Radio-Electronics®

BUILD YOUR OWN SATELLITE TV RECEIVER

$1.25 JUNE 1982

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STEREO IMAGE EXPANDER
for concert hall effects

How to
DESIGN ANALOG CIRCUITS
using diodes

Build a
POCKET CALIBRATOR
for volts and ohms

Technology overseas:
STEREO AUDIO FOR TV
New German system

Build a
GATED IF AMP
pay-TV decoder

ENERATORS
and applications

PLUS:

- ★Hobby Corner ★Communications Corner
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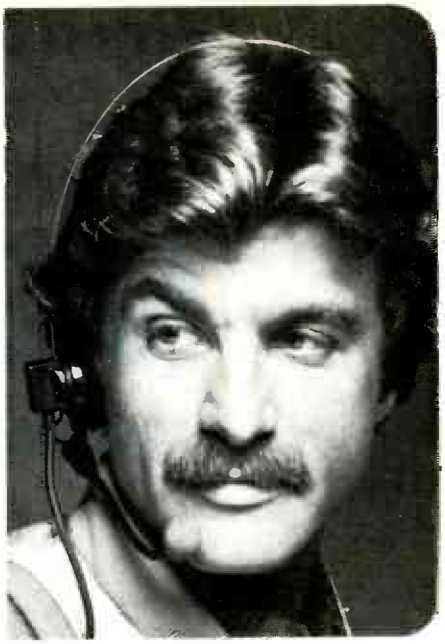

TalkTalk™

The world's first hands-free consumer mobile communication system lets you keep in touch while on the go.

Do you remember the CB fad? Six years ago Americans jammed the air waves as everybody discovered the fun of personal communications.

But like all big fads, CB soon died. People hung up their mikes and gave CB back to the truckers who started the fad in the first place.

The personal communications fad is now back with an entirely new concept. TalkTalk is a headphone with a boom mike that lets you talk hands-free with someone else blocks away. Your voice activates a transmitter. When you stop talking, the transmitter automatically shuts off and you receive. The transmitter, receiver and power supply are located in a small case thinner than a pack of cigarettes which you wear clipped to your belt or placed in your pocket.

SAFER THAN HEADPHONES

You hear the receiver through an adjustable headphone which you comfortably wear over your right or left ear. This leaves one ear free to hear the sounds around you – much safer for outside activities than the popular stereo headphones.

You can now communicate, hands-free and in safety, while you cycle, hike, jog, work or play. It works for up to one-half mile and all on a single 9-volt battery that lasts up to 8 hours under typical use. But there's much more.

An antenna circles the headphone so there's no ugly wire protruding from the top of your head, and you keep your conversations private because the range is reduced to a block. But if you want to reach out to the unit's half mile range, simply unhook the antenna wire from its clamp and presto, you have an ugly wire protruding from the top of your head.

UNIT CAPTURES SIGNAL

TalkTalk was built in Japan with the same technology used in professional communication systems. For example, the system uses frequency modulation (FM) as opposed to the amplitude modulated signal used in CB. CB frequencies tend to get crowded – with powerful stations often talking on top of each other. Not true with FM. The system's FM receiver uses a "capture effect" to reject all other signals. You hear only the one signal closest to you. You capture a clear, crisp, easy-to-hear transmission. And since the Federal Communicatons Commission has set aside the TalkTalk's frequency of 49 megahertz for 100 milliwatt maximum power, no other higher power station will bury you. But wait. There's even more.

EVEN CLIP IMPRESSIVE

A voice-activated sensitivity switch lets you adjust your boom mike for all outside noise conditions – low for a motorcycle and medium or high for a bicycle. And a two-staged volume control lets you securely adjust the volume level with no fear of accidentally moving it.

You can keep the system's 6-ounce case in your vest pocket or clip it to your belt with its removable pager-styled clip. In fact, even the clip is impressive. It's a heavy-duty device that can be slipped off when you want to keep the unit in your pocket.

The boom portion of the mike is malleable. That means you can bend it in any direction and it will stay there. Wear the mike close to your mouth, far away, or even bend it out of the way completely.

LONG LIST

Use your imagination. We used ours and came up with over 100 activities that make the TalkTalk useful or fun. Sure, the obvious ones like cycling, hiking, sports, work and play came easily. But how about using a pair in a shopping center to keep in touch? Or keeping in contact with your home while you walk the dog? TalkTalk can be used for outdoor treasure hunts, by tour directors and ski instructors. The list goes on.

There are five separate channels to choose from. If you order a pair, we'll send you a matched frequency set. To order more on that frequency simply specify the frequency on your reorder form.

TalkTalk is not cheap. In fact its high price may at first frighten you until you realize that TalkTalk is not a toy but a professional voice-activated FM transceiver similar to systems that sell for more than a thousand dollars.

TalkTalk is manufactured by Standard Communications – an established manufacturer of professional two-way communications systems – assurance that your modest investment is well protected. The TalkTalk was designed for rugged use but if service is ever required, Standard's convenient service-by-mail center is as close as your mailbox.

GIVE IT A WORKOUT

When you receive your unit, really give it a workout. See how far you can transmit with the antenna up or down. Use it in a shopping center, on a bike ride or in your factory. See how comfortable it feels and how safe you feel with one ear free to hear outside sounds. Then decide if you want to keep it. If for any reason you are not satisfied, return your unit in its original condition within 30 days and we'll refund your money in full including $4.00 postage and handling.

Sometimes we discover a product that really is fun yet opens up a new dimension in convenience and utility. The TalkTalk is just that product. Order a pair at no obligation, today.

To order, send a check or money order or credit card holders call toll-free **800 228-5000** (In Nebraska call **800 323-6400**). When ordering, please use order number (shown in parenthesis) for faster service. Unit comes complete with 9-volt battery, complete instructions and a one-year limited warranty. Please add $4.00 for postage and handling and Illinois residents add 6% sales tax.

TalkTalk per unit **$119.95** (4010RE01)

Send $1 for the new JS&A catalog and see our other advertisement in this issue.

JS&A® PRODUCTS THAT THINK

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Why use their flexible discs:

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high quality error free discs?

Product Description	Part #	CE quant. 100 price per disc ($)
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8″ SSSD Shugart Compatible, 32 Hard Sector	**3015**	2.09
8″ SSDD IBM Compatible (128 B/S, 26 Sectors)	**3090**	2.74
8″ DSDD Soft Sector (Unformatted)	**3102**	3.14
8″ DSDD Soft Sector (128 B/S, 26 Sectors)	**3115**	3.34
8″ DSDD Soft Sector (1024 B/S, 8 Sectors)	**3104**	3.34
8″ DSDD Burroughs B-80 Comp., 32 Hard Sector	**3092**	3.34
5¼″ SSSD Soft Sector (Unformatted)	**3401**	1.94
5¼″ SSDD Soft Sector w/Hub Ring	**3481**	2.34
5¼″ SSDD 10 Hard Sector w/Hub Ring	**3483**	2.34
5¼″ SSDD 16 Hard Sector w/Hub Ring	**3485**	2.34
5¼″ DSDD Soft Sector w/Hub Ring	**3491**	3.09
5¼″ DSDD 10 Hard Sector w/Hub Ring	**3493**	3.09
5¼″ DSDD 16 Hard Sector w/Hub Ring	**3495**	3.09

SSSD = Single Sided Single Density; SSDD = Single Sided Double Density
DSDD = Double Sided Double Density

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Quality
Memorex means quality products that you can depend on. Quality control at Memorex means starting with the best materials available. Continual surveillance throughout the entire manufacturing process. The benefit of Memorex's years of experience in magnetic media production, resulting, for instance, in proprietary coating formulations. The most sophisticated testing procedures you'll find anywhere in the business.

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Memorex Flexible Discs will be replaced free of charge by Memorex if they are found to be defective in materials or workmanship within one year of the date of purchase. Other than replacement, Memorex will not be responsible for any damages or losses (including consequential damages) caused by the use of Memorex Flexible Discs.

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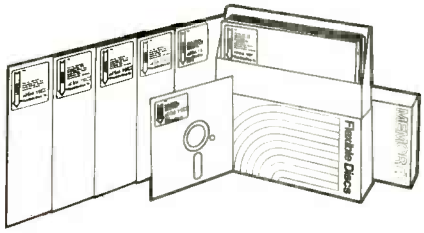

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Radio-Electronics

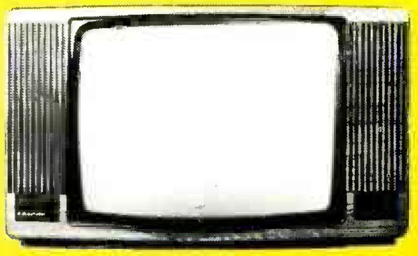
THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

Electronics publishers since 1908

JUNE 1982 Vol. 53 No. 6

ON THE COVER

A lot has been written recently about "sonic imagers." Those devices modify the sound reproduced by your stereo system so that it appears to come from outside of, behind, and even in front of your two speakers—in fact, the speakers almost seem to disappear. To find out how you can build your own stereo image expander for under $100, turn to page 45.



STEREO AND BILINGUAL programs are regularly broadcast on Japanese and German TV. The German system uses a technique quite different from the former, and it may be better. Learn how it works, starting on page 58.

HOW ACCURATE is your test equipment? You can check out volt- and ohmmeters—as well as oscilloscopes—with the easy-to-build pocket-size calibrator described, beginning on page 49.

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VIDEO ELECTRONICS

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

SONY'S COLOR PRINTER

Sony dropped the other shoe in its crusade for electronic still photography by showing its "Mavigraph" color printer. That color printer is intended to be a companion to the Mavica magnetic-disc still camera Sony demonstrated for the first time last year. Mavica stores 50 pictures in video form on a tiny disc for playback through a TV set. The Mavigraph home printer uses a heat process to make color prints from the magnetic disc by using special dye-transfer sheets. Although a commercial version will make larger prints, the home Mavigraph will provide 3×4-inch prints, taking five minutes each to make at a cost of about 50 cents each for materials. Sony estimates the Mavigraph printer will cost $600 to $700 when it is introduced; that is tentatively scheduled for 1983.

VIDEODISC SPINNING

They may not be spinning the way they're supposed to, but videodiscs are in a mad whirl following two major events reported in this column in the June 1982 issue of **Radio-Electronics.** The first was the dropout of IBM and MCA from the optical-disc race, leaving Pioneer and North American Philips as the LV format's virtually exclusive managers. The second event was RCA's reduction of $150 in the suggested list price of its new CED player model to $349.95, with the identical former model selling at $299.95 and very often below.

Combined with the recent and not notably successful Japan-market debut of the laser optical system, what effect will those developments have on the as-yet-unintroduced Japanese grooveless capacitance VHD system, scheduled for introduction here at midyear, and earlier on the Japanese market? The initial signs are that they're close to devastating. VHD was designed as a sort of middle-ground system, with many of the special effects of the optical technique and a price closer to CED. But that design was based on two assumptions: (1) A highly successful market for special-effects discs, and (2) CED players selling at around the $500 level. Those assumptions have not been born out.

JVC, the originator of the VHD system, announced the "indefinite postponement" of its Japan-market debut, blaming "stagnant consumer demand" and "the sluggish market situation." Earlier, JVC's parent Matsushita Electric (Panasonic and Quasar in the U.S.) presumably had decided to delay manufacture of VHD players. U.S. introduction of the system had been planned shortly after midyear by General Electric, Matsushita, Quasar, and Sharp. Now it seems likely that at the very least there'll be a relatively long postponement of marketing.

SPACE WARS

Videogame wars may be fun, but they're also dead serious, as a recent federal appeals court ruling showed. The appeals court in Chicago, in effect, ordered an injunction on sales of the Odyssey videogame cartridge, K.C. Munchkin, on the grounds that it might infringe on Atari's popular Pac-Man. North American Philips Consumer Electronics notified its dealers that it won't accept any more orders for Munchkin, presumably at least until the Supreme Court rules on the injunction, or the actual copyright-infringement trial is completed. **R-E**

"No one else gives you as many functions in a handheld DMM.

Now you can move up to Fluke."

We've got great news for people who've been holding out for a high quality, high performance DMM at a moderate price: Fluke's new nine-function model D 804 is now available at select electronics supply stores.

With a suggested U.S. price of only $249 and features you won't find in any other handheld DMM, the D 804 is an exceptional value. Here's why.

Logic level and continuity testing: A real time-saver for troubleshooting passive circuits in pcb's, cables, relay panels and the like. The D 804 has a switch-selectable audible tone and visual symbols to indicate continuity or logic levels.

Direct temperature readings in °C: Used with any K-type thermocouple, the D 804 delivers fully-compensated readings in °C from -20°C to +1265°C, for checking heating and refrigeration systems.

Peak hold feature captures transients: A short-term memory in the D 804 captures and holds the peak reading of a motor starting current.

And more: 0.1% basic dc accuracy, conductance, 26 measurement ranges, battery, safety-designed test leads and a one year parts and labor warranty. A full line of accessories is also available to extend the measurement capabilities of your DMM.

Ask your dealer about the powerful, versatile D 804 and the rest of Fluke's new Series D line of low-cost digital multimeters.

From the world leader in DMM's. Now we've designed one for you.

Suggested U.S. list price
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RE 6/82

If your dealer doesn't carry Series D Multimeters yet, call this number. We'll be happy to tell you who does. **1-800-426-9182**

FLUKE®

WHAT'S NEWS

GE "branding" diamonds for identification

From General Electric comes the report that their scientists have developed a novel technique for "branding" diamonds, nature's hardest material. The new technique is fast, convenient, and non-destructive. The "brand" is absolutely invisible under normal conditions.

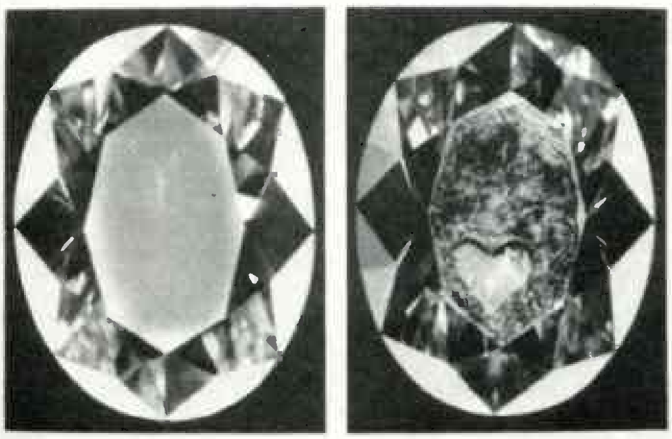
The researchers use an ion implanter to create an invisible mark inside a diamond. That instrument emits a beam of charged atoms (ions). It is normally used to create regions of different conductivity in silicon chips. When the silicon is bombarded with the beams, the ions penetrate its surface (are "implanted") and create a modified region just below the surface.

To create a desired pattern on a diamond, a custom-made mask is placed over one of its surfaces before it is exposed to the beam. The ions then create a patterned region with an electrical conductivity different from that of the surrounding area.

To reveal the hidden pattern, the diamond is given an electrostatic charge by rubbing it with a piece of silk, or by using a corona-discharge apparatus. The charge is held in the region where the ion pattern is implanted—or everywhere but that region, depending on the charging method.

The diamond is then dusted with a special powder, which clings to the charged region only, revealing the distinguishing pattern. The powder is then wiped away with a cloth and the pattern disappears.

The new method could be a boon to jewelers, diamond owners, and police. (Identifying stolen diamonds is difficult. Thieves remove them from their settings and group them with similar ones.) Jewelers could implant a distinctive mark in each diamond sold, photographing it and giving a copy to the customer, while keeping one copy for the record.



"BRANDED" DIAMONDS CAN be identified quickly and conveniently. The distinguishing mark (actually, an area of altered electrical conductivity) is normally invisible (left). To make it visible (right), the diamond is given an electrostatic charge and dusted with a special powder. That outlines the branded region—here, a heart-shaped pattern.

Tactile communicator aids the handicapped

The Helen Keller National Center's Research Department has developed a new signalling system that alerts deaf/blind persons to such incoming signals as a ringing doorbell or a telephone. A form of paging system, the Tactile Communicator uses a transmitter about the size of a clock-radio and a pocket receiver that imparts a vibratory sensation when a signal is received.

The transmitter has five inputs: three for high-priority devices such as telephone, doorbell, or smoke detector, and two for any other desired use, such as oven timer or burglar alarm. A button on the transmitter permits the user to tap out code messages to a deaf or blind person in the same house or yard.

THE TACTILE COMMUNICATOR, with which the deaf or blind may receive signals they could not otherwise see or hear, at left; the pocket receiver at right.

The receiver has a low-power motor that causes the wearer to feel a vibration when a signal is received. For a fire alarm, a single vibration is felt every half second, for the doorbell, two pulses 2½ seconds apart, and for the telephone, a pulse every four seconds. When the fire signal is received, it obliterates all others.

A battery-saving circuit is a special feature of the device. The receiver turns itself on for 5 milliseconds to "listen" for a signal. If none is received, it turns itself off for 100 milliseconds. That lengthens battery life 20 times, so that an ordinary 9-volt alkaline battery can power the receiver for more than 75 hours continuously.

The system uses the new handicapped persons frequency of 43.64 MHz. Price is $300.

Further information may be obtained from the Helen Keller National Center, Research Dept., 111 Middle Neck Road, Sands Point, NY 11050.

Zenith urges that FCC authorize teletext

Stating that "in principle, Zenith supports the concept that a single technical standard is usually desirable for major broadcast services," Zenith Radio Corp. nevertheless has urged the FCC to authorize commercial teletext operations in the U.S. and let the technical problems be solved by competition in the marketplace.

"It is not even presently known whether there is a viable market for teletext service in the United States," Zenith commented at an FCC hearing on the subject last February. For more than three years, a special EIA teletext committee composed of the nation's leading experts has addressed the standards issue and has failed to reach an agreement on even the broad system parameters of a preferred technical standard.

The basic issues concern the need or desirability of high-

continued on page 12

Digital Watch Radio

When people see you plug stereo headphones into your digital watch, they may wonder. Walkman, move over.

The samarium headphones and the Digital Watch Radio produce a strong sound you'll find hard to believe.

It all makes sense. If you wear your digital watch most of the time just adding an alarm, a chronograph, and even an hourly chime might make it more appealing. But adding a radio, that tops it all.

The Advance Digital Watch Radio is exactly that–a full-featured digital watch with a built-in AM radio that lets you listen to music, news and sports anytime, anywhere–all with a sound so powerful that you'll shake your head in disbelief.

Remember your surprise the first time you listened to a Sony Walkman or to one of the new headphone radios? Remember the sound quality, the deep bass response and the crystal clear highs? That's what you'll discover from that little sound package on your wrist. But wait, there's more.

NO EASY TASK

Keeping the radio small and powerful was no easy task. It involved new technology and some pretty clever thinking. For example, the volume control is located on the headphones and there is no on/off switch. Just plugging in the headphone jack turns on the radio.

The 2 milliamp circuit gives you over 100 hours of play from your radio–all from just one commonly available silver oxide battery. A separate battery runs your watch for over a year. But the features don't stop there.

The AM radio tuner is attached to a thin flat disc that you turn with your thumb. Stations come in clear and crisp and despite the tuner's small size, the stations are easy to fine tune thanks to a highly directional Hitachi radio antenna which has a low signal-to-noise ratio. But what about the watch?

FULL-FUNCTION WATCH

The Watch Radio is a full-function LCD digital alarm, chronograph timepiece with hourly componentry. The watch is an impressive product that could alone be worth $49.95.

Now, when you add the powerful AM radio and a set of samarium cobolt high fidelity headphones, only then can you appreciate the real value of the Watch Radio. Samarium cobalt, a space-age material, reduces the weight of the headphones, provides outstanding frequency response and replaces the need for the bulkier iron magnet traditionally used in today's smaller headphones. The combination of both the samarium cobalt headphones and the unique circuitry is one of the breakthroughs that has made this product possible.

With the lightweight headphones, you also get a small ear plug headphone which lets you monitor your radio without drawing too much attention to it. It's really a cheap listening device that makes a perfect accessory because you can easily carry it with you in your pocket or purse.

Now you can jog or play most sports without having to lug a cassette recorder or AM radio around. Just plug the long headphone wire into your watch and select your entertainment. At sporting events, while walking your dog, riding your bicycle or even waiting in line at the checkout counter, you've always got your entertainment with you. Think of it. Now to check the weather you can use your watch.

You can easily change the battery after 100 hours of use. The small opening to the right of the dial (shown in the photo at the bottom) is a sound port for the watch chime and alarm.

We suggest you order an Advance Digital Watch Radio on our 30-day, no obligation trial. We realize that it is impossible for you to imagine the incredible sound and the watch quality until you personally wear and use it. So, when you receive it, give it a real work out. Use it while you shop, work or play. Take it with you on a trip. See how handy it is when you want to check the weather or sports results.

But the most fun is watching the reactions of people who see you listening to your digital watch or seeing their expressions after they hear its powerful sound on your headphones. It's a product that people will find hard to believe–even in today's electronic revolution.

If after your testing you're not convinced that the Advance Digital Watch Radio is even more than we've described, no problem. Return your watch and headphones for a full refund including your $3.00 for postage and handling.

GREAT VALUE PACKAGE

But with all its advanced technology and sophisticated electronics, the Advance Digital Watch Radio is probably one of the greatest values we've ever offered in one complete package. A digital watch, a built-in radio, a handsome set of samarium cobalt headphones, a cheap ear plug headphone plus the batteries–all for $49.95. Each watch comes complete with a one-year limited warranty and all batteries. Just open up your package, plug in the headphones and you're ready to go.

The Watch Radio offers us the opportunity to add some fun and everyday practicality to our life–all at a very reasonable price.

Technology keeps marching on. So, we wouldn't be surprised if the Advance engineers are working on the TV version of their new watch. And you won't be too surprised either–once you personally hear the phenomenal sound from their radio. Order your Digital Watch Radio at no obligation, today.

To order send a check or money order to the address below or credit card holders call toll-free **800 228-5000** (In Nebraska call **800 323-6400**). When ordering, please use order number (shown in parenthesis) for faster service. Please add 3.00 for postage and handling and Illinois residents add 6% sales tax.

Digital Watch Radio **$49.95** (2040RE01)

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JS&A PRODUCTS THAT THINK ®

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WHAT'S NEWS

continued from page 6

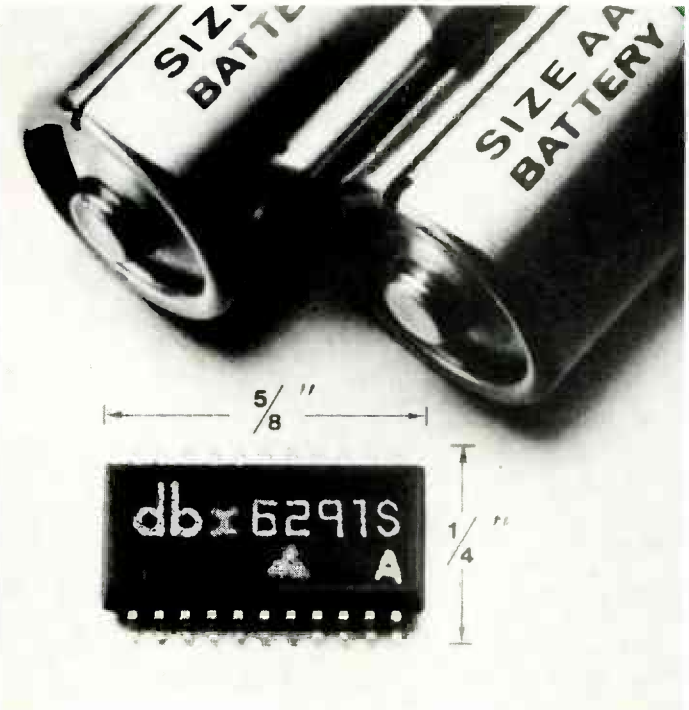
resolution graphics, format flexibility, optional marketplace applications, and cost/benefit tradeoffs. No amount of rationalization in industry committees or FCC comments can match the experience of commercial marketplace operations in reaching an authoritative resolution of such issues.

"And," says Zenith, "if marketplace experience should establish that there would be a major benefit in reaching a common technical standard or format, such a standard will undoubtedly be reached through a natural industry evolutionary process."

New IC cuts price of "superfidelity"

A new, low-cost low-voltage integrated circuit for the dbx noise-reduction system has been announced by Matsushita Electric. That ⅝ × ¼ × 1/16-inch IC is expected to make noise reduction for both recording and playback available at a cost that will make it viable for mass-market products, such as personal portables.

The dbx NRX IC solves two major problems of portable cassette and car-stereo players, according to dbx president David Blackmer. Those are limited dynamic range and tape hiss. With the NRX, tape hiss is eliminated, and dynamic range increased phenomenally, "making the personal portable and car-stereo player high-fidelity instruments," says Blackmer.



THE NEW dbx NRX IC, in size-comparison with two AA cells. It was developed jointly by dbx, Inc., and Matsushita Electric. It is expected to make portable cassette and car-stereo players provide the full fidelity sound and wide dynamic range hitherto associated with "high fidelity" equipment.

Pact signed to make new high-speed CMOS

RCA, Philips, and Signetics have signed an alternate-source agreement for a new family of high-speed CMOS (*C*omplementary *M*etal *O*xide *S*emiconductor) circuits. The three have agreed to develop more than 180 high-speed CMOS circuits that will combine the low-power advantages of the present 4000B series with the high speed and drive capability of low-power Schottky LSTTL (*L*arge *S*cale *T*ransistor-*T*ransistor *L*ogic).

The new series will provide a full catalog of high-performance CMOS circuit functions for the next generation of equipment design as well as a select group of CMOS drop-in replacements for LSTTL types used in current equipment designs. Circuits will be as much as 20 times faster than conventional metal-gate devices at 5 volts, yet dissipate only one-thousandth the normal power of LSTTL devices.

The three companies view the development of those CMOS types as providing a major impetus for accelerating the establishment of CMOS as the preferred technology of the future. In developing that broad range of products, RCA, Philips, and Signetics expect to make a positive contribution to fulfilling that goal.

Educators get awards that total $125,000

Apple Education Foundation has just awarded $125,000 worth of microcomputer equipment to educators who have developed new methods of learning through innovative use of small computers. Since October 1979, approximately $750,000 in equipment has been donated to educational institutions, for instructional development.

The grants cover a wide range of values and subjects. A partial microcomputer system valued at $790 was given to George Brown, of Savana High School, Anaheim, CA, to develop a program that teaches genetics to high-school students. At the other end of the scale, a $12,400 system—to develop graphic programs that teach the dynamics of environmental systems to undergraduates—was awarded to Henry Hart and Calvin B. DeWitt, of the University of Wisconsin.

At least a dozen other companies—in the fields of computers, peripheral equipment, software, and even public relations—have contributed to the Foundation.

Radio-Electronics

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LETTERS

Address your comments to: Letters, **Radio-Electronics**, 200 Park Avenue South, New York, NY 10003

COPYRIGHT AMENDMENT

Please advise your readers of pending legislation in respect to video recorders. Bill S.1758 would amend Title 17 of the United States code to exempt the private, non-commercial recording of copyrighted works on video recorders from copyright infringement.

The key sentences in the bill are these: "Notwithstanding the provisions of section 106, it is not an infringement of copyright for an individual to record copyrighted works on a video recorder if—(1) the recording is made for private use; and (2) the recording is not used in a commercial nature."

Write to your senators and congressmen, urging them to support Bill S. 1758.
A. E. MORRIS,
Otter Lake, MI

TEMPERATURE SCALES

I wish to comment on Dr. D.G. Henning's comments on J.J. Carr's discussion of temperature scales ("Letters," February 1982 **Radio-Electronics**). Dr. Hennings statement that "the triple point of water, the point where gas, liquid, and solid exist in equilibrium at 1-atmosphere pressure, is defined as 273.16°K ..." is incorrect. The triple point of water occurs at 0.00602 atmosphere, not at 1 atmosphere.
PAUL CERTA,
Richland, WA

SABTRONICS FREQUENCY COUNTER

The equipment report on the *Sabtronics 8610A* frequency counter in the February 1982 issue of **Radio-Electronics** was very good, but it contained a misleading statement in respect to the frequency accuracy of WWV: " ... When the National Bureau of Standards says it's transmitting on 10 MHz, who's to doubt it?"

The frequency and time broadcasts of WWV, as received via ionospheric propagation, are not nearly so accurate as at the source " ... due to the unstable nature of the ionosphere." (*Frequency and Time*, by P. Kartaschoff, Academic Press, 1978; page 183). Kartaschoff states further: "These fluctuations limit the highest achievable precision to about $\pm 1 \times 10^{-7}$ for frequency comparisons, and to about 500 to 1000 μS for the reception of timing pulses."

Further support for that concept is found in *Ionospheric Radio Propagation*, (pp 113 and 115), NBS Monograph 80, 1 April 1965; NBS Special Publication 432, page 1, issued September 1979; NBS Technical Note 668, pp 10-15, issued May 1975, and Hewlett-Packard Application Note 52-2, pages 4-2 and 4-3.

The point is that WWV, as received via ionospheric propagation is not accurate enough to adjust the standard contained in many of today's moderately priced frequency counters.
JOHN H. HENNING,
APO Miami

THE dB WAR

I really enjoyed your December 1981 edition, especially the article, "Radio Moscow is Winning the dB War." SWL is my hobby, so I found that article very educational and helpful. Thank you. Can I expect to see more articles on SWL in **Radio-Electronics?**
CHARLES PIERCEALL,
Charleston, MO

We read the article, "Why Radio Moscow is Winning the dB War," by Stanley Leinwoll in the December 1981 issue of **Radio-Electronics** with much interest. Anyone who has done some shortwave listening over the last few years will be aware of the interference apparently emanating from the USSR, known as the "Russian Woodpecker." That QRM consists of very strong, short-duration pulses with a repetition rate of a few Hz. Those pulses are swept up and down in frequency over a band of a few MHz.

When that QRM first came on the air, there was speculation in the press that it might be anything from over-the-horizon radar to Soviet attempts to change our weather by heating up the atmosphere. It appears, however, that those pulses fit the bill suitably for Mr. Leinwoll's backscatter ionospheric-sounding method. We find it curious that he did not mention that very obvious connection.
CLAUS SCHOENFELD,
JOHN HUDAK,
Ontario, Canada

CAR TELEPHONES

I would like to correct some errors in the story, "Cellular Car Telephones," that appeared in the February 1982 issue of **Radio-Electronics.**

Your report on the advanced mobile telephone system (A.M.P.S.) was very interesting. As a mobile-radio system technician with Pacific Northwest Bell, I have thought many times about how nice it would be to have mobile-telephone service. The new A.M.P.S. system can provide mobile service to many more people than current technology permits. However, let's get to the errors in the story.

continued on page 16

Replace Your Conventional Scope With The Sencore SC61. The First Scope With Pushbutton, Automatic Readout.

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Sencore SC61 60 MHz Waveform Analyzer.

LETTERS

continued from page 13

The first point of interest is Figure 3, a photo of the "Hump-mounted Control Head." The caption noted that the control head had a *Touch-Tone* keypad. That is not so. The control head *does* have a "pushbutton" keypad for dialing; however, the output of that keypad is digital information transmitted to the mobile-communications switching office (M.T.S.O.). The *Touch-Tone* that many of our **Radio-Electronics** readers are familiar with is an analog, dual-tone multi-frequency (D.T.M.F.) signal. The *Touch-Tone* signaling format has been popularized with the advent of the single-chip encoder and various decoding methods.

The second point is that of the mobile transmitter/receiver. It was noted in the article that "Because of the 45-MHz separation between transmit and receive frequencies, cellular mobile phones use two 2.5 dB gain antennas at the car; one each for transmit and receive." It is *not* to bridge the 45-MHz separation between transmit and receive that the two antennas are used. That function is performed by a diplexer in the radio. Rather, the two antennas are used to overcome fading at 800 MHz, thus providing an effective increase in average signal to noise. The same argument applies here as was presented in the article about the base-station receivers.

One more note: The article implied that the data rate between the cell site and the mobile radio was "... a data rate of 10 megabytes-per-second." That is also a mistake. The data rate is only 10 kilobits-per-second. That data rate can also be derived from the fact that the communication channel is ± 5-kHz wide, 10-kHz total. We can also see that running our data rate near the maximum of the channel bandwidth provides a justification of the receiver diversity, thus significantly improving the bit error rate.

PAUL R. RODRIGUEZ,
Bothell, WA

NIKOLA TESLA

I would like to express my agreement with the letter by Alfred Powell in the February 1982 issue of **Radio-Electronics** about general public unawareness of Nikola Tesla's work. It is a shame that more people do not realize how many of his discoveries are the root of our day-to-day activities.

There is one thing, though, where I can't entirely agree with Mr. Powell. How can you link the ideas and inventions of Tesla with those of Edison? The two men were entirely different, both in their outlook and work. As I stated in my letter that you ran in the June 1981 issue, Edison was concerned with *devices;* Tesla was not. Tesla had no time to work out devices because he was concentrating upon discoveries that proved to be major breakthroughs in the electronics industry when they were put to use.

The reason why Edison is immortalized in American history and Tesla is not is because of those many devices that Edison brought to fruition—they are used by millions in the home.

Tesla's discoveries also led to things constantly used in the home, but his part in them is not so apparent as Edison's—we all know that Edison worked out the practical electric light and the gramophone, but what do we connect with Tesla? Yet Tesla's discoveries were far more significant than any of Edison's devices.

As a member of the Tesla Memorial Society, I take the subject of Nikola Tesla very seriously. It is too bad that so few people in the world are aware of how great that man was. I feel that, as the years pass, more and more people will become interested in Nikola Tesla. If that happens, he will become more of a part of American history.

VINCE MARASCO,
Linden, NJ

It would help if admirers of Tesla, like you, took the trouble to mention in your letters some of the things constantly used in the home today that can be traced to Tesla's work, rather than just repeating what a great discoverer he was. As you say, we can pin down easily many day-to-day devices that Edison made practical. But if Tesla is to become appreciated by the public, as we agree that he should be, we have to tell people specifically about things we owe to Tesla—things that people will remember.—Editor.

continued on page 42

ANNOUNCING RADIO-ELECTRONICS VIDEO GAME CONCERT CONTEST!

Test your skills! Meet our challenge! Compose your own electronic musical score from the sounds of your favorite TV game...and win these Kenwood state-of-the-art components—and more—valued at over $10,000 retail!

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- 1 pair of Kenwood LS-1000 Speakers (list price: $500)
- 1 Kenwood DC-20 integrated stereo system (list price: $900)
- 4 sets of ten TDK video cassettes (list price: $350 per set)
- Plus...even *more* valuable prizes yet to be announced!

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John E. Cunningham

Special Projects Director
Cleveland Institute of Electronics

SATELLITE/TELETEXT NEWS

GARY ARLEN
CONTRIBUTING EDITOR

HOME SATELLITE LEGISLATION

Controversy continues about a proposed law that could restrict private reception of satellite signals. Although the situation seems to change week-by-week, the latest indications are that an alternative will be proposed so that any restrictions would apply only to "commercial" interception of communications. That would probably mean that apartment complexes, hotels, bars, etc., would be prohibited from receiving satellite signals, but "backyard" personal users would be exempt. Even people who like that compromise are not completely satisfied, though, because it would leave unsettled a fundamental question involving the Communications Act's principles of private commuications.

Meanwhile, manufacturers of earth station equipment are rallying to make sure that any law that emerges does not include penalties for building satellite-reception devices. As SPACE, the association representing the private earth-station industry, points out, the wording of the proposed law is so vague that "commercial use" could be construed to apply to "commercial manufacturing" of equipment. "Under such circumstances, who would be willing to manufacture backyard earth stations? SPACE asks rhetorically.

Although the pending legislation involving satellite reception is separate from other Capitol Hill activities involving the Communications Act, it could become incorporated into the larger issue of revising telecommunications laws. Congress was already deeply involved in rewriting the 48-year-old Communications law—but now the changes soon to take place in the Bell System have accelerated interest in a sweeping revision of that law. Because of that increasing interest, a number of issues involving satellite communications could work their way into those revisions of the Communications Act during the coming months.

THE HBO SCRAMBLE IS ON

Home Box Office has plans to scramble its pay-TV satellite programming signal—possibly by the end of this year. Hoping to prevent private earth-station owners from seeing HBO programs, the company will spend up to $5 million to give decoders to all cable systems using their service. The digital encryption system will include an individually addressable feature permitting HBO to control the decoding devices from a central point and to change the encryption/decoding patterns as often as necessary. According to HBO, the coding system is tamperproof because it depends on the code being used. Duplicating the electronics in the decoder will be useless without also knowing the code that is in use.

At the time HBO announced the encoding plan, it hadn't decided on which encryption technology to use. It was debating between several cable/satellite coding devices and those made for military electronics. HBO also has plans to encode its audio signal—with an eye toward putting in place a digital transmission system that can be used for higher-quality digital stereo sound at a future time.

It's hard to tell yet whether HBO's plan to encode its satellite transmission will cause other satellite programmers to do the same thing. The growing number of private earth stations is beginning to concern a great number of movie producers and other software suppliers. Efforts by SPACE and others to encourage HBO to permit private dish-owners to pay for a reception license are falling on deaf ears; HBO has repeatedly claimed that it has no interest in becoming involved in the retailing of programs directly to individual owners of private earth-stations.

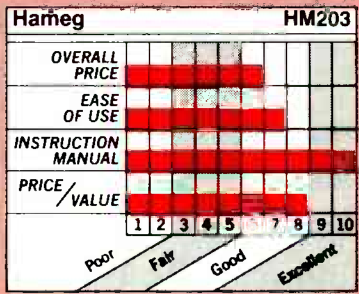
AROUND THE SATELLITE CIRCUIT

Intelsat has added a new full-time TV service to its network, permitting worldwide TV networking to more than one member user of the service at the same time. The new video networking arrangement also means that Intelsat users can sign up for short-term video services instead of the previous two-year minimum contract. That availability of short-term video services is a factor that should encourage an increase in specialized video satellite transmissions.

SPACE (the Society for Private and Commercial Earth Stations), the association representing satellite users, is planning its first-ever SPACE Trade Show in Omaha during the second week of August. Details are available from the group at 1920 N Street NW, Suite 510, Washington, DC 20036 R-E

EQUIPMENT REPORTS

Hameg HM203 Dual-Trace Oscilloscope



CIRCLE 101 ON FREE INFORMATION CARD

MOST TECHNICIANS AND EXPERIMENTERS will readily agree that a good oscilloscope is one of the most powerful tools you can own. It can be used for a variety of waveform measurements, and may even be substituted for voltage- and current-measuring devices when necessary. Because of its compact appearance and apparent flexibility, we decided to take a closer look at the Hameg *HM203* dual-trace oscilloscope.

The traces can be displayed either alternately or in a chopped mode. In the chopped mode, the chopping rate is 120 kHz. Vertical response is down 3 dB at 20 MHz, and down just 6 dB at 28 MHz. Vertical deflection varies from 5 to 20 volts-per-division, in 12 calibrated steps, and is accurate to within ±3%. The vertical input has an impedance of 1 megohm in parallel with 25 pF and can handle up to 500 volts. A ground position on the input selector switch may be used to prevent stray signals from reaching the amplifiers without loading the circuit under test. Also, AC and DC positions are provided on the input selector switch.

The front-panel vertical-amplifier controls are laid out in mirror-image fashion, making it relatively easy to become familiar with the instrument.

The sweep rate can be selected, from 0.5 microseconds to 0.2 seconds-per-centimeter, in 18 calibrated steps. A continuously variable control is also provided for fine adjustments of the sweep rate. That uncalibrated control will shift the sweep rate up to 200 nanoseconds-per-centimeter. An uncalibrated ×5 magnifier lets you extend the sweep to 40 nanoseconds-per-centimeter.

An input is provided for displaying signals on the horizontal axis. The response of the external horizontal input is down 3 dB at 2 MHz.

Automatic and variable trigger levels are available for either channel. Positive or negative slopes are switch selectable. The trigger sensitivity is 0.7 volts if an external source is selected, or 3 millivolts with the internal source. Both manual and automatic triggering is available.

A calibrated square-wave generator provides a 1-kHz reference signal at 0.2 volts ±1%. Trace rotation can be corrected using a front-panel control.

Any line voltage from 100- to 240-volts AC (50/60 Hz) can be used to power the instrument; all internal DC operating voltages, including the high voltage, are regulated.

The accompanying operator's manual is one of the best we've seen. It is well illustrated, and contains technical and tutorial information for both use and maintenance.

Our test

The unit is completely solid-state except, of course, for the CRT. As expected, the trace came up to full brilliance within 30 seconds. Under varying ambient temperature conditions (and even several days' power-down between trials), the trace came on exactly at the baseline, requiring no vertical or horizontal positioning.

The blue-white trace was sharp and brilliant; it did not show any noticeable astigmatism. The X and Y position, as well as the intensity and focus of the trace could be easily adjusted using front-panel controls.

We found that the ×5 magnifiers were very useful at higher frequencies, where a waveform would normally become very crowded.

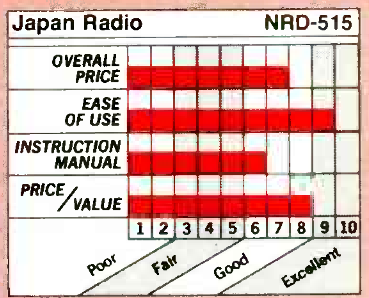
Trace drift, a common problem with many inexpensive oscilloscopes, was totally absent on the *HM203*. Linearity of the vertical amplifier showed excellent accuracy on all ranges.

Lastly, but an important consideration, the unit's light weight (13 pounds) and compact construction (11 × 6 × 16 inches) make it easy to move around, and easy to use on even the most crowded workbench.

The *HM203* sells for $580.00; the price includes a ×1 and ×10 switchable oscilloscope probe. If you can not find the scope locally, it is available from the manufacturer: Hameg, 88-90 Harbor Rd., Port Washington, NY 11050. **R-E**

Japan Radio Company NRD-515 Communications Receiver

CIRCLE 102 ON FREE INFORMATION CARD



A RENAISSANCE IN SHORT-WAVE LISTENing has resulted in the introduction of quality receivers at a rate unmatched since the 1950's. In those days, the best known names belonged to firms such as

Hallicrafters, Hammarlund, and National. Those companies are now gone, but they have been replaced by others such as Kenwood, Yaesu, and Sony.

You can add Japan Radio Company (120 E. 56th Street, New York, NY 10022) to that growing list of "new" manufacturers. That company, famous in Japan but relatively unknown here, has introduced a high-quality communications receiver, the *model NRD-515*.

Even at first glance, the receiver's sturdy construction and functional styling are impressive. The front-panel controls are sturdy—not thin plastic. On that receiver, detents snap securely in place, toggle switches click into position, and the flywheel tuning mechanism spins securely on its bearings.

But the quality does not stop with construction and styling. Frequencies are displayed on a six-digit, LED readout; the readout is claimed to be accurate to within 100 Hz. The accuracy of the readout is enhanced by an automatic offset circuit that allows the carrier frequency of an upper- or lower-sideband signal to be displayed directly—no mental interpolation is required. The thermal and mechanical stability of the oscillators help assure virtually drift-free performance. The frequency range is specified as 100 kHz to 30 MHz.

The tuning mechanism used in the receiver is rather unusual. It uses an optical encoder to translate visual "pulses" from a slotted disc into electronic pulses that are used to change frequencies. The slotted disc is spun by turning the tuning dial. One complete rotation of the tuning dial will result in a 10-kHz change in frequency. That 10 kHz is composed of a series of 100 integral steps of 100 Hz each, with a fine-tuning control used for the frequencies between steps. Because of that scheme, tuning across a band consists of a series of abrupt frequency shifts, although if the BFO is on (for SSB reception, etc.) it shoulds more like someone sliding a hand across a piano keyboard. In any event, it may take a little getting used to.

As with most modern frequency synthesized receivers, the tuning range is divided up into a series of 1-MHz increments. Fast tuning within those increments is done using a UP/DOWN toggle switch. The switch is used to shift the receiver's frequency quickly in the direction indicated. Once you get close to the frequency you want, the tuning dial is used to find the precise setting. Incidentally, you can tune above and below the limits of each individual increment simply by holding the toggle switch in position. In fact, you could tune all the way from 100 kHz to 30 MHz using just the toggle switch if you wished; but that is not recommended.

Among the receiver's features is a built-in noise blanker. It suppressed sharp rise-time pulses effectively, provided that there was sufficient recovery time between pulses. However, it was not effective against short-period pulses, such as arcing or appliance noise.

RF bandpass filters eliminate the need for a tunable preselector for most frequencies; the tunable BFO is used as an effective preselector on the 600- to 1600-kHz broadcast band. IF bandpass tuning, something not often found on consumer receivers, is very well designed here. With it, the user can slide the IF passband across a signal, positioning it to reject the greatest possible amount of interference. An IF bandwidth control lets you select among 6-, 2.4-, and 0.6-kHz bandwidths; an auxilliary position on that control is for any user-installed filter. Selectable AGC allows for fast, slow, or no AGC at all.

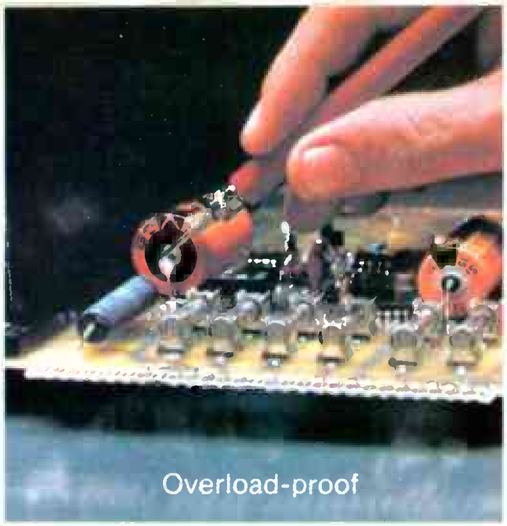
The owner's manual that comes with the unit is quite comprehensive. It includes detailed operating instructions, technical information, maintenance procedures, and alignment instructions.

The memory unit

For the ultimate in convenience, you'll want to investigate the optional *model NDH-515* "memory unit." The unit can store up to 24 frequencies.

Using the memory unit is easy. To enter a frequency, simply tune the re-

Drop-proof



Overload-proof

Contamination-proof

Oops proof.

Now there's a hand-held DMM tough enough to withstand accidental drops, destructive environments, and input overloads — and still give you superior Beckman performance.

The HD-100 from Beckman is drop-proof, sealed against contamination, and packed with overload protection. You won't find a more rugged meter inside or out.

Drop-proof

Constructed of double-thick thermoplastics, the HD-100 resists damage even after repeated falls. All components are heavy duty and shock mounted.

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The HD-100 is designed to keep working even around dirt, heavy grime and moisture.

The special o-ring seals, ultrasonically-welded display window and sealed input jacks protect the internal electronics of the HD-100 from any source of contamination. The HD-100 is sealed so tightly, it's even waterproof.

Accidental overload protection

All voltage inputs are protected up to 1500 Vdc or 1000 Vrms. Current ranges are protected to 2A/250V with resistance ranges protected to 600 Vdc. Transient protection extends up to 6KV for 10 microseconds.

More meter for the money

For starters you get 2000 hours of continuous use off a common 9V transistor battery. You can run in-circuit diode tests and check continuity. You even get a one year warranty.

The 0.25% basic volt dc accuracy HD-100 serves you with 7 functions and 29 ranges. With one simple turn of the single selector switch, you can go directly to the function and range you need. There's less chance of error.

Feature for feature you can't find a more dependable meter priced at just $169 (U.S. only).

To locate your nearest distributor write Beckman Instruments, Inc., Instrumentation Products, 2500 Harbor Boulevard, Fullerton, CA 92634 or call (714) 993-8803.

BECKMAN

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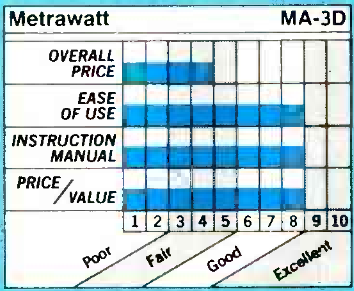
ceiver to the frequency you want, set the CHANNEL dial on the memory unit to the channel you wish to assign the frequency to, and press the unit's MEMORY button. When you recall the frequency, the channel is displayed by the memory unit, and the frequency by the receiver.

Finding fault with an outstanding receiver such as the *model NRD-515* is difficult, but there *were* a few minor shortcomings. The noise blanker would be more effective if it suppressed appliance noise. The pulses from the optical encoder caused distracting noise over some frequencies—12-18 MHz—during tuning. Although an accessory speaker is available, including a built-in one would have been desirable. In addition, there are brief dropouts as the receiver is tuned beyond the increment it is set for. Finally, the audio-gain control does not cut the sound off completely when it is turned fully counterclockwise. But those faults are insignificant when compared to the overall performance of this receiver.

The *model NRD-515* communications receiver has a suggested retail price of \$1395.00; the price of the *model NDH-515* memory unit is \$249.00. The matching speaker sells for \$49.95. All are available from Universal Amateur Radio, Inc., Department B, 1280 Aida Drive, Reynoldsburg, OH 43086. **R-E**

Metrawatt MA-3D Digital Multimeter



CIRCLE 103 ON FREE INFORMATION CARD

EARLIER THIS YEAR WE REPORTED ON A new line of test equipment, the BBC-Georz-Metrawatt line. Made in Germany, they're now being sold in the U.S. by BBC-Metrawatt-Goerz, 165 Fieldcreast Ave., Raritan Center, Edison, NJ 08837. The new one is the model *MA-3D*. It's a digital; the first one, exactly like it on the outside, was an analog meter. The same design is used for both; a hinged case with readout on the cover. When closed, that protects not only the readout but all controls as well. Flat, it's very compact, and would go into a caddy very easily. Powered by a single 9-volt rectangular battery, the lid serves another purpose; when it's closed, a stud hits the on-off switch and turns it off. An AC adapter is available; when that is used, the panel switch is bypassed and it's on all the time. Battery life is very good, due to low-current design and use of IC's.

The *MA-3D* has a total of 25 measuring ranges, on AC volts, DC volts, AC or DC current, and resistance. The cover of the case can be adjusted easily to give the best viewing angle for the readout. That is an LCD type, with nice big digits. It uses the now-familiar "2"-based scale in which each range reads up to 1.999 and the decimal point automatically adjusts itself to tell you what range you're on. The display features a 3.5 digit readout; overrange is shown

continued on page 32

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$349. 8060A

$279. 8062A

Display: 4½ digit duplex LCD (19,999 count)

A/D Converter: Dual slope converter, autozero, autopolarity.

Conversion: TRMS, AC coupled

Display Annunciators: BT, low battery indication.

REL, relative reference mode activated. [8060A: **(k)Hz,** frequency function activated. **dB,** dB function activated.] continuity activated.))), continuity tone activated.—,continuity detected indicator.

Temperature: 0° to +50°C operating, −35° to +60°C storage.

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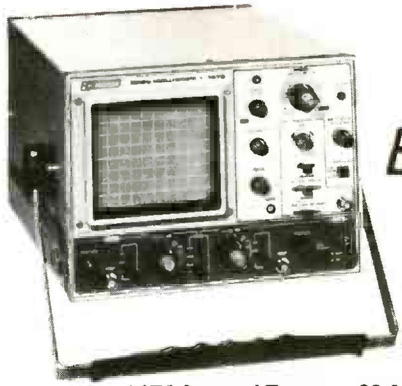

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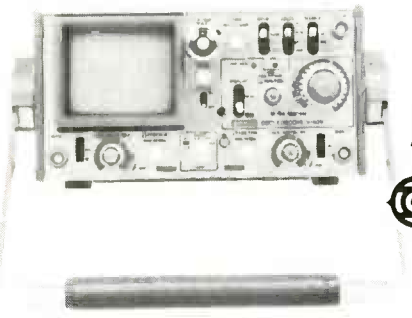

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DC CURRENT	2mA, 20mA, 200mA, 2000mA, 10A	2%
AC CURRENT	2mA, 20mA, 200mA, 2000mA, 10A	3%
RESISTANCE	200Ω, 2kΩ, 20kΩ, 200kΩ, 20MΩ	.5%

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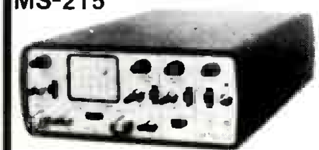

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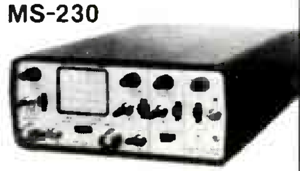

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EQUIPMENT REPORTS

continued from page 28

by a readout of "1" with a decimal point. That is also the "open" indication when checking resistance. Polarity switching is automatic. No sign, positive voltage; minus sign, negative polarity. Low battery-voltage is shown by the appearance of a small arrow above the minus sign on the readout.

