmed to duplicate Explosions, **Phasor Guns, Steam Trains,** or almost an infinite number of other sounds. The unit has a multiple of applications. The low price includes all parts, assembly manual, programming charts, and detailed 76477 chip specifications. It runs on a 9V battery (not included). On board 100MW amp will drive a small speaker directly, or the unit can be connected to your stereo with incredible results! (Speaker not included)

ALLOW 3 WKS. FOR DELIVERY

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

2.95 NEW!



MC1468R POSITIVE VOLTAGE REGULATOR

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

1.25 EA.
10/10.00
HOUSE #

QUAD MATCHED DIODES

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

50¢ ONE SET (4)

XAN SUPER DIGITS

.6" JUMBO LED
7 SEGMENT
RED

99¢

6640 COMMON ANODE
6920 COMMON CATHODE

NOW A SUPER READOUT AT A SUPER BUY! These are factory fresh prime LED readouts, not seconds or rejects as sold by others. Compare our price and send for yours today, but hurry, the supply is limited!
SPECIFY: COMMON ANODE OR COMMON CATHODE

PARTS

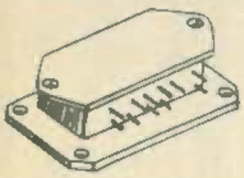
301 OP AMP 8 LEAD CAN	3/1.00
723 VOLT REG. 10 LEAD CAN	.50
*13741 FET INPUT 741 MINI DIP	3/1.10
30,000 @ 15V COMPUTER GRADE	2.10
2N4400 NPN GEN. PURPOSE	8/1.00
2N4402 PNP COMPLEMENT	8/1.00
2N6028 PUT w/SPECS	.50
LM380 2W AUDIO IC w/SPECS	1.09
LM377 DUAL LM380 w/SPECS	2.50
*7815 VOLT REG. PA 15V	.60
*725 LOW NOISE OP AMP	.95
4N27 OPTO ISOLATOR MINI DIP	.60
*MFE 131 DUAL GATE MOSFET DIODE PROTECTED SIMILAR TO 40673	.50
MV1624 VARICAP DIODE 10 PFD	.49
1N4003 1A 200V DIODE	15/1.00
TIP30 1AN PNP POWER	3/1.00
*MC1351P FM IF DISC IC	.50

*INDICATES ITEM @ HOUSE NUMBERED

LED'S

JUMBO GREEN	4/.99
JUMBO RED	5/.89
MEDIUM RED (MV2)	.15
MEDIUM GRN OR YELLOW	.18

A RARE FIND!
LAMBDA HIGH POWER REGULATOR 3205 MODULE



$12.95 W/SPECS
LIMITED QTY.

- 5V @ 10A with 8-30VDC input.
- Current limiting, thermal shutdown and short protection.
- 2% Load regulation.
- Only 2 external components needed.

All you need to add is a transformer, rectifier, heatsink and filter cap to have a super regulated supply for 5 volts at 10 amps!
SPECIAL BONUS! Order the 3205 Module and get **FREE** a LAMBDA L-20-5 overvoltage protector that triggers at 6.6 volts up to 20 amps.

NEW ITEMS

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

POTENTIOMETER ASSORTMENT

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

10/2.00

7 WATT AUDIO AMP KIT

SMALL SINGLE HYBRID IC AND COMPONENTS FIT ON A 2" x 3" PC BOARD (INCLUDED). RUNS ON 12 VDC. GREAT FOR ANY PROJECT THAT NEEDS AN INEXPENSIVE AMP. LESS THAN 3% THD @ 6 WATTS. COMPATIBLE WITH SE-01 SOUND KIT

$5.95

1/2W RESISTOR ASSORTMENT

A good mix of 5% and 10% values in both full lead and PC lead devices. All new, first quality.

(ASST.) 200 pieces/ 2.00

LAS15U • 1.5A Four Terminal Adjustable Regulator. 3-30V W/current limiting, short protection and thermal shutdown. TO-3 style. All units are prime. Spec sheets included. $2.50

SLIDE SWITCH ASSORTMENT

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

6 DIGIT AUTO/VAN CLOCK

- LARGE ½" CHARACTERS (LED)
- QUARTZ XTAL TIMEBASE
- ALARM & SNOOZE OPTIONS
- NOISE FILTERING
- EASY TO ASSEMBLE
- 4¼" x 2" x 1½"
- DRILLED & PLATED PC BOARDS

NEW!

