UNDERSTANDING TEST EQUIPMENT, Part I—FREQUENCY COUNTERS

elementary Electronics

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BINARY CLOCK
Only you can read it!
Page 33

NOVEMBER-DECEMBER 1979 CC 02342

ANALOG COMPUTER MAKES SCOPE MAGIC
complete plans on page 56

Build an Electronic Lock You Can Program

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SPOTLIGHT
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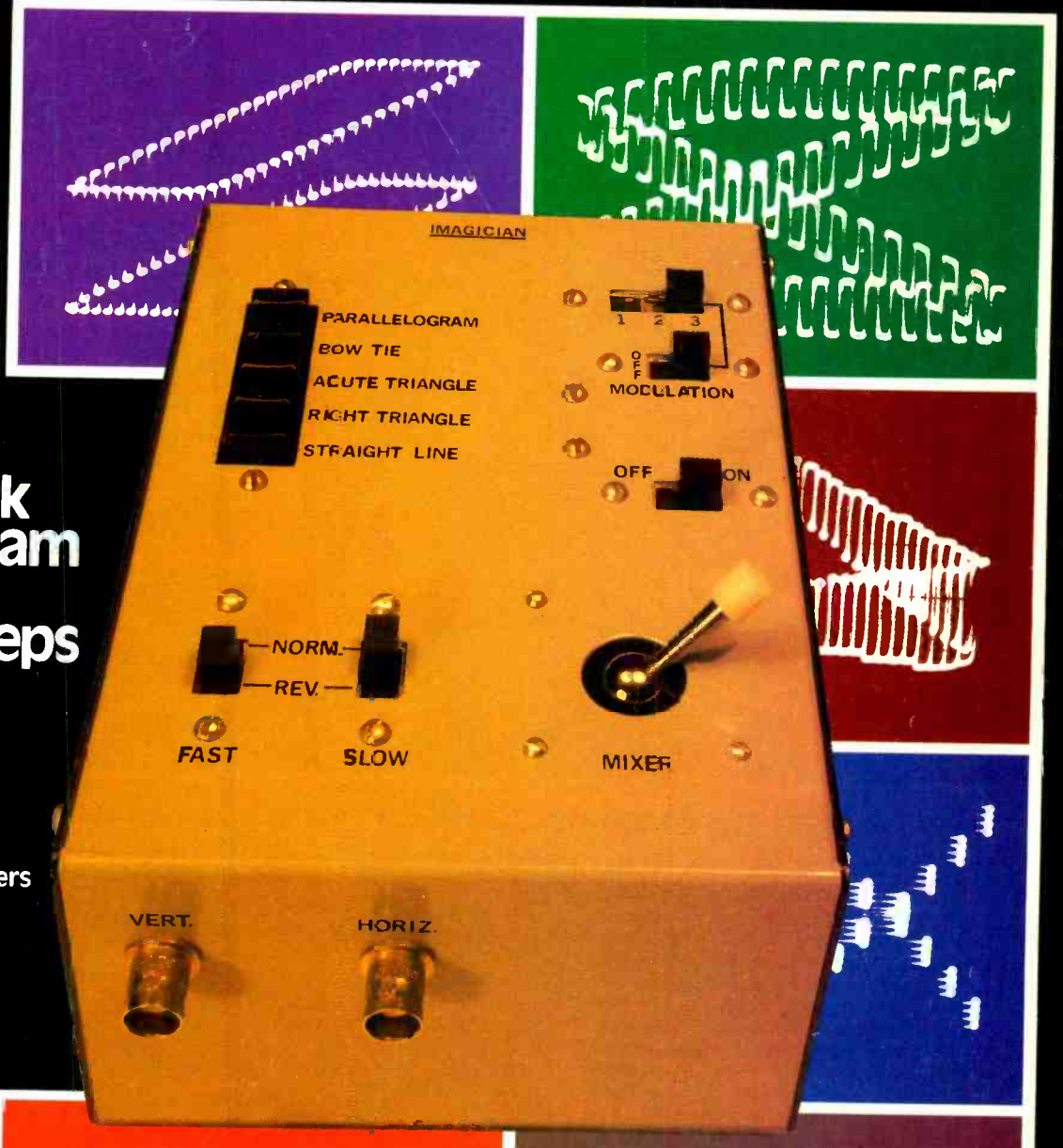


A DAVIS PUBLICATION

R-1000 Brings You The World.

Now, a high-performance, easy-to-operate Communications Receiver with single-knob tuning system and digital frequency display!

Up-to-the-minute events and information from anywhere in the world, including foreign shortwave broadcast (music, news, propaganda, etc.), emergency ship communications and other marine traffic, standard AM broadcast, Amateur Radio Operators, all 40 CB channels, military and government messages, long-distance industrial communications, standard time/frequency signals...and other exciting transmissions...it's all yours through the R-1000!

Highly accurate, sensitive, selective, and stable, the R-1000 has a unique fast-tuning system that covers the shortwave bands, plus medium-wave and long-wave frequencies. Even SSB communications signals are received perfectly.

Its many features include:

- Continuous frequency coverage from 200 kHz to 30 MHz
- 30 bands, each 1 MHz wide
- Accurate five-digit frequency display and illuminated analog dial
- Built-in quartz digital clock and ON/OFF timer
- Up-conversion PLL circuit and wideband RF circuits provide exceptional performance and easy operation without the need for bandspread, preselector, or antenna tuning
- Multi-modes...AM (wide and narrow), SSB (USB and LSB), and CW
- Three built-in IF filters...for SSB and CW (2.7 kHz), for AM narrow (6.0 kHz), and for AM wide (12 kHz)
- Effective communications-type noise blanker (superior to noise limiter)
- Step attenuator (0-60 dB in 20-dB steps) to prevent overload
- Recording terminal (built-in timer controls recording time through remote terminal)
- Tone control for best audio response
- Built-in 4-inch speaker for quality sound reproduction
- Illuminated S-meter
- Dimmer switch to control panel lights and digital display intensity
- Adjustable bracket for optimum operating angle
- Three antenna terminals for high-impedance wire leads and a 50-Ω coaxial lead

Optional Accessories:

- SP-100 matching external speaker
- HS-4 and HS-5 headphones

The exciting R-1000 is designed specifically for those who demand the highest quality and it's *available only* through selected communications equipment specialists.

Write or call today for more information and for the address of your nearest Authorized Kenwood Communications Dealer.

KENWOOD

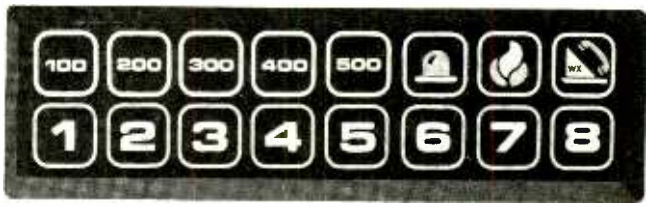
TRIO-KENWOOD COMMUNICATIONS INC.
1111 WEST WALNUT/COMPTON, CA 90220
TELEPHONE: (213) 639-9000

Now there's finally a scanner for those who simply will not settle for anything less than everything. We call it the Touch K500. And we've included everything it takes to make public service band scanning more enjoyable and more exciting than ever.

If you want it all, the place to start is with all the frequencies. The Touch K500 covers each one by searching. It's like tuning the dial on an ordinary radio, but much more precise and versatile. You see, when it hears something, you don't have to remember a thing. Just keep on searching and enjoying. Later you can go back and ask the memory to recall the active frequencies. It never forgets.

Now, if you're into scanning, you know that sometimes a scanner will miss some calls you want to hear. Remember what we said about everything? With the Touch K500 you can stick around for a reply to a call by delaying scan resumption for up to 4 seconds. If you need more time, you can program an indefinite hold.

You'll never have to miss calls on your favorite frequency either. Just touch priority and the Touch K500 will sample channel 1 every 1.5 seconds. Another feature to interrupt



things is the Weather Alert® we've included to respond to severe weather alerts direct from the National Weather Service.

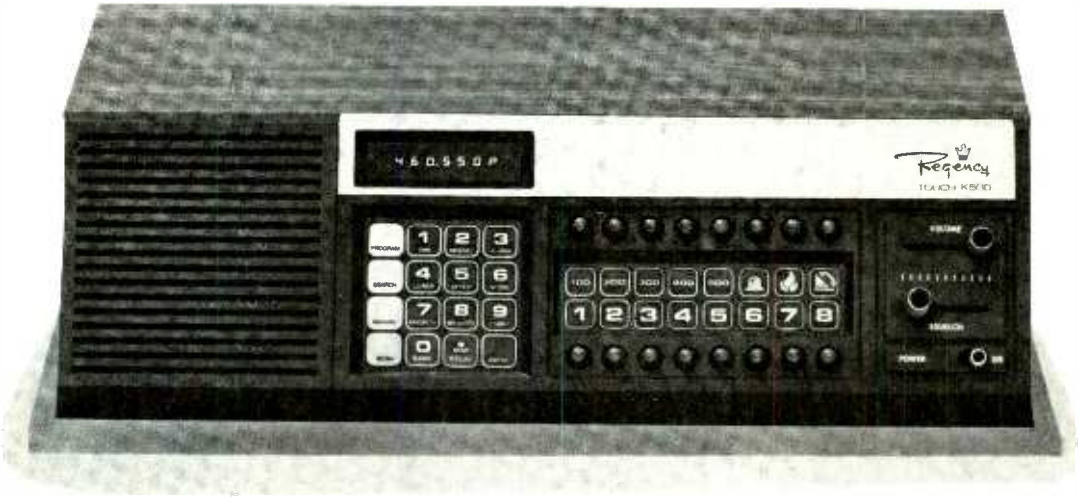
"Everything" is a big subject. We're just beginning. Next consider the scan channels: all 585 of them. We built-in an amazing 40 RAM* channels for conventional touch entry crystalless scanning. But even that's not enough for you. So we gave it 545 ROM* channels that let you scan just by selecting the type of frequency you want to hear. Touch the flasher symbol for police, the flame for fire or the sailboat for marine, weather, or mobile phones. The Touch K500 will cover any common frequency in the ROM set you select.

There's also an LED quartz clock with an alarm. A counter that tallies the number of times a channel is used. Plus a device that can remotely activate electrical equipment.

To really experience it all, see your Regency retailer. When it comes to scanners, he has everything.

Regency®
TOUCH K500

The scanner for those who won't settle for anything less than everything.



Regency Electronics, Inc. • 7707 Records St. Indianapolis, IN 46226

*RAM: Regency Alterable Memory
*ROM: Regency Organized Memory

CIRCLE 23 ON READER SERVICE COUPON

elementary electronics

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AUTHORS IN THIS ISSUE

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The World's biggest Bearcat® scanner sale!