AC and DC voltages start at 200 mV and go up to 650V maximum in five ranges. Current ranges for AC or DC start at 2.0 mA and go up to 2A. A separate 10-amp range is provided along with a separate jack on the side of the case. Resistance starts at 2,000 ohms and goes up to 20 megohms. Accuracy is 0.25% for DC volts.

All ranges are well-protected by fuses and internal protective circuitry, including thermistors, zener diodes, and so on. The 10-amp range does not have fuse protection. However, it will withstand currents up to 20-amps—but for not more than 30 seconds! The DC voltage ranges are designed to take overloads up to 260 volts (and that is on the 200-mV range!) and the other ranges will take 780 volts. AC ranges will take voltages up to 250 volts on all ranges. Even the ohmmeter is protected against accidental application of up to 250 volts. (The manufacturer says that, but so far I've never had the intestinal fortitude actually to try it!)

To go back to the folding case for a moment, that is a neat and practical design. The workmanship looks very good, and the cover stays right where you set it (Incidentally, the case was designed by Porsche. If you buy one, you can tell your friends casually that you just got a new Porsche!) The panel design is uncluttered; there's only one thing on it: the RANGE/FUNCTION selector switch.

Well...there are two, if you count the ON-OFF switch, which is a little rocker switch down in the lower right corner. The front panel is solid black with white markings that are easy to read. Test leads plug into a row of jacks, plainly marked on the panel, on the right side of the case. The case can be closed without unplugging the leads. The protective fuse is also here, between the + and the 10A jacks.

The test leads are *model KS-17* and are contructed of heavy wire, with corrugated grips on the handles, and a protective collar at the end. The probe has a sharp-pointed banana tip, and if you want to check components with thin leads, just slip them inside the springs of the banana clips. The instrument-end

continued on page 103

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20ns/div. to 50ms/div. in 20 calibrated steps 1-2-5 sequence. 10x mag extends fastest sweep rate to 2ns/div.

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STATE OF SOLID STATE

Advances in IC-timer technology

ROBERT F. SCOTT, SEMICONDUCTOR EDITOR

THE 555 INTEGRATED-CIRCUIT TIMER IS probably the most popular and widely used IC since the development of the 709 and 741 op-amps. Numerous applications for this device have appeared in nearly all contemporary electronics magazines and in several books devoted entirely to the 555. The device can be used in the monostable mode as a timer, or as a free-running multivibrator when operated in the astable mode. The theory of operation and a number of applications for that versatile semiconductor device were covered in-depth in the February, March, and September 1976 issues of **Radio-Electronics.**

Now, Exar Integrated Systems (750 Palomar Avenue, Box 62229, Sunnyvale, CA 94088) has introduced the more sophisticated XR-2243 Micropower Long-Range Timer; a device that can easily surpass the 555-family of IC's in versatility, and popularity among electronics hobbyists and experimenters.

That device is a monolithic timer/controller capable of producing time delays ranging from microseconds to days. The functional diagram for the XR-2243 is shown in Fig. 1 and the basic schematic diagram is shown in Fig. 2. (Compare these circuits with the 555-timer IC's block diagram and schematic that appears in the February 1976 issue and you'll see some of the advances that have been made since the 555 IC was first introduced.)

Applications for the XR-2243 include: sequential timing, generation of long time-delay periods, precision timing, and ultra-low-frequency oscillation. Its current drain is extremely low—less than 100 μA on standby and less than 1 mA during normal operation. Those minimal current requirements make the XR-2243 highly applicable for use in battery-powered circuits. The XR-2243's basic electrical characteristics are listed in Table 1.

TABLE 1—XR-2243 BASIC CHARACTERISTICS

Parameters	Typical values	Conditions
Supply voltage	2.7V min, 15V max	
Standby current	45—80—250 μA	V_{CC} = 2.7*—5—15 V
Operating current	750—900—1250 μA	V_{CC} = 2.7**—5—15V
Timebase timing accuracy	0.5%	V_{CC} = 2.7V**
Temperature drift	80—150—300 ppm/°C	V_{CC} = 5—15—8V
Maximum frequency	35 kHz	
Timing resistor R_T	5K to 10 meg	
Timing capacitor C_T	.005 μF to 1000 μF	
Trigger threshold	1.4V	
Trigger current	22 μA	V_{RS} = 0V, V_{TR} = 2V
Trigger impedance	25K	
Reset threshold	1.4V	
Reset current	22 μA	V_{TR} = 0V, V_{RS} = 2V
Reset impedance	25K	
Power dissipation	300 mW (plastic package)	

*V_{TR} = 0V, V_{RS} = 5V
**V_{TR} = 5V, V_{RS} = 0V

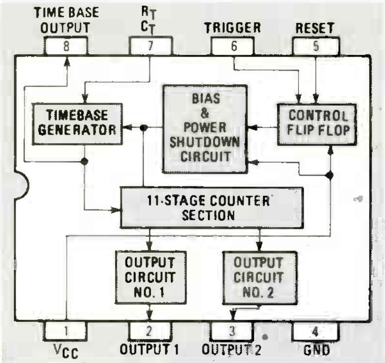


FIG. 1

Operation

The XR-2243 (see Figs. 1 and 2) has three main sections: the timebase generator, an 11-stage binary counter and a control flip-flop. The timebase generator is a relaxation oscillator, whose frequency and period of oscillation are determinated by the values of the components of an external R-C network (R_T and C_T) that is connected to pin 7 of the device, as shown in Fig. 3.

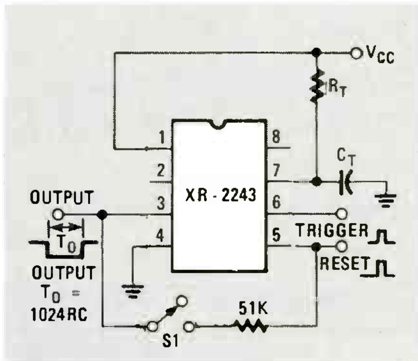


FIG. 3

The timebase flip-flop produces a string of clock or timing pulses with a period equal to R × C. Those pulses

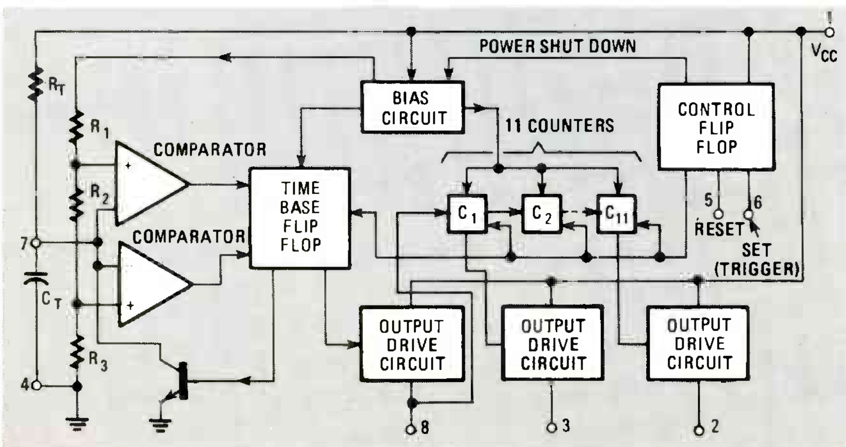
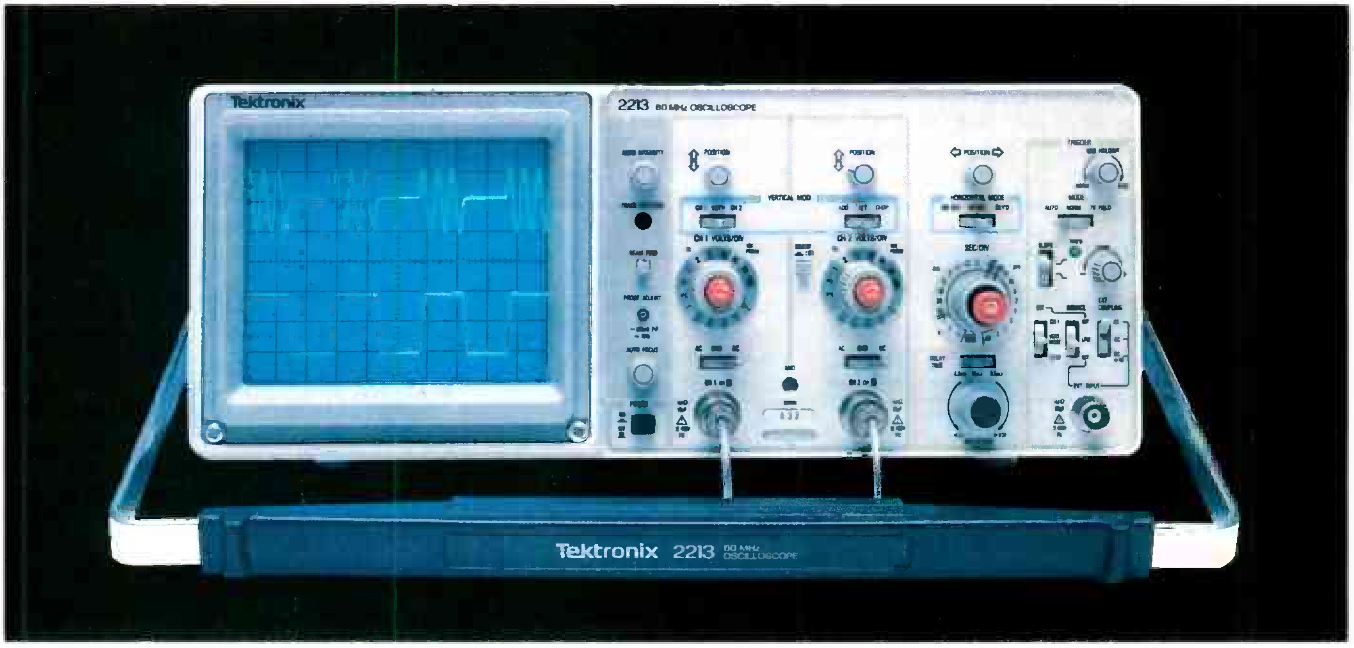


FIG. 2



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(available at pin 8) are internally fed to an 11-stage binary counter. For a given R × C product, the counter produces (at output pin 3) an output-delay pulse of 1024 × R × C. Cascading two XR-2243's produces a total time delay of 1024^2 × R × C or 1,048,576 × R × C. Similarly, cascading three stages will produce a 1024^3 × R × C time delay. Thus, we see that by simply cascading timer stages, we can achieve delays of days, weeks, months, and even years. For example, a controller for time-lapse photography applications can be designed around just a single XR-2243 timer.

The first and last counter stages drive output transistors that are capable of sinking 10 milliamperes. The second output pin (pin 2) delivers a squarewave with a period of 2 × R × C during the timing interval.

The third section of the timer IC is the control flip-flop. That circuit resets each counter stage in the XR-2243 to a logic-1 level and starts the timebase generator when a positive-going trigger pulse is applied to the SET (TRIGGER) pin. That section also activates a shutdown circuit when the timing cycle is completed, or when a positive-going reset pulse is applied to pin 5. When power is shut off, bias voltages are removed from the timebase generator and the counters. Standby power drops to the microwatt range with a typical supply current around 85 μA when V_{CC} is 5 volts.

Figure 3 shows the two basic modes of operation for the XR-2243. In the monostable mode—as used for time-delay and timing applications—the output terminal (pin 3) is connected to the RESET pin (pin 5) through an external resistor. The circuit is triggered by a positive-going pulse applied to pin 6. The last counter output goes low as the first timing pulse is fed through from the timebase generator. The pin-2 output remains low until after the 1024th timing pulse has passed.

After the 1024th timing pulse, the output goes high, delivering a positive-going pulse to pin 5. That positive-going pulse terminates the timing cycle and resets the circuit. The time interval between the set and reset actions is 1024 × R × C. During the timing interval, the timebase generator produces, at pin 2, a squarewave output with a period of 2 × R × C.

In the astable mode, the output at pin 3 is not connected back to the RESET pin. A trigger pulse on pin 6 starts the timer. That timer continues to operate in the free-running mode and produces, at pin 8, a squarewave with a frequency that is 1/2048th of the timebase-generator frequency. **R-E**

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LETTERS

continued from page 16

8-BALL ANTENNA

I built the 8-Ball satellite-TV antenna described in the August, September, and October 1981 issues of **Radio-Electronics.** It is a well-thought-out design, and a fine project for someone who wants to save money, after considering the cost of a commercial dish. The over-all article is written very well, with all the necessary details to complete the projects.

I did notice two small mistakes, however. In Part 1, 9/16-inch holes are specified for the vertical strips of the lattice assembly. Those should have been 5/16-inch to accommodate the ¼-inch bolts called for. In Part 2, Fig. 20-a, a hole is shown as being drilled four inches above the center line; it should be drilled four inches below the center line.

I also designed and built my own feed-horn assembly. If any readers are interested in that information, I would be happy to respond if an S.A.S.E. is sent.

The over-all cost of my antenna, including concrete pillars, was $287.00. I used cypress for the lattice assembly; that kind of wood will not rot, and is readily available here in Florida. I built a template to align the curvature of the dish, instead of the radius-wire method specified in the article and was able to obtain a very close tolerance.

I'm using a *KLM Sky Eye 2* receiver kit, and a 120° LNA. My TV reception is very good, and the results are well worth the effort. I am looking forward to more satellite-TV construction articles in future issues of your magazine.

WILLIAM B. CLRIDA, Sr.,
2024 Magnolia Ave.
South Daytona, FL 32019

CAR PROJECTS

Although I enjoyed "6 Projects for Your Car" in the April 1982 **Radio-Electronics,** I must say that I found it rather incomplete. The most important addition follows:

Murphy's Failure-Detector-Failure Detector: Since, by Murphy's Law, something will always go wrong, it's immediately obvious that at least *one* of the LED's in your projects 2 through 6 will *always* be lit! Therefore, your readers can easily work out an elementary 5-input logic gate that will light a *warning* if none of the regular warning lights are lit.

Now unless your readers are unusually astute, it should be pointed out that the Failure-Failure Alarm should monitor *itself* also! If it does not light, it should, of course, give some indication that it isn't going to light.

Not only that, but a 7th alarm should be provided (with an extra bright light) to indicate a dead battery. Writers Gartman and Weinstein failed to realize that that common failure would render the other 5 alarms inoperative.

I will leave it to your readers to suggest a simple way to warn the driver of his failure to notice the alarms.

PETER LEFFERTS,
San Martin, CA R-E

Introducing incredible tuning accuracy at an incredibly affordable price: The Command Series RF-3100 31-band AM/FM/SW receiver.* No other shortwave receiver brings in PLL quartz synthesized tuning and all-band digital readout for as low a price.† The tuner tracks and "locks" onto your signal, and the 5-digit display shows exactly what frequency you're on.


RF-6300 8-band AM/FM/SW

There are other ways the RF-3100 commands the airways: It can travel the full length of the shortwave band (that's 1.6 to 30 MHz). It eliminates interference when stations overlap by narrowing the broadcast band. It improves reception in strong signal areas with RF Gain Control. And the RF-3100 catches Morse communications accurately with BFO Pitch Control.

Want to bring in your favorite programs without lifting a finger? Then consider the Panasonic RF-6300 8-band AM/FM/SW receiver (1.6 to 30 MHz) has microcomputerized preset pushbutton tuning, for programming 12 different broadcasts or the same broadcast 12 days in a row. Automatically. It even has a quartz alarm clock that turns the radio on and off to play your favorite broadcasts.

The Command Series RF-3100 and RF-6300. Two more ways to roam the globe at the speed of sound. Only from Panasonic.

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

†Based on a comparison of suggested retail prices.

This Panasonic Command Series™ shortwave receiver brings the state of the art closer to the state of your pocketbook.

With PLL Quartz Synthesized Tuning and Digital Frequency Readout.

Panasonic.
just slightly ahead of our time.

CIRCLE 6 ON FREE INFORMATION CARD

BUILD THIS

STEREO IMAGE EXPANDER

Stereo sound shouldn't come from just between your two speakers. This easy-to-build stereo image expander can turn your whole listening room into a "sonic stage."

JOEL COHEN

THE BIGGEST PROBLEM WITH YOUR stereo system is probably in your head. If all the sound that came out of one speaker went into one ear, and all the sound that came out of the other speaker went into the other ear, you would perceive an astonishing sonic image. Unfortunately, your ears don't work that way — they both hear some sound from both speakers. That makes the sonic image — your perception of the stereo "stage" — considerably smaller and a lot less detailed than it could be.

While the basic components of a stereo sound-system are constantly being improved, their performance has reached the point where it is difficult to hear the difference between the new models and the old. The IR2200 stereo image expander, however, can enhance the performance of any stereo system, regardless of its age or cost, by processing the sound to bring out depth and dimension that is normally lost in reproduction.

Listening to stereo

The basic stereophonic process attempts to reproduce a detailed three-dimensional sound picture or image using two loudspeakers. In the analogous 3D-movie process the left image is kept out of the right eye, and vice versa, by polarized lenses and each eye sees only what was intended for it producing in the brain a true 3-dimensional image. The sound of each stereo loudspeaker, though, is heard by both ears and the illusion of space and depth is muddied.

The major effect of that stereo cross-coupling is to limit the perception of the stereo image to the small area between your speakers. Time-delay circuits and some specially designed speakers can add ambience or a sense of spaciousness to the sound but they can never recover the major portion of the orginal image that is lost because of the stereo "double exposure."

The stereo image expander functions as the sonic equivalent of 3D's polarized glasses. It cancels most of the stereo crosscoupling, thus unfolding and refocusing the original sound picture to fill the space before you.

The image-limitation of the stereo playback-process is not a new problem invented to sell new equipment. It, and a process to correct it, were first described over 20 years ago. It is the technique (U.S. patent No. 4,308,423) used in the stereo image expander that is new and its design overcomes a number of the limitations of earlier equipment.

How we hear stereo

In a typical live listening-situation a listener hears all sounds at almost the same level in both ears. He uses the slight difference between the *first-arrival times*—the instants that the ears first perceive the sounds—of the sound at his left and right ears to pinpoint its source. That time difference is known as *interaural delay* and Fig. 1 shows an example for a sound source located 60° to the left of the listener.

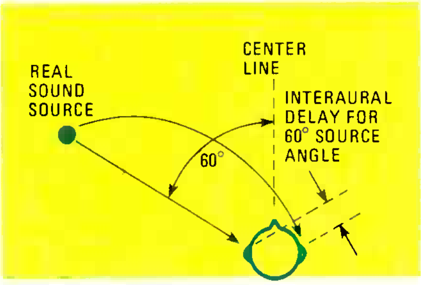


FIG. 1—INTERAURAL DELAY is what tells you what direction a sound is coming from.

No matter what stereo recording-technique is used, the two channels of a stereo playback-system contain signals whose time and amplitude relationships relate to the positions of the original sound-sources (Fig. 2). However, there is a basic problem in the reproduction of an accurate sonic image of a sound originating outside the space encompassed by the two speakers used in a typical stereo system. It was first described by Ben Bauer in a paper presented 20 years ago and is illustrated in Fig. 3. That problem is created by the crosscoupling of sound from the left speaker to the right ear and vice versa.

For example, a sound recorded from a source to the left of the left loudspeaker, as shown in Fig. 4, will not be accurately reproduced for the listener in normal stereo playback because the first sound to reach his *right* ear will be the crosscoupled sound from the *left* loudspeaker. (In the figure, "LL" represents the sound from the left source heard by the left ear; "LR" represents the sound from the left source heard by the *right* ear. We'll use "RR" and "RL" in a similar fashion.)

You can see from Fig. 5 that the sound from the left loudspeaker located 20° off center reaches the right ear before the sound from the right loudspeaker which would have identified the position of the recorded sound at 60° if cross coupling did not occur. In conventional stereo playback through loudspeakers, any sound that was recorded from a source outside the audio "stage" formed by the loudspeakers will still seem to come from somewhere on that stage. That is, the source of the 60° off-axis sound shown in Fig. 3 will appear to be the left-hand speaker —not to the left of the left-hand speaker, as it should be in that instance.

Immediately after determining the position of the sound source by comparing first-arrival times at both ears, the hearing mechanism begins to block out subsequent arrivals. Therefore, correct precedence is the primary key to stereo imaging. As long as the ears and brain can determine correctly when a sound has arrived, a good stereo image can be perceived.

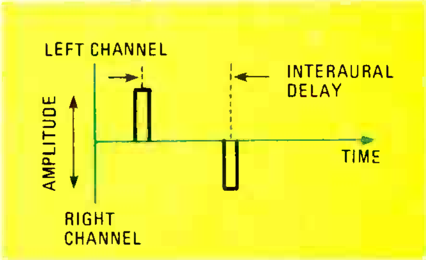


FIG. 2—RECORDED STEREO SIGNAL equivalent to Fig. 1. Left channel is shown above, right channel below.

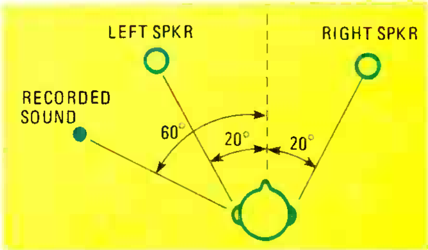


FIG. 3—SOUND FROM POINT outside speaker area will still appear to come from within it.

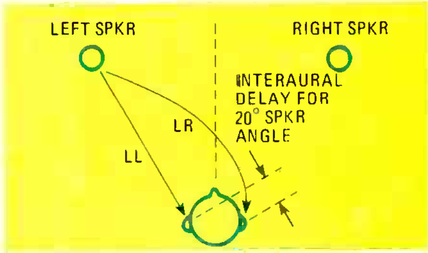


FIG. 4—CROSSCOUPLING (left-channel effect shown) feeds "false" stereo information to ears. "LL" is left signal heard from left ear; "LR" is left signal heard by right ear.

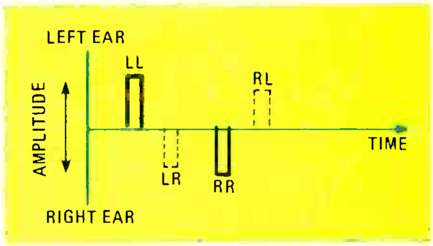


FIG. 5—HOW CROSSCOUPLED SIGNALS appear at listening position. Left-ear signal is above; right-ear signal below.

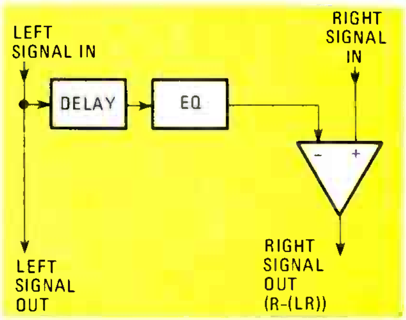


FIG. 6—BASIC CROSSTALK-CANCELLING circuit (one channel). "Right-signal out" is the right signal minus the "LR" compensation-signal.

Principles of stereo expansion

Over the years, by calculation and or measurement, the character of acoustic crosscoupling of first-arrival sounds has been well documented. While perfect cancellation of the entire crosscoupled sound must take into account a number of variations in listening-room characteristics, including the location of the listener, experimental and commercial equipment has been built over the past ten years that cancels that crosscoupling to a great degree,

PARTS LIST

All resistors ¼-watt, 5%, unless otherwise specified

R1, R6, R14, R16, R17—1000 ohms
R2, R4, R25, R26, R30, R31—100,000 ohms
R3, R5—47,000 ohms
R7, R15, R23, R24, R27-R29—20,000 ohms
R3, R5—47,000 ohms
R7, R15, R23, R24, R27-R29—20,000 ohms
R8—100,000 ohms, PC-mount potentiometer
R9, R13—4.7 ohms
R10, R20, R22, R34—4700 ohms
R11—100 ohms
R12—2000 ohms
R18, R19—10,000 ohms
R21—100,000 ohms, potentiometer, audio taper
R32, R33—390 ohms

Capacitors

C1, C2—470 µF, 35 volts, electrolytic
C3, C4, C6-C8, C12—0.1 µF, ceramic disc
C5—47 µF, 16 volts, electrolytic
C9, C17, C18—0.01 µF, axial ceramic or ceramic disc
C10, C13, C16—10 µF, 16 volts, electrolytic
C11—100 pF, axial ceramic or ceramic disc
C14—390 pF, axial ceramic or ceramic disc
C15—1500 pF, axial ceramic or ceramic disc

Semiconductors

IC1—LM340L15, 15-volt positive regulator
IC2—LM320L15, 15-volt negative regulator
IC3, IC4—MC4558 dual op-amp
IC5—CD4049 CMOS hex inverter
IC6—SAD512 or SAD1024 N-channel bucket-brigade device (Reticon. Also Radio Shack 276-1761.) (See text.)
Q1, Q2—2N2222, 2N3904 or similar
D1-D4—1N4002 or 1N4003
LED1—jumbo red LED
T1—35 volts, center-tapped, PC-mount (Dale PL-12-09 or similar)
S1-S3—pushbutton switch assembly: 3 DPDT or 1 DPDT, 2 4PDT (Schadow F-series or Centralab PB20-series)
J1-J8—RCA-type phono jack, right-angle PC-mount

Miscellaneous: PC board, IC sockets, enclosure, line cord, strain relief, hardware, etc.

The following are available from Sound Concepts, Inc., P.O. Box 135, Brookline, MA 02146: assembled and tested IR2200 stereo image expander, $169.00; kit of all parts (KIR-1), $95.00; PC board (KIR-2), $16.00; T1 (KIR-3), $7.50; all pots, knobs, switches and jacks (KIR-4), $12.50; all semiconductors and sockets for them (KIR-5), $19.00. Please add $2.00 for shipping and handling; MA residents add 5% sales tax. If at all possible give street address for UPS delivery. Please add 10% ($5.00 minimum) for parcel post outside contintental U.S.A.

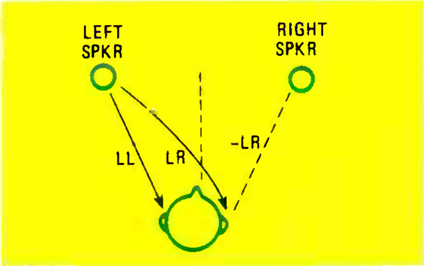


FIG. 7—SOUND FROM LEFT SPEAKER is cancelled at right ear by "−LR" signal.

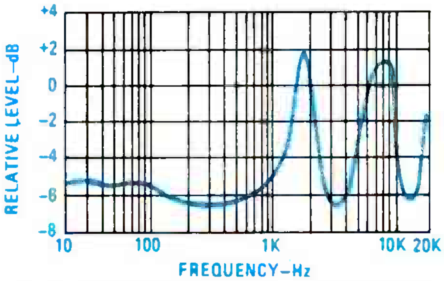


FIG. 8—MIXING OF MID-CHANNEL original and compensation signals can cause "comb effect" that distorts frequency response.

although not completely. Those systems derive a compensation signal from each channel which is the inverted analog of the crosscoupled signal, and then mix it into the opposite channel. A block diagram of such a system is shown in Fig. 6. To operate effectively, the playback system must be arranged so that the compensation signal meets the original crosscoupled signal in space just at the listener's ears (Fig. 7). That requires a fixed listening-position, which, for simplicity, is centrally located between the loudspeakers.

This type of crosscoupling cancellation uses the original signal—delayed by the interaural transit time and frequency-contoured to compensate for facial transmission and absorption characteristics—subtracted from the opposite channel.

Complete crosscoupling-cancellation, though, generates an unfortunate side effect. When the sound originates from directly between the speakers, the signals in each channel are identical in time and amplitude and the cancellation signals interfere seriously with the original ones, since the same signals are being delayed and then mixed back with themselves. That produces a combed frequency-response, shown in Fig. 8, that typically reduces the bass and upper-midrange levels and emphasizes the rest. The effect can be partially subdued by using equalization but, overall there is still a significant deterioration in fidelity in the critical central image-area where soloists are usually heard. At the same time, the cancellation signals do nothing to clarify the central sonic-image, since it would sound normal without any processing whatsoever.

How the stereo image expander works

The device described here uses an R−L (right-minus-left) difference component for generating the compensation signal. It is that signal, delayed and frequency-contoured, that is *added to the right channel* as shown in the block diagram in Fig. 9. That difference signal is also used to generate an L−R signal, which is added to the *left* channel. With a monophonic, or a centrally positioned stereo-source, there is no difference signal; nothing is added to either channel and the comb-effect is not apparent—and the tonal balance remains unaffected. As the sound source moves toward the right or left, the level of the compensation-signal increases accordingly.

At the extremes of the expanded stereo "sonic stage," a compensation-signal level about 6 dB below the main signal level is the optimum for a perfectly balanced stereo-signal source. In many (disc) recordings, though, the difference-signal level has been suppressed to reduce cutting and vertical-tracking problems. Increasing the level of the compensation or "image" signal increases the relative amount of difference-signal energy, effectively amplifying the sound in proportion to its angle off-center.

With the crosstalk minimized, the strongest difference-signals represent sounds at the left and right edges of the recording "stage" and now appear far to the outside of the loudspeaker positions. The IMAGE control can be thought of as an "edge-to-central area" balance control.

As a result of miking techniques, or the suppression of vertical-modulation components for the purposes of avoiding problems in record pressing, most records contain very little stereo information in the frequencies below 100 Hz and there is no substantial difference-signal to be processed below that frequency. As suggested earlier, however, record-warp and vertical-rumble signals from cutting lathes, turntables and non-uniform record surfaces that generate spurious low-frequency difference-signals may be present. For that reason, the image expander contains a 70-Hz high-pass filter in the difference-signal path.

Circuit description

A schematic of the stereo image expander is shown in Fig. 10. Its power

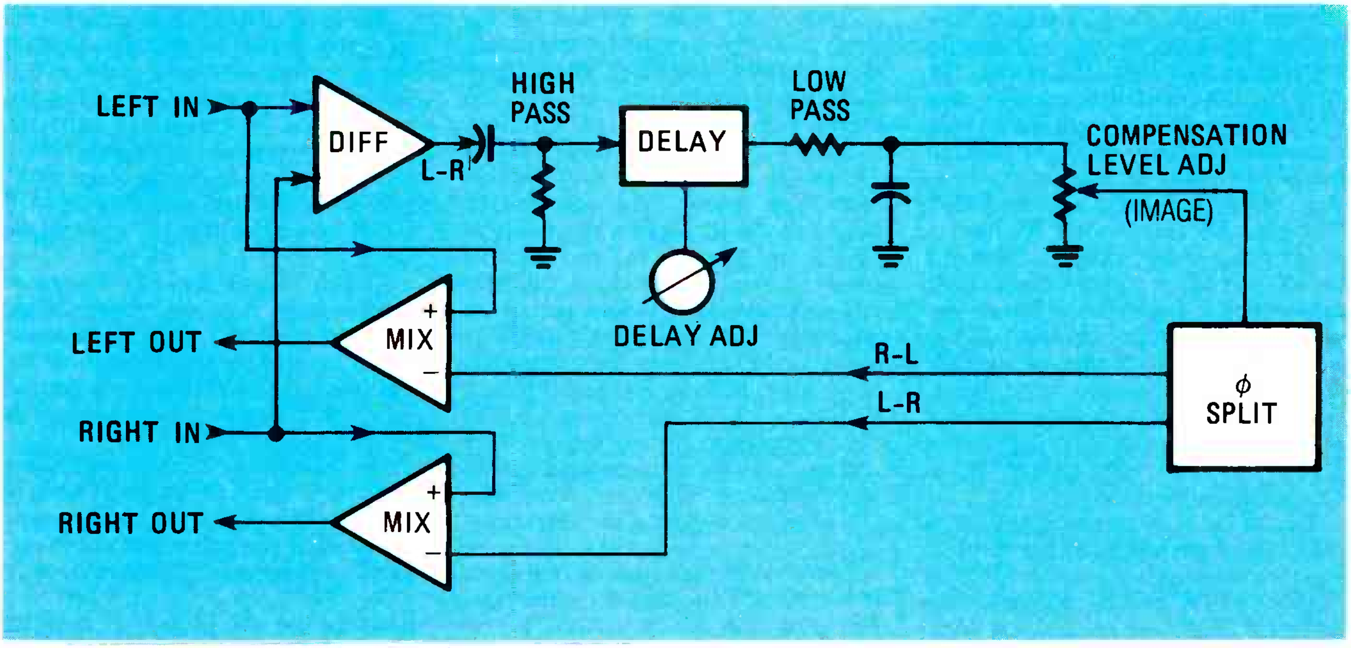


FIG. 9—BOTH CHANNEL-COMPENSATION signals are derived from original R−L signal by phase splitter.

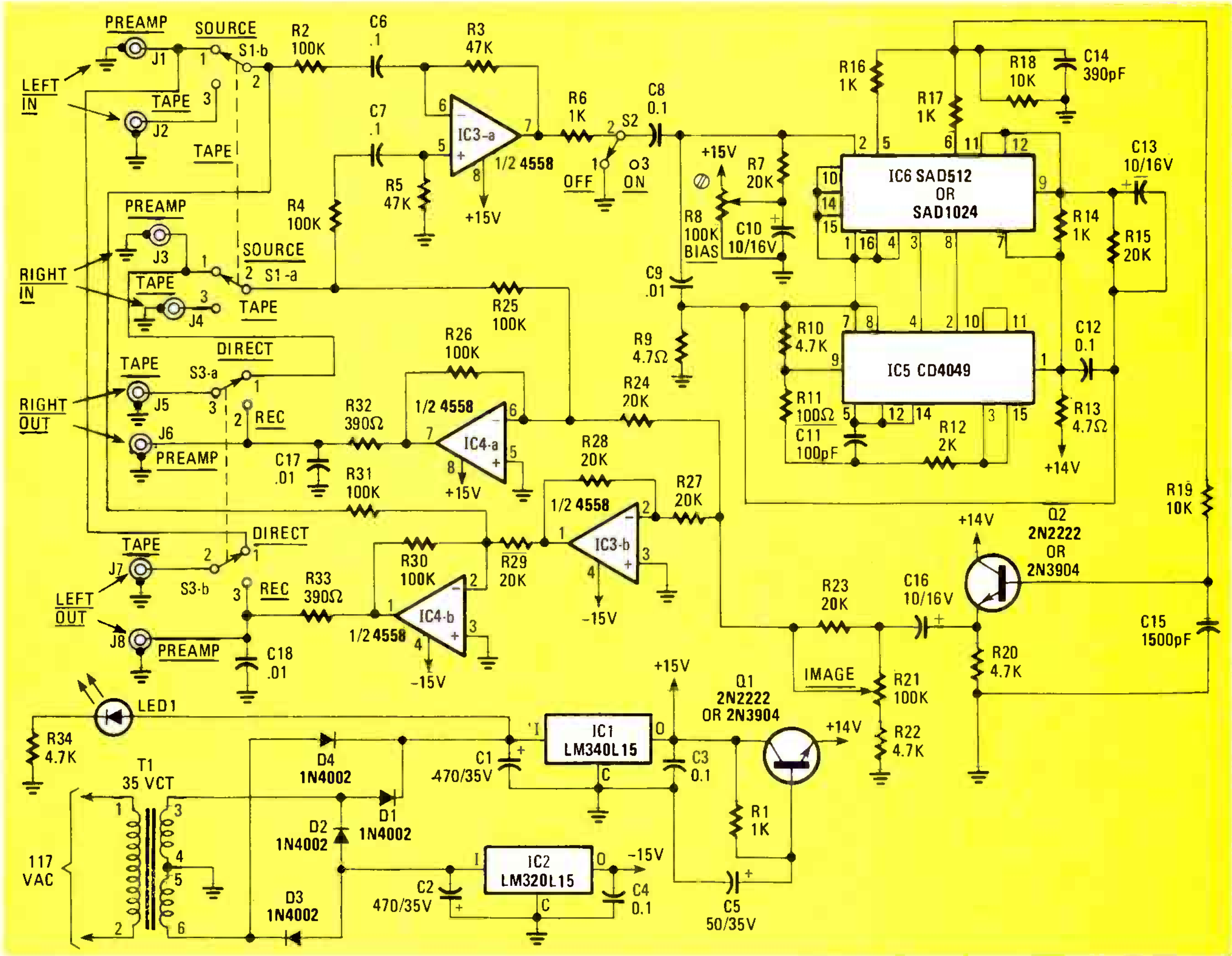


FIG. 10—BBD DEVICE, IC6, can be either SAD512 or SAD1024. See text for details.

supply delivers regulated ±15 volts for all the IC's except IC5 and IC6, which make up the delay line. An additionally filtered +14-volts is used for them to minimize the noise in the SAD512 BBD (*B*ucket *B*rigade *D*evice) circuit. The BBD IC, incidentaly, can be either an SAD512 *or* SAD1024—the pinouts are identical. The SAD1024 contains two SAD512's, and one of them will just not be used. The input signals are selected by S1 from either the main source (preamp or receiver) or a tape recorder. Capacitor C6 and resistor R2 form a single pole, 16-Hz, subsonic filter for the left part of the correction signal and capacitor C7 and resistor R4 do the same for the right channel. IC3-a, with resistors R2-R5, derives an R−L signal at −6 dB referred to the input. Switch S2 (ON/OFF) either passes that signal to the rest of the circuit, or routes it to ground. If routed to ground, no compensation signal is generated.

The 70-Hz high-pass rumble filter is made up of C8 and R7. That resistor, together with potentiometer R8, also supplies the DC bias for the input to the SAD512 BBD. An anti-aliasing high-frequency (15 kHz) filter is formed by C9 and R6. Resistors R9 and R13, and capacitor C12 RF-isolate the rest of the circuit from noise that may be generated by the clocking circuitry.

Five out of six sections of the CD4049 inverter operate as the clock oscillator and buffer drivers for the BBD, IC6. The nominal 1.8-MHz clock rate is set by C11 and R12. The SAD512 shifts the signal through one of its 256 stages with each cycle of the clock (0.55 μs) resulting in a delay time of 140 μs, the optimum for a 40° speaker angle (see below). The time-delayed output of the IC appears alternately at pins 5 and 6; tying the two together gives a complete waveform. Resistor R18 and capacitor C14 form part of the interstage coupling-circuit, with C14 acting as the first-stage clock-frequency noise filter. Resistor R19 and capacitor C15 form a 10-kHz high-frequency filter that completes the clock-noise filter and contours the compensation signal's high-frequency response. Transistor Q2 provides buffering for the output mixers.

The level of the compensation signal is set by R21 (IMAGE), an audio-taper potentiometer. At mid-setting it sets that level to about −6 dB with respect to the input signals. At settings above that point it adds a boost of up to 10 dB for stereo-deficient source material. The control can also attenuate the compensation signal for that rare material that exhibits "a hole in the middle."

The delayed R−L signal is fed via R24 into mixer/buffer stage IC4-a along with the direct right-channel signal from R25. Resistor R32 provides short-circuit protection and C17 bypasses any stray clock-noise to ground. Integrated circuit IC3-b forms an inverting stage with a gain of −1 that delivers a delayed L−R signal into IC4-b, the left mixer/buffer stage.

Switch S3 is used to switch the tape-output jacks between either a direct connection to the main signal-source (DIRECT) or to the image-enhanced output (REC). The function of the REC outputs will be completely explained in the next part of this article.

We'll begin our discussion of how to build the stereo image expander when we continue this article. In the meantime, for those of you that would like to get a head start, we have included a complete parts list for the project. A complete kit, as well as an assembled-and-tested version, is also available—see the Parts List for ordering information. **R-E**

POCKET CALIBRATOR For Volts & Ohms

Build a multi-function calibrator for your bench for under $40.00. Your test equipment will appreciate it.

GARY McCLELLAN

HOW MANY TIMES HAVE YOU BEEN working on a piece of equipment or a new project and wondered, "Is the problem due to the equipment or is my test gear out of alignment?" Or perhaps you are concerned about the accuracy of a digital multimeter or VTVM that was dropped or overloaded. It seems that whenever the subject of test equipment comes up, so does the questionof accuracy. There's a good reason for that—it's because inaccurate multimeters and scopes can cause more problems than they solve. You should have a way to check them periodically.

That is where the pocket calibrator comes in. It is designed for use with low-to-moderate-cost digital multimeters, VOM's, VTVM's and scopes. Packed into a small box are three stable DC-voltage outputs for calibrating the most-used meter ranges. There are also five resistance ranges, and two AC-voltage outputs. One of them is a 10-volts p-p square wave for scope calibration, and the other a 1-volt-RMS sine wave for meter calibration. The unit is battery powered to eliminate error-causing AC hum, and for portability.

Although this construction project uses low-cost parts, it is capable of a high level of performance. A precision regulator insures that all voltages will be stable once they are set. The 10-volts-DC output can be set to within ±0.05% if the equipment is available to do so. And, thanks to increased availability of 1%-precision resistors, you can get outputs of one volt ±2% and 0.1 volts ±3%, which are more than adequate for analog meters. For the more accurate digital multimeters, you can substitute higher-precision (0.1%) resistors for more accurate output voltages, with worst-case accuracy typically an order of magnitude higher.

Many of the precision resistors are also used to calibrate resistance scales, with an accuracy greater than 1%. The values run in decades from 111.1 ohms to one megohm.

The AC voltages are derived from a 60-Hz signal source that is crystal-controlled for stability. That IC-based circuit is powered from the 10-volt regulator for maximum stability. The 10-volts p-p square wave, intended for scope calibration, is accurate to within several percent at room temperature. Finally, there's a 1-volt, 60 Hz, sine-wave output that is adjustable to within 0.1%.

You should be able to build the pocket calibrator for under $40, which is a good price considering that some *single-function* calibrators sell for over $400!

Great pains were taken to use common, readily available, components. The precision resistors may be slightly difficult to locate, but they are available from several **Radio-Electronics** advertisers, and also as a set from the supplier indicated in the Parts List. You can buy the PC board from the same supplier, or make it yourself. The IC's and remaining components are available "off the shelf."

Only two simple adjustments are needed for calibration of the device. Although a 4½-digit DMM is recommended, you can do a creditable job with an accurate 3½-digit DMM or with a good VTVM or VOM.

Circuit description

The pocket calibrator consists of four basic circuits. The first is a 10-volt precision voltage-regulator that provides the basic DC calibration-voltage. Second is a set of precision resistors used for resistance calibration, and for dividing down the DC voltage. Next is a 60-Hz crystal-controlled square-wave generator that produces a 10-volt signal for oscilloscope calibration. Finally, there's a filter circuit to smooth the square wave into a one-volt sine wave used for AC meter-calibration. The double-sided PC board on which all that is built also serves as the unit's front panel.

Refer to Figs. 1 and 2 as we discuss the calibrator's circuits.

The first area we'll consider is the 10-volt regulator, built around an LM723

IC. That IC contains a precision voltage-reference, an op-amp, and a series pass-transistor. Using just a few external components, that IC produces a highly stable source of 10-volts DC. (Precision resistors R1 and R3 set the output voltage.) Potentiometer R2 allows adjustment of that voltage over about a 10% range. The 10-volt output of the circuit drives the 60-Hz circuitry at all times, and drives the resistor voltage-divider when switch S2 is closed.

The second section is made up of a set of precision resistors, R4-R8. Next to the 10-volt regulator, they are the backbone of the project, and supply the required voltage and resistance values. Resistors R4-R6 are wired as a simple voltage divider, and provide 0.1 volt and 1 volt when switch S2 is closed. When the switch is open, they serve as resistance standards. Resistors R7 and R8 are used only for resistance checks.

The third section consists of a simple 60-Hz square-wave signal source. The output of a standard TV color-burst reference crystal is divided down from 3.58 MHz to 60 Hz by an MM5369 IC. Since it is CMOS, its output can swing between the 10-volt supply voltage and ground, providing a 10-volt p-p square wave useful for checking oscilloscopes.

The last section is a square-to-sine-wave converter. Refer to the schematic in Fig. 2 for details. The square-wave signal from IC2, the MM5369, is integrated into a rough triangle-wave by C6 and R10 for better filtering by the circuitry that follows, a low-pass filter that smooths the triangle wave into a sine wave. Darlington transistor Q1 is wired as an emitter follower buffering a two-pole filter. Capacitors C7 and C8 perform the bulk of the filtering by supplying feedback through Q1, and capacitors C9 and C10 perform additional smoothing of the signal. The sine-wave output appears on potentiometer R15, which permits adjustment over a small range. Since a DC voltage also appears at that point, and can be read by many AC meters, C11 and R17 remove that undesirable component. The result is a clean one-volt AC sine wave.

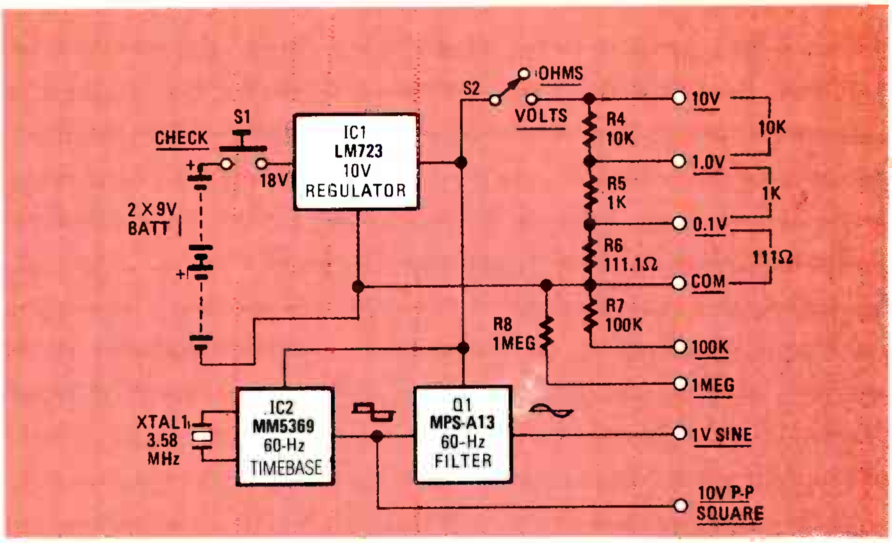


FIG. 1—POCKET CALIBRATOR has DC and AC-waveform outputs, and provides several high-precision resistances.

Component selection

The quality of the parts used in the calibrator plays an important part in how well it performs, so let's discuss the most important ones.

Of the components used, the precision resistors (R4-R8) are the most important. They should be at least 1% tolerance, deposited metal-file types. Ordinary carbon-composition resistors of the type found in radios and TV's will drift too much with age and temperature to be reliable. Fortunately, metal film resistors have become available in the past few years from R Ohm (Japan) and Siemens (Germany). They are known as type-RN-55C resistors in the industry, and you should be able to find them without too much difficulty. Using those resistors should result in a calibrator that is accurate on the 0.1 VOLT range to within 3%. However that is the worst-case error; other ranges will be better. If still greater ac-

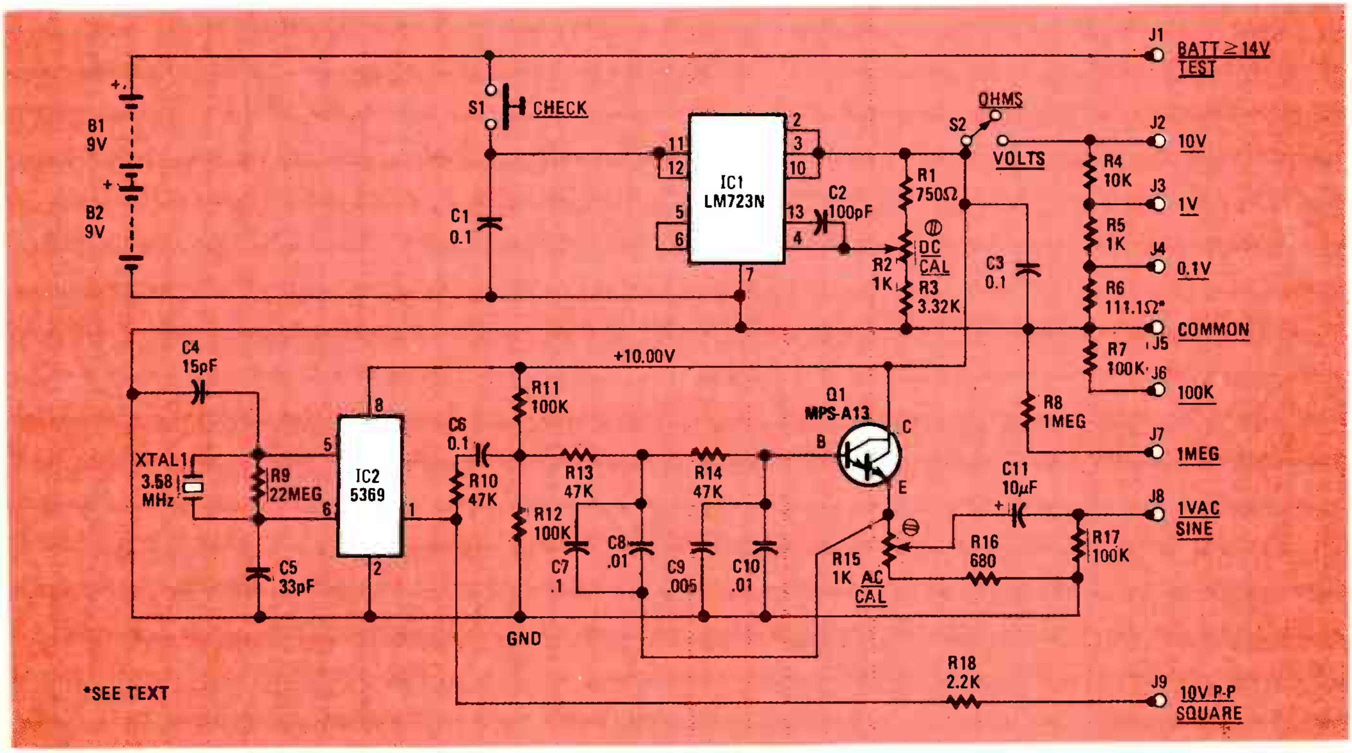


FIG. 2—60-Hz TIMEBASE uses readily available 3.579-MHz crystal and MM5369 IC.

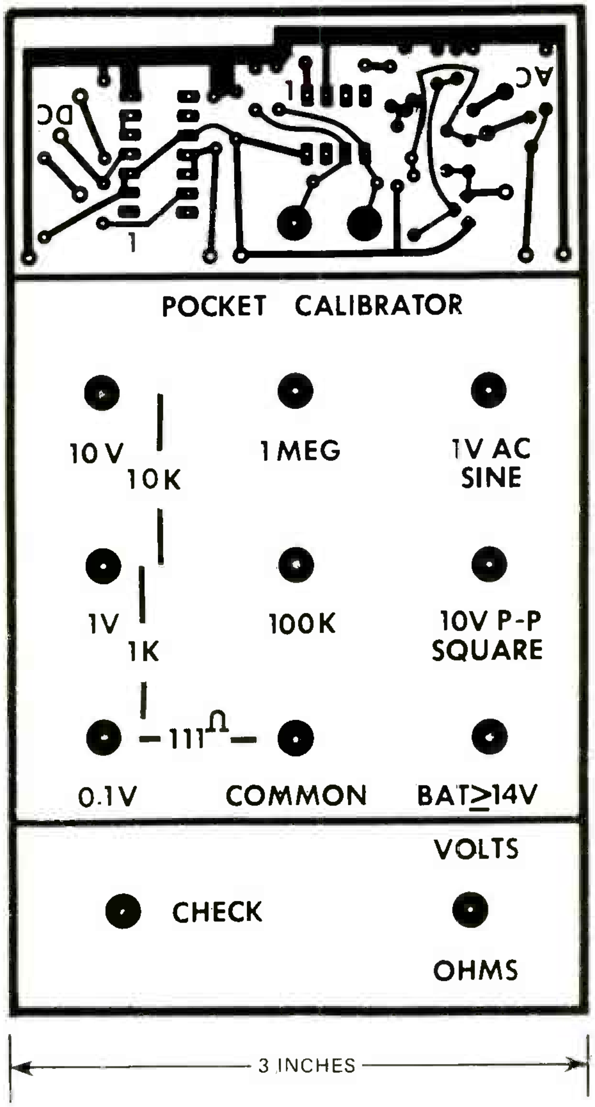


FIG. 3—TOP OF PC BOARD bears labels as well as foil pattern for circuit.