COMPLETE KIT 12 VDC **$16.95**

ULTRASONIC RELAY KIT

INVISIBLE BEAM WORKS LIKE A PHOTO ELECTRIC EYE. USE UP TO 25 FT APART. COMPLETE KIT. ALL PARTS & PC BOARDS

$21.50

POLICIES

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

PRICES SUBJECT TO CHANGE WITHOUT NOTICE

100 W CLASS A POWER AMP KIT

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

Specifications:
- Output power: 100W RMS into 8-ohm 125W RMS into 4-ohm
- Frequency response: 10Hz - 100 KHz
- T.H.D.: less than 0.008%
- S/N ratio: better than 80dB
- Input sensitivity: 1V max.
- Power supply: ±40V @ 5 amp

TA-1000 KIT $51.95
Power transformer $15.00 each

MARK IV 15 STEPS LED POWER LEVEL INDICATOR KIT

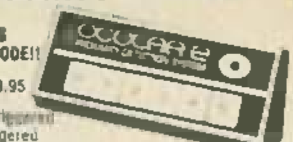
This new stereo level indicator kit consists of 36 4-color LED (15 per channel) to indicate the sound level output of your amplifier from −36dB ~ +3dB. Comes with a well-designed silk screen printed plastic panel and has a selector switch to allow floating or gradual output indicating. Power supply is 6 ~ 12V D.C. with THG on board input sensitivity controls. This unit can work with any amplifier from 1W to 200W!
Kit includes 70 pcs. driver transistors, 38 pcs. matched 4-color LED, all other electronic components, PC board and front panel.

MARK IV KIT $31.50

DIGITAL AUTO SECURITY SYSTEM

4 DIGITS PERSONAL CODE!!

SPECIAL $19.95



- proximity triggered
- voltage triggered
- mechanically triggered

This alarm protects you and itself! Entering protected area will set it off, sounding your car horn or siren you add. Any change in voltage will also trigger the alarm into action. If cables within passenger compartment are cut, the unit protects itself by sounding the alarm. **3-WAY PROTECTION!**
All units factory assembled and tested — Not a kit!

SANWA

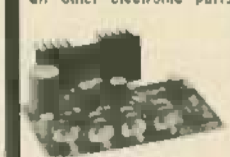
COMPACT — LIGHTWEIGHT — ULTRA SLIM
BATTERY CHECKER — LED TESTER
T-550 (w/o temp probe) $44.50
T-55THD (temp probe) $56.50

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

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

30W + 30W STEREO HYBRID AMPLIFIER KIT

It works in 12V DC as well! Kit includes 1 PC SANYO STK-043 stereo power amp. IC LM 1458 as pre amp, all other electronic parts. PC Board, all control pots and special heat sink for hybrid. Power transformer not included. It produces ultra hi-fi output up to 60 watts (30 watts per channel) yet gives out less than 0.1% total harmonic distortion between 100Hz and 10KHz.



$32.50 PER KIT

A NEW LED ARRAY AND DRIVER FOR LEVEL METERS

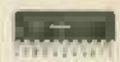
This series covers a wide range of level indication uses, output and input voltage, time related change, temperature, light measurement and sound level. The problem of uneven brilliance often encountered with LED arrangements as well as design problems caused by using several units of varying size are substantially reduced. 12 LEDs in one bar.

LED ARRAY

GL-112R3 Red, Red, Red	$5.50
GL-112N3 Green, Yellow, Red	$6.50
GL-112M2 Green, Green, Red	$6.50
GL-112G3 Green, Green, Green	$6.50

0.27"

2.28"



LED DRIVERS

IR 2406G is an I.C. specially designed to drive. 12 LED. The number of LED is lineally illuminated according to the control voltage input terminal 21. Operating voltage is 9 12V D.C. $5.35 EACH

BATTERY POWERED FLUORESCENT LANTERN

MODEL 888 R

FEATURES
- Circuitry: designed for operation by high efficient, high power silicon transistor which enable illumination maintain in a standard level even the battery supply drops to a certain low voltage.
- 9" 6W cool/daylight miniature fluorescent tube.
- 8 x 1.5V UM-1 (size D) dry cell battery.
- Easy sliding door for changing batteries.
- Stainless reflector with wide angle increasing lumination of the lantern.