Communications Electronics,™ the world's largest distributor of radio scanners, celebrates the introduction of four new *Bearcat* brand monitors with the world's largest scanner sale. From now, until January 31, 1980, you can save hundreds of dollars during our ***two-million dollar Bearcat sale.*** Even the new *Bearcat* models 300, 220 and Eight Track scanners are on sale. If you've previously purchased a *Bearcat* scanner from **Communications Electronics,** then you *already* know you're getting all the real, live excitement that a television program or newspaper can't provide. If you don't have at least one *Bearcat* scanner, the time to buy is now! Since we distribute more scanners worldwide than *anyone* else, we can sell the newest factory production models with the *latest* engineering updates, at rock bottom prices. Our warehouse facilities are equipped to process over 1,000 *Bearcat* orders per week and our order lines are always staffed 24 hours. We also export *Bearcat* scanners to more than 300 countries and military installations. Almost all items are **in stock** for **immediate shipment,** so **save now** and get a *Bearcat* scanner during the ***world's largest*** two-million dollar scanner sale!

NEW! Bearcat® 300

Available February – March, 1980
List price $499.95/**CE price $329.00**
7-Band, 50 Channel • Service Search • No-crystal scanner • AM Aircraft and Public Service bands. • Priority Channel • AC/DC *Bands: 32-50, 118-136 AM, 144-174, 420-512 MHz.*
The new *Bearcat* 300 is the most advanced automatic scanning radio that **Communications Electronics** has ever offered to the public. Since the *Bearcat* 300 has over 2,100 active frequencies in memory, you can touch one button and search any of many preprogrammed services such as police, fire, marine and government. Of course, you still can program your own frequencies and monitor up to 50 channels at once. Since the *Bearcat* 300 uses a bright green flourescent digital display, it's ideal for mobile applications. The *Bearcat* 300 now has these added features: Service Search, Display Intensity Control, Hold Search and Resume Search keys, Separate Band keys to permit lock-in/lock-out of any band for more efficient service search and a new vacuum fluorescent digital display. Reserve your *Bearcat* 300 now for February – March, 1980 delivery.

Bearcat® 250

List price $399.95/**CE price $259.00**
50 Channels • Crystalless • Searches Stores • Recalls • Self-Destruct • Priority channel • 50 Channel • 6-Band.
Frequency range 32-50, 146-174, 420-512 MHz.
The *Bearcat* 250 performs any scanning function you could possibly want. With push button ease you can program up to 50 channels for automatic monitoring. Push another button and search for new frequencies. There are no crystals to limit what you want to hear. A special search feature of the *Bearcat* 250 actually stores 64 frequencies, and recalls them, one at a time, at your convenience. Automatic "count" remembers how often frequencies are activated by transmission–so you know where the action is. Decimal display shows the channel, frequency and other programmed features. The priority feature samples your programmed frequency every two seconds. Plus, a digital clock shows the time at the touch of a button. This is the only monitor radio that has received the **Communications Electronics** quality control approval rating #1. Our highest quality grade for technologically sophisticated equipment. The *Bearcat* 250. Scanning like you've never seen or heard before. Now in stock!

NEW! 50-Channel Bearcat 300

NEW! Aircraft Bearcat 220

Aircraft Bearcat® 220

List price $399.95/**CE price $259.00**
Aircraft and public service monitor. *Frequency range 32-50, 118-136 AM, 144-174, 420-512 MHz.*
The *Bearcat* 220 is one scanner which can monitor all public service bands plus the exciting aircraft band channels. Up to twenty frequencies may be scanned at the same time.

Not only does this new scanner feature normal search operation, where frequency limits are set and the scanner searches between your programmed parameters, it also searches marine or aircraft frequencies by pressing a single button. These frequencies are already stored in memory so no reprogramming is required. The *Bearcat* 220 also features a Priority channel, Dual scanning speeds, Patented track tuning and Direct channel access and AC/DC operation.

New! Bearcat® 211

List price $339.95/**CE price $229.00**
Frequency range: 32-50, 146-174, 420-512 MHz.
The *Bearcat* 211. It's an evolutionary explosion of features and function. 18-channel monitoring. With no-crystal six-band coverage. Dual scan speeds. Color-coded keyboard. Even a digital clock. All at a modest price. More scanning excitement than you bargained for.

Bearcat® 210

List price $299.95/**CE price $199.00**
10 Channels • 5 Bands • Crystalless
Frequency range: 30-50, 146-174, 416-512 MHz.
Use the simple keyboard to select the 10 channels to be scanned. Automatic search finds new frequencies. The 210 features patented selectable scan delay, push button lockout, single antenna, patented track tuning, AC/DC operation. With no crystals to buy. Ever!

NEW! Bearcat® 8 Track

List price $99.95/**CE price $79.00**
4 Channels • 2 Bands • Plays off any AC or DC Powered 8 Track Tape Player. *Frequency range: 33-49, 151-165 MHz.*
The *Bearcat* 8 Track Scanner. It converts any 8 track tape player into a live-action scanning radio instantly.

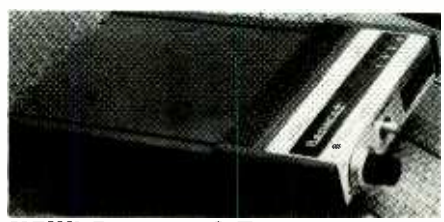
This incredibily compact 4-channel/2-band crystal scanner plugs into the tape player where an 8 track cartridge normally goes. Police, fire, emergency calls—as-it-happens scanning excitement—from an existing home entertainment center, in-car/in-boat system or portable 8 track tape player. The *Bearcat* 8 Track Scanner plugs live-action into any 8 track player. Anywhere. Crystal certificates **# A-135cc** are $4.00 each.

Bearcat® Four-Six

List price $169.95/**CE price $109.00**
The first 4 Band, 6 Channel, Hand-Held Scanner.
Frequency range: 33-47, 152-164, 450-512 MHz.
The *Bearcat* Four-Six offers "hip pocket" access to police, fire, weather and special interest public service broadcasts. Lightweight. Extremely compact. The *Bearcat* Four-Six—with its popular "rubber ducky" antenna and belt clip— provides "go anywhere/hands-off" scanning.

NEW! Aircraft and UHF Bearcat® ThinScan™

List price $149.95/**CE price $99.00**
World's smallest scanner!
The *Bearcat* ThinScan.™ High-performance scanning has never been this portable. There are **now three models** available. The **BC 2-4 L/H** receives 33-44 and 152-164 MHz. The **BC 2-4 H/U** receives 152-164 and 450-508 MHz. The new high-performance Aircraft ThinScan model **BC 2-4 AC** receives 118-136 and 450-470 MHz. Go ahead, size it up. *Bearcat's* ThinScan™ measures 2¾ " across. Just 1" deep. And 5⅝" high. Four crystal-controlled channels are scanned every ½ second providing immediate access to police, fire, weather and other special-interest broadcasts.



NEW! Bearcat 8 Track scanner

CIRCLE 108 ON READER SERVICE COUPON

INCREASED PERFORMANCE ANTENNAS

If you want the utmost in performance from your *Bearcat* scanner, it is essential that you use an external antenna. We have four base and mobile antennas specifically designed for receiving all bands. Order **#A60** is a magnet mount mobile antenna. Order **#A61** is a gutter clip mobile antenna. Order **#A62** is a trunk-lip mobile antenna and **#A70** is an all band base station antenna. All antennas are $25.00 and $3.00 for UPS shipping in the continental United States.

OTHER BEARCAT ACCESSORIES

SP50 AC Adapter	$12.00
SP51 Battery Charger	$12.00
SP55 Carrying Case for Four-Six	$15.00
SP57 Carrying Case for ThinScan	$15.00
SM210 Service manual for *Bearcat* 210	$15.00
SM220 Service manual for *Bearcat* 220	$15.00
SM250 Service manual for *Bearcat* 250	$15.00
B-31 2 V AA Ni-Cad's for Four-Six (Pack of 4)	$15.00
B-41 2 V AAA Ni-Cad's for ThinScan (Pack of 4)	$15.00
B-5 Replacement memory battery for Bearcat 210	$5.00
A-135cc Crystal certificate	$4.00

Add $3.00 shipping for all accessories ordered at the same time.

TEST A BEARCAT SCANNER FREE

Test any *Bearcat* brand scanner from **Communications Electronics**™ for 31 days before you decide to keep it. If you do, you'll own the most sophisticated and technologically advanced scanner available. If for any reason you are not completely satisfied, return it in new condition with all accessories in 31 days, for a courteous and prompt refund (less shipping charges).

NATIONAL SERVICE

With your *Bearcat* scanner, we will send all accessories, a complete set of simple operating instructions and a one-year limited warranty. If service is ever required on any *Bearcat* scanner purchased from **Communications Electronics,™** just send your receiver to a CE approved *Bearcat* national service center. Another *Bearcat* service is the frequency information hotline. After you get your scanner from CE, you may call 317-894-1230 and get up to the second information on active frequencies in your area. If you ever need engineering assistance, feel free to call the factory during the day at 317-894-1440.

BUY WITH CONFIDENCE

All *Bearcat* scanners are extraordinary scanning instruments. They provide virtually any scanning function that the most professional monitor could require. To ***get the fastest delivery*** of any *Bearcat* scanner, send or phone your order directly to our Scanner Distribution Center.™ Be sure to calculate your price using the CE prices in this ad. Michigan residents please add 4% sales tax. Written purchase orders are accepted from approved government agencies and well rated firms at a 10% surcharge for net 30 billing. All sales are subject to availability. Prices and specifications are subject to change without notice. Out of stock items will be placed on backorder automatically unless CE is instructed differently. International orders are invited with a $10.00 surcharge for special handling in addition to shipping charges. All shipments are F.O.B. Ann Arbor, Michigan. No COD's please. Cashier's checks will be processed immediately and receive an order priority number. Personal checks require three weeks bank clearance. Mail orders to: **Communications Electronics,™** Box 1002, Ann Arbor, Michigan 48106 U.S.A. Add $5.00 per scanner for U P.S. *ground* shipping, $9.00 for faster U.P.S. *air* shipping or $30.00 for *overnight delivery* to most major U.S.cities via Airborne Air Freight. If you have a Master Charge or Visa card, you may call anytime and place a credit card order. **Order toll free** 800-521-4414. If you are outside the U.S. or in Michigan, dial 313-994-4444. **Dealer inquiries invited.** All order lines at **Communications Electronics**™ are staffed 24 hours.

Since this ***two-million dollar Bearcat sale*** is the world's largest, please order today at no obligation to assure a prompt order confirmation and delivery.