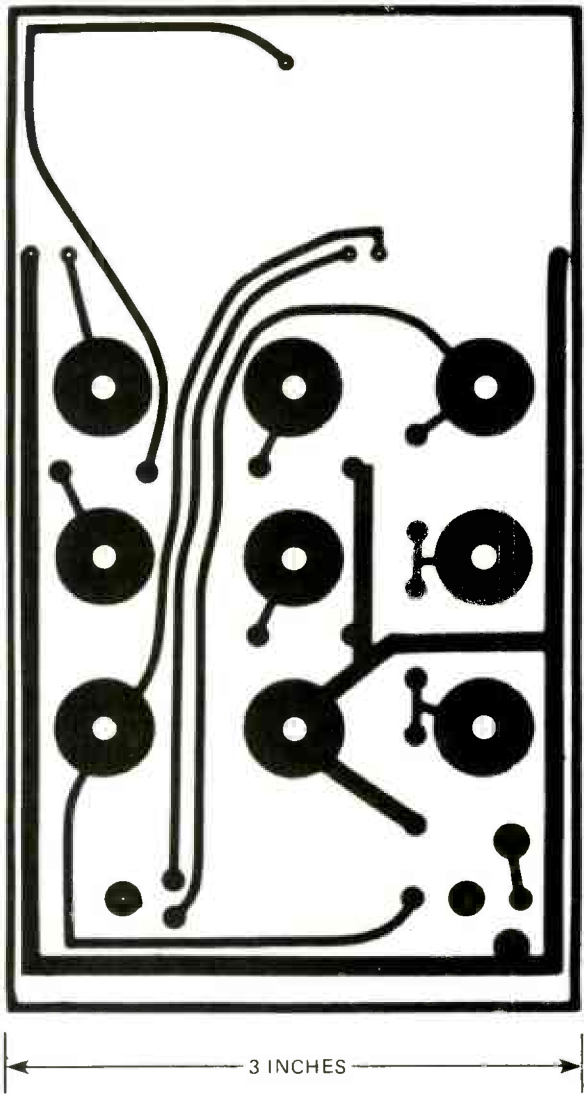


FIG. 4—BOTTOM OF BOARD shows where jacks J1-J9 are mounted.

curacy is desired, 0.1%-tolerance resistors can be used. They can be obtained from the source listed in the Parts List.

One resistor that may be hard to find is R6, which is 111.1 ohms. If necessary it can be made up by connecting a 100-ohm resistor in series with an 11-ohm one. Other combinations—in series or in parallel—will work as well, of course.

The quality of the LM723 IC is important. Since it must provide a stable 10-volts, it must be of high quality. Don't use anything but first-line quality here. Also, there are different types of LM723's on the market. The most common are the LM723C types. They'll do a good job, but if you can find an LM723N, you'll be getting a more stable part with temperature characteristics several times better than the LM723C.

To round up the list of parts of special importance, a few words about the 10-turn potentiometers. Although widely used in the industry, they may be new to you. Their multi-turn features means that they can be set quite accurately and they are very stable. They are not difficult to find; many advertisers in **Radio-Electronics** can supply them.

Construction

Foil patterns for the double-sided PC board are shown in Figs. 3 and 4. The board is also available from the supplier indicated in the Parts List.

Figure 5 shows the parts-placement diagram for the calibrator, and Fig. 6 will also help you in installing the components on the board. A good way to begin is to install the banana jacks at J1-J9. Insert each jack from the front-panel side (the side with the labels etched on it). Then place a ¼-inch toothed lockwasher over the threaded bushing of the jack, and secure it with a ¼-inch nut. The lockwashers are used to insure that the jacks don't loosen with use and cause erratic readings. After the jacks have been installed, recheck them to be sure the hardware is tight.

The switches are next. Be sure to position the board as shown in Fig. 5, with the component (non-labelled) side up. Then install the pushbutton CHECK switch at S1. Solder short pieces of wire to its terminals and then to the foil on each side of the switch as shown. Next, install S2 (VOLTS/OHMS) in the other switch position. (If you can't locate a SPST switch, use a SPDT one, but clip off one of the end lugs.) Flip the handle of the switch so that the contacts are closed. Then rotate the switch body so that the handle points to the VOLTS on the reverse side of the board. Connect S2 the same way you did for S1.

You should use IC sockets, and they can be installed next. Install a 14-pin socket at the IC1 position, and an 8-pin socket at the IC2 position, but don't insert the IC's yet.

The two potentiometers can be installed next. Insert one at the R2 location, pressing it flush against the board before soldering. Then insert the other at R15, pressing it against the board before soldering.

With the exception of R13, all the resistors mount on the component side of the board. (You will install R13 later.) Start at the top left corner of the board and install a 100K, 5% resistor at R17.

PARTS LIST

All resistors ¼ watt, 5% unless otherwise noted

R1—750 ohms, 1%
R2, R15—1000 ohms, 10-turn PC-mount potentiometer (Beckman 89PR1K or equivalent)
R3—3320 ohms, 1%
R4—10,000 ohms, 1%
R5—1000 ohms, 1%
R6—111.1 ohms, 1% (see text)
R7—100,000 ohms, 1%
R8—1 megohm, 1%
R9—22 megohms
R10, R13, R14—47,000 ohms
R11, R12, R17—100,000 ohms
R16—680 ohms
R18—2200 ohms

Capacitors
C1, C3—0.1 µF, 25 volts, ceramic disc
C2—100 pF, ceramic disc or mica
C4—15 pF, ceramic disc or mica
C5—33 pF, ceramic disc or mica
C6, C7—0.1 µF, 50 volts, Mylar
C8, C10—0.01 µF, 50 volts, Mylar
C9—0.005 µF, 50 volts, Mylar
C11—10 µF, tantalum

Semiconductors
IC1—LM723 adjustable precision voltage regulator
IC2—MM5369 60-Hz timebase
Q1—MPS-A13 NPN Darlington
XTAL1—3.579-MHz TV color-burst reference crystal
S1—SPST N.O. pushbutton switch
S2—SPST mini toggle switch
B1, B2—9-volt transistor battery
J1-J9—banana jack (Smith 101 or similar)
Miscellaneous: PC board, battery clips, IC sockets, heat-shrink tubing, enclosure (Vertox model 2000 or similar), etc.

The following are avalable from: Technico Services, P.O. Box 20HC, Orangehurst, Fullerton, CA 92633: PC board and 1% resistors (CAL-1), $13.00; PC board and 0.1% resistors (CAL-2), $16.00; 1% resistors only (RES-1), $3.00; 0.1% resistors only (RES-2), $6.00. CA residents please add sales tax. Non-USA orders please add $3.50 for shipping and handling.

The following is available from: Circuit Specialists Co., P.O. Box 3047, Scottsdale, AZ 85257: kit KT-2 (does not include PC board, precision resistors or case), $21.95 plus $0.90 for shipping and handling.

On the other side of potentiometer R15 install a 680 ohm, 5% resistor at R16. The fit is very tight here, so you may want to stand the resistor on its end. Then install a 100K, 5% resistor at R12, and another 100K unit at R11. Install a 47K, 5% resistor at R13, which is next to R11. Move down to J9 and install a 2.2K, 5% resistor at R18 as shown. Cut the leads to ¼-inch, and bend them at right angles to the resistor body. Then solder the resistor in place with its body off the PC board. At the top of the board install a 47K, 5% unit at R10, just above IC2 and, on the other side of the socket install a 22 megohm, 5% resistor at R9. If you have trouble finding that value, you can use a 10 megohm, 5% resistor; it should work just as well.

Stop for a moment and check your work. Make sure that all parts are installed correctly before going any further.

Finish up the resistors by installing the precision units. They are mounted in the same manner as R18. That is, the leads are cut to ¼-inch and bent at right angles to the body. Start by installing a one megohm resistor at R8. Solder the connection quickly to avoid overheating the part (that advice goes for *all* the precision resistors). Then install a 100K resistor at R7 in the same manner. Move to the right edge of the board and install a 10K resistor at R4 as shown and a 1K resistor at R5. Move down and install a 111.1-ohm resistor (or combination of resistors) at R6. After that, move up to the top right side of the board and install a 3.32K resistor at R3. On the other side of the potentiometer install a 750-ohm unit at R1. That completes the installation of the precision resistors.

It's a good idea to check the precision-resistor connections at this point. Make sure that they are good, and that the parts are securely mounted. That is important because any extra resistance caused by a bad solder connection will affect the performance of the calibrator.

The capacitors come next, and they are all mounted at the top of the board. Install a 10-µF tantalum at C11. Note that the plus sign points toward the edge of the board. Move to the right and install a 0.01-µF Mylar capacitor at C8, and another at C10. Those capacitors are the green rectangular units often found in transistor radios, although conventional ceramic-disc types should work well if you can't find the Mylar ones. Next, install a 0.005-µF Mylar-type at C9. After that, install 0.1-µF Mylar capacitors at C7 and C6. On the other side of the IC2 socket, install a 15-pF ceramic disc-type at C4 and next to it a 33-pF ceramic disc at C5. Continuing, mount a 0.1-µF ceramic disc at C3 and another at C1. Finish up by installing a 100-pF ceramic disc at C2.

Five wire jumpers are used to connect one side of the board to the other. Run pieces of excess resistor lead through the holes indicated by asterisks in Fig. 5 and solder them on both sides of the board. Clip off any excess lengths.

The battery connectors are installed next. Cut the positive lead of one connector to a length of about an inch, and the *negative* lead of the *other* connector to the same length. Then slip a piece of heatshrink tubing all the way onto one of the wires, and solder the two together. When the solder joint has cooled, move the tubing down over the joint and use a match or other heat source to shrink it. (Don't hold the heat source too close to the tubing—it will start to char.) Wrap the remaining leads from the connectors around switch S1's body and knot them securely around it; then connect the leads to the pads as shown in Fig. 5. The batteries themselves are attached to the bottom of the case with double-sided tape.

Finish up the component side by installing the ICs. Double-check their orientation. Turn the board over (label-side up) and install R13, a 47K, 5% resistor. Cut the leads short first, to about ¼ inch; then bend them and solder them to the pads. Note the position of the 8-pin IC socket nearby—that should make it easier to locate the pads. Once the resistor is in place, press its body tight against the board. That completes the component installation.

If you like, you can deflux the board for a more professional appearance. Use a small brush and acetone in a well-ventilated area to remove the solder flux.

Caution: Acetone is highly flammable! Always use it in a well ventilated area, away from flame.

Clean only the front panel side of the board, and keep the solvent away from the battery connectors and plastic base of the crystal—not only is acetone flammable, but it also dissolves many plastics. After the flux has been removed, and the front panel has dried, coat the panel with clear acrylic spray to preserve its appearance.

You can fashion a plate out of Formica or other material to hide the circuitry on the top of the panel. Secure it with two small blobs of silicone sealant.

Checkout and calibration

Install the batteries. Then, if you can, obtain a 4½-digit DMM to check out the calibrator. In the event you don't have—or can't borrow—one, a freshly calibrated 3½-digit instrument will work. In fact, a good time to build the calibrator is right after the purchase of a new multimeter, so you can check it on an instrument that is "known good."

A good place to start is with the resistance ranges. Set S2 to the OHMS position. Connect one of the DMM leads to the COM jack and the other to the 0.1V/111Ω jack. Set the meter for that resistance range and you should read 111.1 ohms ±1% or ±0.1%, depending upon the resistors used in the calibrator.

Note that most test leads can contribute at least 0.1 ohm of resistance themselves; be sure to allow for that error:

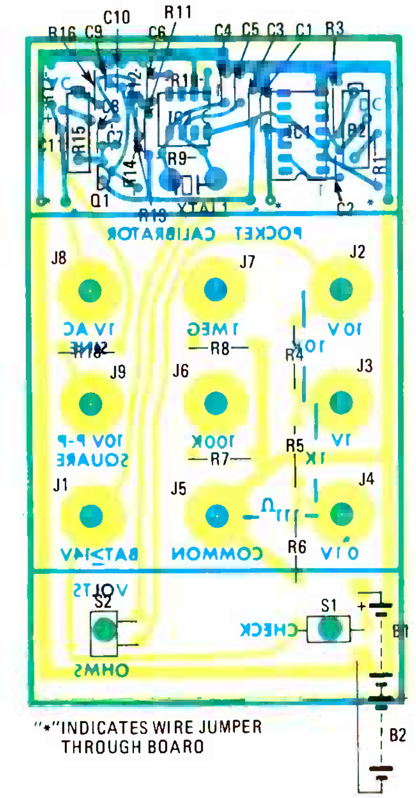


FIG. 5—COMPONENTS ARE MOUNTED on bottom of PC board with the exception of R13, which is mounted on the top.

Disconnect the leads from the calibrator, short them together, and read the lead resistance. Then subtract that value from the reading you get with the 111.1-ohm resistor.

Remove the lead from the COM jack, and plug it into the 1V/1K jack. Change the multimeter range; you should get a reading of 1000 ohms, plus or minus the resistor tolerance. Continue by removing the lead from the 0.1V/111Ω jack, and transferring it to the 10V/10K jack. You should read 10,000 ohms. Then switch your leads to the COM and 100K jacks. Change the range switch on the DMM and the reading should be 100,000 ohms. Finally, with the leads in the COM and 1 MEG jacks, the DMM should give you a reading of one megohm.

Many low-cost digital multimeters are hum-sensitive on the high resistance ranges, so your readings may change if you use long test leads. If you have that problem, simply use shorter leads (1 foot or less), and work away from 60-Hz sources.

The next check is for the correct DC-voltage output. Set S2 to the VOLTS position. Then switch the DMM to the DC VOLTS position. Press S1 and measure the voltage at the BAT ≤14V jack. The exact value you read isn't important, as long as it is 14 volts or higher—that is just a check on the condition of the calibrator's batteries to insure that the calibrator will put out accurate voltages. Transfer the test lead to the 10V/10K jack. You should read *approximately* 10 volts—the value will be set precisely in a little while.

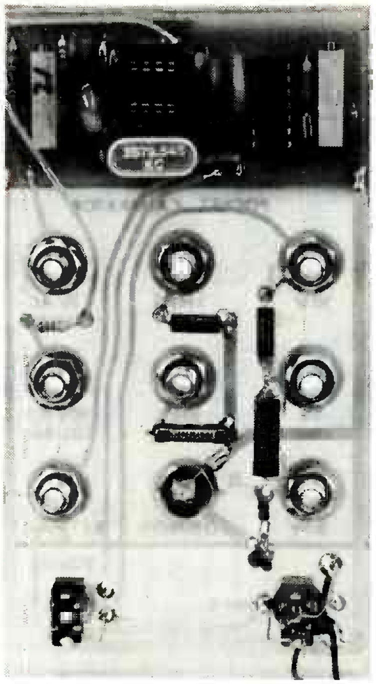


FIG. 6—NOTE HOW 1% RESISTORS are mounted ¼-inch above board.

The final checks are for the AC outputs. An oscilloscope would be handy at this point to measure the 10-volt p-p squarewave, but it isn't absolutely necessary; at this point all we are really interested in is the one-volt sine-wave output. Set your DMM to its 1 VOLT AC range, or as close to it as you can come. Plug the test lead into the 1V AC SINE jack. Press S1, and wait a few seconds. When the reading stabilizes, it should be close to one volt. That completes the performance checks. If you encounter any difficulties, correct them before going any farther.

The next step is calibration, which is quick and easy. The first thing is to adjust the 10-volt source. Connect the DMM to the COM and 10V/10K jacks and set the DMM to its 20 VOLTS DC range. If the instrument has a 10 VOLTS DC range instead, use that one. (The object is to be able to read voltages both below and above 10 volts, but accuracy is more important.) With S2 in the VOLTS position, press S1. Hold it for a few moments, and then adjust R2 for exactly 10.000 volts. That completes the DC voltage calibration.

The last step is the AC calibration. Reconnect the DMM's "hot" lead to the 1V-AC SINE jack and set the meter to its 2-VOLTS AC range. If the meter has a 1-VOLT AC range, use it instead. Press S1, and hold it for a few moments. After the reading stabilizes, adjust R15 for exactly 1.000 volt. That completes calibration of the unit.

Use

In order to get the most out of the calibrator, it pays to look at a few common applications.

As a voltmeter calibrator, it's ideal because it provides voltages that correspond to the voltmeter ranges most often used. With its 10-volt output, the unit is right at home with IC's and other devices that normally operate in the 3- to 15-volt range. There should be no problems working with instruments having input resistances of a megohm or more, which includes most FETVOM's, VTVM's, and all digital multimeters. Lower-resistance analog meters can be accurately calibrated using the 10-volt output but somewhat reduced accuracy will result using the 1-volt outputs or 0.1-volt outputs. If you are checking a known-good analog meter, make a note of the readings you get; that way you will have a way to check the meter later on.

Before checking the calibration of any voltmeter, make sure that it is zeroed properly. Generally, that step is not necessary with modern digital voltmeters (which zero themselves automatically), but older digital meters and analog meters may require zeroing.

In case of analog meters, be sure to place the instrument in the viewing position you normally use before adjusting the mechanical zero. That's because some meters (usually low-cost imported models) aren't compensated for gravity, and the needle can wander over the zero mark. Static electricity on the plastic meter-cover can cause zeroing problems too, so clean it gently with a mixture of detergent and water. Don't wipe it with a dry cloth; use a damp one to keep static generation down.

Always check the BATT ≤14V jack for at least 14 volts before using the calibrator to insure that the 10-volt regulator is being supplied enough voltage to function properly.

To calibrate a voltmeter, set S2 on the calibrator to VOLTS and connect the voltmeter across the appropriate jacks. For maximum accuracy, use the 10-volt output, if possible. Then press S1 to apply voltage to the meter. If you are checking a meter that can't be easily calibrated, make up a note showing how great the error made is, and tape it to the meter. That is usually done with analog instruments. Digital voltmeters are generally easier to calibrate, and can be readily adjusted to match the output of the calibrator.

When calibrating a digital meter that has several ranges, always calibrate on the *lowest* range. That is known as calibrating the "basic accuracy," because the error-causing attenuator built into the digital meter is out of the circuit under those circumstances. Use either the 1-volt output or the 0.1-volt output of the calibrator.

continued on page 99

HOW TO DESIGN ANALOG CIRCUITS

Junction Diodes — Rectifiers & Zeners

Made up of two different types of semiconductor material, the diode is found in a wide variety of applications. This month we'll learn how it is used.

MANNIE HOROWITZ

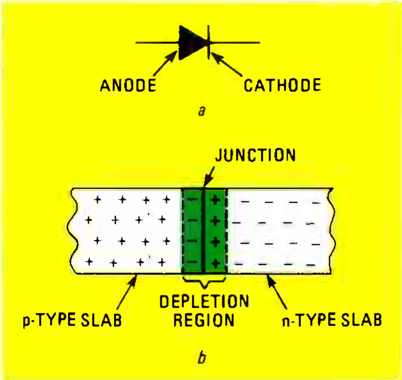


FIG. 1—A JUNCTION DIODE consists of a slab of n-type- and a slab of p-type-semiconductor material in close contact with each other, as shown in *b*. The schematic symbol for that device is shown in *a*.

THIS MONTH, WE ARE GOING TO LOOK AT another semiconductor device—the diode. Unlike the devices we discussed in the last part of this series, it is made up of both p-type and n-type semiconductor material. Diodes pass current readily in only one direction. It is that property that makes the device useful in a wide variety of circuits. Let's take a closer look at one of the most popular types of diode—the junction diode.

Junction diodes

The schematic symbol for a junction diode is shown in Fig. 1-a. Junction diodes are formed by placing a slab of n-type semiconductor material in contact with a slab of p-type semiconductor material. Now you would think that because you have an n-type slab touching a p-type slab, some of the excess electronics from the former will be attracted to and flow to the latter. That is exactly what happens.

Let's take a look at what happens at the junction of the p- and n-type semiconductor material, as shown in Fig. 1-b. Near the junction, there is a small area of electrons on the p-type slab and a small area of *holes* on the n-type slab. (A hole is an area with a shortage of electrons. In Fig. 1-b, the holes are indicated by the + signs.) That area near the junction is called the *depletion region*.

Normally, the number of electrons that cross over the junction is limited because the first electrons to do that repel the rest. The same holds true for the holes. To have more electrons and holes cross the junction, a negative voltage (relative to the voltage on the p-type slab) must be applied to the n-type slab. When that is done, the diode is said to be *forward biased*. If a positive voltage (again relative to the voltage on the p-type slab) were applied to the n-type slab, few, if any electrons or holes would cross the junction. In that case, the diode is said to be *reverse biased*.

A forward-biased diode is *not* a linear device. That means that the current that flows through it is not proportional to the applied voltage. That is shown in Fig. 2. Note that when the applied voltage is small, the current rises very slowly. As the voltage increases, however, the current flow begins to increase rapidly—in fact, it increases so much faster than the voltage that a slight increase in applied voltage will cause a large increase in current.

But what happens when the voltage across the diode is very small? In that situation, so little current passes through the diode that for all intents and purposes, it is said to be cut-off. It is only after the voltage exceeds a critical point, called the *threshold voltage*, that the rapid increase in current we discussed occurs. The threshold voltage can be found easily by examining the diode's

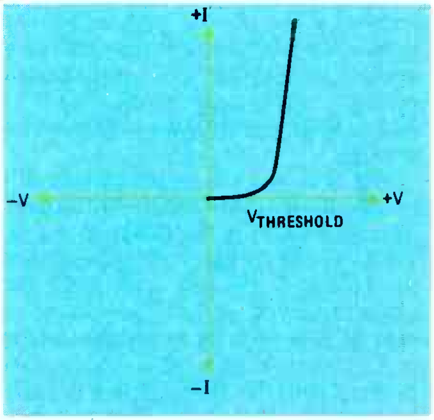


FIG. 2—A FORWARD-BIASED DIODE is considered "off" until the voltage across it exceeds the threshold voltage.

characteristic curve (a typical forward-bias characteristic curve is shown in Fig. 3). All you have to do is extend the straight portion of the curve, by drawing a dashed line, to the V (voltage) axis. The point at which the line crosses the V axis is the threshold voltage. Generally, that voltage falls between 0.6 and 0.8 volts for diodes made of silicon, and between 0.1 and 0.3 volts for germanium diodes. Knowing the threshold voltage of a diode is important, because the device will not conduct at voltages below that point.

As we all know, voltage, current, and resistance are related through Ohm's Law. Because of that, our discussion of the voltage and current characteristics of a diode leads us to another important diode characteristic—its resistance. At any point on the diode's characteristic curve, diode resistance is equal to the voltage applied to the diode divided by the resulting current flow. Finding the DC resistance of a diode at any point is fairly easy. To show how it is done, let's first pick a point on the curve and label it A. The voltage can be found by drawing a line from point A to the voltage (V) axis; that line should be perpendicular

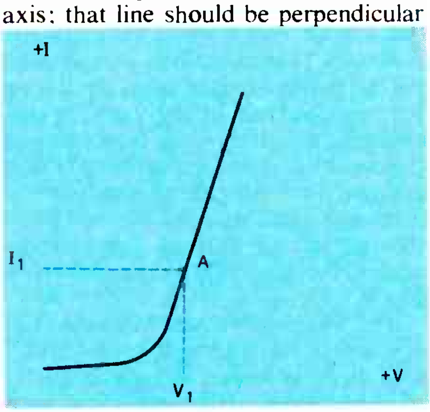


FIG. 3—THE RESISTANCE OF A DIODE at any point can be easily determined by finding the voltage across the device and the current through it, and applying Ohm's law.

to the axis as shown in Fig. 3. The point at which the line crosses the axis is the voltage across the diode; let's call it V_1. As shown in Fig. 3, the current that flows through the diode can be found in the same manner; we'll call the point at which the line crosses the current (I) axis I_1. The diode's DC resistance at point A is, by Ohm's Law, the ratio of the voltage to the current, or $R = V_1/I_1$.

The AC resistance of a diode will usually vary from its DC resistance. That is because the AC voltage is not a constant, fixed value, but varies with time. Consequently, the AC current must also vary. Since the diode is not a linear device, its resistance varies with applied voltage. AC resistance (sometimes called dynamic resistance, R_d) is therefore a change in voltage, V V, divided by the change in current, ΔI. The method for determining AC resistance is shown in Fig. 4.

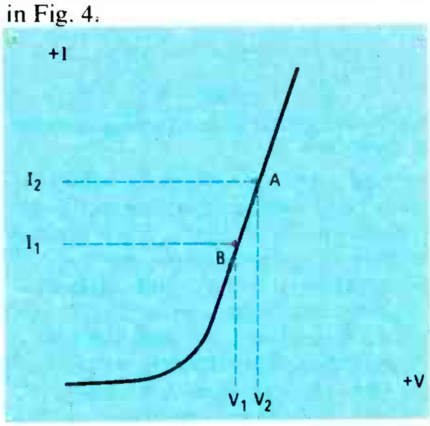


FIG. 4—FINDING THE AC RESISTANCE of a diode. Here, the voltages and currents at two points are used.

For example, let's find the AC resistance of the diode when the AC voltage across the device varies from V_1 to V_2. Here $\Delta V = V_2 - V_1$ and $\Delta I = I_2 - I_1$. Dividing, the AC resistance, R_{AC}, is $\Delta V/\Delta I = (V_2 - V/(I_2 - I_1)$. That is the resistance of the diode when the current varies between I_1 and I_2. If you were interested in the diode's resistance at lower current levels, you would find that the resistance of the diode rises as the current drops. Thus, the AC resistance will be the lowest when the current flow is a maximum; that is at the "top" of the curve.

The forward characteristics of a diode are quite important, but it is the combination of the diode's forward and reverse characteristics that makes it so useful. A diode is reverse-biased by applying a positive voltage to the n-type semiconductor material, so that it is made more positive than the p-type semiconductor material. If that were done, and the diode were an *ideal* device, it would not conduct any current. But, of course, no electronic device is ideal, and diodes *do* conduct a small amount of current. That current, called reverse or leakage current, flows because electrons and holes in the diode's depletion region are transferred back to their respective n-type and p-type slabs when reverse bias is present. That transfer generates heat in the diode, which reduces its resistance and allows an increasing amount of current to flow. Incidentally, that's the reason why manufacturer's data sheets give operating characteristics at a specific ambient temperature—those characteristics will vary somewhat with temperature.

As the reverse bias is increased, the reverse current also increases, but very gradually. However, if the reverse bias is increased to a critical point V_B, the *breakdown* voltage, an interesting phenomenon takes place. What happens is that reverse-current flow suddenly increases to a high level. In fact, it increases so much that, no matter how much more reverse bias is applied, the voltage across the diode will not change. The area of that increased current is called the *breakdown* or *avalanche* region. Reverse current is usually specified at a reverse bias just before breakdown occurs. That reverse bias, V_R, is the highest reverse bias that can be applied without breakdown occurring. A

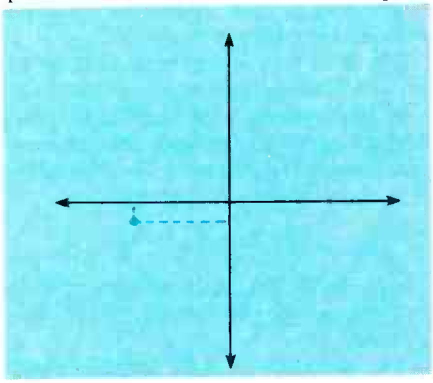


FIG. 5—REVERSE-BIASED CHARACTERISTIC of a diode. In manufacturer's specifications, reverse current (also called leakage current) is usually defined at a point just before breakdown.

typical reverse-characteristic curve, showing the points we've discussed, is shown in Fig. 5.

Diode ratings

The first step in choosing a diode for a specific application is to obtain the manufacturer's data sheets. Those data sheets provide both the ratings and characteristics of the diode. The ratings are the maximum allowable values given to the diode before damage results. The characteristics are the normal operating parameters of the diode.

Unfortunately, there isn't an industry standard for diode specifications; you may find that the same specification has different names, depending on which manufacturer the data sheet comes from. Looking at a typical data sheet, you are likely to find a rating called *peak reverse voltage* (PRV) or *peak inverse voltage* (PIV). Both of those terms refer to the maximum allowable instantaneous reverse voltage that can be applied across the diode before breakdown occurs. Another rating is the *maximum reverse DC voltage* (V_{RDC}) or *working inverse voltage* (WIV). Those terms refer to the maximum allowable reverse-DC voltage. That rating is usually less than the peak rating. Those ratings are important, because a standard junction diode should never be operated in the breakdown region.

Other specifications found on the data sheets include the *maximum continuous forward current* (I_F). That refers to the maximum allowable forward current at a stated temperature. The *forward-voltage drop* (V_F) refers to the voltage drop across the diode at a specified forward current, at a given temperature. The *reverse-leakage current* (I_R) refers to the reverse current flow at a specified reverse voltage.

Another important specification refers to the maximum power dissipation, and it depends on the operating temperature. Manufacturer's data sheets will provide the information necessary, so that you can determine the maximum power dissipation at any given operating temperature. That information will be provided in either of two ways.

The first way is for the data sheet to provide the *maximum allowable junction temperature* (T_J) and the *thermal resistance* (θ_{JA}) between the junction and the air. To calculate the maximum power dissipation use the equation:

$$T_J = T_A + \theta_{JA} \times P_D$$

where T_A is the ambient temperature and P_D is the maximum power dissipation.

The second way is for the data sheet to provide the maximum power dissipation (P_D) at a specified temperature and also provide a derating factor expressed in milliwatts-per-°C. For example, suppose that a diode can dissipate 50 mW at 25°C, has a derating factor of 1 mW-per-°C, and the surrounding air temperature is 50°C. The maximum power dissipation will be 50 mW − 1 mW-per-°C × (50°C − 25°C), or 25 mW.

Junction diode applications

Junction diodes have a wide variety of applications. One of those is in power supplies. While we do not want to get into a detailed discussion of power-supply design at this point (that topic will be discussed later in this series), let's see how the diode can be used to convert AC into DC.

For discussion, we'll take a close look at a simple circuit, called a *half-wave rectifier*. This circuit is shown in Fig. 6.

Before we get too much farther, this is a good time to take a close look at an AC-voltage waveform; that information will be useful in other parts of this series as well. An AC-voltage waveform is made up of many cycles; one such cycle is shown in Fig. 7. Each cycle is divided into 360 angular degrees; the cycle is positive from 0 to 180 degrees, and negative from 180 to 360 degrees. The period, τ, of a sinewave is the length of time it takes to complete one cycle. Since there are 60 cycles-per-second in a 60-Hz AC voltage waveform, the period of the waveform is 1/60 of a second.

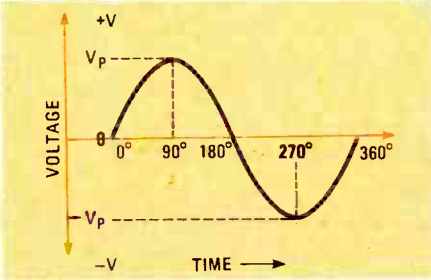


FIG. 7—ONE CYCLE of an AC voltage waveform is shown here.

While the sinewave is, as we said, divided up into 360 angular degrees, it is often more convenient to measure angles in other units, called *radians*. To convert from degrees to radians, or back again, the following formula is used:

$$\frac{\text{Angle in Radians}}{2\pi} = \frac{\text{Angle in Degrees}}{360°}$$

As you can see in Fig. 7, the level of an AC voltage varies with time. If you wanted to find the voltage at any particular instant of time (called the *instantaneous voltage*), the following formula should be used:

$$V = V_P \sin(2\pi ft)$$

or, since 2π is approximately equal to 6.28:

$$V = V_P \sin(6.28ft)$$

Where V_P is the peak voltage, f is frequency, and t is time. As you probably noticed, we used radians in that equation.

Now let's refer back to the half-wave rectifier shown in Fig. 6. As you can see, that circuit is made up of just a transformer, diode, and capacitor. The transformer is needed because the voltage available from a wall outlet is usually about 117-volts AC; but, aside from requiring DC instead of AC, few devices will be able to use exactly that voltage for operation—some will require more, some will require less.

For the time being, let's ignore the presence of the capacitor and see how the half-wave rectifier works. When an AC voltage is input to the transformer, the output of the transformer is also an AC voltage, but at a different level. During the positive half of the cycle, the top of the transformer, as drawn, will be positive with respect to ground. Because of that, the diode in the circuit will be forward-biased, and thus conduct. Since there is very little voltage drop across the diode (no more than about 0.7 volts), the diode has little effect on circuit operation during the positive half of the cycle, and the output of the transformer appears across the load.

During the negative half of the cycle, however, the top of the transformer is negative with respect to ground. That, of course, means that the diode is reverse biased and will not conduct. Since no current will flow (actually, a *small* amount of current will flow but not enough to have any effect), the circuit is essentialy an open circuit and no voltage is placed across the load. The output voltage of the half-wave rectifier (again *ignoring* the presence of the capacitor) is shown in Fig. 8.

But we are not done yet. The rectifier's output as shown is called pulsed DC, and is not really that useful, especially in such things as radio circuits. Something must be done to smooth out that output; that is where the capacitor comes in. That capactior is charged during the positive half of the cycle; during the negative half of the cycle, it discharges through the load. If the value of the capacitor is chosen so that it is high enough, it will only have enough time to discharge slightly before the next positive pulse. As a result, the voltage across the load will be as shown in Fig. 9.

You've probably noted that the voltage across the load is still not "pure" DC. It is, however, close enough for most applications; the output from most wall-plug power-supplies is generally no smoother than what is shown here. The amount of the remaining *ripple* will depend upon the size of the capacitor used. How to find out how large a capacitor you need, as well as other types of rectifier circuits, will be covered when we take a closer look at power supplies later in this series.

Zener diodes

Let's take another look at the diode's reverse characteristic shown in Fig. 5. That figure shows that, in the breakdown region, the voltage across the diode remains constant, no matter how much reverse bias is applied. While operating a general-purpose diode in the breakdown region is not advisable (the result is likely to be at least a ruined diode), *Zener* diodes are designed to be operated in the breakdown region; they can do so without adverse results, up to

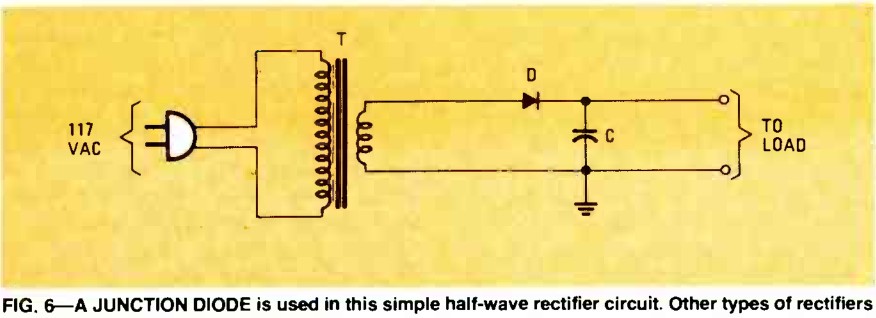


FIG. 6—A JUNCTION DIODE is used in this simple half-wave rectifier circuit. Other types of rectifiers will be discussed later in this series.

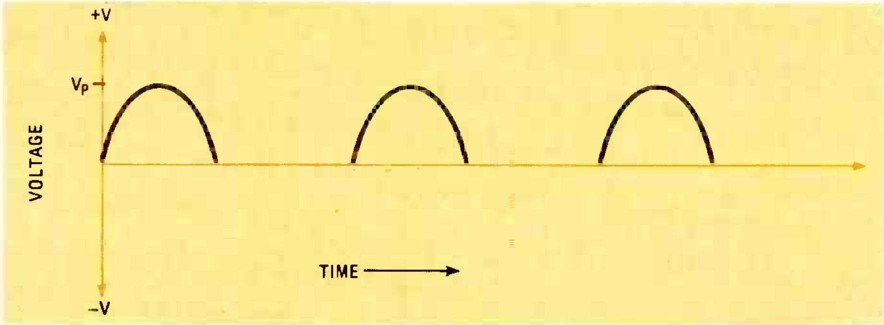


FIG. 8—THE OUTPUT of the rectifier shown in Fig. 6, ignoring the presence of the capacitor.

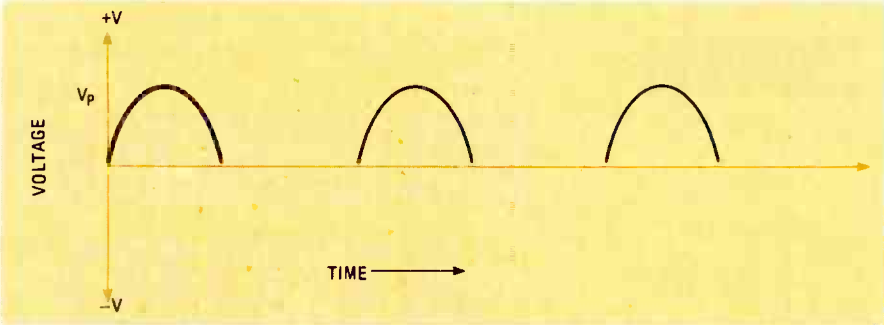


FIG. 9—WHEN THE CAPACITOR is added, the pulsing DC is "smoothed" out, making it more useful. The output from a wall-plug power supply is rarely smoother than this.

the device's rated limits. That property makes the Zener diode useful in a wide variety of voltage-regulator and voltage-reference applications.

A circuit using a Zener diode is shown in Fig. 10. Since it is the reverse characteristic that's important, the diode is connected so that it is reverse biased. The resistor is added so that the current through the Zener is limited to safe (i.e., within the device's rating) levels. Here, the Zener is used as a voltage "regulator." What happens is that, regardless of the level of the supply voltage, the voltage across the Zener will remain at V_B. Since the diode is in parallel with the load, the voltage across the load is equal to the voltage across the diode.

Zener diode applications

The circuit in Fig. 10 can be used to remove the ripple from DC output of the rectifier in Fig. 6. To do that, simply replace the battery with the output from the rectifier. The voltage across the Zener will remain at V_B regardless of how much ripple is in the rectifier's output. The output, which is taken across the Zener, is pure DC and will also be fixed at V_B.

Using what we now know about Zeners, we can now attempt some simple design work. Rather than design an entirely new circuit, however, let's see if we can calculate what values are required for the components used in the circuit shown in Fig. 10. We need to start off by defining some of the terms that we'll be using.

First of all, if the current that flows through the Zener is I_Z and the current that flows through the load is I_L, then the current that flows through the resistor is $I_Z + I_L$. That is the current that must be supplied by the battery. Additionally, the voltage supplied by the battery is V, and the circuit's output voltage is equal to the Zener's breakdown voltage, or V_B. Finally, the resistance of the load is R_L. Using those terms, we can now write a basic equation that describes the circuit:

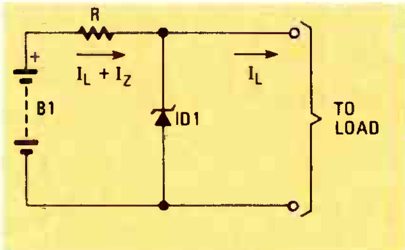


FIG. 10—A SIMPLE VOLTAGE REGULATOR using a Zener diode. This circuit will keep the voltage across the load at a constant level equal to the breakdown voltage of the Zener.

$$V_B = V - R(I_Z + I_L) \qquad (1)$$

That equation can be somewhat simplified, however. In designing Zener regulator circuits of this type, I_Z is generally assumed to be equal to 10 percent of I_L, or $I_Z = 0.1I_L$. Let's also make that assumption. Plugging that back into our circuit equation, we get:

$$V_B = V_{MIN} - 1.1I_LR \qquad (2)$$

In the circuit we've been discussing, either the supply voltage or the load could vary; or both could vary. Let's look at what happens when only the supply voltage varies.

The first thing we need to calculate is a value for R. To do that, we need to rewrite equation 2 as:

$$R = \frac{V - V_B}{1.1I_L} \qquad (3)$$

To solve for the maximum value that we can use for R, simply substitute V_{MIN} for V, or:

$$R = \frac{V_{MIN} - V_B}{1.1I_L} \qquad (4)$$

One more thing we need to know about the resistor is how much power it will need to dissipate. The maximum current flows through the resistor when the supply voltage is at V_{MAX}, and is equal to $(V_{MAX} - V_B)/R$. Using the relationship $P = V^2/R$, the power rating of the resistor, in watts, must be greater than $(V_{MAX} - V_B)^2/R$.

Let's now turn our attention to the Zener. Because the maximum current flowing through the Zener ($I_{Z(MAX)}$) is equal to the maximum current flowing through the resistor, minus the current that flows through the load, then:

$$I_{Z(MAX)} = \frac{V_{MAX} - V_B}{R} - I_L \qquad (5)$$

and the power rating of the Zener must be greater than $V_BI_{Z(MAX)}$.

Now, let's consider what happens when the supply voltage remains constant, but the load varies. We can find the largest and smallest acceptable values for R in the same way we did before. However, the equation we used must be changed slightly, because we are now concerned with a variable load current and a fixed supply voltage (instead of a fixed load current and a variable supply voltage).

The maximum acceptable value of R is found by looking at the circuit when the current through the load is at a maximum. That can be found from the equation: $I_{L(MAX)} = V_B/R_{L(MIN)}$. Substituting into equation 4, we can find the maximum value of R from:

$$R = \frac{V - V_B}{1.1I_{L(MAX)}} \qquad (6)$$

The power rating of the resistor is equal to $(V - V_B)/R$. The power rating of the diode is equal to $V_BI_{Z(MAX)}$, where:

$$I_{Z(MAX)} = \frac{V - V_B}{R} - I_{L(MIN)} \qquad (7)$$

Things get slightly more complicated when both the supply voltage and the resistance of the load vary. In that case, the maximum value of R is limited to

$$R = \frac{V_{MIN} - V_B}{1.1I_{L(MAX)}} \qquad (8)$$

The power rating of the resistor is the same as it would be if just the supply voltage varied. To find the power dissipated by the Zener, substitute $I_{L(MIN)}$ for I_L in equation 5.

Even though we've learned a lot about diodes this month, there is still quite a bit that needs to be covered. But let's leave that for the next part of this series. Among the things we'll discuss then will be special-purpose diodes and how to use them. **R-E**

NEW GERMAN SYSTEM STEREO AUDIO FOR TV

Three stereo TV-audio systems are currently under consideration by the FCC, but none offer the channel separation of this new one from West Germany.

LEN FELDMAN

WHILE THE FCC IS CHOOSING A STANDARD for multi-channel audio transmission for TV broadcasting in the U.S., the rest of the world is moving ahead. Japan has now been broadcasting TV programs with two audio channels for more than three years. In fact, the Japanese system of multi-channel audio for TV is one of the three systems being considered by the FCC. (See the February 1982 issue of **Radio-Electronics**, page 74.)

But Japan and the U.S. are not the only countries concerned with multi-channel TV audio. Other countries, such as West Germany, have also been exploring the possibilities of multi-channel audio for some time. And while it may be argued that not too many TV programs lend themselves to multi-channel audio, the use of two-channel audio in connection with motion pictures is of special interest to Europeans and the Japanese.

Often, those countries broadcast motion pictures that have been made in the U.S.A., or in other countries where different languages are spoken. In most cases, dialogue is dubbed into the language of the country in which the movie is to be shown. But many viewers in those countries would rather hear the original soundtrack, either as a means of learning a second language or because they already know the language and would rather hear the actual voices of the actors and actresses involved. That's where multi-channel audio plays its most important role. Given two distinct channels of audio, one channel can be used to carry the dubbed version of the soundtrack, while the second channel can be used to transmit the original soundtrack.

Much to everyone's surprise, in conjunction with the International Radio Exhibition in Berlin, a second German TV Network, ZFD (*Z*weite *D*eutsche *F*ernsehen), began broadcasting in stereo and in a two-channel bilingual mode, using a transmission system that differs entirely from any of the three systems currently being studied for possible use in this country. Furthermore, since Germany does not have the same sort of anti-trust laws that we have in the U.S., almost all the German manufacturers of TV receivers were well aware of the impending beginning of multi-channel audio broadcasting long before it began. They had ample time to design and produce a wide variety of TV sets with multi-channel audio, multi-channel adaptors for existing TV's and other related audio products. By the time broadcasting began and the International Exhibition in Berlin opened, German TV viewers could walk into many TV sales shops and purchase the needed equipment to receive TV programs with the new multi-channel audio service.

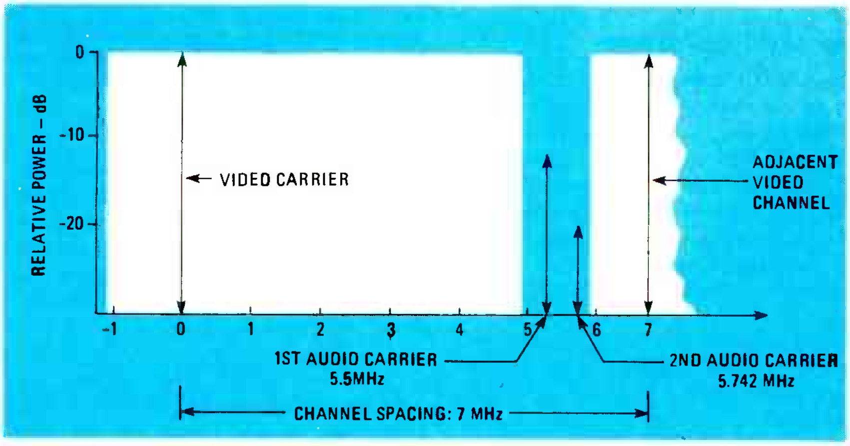
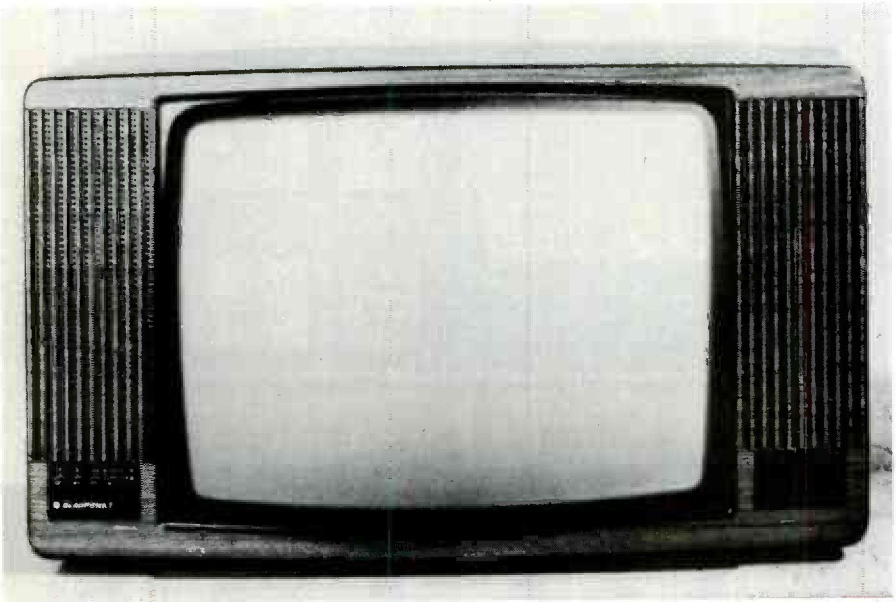


FIG. 1—FREQUENCY SPECTRUM of a PAL TV channel showing the location of the first and the new second audio carriers.

The German two-carrier system

Unlike the multiplexing systems proposed for the U.S., the new German multi-channel audio system for TV uses two separate audio RF carriers. The video and audio carriers are located within the PAL channel-bandwidth as



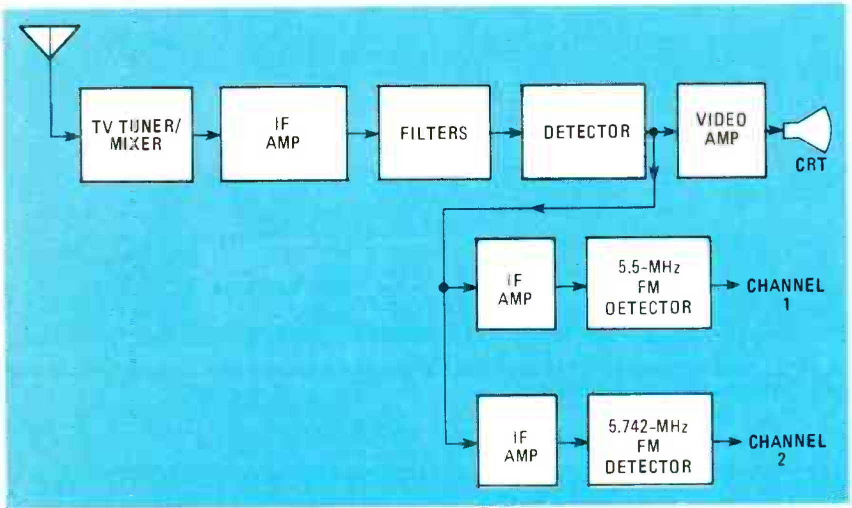


FIG. 2—BASIC INTERCARRIER DESIGN with the audio signal being processed after detection.

shown in Fig. 1. Note that the main audio carrier is 5.5 MHz above the video carrier, while in the NTSC system used in this country, it is 4.5 MHz above it.

In the German multi-channel system, a second RF carrier is added for the new audio channel. That carrier is 5.742 MHz away from the video carrier and its amplitude is 7-dB lower in power than that of the original audio carrier. The original audio carrier, in turn, was and continues to be 5.5 MHz away and 13-dB lower in power than the video carrier. The new, second audio carrier is, therefore, 20-dB lower in power than the video carrier. The reasons for those power relationships will be explained shortly.

Audio modulation

The original audio channel (which we'll call Channel 1) carries a half amplitude left-plus-right sum signal —(L + R)/2—when stereo is broadcast. The newly added audio carrier (Channel 2) is modulated by a right-only signal during stereo transmissions, plus a pilot carrier signal having a frequency of 54.7 kHz (3.5 times the line repetition rate of 15,625 kHz). During stereo transmission, the 54.7 kHz pilot carrier is AM modulated at 50% by an audio signal having a frequency of 117 Hz. During bilingual broadcasts, the carrier for Channel 1 carries the dubbed language while Channel 2 is modulated by the other language (usually the original soundtrack of a film) and the pilot carrier is now AM-modulated at 50% by a 274-Hz signal. Finally, during ordinary monophonic transmission, both Channels 1 and 2 carry the same audio information and the pilot carrier, though continuing to be present in the signal baseband, is unmodulated.

Referring back to the signal components used during stereo transmission—(L+R)/2 on Channel 1 and R on Channel 2—you may be wondering why such an asymetrical modulation arrangement was chosen. The answer relates to those carrier power levels mentioned earlier. Since the power level of the Channel 2 carrier is 7-dB lower than that of the Channel 1 carrier, a unity-level R signal is used to modulate that carrier. In the course of matrix decoding to recover separate L and R signals, only 50% of the R signal (R/2) needs to be subtracted from the signal recovered from the Channel 1 carrier—(L+R)/2—to obtain L/2. That method introduces less signal-to-noise degradation than would have occurred with a symmetrical L+R, L-R type of carrier modulation tha is used in stereo FM and in the other multi-channel TV systems presented to the FCC for their consideration. As for the recovered R signal, it is only necessary to reduce its gain by 6 d B (R divided by 2) to make its amplitude consistent with the dematrixed L/2 signal. Alternatively, of course, the L/2 recovered signal can be amplified by 6 dB to form a unity-level L signal that matches the demodulated unity-level R signal from the Channel 2 carrier.