$10.50 EA

PROFESSIONAL FM WIRELESS MICROPHONE

TECT model WEM-16 is a factory assembled FM wireless microphone powered by an AA size battery. Transmits in the range of 88-108MHz with 3 transistor circuits and an omni-directional electric condenser. Element built-in plastic tube type case; mike is 5¾" long. With a standard FM radio, can be heard anywhere on a one-acre lot: sound quality was judged very good.

$16.50

STEREO AMPLIFIER

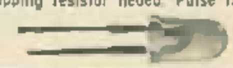
60 W + 60 W

COMPLETED UNIT — NOT A KIT!

OCL pre amp. & power stereo amp. with bass, middle, treble 3-way tone control. Fully assembled and tested, ready to work. Total harmonic distortion less than 0.5% at full power. Output maximum is 60 watts per channel at 8Ω. Power supply is 24 - 36V AC or DC. Complete unit. Assembled $49.50 ea.
Power transformer $ 8.50 ea.

FLASHER LED

Unique design combines a jumbo red LED with an IC flasher chip in one package. Operates directly from 5V-7V DC. No dropping resistor neded. Pulse rate 3Hz @ 5V 20mA.



2 for $2.20

NEW MARK III

9 Steps 4 Colors

LED VU

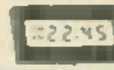
Stereo level indicator kit with arc-shape display panel!!! This Mark III LED level indicator is a new design PC board with an arc-shape 4 colors LED display (change color from red, yellow, green and the peak output indicated by rose). The power range is very large, from −30dB to +5dB. The Mark III indicator is applicable to 1 watt - 200 watts amplifier operating voltage is 3V - 9V DC at max 400 MA. The circuit uses 10 LEDs per channel. It is very easy to connect to the amplifier. Just hook up with the speaker output!

IN KIT FORM $18.50

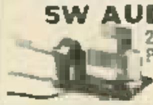
LCD CLOCK MODULE!

- 0.5" LCD 4 digits display - X'tal controlled circuits - D.C. powered (1.5V battery) - 12 hr. or 24 hr. display - 24 hr. alarm set - 60 min. countdown timer - On board dual back-up lights - Dual time zone display - Stop watch function

NIC1200 (12 hr) $24.50 EA.
NIC2400 (24 hr) $26.50 EA.



5W AUDIO AMP KIT



2 LM 380 with Volume Control
Power Suply 6 18V DC
ONLY $6.00 EACH

MINI-SIZED I.C. AM RADIO

Size smaller than a box of matches!
Receives all AM stations.
Batteries and ear phones Included.
Only $10.50

PROFESSIONAL PANEL METERS

Type MU-52E

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

All meters white face with black scales. Plastic cover.

12 DC MINI RELAY

6V	SPDT	2 AMP	1.30
12V	SPDT	3 AMP	1.60
12V	DPDT	2 AMP	2.50
12V	4PDT	3 AMP	3.50

MARK II SOUND ACTIVATED SWITCH KIT

A new designed circuit employed 2 I.C., a DPDT relay with a led indicator. A condensor microphone comes with the kit. The relay can handle up to 200 watts contact to allow to control most things. Just click the finger, the relay will close, the second click will release it. Sensitivity can be adjusted by an on board trim-pot. Operating voltage 9V D.C.
TY-18
$8.50 PER KIT

LINEAR SLIDE POT

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

0.5" LED ALARM CLOCK MODULE

ASSEMBLED! NOT A KIT!

Features: • 4 digits 0.5" LED Displays • 12 hours real time format • 24 hours alarm audio output • 59 min. countdown timer • 10 min. snooze control

ONLY $7.00 EACH
SPECIAL TRANSFORMER FOR CLOCK $1.50 EACH

CONDENSER MICROPHONE

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

CIRCLE 6 ON FREE INFORMATION CARD

CIRCLE 7 ON FREE INFORMATION CARD

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Active Electronic Sales Corp.