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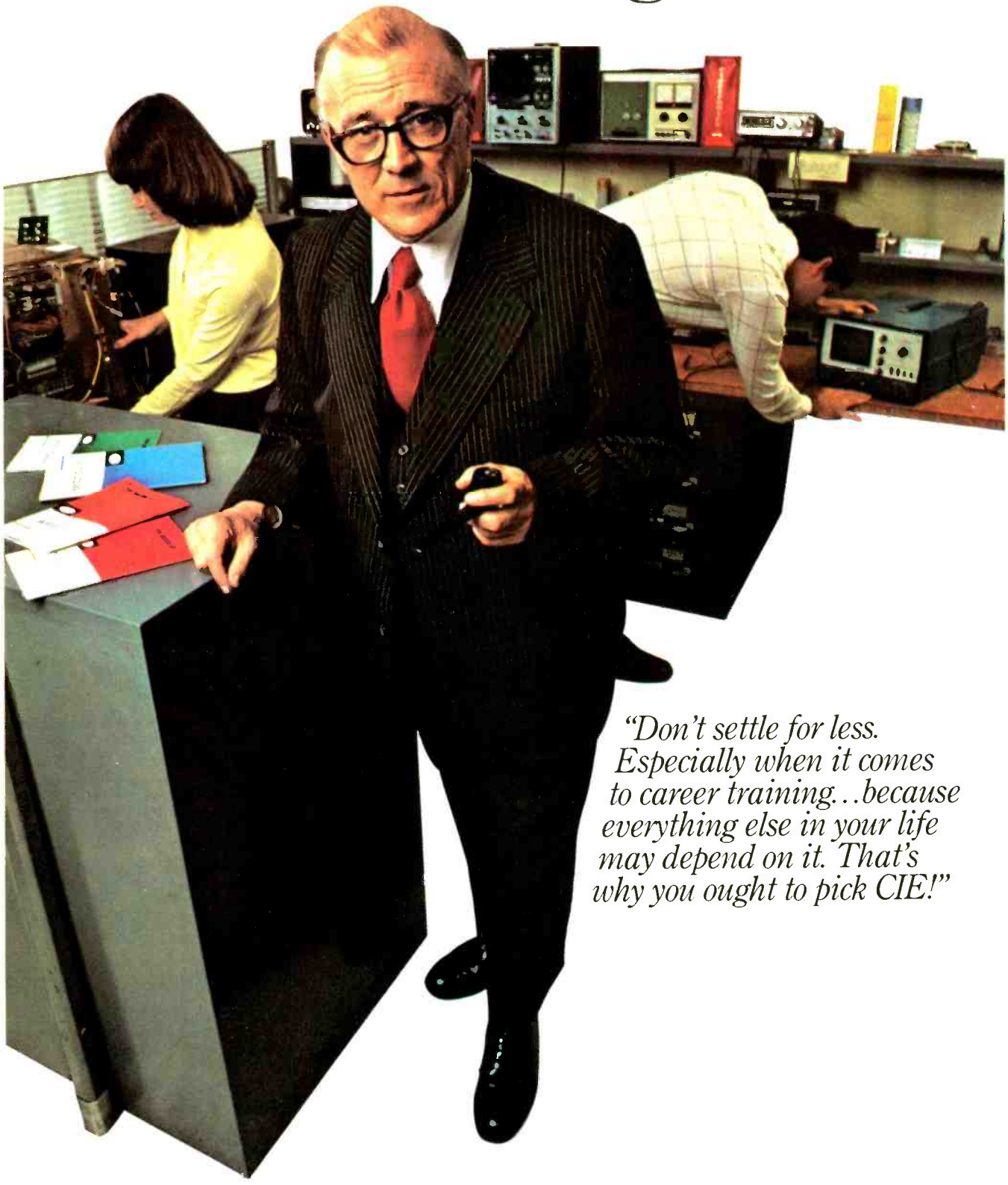
We're first with the best.℠

"If you're going to learn electronics, you might as well learn it right!"



"Don't settle for less. Especially when it comes to career training...because everything else in your life may depend on it. That's why you ought to pick CIE!"

You've probably seen advertisements from other electronics schools. Maybe you think they're all the same. They're not!

CIE is the largest independent home study school in the world that specializes exclusively in electronics.

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Meet the Electronics Specialists.

When you pick an electronics school, you're getting ready to invest some time and money. And your whole future depends on the education you get in return.

That's why it makes so much sense to go with number one . . . with the specialists . . . with CIE!

There's no such thing as bargain education.

If you talked with some of our graduates, chances are you'd find a lot of them shopped around for their training. Not for the lowest priced but for the best. They pretty much knew what was available when they picked CIE as number one.

We don't promise you the moon. We do promise you a proven way to build valuable career skills. The CIE faculty and staff are dedicated to that. When you graduate, your diploma shows employers you know what you're about. Today, it's pretty hard to put a price on that.

Because we're specialists, we have to stay ahead.

At CIE, we've got a position of leadership to maintain. Here are some of the ways we hang onto it . . .

Our step-by-step learning includes "hands-on" training.

At CIE, we believe theory is important. And our famous Auto-Programmed® Lessons teach you the principles in logical steps.

But professionals need more than theory. That's why some of our courses train you to use tools of the trade like a 5 MHz triggered-sweep, solid-state oscilloscope you build yourself—and use to practice troubleshooting. Or a beauty of a 19-inch diagonal Zenith solid-state color TV you use to perform actual service operations.

Our specialists offer you personal attention.

Sometimes, you may even have a question about a specific lesson. Fine. Write it down and mail it in. Our experts will answer you promptly in writing. You may even get the specialized knowledge of all the CIE specialists. And the answer you get becomes a part of your permanent reference file. You may find this even better than having a classroom teacher.

Pick the pace that's right for you.

CIE understands people need to learn at their own pace. There's no pressure to keep up . . . no slow learners hold you back. If you're a beginner, you start with the basics. If you already know some electronics, you move ahead to your own level.

Enjoy the promptness of CIE's "same day" grading cycle.

When we receive your lesson before noon Monday through Saturday, we grade it and mail it back—the same day. You find out quickly how well you're doing!

CIE can prepare you for your FCC License.

For some electronics jobs, you must have your FCC License. For others, employers often consider it a mark in your favor. Either way, it's government-certified proof of your specific knowledge and skills!

More than half of CIE's courses prepare you to pass the government-administered exam. In continuing surveys, nearly 4 out of 5 CIE graduates who take the exam get their Licenses!

For professionals only.

CIE training is not for the hobbyist. It's for people who are willing to roll up their sleeves and go to work . . . to build a career. The work can be hard, sure. But the benefits are worth it.

Send for more details and a FREE school catalog.

Mail the card today. If it's gone, cut out and mail the coupon. You'll get a FREE school catalog plus complete information on independent home study. For your convenience, we'll try to have a CIE representative contact you to answer any questions you may have.

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Patterns shown on TV and oscilloscope screens are simulated.

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MAIL TODAY!

Hey, look me over

Showcase of New Products

Upgrade TRS-80 to 16K RAM

Ithaca Audio has a complete and inexpensive kit for upgrading the Radio Shack TRS-80 Microcomputer System to 16K RAM. The Ithaca Audio 16K TRS-80 Upgrade Kit supplies everything needed for fast, reliable memory expansion. The TRS-80 owner can enlarge the capabilities of his system to include more extensive programming in just minutes, absolutely no soldering is required. The kit comes complete with pre-programmed jumper shunts for both Level I and Level II machines in addition to eight-fully-tested 16K dynamic RAMs. These are simply plugged into the keyboard or

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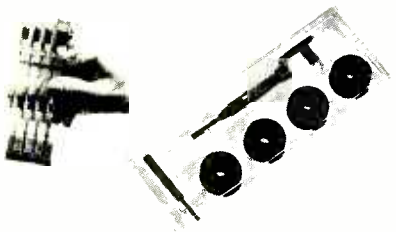
expansion module of the TRS-80. The 16K TRS-80 Upgrade Kit is now available nationwide through all Ithaca Audio dealers or can be ordered from any independent computer retailer. The suggested retail price is just $140.00. For more information, contact Ithaca Audio, P.O. Box 91, Ithaca, NY 14850.

Just Wrap Kit

Complementing the introduction of its remarkable new Just Wrap wire wrapping tool, O.K. Machine and Tool Corp. has announced its new Just Wrap Kit. The Just Wrap tool wraps 30 AWG wire onto standard .025 square posts without



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stripping or slitting the insulation. The tool can "daisy chain" continuously through several points or can be used in the "point-to-point" mode. It contains a built-in wire cutoff device for terminating the final connection of each chain. The JWK-6 Kit contains the "Just Wrap" wrapping tool, the JUW-1 unwrapping tool, and four 50-ft. wire refill cartridges, one each in red, white, blue and yellow, all packaged in a sturdy, reusable clear plastic box. Priced at $24.95 the JWK-6 Just Wrap Kit is available from stock at local electronics retailers or directly from O.K. Machine and Tool Corp., 3455 Conner Street, Bronx, NY 10475.

Moonrotor

Avanti's rotor and control system for CB and amateur communications, called the Moonrotor, is a natural companion to its namesake, the Moonraker, and the popular P.D.L. II (Polar Diversity Loop) antennas. Developed with design and production specialists at Cornell-Dubilier Electronics, Moonrotor features an advanced solid state control system with the appearance of a jet aircraft control panel. Its aluminum housing unit holds a double row 98 ball bearing support system. It is driven through steel intermediate and ring gears by a stainless steel main drive. Moonrotor also features a four-pole, high-torque electric motor with a safe low voltage control which provides turning power for the big beams —up to 8.5 square feet of wind load area. The Moonrotor's integrated cir-

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cuitry has five preset azimuth memory circuits positioned by 30 turn potentiometers. A simple flip of the switch actuates precision beam positioning on any one of the preselected stations. Both the directional control and the special azimuth memory circuits are linked to the integrated circuit which continually senses antenna location and selects the shortest direction of rotation to turn to the desired position. For more information on the Moonrotor, which sells for $129.95, write to Avanti Research & Development, Inc., 340 Stewart Avenue, Addison, IL 60101.

Futuristic Car Stereo

Panasonic has introduced "Cockpit," a ceiling-mounted, modular control unit that offers stereo sound. Cockpit, Model RM-610, includes a Dolby cassette deck, FM stereo tuner, and pre-amp—all in a neat, slender console that hangs overhead in the cabin of your vehicle. The stereo amplifier offers 60 watts total output power and has a flat frequency response and total harmonic distortion of less than .5%. The FM tuner section has an automatic multi-path noise suppressor, special RF AMP and double balanced mixer circuit, high sensitivity and excellent performance of RF intermodulation distortion, 3 pre-set soft touch buttons or manual electronic FM stereo tuning, FM stereo auto/mono switch and stereo indicator, 16 flash

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running LED dial frequency indicators, muting switch, DX/local sensitivity selector, built-in impulse noise quieting circuit, and an on/off power switch and noise blanker. The tape deck section has an auto-reverse cassette player system with locking fast forward and rewind, switchable Dolby noise reduction system, auto eject system when ignition key is off, normal/CRO., tape selector, lighted tape direction indicator and volume control. The pre-amp section offers bass and treble controls with center click, balance and fader controls with center clock, volume control with 21 clickstops, loudness switch, and 10 LED Output Power Indicators. The Cockpit RM-610 sells for $999.95. For all the facts on the Cockpit and other auto audio products, write to Panasonic, One Panasonic Way, Secaucus, NJ 07094. ■

Finding Hidden Treasures

Searching for hidden treasure or lost valuables is fun and easy with the Micronta Metal Detector, new from Radio Shack. The new metal detector is ideal for finding lost coins, relics, jewelry, keys, hardware or anything metallic. It works equally well at finding things under water, wood or soil. The Detector features a water-resistant 8-inch search coil with a Faraday shield to eliminate false indications, a ferrous/non-ferrous control which optimizes the circuit for finding magnetic or non-magnetic objects and a large, easy-to-read meter and adjustable audio alert. The detector has volume, peaking and sensitivity con-

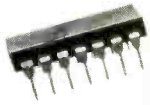
(Continued on page 10)

Radio Shack—Your No. 1 Parts Place™

Low Prices and New Items Every Day!