Stereo TV receiver circuits

Figure 2 is a block diagram of a possible TV receiver that could be used in conjunction with the new German multi-channel audio system. The basic set would be configured much like the familiar intercarrier type of set, except that two intercarrier IF sections would be needed: one at 5.5 MHz (for the Channel 1 audio-carrier amplification and FM demodulation) and the other tuned to 5.742 MHz for amplification and FM demodulation of the Channel 2 audio carrier.

A second and more costly design, shown in Fig. 3, uses a common IF amplifier for both audio carriers plus the video carrier. After the IF amplifier, the audio carriers are first isolated by the audio IF filters and then the carriers are recovered by the mixer/detector. After recovery, the 5.5-MHz carrier and the 5.742-MHz carrier are amplified and detected separately.

The third possible circuit arrangement (and the most costly) is shown in Fig. 4. Here, after the RF mixer, an IF amp centered at 38.9 MHz passes both the video-IF and audio-IF signals. The video-IF signal is isolated by a filter network and then detected and amplified to recover the composite-video signal.

The combined audio-IF and video-IF signals are also supplied to two separate audio-IF amps. The first audio-IF amp is centered at 33.4 MHz and its output is detected to obtain the Channel 1 audio signal. In a similar manner, the second audio-IF amp is centered at 33.158 MHz and its output is detected to obtain the Channel 2 signal.

Each of the three circuit arrangements just described recovers the audio (and pilot signal) content from the Channel 1 and Channel 2 audio carriers used in the new multi-channel audio system. However, additional circuitry is still required to determine whether mono, stereo, or bilingual information is being broadcast and to do the necessary switching and dematrixing in the receiver.

A block diagram of that additional circuitry is shown in Fig. 5. The pilot carrier decoder circuit detects the frequency of the pilot-carrier modulation (or, in the case of mono, the absence of modulation) and electronically switches either to the stereo mode or to the mono/bilingual mode. Prior to the individual power amplifiers for each audio channel, switching circuitry either parallels the inputs to the amplifiers in the case of mono, or separates the inputs to the amplifiers in the case of stereo. This switching circuitry also permits switching from one sound track to the other for bilingual reception. Which sound track is to be received is left to the option of the viewer/listener.

In speaking with some of the engineers from various TV manufacturing firms in Germany, we learned that one of the main reasons for rejecting the standard type of multiplexing system for multi-channel audio was the relatively poor channel separation afforded by such a system. Of course, channel separation on the order of 30-dB or even 20-dB is perfectly adequate when we are talking about stereo programming (most stereo phono cartridges offer no more than that). But when the programs from each channel are not related (as would be the case with dialogue coming over in two different languages), much higher orders of separation are called for. According to the engineers, separation on the order of 60-dB between channels is realizable using this two-audio-carrier system and that should be more than enough for even the most critical listener.

The introduction of this new multi-channel audio system for TV came as a surprise not only to American visitors to the Berlin Fair, but to many Japanese manufacturers represented at the show, none of whom had even prototype models of TV sets capable of handling the new system. Clearly, the German TV set manufacturers want at least some brief time advantage in selling their domestically made sets before having to face the competition offered by foreign manufacturers.

Having now been exposed to this type of multi-channel sound system and impressed with its high quality level, it seems to me that it might be wise for those U.S. committees that are involved in evaluating such systems and making recommendations to the FCC to take a good look at this new German system before coming to any conclusions. It would be a pity if, acting in haste, we chose an inferior multi-channel audio system for TV when a better one was available in Europe, or anywhere else for that matter. R-E

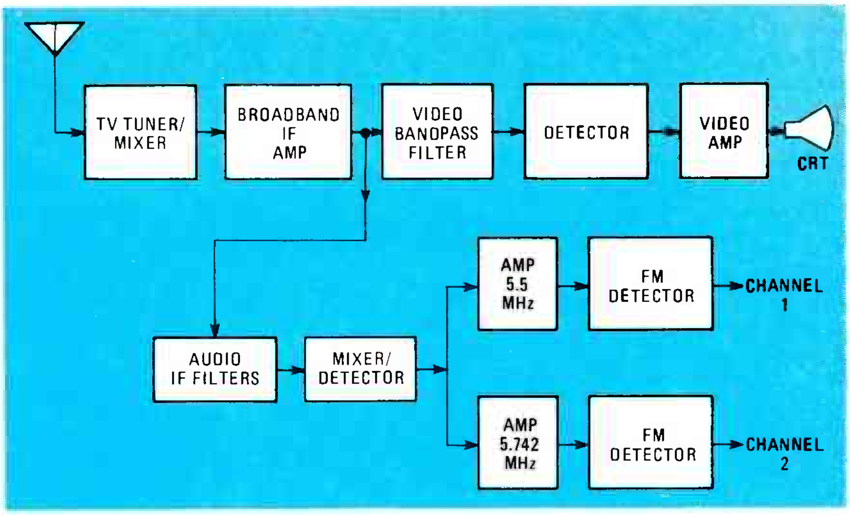


FIG. 3—HYBRID TV SET where a full split-sound system and intercarrier design are combined.

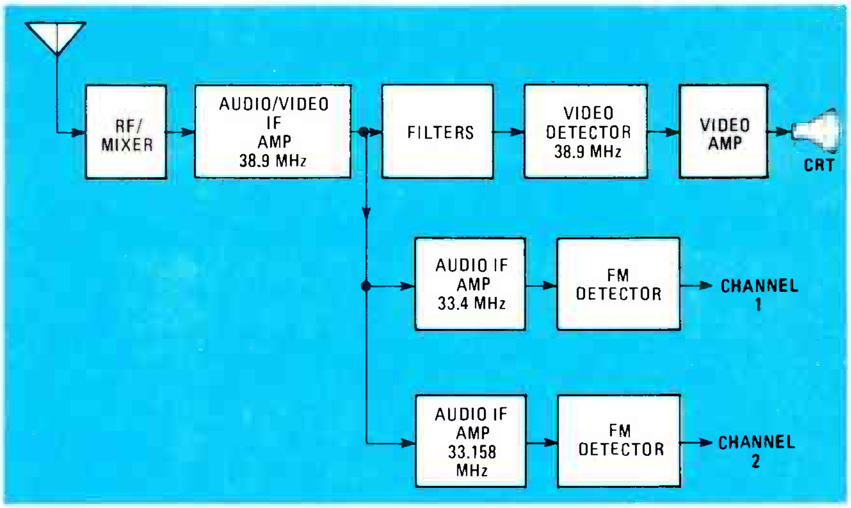


FIG. 4—FULL SPLIT-SOUND SYSTEM. The audio signal is processed just after the audio/video IF amp and prior to filtering and video detection.

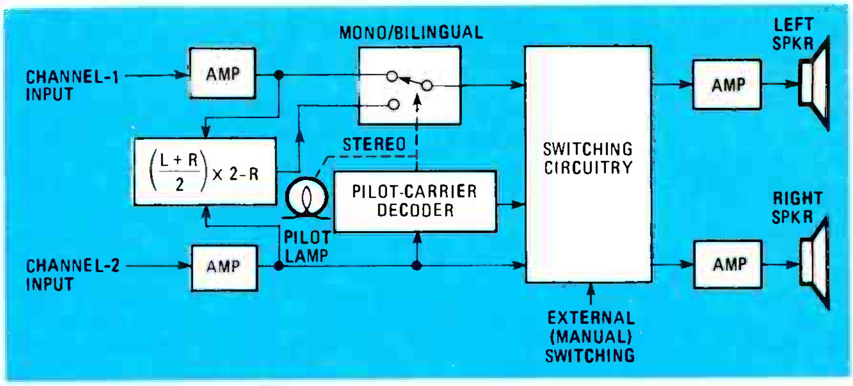


FIG. 5—FINAL AUDIO PROCESSING where selection of mono/bilingual or stereo reception modes occurs automatically. When receiving bilingual broadcasts, the user can select which channel is heard.

SATELLITE TV RECEIVER

DAVID BECKER

Now that you know how a satellite-TV receiver operates, it's time to get to work and put one together.

Part 2 LAST MONTH WE looked at how satellite communications developed, and at some of the programming available on domestic satellites. We also discussed the mechanics of uplink/downlink transmission and reception and the theory of operation of the R2B satellite-TV receiver. This month we'll cover the construction of that receiver.

Due to the extremely high frequency of the signals involved, parts placement is critical and double-sided PC-board construction is required. The receiver uses two boards—a main board and a smaller mixer board that mounts at the rear of the main board.

Main board

The first step in building the receiver is to assemble the main PC board. Foil patterns for the top and bottom of that board, respectively, are shown in Figs. 9 and 10. A parts-placement diagram is shown in Fig. 11. Position the board so the side shown in Fig. 9 is facing up. Use a good grade of rosin-core solder and a fine-tipped iron rated at 40-50 watts. Install all of the resistors first, with the exception of R52—that will be mounted on the bottom of the board later.

(If you purchased a complete R2B receiver kit, you will have noticed that the 1170-MHz oscillator and the 2nd-IF sections were assembled and tested. That is because alignment of those sections requires specialized test equipment that the hobbyist may not have access to, such as a CATV-type sweep generator and a high-frequency spectrum analyzer; complete details will be given in the next installment of this article.)

Note that you will have to solder all ground leads on both the top and bottom sides of the board. (A ground does *not* have the ground plane on top of the board etched away from around its mounting hole.) Next, install IC sockets for IC4-IC7.

Now mount diodes D1-D7. Note that D7 is made from an NPN transistor that has been modified by soldering its base and collector leads together; the base-emitter junction works as a diode. That arrangement is used because D7 and Q12 together form a current mirror and its two components should be matched fairly well.

Install LED1, but do not solder it flush to the board—leave its leads long so that it can be mounted on the front panel later.

With that done, install all the transistors. You will notice that there are two possible ways to install the NEC 02136 transistors (Q1-Q3, Q5, Q6). Transistors Q1-Q3 should have their markings face-up; Q5 and Q6 should be installed with the markings facing down.

Installation of the capacitors is fairly straightforward and should be done next. One lead of C3 must be soldered to the leg of C4 before installation, as shown in Fig. 12. Similar preparation is required for capacitors C5 and C6, C8 and C9, and C10 and C11. That may seem odd, because the mounting tabs of

the trimmer capacitors are connected to ground; but there is an explanation. At the high frequencies involved, the bent legs of the trimmers actually act as inductors, and the C4-C5 and C9-C10 pairs form transformers. The capacitance of the trimmer in parallel with the inductance of its leg creates an L-C tank circuit that provides the selectivity of the first-IF section. Because the values are critical, it is important not to use substitutes for the Stettner trimmer capacitors.

Before installing the remaining capacitors, solder a shield around the 1170-MHz oscillator and first-IF sections as shown in the parts-placement diagram and in Fig. 13. Don't forget to include a partition between C5 and C9; it will sit over resistors R3 and R4, and Q2. Use ¾-inch-wide strips of 28-gauge tin to make the shield and be sure to solder all the seams completely. Then install all the remaining capacitors, except for C1, paying special attention to the polarity of electrolytics.

Install trimmer potentiometers R13 and R37, and insulated jumper JU1, being careful not to cause a short between the jumper and the ground plane. Mount L1, L8, and L9 in their respective positions and also solder the constant-current source, IC8, into position. Solder IC1-IC3 to the board, taking care to orient them properly. Pin 1 of IC1 is identified by a colored dot on the underside of the package. Integrated circuits IC2 and IC3 are in SIP *S*ingle *I*n-line *P*ackage) types and pin 1 is on the far left when the IC's are held so that the identification number can be read. Don't forget that you should still be soldering ground leads on both the top and bottom sides of the board.

Install the slug-tuned coils, L2-L6, and mount shield cans over them. (If you're wondering what happened to L7, it's formed by the lead of R51.) Install the Berg test jacks TP1 and TP2 along with the AC-power jack, J5. Also mount the rear-panel RCA jacks, J2-J4. You may want to solder the bodies of those jacks to the top of the board for added mechanical integrity. Install voltage regulators IC11-IC13 (a heat sink is required for IC12) and power switch S1. Solder R52 in place on the bottom side of the board between pins 2 and 10 of IC7.

Finally, connect the TUNING and AUDIO front-panel potentiometers. (Use ribbon cable to keep things neat.) Viewing the TUNING pot (R47) from the front with the solder lugs at the top, connect the rightmost lug to the hole marked "1" on the parts-placement diagram and the center tab to the hole marked "2." Similarly, connect the rightmost tab of the AUDIO potentiometer (R48) to the hole marked "3," the center tab to the one marked "4," and the leftmost tab to the hole marked "5." Be sure to make the cables long enough for the controls to reach the front panel. Plug IC4-IC7 into their sockets, and the main board will be complete.

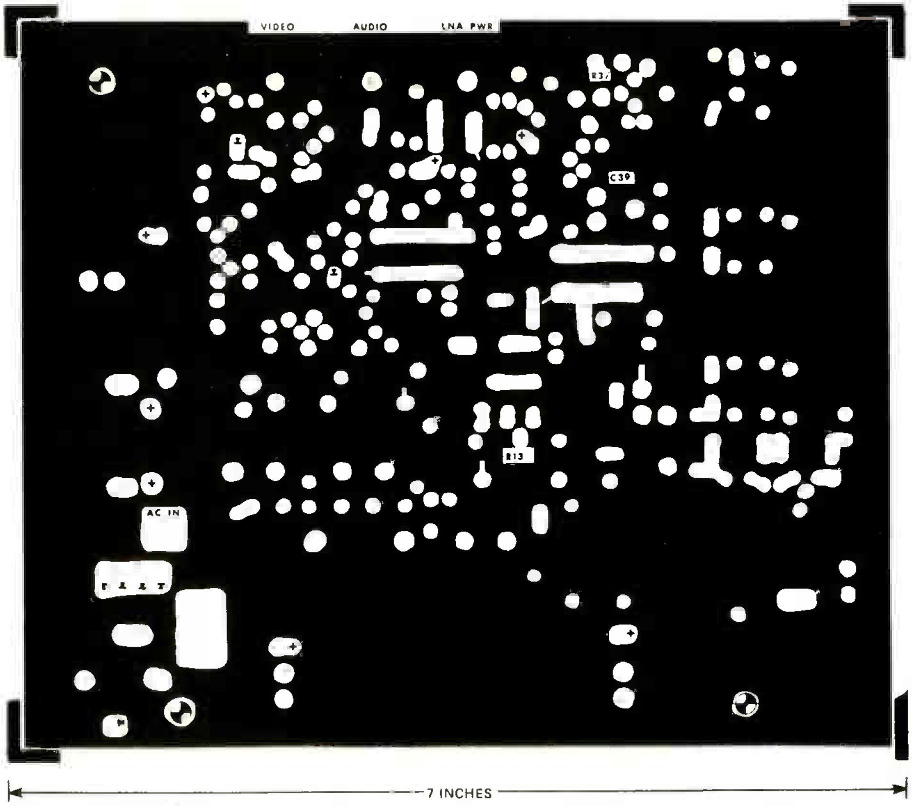


FIG. 9—TOP OF MAIN receiver board is a large ground plane with foil-free areas to provide clearance for component leads that pass through board.

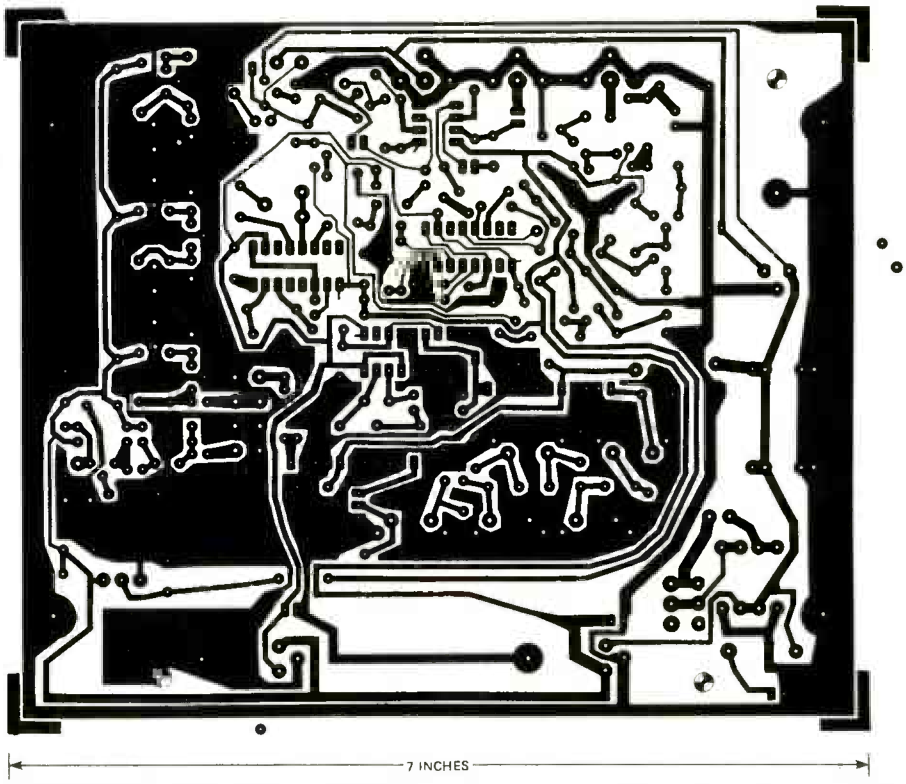


FIG. 10—BOTTOM OF MAIN receiver board. All components connected to ground must be soldered to ground plane on *both sides* of board.

Mixer board

The mixer board performs the job of mixing the 4-GHz input from the LNA with the first local-oscillator signal. It is the most critical part of the entire receiver, so extra care must be taken in its construction.

To assure proper operation, the PC board used for this section must be made

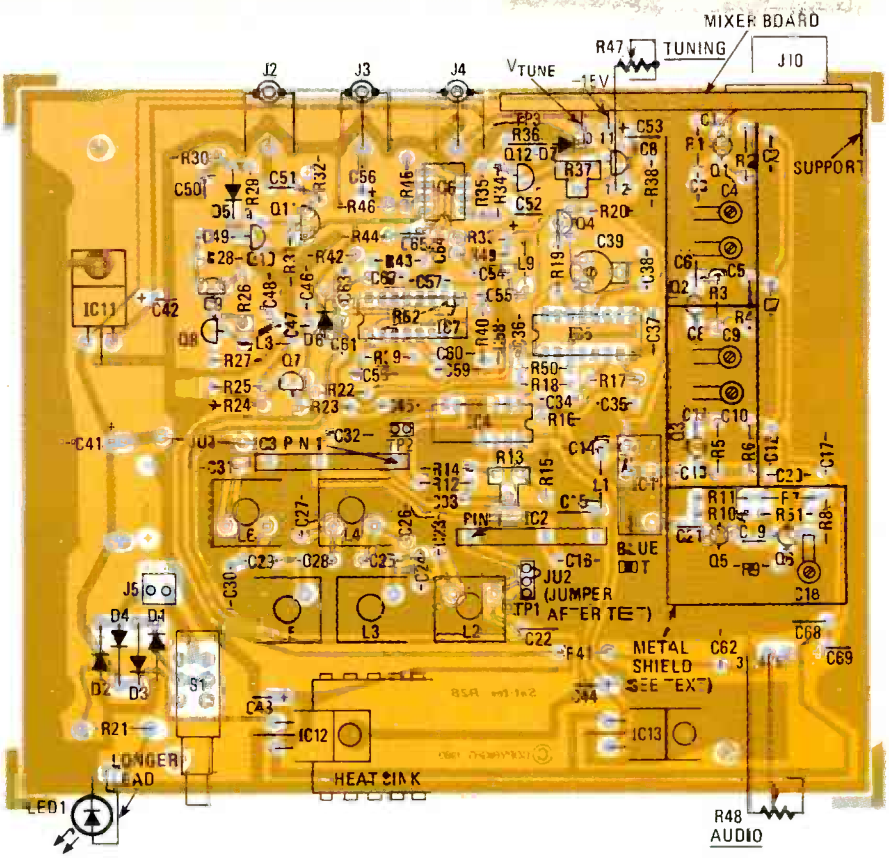


FIG. 11—NOTE THAT IC1 AND IC2 are in SIP (Single In-line Package) packages. Pin-1 end is on left when package is viewed from side with markings.

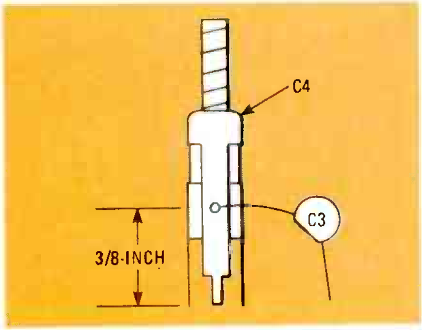


FIG. 12—CAPACITOR C3 should be soldered to leg of trimmer C4 before it is mounted on board. Capacitors C5/C6, C8/C9, and C10/C11 should be prepared the same way.

The following are available from Ramsey Electronics, 2575 Baird Rd., Penfield, NY 14526: Complete Sat-tec R2B satellite-TV receiver kit with pre-aligned 70-MHz IF and 1170-MHz oscillator sections, $495.00; completely wired and tested Sat-tec R2B satellite-TV receiver, $749.95; RM3 RF modulator, $69.95; Watkins-Johnson V815 oscillator IC (IC10), $125.00; Avantek 120°K, 50-dB gain LNA, $595.00.

The above prices include shipping and insurance charges to points in the U.S. and Canada. Overseas orders please add 15% to cover shipping. MC and Visa accepted.

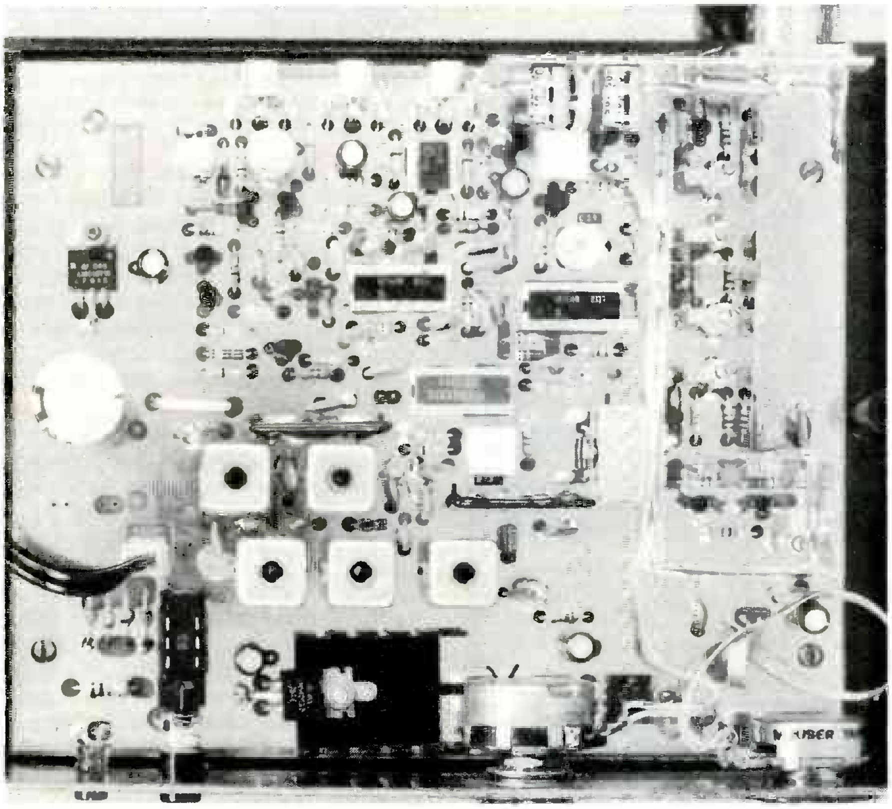


FIG. 13—SHIELD AROUND 1170-MHz oscillator and first-IF sections is made from ¾-inch-wide strips of 28-gauge sheet tin.

of .062-inch thick FR-4 material with special plating and a dielectric constant of 4.84 ±.15 (see Parts List). One important reason for that requirement is that two of the capacitors used in the mixer circuit, C72 and C73, are actually formed by the copper and plating on both sides of the PC board, with the board material acting as their dielectric.

Foil patterns for both sides of the mixer board are shown in Figs. 14 and 15. Figure 15 also shows where component mounting holes are to be drilled; there are only a few of them—most components are soldered directly to the foil of the board or to other components. Note that J10 will need a large mounting hole. Figure 16 shows component placement on both sides of the board. Refer also to Figs. 17 and 18 for further details of component placement. We'll refer to the side of the board on which the capacitors are mounted as the *bottom* side, and the side on which the diodes are mounted as the *top* side.

Begin assembly by soldering J10 to the top side of the board. Run a solder bead all around the flange and also solder the connector on the bottom side of the board. You may need to use a 100-watt soldering gun or iron for this.

While the board cools, prepare quarter-wave transmission-line balun L11 from .141-inch diameter Teflon hardline (Cablewave Systs. type CT-.141-50). Use a small tubing cutter to cut the hardline to the dimensions shown in Fig. 19-a. Solder the inductor into place on the bottom of the board with the longer end of the center conductor facing J10. Solder that end to J10 and the other to the foil pad indicated in the parts-placement diagram. The copper jacket of L11 should be soldered to the PC board only at the extreme ends, not along its entire length.

Next, install IC10, the VCO (*V*oltage-*C*ontrolled *O*scillator) from the bottom side of the board. Note that one lead (pin

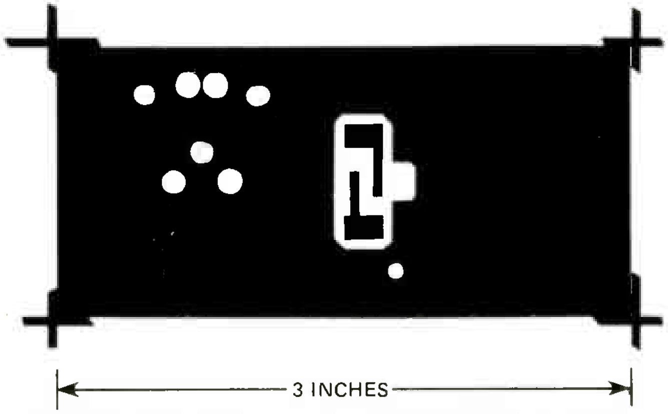


FIG. 14—BOTTOM OF MIXER BOARD shows two capacitors (C72 and C73) formed from PC-board material.

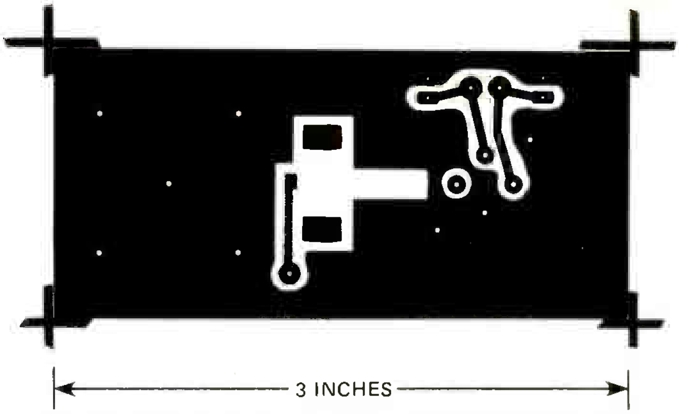


FIG. 15—TOP OF MIXER BOARD shows where holes are to be drilled. Jack J10 will require large hole so that it can pass through board.

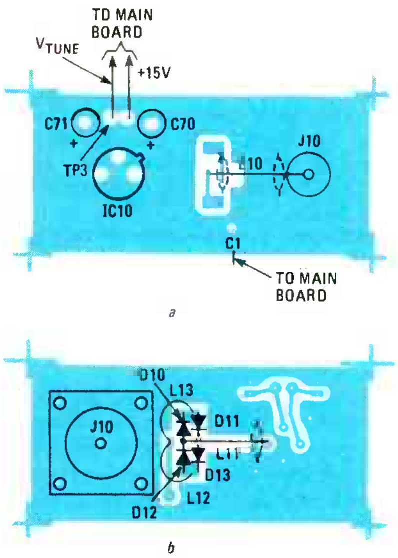


FIG. 16—CAPACITORS AND IC10 are mounted on bottom of mixer board (a); diodes on top (b).

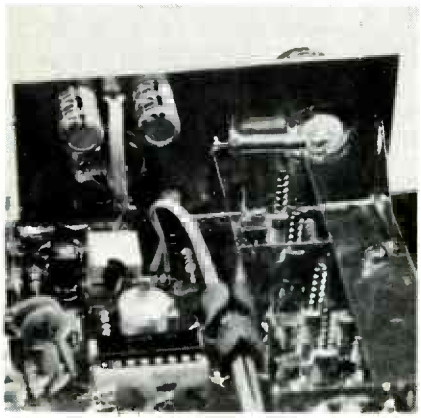


FIG. 17—QUARTER-WAVE HARDLINE BALUN is soldered to board only at its ends.

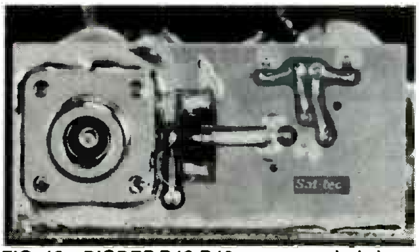


FIG. 18—DIODES D10-D13 are connected at one end to Teflon balun on top of mixer board. Wire loops L12 and L13 are described in text.

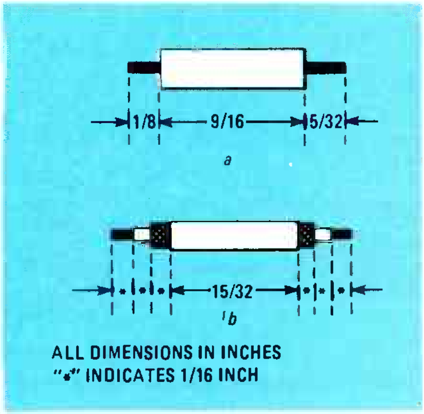


FIG. 19—TRIMMING GUIDES for hardline (a) and Teflon (b) baluns, L11 and L10.

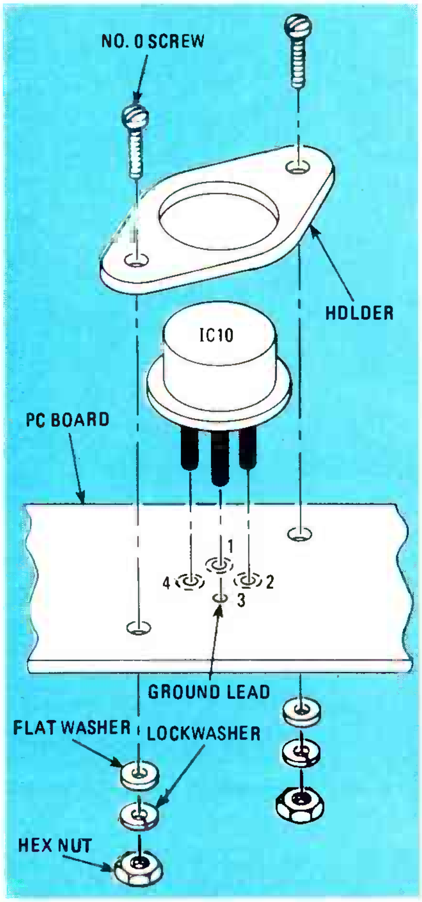


FIG. 20—OSCILLATOR IC, IC10, can be mounted using hardware shown, or secured by soldering case to board.

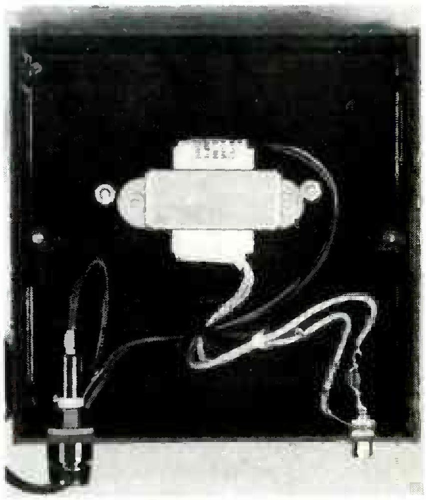


FIG. 21—TRANSFORMER AND FUSE are mounted in their own enclosure to avoid heat generated by transformer from affecting the receiver.

3) of the IC is not isolated from the case like the others. That is the ground lead and should be inserted into the hole going to ground. Use the hardware package that came with the IC to mount it to the board as shown in Fig. 20, or carefully solder its case to the bottom side of the board in several places. You will be soldering L10 to pin 4 of the IC later, so do not cut it off.

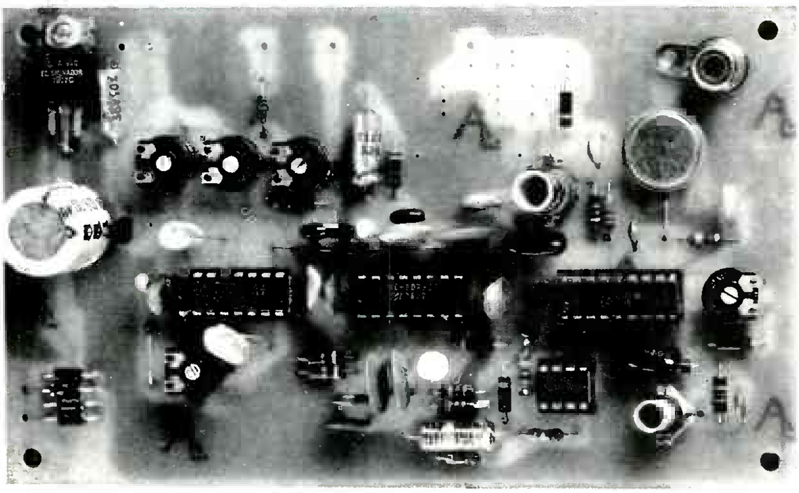
Install C70 and C71, noting polarity, and then prepare the other transmission-line balun, L10, from Teflon coaxial cable (Alpha type R6179B/U) as shown in Fig. 19-b. It is perhaps easiest first to cut away the outer sleeving by scoring it with a sharp knife and pulling it off. Do that for the wire braid and the inner insulation as well, being careful not to nick any of the wires. Connect one end of the center conductor to pin 4 of IC10. Also solder the braid at the end to the foil. Solder diodes D10-D13 to the other end of the piece of coax, paying attention to polarity. Start with the two diodes that are connected to the braid. Keep the diode leads as short as you can. The ends of the diodes that are not connected to the coax are soldered to the two rectangular pads on the board. Those connections can be seen in Fig. 18.

continued on page 102

ADD-ON IMPROVES PAY-TV DECODER

If you can't get your pay-TV decoder to work, it may be because your set does not have enough IF gain. If so, try this simple circuit.

STEPHEN B. MILLER



A TYPICAL DECODER BOARD. The gated IF amplifier can be used to improve this device's performance.

BUILDING OVER-THE-AIR, SUBSCRIPTION-TV decoders, such as the one featured in the January and February 1981 issues of **Radio-Electronics,** has become popular with electronic experimenters and hobbyists. Many popular decoder designs require the unit to be attached to the IF strip in the receiver. A drawback to that scheme, however, is that sometimes signal levels at that stage are inadequate for proper decoder operation. This article offers one solution to that problem—a gated IF-amplifier that is installed in the TV set between the tuner output and the IF input. It is intended for use only with suppressed-sync-signal system decoders.

Suppressed-sync-signal encryption

To understand the problems here better, let's look at the differences between a standard and encoded TV signal. Both signals are shown in Fig. 1. Each complete picture, called a *frame*, is made up of 525 lines; 30 such frames are sent each second, for a total of 15,734 lines per second. To recreate the transmitted signal, the receiver must take those lines and display them in the correct sequence and location. That is why sync pulses are needed—they tell the television receiver *when* to display the lines. Two types of sync pulses are used: One, the *vertical*-sync pulse identifies the beginning of each frame and field (a field is a half frame); the other, called the *horizontal*-sync pulse, identifies the beginning of each line. In a surpressed-sync television signal, the horizontal-sync pulse is missing, as shown in Fig. 1-b, destroying picture sync.

To restore the sync, some type of "decoder" is needed. What those devices do is to restore the sync pulses artificially during the interval that it is supposed to be present. The technique used is to reduce the AGC voltage so that there is enough IF gain to raise the signal to the proper level.

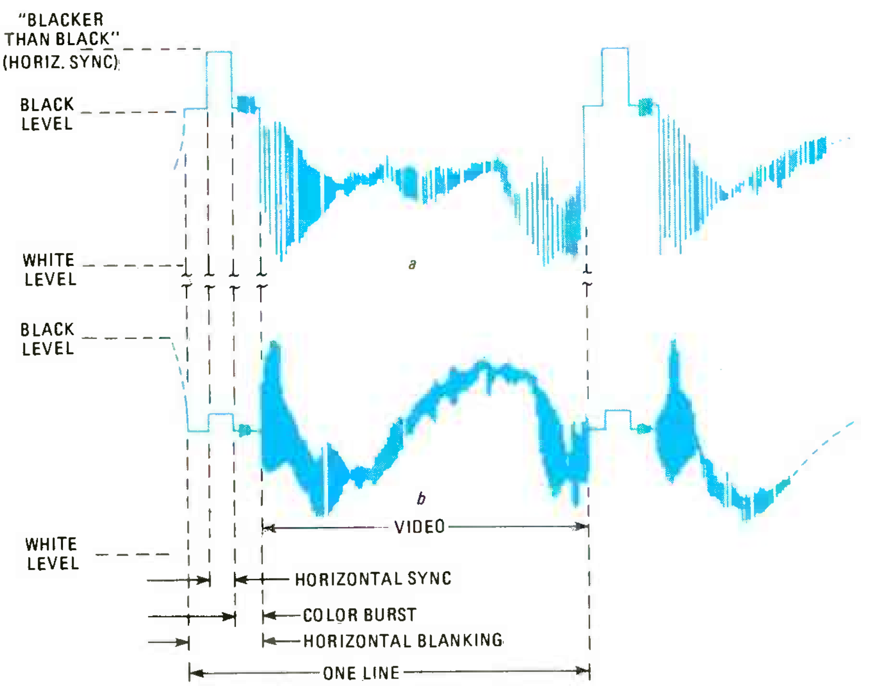


FIG. 1—THE DIFFERENCE BETWEEN a standard television signal (*a*) and a suppressed-sync signal (*b*) is shown here.

NOTE:

The legality of the use of privalety-owned devices to decode subscription TV broadcasts is currently the subject of much debate and pending litigation. The subscription companies have taken the position that decoding of broadcasts without payment is "theft of service" and the FCC has issued a notice to the effect that subscription-TV decoders are subject to FCC approval.

That system, however, is based on the premise that there is enough IF gain available to do that. Unfortunately, the signal received by the television is often so low that the IF is running wide open, with little or no AGC required. If that is the case, there is little or no IF gain available and the signal can not be raised to the proper sync level.

The easiest way to correct that problem is to insure that a strong enough signal is available from the antenna. If the signal from the antenna can be boosted sufficiently, the decoder will function exactly as intended. In many cases, however (especially if you live in a fringe reception area), picture quality cannot be improved enough to make a difference, and the decoder still will not work properly. The solution is to add more gain to the IF amplifier.

A schematic diagram of a simple IF amplifier with adjustable gain is shown in Fig. 2. The heart of that circuit is an MC1590G differential input/differential output amplifier; that device is used as a wide-band (i.e., un-tuned) amplifier. The gain is controlled by adjusting the voltage level at the device's gain control (AGC) terminal. In this design, the decoder's AGC voltage is used as the AGC control voltage for the gated IF-amp. That signal determines when the additional gain is required.

The circuit was built on a copper-clad perforated construction board; the small number of parts made designing and etching a PC board unnecessary. The construction is quick and straightforward. While component tolerances are not critical, all leads should be kept as short as possible. To avoid the use of a separate heat sink, the IC was mounted upside-down.

For best results, you'll need an RF signal generator and either an oscilloscope or an RF voltmeter to align the circuit. Set the output of the signal generator to an amplitude equal to the lowest level that can be measured by the scope or voltmeter; the generator's frequency should be set at 44 MHz. Attach a variable power-supply to the amp's AGC input (pin 2) and set it to 10 volts. Using the meter or the scope, measure both the input and the output amplitudes, and adjust the AGC input until they are equal. That is the approximate 0-dB AGC input level, the level that is applied to the amp during normal (i.e. unscrambled) operation. Next adjust the voltage input to the AGC until the output of the amp is 2.5 times higher than the input. That corresponds to about an 8-dB gain, the level that is required to reproduce the sync pulse. The voltage applied to the AGC input at that point is the value that will have to be applied whenever the sync pulse is to be generated. If you do not have access to the equipment required to make those tests, use 10V for the 0-dB control voltage, and 8V for 8-dB gain.

Hooking it up

The gated IF-amp can be interfaced easily with the decoder, using the circuit shown in Fig. 3. That simple circuit inverts and amplifies the decoder's output. To align the circuit:

1) Attach the interface to the decoder, set S1 to NORMAL, and adjust R5 so that the output of the circuit matches the voltage required for 0-dB gain as found above, or 10 volts.
2) Set S1 to DECODE, connect the circuit input (R1) to ground, and adjust R3 so that the voltage from step 1 still appears at the output.
3) Apply 5 volts to the circuit input and verify that the output drops to the 8-dB voltage, or about 8 volts. If not, re-adjust R3 until that occurs. If readjustment is required, repeat step 2 and verify that the output is still close to the 0-dB voltage (do not readjust R3 at this point, however).

Mount the amplifier circuit inside a metal box, and connect the box to ground. Cut the coax from the tuner to the IF and insert the amplifier. The cables' braids should be soldered to the copper board, and the center conductors should be connected to the appropriate points, as shown in Fig. 2. If you wish, a better approach would be to use BNC connectors. Make your power connections, and the connection from the decoder, using shielded cable. In the test circuit, the cable braid was connected only at the decoder; there were no interference problems, but some experimentation may be required for best results.

The decoder interface (Fig. 3) should be mounted near the decoder so that the final alignment and any future servicing is made easier. If it ever becomes necessary to remove the interface for servicing, it can be replaced by a 10-volt power supply, and normal TV operation can be maintained while the gated IF-amplifier remains connected. As a precaution, you should be sure that the amplifier's power supply is always on, but that the supply to the decoder is off when it is not in use.

Final alignment is accomplished by watching the TV screen while receiving a "scrambled" picture. No test equipment is used for that procedure. Resistor R3 is adjusted slightly until the picture quality is as good as possible. You should note in which direction the pot was adjusted, and approximately how much rotation was used. That could become important in the event that total loss of sync occurs, and it becomes necessary to start again from the beginning. **R-E**

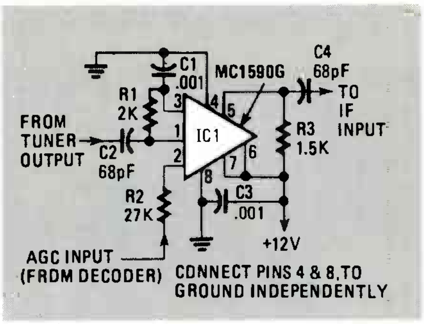


FIG. 2—SCHEMATIC DIAGRAM of the gated IF amplifier. The heart of the circuit is an MC1590G differential input/differential output amplifier. It's control signal is taken from the decoder's output.

PARTS LIST—AMPLIFIER

Resistors, ¼ watt, 5%
R1—2000 ohms
R2—27,000 ohms
R3—1500 ohms
Capacitors
C1, C3—.001 μF, ceramic disc
C2, C4—68 pF, ceramic disc
Semiconductors
IC1—MC1590G differential input/differential output amplifier (Motorola)
Miscellaneous: copper-clad perforated construction board, metal enclosure, shielded cable, wire, solder, etc.

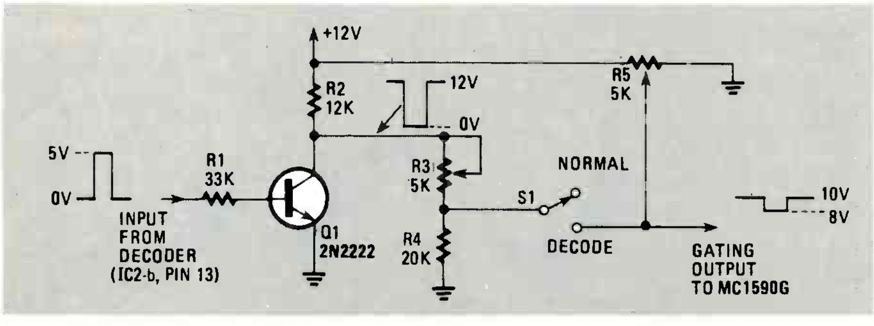


FIG. 3—THIS CIRCUIT IS REQUIRED to interface the IF amplifier with the decoder. It inverts the output from the decoder, gives you enough range for adjustments, and gives you a way to switch from NORMAL to DECODE modes.

PARTS LIST—INTERFACE

Resistors, ¼ watt, 5%, unless otherwise noted
R1—33,000 ohms
R2—12,000 ohms
R3, R5—5000-ohm potentiometer, linear
R4—20,000 ohms
Semiconductors
Q1—2N2222 NPN transistor
S1—SPST switch
Miscellaneous: wire, solder, etc.

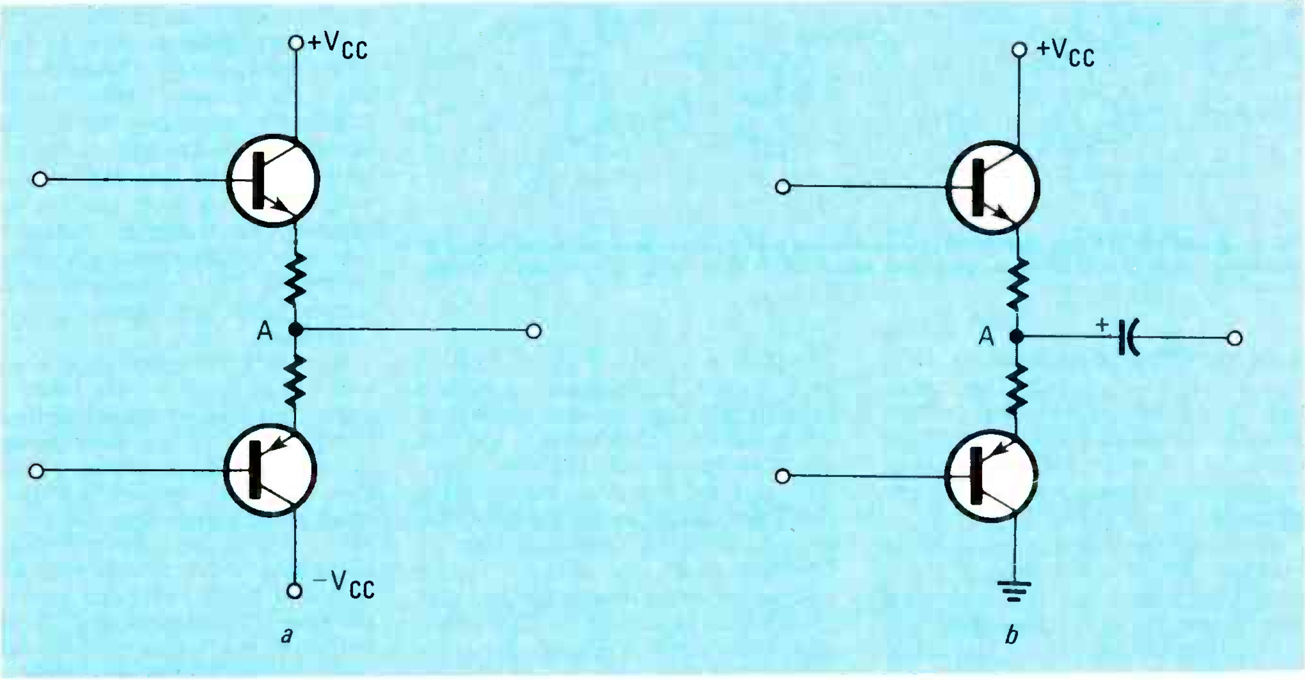


FIG. 1—THE OUTPUT STAGE of most modern audio amplifiers uses the direct-coupled configuration shown in *a*. Earlier amplifiers mostly used the capacitor-coupled configuration shown in *b*.

IMPROVE AUDIO AMP PERFORMANCE

You haven't finished repairing that audio amplifier until you've made these two simple, yet often-overlooked, adjustments. Here is what they are, and how to do them.

KIRK VISTAIN

DOES YOUR HI-FI POWER AMPLIFIER sound as good to you as it did the day you bought it? Components drift with age and when they do, so do the specifications and performance. Or, suppose an output transistor shorted and you just replaced the shorted output, a transistor driver, and a handful of burnt resistors. If you replace the cover without adjusting the bias and symmetry, you've left out one of the most important steps. Sure, maybe thermal runaway won't occur. Maybe there won't be any DC-offset at the speaker terminals. Maybe the crossover notch won't be too bad. But that's too many maybe's. Let's see how two simple adjustments can improve performance.

For reasons of efficiency, the most popular audio-output configuration these days is the Class B, push-pull direct-coupled design shown in Fig. 1-a. A few years ago capacitor coupling (shown in Fig. 1-b) was the norm; that's because it needed only a single-ended power supply and speaker damage, in the event of output failure, was unlikely. After a while though, those amplifiers gained a reputation for poor low-frequency response and instability; that is why direct-coupling is now so popular. But, with that technique, dual-polarity power supplies are needed, as well as complex circuits to protect the speakers in the event that one of the output transistors shorts (dumping the full supply voltage across the speaker's voice coil).

With either design, there are only two basic adjustments to be made, although different manufacturers may use different terminology for one or the other. They are:

1) Quiescent (low, or no-signal) bias through the output transistors.

2) Output symmetry.

A source of bias is provided in Class B audio-amps to reduce crossover distortion to an acceptable level (see Fig. 2). That actually makes them Class AB, since collector current flows for more than 180 degrees of the input waveform.

Output symmetry refers to how equally the positive and negative halves of the input waveform are reproduced. A misadjustment of that usually results in asymmetrical clipping and reduced output power for a given distortion rating. Usually, that adjustment is labeled BALANCE in capacitor-coupled units. In direct-coupled amps, it is called OFFSET and determines the DC potential across the speaker terminals; that potential, of course, is ideally zero. Regardless of what it's called or exactly where in the circuit it is, that control does the same thing, trim circuit values so that the output transistors conduct equally. If that is

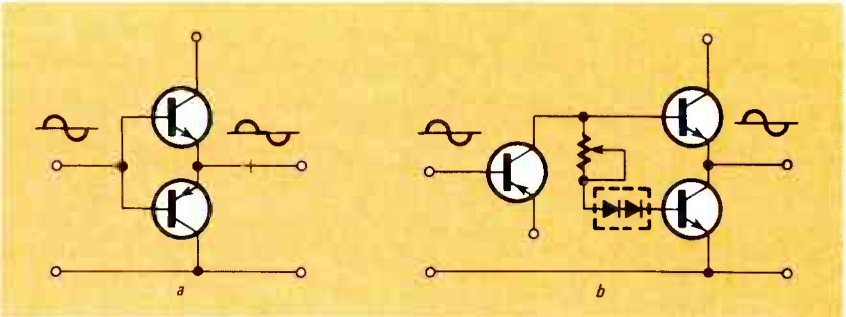


FIG. 2—A SIMPLE CLASS-B AMPLIFIER (shown in *a*) will produce some distortion in the form of a crossover notch. That amplifier is made Class AB (shown in *b*) by using a bias source to reduce distortion.

done, the voltage at point A in Fig. 1 will equal $(+V_{CC} - -V_{CC})/2$. That comes out to half the power-supply voltage when a single-ended power supply and capacitor coupling is used, or zero volts when a dual-polarity power supply and direct coupling is used.