Zilog

Z8001	$195.00	16 Bit CPU with segmented address space to 8 Megabytes
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				6505	9.95
8212	3.45	6810	3.95		
8214	3.95	6820	3.95	6520	6.95
8216	3.25	6821	3.95	6522	9.95
8224	2.95	6850	4.25	6532	13.95
8226	2.25	6852	3.95	6551	13.95
8228	3.98				
8238	4.75				
8251	5.75	1802LE	9.95	1854LE	6.95
8253	14.95	1824LE	3.50	1856LE	1.95
8255	5.75	1852LE	1.50	1858LE	1.95
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MOS MEMORIES

MOS Static RAM's

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2102-1PC 1K (1K x 1) 450ns 16 PIN	0.94
2102-2PC 1K (1K x 1) 650ns 16 PIN	0.89
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Gate:	0.1 sec and 1.0 sec LED gate light
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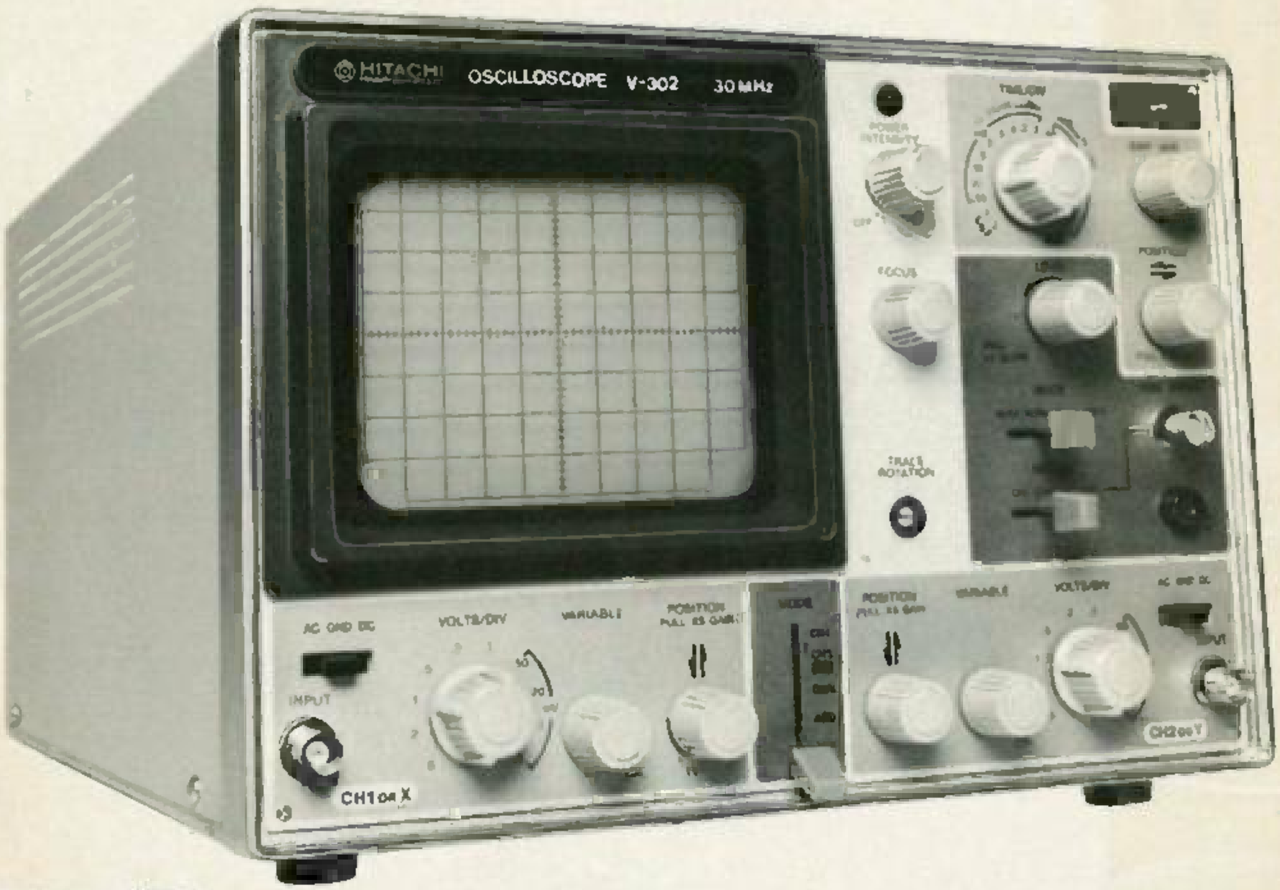

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