Low-Power Schottky ICs

Low As **49¢**



- *100% Prime*
- *Guaranteed Specs*

Improved 5-volt logic devices use Schottky diode technology for minimum propagation delay and high speed at minimum power.

Type	Cat. No.	ONLY
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74LS02	276-1902	.59
74LS04	276-1904	.59
74LS08	276-1908	.49
74LS10	276-1910	.59
74LS13	276-1911	.99
74LS20	276-1912	.59
74LS27	276-1913	.69
74LS30	276-1914	.59
74LS32	276-1915	.69
74LS47	276-1916	1.29
74LS51	276-1917	.59
74LS73	276-1918	.69
74LS74	276-1919	.69
74LS75	276-1920	.99
74LS76	276-1921	.79
74LS85	276-1922	1.29
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74LS192	276-1935	1.49
74LS193	276-1936	1.49
74LS194	276-1937	1.49
74LS196	276-1938	1.59
74LS367	276-1835	1.19
74LS368	276-1836	1.19
74LS373	276-1943	2.39
74LS374	276-1944	2.39

4000-Series CMOS ICs

Type	Cat. No.	EACH
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4011	276-2411	.69
4012	276-2412	.79
4013	276-2413	.99
4017	276-2417	1.69
4020	276-2420	1.69
4021	276-2421	1.69
4023	276-2423	.69
4027	276-2427	.99
4028	276-2428	1.29
4046	276-2446	1.89
4511	276-2447	1.69
4049	276-2449	.79
4050	276-2450	.79
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4070	276-2470	.79
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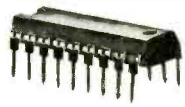

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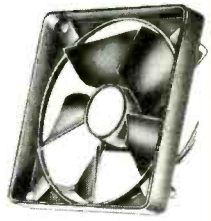

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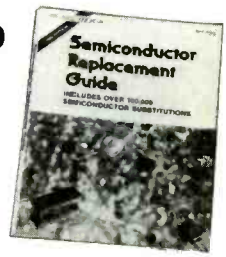

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CIRCLE 29 ON READER SERVICE COUPON

HEY, LOOK ME OVER

(Continued from page 8)

trols, a built-in speaker and earphone jack, and an adjustable shaft that extends up to 36 inches. It requires 6 AA batteries, weighs only 2 lbs., and it's easy to carry. The Micronta Metal Detector is priced at $39.95, and is available at Radio Shack stores and participating dealers nationwide.

CIRCLE 32 ON READER SERVICE COUPON

12-Band Trans-Oceanic Radio

Zenith's new 12-band Trans-Oceanic portable radio is designed to receive more types of broadcast transmissions than most, if not all, comparable portable radios. In addition to FM and AM broadcasting, the Trans-Oceanic has four international shortwave bands. For boating enthusiasts, the R-7000 offers two shortwave marine bands which include marine weather, amateur radio, ship-to-ship/ship-to-shore communications, CB, single sideband transmissions, time, and several amateur frequencies. A rotary azimuth disc, built into the lower lid of the Trans-Oceanic, may be used as an emergency navigation aid in conjunction with up-to-date marine charts, and as a radio direction-finder. The multi-band R-7000 also features two aviation service bands: a VHF aircraft communications band for ground control and aircraft navigational aids, and a longwave FAA weather band which continuously broadcasts flying condition weather reports. The Trans-Oceanic also has a Public Service band that covers a variety of broadcasts: police, fire, news reporters, mobile telephone, and vehicle dispatching. Two built-in antennas including a ferrite rod used on AM and LW bands, and a 7-section telescoping antenna covering FM/SW/VHF, plus external antenna connection terminals for AM/LW, SW and FM/VHF to increase reception in weak signal areas, all add to the Trans-Oceanic's versatility and flexibility. The Trans-Oceanic R-7000 may be powered by 8 "D" cell batteries for complete portability or 120V AC plus protected voltage switch for 240V in areas where only 240V is available. In addition, a rear jack permits powering from a car or boat 12-volt system with use of an optional accessory plug. A concise and easy-to-understand guide to the Trans-Oceanic's operation, plus other important information, fits conveniently inside the front panel of the radio. Manufacturer's suggested retail price is $379.95. Get all the facts direct from Zenith Radio Corp., 1000 Milwaukee Ave., Glenview, IL 60025.

CIRCLE 40 ON READER SERVICE COUPON

Support Trestles/Sawhorses

Two new support trestles of plywood construction, Stable-Mates, are designed so legs and tops slip firmly together or smoothly disengage in seconds. No tools, fasteners or grips are needed for assembly or dissassembly. The interlocking design makes them solidly stable and strong. Ideal for knockdown lab or test

(Continued on page 26)

HI•FI REPORTS

Put supersound in your supercar

by Gordon Sell

Car-Fi, Auto-Audio, Mo-Fi, Auto-Sound and Car-Stereo are just a few of the names given to what has become one of the hottest things in electronics since the transistor radio. All over the country people are turning their cars into mobile listening rooms with audio control panels that make their dashboards look like a 747's instrument panel.

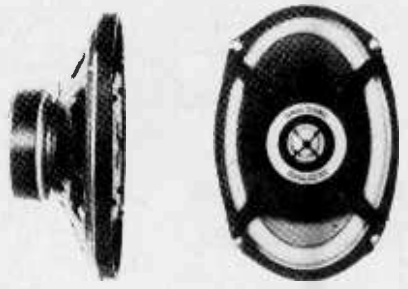
My own theory about the cause of this boom in car stereo is based on this country's love of the automobile. With all the environmental and energy problems this love has been redirected from building high performance, gas eating, air poluting, hot rods towards improving a car as a living environment. Your basic, gas stingy, non-poluting car just doesn't have the pizzazz of the supercars of yesteryear, so people are giving their cars a new kind of electronic pizzazz. That super, sound system also has the advantage of making your average, tinny subcompact sound a lot more sumptuous.

Installing a car stereo is a lot easier when the manufacturer provides the correct adapters. This Jensen R-420 AM/FM cassette unit fits all standard cars. For more information about this $399.95 unit circle No. 44.

Avoiding the Pot Holes. Buying a car stereo system today is a lot like buying a component hi-fi back when it first became popular. There are no industry standards or federal trade commission rules that specifically govern car-fi. A car stereo that is claimed to have "50 watts of music power" can actually have less power than a 20-watt unit. Hi-fi manufacturers are required to rate amplifier output in watts-per-channel RMS (Root Mean Square or .707 of the peak power level; i.e. 100 watts peak power is equal to 70.7 watts RMS), car-fi manufacturers are not.

Clarion has been promoting their mobile rack-mounting components. These give an installation a more permanent look. Racks come with up to four wells either vertically or horizontally. From $6.50. Circle 50.

So that 50 watts is now down to about 35 watts, but we've forgotten those magic words "per channel." If a car stereo manufacturer doesn't specify watts-per-channel then assume they mean total power—the sum of the two channels. Well now our 50 watts is down to 17.5, and if you are planning to feed four large speakers they are going to be a bit hungry with only 8¾ watts per speaker RMS.



The 6x9 is a standard auto speaker size that will usually replace the stock speaker. These Royal Sound RS-600s are two way units that cost $125 per pair. Circle 49.

Most of the respectable companies don't use this sort of rating although I've seen one or two who succumbed to advertized-spec inflation. With some of the fly-by-night outfits you can safely take their power figure and divide by four to get the RMS per channel figure. Compare power in terms of watts-per-channel RMS only.

Road Noise. The inside of an automobile is probably the worst possible place short of a machine shop to try to get good sound. There is not enough room for a large speaker so the low frequency response doesn't get much below 50 or so Hz, and road and machinery noise blocks out the high frequency music. On the road you won't be able to appreciate a set-up

(Continued on page 14)

ANNOUNCING ONLY AIR AMERICA LAND, SEA AIR SCANNER.

Only the incredible, new, no-crystal Bearcat 220 Scanner tunes in all the real excitement of the entire AM aircraft band—plus every FM public service frequency—with pushbutton ease.

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CIRCLE 11 ON READER SERVICE COUPON

HI-FI REPORTS

that delivers a frequency response much better than 50 to 13,000 Hz—of course when you are parked that's another matter altogether. With vans and RVs (recreational vehicles) the sky's the limit as far as finding space for those bigger speakers, but since most of us are concerned with equipping a standard sedan, that is all I will refer to in this article.

If you think car stereo is just an AM/FM radio in the dash then take another look. A good car-fi unit is a full stereo receiver with excellent electronic specifications, separate balance, treble and bass controls. It can be connected to a number of other components just like a home stereo receiver.

In addition to receivers there are eight-track and cassette tape decks, power amplifiers, graphic equalizers, reverberation units and time delay units. These components can be mounted under the dash or in add-on consoles. Choosing components is even harder than picking a good auto-receiver, so choosing a reliable manufacturer is even more important.

Sparkomatic's SR-3400 AM/FM cassette, in-dash unit has built-in clock for $300. Circle Reader Service Number 45 for information.

Another important consideration is whether you intend to do the installation yourself. This is not always as easy as it looks especially on newer cars and cars with air conditioning. Before you go shopping take a good, long look under your dashboard. Can you get the old radio out and a new one in without first getting a degree in mechanical engineering; if you have stereo speakers will you be able to replace them with more suitable ones; and if you don't have two speakers, will you be able to find a place for the new ones? While you are under the dash take a look at how the radio is supported. It might help to make a rough sketch of the various support straps and jot down the dimensions of just about everything before you go shopping. You can even take the radio

Three-way car speakers usually have the tweeter and midrange inside the woofer cone for compactness. These Jensen Triax II's carry a retail price of $140. Circle 44.

(Continued on page 16)

BUILD 20 RADIO AND ELECTRONICS CIRCUITS

PROGRESSIVE HOME RADIO-T.V. COURSE

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Training Electronics Technicians Since 1946

Now Includes

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- ★ No Knowledge of Radio Necessary
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- ★ Solid State Circuits
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The "Edu-Kit" offers you an outstanding PRACTICAL HOME RADIO COURSE at a rock-bottom price. Our Kit is designed to train Radio & Electronics Technicians, making use of the most modern methods of home training. You will learn radio theory, construction practice and servicing. THIS IS A COMPLETE RADIO COURSE IN EVERY DETAIL.

You will learn how to build radios, using regular schematics; how to wire and solder in a professional manner; how to service radios. You will work with the standard type of punched metal chassis as well as the latest development of Printed Circuit chassis.

You will learn the basic principles of radio. You will construct, study and work with RF and AF amplifiers and oscillators, detectors, rectifiers, test equipment. You will learn and practice code, using the Progressive Code Oscillator. You will learn and practice trouble-shooting, using the Progressive Signal Tracer, Progressive Signal Injector, Progressive Dynamic Radio & Electronics Tester, Square Wave Generator and the accompanying instructional material.

You will receive training for the Novice, Technician and General Classes of F.C.C. Radio Amateur Licenses. You will build Receiver, Transmitter, Square Wave Generator, Code Oscillator, Signal Tracer and Signal Injector circuits, and learn how to operate them. You will receive an excellent background for television, Hi-Fi and Electronics.