It is important that you remember to check both bias and symmetry in any high-fidelity amp that is serviced for any reason. Those control settings can drift as the unit gets older, and sometimes they're not set right to begin with. Certainly, whenever any output part fails, especially if general-replacement semiconductors are used, bias and symmetry checks are essential.

How it's done

I developed the following method while doing quality assurance for an importer of Japanese high-fidelity equipment. We ended up with a shipment of receivers whose distortion figures did not meet the manufacturer's specifications; not at full power, but at around 250 milliwatts. That is the bottom of the power band for FTC ratings, as well as a common listening level for headphone users. We traced the problem to crossover distortion, noting that the problem was more severe at higher frequencies. Adjusting the quiescent bias solved the problem. That incident showed me the importance of using dynamic methods to "fine tune" the quiescent bias.

The instruments required include a harmonic distortion meter, an AC voltmeter (many harmonic-distortion meters also include that instrument), a triggered scope (preferably dual-trace), a low-distortion sine-wave generator, and an attenuator (a sine-wave generator and attenuator are also often combined in the same instrument). A DMM with 200 mV and 200 mA ranges is also needed. An eight-ohm standard, non-inductive load-resistor completes the list. Be sure that its power-handling capacity is adequate for the amplifier under test. The setup is shown in Fig. 3.

The output of the attenuator is fed to the power-amp's input. If the unit-under-test is a receiver or integrated amplifier, a high-level input, such as AUX, is used. Set the BASS and TREBLE controls for flat response, center the left-to-right BALANCE control, and turn the BIAS trimmer all the way down. Now's a good time to use your DMM to check the current in the V_{CC} line to the output transistors. Sometimes there's a fuse here, so it's easy. If not, watch the voltage across the emitter loads and use Ohm's law to calculate the bias. In any case, make sure you're only reading one channel at a time.

Plug the amp into a variable autotransformer (such as a Variac), and increase the supply voltage slowly, watching the bias current. It shouldn't be much more than 10 mA with a full 117-volts AC input. If it exceeds that level, make sure that you have the BIAS trimmer set for minimum and that no signal is at the input (or output). If that isn't the problem, look for defective parts. One that many technicians miss is the bias trimmer itself. If it opens up the bias current goes sky-high.

Assuming you made it up to full line voltage with no problems, let the amplifier stabilize. That takes five to ten minutes, depending on the ambient temperature.

There are two types of adjustments you can make—static and dynamic. Static adjustments are made with no input signal to the amp; an input signal must be present for the dynamic adjustments. Turn the amplifier's volume control to maximum. Turn on the sine-wave generator, set the frequency to 20 kHz, and increase the signal level to bring the amp to full power while checking the output waveform for any gross distortion. After you've done that, turn off the sine-wave generator and set the amp's bias trimmer for a current equal to the manufacturer's specification. Then, turn the signal generator back on, but only bring the signal level up high enough to produce a 250-milliwatt output across the eight-ohm load. Readjust the bias, if necessary, to reduce the total harmonic distortion to below the manufacturer's rating. Remove the test signal and check the quiescent bias again. It should be close to that specified in the service manual, and, in any case, no more than 50 mA. Of course, always make sure that the harmonic-distortion meter is not reading spurious noise or ground-loop hum.

The next thing we want to do is to adjust the symmetry. On direct-coupled amps, that is called "offset"; it is best adjusted by measuring the DC voltage across the speaker outputs (those outputs should be properly terminated with a load resistor) and setting the trimmer for minimum voltage. The minimum voltage should be less than 60 millivolts. That adjustment is made with no input signal; there is no dynamic adjustment.

In capacitor-coupled amps, the symmetry adjustment is often called "balance," not to be confused with the front panel control of the same name. To make the static adjustment, simple set the symmetry trimmer so that the input to the output-capacitor is ½ V_{CC}. However, I usually don't bother with that adjustment, but do the dynamic one instead. Using a 1-kHz sine wave, drive the amp to clipping. Monitor the amp's output with a scope, and trim the balance control so that the positive and negative peaks are clipped equally. You can also use a harmonic-distortion meter for that if you reduce output to just the point at which clipping begins. In that case, adjust for minimum distortion.

A word of caution—some earlier amplifiers don't take kindly to being driven into clipping, and may be damaged. I've never had that problem with a unit that was operating properly, but it's good policy not to keep any amp in the clipping region longer than is absolutely necessary.

When you've completed the bias and symmetry adjustments, you should go back and do them again. That is necessary because those adjustments sometimes interact.

No specifications

So far, we've assumed that the specifications needed to make those adjustments are available. As most of you know, that is not always the case. Fortunately there are some rules of thumb that can be used when the exact specifications are not available. First of all, the bias should almost never exceed 50 mA. As a matter of fact, 30 mA is a safer figure for most mid-powered amps. For the dynamic adjustment, simply trim the bias for a minimum crossover notch. Use the scope to find that, and remember to take into account those maximum bias figures we just stated. Don't use the harmonic-distortion-meter/voltmeter here to avoid any distortion caused by the output stages of those instruments.

Symmetry adjustments are straightforward. You don't need any service data for them, assuming, of course, that

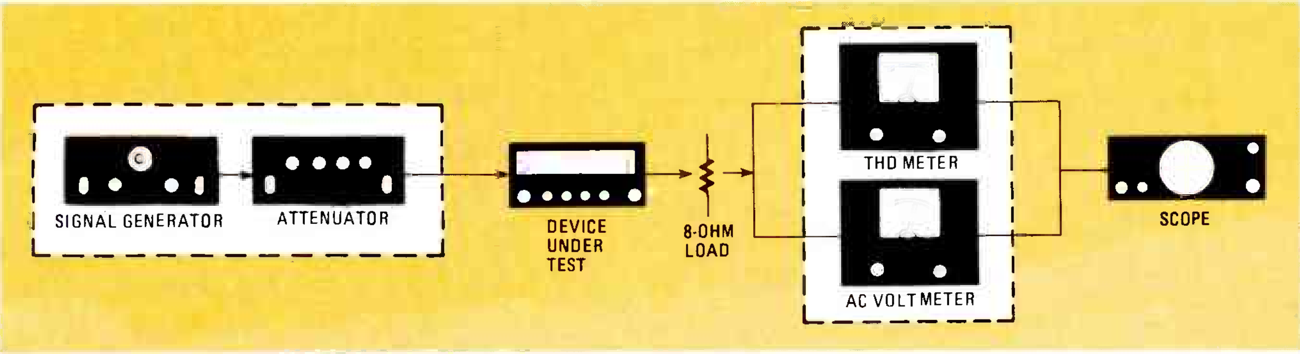


FIG. 3—THE SETUP USED for dynamic bias adjustments. Note that the devices grouped together by the dashed boxes are often found in a single instrument.

you can identify the trimmers. If you can't, remember that the bias trimmer usually has a low resistance, around 500 ohms, while the symmetry trimmer is generally more than 5000 ohms.

When all adjustments have been completed satisfactorily, let the device burn-in for a while to insure that thermal runaway or excessive heat-dissipation does not occur. At idle, the output transistors should get warm, not hot.

A simple technique

The method I have outlined is the best way to make those adjustments. However, the hobbyist or technician who only occasionally repairs audio gear is not likely to own, or have access to, that equipment. If that is your situation, here is an alternate method that requires only a service-grade audio generator and an oscilloscope.

Fortunately for us, the type of distortion produced by the typical service-grade audio generator is not crossover distortion, since most of them don't have Class-B output sections. That means we can obtain a quick, relative measurement of the crossover notch using a scope, and adjust the bias for the minimum distortion that is commensurate with a practical bias level.

The same test frequency and power level—20 kHz at 250 milliwatts across an 8-ohm load—are used, but this time the output of the terminated amplifier is fed directly to the scope. Vertical scope-gain is set to give a trace that excludes the tips of the sine wave. That allows us to concentrate on the zero-crossing point, where crossover distortion occurs. With the quiescent bias set at a minimum, you will see the notch in most cases. As the quiescent bias is increased, the notch will become smaller, or disappear. Just remember the guidelines for maximum bias outlined earlier. Sometimes you won't see a notch—that's great! Crossover distortion is no problem then, and quiescent bias can be set using the static technique.

While the method outlined here cannot give absolute measurements, it is quite effective, it certainly is useful for those not equipped with expensive, high-quality test gear.

The bias and symmetry adjustments that we've covered here are useful and important procedures. It does not take much time to make those adjustments, and, in any case, they should be done to retain high-fidelity performance. **R-E**

What's News

Supreme Court asked to protect videotapers

Sony Corporation of America has petitioned the Supreme Court to review the widely criticized decision of a California court that would make it an offense for videotape-recorder owners to tape TV programs in their own homes. According to the decision of the U.S. Court of Appeals for the Ninth Circuit, that would be a violation of Federal copyright law.

The decision resulted from a suit brought in 1976 by Universal City Studios and Walt Disney Productions. Up to the time of the decision, the right of the home recorder to copy anything off the air was unchallenged, as long as no attempt was made to sell or otherwise commercialize the recordings.

Universal has sued 43 manufacturers, distributors, and advertisers of home videotape equipment—in effect, the whole home-video recording industry.

Since the main object of the buyer of a videocassette recorder is to tape programs off the air, the ruling might ruin the industry. Sony says: "Billions of dollars in sales and thousands of U.S. jobs will be threatened if the decision stands." Furthermore, Sony pointed out in its petition, "Universal and Disney admitted that they had suffered no damage, and they could not show that home recording would reduce the potential market for their productions."

3-degree spacing urged between satellites

RCA American Communications, Inc. (Americom) has come out in favor of a three-degree spacing between communications satellites in stationary orbit. That is in response to widespread discussion of the subject, and specifically, to an FCC request for comment.

Americom also stated that it supports positioning satellites 2 degrees apart eventually.

Reducing the distance between orbiting spacecraft will provide a larger number of "slots" to accommodate the satellites expected in the near future. The present spacing of satellites serving the United States is 4 degrees—approximately 1,800 miles apart. Those are spaced on an arc 22,300 miles above the equator, between 70 and 143 degrees West longitude.

To achieve the long-term objective of 2-degree spacing, RCA Americon recommends:

1. Adoption of uniform standards, to apply to all satellites authorized for future construction;
2. Adoption of uniform standards for earth stations, to permit them to operate in a 2-degree environment.
3. A strong inter-carrier cooperative effort aimed at a phased reduction to 2-degree spacing.

New silicon MESFET's operate at 3 GHz

General Electric scientists report that they have achieved output of 0.6 watts at three gigahetz with silicon-on-sapphire MESFET's (*M*etal *S*emiconductor *F*ield-*E*ffect *T*ransistors).

Efficiency was 50 percent. That is the highest power and efficiency recorded for a silicon device of that type that can be used in a monolithic microwave circuit.

Such microwave circuits are now being developed actively in many laboratories. But most of the work centers around gallium arsenide as the semiconductor material. Gallium arsenide is expensive, and its processing is complex. The GE scientists believe that silicon can perform well up to at least four gigahertz.

MESFET performance is determined—in addition to its intrinsic semiconductor properties—by the device structure. The gate length and width are important factors. The shorter the gate, the higher the frequency with useful gain; the wider the gate, the greater the power handling capability. In the new silicon-on-sapphire MESFET, the gate length is only one micron; the width more than 3200 microns. The gain is 7 dB at 3 GHz. The researchers believe that silicon MESFET's with even wider gates may be practical, offering outputs of several watts while retaining their high efficiency.

ALL ABOUT PULSE GENERATORS

PULSE GENERATORS ARE VERY SIMILAR to function generators in that they are fairly simple instruments that can be made more powerful and versatile by adding special features. We'll look at some of those special features, but first, let's continue our discussion of pulse-generator characteristics.

Output amplifier characteristics

The output-amplifier characteristics are primarily associated with the output-signal amplitude. The maximum output amplitude is usually specified under two conditions: with no load and with the amplifier terminated into a load that is equal to its characteristic impedance. Typical maximum outputs range from 5 to 10 volts.

Output-attenuator specifications indicate the minimum voltage from the pulse generator. A few low-priced pulse generators include a step attenuator that permits a 10:1 adjustment of output amplitude by using a variable control, plus additional switch-selected decade reductions in output amplitude. Frequently, other pulse-characteristic specifications are limited to situations dealing with either the maximum output from the variable attenuator, or with the variable attenuator at some major percentage of full output. Almost always the specifications do not hold at the extreme low-level limits of the continuously variable attenuator.

With the exception of very high voltage units, which are not low cost, pulse generators have a 50-ohm output impedance. Most pulse generators provide both positive and negative outputs. Those outputs are usually taken from a single output connector; the polarity of the output is switch-selected. Some units offer separate variable attenuators and output connectors for the positive and negative outputs. A positive-only output is found only on very low-cost generators.

The pulse baseline offset is a variable control that lets you offset the pulse baseline by some DC voltage. Typically, the offset is limited to a maximum of ±20% of the maximum pulse amplitude. Few low-cost pulse generators offer pulse baseline offset.

Most pulse generators protect the output from damage caused by any possible generator settings or short circuits. However, few pulse-generator outputs are protected from an external signal that is greater than the maximum output amplitude.

Trigger or synchronization output

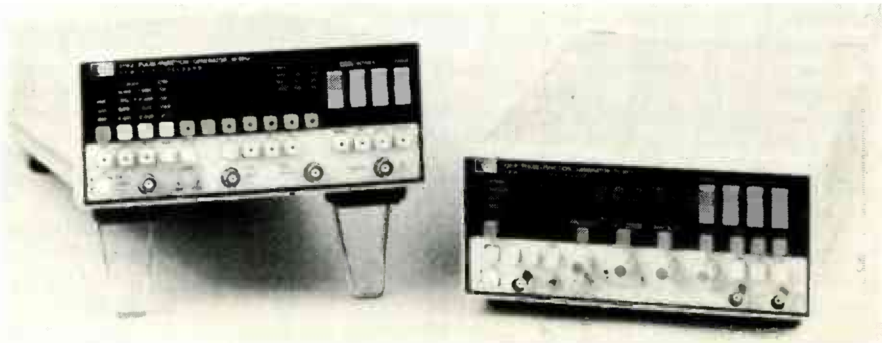
As noted earlier, pulse generators that include a delay generator have a special mode in which an additional pulse is output. That additional pulse is derived from either the trigger circuitry or the basic pulse-rate generator. The purpose of that output is to signal devices outside the pulse generator that a pulse is about to be generated. Frequently, that pulse precedes the generation of the main pulse by 20 to 40 nanoseconds, thus permitting an oscilloscope or other device to start operating on the incoming pulse. The specifications for that additional pulse, called a trigger or synchronization output, include amplitude (usually in the range of 2.5 to 5 volts); source impedance (usually 50 ohms, although 500- or 1000-ohm impedances are not uncommon); pulse width, and waveshape. On some pulse generators, the trigger output consists of a narrow pulse. Other pulse generators provide a square wave. In either case, a particular edge is used as the trigger edge; the other edge of the waveform has no significance.

Externally triggered mode

The specifications for many pulse generators change slightly when the unit is operated in the externally triggered mode. The repetition rate of most pulse generators extends down to DC when they are in the externally triggered mode. However, some pulse generators are AC-coupled in the externally triggered mode and, although the repetition rate may be quite slow, a minimum rise-time signal must be applied to the external input for triggering to take place. Other specifications pertaining to the external-trigger input include the minimum pulse width that can be used for external triggering. Most pulse generators require a minimum-pulse width of 15 nanoseconds. The minimum-pulse amplitude required to trigger the external input of a pulse generator may vary widely from generator to generator. In more sophisticated generators, a pulse amplitude of a few tenths of a volt can be used to trigger the external input successfully; low-cost generators may require pulses in the 3- to 5-volt range for successful triggering. Another specification gives the maximum amplitude that may be used for external-triggering input. The input impedance of an external trigger may run from 50- to 100,000-ohms or more. Another specification indicates whether triggering occurs at the leading or trailing edge.

Double pulse control

We've already discussed one of the



THESE COMPACT UNITS, the *model 8116A* (left) and *model 8111A* (right) from Hewlett Packard, offer the features of a function generator, as well as a pulse generator, in a single device.

One of the big reasons why pulse generators have become so popular is that they are very useful in troubleshooting digital circuits. How they are used for that is just one of the topics we'll cover this month.

CHARLES GILMORE

special features found on many pulse generators—double pulses (see part 1 of this article in the March 1982 issue). Double pulses can be obtained by triggering the pulse generator first from the main repetition-rate generator, and then from the delay generator. In addition to triggering external devices, the double-pulse feature is useful for generating signals whose frequency is twice the repetition rate indicated. The delay generator controls the pulse separation. The basic repetition rate is twice that of the repetition-rate generator; however, the pulse-to-pulse spacing may not be equal unless the delay generator is set to exactly one-half the repetition rate. There is some minimum spacing that must be maintained so that two distinct pulses are produced. Spacings that are below that minimum can result in just a single pulse being output.

The double-pulse feature is also useful for testing logic IC's. Pulse resolution refers to the minimum spacing between input pulses that will permit the IC to respond correctly. That means that the double-pulse feature can be used for determining the pulse resolution of the IC.

Gating

Gating, found on several low-cost pulse generators, basically permits you to generate a pulse burst. The length of the burst is controlled externally. There are two types of gate controls—synchronous and asynchronous.

In the synchronous mode, the gating signal is used to control the repetition-rate generator directly. That is, the repetition-rate generator is turned on and off by the gating signal. When the gating signal is turned on, the repetition-rate generator turns on and the pulse generator creates signals that are synchronized exactly to the gating signal.

When used in the asynchronous mode, the repetition-rate generator runs freely. The output of the repetition-rate generator is turned on and off by the gating signal, and therefore, the pulse-generator output is not synchronized to the gating signal. Asynchronous gating assures more uniformity from pulse period to pulse period, especially within the first few pulses of the gating interval; however that uniformity is achieved by sacrificing synchronization.

The gating amplifier's input requirements vary considerably from generator to generator. In some units, a positive voltage above a certain threshold is required to gate the pulse repetition-rate generator. In other generators, when an impedance that is lower than a certain value is connected from the gating input to ground, the output pulse is cut off.

Pulse-burst mode

The pulse-burst mode found on some generators lets you preset an internal counter, by using thumbwheel switches. When the pulse-burst mode is used, each pulse is counted, and when the count equals the preset value in the counter, no more pulses are output. That is particularly useful for checking the accuracy of counters and similar instruments.

Square-wave mode

With most pulse generators, a square-wave output must be established. That is done by adjusting the repetition-rate control and the pulse-width control. If the pulse-repetition rate is adjusted, a new pulse-width control setting is required to maintain a square-wave output. Some pulse generators come with a special switch setting that allows the pulse generator to be operated in a square-wave mode. When operated in that mode, the output maintains a 50% duty cycle at all repetition-rate settings, regardless of the pulse-width control setting.

Variable risetime and falltime

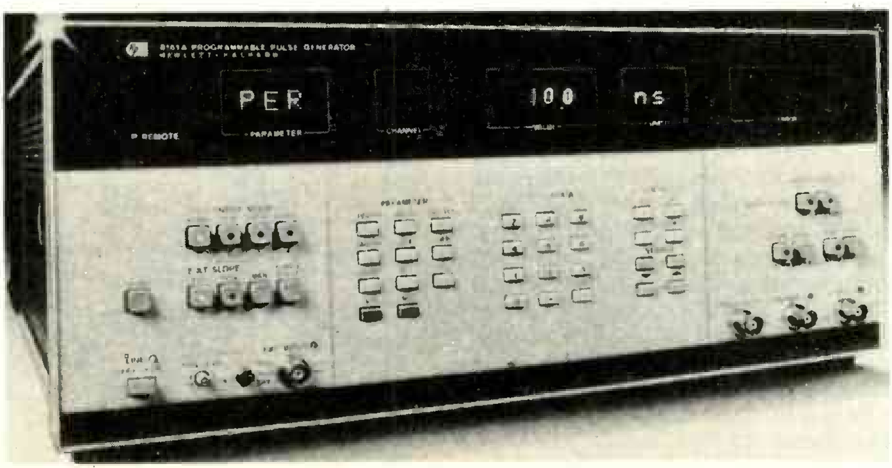
The ability to vary the risetime and falltime of a pulse is often convenient during device testing. In generators having that capability, the output risetime and falltime can be adjusted until the device under test stops. The risetime and falltime that causes that can then be determined. Variable risetimes and falltimes are available only on more expensive generators.

Complementing output

Complementing the output lets a pulse generator that normally produces a positive pulse with a 25% duty cycle produce one with a 75% duty cycle. That, of course, lets a pulse generator output a pulse with a very high duty-cycle.

Output connectors

The most common output connector for use with pulse generators is a BNC connector. A few of the older, high-voltage, vacuum-tube pulse generators have binding posts, but that type of connector is not suitable for handling high-frequency outputs. Pulse generators manufactured by General Radio, and by a few other companies, use a special connector known as the GR connector. The GR connector has a constant impedance that adds virtually no aberrations to the output pulse. Its



INTENDED FOR USE in high-technology applications, the *model 8161A* from Hewlett Packard offers a 100-MHz repetition rate, 5-volt maximum amplitude, and dual-channel capacity (optional).

main disadvantages are its expense and general unavailability. The quality of most available low-cost generators, however, does not warrant the use of that connector.

Applications

As we've seen, there are many special features that can be added to the basic pulse generator to make it more versatile. That is one reason why a pulse generator is such a useful device, with more possible applications than we can reasonably discuss here. However, we will look at some of the basic applications for a pulse generator, especially those that are rather general in nature and can help us understand some of the more special and complicated applications.

Testing IC logic

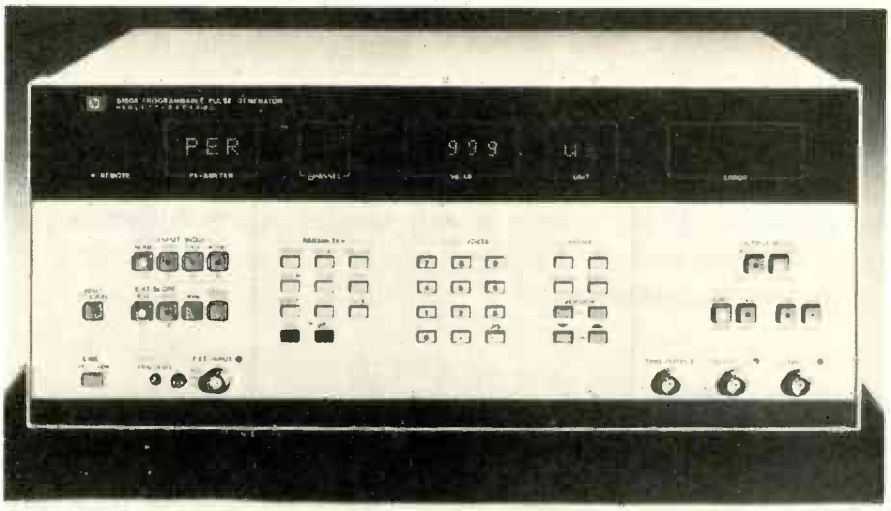
There are three different types of tests that can be performed on logic IC's: they are functional, DC, and AC tests. Functional testing is probably the most commonly used in servicing; the DC and AC tests are more likely to be performed in industrial, production, or research-and-development situations, although they certainly are not confined to those situations.

The functional test simply determines if the IC performs to its truth-table definitions. For most combinational logic IC's (gates, inverters, decoders, encoders, multiplexers, etc.), an adequate functional-test setup will consist of a socket, power supply, some way to check the state of the outputs (i.e., whether the pin or pins are logic 1 or logic 0), and some way to switch the inputs to either a signal source or ground. A pulse generator is by far the best signal source to use when doing functional tests on sequential-logic IC's. In such a setup, a series of pulses from a pulse generator can be used to step an IC through its various states. An oscilloscope or logic monitor can be hooked up to the IC's outputs so that those states can be monitored.

When a pulse generator is used to perform a functional test on saturating logic, the baseline of the generator should be at 0 volts, and the pulse amplitude should be set well above the minimum for logic 1. The object is to see if the IC functions in accordance with its truth table.

In most cases, a simple functional test is all that will be required, since logic IC's rarely fail to meet their other specifications (such as logic-voltage levels, fan-ins and fan-outs, etc.), and even if they do, most logic IC's have a built-in safety factor that will often allow them to continue to operate. However, that is not the case if one of the inputs of a gated fails to operate.

Testing the DC parameters of an IC is usually required only if functional



HEWLETT PACKARD'S *MODEL 8160A* programmable pulse generator features a delay generator, pulse-burst mode, double pulses, as well as optional dual-channel capability.

testing indicates that the IC is following its truth-table, but the circuit is still not operating. If replacing the suspected IC with another causes the circuit to operate properly, a failure to meet either the DC- or AC-voltage parameters is likely to be the cause of the problem.

The DC-voltage parameters of a logic IC are: the maximum DC voltage accepted by an input as a logic 0; the minimum DC voltage accepted by an input as a logic 1; the maximum DC output at logic 0 into full load, and the minimum logic 1 output-voltage level under full load. Other DC parameters that are not quite as important, but can still cause circuit problems, are: maximum power-supply current; maximum output-current supplied by the IC into a short at logic 1, and the IC's ability to operate at the minimum or maximum supply voltage. All that can be tested using a generator with DC-offset.

A close examination of input and output parameters using an oscilloscope is necessary to determine the proper signal level. When testing DC parameters, it is important to set the pulse-generator repetition rate significantly lower (by at least two orders of magnitude) than the maximum operating speed of the logic circuits. Similarly, the pulse width used for testing must be significantly longer (again, by at least two orders of magnitude) than the minimum pulse width that can be handled by the IC family. A good rule-of-thumb to follow when setting the pulse-generator parameters is to use the lowest possible repetition rate that will permit flicker-free oscilloscope readings. Then, adjust the pulse width for approximately a 50% duty cycle. Information on DC-parameter measurement can usually be found in manufacturer's IC data books.

If the IC will be used in a relatively high-frequency application, especially if used at or near its maximum rated frequency, failure to operate may be due to a problem involving the AC parameters. Again, the manufacturer's data handbook contains the method and the specifications for AC parameter measurement. Depending on which logic family is used, a fairly complex pulse generator is likely to be required, along with a sophisticated dual-trace oscilloscope. Some AC parameters are: minimum and maximum input risetimes; minimum and maximum output risetimes and falltimes; propagation delays through the IC, and maximum repetition-rates. When making those tests on TTL logic, a pulse generator with good risetime specifications (on the order of 5 to 10 nanoseconds), a repetition rate of 20 to 40 MHz, and DC offset are the minimum requirements. With ECL and Schottky TTL circuits, it is impossible to measure those AC parameters using a low-cost pulse generator. With MOS and CMOS circuitry, AC parameter measurements can be made using a 10-MHz generator with DC-offset capability and risetimes as great as 10 to 20 nanoseconds. The oscilloscope must be able to measure risetimes of 10 to 40 nanoseconds.

In the next part of this series, we'll continue our look at how to use pulse generators by showing you the proper way to connect them to a circuit. **R-E**

"Hold it! I ordered two MICRO farad!"

HOBBY CORNER

Getting youngsters started in electronics

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

HOW MANY TIMES HAVE YOU HAD youngsters come up and ask such questions as *"What 'cha doin'?", "What's that?", "How does that work?", "Why are you putting that wire there?", "Can I do that?....Can I help?"*, etc., etc.? If you are like most of us, you've had these questions thrown at you plenty of times. Perhaps it was your son or daughter, a neighbor's child, or your grandchild.

Sometimes you are so busy that you just mumble some answer or suggest that the questioner go play outside. There are times, however, when you need a change of pace or you feel guilty about brushing aside a perfectly legitimate question. On those occasions, what do you do? From the mail we receive, at least some of you try to teach them the rudiments of electronics. You start by teaching electricity. And there's the rub.

Have you ever tried to start at ground zero with one of those kits that are available for teaching/learning electricity? You know, the type with components mounted on individual rectangular blocks. The kits are convenient; there are a lot of parts and they are easy to interconnect.

Those learning kits are fine for those youngsters who have *already* learned something. But kids with absolutely no background tend to be confused by them. Often, the parts may be too small or it may not be clear exactly what is happening on those blocks. For example, a child can't see what is really going on inside a doorbell-type switch. He needs a few old-fashioned, simple parts that clarify rather than confuse.

Figures 1 through 4 show just such parts that you can build easily. They can be used to teach a lot about electricity as a prelude to electronics. Since those parts are easy to use, children find that playing with them is fun and they learn without even trying. Before we get into them, however, it should be mentioned that a child can learn a great deal if you let him help you do the building.

Figure 1 shows the "power supply." It is a simple battery holder and the child understands it much better than he does the metal one from the parts store. The holder is nothing more than a rectangular piece of wood with two wood side railings to keep the battery from rolling off.

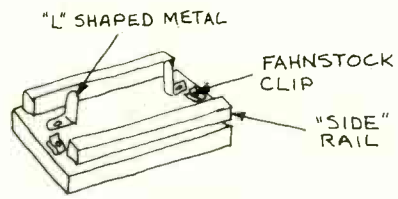


FIG. 1

The rails are attached with small nails or brads, glue, or both. The battery connections are made using two metal strips shaped like an "L". They are fastened to the base with small wood screws that also hold Fahnestock clips for inter-block wiring. Be sure to file the metal strips to remove any sharp edges.

I suggest that you make at least two battery holders; one for each cell. In that way, series and parallel supplies can be "discovered." Of course, you can also blow out more lamps that way.

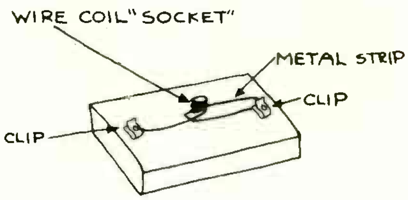


FIG. 2

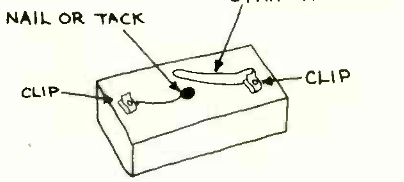


FIG. 3

Next, make a couple of lamp holders as shown in Fig. 2. The center connection is made using a flat metal strip. The "socket" is a piece of stiff copper wire wound around the lamp thread (actually, lamps can be screwed into and out of the coil). The connection to the tip of the lamp is made by springing it against a flat metal strip. Of course, you can use a real socket if it is a plain, non-encased one so that the inner workings can be observed. If you make at least two lamp holders, then you will have the opportunity to get into series and parallel circuits.

No setup would be complete without a switch to turn things on and off. Resist the temptation to stick a regular single-pole, single-throw (SPST) switch on the board. No one can see what is happening in that thing when the handle is pushed. Instead, use a strip of metal as shown in Fig. 3. If you are lucky enough to find an old "knife" switch, that will do the job quite well too.

Well, there you are with a few components that you have made in a short time. All you need to add are a couple of batteries, a couple of 1.5- and 3-volt flashlight bulbs, and a few strips of wire. With little or no further help from you, the child can learn a lot about how electricity works. About all you really need to do is to supply a few terms at the appropriate times: voltage, current, resistance, series, parallel, and the like.

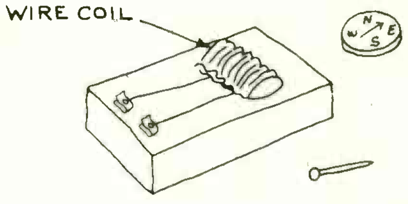


FIG. 4

When the time is ripe, you can add other parts to that electricity "lab." Figure 4 shows a coil of wire, a compass, and a nail. It doesn't take much imagination to see how much information about electromagnetism can be picked up with those items.

Just to keep your creative juices flowing, you can also build a module with a doorbell buzzer. Be sure to remove the cover so that the coils and contacts can be observed. Later on, you can add such things as an open-frame motor and a meter. (Use a panel meter housed in a clear plastic case. Remember, we don't want to have *any* mysterious items.)

As the student's knowledge grows, you can add more sophisticated things. Of course, he will soon get to the stage where he can profitably use one of the many learning lab kits already on the market. Eventually, he (or she) may even be able to help you troubleshoot

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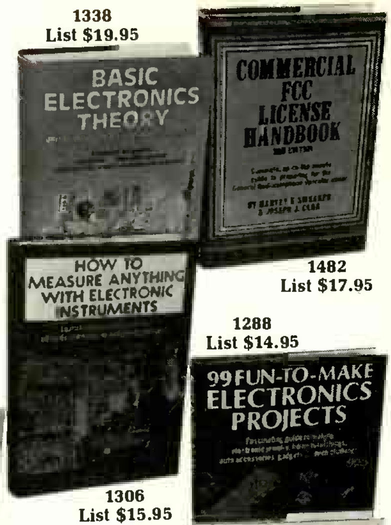

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Time—by the stars

You will recall that we have talked now and again about various ways of keeping sidereal (star) time. The ways discussed varied from relatively simple modifications of standard clocks to fairly complex ones. Now, I have one more method for you.

If you have a computer (and who doesn't have one, or, at least, have a friend with one?) there is a *TRS-80* Level II BASIC program that will give you the exact sidereal time at your house, and in Greenwich, and throw in the Julian date as a bonus.

To find the time, all you have to do is load the program and follow the instructions. Those instructions are complete and there is a tutorial section that "walks" you through a computation session. Of course, you can bypass the tutorial when you no longer need it. You must enter five pieces of readily available information—location, time, and the like. The computer does the rest.

That program, Sidereal Time, is available from Becker Electronics (108 West Franklin St., Chapel Hill, NC 27514). When you contact those folks, you may want to ask about some of their weather-related programs.

Puzzles, anyone

A number of readers have asked for more puzzles of the type you saw here a few years ago. Remember the mystery light box and the light that was bright when it "should" have been dim? I don't know why both puzzles involved lights, but it must have been coincidental.

In any case, some of you want more mysteries and I am fresh out of them. If you know of something relatively simple (at least in appearance) yet puzzling, send it along. We'll publish the best ones we receive and see if some of our other readers can figure it out. Who knows? You, may get a cross-country call from a room full of engineers saying, "It ain't possible!" R-E

"Whatta ya mean, 'That's a catchy tune?'"

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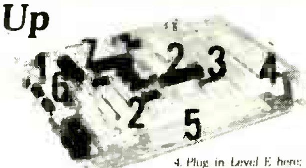

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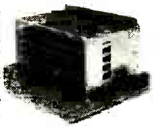

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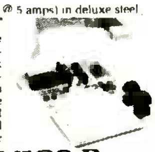

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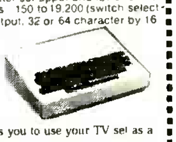

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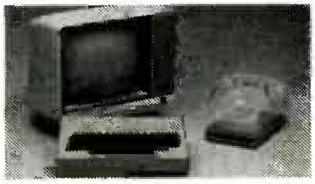

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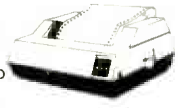

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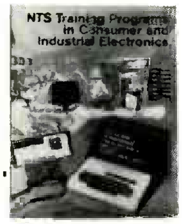

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COMMUNICATIONS CORNER

A digital-delay system for communications

HERB FRIEDMAN, COMMUNICATIONS EDITOR

EVEN AFTER YEARS OF RECORDING EXperience, it still takes studio technicians some time to adjust to the disorientation caused by hearing a performer's voice a few seconds after his lips have moved. If you are not used to that loss of "lip sync," your first experience with it can be particularly discomforting. What causes it, of course, is tape-playback delay; it can be rather amusing once you get over the initial shock.

But what about hearing sound *before* the performer's lips moved? Imagine if you will, a romantic scene in a movie—the male lead looks deeply into his girl's eyes, and through clenched teeth whispers "I love you!," followed by dead silence while he yawns. That used to happen in the old movie houses of thirty and forty years ago; the well-worn film sprockets of their broken-down projectors would lose the sound loop, and the sound would precede the action. I often heard the shot of Gene Autry's gun before it even cleared the holster. (I always wondered how come he didn't hop around after blasting himself in the foot!)

While we've come a long way from those early projectors that literally chewed up film, and we now use computerized continuous-loop film projectors, we have not entirely eliminated sound that precedes the action; we simply do it with high technology and use a satellite to mess things up.

Until recently, television programs were relayed using two modes: the video was sent by satellite and the audio by landline (telephone). The signals were recombined at the receiving end of the relay circuit. There were several reasons why that was done; among them were cost and problems with digitizing the audio. Today, both the video and audio television signals are sent primarily by satellite, but for certain applications, such as teleconferencing, it's still less expensive to use the older technique.

The only problem with splitting the signals, however, is that the audio gets where it's going ahead of the video, because the video travels a longer path. Let's take a look at Fig. 1. As you can see, the video must not only travel up to the satellite, it must also travel back down to the receiving station. The audio, on the other hand, travels a much shorter path (even if you account for the fact that the path is unlikely to be a straight line). The difference is usually great enough that the audio will arrive at the destination slightly ahead of the video, even though both are traveling at the speed of light. How much the video is delayed will vary with the difference in length of the two paths, although 250 milliseconds is considered average. Although that may not sound like much, it's enough to be disconcerting—the cowboy's gun will again be firing before it clears the holster.

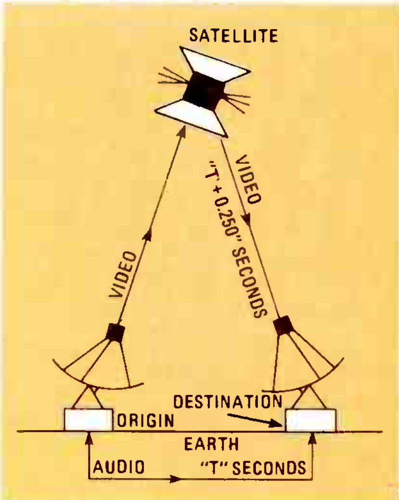

FIG. 1

FIG. 2

One way to eliminate that problem is to delay the audio somehow so that it arrives at the same time as the video. That can be done using a computerized digital delay such as the *model BD955* digital delay-line from Eventide Clockworks (265 West 54th St., New York, NY 10019) shown in Fig. 2.

That device was not originally intended for use with satellite-TV (although they presently manufacture equipment specifically for that application). Its primary purpose was to delay the broadcast of call-in-type radio programs; a problem with those shows is that sometimes the callers try to say things they shouldn't. Many radio stations protect themselves (if an obscenity is broadcast, the station, not the caller, would be in trouble with the FCC) by using a tape-loop delay device. The program is recorded on a 7-second tape loop. The recorder's playback head is located right before the erase head, rather than after the record head. The signal to the transmitter is taken from the playback head rather than fed "live." That introduced a 7-second delay between the live action, and the broadcast; enough time to interrupt the show if something embarrassing is said. After the recording is broadcast, the tape is erased and reused.

As you might expect, the whole procedure, including the durability of the tape loop and mechanism, leaves something to be desired. The obvious solution is to use a digital delay.

A block diagram of the Eventide delay is shown in Fig. 3. In that system, the audio is first digitized, and then entered into a memory. As successive pieces of the audio signal are entered, the first entry is pushed along, bucket-brigade fashion, until it appears at the memory's output. The output signal can be taken from different points along bucket-brigade memory. The actual point where the output is taken determines the amount of delay. The memory output is then fed to a D/A converter, eventually producing an analog output that's an exact replica of the input, only delayed.

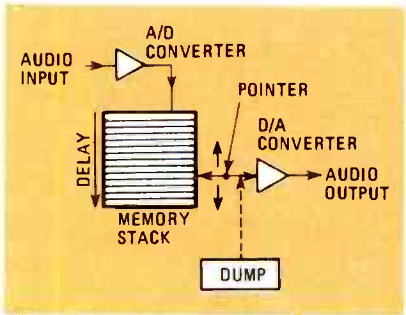

FIG. 3

In that particular system, the amount of delay is set at 6.2 seconds for radio

"talk-show" applications. A MANUAL DELAY control lets you adjust that to suit various other applications. The proper setting for a 250-millisecond delay (for satellite applications) is clearly marked.

Let's get back to how that device is used in radio. At this point you should be asking how the radio station gets rid of an undesirable phone call. That is where the dump function comes in. On the front panel there is a switch labeled DUMP when pressed it instantly flushes the memory of all data and sets the delay to zero. An internal relay then disconnects the phone call.

As the announcer, now broadcast live, talks, the digital-delay line begins to advance the read pointer slowly, actually stretching the waveform. It is done so slowly and efficiently that it is unnoticeable on speech; only a trained listener would detect the change with music. After about 1 minute or so—time that could be filled with a commercial or some comments from the announcer—the delay has built back to its full 6.2 seconds, without anyone noticing.

There you have it. In case you are wondering, the sound quality of digitized audio is very good. Two versions of the unit are available. One, with a response of 7500 Hz is for AM or telephone applications; the high-fidelity version has a 15-kHz response. **R-E**

A look at data base management

LES SPINDLE*

FILE CABINETS HAVE NOT YET EXACTLY gone the way of the dinosaur, but their use as office tools has certainly been curtailed by the microcomputer. In the early days of business microcomputing, considerable programming skill was needed to achieve a truly interactive filing system. Programs for payroll, inventory, employee, payables/receivables, and general ledger were all great aids in keeping track of office records, but each was essentially an entity unto itself. If the payroll file required access to data from the employee file, followed by subsequent calculations, for instance, several extra steps and time-consuming data-entry procedures were required.

A recent development has improved that situation substantially. System designers have engineered an advanced software tool to integrate miscellaneous file-manipulation activities into one software program: the data-base management system (DBMS).

A DBMS software program goes a considerable distance beyond the mere cataloging of various information categories—it actually manages and processes data interactively among the various separate files. With the instantaneous acquisition of required data—and simultaneous updating of one file by another—the DBMS approach represents a big advancement over the use of isolated file programs.

The accompanying figure shows just how much of an improvement it is. In the older file-handling setups, payroll, accountings, and inventory files interacted among themselves to keep data current, but couldn't automatically interface with one another's transactions. In the DBMS configuration (see Fig. 1), all data records are centralized in one main data base that is processed by the DBMS programs, then interfaced with the various accounting programs in use to perform all of the individual functions required of each program.

After purchase of a commercial DBMS program, the software is set up to meet your specific needs. First, it must be decided which categories the system should include, how the main category is to be taken down into sub-units, and how the data is to be sorted. Once the system is established, most DBMS programs are highly tutorial in nature, prompting the user with instructions, preventing accidental data erasure and helping with debugging.

The essential setting up of a file is quite simple. A record, or major category, is established. Then fields, which are sub-divisions within a record, are defined. The fields and records work together to access any necessary data

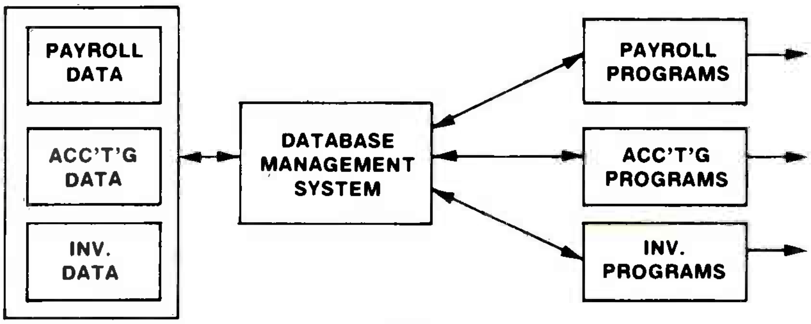

FIG. 1

TABLE 1
SOME DBMS PACKAGE OPTIONS

Manufacturer	Name of package	Compatible system(s)	Price (or range)*
Bottom Shelf Box 49104 Atlanta, GA 30359	Data Manager	TRS-80	$75
Compco 8705 N. Port Washington Rd. Milwaukee, WI 53217	Datastar	any CP/M-based (2.2)	$350
Condor Computer Corp. 3938 Research Park St. Ann Arbor, MI 48107	Series 20/DBMS	any CP/M-based (2.2)	n/a
High Technology, Inc. Box 14665 Oklahoma City, OK 73113	Data Base Management System	Apple II Plus	$100
Microdata Base Systems Box 248 Lafayette, IN 47902	Data Base Management System	Apple II, North Star Horizon, TRS-80, any 2.2 CP/M or OASIS-based	$420
Personal Software 1330 Bordeaux Dr. Sunnyvale, CA 94086	CCA Data Management System	Apple II, TRS-80	$75
Softwarehouse, Inc. 695 E. Tenth N. Logan, UT 84321	Databank	any CP/M 2.2-based	$200

n/a - information not available; check with dealer
*prices are subject to change

*Managing Editor, *Interface Age* magazine.

VIDEO 100

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- 12 MHz band width
- Plug-in compatible with most personal computers
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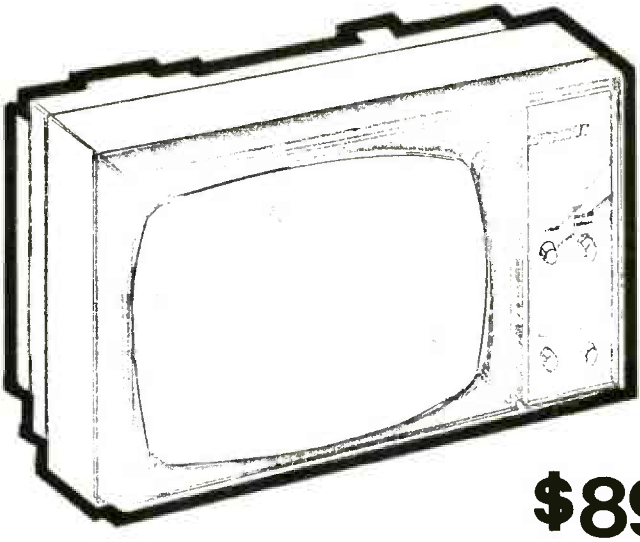
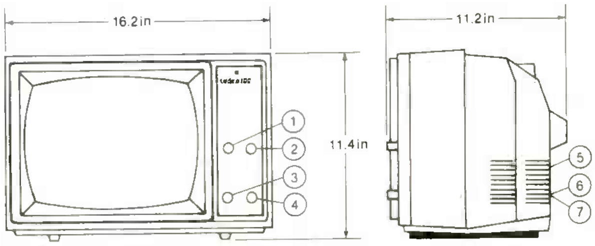


$89.50

ITEM	SPECIFICATIONS
CRT	12″ diag. 90° defl.
CRT Phosphor	P-4
Signal	Composite video input
Input Signal	1.0Vp-p, sync negative
Input Impedance	75 ohms
Scan Frequencies	Horizontal: 15600Hz Vertical: 50/60Hz
Display Size	210 (W) x 158 (H) mm
Deflection Linerity	Horizontal: 10% Max. (refer to EIA ball Chart and dot Pattern.) Vertical 8%
Video Response	12MHz (± 6dB)
Resolution	Center: 650 Corners: 550
Power Source	120V Ac, 50/60 Hz
Dimensions	11.375″ (H) x 16.25″ (W) x 11.25 (D)
Weight	6.5Kg (14.3 Lbs.) net



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A sort function can also be set up in several different ways, based on your requirements. For instance, you may want an alphabetical listing by name. By keying in the command for a particular "sort" routine, you can have an instant printout of the necessary data, sorted to your specifications.

There are a number of DBMS programs, of varying quality, on the market. To illustrate how a typical system is set up, let's take a look at one of the better offerings—*dBASE II*, from Ashton-Tate, 3600 Wilshire Blvd., Suite 1050, Los Angeles, CA 90010. That is one of the most flexible and versatile DBMS microcomputer programs to be found.

To use *dBASE II*, the following configuration is necessary: an 8080, 8085, or Z80-based CPU, 48K bytes minimum RAM, at least one hard or floppy disk operating under CP/M, and a 24-line by 80-column CRT terminal. A text printer isn't required, but comes in handy when setting up command files.

Up to 65,535 records will fit on each data-base file, with 1,000 characters maximum on each record. Up to 32 fields are allowable per record—with up to 254 characters per field.

A versatile assortment of commands is designed with simple verbs as call words, making the program easy to use even for a novice. The CREATE command creates and copies existing files, creates report form files (for outputting records in standard formats), and links files together for exchange of information. With that system, report copies can also be saved for later use, and index files can be created.

The APPEND command allows appending data to the end of a file or inserting data to an existing file.

An EDIT mode allows altering of records and fields, and deletion of records.

The DISPLAY and LIST commands allow access to the records or fields on the format used in the set-ups.

Several positioning commands control the manner in which the record pointer is positioned in the field; those commands will locate the pointer at the beginning, at some specified position, or at a position either forwards or backwards from the given position.

File-manipulation commands (SELECT, SORT, etc.) allow for file interaction. Files can be appended to one another (even files other than *dBASE II*), or they can be reorganized or interchanged, if desired.

Finally, the memory-variable commands (ACCEPT, WAIT, GET, etc.) allow pending or incomplete information to be sorted for later use in updating the records.

One feature that makes that program a particular standout among DBMS packages is its ability to function almost as a complete programming language. The various commands can be linked together for more complex manipulations, allowing versatility in adapting the program to your individual needs.

Command programs can be devised by the system developer. Those programs can be stored as command files. Upon creation of a menu, the programs are easily accessible by a simple key stroke.

Beyond that, the program is compatible with ASCII files, and can interface with other programs that you might be using on your system. Existing data bases can be easily added to the DBMS file without manually re-entering the data.

As sophisticated and innovative DBMS packages such as *dBASE II* continue to enter the market, the prospects for efficient operation get continually brighter. The DBMS concept has significantly enhanced data-processing techniques where information must be interactive as well as easily retrieved. Table 1 lists a cross section of some of the DBMS packages on the market, with compatible systems indicated. **R-E**

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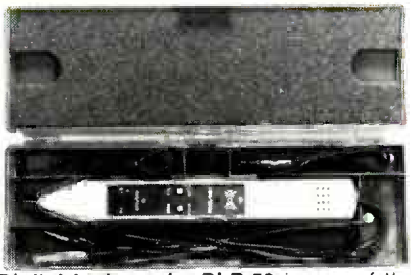

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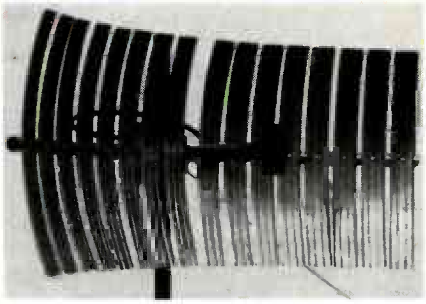

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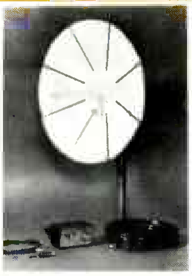

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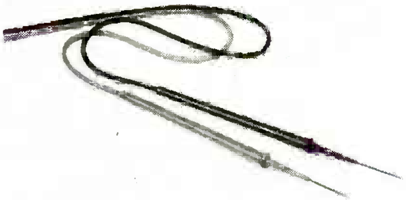

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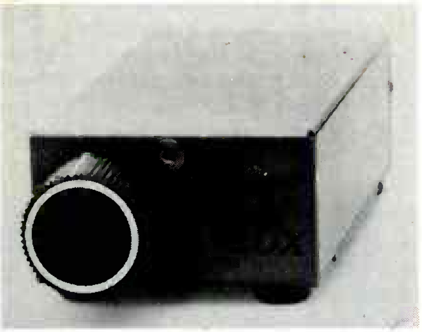

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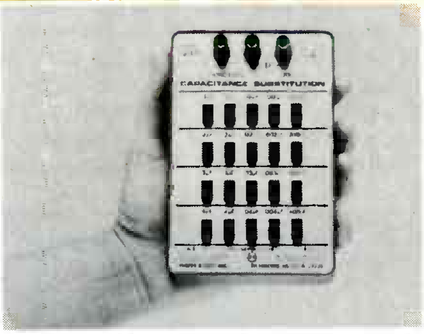

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SERVICE CLINIC

Troubleshooting sync circuits

JACK DARR, SERVICE EDITOR

EVER SINCE THE DAYS OF THOSE FIRST TV sets with their 3-inch screens, we've had sync problems. The manufacturers have learned a lot about how to design sync circuits since then, and modern sets are remarkably reliable. However, there are still occasions when a sync circuit fails to operate properly. Let's take a close look at TV sync circuits: How they work, and what to do when they don't.