Absolutely no previous knowledge of radio or science is required. The "Edu-Kit" is the product of many years of teaching and engineering experience. The "Edu-Kit" will provide you with a basic education in Electronics and Radio, worth many times the low price you pay. The Signal Tracer alone is worth more than the price of the kit.

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You do not need the slightest background in radio or science. Whether you are interested in Radio & Electronics because you want an interesting hobby, a well paying business or a job with a future, you will find the "Edu-Kit" a worth-while investment.

Many thousands of individuals of all ages and backgrounds have successfully used the "Edu-Kit" in more than 79 countries of the world. The "Edu-Kit" has been carefully designed, step by step, so that you cannot make a mistake. The "Edu-Kit" allows you to teach yourself at your own rate. No instructor is necessary.

PROGRESSIVE TEACHING METHOD

The Progressive Radio "Edu-Kit" is the foremost educational radio kit in the world, and is universally accepted as the standard in the field of electronics training. The "Edu-Kit" uses the modern educational principle of "Learn by Doing." Therefore you construct, learn schematics, study theory, practice trouble shooting—all in a closely integrated program designed to provide an easily-learned, thorough and interesting background in radio.

You begin by examining the various radio parts of the "Edu-Kit." You then learn the function, theory and wiring of these parts. Then you build a simple radio. With this first set you will enjoy listening to regular broadcast stations, learn theory, practice testing and trouble-shooting. Then you build a more advanced radio, learn more advanced theory and techniques. Gradually, in a progressive manner, and at your own rate, you will find yourself constructing more advanced multi-tube radio circuits, and doing work like a Professional Radio Technician.

Included in the "Edu-Kit" course are Receiver, Transmitter, Code Oscillator, Signal Tracer, Square Wave Generator and Signal Injector Circuits. These are not unprofessional "breadboard" experiments, but genuine radio circuits, constructed by means of professional wiring and soldering on metal chassis, plus the new method of radio construction known as "Printed Circuitry." These circuits operate on your regular AC or DC house current.

THE "EDU-KIT" IS COMPLETE

You will receive all parts and instructions necessary to build twenty different radio and electronics circuits, each guaranteed to operate. Our Kits contain tubes, tube sockets, variable, electrolytic, mica, ceramic and paper dielectric condensers, resistors, tie strips, hardware, tubing, punched metal chassis, Instruction Manuals, hook-up wire, solder, selenium rectifiers, coils, volume controls, switches, solid state devices, etc.

In addition, you receive Printed Circuit materials, including Printed Circuit chassis, special tube sockets, hardware and instructions. You also receive a usefui set of tools, a professional electric soldering iron, and a self-powered Dynamic Radio and Electronics Tester. The "Edu-Kit" also includes Code Instructions and the Progressive Code Oscillator, in addition to F.C.C. Radio Amateur License training. You will also receive lessons for servicing with the Progressive Signal Tracer and the Progressive Signal Injector, a High Fidelity Guide and a Quiz Book. You receive Membership in Radio-TV Club, Free Consultation Service, Certificate of Merit and Discount Privileges. You receive all parts, tools, instructions, etc. Everything is yours to keep.

FREE EXTRAS

• SET OF TOOLS

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SERVICING LESSONS

You will learn trouble-shooting and servicing in a progressive manner. You will practice repairs on the sets that you construct. You will learn symptoms and causes of trouble in home, portable and car radios. You will learn how to use the professional Signal Tracer, the unique Signal Injector and the dynamic Radio & Electronics Tester. While you are learning in this practical way, you will be able to do many a repair job for your friends and neighbors, and charge fees which will far exceed the price of the "Edu-Kit." Our Consultation Service will help you with any technical problems you may have.

FROM OUR MAIL BAG

Ben Valerio, P. O. Box 21, Magna, Utah: "The Edu-Kits are wonderful. Here I am sending you the questions and also the answers for them. I have been in Radio for the last seven years, but like to work with Radio Kits, and like to build Radio Testing Equipment. I enjoyed every minute I worked with the different kits; the Signal Tracer works fine. Also like to let you know that I feel proud of becoming a member of your Radio-TV Club."

Robert L. Shuff, 1534 Monroe Ave., Huntington, W. Va.: "Thought I would drop you a few lines to say that I received my Edu-Kit, and was really amazed that such a bargain can be had at such a low price. I have already started repairing radios and phonographs. My friends were really surprised to see me get into the swing of it so quickly. The Trouble-shooting Tester that comes with the Kit is really swell, and finds the trouble, if there is any to be found."

SOLID STATE

Today an electronics technician or hobbyist requires a knowledge of solid state, as well as vacuum tube circuitry. The "Edu-Kit" course teaches both. You will build vacuum tube, 100% solid state and combination ("hybrid") circuits.

PRINTED CIRCUITRY

At no increase in price, the "Edu-Kit" now includes Printed Circuitry. You build a Printed Circuit Signal Injector, a unique servicing instrument that can detect many Radio and TV troubles. This revolutionary new technique of radio construction is now becoming popular in commercial radio and TV sets.

A Printed Circuit is a special insulated chassis on which has been deposited a conducting material which takes the place of wiring. The various parts are merely plugged in and soldered to terminals.

Printed Circuitry is the basis of modern Automation Electronics. A knowledge of this subject is a necessity today for anyone interested in Electronics.

Progressive "Edu-Kits" Inc., 1189 Broadway, Dept. 599-DJ Hewlett, N.Y. 11557

Please rush me free literature describing the Progressive Radio-TV Course with Edu-Kits. No Salesman will call.

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CIRCLE 18 ON READER SERVICE COUPON

part way out just to see how the new one will have to be mounted.

Installation. Some units will install in some cars in next to no time while others will require a lot of time and effort. Any reputable manufacturer includes or has

In the jumbled audio environment of a car an equalizer can make a real difference. This Mitsubishi CV-23 is a booster/equalizer and sells for $179.95. Circle service number 46.

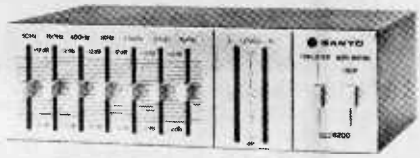
available instructions and adapters to allow installation in most American and imported cars. Some dealers may act dumb when you ask about adapter kits if they are not included with the radio. Just don't take no for an answer, some dealers will tell you nothing is available when they are just too lazy to order, or they are trying to drum up business for their own installer. If a dealer is uncooperative, just go to another dealer.

Try to do a quality installation job. There is nothing more unattractive than a car with wires running here and there, and brackets held in place with duct tape. Feed wires under the rugs and tie them up under the dashboards so they don't hang down.

To get wires from the front of the car to the back, detach the trim on the bottom of the door frame so that you can get under the edge of the rubber floor pan covering. Slip wires under the covering and replace the trim. You'll be the only one who knows they are there.

Install rear speakers unobtrusively if you live in a high car theft area. Having big, bulky rear shelf speakers is like putting a sign up that says "this car has an expensive stereo." Try to make all installations look like they were done when the car was built and you'll be much less likely to be ripped off.

It is almost impossible to make under-



Sanyo's extensive line of auto-audio products includes this sharp looking 7-band graphic equalizer. Costs: $70. Circle 80.

dash units look standard but you can make them as descrete as possible. Put them as far under the dash as you can without putting them out of reach. If you are very good with tools you might even find a blank spot in the dash and mount it there, but don't do this unless you really know what you are doing. If you want to give a gadget a permanent in-dash mount you have to decide what you will do when you sell the car. Either sell the gadget with the car or expect a large drop in value because of the empty hole in the dash. If you change cars often you might be better off sticking to under-dash mounts for your specialty gear. Power amps and devices with permanently set controls can go way back under the dash, under the seat or even in the trunk.

What's Available. The auto-sound marketplace is almost limitless. Just about anything short of a turntable is available in one form or another for car installation. The manufacturers include most of the big

Expand the size of your car with Fujitsu Ten's RV-130EX-1 graphic time delay. This $180 unit also has a reverbe. Circle 47.

names from the audio industry, some CB manufacturers who are taking advantage of their long experience with auto electronics and a couple of newcomers who are making their name in auto sound.

On these pages I've shown a small sample of what's available. We have not had a chance to test all of these in the lab, but they all come from well respected companies so you can be reasonably sure of the quality. If you want more information about these company's product lines then circle the appropriate Reader Service Numbers on the card elsewhere in this issue. Fill out the card and send it in. We'll tell the manufacturers to send you their latest brochures. ■

BOOKMARK
BY BOOKWORM

Z-80 Brain Waves. The Zilog Model Z-80 represents a microprocessor that is extremely sophisticated and attractive to many computer users. Now you can pick inside the Z-80's brain by reading *Z-80 Microcomputer Handbook* by William Barden, Jr. Organized into three sections, the first section concentrates on hardware; the second on software; and the third on microcomputers built around the Z-80. This handbook will provide the current user and the prospective user with essential infomation on the technology of the Z-80 Published by Howard W. Sams & Co., Inc., 4300 West 62nd St., Indianapolis, IN 46206.

A handy guide to the Zilog microcomputer.

Soft cover
304 pages
$8.95

CIRCLE 56 ON READER SERVICE COUPON

Tuning In. Thanks to author Oliver P. Ferrel, the *Fourth Edition of Confidential Frequency List* identifies over 6000 stations operating betwen 4000 and 25,590 kHz in what is broadly termed the "Utility" stations. This compilation in a new convenient format is a "hot dog" text for SWLs who specialized in tuning in Military, Coast Guard, Maritime, Aeronautical Mobile, Fixed, VOLMET Time, RCMP, etc. stations. The authenticity of the text springs from the author's lifetime experience. Perry, as his friends call him, wrote numerous articles on FM and VHF propagation in the late 1930's. After service in WWII, Perry served as chief editor of CQ, Stereo Review and Popular Electronics. He has published original research papers on meteoric unization and sporadic-E cloud movements. The *Confidential Frequency List* is published by Gilfer Associates, Inc., P.O. Box 239, 52 Park Avenue, Park Ridge, NJ 07656.

Firsthand "Utility" station news.

Soft cover
104 pages
$6.95

CIRCLE 57 ON READER SERVICE COUPON

Solar Electricity Guide. How to put solar electricity to work for you is explained in a new manual, *The Solarex Guide to Solar Electricity*. Designed for everyone from the amateur solar enthusiast to the professional energy expert, the new guide provides a full description of the do's and don'ts of converting the solar system's most abundant energy resource, sunlight, into useable electrical energy by means of solar cells. The pages of this resource book are filled with charts, graphs, drawings and diagrams of solar cell applications. Photographs and text provide full description of projects. These range from solar electric demonstration set-ups for schools to solar-powered toys and wrist watches, solar-powered fans and recreational equipment on up to large scale applications, such as a massive installation for total energy requirements of Mississippi County Community College, Blytheville, Ark. Parallel and series connections of solar cells with capacitors, current limiters, storage batteries and voltage multipliers are diagrammed and explained. The guide book may be obtained by writing to Ed Roberton, Solarex Corp., CPD-Dept. L100, 1335 Piccard Drive, Rockville, MD 20850. Add 55 cents to the purchase price for shipping and handling.

A how-to guide on solar energy.

Soft cover
140 pages
$6.50

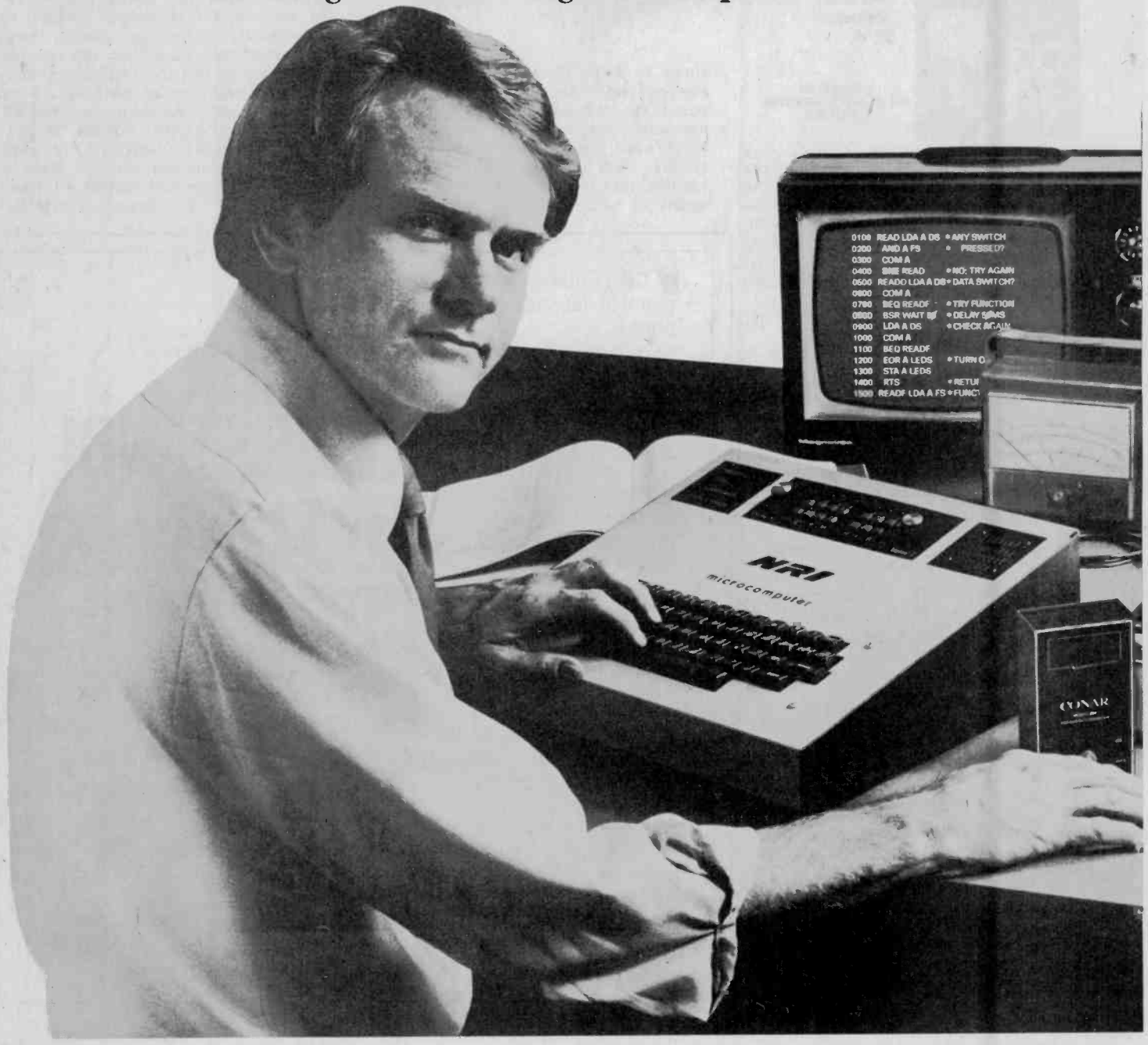
CIRCLE 54 ON READER SERVICE COUPON

Bell Started It. Nowadays telephones are much more than just another space-age communications gadget. Thanks to 20th century technology, phones have hundreds of new capabilities: one can add an accessory or two and it will dial a number automatically, or let one hear and see a friend, or sound an alarm, or divert incoming calls to another number, or handle mathematical calculations, or even accesss to a computer. At last here's a book by Van Waterford entitled *All About*

(Continued on page 84)

Microcomputers are here! Get in on the ground floor with NRI's new "at home" training in computer technology.

Only NRI Gives You "Hands-on" Experience as You Build Your Own Designed-for-learning Microcomputer



The microprocessor, that amazing little chip which shrinks electronic circuitry to microscopic size, has changed the world of the computer with dramatic speed. Now, big-performance computers are here in compact sizes...priced to make them practical for thousands of medium and small businesses, even homeowners and hobbyists.

Microcomputers are already being put to work on jobs like inventory control, payrolls, cost analysis, billing, and more. In homes, they're able to handle budgets and tax records, control environmental systems, index recipes, even play sophisticated games. And hobbyists across the country are expanding the state of the art while developing their own programs.

Become a Part of This Incredible World ... Learn at Home in Your Spare Time

NRI can give you the background you need to get into this booming new field. Microcomputers require a new discipline, a broader viewpoint... the ability to think in both hardware and software terms. And NRI's new course in computer technology is geared to bridge the gap.

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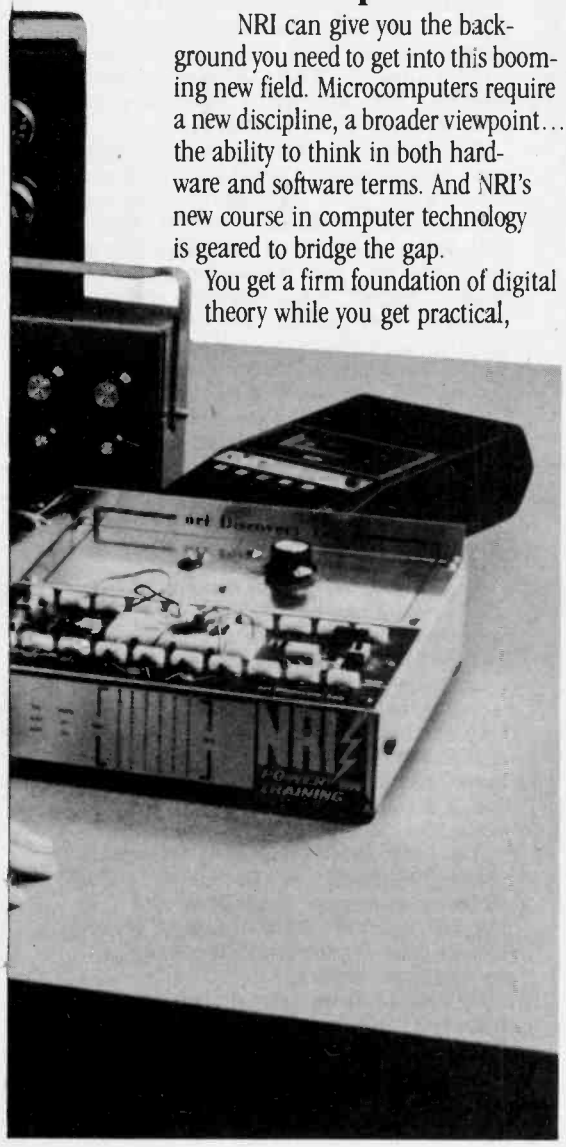

"hands-on" experience working with the NRI Discovery Lab®, assembling test instruments you keep, and even building your own fully functional microcomputer.

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You also assemble professional test instruments for use in your training. You get your own CMOS digital frequency counter and transistorized volt-ohm meter to keep and use in diagnosing problems and servicing computers. Together with up-to-the-minute lessons and NRI's 60-plus years of home study experience, you get the most in training and value.

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DX central reporting

A world of SWL info!

BY DON JENSEN

AS YOU READ THIS, the long awaited World Administrative Radio Conference (WARC) of the International Telecommunications Union is underway in Geneva, Switzerland.

At WARC-79, for ten weeks this fall, representatives of the 154 nations which are members of the ITU have been working on the frequency allocation ground rules that will govern broadcasting—and especially shortwave—channels for the rest of the century.

The work of the conference is important. It is estimated that there are some 900 million radio receivers in the world today; 300 million of them capable of tuning the shortwave frequencies. Also, according to estimates, on any given day around the globe, up to 200 million persons listen to a shortwave radio broadcast.

The importance of the conference's work was highlighted earlier this year by John A. Gronouski, chairman of the U.S. Board for International Broadcasting, in an address to the North Atlantic Treaty Organization (NATO) Cultural Affairs Committee.

Viable Medium. "Shortwave radio appears to be the only viable medium for international broadcasting in the foreseeable future," Gronouski said.

"Shortwave broadcasting is not the exclusive domain of the more powerful industrialized nations. It is the only practical information medium at present through which the voice of the smaller, less affluent country can be heard, and can reply to the major powers. Installations are relatively inexpensive, within the means of most of the developing nations."

Gronouski went on to note that the number of shortwave transmitters in use jumped from 300 in 1950 to 1,500 today. The amount of broadcasting has increased five times since the end of World War II.

"Most shortwave frequencies are now being used by double (and during preferential broadcasting hours), three and four times the number of transmitters recommended as a reasonable norm by the ITU."

The former ambassador told the NATO delegates that at the last WARC conference, in 1959, the technologically advanced countries of the West had a voting edge. At WARC-79, however, the voting clout is within the smaller Third World nations. Countries such as Togo and Fiji have one vote each, just as the United States and the Soviet Union do. But there are many of these developing countries, and as Gronouski pointed out, they are seeking a "share of the pie."

Gronouski proposed to the NATO delegates that the more technologically advanced nations demonstrate leadership at the Geneva conference, that they propose, in effect, a larger "pie," a doubling of the shortwave broadcasting frequencies. Also, he urged a recognition of the desires and goals of the Third World majority for a greater share of the shortwave frequencies.

Ambassador Gronouski spoke to the NATO committee delegates in February. Several months later the United States proposals for the WARC-79 meeting were finalized. Not surprisingly they reflected what Gronouski had suggested.

Happily for just about everyone—including SWLs—earlier "talking" positions which would have gobbled up some of the low SW frequency Tropical Bands (the special territory of the Third World countries) by the International Broadcasting "biggies" were forgotten. In fact, the U.S. final position proposed an expansion, not a contraction, of the Tropical Bands for domestic broadcasting use, especially in the developing nations. If adopted as proposed by the U.S. delegates, the Tropical Bands in the lower end of the shortwave spectrum would grow by some 300 kilohertz, and there would be new Tropical Bands, from which so-called International Broadcasting would be excluded, as high as 14 MHz.

The United States, of course, is primarily interested in increasing the shortwave bands for International Broadcasting. The proposal would expand the existing frequencies used by the major foreign service broadcasters by about 1,500 kilohertz of band space, between 5,800 and 22,000 kHz. And the American proposal would create two completely new bands. one in the upper 13 MHz range, the other just below 20 MHz.