Two different types of sync pulses are necessary to stabilize a TV picture. One is called the horizontal sync pulse and it is used to stabilize each line of the raster. The other is called the vertical sync pulse and is used to stabilize each field of the raster. Two vertical sync pulses are used for each frame. There are thirty frames per second and two fields per frame. Each vertical sync pulse intiates the scanning of each of those fields.

The sync pulses are generated at the TV station and must meet very rigid standards of timing, pulse shape, and pulse width. The TV set separates the vertical and horizontal sync pulses, and then feeds them to the proper deflection circuits. It sounds complex but it isn't. The horizontal sync pulses are made up of a single pulse, while the vertical sync pulses are actually made up of a number of horizontal sync pulses, that are specially shaped and spaced. That is done to keep the horizontal oscillator synchronized during the comparatively long vertical blanking interval. The horizontal and vertical sync pulses are combined at the transmitter into a single pulse train called the composite sync. It is broadcast along with the picture signal, and is known as the composite video signal. Each sync pulse rides on top of a pedestal in the video signal that is at the black level (that is the video level that produces black in the picture), and all of the sync pulses are in the "blacker-than-black" area so that they don't show up in the picture.

In practically all TV sets, the sync signal is separated from the composite video signal after the video detector. (One old chassis picked it off at the 3rd IF stage and fed it to a sync-sound detector. That circuit arrangement has disappeared.) A sample of the composite video signal is taken from the output circuit of one of the video-amplifier stages. Sometimes, it is fed through circuitry that compresses only the video portion of that signal and not the sync pulses. That signal is then fed to the input of a sync separator/clipper stage, and usually on to the AGC input. The sync separator/clipper stage is nothing more than an amplifier that is biased to the point where it will not conduct at all until the black level of the video signal is reached. Since the sync pulses are above the black level, the sync pulses are amplified and appear at the output as composite sync, which includes both the vertical and horizontal pulses.

When displayed on an oscilloscope, the composite-sync signal looks like a fuzzy bar with little pips in it. That fuzzy bar is the horizontal sync, and the pips are the vertical sync. In tube-type sets, the fuzzy bar's amplitude is about 50-60 volts peak-to-peak and in transistorized sets, the amplitude is around 15-20 volts peak-to-peak. The amplitude of that waveform should appear on all schematics, but regrettably it's only found on a few.

Now, that we have recovered that composite sync signal, the horizontal and vertical pulses must be separated and fed to their own oscillator stages. That is much easier than it sounds; its based on one of the oldest principles in electronics—the reactance of a capacitor! The composite sync signal is fed to a circuit called an integrator. Figure 1 shows that circuit. The capacitors here do the actual separating. The integrator has a series resistor with a bypass capacitor shunted to ground on each end. The values of the capacitors are large enough to shunt the high-frequency horizontal sync pulses to ground. The charge-discharge action of the R-C circuit integrates the vertical sync pulse (that is made up of horizontal sync pulses) into a smooth, sharp pulse at the vertical frequency.

The horizontal sync is separated by using an even simpler circuit; just one low-value coupling capacitor. It has such a high reactance at 60 Hz that the vertical sync doesn't even know it's there. The high-frequency horizontal sync pulses pass through it with ease and are fed to the AFC stage of the horizontal oscillator.

What if it doesn't work?

Let's see what happens when the sync circuit doesn't work, or is suspected of not working. The first question to ask is: "Is the problem being caused by the oscillator circuit or the sync circuit?" If you have a full raster in both directions that responds to the turning of the horizontal- and vertical-hold controls, but won't stand still, the oscillator circuits are OK and the problem is in the sync circuits.

You can lose either the horizontal or the vertical sync alone. If the picture is horizontally stable but floats up and down vertically, then the trouble is in the vertical sync circuit. The fact that it's horizontally stable shows that you do have at least *some* sync, but that you're losing the vertical sync somewhere between the sync separator and the input of the vertical oscillator. Scope the composite sync output of the sync-separator. If that signal is OK, then go on to the integrator circuit. If the input to that circuit is normal but its output is not, turn the set off and check the shunt capacitors for leakage and the value of the series resistor. Also check the vertical output stage. You

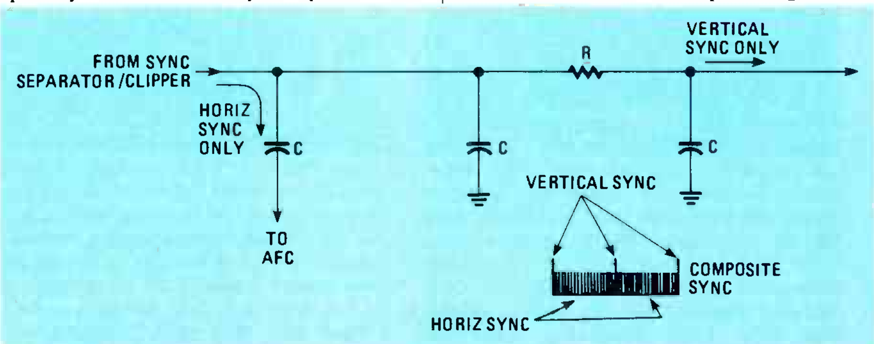


FIG. 1

may find that the last capacitor in the feedback loop that goes from the output of the vertical output stage back to the input is leaky. That can upset the bias on the vertical oscillator and cause it to act as if the sync were missing! There will usually be at least one other coupling capacitor between the integrator output and oscillator input; make sure that *it* isn't leaky as well.

Horizontal-sync problems are simpler. If you see a picture that floats from side to side, you've lost all horizontal sync (but the AFC is OK). Scope the circuit from the sync-separator output back to the AFC input to see where the sync is being lost. The low-value coupling capacitor (about 50 pF) may be open, or one of the PC-board conductors between the sync-separator output and AFC input may be open!

Vertical sync works on amplitude; horizontal sync works on phase. If the sync-separator circuit is bad, and you lose the peak-to-peak amplitude of the sync, the vertical sync will be the first to show it. Look for problems in the sync-separator circuit that could reduce gain—a weak tube, a bad resistor, a leaky transistor, etc. Make sure that the video-signal input to the sync-separator is also normal.

Quite a few sets use gated sync-separators. If you have a problem with one of those, be sure to check for the presence of the gating pulse coming from the flyback transformer. If it is missing, you'll lose all of your sync.

Some sync problems can come from other stages. For example, an AGC problem can cause sync-signal compression. Scope the video signal at the output of the video detector to make sure that you have the normal 75:25 ratio of video to sync.

Jitters

If the sync isn't clean, the picture may show vertical or horizontal jitter. Scope the sync pulses and look for any signs of movement in them. If a black-and-white signal gets into the sync-separator circuit, it'll cause jitter. Jitter is usually due to incorrect biasing of the sync-separator. One case of severe horizontal jitter was finally caught by scoping the horizontal sync pulse: instead of a sharp peak, it had a distinct "saddleback" or dual hump! That turned out to be caused by an open bypass capacitor; the horizontal oscillator was triggering first on one peak and then on the other.

Whenever you get a case of sync trouble, get out the scope first! That is the only instrument you can use for examining the critical shape of those tiny pulses, and to follow them through the circuitry to wherever they are or aren't. If all of the sync separator circuits are in an IC, be sure that you have all the proper DC voltages and video signals. If there is no sync coming out, the IC could be bad. **R-E**

SERVICE QUESTIONS

FLUTTERING PICTURE

This Zenith 25EC58 had a pulsating or fluttering picture when the brightness was turned down to the proper level. Tried many things, then I sat down and wrote you. After receiving your reply, I started to take readings around the power supply. Sure enough, it would not turn on: I forgot to tell you that I had intermittent turn-on problems with this set. Pulled the plug to the triac, and jumpered it to turn on the set. Came on very nicely, with no flutter. I replaced the opto-isolator and it works great!—*Herb Glenn, Saint Croix, Virgin Islands*

POWER-SUPPLY PROBLEM

I had an RCA CTC-81 that had violent voltage swings in the power supply. It has a ferro-resonant transformer and should not be doing that. I eventually got down to checking the opto-isolator that it used as a switch—that was the source of the problem. Everything worked fine after I replaced that unit.—*George Dyer, Yucaipa, CA*

LOSS OF HEIGHT

I've only got ¼ of a raster, vertically, on this Motorola TS-584. The vertical hold control works fine, and everything in the output circuit seems to be fine. Can you help?—R.A., Wichita, KS

Have a look at this: There is a voltage-dependent resistor connected across the primary of the vertical-output transformer—remove it. If you get a full raster, you've found your problem. The resistor was put there as a clamp; it holds down the sweep. If it is shorted, it may be overdoing it. You might also want to check the resistance of the primary's windings, although any shorted turns there usually cause severe distortion in the raster.

COLOR DRIFT

I've got a Sears 528.41682216 with a color problem that is giving me fits. Ran the color AFPC setup adjustment and got a good set of color bars. On a station, most of the programs look fine, except for the local ones. Sometimes people have blue faces, and so on. Any ideas?—J.O., Winthrip, MA

For one, from what you've said, your local station may be at fault. If you get good, steady color from network programming, but not on local shows, then someone at the local station may not be setting the cameras properly. That happens more often than you might think.

The problem, however, may be with your set. I see that this one has an "injection-lock" type of 3.58-MHz oscillator. Actually, what it does is to gate out the burst itself, amplify and filter it through the cyrstal, and then amplify it again to get the reference oscillator signal. Try a new crystal—but those are special, so do not use a stock type.

LOW HIGH-VOLTAGE

I've got a problem with low high-voltage on this Magnavox T-919. I get only about 15 kilovolts, even with the 6BK4's plate capacitor pulled off. The boost is +800 volts, and the boosted boost is +1200 volts. A Magnavox technician said that the cause is a bad flyback, but you've always said that if the boost and B++ are up, then the flyback is good.—S.V., Brooklyn, NY

And I'll keep right on saying it—I've verified it enough times to believe it. The flyback has several outputs—high voltage, sweep, focus, boost, etc. If even *one* of those is normal, the flyback and its associated circuitry should be fine. You've already checked quite a bit, but try this. Read the focus voltage. If it is very low or missing, it can upset the high voltage. That should be about 5 kilovolts, give or take a few hundred volts. The cause of problems here is a bad focus rectifier. If the focus is fine, try running the set for a while, then turn it off and quickly pull the 3A3 tube. If the tube is quite cool, it may not be getting enough heater voltage, perhaps due to a dirty contact in the socket, bad series resistor, etc. That could also cut the high-voltage.

PICTURE DRIFT

This Channel Master 6141 has an odd symptom. When you change the channel, the picture starts out very faint. It darkens slowly until it is overloaded, and then starts pulling and jittering. All of that takes about 10-15 seconds. I suspected the AGC, but everything there seems to check out.—J.F., Cincinnati, OH

That certainly sounds like an AGC problem. Try clamping the AGC and set it to produce a good picture. If it doesn't change, the problem must be in the AGC. (If it does, at least you've eliminated that and the IF as the source of your problems.)

The problem has all of the characteristics of a bad resistor; one that starts out at about the proper value and slowly changes as the set warms up. Heating and cooling parts around the AGC would be a good way to find the problem as, from the time it is taking for things to act up, it looks as if something is being affected by temperature.

BLUE PROBLEM

I wrote you about a sync problem I was having in this Magnavox T-920. You said it was the filter, and you were right. But now I have a convergence problem in the same set—the blue convergence doesn't have enough range and I can't get the blue line down far enough. Any ideas on this one?—S.A., Salamanca, NY

Well, if you can't get the line down far enough, try getting the line straight using the dynamic controls. If you can, all you need do is move it down with the blue vertical static-magnet.

THANKS!

In the November 1981 issue of **Radio-Electronics,** I ran a question from a reader wanting a 6HU8 tube. I couldn't help him, but there were a lot of you out there who could. In fact, so many have written in that I can't possibly answer them all. I've passed the information on to the reader, and would just like to say "thanks" to all of you who took the time to help.

TUBE REPLACEMENT

I need a substitute or replacement for a 25HX5 tube. They were used by Panasonic as vertical amplifiers in the late 60's. Can't find the listing anywhere!—P.L.S., New Paltz, NY

Interestingly enough, the answer to your question came in the same batch of letters. Mike Danish of Mike's TV in MD had asked me about the same tube. I could not help, but he wrote back to tell me that he found a source. It is Transleteronic, 1365 39th Street, Brooklyn, NY 11218. Those tubes are new and carry the Sylvania brand.

VERTICAL LINES

I wrote you about a problem I was having with a Sylvania D-12 chassis. You gave me several suggestions, including checking all of the DC voltages around the 6BL8 tube in the horizontal-regulator stage. Checked several other things first, then turned to that tube. Found that the DC voltages were off. Turns out that R114 had gone up in value and R259 had gone down in value. Replacing those cleared up all of the problems: thanks!—*H.A. Baltimore, MD*

BLACK SCREEN

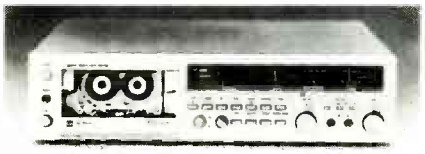
If you run into a dark-screen problem in a Sanyo 21T66, try this suggestion from John Conti of Conti's TV Service, Texas City, TX: If the screen is dark, but high voltage is present, check R901, a 1500-ohm, ½-watt resistor on the picture tube socket, with an oscilloscope. If you see video on one end but none on the other, you've found your problem. Replace that resistor and everything should be as good as new. **R-E**

NEW PRODUCTS

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

CASSETTE DECK, *Dual 844,* has a direct load-and-lock system that eliminates the door between the user and the cassette compartment. The cassette is slipped directly in place, where it is locked in perfect alignment with the tape heads. The cassette can just as easily be removed at any time, even when the tape is in motion. Photo-electric infra-red beams in the cassette compartment stop the transport when interrupted.

Only the RECORD button need be pressed to set the record mode. Accidental recording is prevented by simultaneous and automatic activation of PAUSE. Separate record and playback heads provide optimum gaps for each mode and allow for source/tape monitoring. The heads are mounted in a combined housing to maintain perfect alignment and azimuth. *Dolby B* and *Dolby C* noise-reduction systems function in both record and playback. Electronic fade/edit allows unwanted portions of recorded material to be faded out while being monitored in the playback mode.



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In addition to the standard 1⅞ ips speed, the *Dual 844* provided 3¾ ips. The faster speed results in extended frequency resonse and dynamic range, as well as improved signal-to-noise ratio.

The *Dual 844* is priced at $700.00 — **United Audio,** 120 So. Columbus Ave., Mt. Vernon, NY 10533.

INTERCOM HEADPHONES, *model TR 50/VOX,* are voice-actuated, and provide "hands free" 2-way FM communications, without wires, to any number of similar headphones within a 150-yard range.

The *model TR-50/VOX* headphones are FCC-certified and license-free. Five channels are available for operation. Each set of headphones has a built-in, crystal-controlled FM transmitter, superheterodyne receiver, standard 9-volt battery supply, and 7-inch receiving antenna. A sensitive squelch circuit drives the receiver into "quieting" during times of no transmission. Each operator hears his or her own sidetone as an indicator that transmission is taking place. Soft, foam-filled vinyl ear cushions surround the ear without pressure, and there is complete adjustability

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for individual fit. The *model TR-50/VOX* (including VOX control) is priced at $396.75. Without VOX (push-to-talk operation only), the price is $297.00—**R. Columbia Products Co., Inc.,** 2008 St. Johns Ave., Highland Park, IL 60035.

SPEAKERS, *model JansZen Z-1,* feature uniform spectral energy density (total dispersion); bi-radiating support of reverberant field; new low-mass electrostatic diaphragm; failure-free electrostatic element (nine-thousands of 1% field-re-

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ject rate); inherent overload protection without fuses or circuit-breakers, and high efficiency. The *model JansZen Z-1* is priced at $950.00 a pair.—**Janszen Electronics, Division of Soundmates,** 796 29th Ave. S.E., Minneapolis, MN 55414.

MOBILE CB ANTENNA, the *"Illuminator" model TAK-10L,* features a 5000-hour, 0.5 candlepower, 12-volt DC incandescent lamp installed in the clear molded base, thus illuminating the exclusive hollow coil form. The lamp is functional as well as decorative in that it will fail to light unless the antenna is grounded properly for optimum performance.

The *model TAK-10L* also introduces *Clear-Flex* (RG58-AU) clear coax cable. Included are 18 feet of the cable with an in-line coax connector. An additional lamp circuit lead provides for easy hook-up to a vehicle's tail light or running lights; thus, the *"Illuminator"* lights up only when the vehicle lights are on.

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The *model TAK-10L* has a suggested retail price of $54.95, complete with mounting hardware.—**Armstrong Industries,** Division of MCS, Inc., PO Box 237, Watseka, IL 60970.

TELEPHONE SILENCER, the *Silencer Cord,* is a plug-in phone cord with a handy switch that prevents the phone from ringing when you're taking a nap or doing any-

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thing else at which you don't want to be disturbed. The *Silencer Cord* comes in 7, 14, and 25-foot lengths, and retails between $7.00 and $9.00.—**Zoom Telephonics,** 122 Bowdoin Street, Boston, MA 02108.

MINI-DISK STORAGE SYSTEMS, called *MFD* systems, are designed for the *AIM-65, KIM,* and *SYM* computers. Forty- and eighty-track models are available in both standard and flippy-drive versions. (With a flippy drive, data can be stored on the back side of a diskette by flipping the diskette.)

The *MFD* systems are available in 1-, 2-, and 3-drive units. A system includes a disk-controller circuit card, a disk-operating system (DOS), an interconnecting cable, user's manual, and the drives. Two controllers are available: one for the *AIM-*

CIRCLE 136 ON FREE INFORMATION CARD

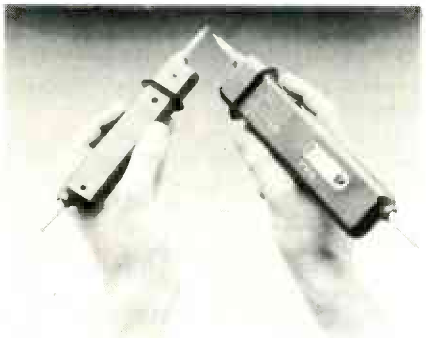
65 expansion bus and one for the *System-50* (SS-50) bus.

The *MFD* disk-operation system is provided in ROM's and on diskette. Eight commands are included in the ROM's, which plug into sockets on the controller. The system diskette includes utilities and a library of 20 system commands. The system communicates directly with an *AIM* Monitor, Editor, BASIC, or other *AIM* program through user's I/O, and F1 and F2 keys.

The *MFD* drive systems start at $599.95.

There is also an adapter, *model M-65/50,* which permits expansion of an *AIM-65, KIM,* or *SYM* with proven *System-50* modules. The model *M-65/50* Interface is priced at $49.85.—**Percom Data Company,** 211 N. Kirby, Garland, TX 750412.

MULTIMETER, the Steinel *Digi-Check,* is a precision, 3½-digit hand-held probe multimeter that uses two probe tips interconnected by a 1-meter long cable. the probes, which are slightly longer than conventional test probes, contain the liquid-crystal display range and function-selector slide switches, NiCad batteries, and an integral battery charger. No other cables, clips, or test leads are needed. The display probe is approximately 7.3 × 1.75 × .68 inches, while the battery-containing probe is approximately 5.4 × 1.3 × .64 inches; total weight is 9 ounces.



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Technical features include 5 AC and DC voltage ranges from 200 millivolts to 500 volts full scale, with an accuracy of ±0.3% for DC and ±1% for AC. Resistance is measured in six ranges from 200 ohms to 20 megohms, full scale, with a measurement accuracy of ±0.5%. All ranges are fully protected against overload. The Steinel *Digi-Check* is priced at $169.00 (meter only); the carrying case is $10.00.—**Energy Electronic Products Corporation,** 5441 W. 104th Street, Los Angeles, CA 90045.

VHF CONVERTERS, *model V5736* (shown) and *model V5836* enable VCR owners to record VHF, UHF, cable, or pay-TV while watching in any other mode at the same time. The converters cover 36 channels, receive wideband, superband/pay, and all VHF channels on UHF. The viewer receives superior color quality, with the shielding necessary for eliminating inter-

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ference and minimizing drift. Both converters can be used with Beta and VHS-type recorders, and conform to all cable and broadcast-TV standards for performance and safety of equipment. Both are compact and self-contained.

The *model V57376*, standard, is priced at $59.95; the *model V5836*, heavy-duty, costs $69.95.—**BP Electronics,** 855 Conklin Street, Farmingdale, NY 11735.

NIPPERS, *model 2131* and *model 2132*, feature an adjustable pivot; black oxidized jaws (non reflective); high-grade, case-hardened steel (to a Rockwell-64 hardness) along the entire cutting surface; replacable springs; replacable lead catchers for safety, and red polypropylene handles for a firm and comfortable grip.

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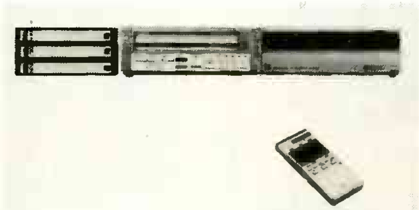
The *model 2131* is a side cutter with outer edge bevel; the *model 2132* is a close-cutter with inside bevel only. Each is priced at $12.50 and has a lifetime guarantee.—**The Shields Corporation,** 3000 Dundee Rd., Suite 420, Northbrook, IL 60062.

VIDEOCASSETTE RECORDER, the *Betamax SL-2500,* includes the *model RMT-312* Remote Commander, and is designed to meet five primary requirements: high-quality reproduction of both video and audio signals; greater precision at a variety of speeds (Beta I and Beta II); non-visual tape indexing and retrieving features; professional editing capability, and hi-fi component styling.



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Other features of the *Betamax SL-2500* include front loading; BetaScan II high-speed picture search; new Swing-Search multi-speed bi-directional playback; freeze frame capability with "noiseless" clear picture; electronic tab-marker indexing system for random access to as many as nine selectable positions on any recorded tape, and programmable two-week timer with "conversation-style" setting sequence. For home-movie buffs, the *Betamax SL-2500* incorporates its own fittings and power supply for use with video cameras such as the Sony *model HVC-2200.*

The wireless remote control allows

armchair command of all key functions, including power on/off, channel change, record start/stop, and others. Optional accessories include the new *model AG-400* Betastack autochanger that permits automatic recording of 20 hours on four Beta videocassettes. The *Betamax SL-2500* has a suggested retail price of $1500.00—**Sony Consumer Products Company,** Sony Corporation of America, 9 West 57th Street, New York, NY 10019.

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INTEGRATED STEREO SYSTEM, the *Beocenter 7000,* is computer-controlled and combines the primary components of a complete system in a single unit that fits easily into a limited space. It includes a stereo FM receiver, cassette recorder, radial-arm turntable, loudspeaker system, and remote-control module.

The *Beocenter 7000* is designed to place every music source at the listener's fingertips. Its wireless remote-control module allows music from different sources to be selected from any point in the listening room. Just one touch of a button on the remote-control unit will allow the user to listen to any one of six pre-selected FM stations; another touch will activate the cassette unit or turntable. The microcomputer controlling the system directs one music source to be switched off when another source is selected.

The *Beocenter 7000* can be programmed to start or stop automatically, record a radio program at any time of day or night, activate the turntable to start the morning off with a favorite record album, or shut the system off completely at bedtime. An easy-to-read digital display indicates which music system is being used at the moment, and also shows the correct time when the system is activated and while the turntable or tuner is in operation. A continuously changing four-digit tape-movement indicator is displayed while a tape is played, allowing the user to know exactly where on the tape each music-selection is located. A recording-level scale is included for recording. The *Beocenter 7000* is priced at $2100.00—**Bang & Olufsen of America, Inc.,** 515 Busse Road, Elk Grove Village, IL 60007. **R-E**

CALIBRATOR

continued from page 53

Multimeters are calibrated in much the same way as straight voltmeters. Regardless of instrument, you should always calibrate it for DC volts first. Then you can set the multimeter to AC VOLTS and to the 1 VOLT range for AC calibration. Use the calibrator's 1V AC SINE jack. *Don't* use the 10-volt square-wave output—some meters react differently to a square-wave input.

The resistance ranges can be calibrated next. Switch S2 to the OHMS position, and plug in the test leads as required to get 111.1 ohms, and the decade values from 1K through 1 megohms. Remember that you get 1K by using the 1V/1K and 0.1V/111 Ω jacks and 10K by using the 10V/10K and 1V/1K jacks. The rest of the resistance connections are obvious. Generally, it is necessary only to check out a few ranges of a multimeter to get full calibration, so the entire procedure takes about five minutes on modern meters. For best results, see your meter's service manual for helpful hints.

The calibrator should also come in handy for adjusting A/D converters. Generally, all you have to do is check them on the 10-volt DC range, and adjust the converter for a corresponding output. Of course, different systems may have different input requirements, and the 1-volt or 0.1-volt dc outputs can be used if necessary. For best results, measure the exact output voltages from the calibrator and jot down the values; then you can adjust the A/D converter precisely.

If you are calibrating a 10-volt-input converter, you can get an idea of its linearity by switching to the two lower calibrator outputs. The readings from the converter should drop correspondingly. Finally, bipolar-type A/D converters, which convert either positive or negative voltages can be checked simply by reversing the leads to the calibrator. The positive and negative values should be the same, or nearly the same; otherwise the converter is suffering from excessive "rollover" error. The calibrator has been very handy in checking out A/D converters in home computers, and experimental digital voltmeters.

Oscilloscopes can benefit from the pocket calibrator. The 10-volt square-wave output was designed with them in mind. To use it, connect the scope to the COM and 10V P-P SQUARE jacks. Then press S1 and observe the scope display. Adjust the vertical gain as required to get a reading of 10 volts where you want it on the display. As a bonus, you can check ×10 probes, and adjust them with the calibrator. With the ×10 probes, the 10-volt signal should be displayed as a 1-volt peak-to-peak waveform. Anything else may indicate a defective or misadjusted probe. With the calibrator, the probe's internal compensation-trimmer can be adjusted with an insulated screwdriver for the squarest corners on the display.

Some final advice

Here are a few additional tips that can help you to get more out of your calibrator.

Perform the initial calibration using the best meter you find! Also, after the calibration, measure all the resistances and voltages. Prepare a chart, and paste it inside the lid of the calibrator. Use those values when calibrating other equipment.

Always use top-quality leads when calibrating other meters. Cheap ones, or bad ones, can introduce resistance errors.

If the pocket calibrator has been unused for a while, check the battery voltage before using it. It's embarrassing to calibrate an instrument with a calibrator that's in error due to weak batteries!

Finally, try to work in a temperature-stable environment. Calibration under unusual temperature conditions usually results in slight errors, and isn't such a good idea. **R-E**

NEW BOOKS

ANDROID DESIGN, by Martin Bradley Weinstein, Hayden Book Company, 50 Essex Street, Rochelle Park, NJ 07662. 248 pages, including appendix and index; 5¾ × 9 inches; softcover; $11.95.

The author defines the term "android" as: "A mobile mechanism capable of manipulating objects external to itself under the *constant control of its own resident intelligence*, operating within guidelines initially established and occasionally updated through reprogramming by a human, a computer, or other external intelligence. It is capable of adapting its actions according to decisions governed by its programming and by observations of the objects it manipulates. It is capable of limited self-direction and initiative when not involved in program-mandated tasks." Others would call that a "robot," but, no matter: We are given a clear description of what is really meant.

What we have here is a comprehensive look at the tools, materials, and techniques necessary for designing the device. It examines what the finished product will do, what you can expect it to do, and how those expectations will affect the design requirements. Also included is a look at both usual and unusual hardware and software, and mechanics and mechanisms. Fascinatingly sophisticated designs are offered and the opportunity to see them realized. As the author notes in the opening chapter: "Though android design requires no small involvement in a number of technologies, it is an engineering task that crosses traditional engineering boundaries." Experienced amateurs have the opportunity to make significant contributions to the art of android construction, before the first commercial models appear.

CIRCLE 111 ON FREE INFORMATION CARD

OWNING YOUR HOME COMPUTER, by Robert L. Perry, Everest House, Publishers, 1133 Avenue of the Americas, New York, NY 10036. 224 pages, including appendix, glossary, bibliography, and index; 7⅜ × 10 inches; softcover; $10.95.

This book introduces home computers to the general reader, showing how the home-information explosion came about; discussing the latest trends in the field, describing the most up-to-date home computers (showing how they differ from personal and business microcomputers), and telling the reader how to put them to their best use. There are many ways in which a home computer can be used that may be surprising to the reader—such as help for the handicapped, home-control system, home education, and much, much more. There is also a discussion of new developments that are being planned for the future.

There are many clear photos and diagrams, and the glossary of terms makes computer language easier to follow; in addition, there is a list of over 1,000 computer programs that are now available on the general market.

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THE "TOP SECRET" REGISTRY OF U.S. GOVERNMENT RADIO FREQUENCIES, by Tom Kneitel, K2AES, CRB Research, P.O. Box 56, Commack, NY 11725. 120 pages; 5⅜ × 8¼ inches; softcover; $9.95 (plus $1.00 for first-class mailing).

This new 4th edition presents a considerable amount of new, revised, corrected, and expanded data. It deals with scanner-frequency listings for federal operations including Secret Service, Border Patrol, Immigration, FBI, DEA, Customs Service, Alcohol, Tobacco, and Firearms, Treasury, CIA, all military services, plus military/civilian satellites operating below 470 MHz. There are also detailed listings for the hot "military UHF aero band"—225 to 400 MHz.

The new edition also lists frequencies of major suppliers to the government in the fields of electronics, avionics, aerospace, missiles, ordnance, shipbuilding, astronomical observatories, aviation, the Space Shuttle, and other similar facilities. A special section lists hundreds of call signs and tactical identifiers.

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CB PROJECTS, by R.A. Penfold, Bernard Babani (publishing) LTD, England (available from Electronic Technology Today, P.O. Box 83, Massapequa Park, NY 11762; 88 pages; 4¾ × 7 inches; softcover; $5.00.)

You do not need any technical know how to use a CB rig, of course; but for the electronics hobbyist (or anyone else capable of using a soldering iron and a few other simple tools) it is possible to derive more pleasure from this hobby by constructing some items of equipment for yourself.

There are a number of accessories that can be built at home quite inexpensively, making them competitive with commercially-produced equipment—in instances where a commercial alternative exists, which is not always the case.

The projects include a speech processor, aerial booster, cordless microphone, high-pass filter, field-strength meter, NiCad charger, and others. There are many diagrams, along with parts lists and building instructions. R-E

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SATELLITE TV RECEIVER

continued from page 64

To complete the mixer board, form L12 and L13 from a single 1⅛-inch piece of 28-gauge enameled wire. Bend the wire in half and tin a ⅛-inch section in the middle. Then tin ⅛-inch at both ends. Solder the middle section to the small pad located next to the diodes and the ends of the wire to the rectangular diode-pads. Raise the two loops so that they form about a 45-degree angle with the board to avoid capacitive effects.

The final step in assembly is to solder the two PC boards together. The mixer board mounts vertically at the rear of the main board, with the "bottom" side facing in, about ⅛-inch in from the rear and flush with the side. Solder the ground planes of the two boards together along the entire length and on both sides of the mixer board. Also solder a triangular piece of tin to both boards at their outer edges for added support. Insert C1 between the mixer board and main board. To finish up, connect holes 10 and 11 on the mixer board to the corresponding holes on the main board. The receiver is much easier to work on while it is out of its case, so final assembly will be postponed until after alignment.

Power supply

The power transformer is housed in its own case (Fig. 21) to keep the size of the receiver itself comfortably small. Isolating it from the components of the receiver also reduces drift and other heat-related problems.

A schematic for the transformer and its associated components is shown in Fig. 8 in Part 1 of this article in the April 1982 issue of **Radio-Electronics.** The cable connecting the transformer to the receiver should terminate in a two-pin Molex connector to mate with J5 on the main board.

Before plugging anything in, check all the wiring of both units and verify that all the components are in the correct positions and properly oriented. Also check for solder bridges on the PC boards. In the next part of this article, we will cover the final assembly of the receiver. We will also discuss alignment procedures and—just in case you need them—provide some troubleshooting hints. **R-E**

EQUIPMENT REPORTS

continued from page 32

of the test leads also use banana plugs, with a long protective sleeve. Those plug into recessed jacks on the case; no bare metal is exposed at any point. There's also another set of test leads available, the *model KS-19*. The *model KS-19* test leads have banana plugs on both ends. Those can be used to connect the *MA-3D* to other equipment, or anything having banana jacks.

The instruction manual is excellent. Plainly written, it describes and illustrates the setup to make any kind of measurement. The battery is housed in a compartment on the right rear of the case. The lid snaps on, and can be removed with a screwdriver or coin. Use alkaline batteries for maximum service life. I've only one minor beef about the manual: in one place (pages 10-11) they use "U" instead of "V" as a voltage symbol. However, I suspect that it is a typo—anyway, the meaning is quite clear. (It *must* be a typo; the German word for voltage is *spannung* or "S"!) The instrument looks well constructed and should provide reliable service for a long time. Priced at $199.00, it is well in the ballpark for instruments of similar accuracy and quality. **R-E**

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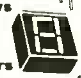

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3429	050C	104K	.19
3429	050E	104M	.12
3439	050E	104M	.12
3430	050E	105M	.49
3418	100A	220K	.23
3429	100C	223K	.24

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3418	.150"	.100"	.100"
3429	.200"	.100"	.100"
3430	.200"	.200"	.200"
3439	.300"	.200"	.200"

	Volts	Value (PF)	
3418	100C	331K	.23
3429	100C	333K	.25
3439	100C	333K	.25
3418	100A	470K	.23
3418	100C	471K	.23
3418	100C	472K	.13
3418	100E	472M	.12
3429	100C	473K	.15
3439	050E	473M	.11
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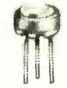


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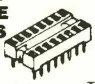

Contacts	Price	Contacts	Price
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16	.16	24	.26
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		40	.40

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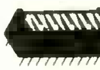

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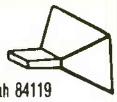

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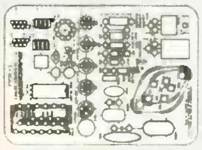

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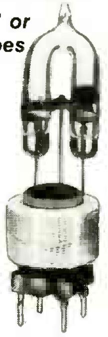

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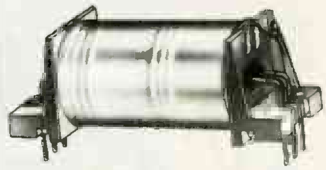

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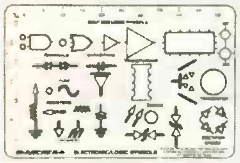

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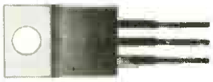

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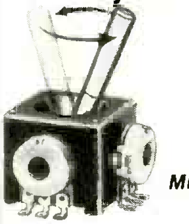

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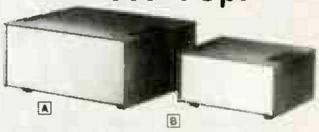

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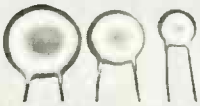

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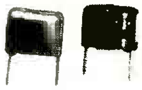

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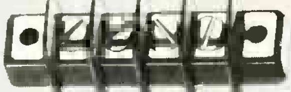

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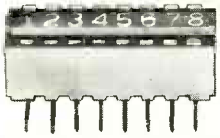

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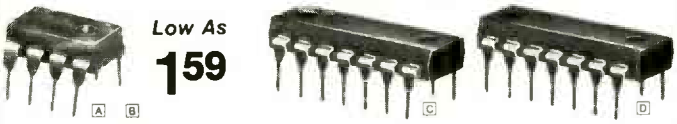

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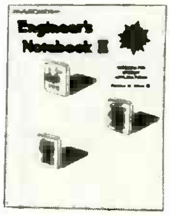

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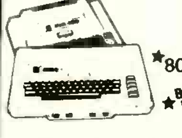

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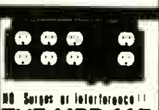

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Sensitivity:	Less than 10 MV to 150 MHz Less than 50 MV to 500 MHz
Resolution:	0.1 Hz (10 MHz range) 1.0 Hz (60 MHz range) 10.0 Hz (600 MHz range)
Display:	9 digits 0.4" LED
Time base:	Standard-10.000 mHz, 1.0 ppm 20-40°C. Optional Micro-power oven-0.1 ppm 20-40°C
Power:	8-15 VAC @ 250 ma

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Sensitivity:	Less than 50 MV to 150 MHz Less than 150 MV to 500 MHz
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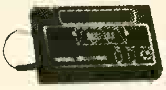

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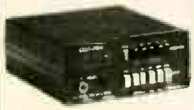
Range:	20 Hz to 600 MHz
Sensitivity:	Less than 25 mv to 150 MHz Less than 150 mv to 600 MHz
Resolution:	1.0 Hz (60 MHz range) 10.0 Hz (600 MHz range)
Display:	8 digits 0.4" LED
Time base:	2.0 ppm 20-40°C
Power:	110 VAC or 12 VDC

The CT-50 is a versatile lab bench counter that will measure up to 600 MHz with 8 digit precision. And, one of its best features is the Receive Frequency Adapter, which turns the CT-50 into a digital readout for any receiver. The adapter is easily programmed for any receiver and a simple connection to the receiver's VFO is all that is required for use. Adding the receiver adapter in no way limits the operation of the CT-50, the adapter can be conveniently switched on or off. The CT-50, a counter that can work double-duty!

PRICES:

CT-50 wired, 1 year warranty	$159.95
CT-50 Kit, 90 day parts warranty	119.95
RA-1, receiver adapter kit	14.95
RA-1 wired and pre-programmed (send copy of receiver schematic)	29.95



DIGITAL MULTIMETER $99.95 WIRED

PRICES:

DM-700 wired, 1 year warranty	$99.95
DM-700 Kit, 90 day parts warranty	79.95
AC-1, AC adaptor	3.95
BP-3, Nicad pack +AC adapter/charger	19.95
MP-1, Probe kit	2.95

The DM-700 offers professional quality performance at a hobbyist price. Features include; 26 different ranges and 5 functions, all arranged in a convenient, easy to use format. Measurements are displayed on a large 3½ digit, ½ inch LED readout with automatic decimal placement, automatic polarity, overrange indication and overload protection up to 1250 volts on all ranges, making it virtually goof-proof! The DM-700 looks great, a handsome, jet black, rugged ABS case with convenient retractable tilt bail makes it an ideal addition to any shop.

SPECIFICATIONS:

DC/AC volts:	100uV to 1 KV, 5 ranges
DC/AC current	0.1uA to 2.0 Amps, 5 ranges
Resistance:	0.1 ohms to 20 Megohms, 6 ranges
Input impedance:	10 Megohms, DC/AC volts
Accuracy:	0.1% basic DC volts
Power:	4 'C' cells

AUDIO SCALER

For high resolution audio measurements, multiplies UP in frequency.

- Great for PL tones
- Multiplies by 10 or 100
- 0.01 Hz resolution!

$29.95 Kit $39.95 Wired

ACCESSORIES

Telescopic whip antenna - BNC plug	$ 7.95
High impedance probe, light loading	15.95
Low pass probe, for audio measurements	15.95
Direct probe, general purpose usage	12.95
Tilt bail, for CT 70, 90, MINI-100	3.95
Color burst calibration unit, calibrates counter against color TV signal	14.95

COUNTER PREAMP

For measuring extremely weak signals from 10 to 1,000 MHz. Small size, powered by plug transformer-included.

- Flat 25 db gain
- BNC Connectors
- Great for sniffing RF with pick-up loop

$34.95 Kit $44.95 Wired

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2575 BAIRD RD. • PENFIELD, NY 14526

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CALL 716-586-3950

TERMS Satisfaction guaranteed - examine for 10 days, if not pleased, return in original form for refund. Add 5% for shipping - insurance to a maximum of $10. Overseas add 15%. COD, add $2. Orders under $10., add $1.50. NY residents add 7% tax.

CIRCLE 62 ON FREE INFORMATION CARD

7400

SN7400N	.20	SN7472N	.29	SN74156N	.79
SN7401N	.20	SN7473N	.35	SN74157N	.69
SN7402N	.25	SN7474N	.35	SN74160N	.89
SN7403N	.25	SN7475N	.49	SN74161N	.89
SN7404N	.25	SN7476N	.35	SN74162N	.89
SN7405N	.29	SN7479N	5.00	SN74163N	.89
SN7406N	.35	SN7480N	.50	SN74164N	.89
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SN7411N	.29	SN7489N	1.75	SN74172N	4.95
SN7412N	.35	SN7490N	.49	SN74173N	1.39
SN7413N	.40	SN7491N	.59	SN74174N	.99
SN7414N	.69	SN7492N	.45	SN74175N	.89
SN7416N	.29	SN7493N	.45	SN74176N	.79
SN7417N	.29	SN7494N	.69	SN74177N	.79
SN7420N	.25	SN7495N	.69	SN74179N	1.49
SN7421N	.29	SN7496N	.69	SN74180N	.79
SN7422N	.45	SN7497N	3.00	SN74181N	2.25
SN7423N	.29	SN74100N	1.49	SN74182N	.79
SN7425N	.29	SN74104N	.89	SN74184N	2.49
SN7426N	.29	SN74105N	.89	SN74185N	2.49
SN7427N	.25	SN74107N	.35	SN74190N	1.25
SN7428N	.49	SN74109N	.39	SN74191N	1.25
SN7430N	.25	SN74116N	1.95	SN74192N	.89
SN7432N	.29	SN74121N	.39	SN74193N	.89
SN7437N	.25	SN74122N	.55	SN74194N	.89
SN7438N	.40	SN74123N	.59	SN74195N	.69
SN7439N	.25	SN74125N	.49	SN74196N	.89
SN7440N	.20	SN74126N	.49	SN74197N	.89
SN7441N	.89	SN74132N	.75	SN74198N	1.49
SN7442N	.59	SN74136N	.75	SN74199N	1.49
SN7443N	1.10	SN74141N	.99	SN74221N	1.25
SN7444N	1.10	SN74142N	3.25	SN74251N	.99
SN7445N	.89	SN74143N	3.49	SN74276N	1.95
SN7446N	.79	SN74144N	3.49	SN74279N	.79
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SN7448N	.79	SN74147N	1.95	SN74284N	3.95
SN7450N	.20	SN74148N	1.29	SN74285N	3.95
SN7451N	.20	SN74150N	1.25	SN74365N	.69
SN7453N	.20	SN74151N	.69	SN74366N	.69
SN7454N	.20	SN74152N	.69	SN74367N	.69
SN7459A	.25	SN74153N	.79	SN74368N	.69
SN7460N	.20	SN74154N	1.25	SN74390N	1.49
SN7470N	.29	SN74155N	.79	SN74393N	1.49

74LS

74LS00	.29	74LS92	.75	74LS192	1.15
74LS01	.29	74LS93	.75	74LS193	1.15
74LS02	.29	74LS95	.99	74LS194	1.15
74LS03	.29	74LS96	1.15	74LS195	1.15
74LS04	.35	74LS107	.45	74LS197	1.19
74LS05	.35	74LS109	.45	74LS221	1.19
74LS08	.35	74LS112	.45	74LS240	1.49
74LS09	.35	74LS113	.49	74LS241	1.49
74LS10	.35	74LS114	.49	74LS242	1.49
74LS11	.39	74LS122	.89	74LS243	1.49
74LS12	.35	74LS123	1.25	74LS244	1.49
74LS13	.45	74LS125	.59	74LS245	2.95
74LS14	.99	74LS126	.59	74LS247	1.19
74LS15	.35	74LS132	.99	74LS248	1.19
74LS20	.35	74LS133	.89	74LS249	1.19
74LS21	.35	74LS136	.49	74LS251	.99
74LS22	.35	74LS138	.89	74LS253	.99
74LS26	.35	74LS139	.89	74LS257	.89
74LS27	.35	74LS151	.89	74LS258	.69
74LS28	.35	74LS153	.89	74LS260	.69
74LS30	.35	74LS154	1.75	74LS266	.69
74LS32	.35	74LS155	.89	74LS273	1.95
74LS33	.59	74LS156	.89	74LS279	.89
74LS37	.45	74LS157	.89	74LS283	.89
74LS38	.39	74LS158	.89	74LS290	.99
74LS40	.35	74LS160	1.15	74LS293	.99
74LS42	.89	74LS161	1.15	74LS298	.99
74LS47	.89	74LS162	1.15	74LS352	1.29
74LS48	1.15	74LS163	1.15	74LS353	1.29
74LS49	1.15	74LS164	1.15	74LS365	.69
74LS51	.35	74LS165	1.15	74LS366	.69
74LS54	.35	74LS166	1.15	74LS367	.69
74LS55	.35	74LS168	1.19	74LS368	.69
74LS73	.45	74LS169	1.19	74LS373	1.95
74LS74	.45	74LS170	1.95	74LS374	1.95
74LS75	.59	74LS173	.99	74LS375	.89
74LS76	.45	74LS174	.99	74LS386	.69
74LS78	.49	74LS175	.99	74LS393	2.49
74LS83	.89	74LS181	2.95	74LS399	2.49
74LS85	1.25	74LS190	1.25	74LS670	2.49
74LS86	.49	74LS191	1.25	81LS95	1.95
74LS90	.69			81LS97	1.95

74S

74S00	.45	74S124	3.95	74S243	3.25
74S02	.45	74S133	.55	74S244	3.25
74S03	.45	74S134	.69	74S251	1.45
74S04	.55	74S135	1.19	74S253	1.45
74S05	.55	74S136	1.75	74S257	1.35
74S08	.50	74S138	1.35	74S258	1.35
74S09	.50	74S139	1.35	74S260	.79
74S10	.45	74S140	.79	74S280	2.95
74S11	.45	74S151	1.35	74S287	3.25
74S15	.45	74S153	1.35	74S288	2.75
74S20	.45	74S157	1.35	74S373	3.49
74S22	.45	74S158	1.35	74S374	3.49
74S30	.45	74S160	2.95	74S387	2.95
74S32	.55	74S174	1.59	74S471	10.95
74S38	1.25	74S175	1.59	74S472	10.95
74S40	.50	74S188	2.95	74S473	10.95
74S51	.45	74S194	1.95	74S474	12.95
74S64	.50	74S195	1.95	74S475	12.95
74S65	.50	74S196	1.95	74S570	5.95
74S74	.75	74S240	2.95	74S571	5.95
74S86	.79	74S241	2.95	74S572	9.95
74S112	.79	74S242	3.25	74S573	9.95
74S113	.79			74S940	3.15
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CA3010H	.99	CA3060N	3.25	CA3089N	3.75
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CA3023H	3.25	CA3081N	2.00	CA3130H	1.39
CA3035H	2.49	CA3082N	2.00	CA3140H	1.25
CA3039H	1.35	CA3083N	1.60	CA3160H	1.25
CA3046N	1.30	CA3086N	.85	CA3401N	.59
CA3059N	3.25			CA3600N	3.50

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CD4001	.39	CD4042	.99	CD4506	.75
CD4002	.39	CD4043	.89	CD4507	.99
CD4006	1.19	CD4044	.89	CD4508	3.95
CD4007	.25	CD4046	1.79	CD4510	1.39
CD4009	.49	CD4047	2.50	CD4511	1.29
CD4010	.49	CD4048	1.35	CD4512	1.49
CD4011	.39	CD4049	.49	CD4514	3.95
CD4012	.25	CD4050	.69	CD4515	2.95
CD4013	.49	CD4051	1.19	CD4516	1.49
CD4014	1.39	CD4052	1.19	CD4518	1.79
CD4015	1.19	CD4053	1.19	CD4519	.89
CD4016	.59	CD4056	2.95	CD4520	1.29
CD4017	1.19	CD4059	9.95	CD4526	1.79
CD4018	.99	CD4060	1.49	CD4528	1.79
CD4019	.49	CD4066	.79	CD4529	1.95
CD4020	1.19	CD4068	.39	CD4543	2.79
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CD4023	.29	CD4071	.49	CD4583	2.49
CD4024	.79	CD4072	.49	CD4584	.75
CD4025	.23	CD4073	.39	CD4723	1.95
CD4026	2.95	CD4075	.39	CD4724	1.95
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CD4029	1.49	CD4081	.39	MC14411	15.95
CD4030	.49	CD4082	.39	MC14412	15.95
CD4034	3.49	CD4093	.99	MC14419	7.95
CD4035	.99			MC14433	15.95
CD4040	1.49			MC14538	2.49
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A·AMBER — LEDS — G·GREEN R·RED Y·YELLOW C·CLEAR

DIFFUSED BI·COLOR/TRI·STATE
.200 (T1¾) Red/Green

Part No.	1-99	100+
XC5491	[illegible]	[illegible]

POINT SOURCE (RED)
.100 Tapered (Short)

Part No.	1-99	100+
RL 2.02	[illegible]	[illegible]

DIFFUSED
.125 (T1)

Part No.	1-99	100+
XC209R	5/$1.00	$.17
XC209G	4/ 1.00	.20
XC209Y	4/ 1.00	.20

DIFFUSED
.200 dia. (T1¾) Low Profile

Part No.	1-99	100+
XC22R	5/$1.00	$.17
XC22G	4/$1.00	.20
XC22Y	4/$1.00	.20

WIDE ANGLE DIFFUSED
.190 Diameter

Part No.	1-99	100+
XC111R	5/$1.00	$.17
XC111G	4/ 1.00	.20
XC111Y	4/ 1.00	.20
XC111C	4/ 1.00	.20

DIFFUSED
.190 Dia. (Tapered)

Part No.	1-99	100+
XC526R	5/$1.00	.17
XC526G	4/$1.00	.20
XC526Y	4/$1.00	.20
XC526C	4/$1.00	.20

POINT SOURCE
.200 (T1¾)

Part No.	1-99	100+
XC556R	5/$1.00	$.17
XC556G	4/ 1.00	.20
XC556Y	4/ 1.00	.20
XC556C	4/ 1.00	.20

DIFFUSED
.200 (T1¾)

Part No.	1-99	100+
XC554R	5/$1.00	.17
XC554G	4/$1.00	.20
XC554Y	4/$1.00	.20
XC554C	4/$1.00	.20
XC554A	4/$1.00	.20

DIFFUSED TRIANGLE
.200 Triangle

Part No.	1-99	100+
XC880R	5/$1.00	$.17
XC880G	4/ 1.00	.20
XC880Y	4/ 1.00	.20

DIFFUSED RECTANGULAR
.150W x .250L (.271H)

Part No.	1-99	100+
XC8213MG	[illegible]	[illegible]
XC8213MY	[illegible]	[illegible]
XC8713MR	[illegible]	[illegible]

LED Mounting Hardware

Mounts in panels up to .125" thick. Drill .257" diameter hole (F Drill). Can be used with XC22, XC111, XC526, XC554 and XC556 Series (from .160" to .200 Dia.) Black plastic clip and ring.

Part No.	8-99	100+
LMH-200	8/$1.00	.08 ea.