The U.S. also proposed transmitter power limitations of 50 kilowatts for domestic shortwave operations and 250 kW for external services, with a grandfather clause for those stations already exceeding those powers.

Of course, no one expects that the U.S. proposals will emerge unscathed from WARC-79. The Soviet Union is on record

(Continued on page 84)

DX GLOSSARY

DX, DXing=Distant station; the hobby of listening to distant or hard-to-hear stations.

GMT=Greenwich Mean Time, a universal time reference equivalent to EST+5 hours, CST+6 hours, MST+7 hours or PST+8 hours.

kHz=kilohertz, a unit of frequency measurement equal to 1000 cycles per second, formerly expressed as kilocycles per second, kc/s.

MHz=Megahertz, unit of frequency measurement equal to 1000 kHz.

SW, SWL, SWLing=short wave, shortwave listener, hobby of shortwave listening.

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3600A	$199.95	50Hz - 600MHz	Oven .5 PPM 17° - 37°C	10MV	10MV	50MV	8	.5 Inch	115 VAC or 8.2 - 14.5VDC	2⅛"H x 8"W x 5"D
3550W	$149.95	50Hz - 550MHz	TCXO 1 PPM 65° - 85°F	25MV	25MV	75MV	8	.5 Inch	115 VAC or 8.2 - 14.5VDC	2⅛"H x 8"W x 5"D
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newscan

Electronics in the News!

Microcomputer Marathon

After a demanding 8½-day marathon, a group of high school students in the southern Texas city of San Antonio is claiming a new world's record. However, if the students of Holy Cross High School are to be recognized for their efforts, a new category will be needed in the record books.

The famous Guinness Book of World Records, which lists such exotic feats as marathon flagpole sitting, breath holding and rope jumping, as of yet has no category for computer marathons. But the 311

Approximately 300 students at San Antonio's Holy Cross High School recently took part in what they believe was a record-setting eight-day, 24-hour-a-day computer training marathon. Using TRS-80 Microcomputer Systems from Radio Shack, the students learned the basics of computer operation and programming.

Holy Cross students who took part in an eight-day, around-the-clock computer training session during January, 1979 believe that their accomplishment deserves a mention in future record books.

Instructor Dennis Doose, chairman of the Holy Cross science department, agrees. It was Doose who suggested the computer training marathon after students began staying after class—voluntarily—to use the school's TRS-80 Microcomputer System.

"So what better way to get as many students as possible exposed to computers?" Doose asked.

The department chairman then explained that Radio Shack, manufacturer of the TRS-80, agreed to loan the school 22 additional microcomputers for the event.

The response was "fantastic," according to Doose, who added that students were actually lined up at the door when the computer training marathon began on Friday, January 12. About 206 hours later, 311 Holy Cross students had logged time on the computers. Although most had never used a computer before, "everything went well," according to instructor Doose.

The students took turns, and at least two computers—usually more—were in constant use throughout the marathon, which ended at 9 A.M. on Sunday, January 21. More experienced students even brought sleeping bags so 24-hour supervision would be available for computer novices. As a result of the marathon, 72 students completed the TRS-80 computer programming course.

One thing about records! They are made to be broken. I wonder if the people at Apple, Heath or OSI will take up the challenge.

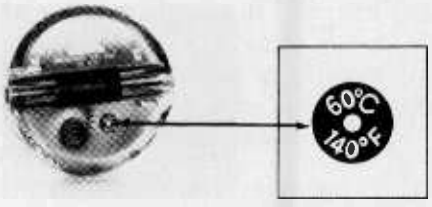
Pacemaker Temperature Monitor

The backstage collapse of 74-year-old movie star Pat O'Brien, as well as the incident of the Arlington, Texas fan revived with mouth-to-mouth resuscitation by Texas Rangers pitcher "Doc" Medich, focused national attention on a vital but vulnerable component of pacemakers: the batteries.

The self-generating lithium oxide batteries used in pacemakers have a life of 10-15 years. That life can be considerably shortened, however, by exposure to temperatures in excess of 140°F. Pacemaker manufacturers, therefore, take every precaution to protect their product during shipment. One highly-effective and widely-used method of protecting against high temperatures is the Tempilabel® temperature indicating monitor.

Tempilabels have spots that turn black at designated temperatures (they are available with temperature ratings of 100°F to 600°F). If a shipment arrives and the spots have turned black, it is certain that it has been exposed to temperatures at least as high as the Tempilabel's rated temperature. If the spots have *not* turned black, it is equally certain that the shipment has not been exposed to that temperature.

Cardiac Pacemakers, Inc., of St. Paul, MN, places a Tempilabel in the shipping carton. The label contains four sequential



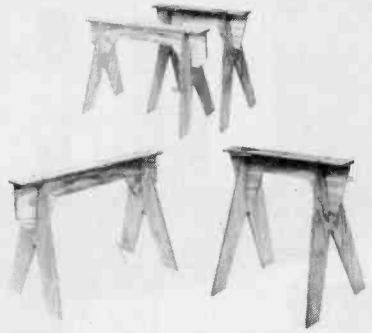
This photo of a pacemaker shows the Tempilabel®, a temperature indicating-monitor, as an integral part of the unit. Diagram shows the high temperature indicator enlarged 4 times.

temperature sensitive spots that turn black when temperatures of 100°F, 125°F, 150°F, and 175°F are reached. American Pacemakers, of Woburn, MA, also places the Tempilabels in the shipping cartons. American Technology, of Northridge, CA, places a Tempilabel directly on each pacemaker. An epoxy coating covers the entire surface of the pacemaker, including the Tempilabel, and eliminates any problem of rejection of the Tempilabel by the patient's body. ■

HEY, LOOK ME OVER

(Continued from page 10)

benches, or lowcost permanent desk supports for SW shacks and home computer labs. The Professional Model is designed for use as a construction bench, as legged supports or as saw horses. It's 27-inch height gives the craftsman proper working leverage for hand and power tools. The Utility Model is made for supporting table-height tops, counters, desks or drawing



CIRCLE 41 ON READER SERVICE COUPON

surfaces. While it can easily be used as a bench support or saw horse, its 30-inch height matches most table and counter measurements and its 30-inch width fits through standard door openings. Stable-Mates models will support tested weights in excess of 700 pounds. The Professional Model weighs 10 pounds and the Utility Model weighs 8 pounds. Both models sell for $25.00 each. Prices are F.O.B. To order, address all correspondence to: Basic Materials, Inc., P.O. Box 415, Richmond, VA 23203.

200 kHz To 30 MHz in 30 Easy Steps

The model R-1000 Communications Receiver, which provides continuous frequency coverage from 200 kHz to 30 MHz in 30 bands, each 1 MHz wide, has been introduced by Trio/Kenwood Communications, Inc. Frequencies are read easily on an accurate, five-digit fluorescent-tube display, backed up by an illuminated analog dial. The digital display also functions with a built-in quartz digital clock and an ON/OFF timer, which continue to operate even when the receiver is turned off.

CIRCLE 52 ON READER SERVICE COUPON

An up-conversion PLL circuit and wideband RF circuits provide exceptional receiver performance and easy operation. Simply switch to the appropriate band and quickly tune to the desired frequency while observing the digital display—no need for bandspread, preselector, or antenna tuning control adjustment. Operating modes include AM (wide and narrow), SSB (USB) and (LSB), and CW. Three IF filters are built-in—one for SSB and CW (2.7 kHz), one for AM narrow (6 kHz), and one for AM wide (12 kHz).

On an easy-access sloping rear panel, are mounted the antenna terminals, ground-wire terminal, external-speaker jack (4-16 ohms), remote connector (for timer-activated start/stop remote control of a recorder or other equipment, and for receiver muting), AC power, fuse holder, and operating-voltage selector (100/110/220/240 VAC). The R-1000 is available through your local Trio/Kenwood dealer. For more information on the R-1000, contact Trio/Kenwood Communications, Inc., 1111 W. Walnut St., Compton, CA 90220, or circle number 52 on the reader service coupon.

Palm-Size DMM

The new hand-held LCD display precision digital multimeter, designed primarily for field use, is a full-function, 3½ digit DMM with 0.1% accuracy. The Model 935 offers 29 ranges of DC or AC voltage and current and resistance measurements, including both high and low resistance excitation capability. Ranges, functions, and excitation level are selected using pushbutton switches, easily allowing one-handed operation of all controls. Measurements including appropriate polarity sign and decimal points and

CIRCLE 36 ON READER SERVICE COUPON

a warning indicator for low battery voltage are displayed on a high contrast 3½ digit 0.5-inch high liquid crystal display. A standard 9 V alkaline transistor battery will power the Model 935 for over 200 hours of continuous use. Battery and overcurrent fuse replacement are easily accomplished after removing one coin operated captive screw. An optional AC line adapter is available for AC line operation on the bench. For further information on the 935 which sells for $149.00, contact Data Precision, Electronics Avenue, Danvers, MA 01923, 617/246-1600.

Enhanced Apple II Computer

Apple Computer, Inc., recently announced the Apple II Plus—an enhanced version of the Apple II computer offering resident Applesoft Extended BASIC language and a new Auto-Start control ROM (Read-Only Memory) for simplified start up and screen editing. Previously available as a separate, extra-cost option, Applesoft has been added to the Apple II Plus as a standard feature. Applesoft is especially designed for business, scientific, and educationally-oriented applications. The new Auto-Start control ROM provides several capabilities including: Automatic Startup (this feature automatically puts the Apple II into BASIC mode allowing a user to begin programming without preliminary commands), Automatic Disk Load (the Auto-Start ROM will automatically load and run a user-specified program from the disk), Reset Protection (the RESET key

(Continued on page 82)