OPTO ELECTRONICS — DISPLAY LEDS —

Part No	Size	Color	Description	Price
MAN 1	.270	Red	C.A. (LHDP)	$2.95
MAN 2	.320	Red	5x7 Alphanumeric (TIL305)	4.95
MAN 52	.300	Green	C.A. (LHDP)	.99
MAN 54	.300	Green	C.C. (RHDP)	.99
MAN 72	.300	Red	C.A. (LHDP)	.75
MAN 74	.300	Red	C.C. (RHDP)	1.25
NSN 74L	.300	Red	C.C. (LHDP)	.99
MAN 82	.300	Yellow	C.A. (LHDP)	.49
MAN 84	.300	Yellow	C.C. (RHDP)	.99
MAN 3620	.300	Orange	C.A. (LHDP)	.49
MAN 3630	.300	Orange	C.A. (±1) Over Flo	.99
MAN 4610	.400	Orange	C.A. (RHDP)	.99
MAN 6610	.560	Orange	C.A. (RHDP) 2 Digit	.99
MAN 6630	.560	Orange	C.A. (±1) 1½ Digit	.99
MAN 6640	.560	Orange	C.C. (RHDP) 2 Digit	.99
MAN 6650	.560	Orange	C.C. (±1) 1½ Digit	.99
MAN 6680	.560	Orange	C.A. (RHDP)	.99
MAN 6710	.560	Red	C.A. (RHDP) 2 Digit	.99
MAN 6740	.560	Red	C.C. (RHDP) 2 Digit	.99
MAN 6750	.560	Red	C.C. (±1) 1½ Digit	.99
DL 34M	.110	Red	C.C. (4 Digit Bubble) RHDP	.49
DLO 304	.300	Orange	C.C. (RHDP)	1.25
DLO 307	.300	Orange	C.A. (LHDP)	1.25
DLG 500	.500	Green	C.C. (RHDP)	1.25
DLG 507	.500	Green	C.A. (RHDP)	1.25
DL 704	.300	Red	C.C. (RHDP)	1.25
DL 707	.300	Red	C.A. (LHDP)	1.25
DL 747	.630	Red	C.A. (LHDP)	1.49
DL 750	.630	Red	C.C. (LHDP)	1.49
FND 360	.362	Red	C.A. (RHDP)	.75
FND 367	.362	Red	C.C. (RHDP) FND 368	.75
FND 500	.500	Red	C.C. (RHDP) FND 503	.99
FND 507	.500	Red	C.A. (RHDP) FND 510	.99
TIL 308	.270	Red	Numerical Display w/Logic	10.95
TIL 311	.270	Red	4x7 Hexadecimal w/Logic	10.95
5082-7300	.600	Red	4x7 Numeric (RHDP)	$22.00
5082-7302	.600	Red	4x7 Numeric (LHDP)	22.00
5082-7304	.600	Red	Over Flo (±1) for 5082-7300-02	19.95
5082-7340	.600	Red	4x7 Hexadecimal (0-9/A-F)	22.50
5082-7432	.110	Red	C.C. (2-Digit/3-Bubble)	.29
HDSP-3401	.800 20mm	Red	C.A. (RHDP)	1.50
HDSP-3403	.800 20mm	Red	C.C. (RHDP)	1.50
HDSP-3406	.800 20mm	Red	C.C. (RHDP) ±1 Over Flo	1.50

Many Other Displays Available — Send for New Catalog

OPTO-ISOLATORS

H11C3	SCR Output Opto Isolators	$1.19
LIT-1	Single Chan. 20% CTR, 2500V (MCT 2/4N25)	.69
4N28	Single Chan. 10% CTR, 500V (Photo Transistor)	.69
4N33	Single Chan. 500% 1500V (Photo-Darlington)	1.25
MOC3010	Optically Isolated Triac Driver	1.25

LITRONIX-NATIONAL Stick Display Sale

LIMITED QUANTITY!

LED NUMERIC ARRAYS

PART NO	DIGIT SIZE (RED)	FORMAT	DRIVE Comm. Cathode/Comm. Anode	OVERALL SIZE	PRICE	SALE PRICE!
NSA186	100 (9 Bubble Stick)	888888	C.C. 8 Digit Multiplexed	2"L x .72"H x .27"D	$.59	2/.99
NSA198	100 (9 Bubble Stick)	888888888	C.C. 9 Digit Multiplexed	2"L x .72"H x .27"D	.69	2/.99
NSA298	100 (9 Bubble Stick)	888888888	C.C. 9 Digit Multiplexed	1.98"L x .72"H x .27"D	.49	2/.99
NSA1150	100 (9 Bubble Stick)	8 88 88	C.C. 5 Digit Multiplexed	2"L x .72"H x .27"D	.49	2/.59

MULTI-DIGIT LED NUMERIC DISPLAYS

*Standard Stocked Items

PART NO	DIGIT SIZE (RED)	FORMAT	DRIVE Comm. Cathode/Comm. Anode	OVERALL SIZE	PRICE	SALE PRICE!
NSN373	.3 No Decimal	88	C.C. 2 Digit Direct	.60"L x .80"H x .225"D	$.69	2/.79
NSN374	.3 No Decimal	88	C.A. 2 Digit Direct	.80"L x .80"H x .225"D	.79	2/.99
NSN602	.6 No Decimal	88	C.A. 2 Digit Direct	1.40"L x 1.14"H x .32"D (7/16" pins)	[illegible]	2/1.49
NSN781	.7	88	C.C. 2 Digit Multiplexed	1.2"L x 1.25"H x .3"D	1.19	2/1.95
NSB2100	.3	88*88=8888	C.C. 8 Digit (10 Spaces)	4"L x .60"H x .280"D	.75	2/.89
NSB3001	.3	88.88	C.A. 4 Digit Multiplexed	1.59"L x .65"H x .25"D (7/16" pins)	.75	2/.89
NSB3382	.3	+1 8.88	C.A. 3½ Digit Multiplexed	1.60"L x .80"H x .225"D	[illegible]	2/1.49
NSB3411	.3	88 88	C.C. 4 Digit – Colon/PM Indicator	1-9/16"L x 13/16"H x 3/16"D	[illegible]	2/1.19
NSB3852	.3	88 88 88	C.C. 6 Digit – AM/PM, Failure Ind.	3"L x 1.10"H x 7/32"D	2.95	2/3.95
NSB3884	.3	88888888	C.C. 8 Digit Multiplexed	3"L x 1-3/32"H x 3/16"D	2.95	2/3.95
NSB3881*	.3	8888	C.C. 4 Digit Multiplexed	1.59"L x .80"H x .225"D	2.95	2/4.95
NSB3882*	.3	8888	C.A. 4 Digit Multiplexed	1.59"L x .80"H x .225"D	2.95	2/4.95
NSB5382*	.5	+1 888	C.A. 3½ Digit Multiplexed	1.99"L x 1.00"H x .28"D	3.49	2/[illegible]
NSB5441	.5	88 88	C.C. 4 Digit – AM/PM, Colon Ind.	3.00"L x 1.10"H x .282"D	2.95	2/3.95
NSB5881*	.5	8888	C.C. 4 Digit Multiplexed	1.99"L x 1.00"H x .280"D	3.49	2/5.95
NSB5882*	.5	88.8.8	C.A. 4 Digit Multiplexed	1.99"L x 1.00"H x .280"D	3.49	2/5.95
NSB5918	.5	+8.888	C.C. 3½ Digit Multiplexed	3.00"L x 1.10"H x .282"D	2.49	2/3.49
NSB5922	.5	88888	C.A. 6 Digit Multiplexed	3.00"L x 1.10"H x .282"D	2.95	2/3.49
NSB7023	.7	888888	C.C. 6 Digit Multiplexed/Direct	3.60"L x 1.36"H x .282"D (3/8" pins)	3.95	2/4.95
DL2300	.3	88	C.C. 2 Digit Multiplexed	13/16" x 7/8" x 1/4"	.79	2/.99
DLG2535	.5 (Green)	88	C.A. 2 Digit Multiplexed	1-5/16" x 1-1/2" x 5/16"	[illegible]	2/1.19
DL3130	1.0	888	C.A. 3 Digit Multiplexed	2-3/4" x 1-13/16" x 5/16"	2.25	2/3.49
DL4500	.5	8888	C.C. 4 Digit, MPX, Colon	3-3/16" x 1-1/4" x 5/16"	1.95	2/2.95
DL4507	.5	8888	C.C. 4 Digit, MPX, Colon	3-3/16" x 1 x 5/16"	1.75	2/2.95
DLG4507	.5 (Green)	8888	C.C. 4-Digit Non-Multiplexed	3-3/16" x 1 x 5/16"	4.95	2/7.95
DL4509	.5	8888	C.C. 4 Digit Multiplexed	2" x 1-5/16" x 5/16"	1.49	2/1.95
DL4520A	.5	8888	C.C. 4 Digit Non-Multiplexed	3-3/16" x 1" x 5/16"	2.49	2/2.95

COMPUTER GRADE CAPACITORS

1¢ SALE — 2 FOR THE PRICE OF ONE PLUS 1¢ MORE

MFD	WVDC	PRICE	MFD	WVDC	PRICE	MFD	WVDC	PRICE
250	150	1.95	7,000	60	4.95	27,000	10	2.95
500	200	2.49	10,000	15	2.95	32,500	25	4.95
1,250	3	.99	10,000	[illegible]	[illegible]	40,000	[illegible]	5.95
1,500	25	1.95	11,000	[illegible]	[illegible]	[illegible]	[illegible]	4.95
1,500	50	2.95	13,000	[illegible]	[illegible]	43,[illegible]	[illegible]	5.95
2,000	10	2.95	14,000	[illegible]	2.95	45,[illegible]	5	5.95
2,100	200	2.95	[illegible]	[illegible]	2.95	52,000	20	5.95
2,250	[illegible]	[illegible]	18,000	10	[illegible]	55,000	15	5.95
2,300	[illegible]	2.95	20,000	20	2.95	58,000	20	5.95
2,500	15	[illegible]	21,000	15	3.95	65,000	10	7.95
3,000	25	[illegible]	22,000	15	4.95	73,800	5	7.95
3,600	40	3.95	23,000	7	1.95	80,000	15	9.95
4,500	50	3.95	23,000	10	2.95	90,000	10	8.95
5,500	25	4.49	23,000	20	3.95	120,000	15	10.95
6,100	40	3.49	24,000	20	2.95	160,000	10	8.95

OVER 200 OTHER VALUES AVAILABLE — CALL OR WRITE FOR YOUR REQUIREMENT

LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100
8 pin LP	.17	.16	.15
14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	.37	.36	.35
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
36 pin LP	.60	.59	.58
40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100
14 pin ST	.27	.25	.24
16 pin ST	.30	.27	.25
18 pin ST	.35	.32	.30
24 pin ST	.49	.45	.42
28 pin ST	.99	.90	.81
36 pin ST	1.39	1.26	1.15
40 pin ST	1.59	1.45	1.30

SOLDERTAIL (GOLD) STANDARD

	1-24	25-49	50-100
8 pin SG	.39	.35	.31
14 pin SG	.49	.45	.41
16 pin SG	.54	.49	.44
18 pin SG	.59	.53	.48
24 pin SG	.79	.75	.69
28 pin SG	1.10	1.00	.90
36 pin SG	1.65	1.40	1.26
40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100
8 pin WW	.59	.54	.49
10 pin WW	.69	.63	.58
14 pin WW	.79	.73	.67
16 pin WW	.85	.77	.70
18 pin WW	.99	.90	.81
20 pin WW	1.19	1.08	.99
22 pin WW	1.49	1.35	1.23
24 pin WW	1.39	1.26	1.14
28 pin WW	1.69	1.53	1.38
36 pin WW	2.19	1.99	1.79
40 pin WW	2.29	2.09	1.89

JUMPER AND CABLE ASSEMBLIES

STANDARD DIP JUMPERS

All jumpers use low profile dip plugs with heavy duty pins for repeated disconnect applications.

JAMECO Part No.	AP Cross-Reference	No. Pins	Description	Wire Length	Price
DJ14-1	924102-12	14	single end	12"	$1.79
DJ14-2	924102-24	14	single end	24"	2.05
DJ14-3	924102-36	14	single end	36"	2.35
DJ14-1-14	924106-12	14	double end	12"	3.20
DJ14-2-14	924106-24	14	double end	24"	3.49
DJ14-3-14	924106-36	14	double end	36"	3.79
DJ16-1	924112-12	16	single end	12"	1.85
DJ16-2	924112-24	16	single end	24"	2.19
DJ16-3	924112-36	16	single end	36"	2.59
DJ16-1-16	924116-12	16	double end	12"	3.35
DJ16-2-16	924116-24	16	double end	24"	3.69
DJ16-3-16	924116-36	16	double end	36"	4.05
DJ24-1	924122-12	24	single end	12"	2.69
DJ24-2	924122-24	24	single end	24"	3.39
DJ24-3	924122-36	24	single end	36"	3.95
DJ24-1-24	924126-12	24	double end	12"	4.79
DJ24-2-24	924126-24	24	double end	24"	5.29
DJ24-3-24	924126-36	24	double end	36"	5.89
DJ40-1	924132-12	40	single end	12"	5.89
DJ40-2	924132-24	40	single end	24"	6.79
DJ40-3	924132-36	40	single end	36"	7.69
DJ40-1-40	924136-12	40	double end	12"	10.95
DJ40-2-40	924136-24	40	double end	24"	11.89
DJ40-3-40	924136-36	40	double end	36"	12.79

STANDARD DB25 SERIES CABLES

Now you can order DB25 P or S connectors with the cable necessary to fit your application. Choose from our standard flat cable in 4-foot lengths.

STANDARD CABLES

Part No.	Cable Length	Connectors	Price
DB25P-4	4 feet	1-DB25P	$ 9.95 ea.
DB25S-4	4 feet	1-DB25S	10.95 ea.
DB25P-4-P	4 feet	2-DB25P	16.95 ea.
DB25P-4-S	4 feet	1-DB25P/1-DB25S	17.95 ea.
DB25S-4-S	4 feet	2-DB25S	18.95 ea.

INTERSIL

Part No.	Function	Price
7045IPI	CMOS Precision Timer	14.95
7045EV/Kit*	Stopwatch Chip, XTL	24.95
7106CPL	3½ Digit A/D (LCD Drive)	16.95
7106EV/Kit*	IC, Circuit Board, Display	34.95
7107CPL	3½ Digit A/D (LED Drive)	15.95
7107EV/Kit*	IC, Circuit Board, Display	29.95
7116CPL	3½ Digit A/D LCD Dis. HLD.	18.95
7117CPL	3½ Digit A/D LED Dis. HLD.	17.95
72011DR	Low Battery Volt Indicator	2.25
7205IPG	CMOS LED Stopwatch/Timer	12.95
7205EV/Kit*	Stopwatch Chip, XTL	19.95
7206CJPE	Tone Generator	5.15
7206CEV/Kit*	Tone Generator Chip, XTL	12.95
7207AIPD	Oscillator Controller	6.50
7207AEV/Kit*	Freq. Counter Chip, XTL	13.95
7208IPI	Seven Decade Counter	17.95
7209IPA	Clock Generator	3.95
7215IPG	4 Func. CMOS Stopwatch CKT	13.95
7215EV/Kit*	4 Func. Stopwatch Chip, XTL	19.95
7216AIJI	8-Digit Univ. Counter C.A.	32.00
7216CIJI	8-Digit Freq. Counter C.A.	26.95
7216DIPI	8-Digit Freq. Counter C.C.	21.95
7217IJI	4-Digit LED Up/Down Counter CA	12.95
7217AIPI	4-Digit LED Up/Down Counter CC	14.95
7224IPL	LCD 4½ Digit Up Counter DRI	11.25
7226AIJL	8-Digit Univ. Counter	31.95
7226AEV/Kit*	5 Function Counter Chip, XTL	74.95
7240IJE	CMOS Bin Prog. Timer/Counter	4.95
7242IJA	CMOS Divide-by-256 RC Timer	2.05
7250IJE	CMOS BCD Prog. Timer/Counter	6.00
7260IJE	CMOS BCD Prog. Timer/Counter	5.25
7555IPA	CMOS 555 Timer (8 pin)	1.45
7556IPD	CMOS 556 Timer (14 pin)	2.20
7611BCPA	CMOS Op Amp Comparator 5MV	2.25
7612BCPA	CMOS Op Amp Ext. Cmvr. 5MV	2.95
7621BCPA	CMOS Dual Op Amp Comp. 5MV	3.95
7631CCPE	CMOS Tri Op Amp Comp. 10MV	5.35
7641CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7642CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7660CPA	Voltage Converter	2.95
8038CCPD	Waveform Generator	4.95
8048CCPE	Monolithic Logarithmic Amp	21.60
8069CCQ	50ppm Band—GAP Volt Ref. Diode	2.50
8211CPA	Volt Ref/Indicator	2.95
8212CPA	Volt Ref/Indicator	2.95

74C

74C00	.39	74C95	1.59	74C221	1.95
74C02	.39	74C107	1.89	74C240	2.25
74C04	.39	74C151	2.95	74C244	2.25
74C08	.39	74C154	3.95	74C373	2.49
74C10	.39	74C157	2.25	74C374	2.59
74C14	.75	74C160	1.69	74C901	.69
74C20	.39	74C161	1.60	74C903	.69
74C30	.39	74C162	1.49	74C911	10.95
74C42	1.39	74C163	1.69	74C912	10.95
74C48	1.95	74C164	1.59	74C915	1.69
74C73	.79	74C173	1.39	74C917	10.95
74C74	.79	74C174	1.39	74C922	5.49
74C85	1.95	74C175	1.19	74C923	5.75
74C86	.99	74C192	1.69	74C925	7.50
74C89	6.95	74C193	1.69	74C926	7.50
74C90	1.29	74C195	1.59	80C95	.79
74C93	1.29			80C97	.79

LINEAR

LH0002CN	6.85			LM702H	.79
LM10CLH	4.50	LM340T-5	1.25	LM703CN	.89
LM11CLH	4.75	LM340T-12	1.25	LM709N	.29
LH0070-OH	4.95	LM340T-15	1.25	LM710N	.79
TL071CP	.79	LM341P-5	.75	LM711N	.79
TL072CP	1.39	LM341P-12	.75	LM723N	.69
TL074CN	2.49	LM341P-15	.75	LM733N	1.00
LH0082CD	35.80	LM342P-5	.69	LM739N	1.19
TL082CP	1.19	LM342P-12	.69	LM741CN	.35
TL084CN	2.19	LM342P-15	.69	MC1741SCG	3.00
LH0094CD	36.80	LM348N	1.25	LM747N	.79
LM300H	.99	LM350K	5.75	LM748N	.59
LM301CN	.35	LF351N	.60	LM1014N	2.75
LM302H	1.95	LF353N	1.00	LM1310N	1.95
LM304H	1.95	LF355N	1.10	LM1458CN	.59
LM305H	.99	LF356N	1.10	LM1488N	1.25
LM307CN	.45	LM358N	1.00	LM1489N	1.25
LM308CN	1.00	LM359N	1.79	LM1496N	1.95
LM309H	1.95	LM370N	4.49	LM1556V	1.75
LM309K	1.25	LM373N	3.25	LM1800N	2.95
LM310CN	1.75	LM377N	2.95	LM1871N	5.49
LM311/CN	.90	LM380N	1.25	LM1872N	5.49
LM312H	2.49	LM381N	1.95	LM1877N-9	3.25
LM317MP	1.15	LM382N	1.79	LM1889N	3.20
LM317T	1.75	LM384N	1.95	LM1896N	1.75
LM317K	3.95	LM386N-3	1.29	LM2002T	1.49
LM318CN	1.95	LM387N	1.45	LM2877P	2.05
LM319N	1.95	LM389N	1.35	LM2878P	2.25
LM320K-5	1.35	LM392N	.69	LM2896P-1	2.25
LM320K-12	1.35	LF398N	4.00	LM3189N	2.95
LM320K-15	1.35	LM399H	5.00	LM3900N	.69
LM320T-5	1.25	TL494CN	4.49	LM3905CN	1.25
LM320T-12	1.25	TL496CP	1.75	LM3909N	1.15
LM320T-15	1.25	NE510A	6.00	LM3914N	3.95
LM323K	5.95	NE529A	4.95	LM3915N	3.95
LM324N	.99	NE531H	3.95	LM3916N	3.95
LM329DZ	.65	NE536H	6.00	RC4136N	1.25
LM331N	3.95	NE540H	6.00	RC4151NB	3.95
LM334Z	1.30	NE544N	4.95	RC4194TK	6.95
LM335Z	1.40	NE550A	1.30	RC4195TK	5.49
LM336Z	1.75	NE555V	.39	LM4500A	3.25
LM337T	1.95	LM556N	.99	ICL8038B	4.95
LM337MP	1.15	NE564N	3.95	LM13080N	1.29
LM338K	6.95	LM565N	1.25	LM13600N	1.49
LM339N	.99	LM566CN	1.95	75138N	1.95
LM340K-5	1.35	LM567V	1.25	75450N	.89
LM340K-12	1.35	NE570N	4.95	75451CN	.39
LM340K-15	1.35			75492	.89

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

Value	1-9	10-99	100+	Value	1-9	10-99	100+
10 pf	.08	.06	.05	.001µF	.08	.06	.05
22 pf	.08	.06	.05	.0047µF	.08	.06	.05
47 pf	.08	.06	.05	.01µF	.08	.06	.05
100 pf	.08	.06	.05	.022µF	.09	.07	.06
220 pf	.08	.06	.05	.047µF	.09	.07	.06
470 pf	.08	.06	.05	.1µF	.15	.12	.10

100 VOLT MYLAR FILM CAPACITORS

.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022mf	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

+20% DIPPED TANTALUMS (Solid) CAPACITORS

.1/35V	.39	.34	.29	1.5/35V	.41	.37	.29
.15/35V	.39	.34	.29	2.2/35V	.51	.45	.34
.22/35V	.39	.34	.29	3.3/25V	.53	.47	.37
.33/35V	.39	.34	.29	4.7/25V	.63	.56	.45
.47/35V	.39	.34	.29	6.8/25V	.79	.69	.55
.68/35V	.39	.34	.29	15/25V	1.39	1.25	.95
1.0/35V	.39	.34	.29	22/6V	.79	.69	.55

MINI. ALUMINUM ELECTROLYTIC CAPACITORS

Axial	1-99	100-499	500+	Radial	1-99	100-499	500+
.47/50V	.16	.14	.10	.47/25V	.15	.13	.12
1.0/50V	.19	.16	.12	.47/50V	.16	.14	.13
3.3/50V	.17	.15	.11	1.0/16V	.15	.13	.12
4.7/25V	.18	.15	.11	1.0/25V	.16	.14	.13
10/25V	.18	.15	.11	1.0/50V	.17	.15	.14
10/50V	.19	.16	.12	4.7/16V	.15	.13	.12
22/25V	.19	.16	.12	4.7/25V	.16	.14	.13
22/50V	.24	.20	.18	4.7/50V	.17	.15	.14
47/25V	.25	.21	.19	10/16V	.15	.13	.12
47/50V	.29	.25	.23	10/25V	.16	.14	.13
100/25V	.28	.24	.22	10/50V	.17	.15	.14
100/50V	.41	.37	.34	47/50V	.25	.21	.19
220/25V	.39	.34	.33	100/16V	.21	.17	.14
220/50V	.49	.45	.41	100/25V	.25	.23	.21
470/25V	.54	.49	.45	100/50V	.37	.34	.31
1000/16V	.79	.69	.61	220/16V	.25	.21	.19
2200/16V	.89	.79	.69	470/25V	.35	.31	.27

$10.00 Minimum Order — U.S. Funds Only
California Residents Add 6% Sales Tax
Postage — Add 5% plus $1.50 Insurance
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Spec Sheets — 25¢
Send 88¢ Postage for your *FREE* 1982 JAMECO CATALOG
Prices Subject to Change

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Jameco® ELECTRONICS

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PHONE ORDERS WELCOME — (415) 592-8097

6/82

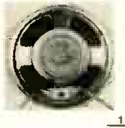
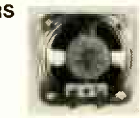
UTIC
MINI STEREO AM/FM RECEIVER
WITH HEADPHONES

For Joggers, Cyclists, Skaters & Sports Events!

FEATURES: Lightweight headphones. Left/right balance control. Full fidelity stereo sound. Additional black soft carrying case & shoulder strap. Belt clip (hands free). Operates on 3 AA cell batteries (not incl.). Compact size: 3⅛" x 4⅞" x 1". Wt. 6 oz.

Model 2830 List Price $89.95 .... **$34.95**

SPEAKERS

	1	2-9
Part # A0201	1.25	.99

2¼" Round — 8 Ohm
.25 Watt (4" Leads)
Size: 2¼" x ¾"

	1	2-9
Part # SF-25016	1.39	1.25

2½" Square — 16 Ohm
.25 Watt (4 mount. holes)
Large Ceramic Magnet
Size: 2⅝" x 2⅝" x ¾"

National Semiconductor
RAM SALE

STATIC RAMS
MM2114N-2 4K (200NS) .... **$2.49 each**
(8 EACH $16.95/lot) (100 EACH $195.95/lot)
MM2114N-2L 4K (200NS) Low Power .... **$2.95 each**
(8 EACH $19.95/lot) (100 EACH $225.00/lot)
MM2147N 4K (70NS) .... **$4.95 each**
(8 EACH $34.95/lot) (100 EACH $419.95/lot)
MM6116P-4 16K (200NS) .... **$14.95 each**
(8 EACH $99.95/lot) (100 EACH $1195.00/lot)

DYNAMIC RAMS
MM4164N-20 64K (200NS) .... **$14.95 each**
(8 EACH $99.95/lot) (100 EACH $1195.00/lot)
MM5290N-2 16K (150NS) 4116 .... **$2.95 each**
(8 EACH $19.95/lot) (100 EACH $225.00/lot)
MM5290N-4 16K (250NS) 4116 .... **$1.95 each**
(8 EACH $14.95/lot) (100 each $175.00/lot)

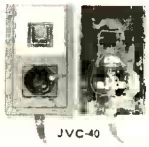
EPROM Erasing Lamp

- Erases 2708, 2716, 1702A, 5203Q, 5204Q, etc.
- Erases up to 4 chips within 20 minutes.
- Maintains constant exposure distance of one inch.
- Special conductive foam liner eliminates static build-up.
- Built-in safety lock to prevent UV exposure.
- Compact — only 7-5/8" x 2-7/8" x 2"
- Complete with holding tray for 4 chips.

UVS-11EL Replacement Bulb $16.95
UVS-11E **$79.95**

JOYSTICKS

JS-5K

JVC-40

JS-5K	5K Linear Taper Pots	$5.25
JS-100K	100K Linear Taper Pots	$4.95
JVC-40	40K (2) Video Controller in case	$4.95

MUFFIN® FAN

The dependable, low cost, largest selling fan for commercial cooling applications.

- 105cfm free air delivery
- 4.68" sq. x 1.50" depth. Weight - 17 oz.
- acoustical rating as low as NC-38
- more than 10 yrs. cont. duty at 10°C.
- impedance protected
- for ambients to 70°C
- UL yellow card recognized & CSA approved

115V, 50/60Hz, 14 Watts, 105cfm — Ultrasonically cleaned & tested.

MU2A1 .... $9.95 ea.

NEW!
JE215 Adjustable Dual Power Supply

General Description: The JE215 is a Dual Power Supply with independent adjustable positive and negative output voltages. A separate adjustment for each of the supplies provides the user unlimited applications for IC current voltage requirements. The supply can also be used as a general all-purpose variable power supply.

FEATURES:
- Adjustable regulated power supplies, pos. and neg. 1.2VDC to 15VDC.
- Power Output (each supply): 5VDC @ 500mA, 10VDC @ 750mA, 12VDC @ 500mA, and 15VDC @ 175mA.
- Two, 3-terminal adj. IC regulators with thermal overload protection.
- Heat sink regulator cooling
- LED "on" indicator
- Printed Board Construction
- 120VAC input
- Size: 3-1/2"w x 5-1/16"L x 2"H

JE215 Adj. Dual Power Supply Kit (as shown) . . $24.95
(Picture not shown but similar in construction to above)
JE200 Reg. Power Supply Kit (5VDC, 1 amp) . . $14.95
JE205 Adapter Brd. (to JE200) ±5,±9 & ±12V . $12.95
JE210 Var. Pwr. Sply. Kit, 5-15VDC, to 1.5amp. $19.95

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES		
INS8080A	CPU	4.95
DP8212	8-Bit Input/Output	3.25
DP8214	Priority Interrupt Control	5.95
DP8216	Bi-Directional Bus Driver	3.49
DP8224	Clock Generator/Driver	3.95
DP8226	Bus Driver	3.49
DP8228	System Controller/Bus Driver	4.95
DP8238	System Controller	5.95
INS8243	I/O Expander for 48 Series	9.95
INS8250	Asynchronous Comm. Element	16.95
DP8251	Prog. Comm. I/O (USART)	6.95
DP8253	Prog. Interval Timer	8.95
DP8255	Prog. Peripheral I/O (PPI)	5.95
DP8257	Prog. DMA Control	9.95
DP8259	Prog. Interrupt Control	6.95
DP8275	Prog. CRT Controller	39.95
DP8279	Prog. Keyboard/Display Interface	9.95
DP8303	System Timing Element	6.95
DP8304	8-Bit Bi-Directional Receiver	3.95
DP8307	8-Bit Bi-Directional Receiver	3.95
DP8308	8-Bit Bi-Directional Receiver	3.95
DP8310	Octal Latched Peripheral Driver	5.25
DP8311	Octal Latched Peripheral Driver	5.25
6800/6800 SUPPORT DEVICES		
MC6800	MPU	7.95
MC6802CP	MPU with Clock and RAM	14.95
MC6810API	128x8 Static RAM	4.95
MC6821	Peripheral Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	17.95
MC6830L8	1024x8-Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	6.95
MC6852	Synchronous Serial Data Adapter	6.95
MC6860	0-600bps Digital MODEM	10.95
MC6862	2400bps Modulator	12.95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25
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Z80 (780C)	CPU (MK3880N) (2MHz)	11.95
Z80A (780-1)	CPU (MK3880N-4) (4MHz)	13.95
CDP1802	CPU	19.95
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IDM2901ADC	CPU—4-Bit Slice (Com. Temp. Grade)	19.95
MCS6502	MPU w/Clock (65K Bytes Memory)	11.95
INS8035N-6	MPU—8-Bit (6MHz)	7.95
INS8039N-6	CPU—Sgl. Chip 8-Bit (128 bytes RAM)	9.95
INS8040N-6	CPU (256 Bytes RAM)	24.95
INS8070N	CPU—64 Bytes RAM	24.95
INS8073N	CPU w/Basic Micro Interpreter	29.95
P8085	CPU	9.95
TMS9900JL	MPU—16-Bit	39.95
1173AN-1	**30 Tune Musical MPU Chip**	**8.95**
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MM503H	Dual 50-Bit Dynamic	.50
MM506H	Dual 100-Bit Static	.50
MM510H	Dual 64-Bit Accumulator	.50
MM1402N	256-Bit Dynamic	2.95
MM5013N	1024-Bit Dynamic/Accumulator	1.95
MM5016N	500/512-Bit Dynamic	1.95
MM5034N	Octal 80-Bit	9.95
MM5035N	Octal 80-Bit	9.95
2504V (1404A)	1024-Bit Dynamic	1.95
2518N	Hex 32-Bit Static	3.95
2522V	Dual 132-Bit Static	2.95
2524V	512-Bit Dynamic	.99
3341PC	Fifo (Dual 80)	6.95
DATA ACQUISITION		
DC10	Mostek DC/DC Convert. +5V to 9V	$2.95
MC3470P	Floppy Disc Read AMP System	4.95
MC1408L7	7-Bit D/A Converter (DAC0807LCN)	4.95
MC1408L8	8-Bit D/A Converter (DAC0808LCN)	5.75
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AF122-1CJ	Touch Tone High Band Filter	19.95
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LM334Z	Constant Current Source	1.30
LM335Z	Temperature Transducer	1.40
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LF398N	Sample & Hold Amplifiers	3.95
LM399H	Temp. Comp. Prec. Ref. (.5ppm/C°)	5.00
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DAC0806LCN	8-Bit D/A Converter (0.78% Lin.)	2.25

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DAC1000LCN	10-Bit D/A Conv. Micro. Comp. (0.05%)	13.95
DAC1008LCN	10-Bit D/A Conv. Micro. Comp. (0.20%)	8.95
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CD4051N	8-Channel Multiplexer	1.19
AY-5-1013	30K BAUD UART	6.95
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1101	256x1 Static	1.49
1103	1024x1 Dynamic	.99
2101 (8101)	256x4 Static	3.95
2102	1024x1 Static	1.75
21L02	1024x1 Static	1.95
2111 (8111)	256x4 Static	3.95
2112	256x4 Static MOS	4.95
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2114L	1024x4 Static 450ns Low Power	2.49
2114-2	1024x4 Static 200ns	2.49
2114L-2	1024x4 Static 200ns Low Power	2.95
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MM5262	2Kx1 Dynamic	.49
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UPD414/MK4027	4K Dynamic 16-pin	4.95
TMS4044-45NL	4K Static	9.95
TMS4045	1024x4 Static	9.95
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1702A	2K UV Erasable PROM	5.95
2708	8K EPROM	2.95
TMS2716	16K EPROM (-5V, +5V, +12V)	9.95
2716Intel (2516) TI	16K EPROM (Single +5V)	8.95
2732Intel TI	32K EPROM	17.95
2758	8K EPROM (450ns) (Single +5V)	7.49
2764Q	64K EPROM (Hitachi HN462764)	49.95
5203	2048 PROM	14.95
82S23 (74S188)	32x8 PROM (Open Collector)	3.95
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2513 (2140)	Character Generator (Upper Case)	9.95
2513 (3021)	Character Generator (Lower Case)	9.95
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MCM66710P	128x9x7 ASCII Shifted w/Greek	13.50
MCM66740P	128x9x7 Math Symbol & Pictures	13.50
MCM66750P	128x9x7 Alpha. Control Char. Gen.	13.50
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M-COP1802	User Manual	7.50
M-2650	User Manual	5.00
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DS0026CN	Dual MOS Clock Driver (5MZ)	1.95
INS1771N-1	Floppy Disc Controller	24.95
INS2651N	Communication Chip	19.95
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MM58174N	Microprocessor Compatible Clock	11.95
COP402N	Microcontroller with 64-Digit RAM and Direct LED Drive	6.95
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COP470N	32-Seg.VAC Fluor. Driver (20-pin pkg.)	3.25
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AY-5-9100	Push Button Telephone Dialer	14.95
AY-5-9200	Repertory Dialer	14.95
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AY-5-2376	Keyboard Encoder (88 keys)	11.95
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MM53190N	Push Button Pulse Dialer	7.95
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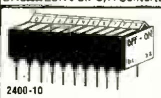

2400-10

EECO Rocker DIP Switch — "Mini-Dip™" 2400 Series
THE MOST UNIQUE DIP SWITCH AVAILABLE!
MINI-DIP is designed to retrofit all major brands of Dip switches. Unique features include locking rod design to prevent accidental actuation and gold self-wiping contact. One-piece housing and press-fit terminals prevent contamination. 2-10 station Form "A" and 1-5 station Form "C." • Terminals on .100 x .300 (2.54 x 7.62) centers • PCB or dip socket mountable • Positive cleaning/wiping action with gold contact • Total seal and bottom seal

Part No.	Pos.	Configuration	Socket	Price	Part No.	Pos.	Configuration	Socket	Price
2400-2	2	12	8 pin	.79 - 10/ 6.95	2400-6	6	123456	14 pin	1.09 - 10/ 9.95
2400-3	3	123	8 pin	.89 - 10/ 7.95	2400-7	7	1234567	14 pin	1.19 - 10/10.95
2400-4	4	1234	8 pin	.99 - 10/ 8.95	2400-8	8	12345678	16 pin	1.29 - 10/11.95
2400-ABCD	4	ABCD	8 pin	.99 - 10/ 8.95	2400-9	9	123456789	18 pin	1.39 - 10/12.95
2400-5C	6	C54321	14 pin	1.09 - 10/ 9.95	2400-10	10	0123456789	20 pin	1.49 - 10/13.95

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GB160 100 pieces Robot/Slot Car Gears, Shafts, Wheels, Motors $9.95

Part No.	Description	Price
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GB101	60 each Mylar	4.00
GB102	60 each Electrolytics	4.00
GB103	40 each Tantalum (tubular & dipped)	4.00
GB176	40 each Dipped Micas (10pf-1000pf @ 100-500V)	4.00
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GB109	30 each Linear — marked (LM301, 307, 741, 308, etc.)	4.00
GB148	30 each Exar — marked (XR320, 1310, 4136, etc.)	4.00
GB150	20 each Shift Registers — marked (2510, 2518, 2532, 2533, etc.	4.00
GB187	50 each DTL Series — marked (DM930, 932, 936, 946, etc.)	3.00
GB158	6 pcs. Positive Voltage Regulators (TO-3 case) (7805, 06, 12, 15, 18, 24, etc.) Linear marked	4.25
GB159	6 pcs. Negative Voltage Regulators (TO-3 case) (7905, 06, 12, 15, 18, 24, etc.) Linear marked	4.00
GB170	25 each Assorted 74LS TTL Series	4.00
GB172	10 pcs. 78M Positive Volt. Reg. (TO-5 case) (78M05, 8, 12, 15, 20, 24, etc.) Linear marked	5.00
LEDS — LAMPS — READOUTS		
GB110	100 each Assorted LEDs (colors & sizes) (XC556, XC526, etc.)	$6.00
GB111	40 each NE-2 Neon Type Lamps	3.00
GB112	20 ea. Multiple Readouts, calculators, sticks, timers, LEDS to Panaplex — new, used and rejects	4.00
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POTENTIOMETERS		
GB113	30 each Miniature Trimmers (100 ohm-1 Meg)	$4.00
GB134	24 each 3/8" square single turn PC Mount (untested — 10 ohm to 500 ohm) marked	3.00
GB136	24 each 3/8" square single-turn PC Mount (untested — 1K to 50K) marked	3.00
GB138	24 each 3/8" square single-turn PC Mount (untested — 100K to 5 Meg) marked	3.00
GB173	100 ea. 3/8" sq. single-turn (U Test & Sort)	5.00
GB174	25 ea. ½ watt thumbwheel single turn (500 ohm-5 Meg)	2.00
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GB107	100 each Silicon (IN914/IN4148)	2.00
GB164	200 each marked, unmarked rectifiers & zeners	2.00
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Part No.	Description	Price
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GB117	200 each 1/2 watt resistor assortment	2.00
GB118	30 ea. Wire Wound 5,10,20W (.1-100 ohm)	4.00
GB154	100 each 1 and 2 watt resistor assortment	2.00
GB178	500 each 1/4, 1/2, 1 watt (marked/unmarked) resistors	4.00
SWITCHES		
GB120	25 each Miniature slide	$3.00
GB122	20 ea. Reed relays with coil and magnet — glass tube	5.00
GB165	40 asst. toggle, rocker, pushbutton	10.00
GB179	20 each Dip Switches (asst. positions)	9.95
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GB140	150 each Spacers, standoff, insulators (metal, nylon and plastic)	2.00
GB141	200 each Washers and Spacers (nylon and teflon)	2.00
GB142	50 ea. Chassis mounting feet (rubber and plastic)	2.00
GB144	200 each Solder lugs (small)	2.00
GB145	100 each Lugs — crimp on (some insulated)	2.00
GB146	100 each Grommets, cord strain reliefs and hole plugs	3.00
GB147	500 each Hardware mix (nuts, bolts, screws, lugs)	5.00
GB166	48 Threaded metal and plastic spacers (⅛-2" long)	2.00
GB167	200 pcs. sheet metal and metal tapping screws	2.00
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GB169	100 pcs. tie wraps and harness clips (3-8")	3.00
GB180	100 pcs. Robot/Slot Car gears, shafts, wheels, motors	9.95
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GB123	30 each Heat Sinks — assorted sizes	$3.00
GB124	8 each assorted calculator type keyboards	8.00
GB126	80 each Opto-Isolators — IL-1 Series (untested)	2.00
GB127	100 each Transistors — plastic and power	3.00
GB128	30 each Toroid Cores — iron and tape	4.00
GB129	50 each Photo Transistors (LPT)	4.00
GB130	1 each Tape Drive — 6V motor with read/write erase head and 2 cassette tapes (no amplifier)	5.00
GB131	30 each 6" shrink tubing, asst. sizes and colors	4.00
GB137	50 each Chokes, coils and inductors (molded-wire-adjustable)	3.00
GB138	2 each Speakers, 2⅝", 8 ohm, 1/4 watt	1.95
GB155	300 each mixed resistors, capacitors diodes, transistors, chokes	3.00
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30003	**National Linear Data Book** (1376 pages) LM, LF, ADC, DAC, LH Series	$11.95
30004	**National Series 80 — Board Level Computer** (224 pages)	$4.95
30005	**National TTL Logic Data Book** (624 pages) 7400,LS,L,H,S, and DM8000 Series	$8.95

30006 Above (3) 30001,3,5 as set $24.95/lot

010400	**Intel Component Data Catalog** Full data sheets for Intel's products incl. memory devices, microproc., peripherals & indust./mil. products (1328 pages)	$14.95
205610	**Intel Peripheral Design Handbook** Full data sheets, appl. notes for Intel peripheral device components (644 pages)	$9.95

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With Universal Plug and 9V Battery Snap

Selective voltages: 6,9,12VDC. Polarity selection (+/-). six-foot line from adapter to plugs — six-inch line from adapter to battery snap. 120V/60Hz. 300mA.

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AC 500	117V/60Hz	12VAC 500mA	$4.95
AC1000	117V/60Hz	12VAC 1 amp	$5.95
AC1700	117V/60Hz	9VAC 1.7 amp	$3.95
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DC6912 (above)	120V/60Hz	6,9,12VDC 300mA	$9.95
DV9200	117V/60Hz	9VDC 200mA	$3.25
DC900	120V/60Hz	9VDC 500mA	$3.95
DC1200	120V/60Hz	12VDC 300mA	$2.95

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DB25P	D-Subminiature Plug	$2.95
DB25S	D-Subminiature Socket	$3.50
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DB51226	Cover for DB25P/S	$1.75
22/44SE	P.C. Edge (22/44 Pin)	$2.95
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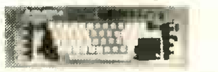
UG89/U	BNC Jack	$3.79
UG175/U	UHF Adapter	$ .49
SO239	UHF Panel Recp.	$1.29
PL258	UHF Adapter	$1.60
PL259	UHF Plug	$1.60
UG260/U	BNC Plug	$1.79
UG1094/U	BNC Bulkhead Recp.	$1.29

TRS-80 16K Conversion Kit
Expand your 4K TRS-80 System to 16K
Kit comes complete with:
- 8 ea. MM5290 (UPD416/4116) 16K Dyn. Ram (*ns)
- Documentation for conversion

TRS-16K2 *150ns 19.95
TRS-16K3 *200ns 16.95
TRS-16K4 *250ns 14.95

KEYBOARDS

Limited Quantity



Datanectics 74-Key Keyboard
Uses EA 20134 Chip (Electronic Arrays). Size: 16¾"L x 5½"W x 1-3/8"H. White, black, blue, grey key caps. (No Data Sheet) —
Part No. KB354 .... $29.95 ea.

Limited Quantity

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Uses AMI SW20350K Chip. Size: 16-3/8"L x 5¼"W x 1-5/8"H Metal Frame. Light & dark grey key caps (No Data Sheet)
Part No. KB69SD12-2 .... $19.95 ea.

Boschert Multi-Voltage Power Supply
5VDC, 12VDC and 24VDC

Limited Quantity

FEATURES: Voltages*: 5VDC @ 25amps, 12VDC @ 4amps, & 24VDC @ 4amps. Reg. Load: +5V out ±1%, +12 & 24V out ±5% (20-100% load). Overvolt. & overcurr. protection. 115 or 230VAC input. Wt. 4 lbs. Size: 4.95" x 2.50" x 15.00"
*Total average output shall not exceed 200 watts.

General Description: The "Boschert" Power Supply was originally designed for application with ITT Advance Terminal Controller (ATC). This open frame switching power supply provides user with high current requirements common in use with computer systems. Its compact size provides versatility for mounting into electronic enclosures. Each supply has 6 threaded fasteners (pem nut type) for mounting. Specification requirements to be used with ATC enclosed.

Part No. 200-3010 .... $69.95 each
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JE600 Hexadecimal Encoder Kit
FULL 8-BIT LATCHED OUTPUT
19-KEY KEYBOARD

The JE600 Encoder Keyboard Kit provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8-bit microprocessor or 8-bit memory circuits. Three additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with 9 LED readouts. Also included is a key entry strobe. Features: Full 8-bit latched output for microprocessor use. Three user-define keys with one being bistable operation. Debounce circuit provided for all 19 keys. 9 LED readouts to verify entries. Easy interfacing with standard 16-pin IC connector. Only +5VDC required for operation. Size: 3½"H x 8¾"W x 8¾"D

JE600/DTE-HK (After assembled as pictured above) **$99.95**
JE600 Kit 19-Key Hexadec. Keyboard, PC Board & Cmpnts. (no case) .. **$59.95**
K19 19-Key Keyboard (Keyboard only) **$14.95**
DTE-HK (case only — 3½"Hx8¼"Wx8¾"D) **$44.95**

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20 Pin	7/1.00
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8748 Intel	15.95

74LS

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LS08	.24	LS153	.79	LS266	.59
LS10	.24	LS154	1.75	LS283	.99
LS14	.89	LS157	.79	LS290	.99
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LS86	.39	LS221	1.10	LS377	1.49
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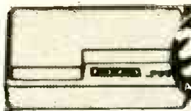

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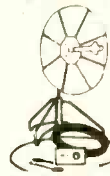

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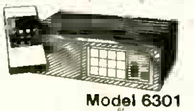

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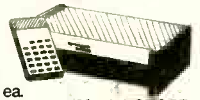

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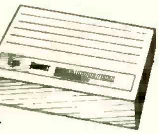

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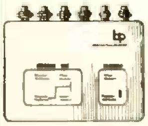

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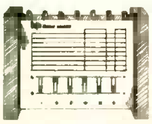

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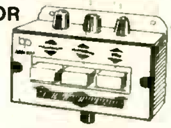

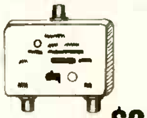

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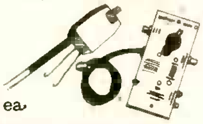

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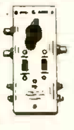

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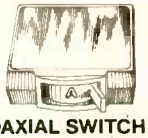

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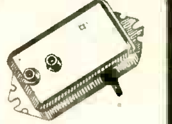

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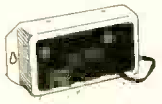

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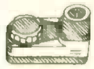

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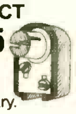

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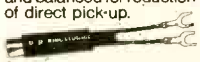

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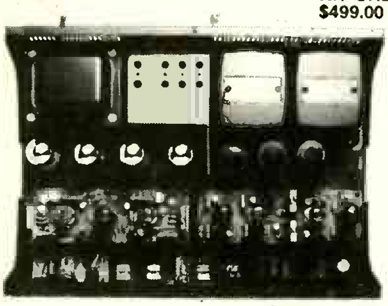

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Send $5.00 for each assembly manual, refundable with order.

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* Signal-to-Noise Ratio 120dB
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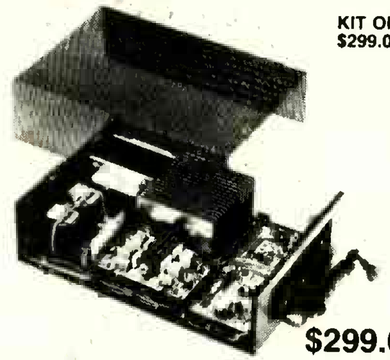

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* Max Output 15V
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LS05	.25	1.23	LS139	.75	3.56	LS243	1.75	8.31
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LS10	.25	1.23	LS147	2.49	-	LS245	2.15	-
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LS26	.35	1.66	LS155	.90	4.28	LS260	.65	-
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LS30	.25	1.23	LS157	.75	3.56	LS279	.50	2.38
LS32	.35	1.66	LS158	.75	3.56	LS290	.80	3.80
LS37	.55	2.50	LS160	.90	4.28	LS293	.80	3.80
LS38	.35	1.66	LS161	.95	4.51	LS295	1.05	4.99
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LS74	.45	2.14	LS163	.95	4.51	LS368	.70	3.33
LS75	.50	2.38	LS164	.95	4.51	LS373	1.85	8.79
LS85	1.15	5.46	LS166	1.75	8.31	LS374	1.80	8.55
LS86	.40	1.90	LS173	.80	3.80	LS377	1.45	6.89
LS90	.60	2.85	LS174	.95	4.51	LS378	1.18	5.61
LS92	.60	2.85	LS175	.95	4.51	LS620	2.25	-
LS93	.60	2.85	LS190	1.00	4.75	LS626	2.25	-
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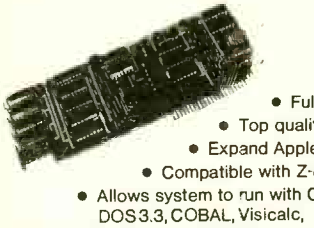

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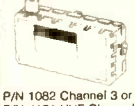

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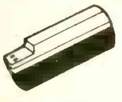

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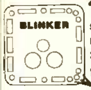

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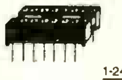

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16 pin LP	.22	.21	.20
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20 pin LP	.34	.32	.30
22 pin LP	.29	.27	.24
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28 pin LP	.45	.44	.43
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LM320T-XX*	1.39	CA3046N	1.29
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LM339N	.95	CA3080T	1.29
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LM340T-XX*	1.25	CA3082N	1.69
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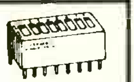
LM741CN-14	.19	SN75454N	.49
LM747N/H	.75	SN75491N	.89
LM748N/H	.39	SN75492N	.89
LM760CN	2.95	SN75493N	.89
LM1310N	1.90	SN75494N	.89
MC1330	1.95	TL494CN	4.20
MC1350	1.95	TL496CP	1.65
MC1358	1.75		

74S00

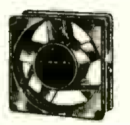
74S00	$.39	74S124	3.69	74S244	$2.99
74S02	.43	74S133	.54	74S251	1.35
74S03	.45	74S134	.66	74S253	1.35
74S04	.52	74S135	1.15	74S257	1.29
74S05	.52	74S136	1.69	74S258	1.29
74S08	.49	74S138	1.29	74S260	.75
74S09	.49	74S139	1.29	74S280	2.79
74S10	.42	74S140	.73	74S287	2.99
74S11	.42	74S151	1.29	74S288	2.55
74S15	.42	74S153	1.29	74S373	3.10
74S20	.42	74S157	1.29	74S374	3.10
74S22	.42	74S158	1.29	74S387	2.75
74S30	.42	74S160	2.79	74S471	7.95
74S32	.49	74S174	1.49	74S472	7.95
74S38	1.19	74S175	1.49	74S473	7.95
74S40	.49	74S188	2.69	74S474	9.95
74S51	.42	74S194	1.89	74S475	9.95
74S64	.46	74S195	1.89	74S570	5.75
74S65	.46	74S196	1.89	74S571	5.75
74S74	.69	74S240	2.75	74S572	8.95
74S86	.72	74S241	2.75	74S573	8.95
74S112	.72	74S242	2.99	74S940	2.90
74S113	.72	74S243	2.99	74S941	2.90
74S114	.72				

DIP SWITCHES



2 Position	$ .99	7 Position	$1.39
4 Position	1.19	8 Position	1.49
5 Position	1.29	9 Position	1.65
8 Position	1.35	10 Position	1.69

MUFFIN® FAN



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7400

7400	$.19	7475	$.38	74161	$.88
7401	.22	7476	.34	74162	.89
7402	.22	7479	4.60	74163	.87
7403	.22	7480	.49	74164	.87
7404	.22	7482	.95	74165	.87
7405	.23	7483	.55	74166	1.20
7406	.35	7485	.65	74167	1.95
7407	.35	7486	.35	74170	1.69
7408	.26	7489	1.75	74172	4.75
7409	.23	7490	.39	74173	.79
7410	.22	7491	.57	74174	.89
7411	.29	7492	.45	74175	.85
7412	.29	7493	.45	74176	.75
7413	.39	7494	.69	74177	.75
7414	.59	7495	.65	74179	1.34
7416	.29	7496	.69	74180	.75
7417	.29	7497	2.90	74181	1.75
7420	.22	74100	2.90	74182	.75
7421	.35	74107	.32	74184	2.25
7422	.29	74109	.37	74185	2.25
7423	.29	74116	1.95	74186	9.95
7425	.29	74121	.29	74188	3.90
7426	.29	74122	.39	74190	1.15
7427	.25	74123	.59	74191	1.15
7429	.45	74125	.39	74192	.85
7430	.23	74126	.44	74193	.85
7432	.29	74128	.59	74194	.85
7437	.25	74132	.69	74195	.68
7438	.29	74136	.75	74196	.85
7439	.29	74139	.95	74197	.85
7440	.19	74141	.79	74198	1.39
7441	.79	74142	2.95	74199	1.39
7442	.57	74143	2.95	74221	1.19
7443	.95	74144	2.95	74251	.95
7444	.95	74145	.62	74273	1.05
7445	.79	74147	1.95	74276	1.89
7446	.79	74148	1.20	74279	.75
7447	.65	74150	1.09	74283	1.40
7448	.79	74151	.67	74284	3.90
7450	.19	74152	.67	74285	3.90
7451	.19	74153	.67	74290	1.25
7453	.19	74154	1.19	74298	.95
7454	.19	74155	.78	74365	.68
7459	.25	74156	.78	74366	.68
7460	.23	74157	.69	74367	.68
7470	.29	74158	1.65	74368	.68
7472	.29	74159	2.49	74390	1.45
7473	.34	74160	.88	74393	1.90
7474	.34			74490	1.90

74LS00

74LS00	$.26	74LS113	$.43	74LS245	$2.20
74LS01	.28	74LS114	.43	74LS247	1.10
74LS02	.28	74LS122	.55	74LS248	1.10
74LS03	.28	74LS123	1.19	74LS249	1.19
74LS04	.35	74LS124	1.35	74LS251	1.40
74LS05	.28	74LS125	.89	74LS253	1.40
74LS08	.28	74LS126	.52	74LS257	.85
74LS09	.35	74LS132	.79	74LS258	.98
74LS10	.28	74LS136	.49	74LS259	2.95
74LS11	.39	74LS138	.85	74LS260	.65
74LS12	.33	74LS139	.85	74LS261	2.49
74LS13	.47	74LS145	1.25	74LS266	.59
74LS14	.95	74LS148	1.49	74LS273	1.75
74LS15	.33	74LS151	.79	74LS275	4.40
74LS20	.26	74LS153	.79	74LS279	.59
74LS21	.33	74LS154	1.70	74LS283	.99
74LS22	.33	74LS155	1.19	74LS290	.99
74LS26	.33	74LS156	.99	74LS293	.99
74LS27	.33	74LS157	.85	74LS295	1.10
74LS28	.33	74LS158	.75	74LS298	1.19
74LS30	.26	74LS160	1.05	74LS324	1.75
74LS32	.33	74LS161	1.15	74LS347	1.95
74LS33	.55	74LS162	1.05	74LS348	1.95
74LS37	.45	74LS163	1.05	74LS352	1.19
74LS38	.39	74LS164	1.19	74LS353	1.19
74LS40	.26	74LS165	.89	74LS363	1.49
74LS42	.79	74LS166	2.48	74LS365	.69
74LS47	.79	74LS168	1.15	74LS366	.69
74LS48	.95	74LS169	1.15	74LS367	.69
74LS51	.26	74LS170	1.99	74LS368	.69
74LS54	.29	74LS173	.89	74LS373	1.89
74LS55	.29	74LS174	.89	74LS374	1.89
74LS73	.45	74LS175	.89	74LS375	.69
74LS74	.42	74LS181	2.20	74LS377	1.95
74LS75	.59	74LS190	1.15	74LS385	1.95
74LS76	.45	74LS191	1.15	74LS386	.65
74LS78	.45	74LS192	.98	74LS390	1.95
74LS83A	.79	74LS193	.98	74LS393	1.95
74LS85	1.19	74LS194	1.15	74LS395	1.70
74LS86	.45	74LS195	.95	74LS399	2.35
74LS90	.57	74LS196	.89	74LS424	2.95
74LS92	.75	74LS197	.89	74LS668	1.75
74LS93	.75	74LS221	1.15	74LS670	2.29
74LS95	.88	74LS240	1.69	81LS95	1.69
74LS96	.98	74LS242	1.69	81LS96	1.69
74LS107	.45	74LS243	1.69	81LS97	1.69
74LS109	.45	74LS244	1.49	81LS98	1.69
74LS112	.43				

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4000	$.35	4037	$1.95	4089	$2.95
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4008	1.39	4044	.85	14408	12.95
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4010	.45	4047	1.25	14410	12.95
4011	.35	4048	.99	14412	12.95
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4013	.45	4050	.69	14419	4.95
4014	1.39	4051	1.10	4501	.39
4015	1.15	4052	1.10	4502	1.65
4016	.59	4053	1.10	4503	.69
4017	1.19	4055	3.95	4505	8.95
4018	.89	4056	2.95	4506	.75
4019	.45	4059	9.25	4507	.95
4020	1.10	4060	1.39	4508	3.75
4021	1.19	4066	.75	4510	1.19
4022	1.15	4069	.35	4511	1.19
4023	.29	4070	.49	4512	1.39
4024	.75	4071	.35	4515	2.75
4025	.25	4072	.35	4516	1.45
4027	.65	4073	.35	4518	1.39
4028	.85	4075	.35	4520	1.25
4029	1.29	4076	1.29	4555	4.95
4030	.45	4077	.35	4556	.99
4031	3.25	4078	.35	4566	2.25
4032	2.15	4081	.35	80C95	1.50
4034	3.25	4082	.35	80C97	1.25
4035	.95	4085	1.95		

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LM730CN	3/1.99	6522	6.95	74LS93	3/1.00	1103 RAM	3/1.50
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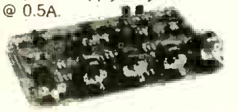
LOW TIM DC STEREO PRE-AMP KIT TA-10 20

Incorporates brand-new D.C. design that gives a frequency response from 0Hz-100KHz ± 0.5dB! Added features like tone defeat and loudness control let you tailor your own frequency supplies to eliminate power fluctuation! Specifications: • T.H.D. less than .005% • T.I.M. less than .005% • Frequency response: DC to 100KHz ± 0.5dB • RIAA deviation: ± 0.2dB • S/N ratio: better than 70dB • Sensitivity: Phono 2MV 47K/Aux. 100MV 100K • Output level: 1.3V • Max output: 15V • Tone control: bass ± 10dB @ 50Hz/treble ± 10dB @ 15Hz • Power supply: ± 24 D.C. @ 0.5A

Kit comes with regulated power supply, all you need is a 48V C.T. transformer @ 0.5A.



ONLY $44.50

X'former

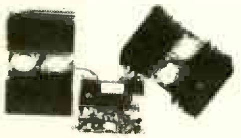
$4.50 ea.

100W CLASS A POWER AMP KIT

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

Specifications:

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



TA-1000KIT
$51.95
Power transformer
$24.00 each

50 WATTS AUTO STEREO BOOSTER BY VERTRONIX

Specifications:
- 50 watts RMS total (25W + 25W)
- Frequency Response: ± 0.5dB, 20Hz ~ 20KHz
- T.H.D.: 0.2% at full rated output
- Input Impedance: 20K ohms
- Crosstalk: Better than 90dB
- Sensitivity: 1.5V for full rated output
- S/N Ratio: Greater than 95dB
- Speaker Load: 2 ~ 8 ohms
- Voltage Supply: 9 ~ 18V D.C.

Model V-Amp 500

REG. PRICE $119.00 EACH

OUR SPECIAL PRICE $55.00 EACH

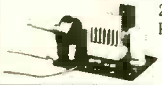
"FISHER" 30 WATT STEREO AMP

MAIN AMP (15W x 2)

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

Super Buy Only $18.50

5W AUDIO AMP KIT

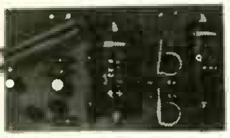


2 LM 380 with Volume Control Power Supply 6 18V DC

ONLY $6.00 EACH

2 WATT AUDIO AMP

Pre assembled units. All you need is to hook up the speaker and the volume control. Supply voltage from 9 ~ 15V D.C. measures only 2" x 3½", making it good for portable or discrete applications. Comes with hook up data.



BUY 2 FOR $4.99

1 WATT AUDIO AMP

All parts are pre-assembled on a mini PC Board. Supply Voltage 6 ~ 9V D.C.

SPECIAL PRICE $1.95 ea.

NEW MARK III 9 Steps 4 Colors LED VU

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

IN KIT FORM $18.50

MARK IV 15 STEPS LED POWER LEVEL INDICATOR KIT

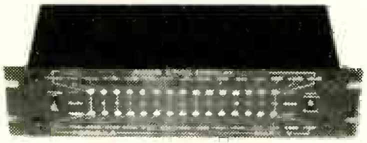
This new stereo level indicator kit consists of 36 4-color LED (15 per channel) to indicate the sound level output of your amplifier from −36dB +3dB. Comes with a well-designed silk screen printed plastic panel and has a selector switch to allow floating or gradual output indicating. Power supply is 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**

MARK V 15 STEPS LED POWER OUTPUT INDICATOR KIT

All functions same as Mark IV but this is with heavy duty aluminum front plate and case. Can be easily slot into the front panel of your auto, truck or boat. Operates on 12V DC.

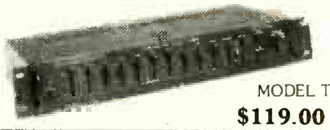


$41.50 EACH KIT

SOLID STATE STEREO GRAPHIC EQUALIZER PRE AMP KIT TA-2500

Specifications:
- Total Harmonic Distortion: Less than 0.05%
- Intermodulation Distortion: (70Hz:7KHz = 4:1 SMPTE Method) Less than 0.03%
- Frequency Response: Overall 10Hz ~ 100KHz +0.5dB, −1dB
- RIAA Curve Deviation: (Phono) +0.2dB, −0.2dB (30Hz ~ 15KHz)
- Channel separation (at rated output 1KHz)
- Phono, Tuner, Aux and Tape Monitor better than 70dB.
- Input sensitivity and impedance (1KHz for rated output)

Phono: 2MV 47K ohms Aux: 130MV 50K ohms
Tuner: 130MV 50K ohms Tape: 130MV 50K ohms
Graphic Equalizer control: 10 Band Slide Control
Frequency Bands: 31.5Hz; G3Hz; 125Hz; 250Hz; 500Hz; 1KHz; 2KHz; 4KHz; 8KHz; 16KHz also with on panel selector for Phono, Tuner, Aux 1 and Aux 2.
Power Supply: 117 VAC
Kit comes with all electronic components, transformer, instructions and a 19" rack mount type metal cabinet.



MODEL TA-2500
$119.00 PER KIT

ELECTRONIC DUAL SPEAKER PROTECTOR

Cutt off when circuit is shorted or over load to protect your amplifier as well as your speakers. A must for OCL circuits.

KIT FORM **$8.75 EA.**

PROFESSIONAL REGULATED VARIABLE D.C. POWER SUPPLY KIT

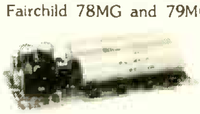
All solid state circuitry with high efficiency power transistor 2SD388 and I.C. voltage regulator MC1733. Output voltage can be adjusted from 0-30V at 1 amp current limited or 0-15V at 2 amp current limited. Internal resistance is less than 0.005 ohm; ripple and noise less than 1 MV, dual on panel meter for voltage and amp reading, also with on board LED and audible over load indicator. Kit comes with predrilled P.C. board, instructions, all necessary electronic components, transformer and a professional look metal cabinet. The best project for school and the most useful instrument for repairman. Build one today!

MODEL TR 88A 0 ~ 15V D.C. 2 amp
MODEL TR 88B 0 ~ 30V D.C. 1 amp

$59.50 PER KIT

REGULATED DUAL VOLTAGE SUPPLY KIT

± 4 ~ 30V DC 800 MA adjustable, fully regulated by Fairchild 78MG and 79MG voltage regulator I.C. Kit includes all electronic parts, filter capacitors, I.C., heat sinks and P.C. board.



$12.50 PER KIT

POWER SUPPLY KIT

0-30V D.C. REGULATED

Uses UA723 and ZN3055 Power TR output can be adjusted from 0-30V, 2 AMP. Complete with PC board and all electronic parts. Tranformer for Power Supply, 2 AMP 24V x 2 **$9.50**

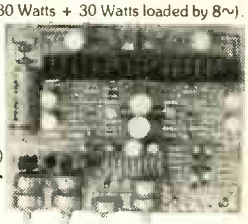
0-30 Power Supply
$10.50 each

TA-323 6 WATTS TOTAL 30W + 30W STEREO AMP KIT

This is a solid state all transistor circuitry with on board stereo pre-amp for most microphone or phone input. Power output employs 2 pairs matching Darlington Transistors. Driven by the popular 2N3053 Driver Transistors. Four built on board controls for, volume, balance, treble and bass. Power supplies requires 48 VET 2.5 amp transformer. T.H.D. of less than 0.1% between 100 Hz and 10KHz at full power. (30 Watts + 30 Watts loaded by 8~).

★ SPECIAL ★

EXCELLENT PRICE!



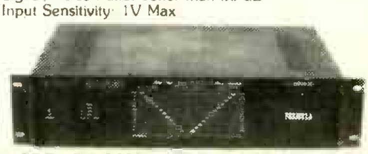
MODEL 001-0034
Transformer (Optional)

$29.50 PER KIT
$10.50 EACH

200 WATTS CLASS 'A' STEREO POWER AMP KIT TA-2600 (WITH LED POWER LEVEL DISPLAY AND RACK MOUNT TYPE CABINET)

TA-2600 is a kit that combines two sets of TA-1000 class A power amplifiers that can give you 100 watts of true power per channel. The kit also has the latest "V" shape LED power level display with memory Peak Hold on the front panel. For speaker protection it also has separate electronic speaker protection circuits. Kit comes with the 19" rack mount type metal cabinet with a professional quality black anodized front panel; all electronic parts and components; P.C. boards; filter capacitors and a heavy duty transformer.

Specifications:
- Power Level Display: Electronic LED type, 12 LED per channel from — 18 dB to 0 dB with Peak Hold memory
- Power Amplifier: Output power 100 Watts per channel into 8 Ohm load. 125 Watts into 4 Ohm load. Total Music power output 250 Watts Max
- Frequency Response: 10 Hz to 100 KHz
- Total Harmonic Distortion: Less than 0.008% at full power
- Signal/Noise Ratio: better than 80 dB
- Input Sensitivity: 1V Max



MODEL TA-2600
$225.00 KIT FORM
$285.00 FULLY ASSEMBLED

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Resistors Set	$2.00	Speaker Cabinet	$12.95
Trim Pots:		Transformer 18V 800MA	$3.00
Trim Caps Set	$13.50		
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We sell you all the above components in a package for **$125.00** and you will receive a free predrilled P.C. board and instructions at no charge!

SANYO UHF VARACTOR TUNER

For UHF CH 14 83

Tuning voltage +1V~ +28V D.C. Input impedance 75 OHM. I.F. band width 7~16 MHz. Noise figure 11.5dB MAX. Size 2⅝" x 1¼" x ¾". Supply voltage 15V D.C. Sound I.F. = 58.0 MHz. Video I.F. = 62.5 MHz.

All units are brand new from Sanyo.
MODEL 115-B-405A
$35.00 EACH

Tuner is the most important part for the circuit. Don't let those $19.00 tuners fool you!

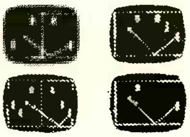
TV GAME BOARD

PLAYS 4 GAMES: TENNIS: HOCKEY: HANDBALL AND JAI-ALAI.

All boards complete with all parts ready to play. Requires 6C size batteries and a small speaker for sound effects. The boards were surplus from a famous game manufacturer. They will play on all US standard black and white or color TV sets. (Regular price for these games were $39.50 each) **OUR PRICE ONLY $6.50 EACH**

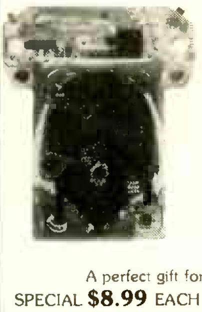
PART #57456

TENNIS JAI-ALAI



HOCKEY HANDBALL

ELECTRONIC PIN BALL MACHINE



That sounds and plays like the real thing. All units are brand new but without the case. Functions of the game include double flipper control, kicker control, 1-4 players, 3 speed ball control, tilt switch, automatic score, extra bonus cave and many more. All solid state with LED panel, no moving parts. Requires 9V battery to operate, speaker not included.

A perfect gift for yourself or friends.

SPECIAL **$8.99** EACH SPEAKER **$1.25** EACH

ELECTRONIC MUSICAL TELEPHONE REST KIT

This telephone rest can be used as a door charm, an audible indicator and for many other sound projects. The special custom made I.C. is pre programmed with 4 musical tunes. Kit comes with a nice looking plastic case, pre-drilled P.C. board, volume control, special sound I.C. speakers and all electronic components and instructions. Ideal for home or school projects.

BUY NOW!

SPECIAL PRICE! ONLY

$15.50 PER KIT

MODEL FIII-3000

DIGITAL TIMER/CLOCK

- 24 Hour preset time to turn on or off
- 12 Hour green 0.5" display for time
- operated on 12~16V A.C.

The whole timer is self contained in a compact plastic case (as seen in photo). Designed for VTR with push button switch for easy setting. Limited quantity available.

NOW ONLY $12.94 MODEL VEQ 0143

SANYO ANTENNA SIGNAL BOOSTER

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

★ **NEW ITEM** ★

MODEL 001-0076

$12.50 EACH

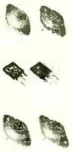
13 FUNCTIONS LCD TIME MODULE

- Displays month, date and day of the week
- Displays hour, minute and second
- AM, PM Indicator
- Alarm 1 and Alarm 2 (Independent)
- 10 Hours Stop Watch
- 12 Hours presettable count down time
- Hour Charm Indicator
- Back light by touch of the switch

MODEL 001-0062
$7.94 EACH

These modules are brand new and made by LITRONIX. Designed for a man's watch. Can be used for many applications. Comes with 2 silver batteries and the ceramic round transducer.

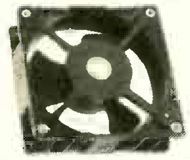
MATCHED PAIR POWER TRANSISTORS BY MOTOROLA



MJ2955	PNP 150 Watts	BV=60 V		**$3.50**
2N3055	NPN		I.C.=15 A	per pair
MJE2955	PNP 90 Watts	BV=60 V		**$3.00**
MJE3055	NPN		I.C.=10 A	per pair
MJ15003	NPN 250 Watts	BV=140 V		**$12.00**
MJ15004	PNP		I.C.=20 A	per pair

All above parts guaranteed to be prime and come with data sheets.

MUFFIN FANS FOR EQUIPMENT COOLING



These fans are pulled out from used computers. But carefully cleaned by ultrasonic cleaner. All in "like-new" condition. Size 4 11/16" x 1-1/2" x 4 11/16".
MODEL MF505
$9.50 EACH

FLUORESCENT LIGHT DRIVER KIT

12V DC POWERED

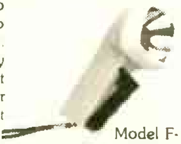
Lights up 8~15 Watt Fluorescent Light Tubes. Ideal for camper, outdoor, auto or boat. Kit includes high voltage coil, power transistor, heat sink, all other electronic parts and PC Board, light tube not included!

$6.50 **Per Kit**

PRESS-A-LIGHT SELF GENERATED FLASHLIGHT

EXCLUSIVE! **$3.95 ea.**

Never worry about battery, because it has none! Easy to carry in pocket and handy to use. Ideal for emergency light. It generates its own electricity by squeezing grip lever. Put one in your car, boat, camper or home. You may need it some time!



Model F-179

CRYSTAL CONTROLLED WIRELESS MICROPHONE SYSTEM

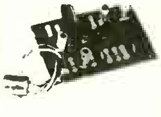
No FCC license required.
OUR PRICE
$49.50
ADDITIONAL MICROPHONE (TRANSMITTER) AVAILABLE AT **$28.00** EACH

MURA WMS-49

Transmitter: FET mic for flat 30 ~18 KHz response extra controlled 49MHz AM Band for drift-free performance. 100 MW output (range approx. ¼ mile) for reliable long range transmission. Powered by a 9V radio battery (included).

Receiver: Extra controlled locks on 49MHz transmitter signal. With on panel VU meter monitors the signal strength from the microphone. Standard phone jack outlet connection to a P.A. or other phone input. 9V battery included. This professional set is ideal for on stage, in field, church, in house or outdoor use.

SUPER FM WIRELESS MIC KIT—MARK III

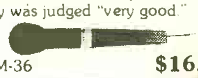


This new designed circuit uses high FEQ. FET transistors with 2 stages pre amp. Transmits FM Range (88-120 MHz) up to 2 blocks away and with the ultra sensitive condensor microphone that comes with the kit, allows you to pick up any sound within 15 ft. away! Kit includes all electronic parts, OSC coils, and P.C. Board. Power supply 9V D.C.

FMC-105 **$11.50 PER KIT**

WEM-36 FM WIRELESS MICROPHONE

TEET MODEL WEM-36 is a factory assembled FM wireless microphone powered by two AA size batteries. Transmits in the range of 88-108 MHz with 3 transistor circuits to meet with F.C.C. part 15 regulations. Element is built in a plastic tube type case with an omni-directional electret condenser microphone unit. By using a standard FM radio, signal can be heard anywhere on a one-acre lot. Sound quality was judged "very good."



MODEL WEM-36 **$16.50 EACH**

WHISTLE ACTIVATED SWITCH BOARD

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

MODEL 968
$4.50 EACH

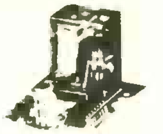
ULTRASONIC SWITCH KIT

Kit includes the Ultra Sonic Transducers, 2 PC Boards for transmitter and receiver. All electronic parts and instructions. Easy to build and a lot of uses such as remote control for TV, garage door, alarm system or counter. Unit operates by 9-12 DC. **$15.50**

ELECTRONIC SWITCH KIT

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

$5.50 each



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SCR SUPER-BUYS

- **UHF-VHF CONVERSION KIT.** Complete with PC board, all required components: cabinet with speaker: and comprehensive brochure incl. schematic, board layout mounting and hook-up diagrams, parts list and assembly and set-up instructions. All parts are industrial prime quality. Our Own Famous Kit **$119.00**
- **NEW ZENITH ZVM-121 HIGH** LEGIBILITY CRT MONITOR. Features 12" green phosphor CRT, with 15 MHz Bandwidth. 40 or 80 character widths are operator switch-selectable. Fully compatible with 80-column Apple cards, etc. Our Factory Direct Price **$117.00**
- **MITSUMI** - MODEL UES-A55F VARACTOR UHF TUNER FREQ. RANGE 470 - 889 MHz ANTENNA INPUT 300 OHMS $25.00 ea. 10 for $220.00

- **SPECIAL** - 2200 MFD 40 VT CAP 10 for $13.50

- **I.C. SPECIAL** LM 565 10 for $16.00
- **H.D. SPECIALS** TRANSISTORS
  - 2 N 3055 10 for $10.
  - 2SA 745 $4.00 ea.
  - 2SA 747B $4.50 ea.
  - 2S C 1116B $3.25 ea.
  - 2SC 1403B $3.00 ea.

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8216	2.90	Z80A S10	12.95
8226	3.25	Z80 P10	5.75
MM5307	8.95	TMS 9927 NL	9.95
8225	2.75	8275	16.95
8228	4.50	6845	16.95
8156	11.95	6810	2.50

RAM's		ROM's	
8264 (4164-2)	8.95	2708	2.95
2114L-3	1.85	2716 + 5V	4.95
4116-3	1.45	2732	11.95
4116-2	2.25	1702A	4.95
21L02-3	.90	2532	11.95
TMS 3409	1.75	82S23	1.95
MK4027-3	3.50	82S112	4.00
MK4086-11	2.95	82S115	4.00
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MS4050NL	3.95	82S129	1.95
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2101-1	2.45	82181	6.00
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MK4008P	1.95	AM9214C	2.95
IM7001	4.96	8256-5 (74188A)	1.25
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2111AL	2.45		

UART's

AY5-1013	3.75	MB868A	8.95
TR1602B	3.95	COM2017	3.75
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INTERFACE & DRIVERS		SHIFT REGISTERS	
FD1791	28.95	MM1402	1.75
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1489	1.10	MM1404	1.75
813C	2.80	MM5013	2.50
883C	2.50	MM5056	2.50
8833	2.50	MM5066	2.50
8834	2.00	MM5057	2.50
8837	2.00	MM5058	2.60
8838	2.00	MM5060	2.50
MM5321	9.50		
MM5369	2.50		

14 PIN HEADERS .... 3/$1.00
16 PIN HEADERS .... .40
24 PIN HEADERS .... .75
40 PIN HEADERS 1.10
50 PIN EDGEBOARD CONN. 3.95
26 PIN EDGEBOARD CONN. 2.50
50 PIN RIGHT ANGLE CONN. 3.95
20 PIN RIGHT ANGLE CONN. 2.25

50 PIN RIBBON CONNECTORS $3.25
40 PIN RIBBON CABLE CONN $2.75
20 PIN RIBBON CABLE CONN $2.35
10 PIN RIBBON CABLE CONN $1.50

PRINTED CIRCUIT BOARD
4"x6" DOUBLE SIDED EPOXY BOARD 1/16" THICK $.60 ea. .... 5/$2.60

EPOXY GLASS VECTOR BOARD

1/16" thick with 1/10" spacing
4½" x 6½" $1.95

DATEL'S DAC-08EQ
8 bit DAC — $4.95

CRYSTALS
2.000, 18.432, 20.000 $4.25 ea. | 3.000, 3.579, 4.000, 5.000, 6.000, 6.144, 8.000, 10.000, 18.000 $3.25 ea.

REDICON SAD 1024 ANALOG DELAY LINE .. $10.95

7 WATT LD 65 LASER DIODE(IR) $8.95

25 watt Infra Red Pulse (SG 2006 equiv.) Laser Diode (Spec sheet included) $24.95

2N3820 P FET .... $ .45
2N 5457 N FET .... $ .45
2N2646 UJT .... $ .45
ER 900 TRIGGER DIODES .... 4/$1.00
2N 6028 PROG. UJT .... $ .65

DISC CAPACITORS
.1UF 16V .... 10/$1.00 .... 100/$8.00
.01UF 35V .... 16/$1.00 .... 100/$5.00

IN4148 (IN914) 15/1.00

TANTALUM CAPACITORS

.22UF 35V	5/$1.00	10UF 35V	— $ .40
.47UF 35V	5/$1.00	22UF 10V	— $ .30
.68UF 35V	5/$1.00	15UF 16V	3/$1.00
1UF 35V	5/$1.00	30UF 6V	5/$1.00
2.2UF 20V	5/$1.00	33UF 20V	$ .60
3.3UF 20V	4/$1.00	47UF 20V	$ .85
4.7UF 35V	4/$1.00	68UF 10V	$1.00
6.8UF 35V	3/$1.00	120UF 6V	$ .75
		200UF 20V	$1.75

SANKEN AUDIO POWER AMPS

Si 1020 G 20 WATTS .$12.50
Si 1050 G 50 WATTS .$27.50

200 PRV 1A LASCR .95

RS232 CONNECTORS

DB 25P male $2.75
DB 25S female 3.75
HOODS 1.25

C/MOS

4001	.25	4027	.40	4081	.20	74C32	.45
4002	.25	4028	.55	4082	.20	74C42	1.00
4006	.65	4029	.75	4093	.60	74C73	.75
4007	.27	4030	.35	4099	1.75	74C74	.50
4008	.70	4034	1.75	4501	.95	74C76	.70
4009	.45	4035	.45	4506	.70	74C83	1.30
4010	.45	4040	.75	4510	.65	74C85	1.40
4011	.22	4042	.65	4511	.65	74C86	.50
4012	.22	4043	.55	4514	1.40	74C90	.90
4013	.36	4044	.55	4515	1.50	74C93	.95
4014	.70	4046	.90	4516	.75	74C151	1.75
4015	.70	4049	.40	4518	1.25	74C157	1.75
4016	.30	4050	.40	4520	.70	74C160	1.15
4017	.80	4051	.80	4558	1.25	74C161	1.15
4018	.50	4052	.75	4563	2.75	74C163	1.15
4019	.45	4053	.75	4583	.90	74C165	1.25
4020	.70	4066	.50	4585	.85	74C173	1.30
4021	.65	4068	.35	74C00	.27	74C174	1.30
4022	.80	4069	.20	74C02	.27	74C175	1.20
4023	.22	4071	.25	74C08	.30	74C192	1.30
4024	.45	4072	.20	74C10	.27	74C901	.50
4025	.25	4076	.65	74C14	1.20	74C914	1.75
		4077	.35	74C20	.27	74C921	3.95

74S SERIES

74S00	.30	74S74	.70	74S158	1.25
74S02	.30	74S86	.60	74S169	1.75
74S03	.30	74S89	1.90	74S174	1.40
74S04	.40	74S112	.85	74S175	1.40
74S06	.45	74S133	1.40	74S194	1.10
74S08	.40	74S136	1.50	74S257	1.50
74S10	.30	74S138	1.25	74S258	1.40
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DOUBLE SIDED DIP RIBBON CABLE JUMPER ASSEMBLIES
16 PIN 4" LONG .... $ 2.00
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RS 232 CABLE

10 Conductor, # 22 color coded wire, gray PVC outer cover, ⅜" diameter
.40 per ft. — 100'/$30.00
Add 20% postage for orders under 100'.
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2114L-4	1.65	4116-2	1.75
8080A	3.75	TMS9927NL	
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8264 (4164-2) 64K RAM	8.95	8275 CRT CONTROLLER	16.95
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SPECIALS GOOD THRU JUNE 1982

MINIATURE MULTI-TURN TRIMMING POTS
50, 100, 500, 1K, 50K, 250K ... $75 each 3/$2.00

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100	.45	.60	1.40	
200	.70	.80	1.90	9.00
400	1.20	1.40	2.60	12.00
600		1.80	3.60	15.00

TRIAC's

PRV	1A	10A	25A
100	.45	.80	1.55
200	.84	1.30	2.10
400	1.30	1.90	3.10
600	2.00	2.75	4.30

L1411-IR DETECTOR .... 3/$1.00
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SFC 3301 — 50 PRV 30A
FAST RECOVERY DIODE (35ns) .. $2.25
20KV 250MA DIODE $1.90

SILICON POWER RECTIFIERS

PRV	1A	3A	12A	50A	125A	240A
100	.06	.14	.35	.90	4.25	6.00
200	.07	.20	.40	1.30	5.25	9.00
400	.09	.25	.65	1.50	6.50	12.00
600	.11	.30	.80	2.00	8.50	15.00
800	.15	.35	1.00	2.50	10.50	18.00
1000	.20	.45	1.25	3.00	12.50	26.00

CLOCK CHIPS

MM5314 ..... $4.75 MM5316 ..... $4.95
MM5387AA 5.95

.5V at 800ma SOLAR CELLS 3" diameter $4.35

7 SEGMENT DISPLAYS

FSC8024-4 digit C.C. 8" display	$5.95	DL-707 C.A. .3"	$ .75
FND 359	$ .75	DL 747 C.A. .6"	$1.50
FND 503 C.C. .5"	$ .85	FND810 .8" CA	$1.95
FND 510 C.A. .5"	$ .85	FND803 .8" CC	$1.95
DL-704 .3" C.C.	$ .85	MAN 5 C.C. Green	$ .75
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TRANSISTOR SPECIALS

2N1307 PNP GE TO 5	$ .40
2N404A PNP GE TO-5	3/$1.00
HEP G6014 — PNP GE TO 3	$ .85
TIP 111 $ .50 TIP 145	$1.35
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MRF-8004 CB RF TRANSISTOR NPN	$ .75
2N3772 NPN Si TO 3	$1.00
2N4908 PNP Si TO-3	$1.00
2N3137 NPN Si RF	$ .55
2N3919 NPN Si TO-3 RF	$1.50
2N1420 NPN Si TO-5	3/$1.00
2N2222 NPN Si TO-18	5/$1.00
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2N6109 PNP Si TO 220	$ .55
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7402	.17	7474	.40	74165	.60
7403	.17	7475	.40	74166	.70
7404	.24	7476	.40	74167	1.25
7405	.24	7480	.45	74170	1.60
7406	.33	7483	.50	74173	.75
7407	.35	7485	.65	74174	.65
7408	.27	7486	.42	74175	.60
7409	.24	7490	.45	74176	.75
7410	.17	7491	.45	74177	.75
7411	.22	7492	.45	74180	.75
7412	.30	7493	.45	74181	1.90
7413	.42	7494	.60	74182	.45
7414	.50	7495	.60	74190	.70
7416	.33	7496	.60	74191	.75
7417	.37	74107	.35	74192	.70
7420	.17	74121	.35	74193	.79
7425	.30	74122	.39	74194	.85
7426	.33	74123	.42	74195	.45
7427	.30	74125	.45	74196	.75
7430	.17	74126	.45	74197	.75
7432	.27	74145	.75	74273	.85
7437	.27	74148	1.25	74279	.60
7438	.27	74150	1.10	74365	.65
7440	.17	74151	.50	74367	.65
7441	.75	74153	.40	74368	.65
7442	.45	75154	1.10	74390	.90
7445	.70	74155	.50	75324	1.75
7446	.75	74157	.50	75325	1.50
7447	.65	74160	.85	75492	1.05
7448	.65	74161	.65	8T31	2.00
7450	.17	74162	.60	8T32	2.75
				9601	.75
				9602	.75
				DS0056H	1.50

FULL WAVE BRIDGE

PRV	2A	6A	25A
100			1.40
200	.80	1.30	2.20
400	1.00	1.65	3.30
600	1.30	1.90	4.40

12V DC RELAYS TTL SIZE
S.P. 1200 ohm coil .95
D.P. 400 ohm coil 1.25

DIP SOCKETS

8 PIN	.17	22 PIN	.30
14 PIN	.20	24 PIN	.35
16 PIN	.20	28 PIN	.40
18 PIN	.25	40 PIN	.60

74LS SERIES

74LS00	.20	74LS107	.40	74LS197	.85
74LS01	.20	74LS109	.38	74LS221	.80
74LS02	.24	74LS112	.38	74LS240	.95
74LS03	.24	74LS113	.45	74LS241	.95
74LS04	.25	74LS114	.55	74LS242	1.20
74LS05	.25	74LS122	.45	74LS243	1.20
74LS08	.25	74LS123	.80	74LS244	1.10
74LS09	.25	74LS124	1.25	74LS245	1.75
74LS10	.24	74LS125	.45	74LS247	.75
74LS11	.25	74LS126	.45	74LS248	1.10
74LS12	.25	74LS132	.55	74LS251	.68
74LS13	.25	74LS136	.45	74LS253	.68
74LS14	.55	74LS137	.55	74LS257	.68
74LS15	.35	74LS138	.52	74LS258	.68
74LS20	.25	74LS139	.52	74LS259	1.40
74LS21	.25	74LS151	.40	74LS266	.65
74LS22	.25	74LS153	.40	74LS273	1.15
74LS26	.35	74LS155	.60	74LS279	.48
74LS27	.25	74LS156	.80	74LS280	1.80
74LS28	.45	74LS157	.44	74LS283	.86
74LS30	.22	74LS158	.48	74LS290	.75
74LS32	.30	74LS160	.75	74LS293	.95
74LS37	.30	74LS161	.70	74LS320	2.00
74LS38	.30	74LS162	.80	74LS365	.80
74LS40	.30	74LS163	.65	74LS366	.80
74LS42	.50	74LS164	.85	74LS367	.58
74LS47	.65	74LS165	.85	74LS368	.58
74LS51	.22	74LS166	1.10	74LS373	1.75
74LS54	.25	74LS168	1.75	74LS374	1.25
74LS73	.35	74LS169	1.50	74LS377	1.25
74LS74	.35	74LS170	1.50	74LS385	.65
74LS75	.35	74LS173	.70	74LS390	1.30
74LS76	.35	74LS174	.70	74LS393	1.30
74LS83	.56	74LS175	.40	74LS398	2.50
74LS85	.85	74LS181	1.95	74LS399	1.60
74LS86	.40	74LS190	.90	74LS670	1.60
74LS90	.39	74LS191	.80	74LS682	3.00
74LS92	.50	74LS192	.72	81LS97	1.10
74LS93	.50	74LS193	.72	81LS98	1.10
74LS95	.70	74LS194	.75	8T26	1.25
		74LS195	.90	8T97	1.85
		74LS196	.85		

LINEAR CIRCUITS

LM201	.75	LM348	.90	709	.25
LM301/748	.30	LM358	.50	710	.45
741CV	.25	LM361	1.75	749	.95
741C	.35	LM377	1.60	711CH	.40
747	.50	LM380	.95	LM1808	1.75
1456	.80	LM382	.80	LM1889	1.65
1458	.50	LM383	2.50	CA758	1.75
4136	.85	LM386	.80	CA3018	1.95
3900	.45	LM387	1.25	CA3078	1.50
LM307	.30	LM393	1.00	CA3080	.95
LM308	.75	LM553	2.25	CA3086	.95
LM324	.65	LM555	.45	CA3140	1.20
LM339	.65	LM556	.85	LM2901	.95
LF351	.75	564B	3.95	8038CC	3.90
LF353	1.25	565	1.40	N5596A	1.50
LF355	1.25	566	1.40	TL062 CP	.95
LF356	1.35	567	.85	TL064 CN	1.50
LM311	.50				
LM318	1.00				

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LM317T $1.75
LM337 .... $2.50
79KC $1.75
723 .... $ .50
320T 5, 12, 15 or 24 $ .90
78M05 .... $ .35
78L05 .... $ .45
LM305G .... $ .75
340T-5, 6, 8, 9, 12, 15, 18 or 24V $ .85
LAS1412 - 12V 3A $3.95

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			Each	100 pcs
2101	256 x 4	(450ns)	1.95	1.85
5101	256 x 4	(cmos) (450ns)	4.95	3.95
2102-1	1024 x 1	(450ns)	.89	.85
2102L-2	1024 x 1	(LP) (250ns)	1.69	1.55
2102L-4	1024 x 1	(LP) (450ns)	1.29	1.15
2111	256 x 4	(450ns)	2.99	2.49
2112	256 x 4	(450ns)	2.99	2.79
2114	1024 x 4	(450ns)	8/16.95	1.95
2114L-2	1024 x 4	(LP) (200ns)	8/19.95	2.35
2114L-3	1024 x 4	(LP) (300ns)	8/18.95	2.25
2114L-4	1024 x 4	(LP) (450ns)	8/17.95	2.10
2147	4096 x 1	(55ns)	9.95	call
TMS4044-4	4096 x 1	(450ns)	3.49	3.25
TMS4044-3	4096 x 1	(300ns)	3.99	3.75
TMS40L44-2	4096 x 1	(LP) (200ns)	4.49	4.25
MK4118	1024 x 8	(250ns)	9.95	call
TMM2016	2048 x 8	(150ns)	call	call
HM6116-4	2048 x 8	(cmos) (200ns)	call	call
HM6116-3	2048 x 8	(cmos) (150ns)	call	call
HM6116-2	2048 x 8	(cmos) (120ns)	call	call
HM6116LP-4	2048 x 8	(LP) (cmos) (200ns)	call	call
HM6116LP-3	2048 x 8	(LP) (cmos) (150ns)	call	call
HM6116LP-2	2048 x 8	(LP) (cmos) (120ns)	call	call
Z-6132	4096 x 8	(Qstat) (300ns)	34.95	call

LP = Low Power Qstat = Quasi-Static

DYNAMIC RAMS

			Each	100 pcs
TMS4027	4096 x 1	(250ns)	2.50	2.00
MK4108	8192 x 1	(200ns)	1.95	call
MM5298	8192 x 1	(250ns)	1.85	call
4116-120	16384 x 1	(120ns)	8/29.95	call
4116-150	16384 x 1	(150ns)	8/18.95	1.95
4116-200	16384 x 1	(200ns)	8/13.95	call
4116-250	16384 x 1	(250ns)	8/13.90	call
4116-300	16384 x 1	(300ns)	8/13.80	call
2118	16384 x 1	(5v) (150ns)	4.95	call
MK4816	2048 x 8	(5v) (300ns)	24.95	call
4164-200	65536 x 1	(5v) (200ns)	call	call
4164-150	65536 x 1	(5v) (150ns)	call	call

EPROMS

			Each	8 pcs
1702	256 x 8	(1us)	4.95	4.50
2708	1024 x 8	(450ns)	3.75	3.50
2758	1024 x 8	(5v) (450ns)	9.95	8.95
TMS2516	2048 x 8	(5v) (450ns)	6.95	5.95
2716	2048 x 8	(5v) (450ns)	4.95	3.95
2716-1	2048 x 8	(5v) (350ns)	9.00	8.50
TMS2716	2048 x 8	(450ns)	9.95	8.95
TMS2532	4096 x 8	(5v) (450ns)	9.95	7.95
2732	4096 x 8	(5v) (450ns)	9.95	7.95
2732A-2	4096 x 8	(5v) (200ns)	call	call
2764	8192 x 8	(5v) (450ns)	call	call
TMS2564	8192 x 8	(5v) (450ns)	call	call

5v = Single 5 Volt Supply

EPROM ERASERS

	Timer	Capacity Chip	Intensity (uW/CM²)	
PE-14		6	5,200	83.00
PE-14T	X	6	5,200	119.00
PE-24T	X	9	6,700	175.00
PL-265T	X	20	6,700	255.00
PR-125T	X	16	15,000	349.00
PR-320T	X	32	15,000	595.00

JUNE SPECIALS

2K x 8 STATIC

TMM-2016 (200NS)

8/6^95 EA.

HM6116 (200NS)

8/7^95 EA.

64K DYNAMIC

4164 (200NS)

8/8^95 EA.

16K DYNAMIC

4116 (200NS)

8/13^95 EA.

16K EPROMS

2716 (450NS)

8/3^95 ea.

32K EPROMS

2532 or 2732
(450NS)

8/7^95 EA.

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PROMS

Order by National Part No.	Function	EQUIVALENT PART NUMBERS TI	SIG	MMI	Harris	
74S188	32x8 OC	18SA030	82S23	6330-1	7602	2.95
74S287	256x4 TS	14S10	82S129	6301-1	7611	3.25
74S288	32x8 TS	18S030	82S123	6331-1	7603	2.75
74S387	256x4 OC	14SA10	82S126	6300-1	7610	2.95
74S471	256x8 TS	18S22		6309-1		10.95
74S472	512x8 TS	18S42	82S147	6349-1	7649	10.95
74S473	512x8 OC	18SA42	82S146	6348	7648	10.95
74S474	512x8 TS	18S46	82S141	6341	7641	12.95
74S475	512x8 TS	18SA46	82S140	6340	7640	12.95
74S478	1Kx8 TS	28S86				19.95
74S570	512x4 OC	27S12	82S130	6305	7620	5.95
74S571	512x4 TS	27S13	82S131	6306-1	7621	5.95
74S572	1kx4 OC	24SA41	82S136	6352-1	7642	9.95
74S573	1kx4 TS	24S41	82S137	6353-1	7643	9.95
87S180	1kx8 OC	28SA86	82S180	6380-1	7680	19.25
87S181	1kx8 TS	28S86	82S181	6381-1	7681	16.25
87S184	2kx4 OC	24SA81	82S184		7684	17.20
87S185	2kx4 TS	24S81	82S185		7685	16.95
87S190	2kx4 OC	28SA166	82S190		76160	39.95
87S191	2kx8 TS	28S166	82S191		76161	39.95

74LS00 SERIES

74LS00	.25	74LS169	1.75
74LS01	.25	74LS170	1.75
74LS02	.25	74LS173	.80
74LS03	.25	74LS174	.95
74LS04	.25	74LS175	.95
74LS05	.25	74LS181	2.15
74LS08	.35	74LS189	9.95
74LS09	.35	74LS190	1.00
74LS10	.25	74LS191	1.00
74LS11	.35	74LS192	.85
74LS12	.35	74LS193	.95
74LS13	.45	74LS194	1.00
74LS14	1.00	74LS195	.95
74LS15	.35	74LS196	.85
74LS20	.25	74LS197	.85
74LS21	.35	74LS221	1.20
74LS22	.25	74LS240	1.29
74LS26	.35	74LS241	1.29
74LS27	.35	74LS242	1.85
74LS28	.35	74LS243	1.85
74LS30	.25	74LS244	1.29
74LS32	.35	74LS245	1.90
74LS33	.55	74LS247	.75
74LS37	.55	74LS248	1.25
74LS38	.35	74LS249	.99
74LS40	.35	74LS251	1.30
74LS42	.55	74LS253	.85
74LS47	.75	74LS257	.85
74LS48	.75	74LS258	.85
74LS49	.75	74LS259	2.85
74LS51	.25	74LS260	.65
74LS54	.35	74LS266	.55
74LS55	.35	74LS273	1.65
74LS63	1.25	74LS275	3.35
74LS73	.40	74LS279	.55
74LS74	.45	74LS280	1.98
74LS75	.50	74LS283	1.00
74LS76	.40	74LS290	1.25
74LS78	.50	74LS293	1.85
74LS83	.75	74LS295	1.05
74LS85	1.15	74LS298	1.20
74LS86	.40	74LS324	1.75
74LS90	.65	74LS352	1.55
74LS91	.89	74LS353	1.55
74LS92	.70	74LS363	1.35
74LS93	.65	74LS364	1.95
74LS95	.85	74LS365	.95
74LS96	.95	74LS366	.95
74LS107	.40	74LS367	.70
74LS109	.40	74LS368	.70
74LS112	.45	74LS373	1.75
74LS113	.45	74LS374	1.75
74LS114	.50	74LS377	1.45
74LS122	.45	74LS378	1.18
74LS123	.95	74LS379	1.35
74LS124	2.99	74LS385	1.90
74LS125	.95	74LS386	.65
74LS126	.85	74LS390	1.90
74LS132	.75	74LS393	1.90
74LS136	.55	74LS395	1.65
74LS137	.99	74LS399	1.70
74LS138	.75	74LS424	2.95
74LS139	.75	74LS447	.37
74LS145	1.20	74LS490	1.95
74LS147	2.49	74LS624	3.99
74LS148	1.35	74LS668	1.69
74LS151	.75	74LS669	1.89
74LS153	.75	74LS670	2.20
74LS154	2.35	74LS674	9.65
74LS155	1.15	74LS682	3.20
74LS156	.95	74LS683	2.30
74LS157	.75	74LS684	2.40
74LS158	.75	74LS685	2.40
74LS160	.90	74LS688	2.40
74LS161	.95	74LS689	2.40
74LS162	.95	74LS783	24.95
74LS163	.95	81LS95	1.69
74LS164	.95	81LS96	1.69
74LS165	.95	81LS97	1.69
74LS166	2.40	81LS98	1.69
74LS168	1.75		

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2N2222	.25	50/10.99
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2N3906	10/1.00	100/ 8.99
1N4148 (1N914)		25/ 1.00
1N4004		10/ 1.00

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8205	3.50
8212	1.85
8214	3.85
8216	1.80
8224	2.50
8226	1.80
8228	4.90
8237	19.95
8238	4.95
8243	4.45
8250	14.95
8251	4.75
8253	9.25
8253-5	9.85
8255	4.75
8255-5	5.25
8257	8.50
8257-5	8.95
8259	6.90
8259-5	7.50
8272	39.95
8275	29.95
8279	9.50
8279-5	10.00
8282	6.65
8283	6.65
8284	5.70
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9368	3.95
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ADC0804	4.95
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ADC0817	10.95
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DAC0808	4.95
DAC1020	8.25
DAC1022	5.95
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6808	13.90
6809E	19.95
6809	19.95
6810	2.95
6820	4.95
6821	4.95
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6840	12.95
6843	34.95
6844	25.95
6845	16.95
6847	12.25
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6860	10.95
6862	11.95
6875	6.95
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6883	24.95
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68B00	10.95
68B02	22.25
68B09E	29.95
68B09	29.95
68B10	7.95
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6800 = 1 MHZ

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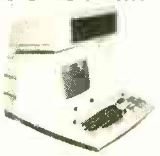

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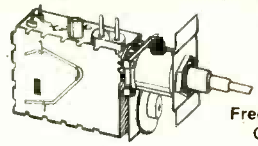

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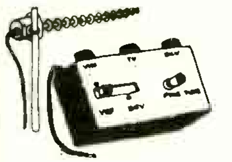

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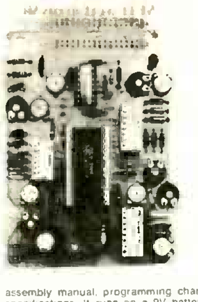
Sound Effects Kit $18.50



The SE-01 is a complete kit that contains all the parts to build a programmable sound effects generator. Designed around the new **Texas Instruments 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 for Level Comparator and Multiplex Oscillator for even more versatility. The 3¾" x 5" PC Board features a prototype area to allow for user added circuitry. Easily programmed to duplicate **Explosions, Phasor Guns, Steam Trains**, or almost an infinite number of **other sounds**. The unit has a multiple of applications. The low price includes all parts, assembly manual, programming charts, and detailed 76477 chip specifications. It runs on a 9V battery (not included). On board 1/2MW amp will drive a small speaker directly, or the unit can be connected to your stereo with incredible results! (Speaker not included). **76477 is included. Available separately for $3.15 each.**

7 Watt Audio Amp Kit $6.95

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

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If you have trouble sleeping and you would like the rest of the neighborhood to share your misery then this little kit will be for you! There is no way to accurately describe the unearthly howls, screams and tones that come out of this kit. Four separate tone oscillators are mixed, cancelled and stepped at a varying rate. 10 Watts of crazy sounds. A great fun kit or a practical burglar alarm. Complete with PC board and all necessary components less speaker. For 6-12 VDC. ORDER DA-02.

New! 3TZ Time Zone Clock Kit

Microprocessor/ROM clock kit keeps local time (12 hour format), and 2 world time zones (24 hour format); Large .6" ORANGE readouts 10 min. ID timer for HAMS. Comes complete with attractive plastic case and wallplug XFMR.

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- 3 Time Zones (Selectable)
- Feathertouch front panel switches
- Seconds Reset/Hold feature
- Quartz XTAL Timebase
- Battery backup
- Quality solder masked and plated PC boards

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SEE SPECIAL WINTER PRICES BELOW

The Super Music Maker

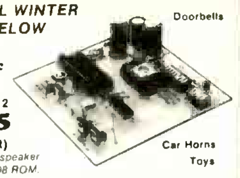
REVISION 2

$24.95

(Basic Kit)

Does not include speaker switches or 2708 ROM.

Doorbells



Car Horns

Toys

Now you can play hundreds of songs using the Bullet **Super Music Maker**. The unit **features a single factory programmed microprocessor** IC that comes with 20 pre-programmed short tunes. By adding the additional PROMS (2708's) the system can be expanded to play up to **1000 notes per PROM**. Just think . . . a compact electronic instrument that will play dozens, hundreds or even thousands of selections of music. The kit comes with **all electronic components (less the PROM)**, and a drilled, plated and screened PC Board which measures 4" x 4¼". The 7 **watt amplifier** section is on the same PC board and drives an 8 ohm speaker (not included), from a whisper to ear splitting volume. Since the unit works on **12 VDC** or **12 VAC**, vehicle or portable operation is possible. **What do you get for $24.95? Everything but a speaker, transformer, case, switches, and PROM.** Additional 2708 albums containing popular tunes are available for **$9.95** each or you can program your own PROMS using information provided with the kit instructions. Lists of available PROM albums are available on request. *(Note: Unit plays electronic music one note at a time, it is not possible to play chords or a melody with harmony simultaneously.)*

- Envelope control gives decay to notes.
- On board inverter allows single voltage (+12) operation.

OPTIONAL ACCESSORIES

DIP Switches (One 8 pos., One 5 pos.) 2.00/set
(Can be **directly soldered** to PC Bd. to access tunes)
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SPECIAL WINTER PRICES

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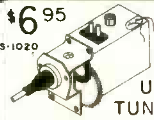
$6.95 S-1020 UHF TUNER



TOP QUALITY, UHF TUNERS ARE BRAND NEW, TESTED, TOP PERFORMERS! GREAT FOR REPLACEMENT USE, CABLE CONVERTERS, DESCRAMBLERS, HAM BAND CONVERTERS, ETC. ETC.

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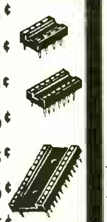

8 PIN	S-0800	16¢
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16 PIN	S-1600	20¢
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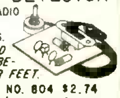

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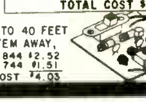

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CIRCUIT BOARD 744 $1.51
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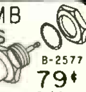

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