CIRCLE 1 ON READER SERVICE COUPON

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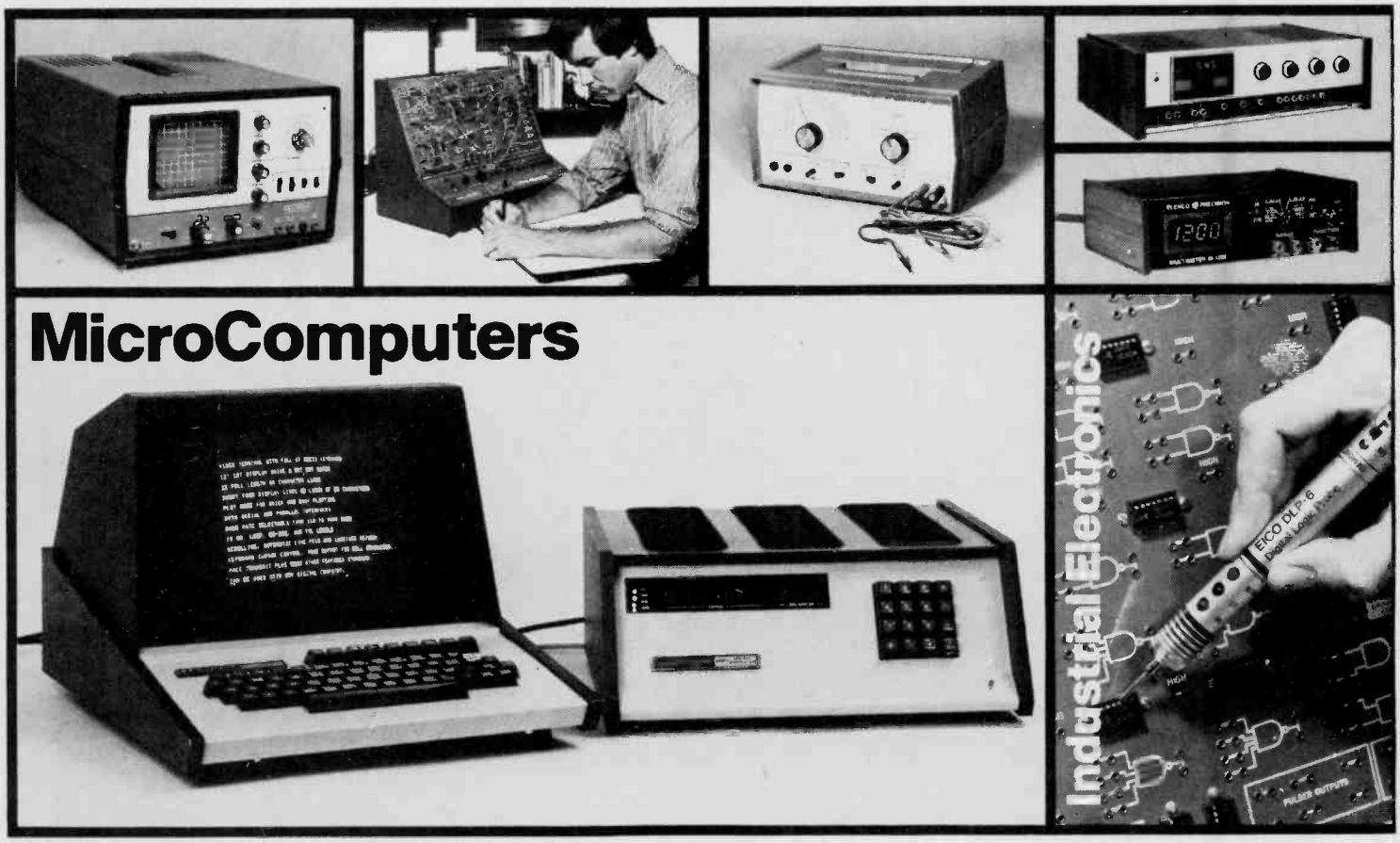

The world of electronics is daily becoming more challenging. Technology is growing more specialized, and the importance of digital systems increases every day. Test instruments, home entertainment units and industrial control systems are all going digital. And now, NTS training programs include a wider choice of solid-state and digital equipment than ever before offered in any home study course: Advanced NTS/Heath digital color TV (25" diagonal with optional programming capability), NTS/Heath microcomputer, digital test equipment, digital stereo receiver (70 watts per channel), NTS compu-trainer, plus much more state-of-the-art equipment to make your training exciting and relevant.

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RF-2900

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

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

The Command Series from Panasonic. If you had short wave receivers as good. You wouldn't still be reading. You'd be listening.

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

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CIRCLE 107 ON READER SERVICE COUPON

elementary Electronics

24-Hour BCD Clock

Learn to count like a computer with this binary clock

by Fred Blechman, K6UGT

OVER THE CENTURIES inventors have made ingenious devices to keep track of time, and displays of all sorts have been used. From interpreting the sun's shadows falling on the marked circle of the ancient sundial to the simplicity of the modern digital displays, man has developed myriad ways to represent the passage of hours, minutes and seconds. In the last few years many innovative clocks have appeared. The "Ball Clock," for example, uses an electric motor to place steel balls in counterbalanced tracks, one per minute. The balls circulate in response to the laws of gravity and the physics of levers to "read" time by totalling the number of balls in each track. Another unique clock uses three concentric circular groups of LED's (light-emitting diodes); as each LED lights it represents the tip of the hour, minute or second hand of a conventional clock face.

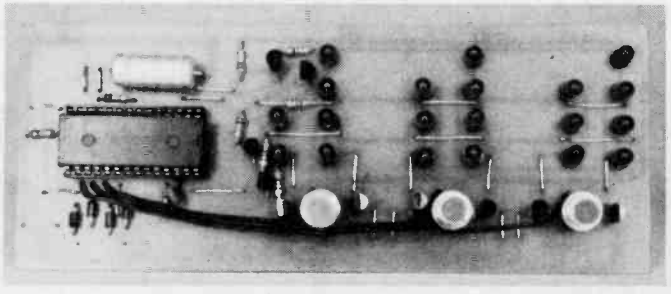
Clock With a Code. Which brings us to the BCD Digital Clock. Here the display reads out hours, minutes and seconds in a code familiar to virtually anyone involved with computer technology—BCD or Binary-Coded Decimal. The clock is extremely easy to build if a printed circuit board is used, taking less than an hour to assemble.

The BCD Digital Clock reads in a 24-hour format on either 50 or 60 Hz. Built around an MM5311 or MM5309 integrated circuit clock chips, which have BCD outputs, you don't have to add much more than indicator LED's, driver transistors and resistors. The "on-board" rectifier/filter assembly allows use on low-voltage AC. For simplicity in packaging an external wall-plug transformer is used for AC power.

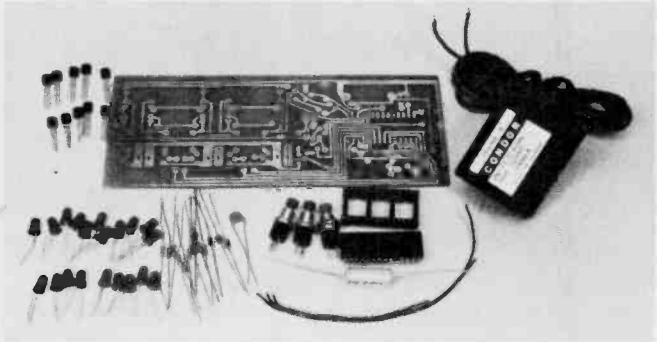
You can also use this clock as an elapsed timer by using the MM5309 clock chip in place of the MM5311; they are interchangeable with only one pin function difference, as explained later. A complete kit of parts is available for under $20, with an optional fitted stained wooden case and drilled faceplate for under $5.

Why BCD? Admittedly, BCD readout is used here for novelty purposes. It makes a great conversation piece, especially among the scientific community. However, from a practical standpoint, if you're not already familiar with BCD you'll quickly learn to read it and will soon be explaining it to others—so the BCD clock has educational value.

While machines and electronic circuits readily handle "binary" numbers —0's and 1's in a powers-of-2 format— people are used to working with decimal numbers. So, whenever people and digital circuits confront each other, the data will usually be presented in a decimal format. The digital circuits in these cases use binary codes to convert



All of the 24-Hour BCD Clock's parts fit neatly on a PC board. Righthand set of LEDs is for seconds, the center group for minutes and the lefthand group is for hours.



A complete kit of parts is available from West Side Electronics. Be sure to decide which integrated circuit you are going to use before you order the IC.

binary numbers to decimal numbers. Of various binary codes that have been developed, the Binary-Coded-Decimal, or BCD, format is the most common.

Reading BCD. A BCD code contains from one to four "bits" (binary digits) for each decimal digit. A bit can be either a 0 or a 1. The so-called "8421 Code" is the BCD code most frequently used, and is relatively simple to understand with a little explanation.

The BCD Code chart shows the 8421 Code for decimal digits. Note that each column of the 8421 code, reading from right to left, increases by a power of 2, starting at 2^0 (which is equal to 1). This is the basis of the binary code. By simply using the decimal equivalent of each bit and adding them together you obtain the BCD value.

A simple example is binary 0101. Since there is a "1" in the "1" (2^0) column, and a "1" in the "4" (2^2) column, we add 1 and 4 to get decimal 5. Therefore, as stated before, any decimal digit from 0 to 9 can be represented by four binary digits.

What Time Is It? Now look at the BCD clock display diagram, which is a representation of the "face" of the BCD Digital Clock. The LED's are placed in six vertical columns and four horizontal rows, with each column representing hours, minutes or seconds, as indicated. The LED's in the lowest row represent a decimal 1, the next highest row in each column represents a decimal 2, the next a 4 and the uppermost an 8. Some columns have only 2 or 3 LED's since they need not count higher than 2 or 5.

8421 BCD CODE CHART

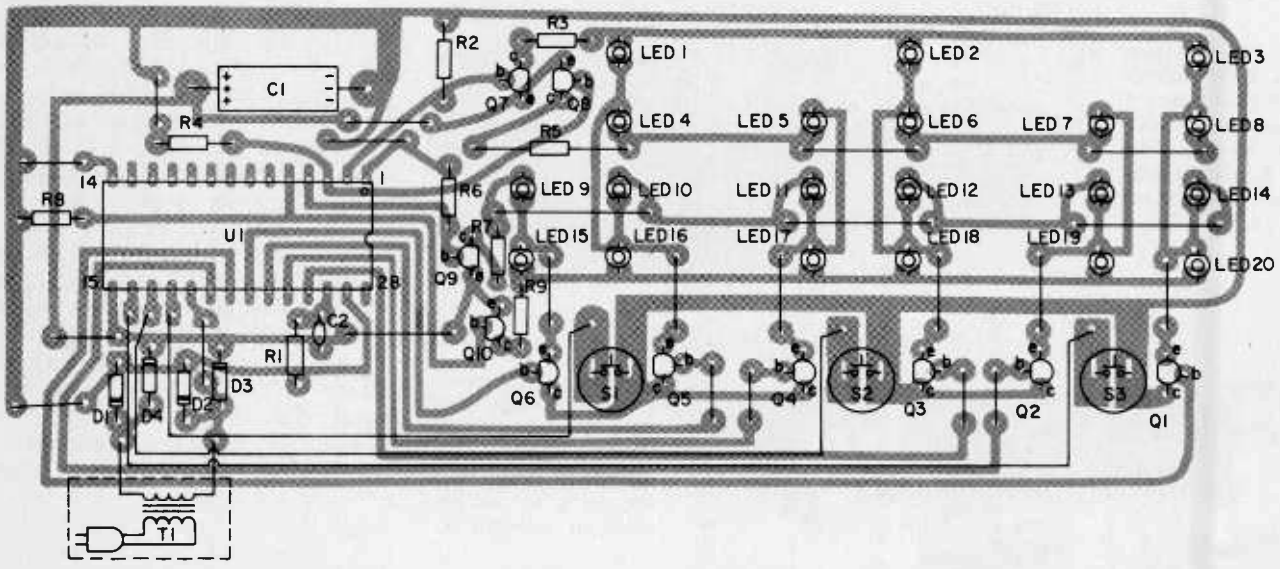
(2^3) "8"	(2^2) "4"	(2^1) "2"	(2^0) "1" ← POWERS OF 2		DECIMAL
○	○	○	○	=	0
○	○	○	☼	=	1
○	○	☼	○	=	2
○	○	☼	☼	=	3
○	☼	○	○	=	4
○	☼	○	☼	=	5
○	☼	☼	○	=	6
○	☼	☼	☼	=	7
☼	○	○	○	=	8
☼	○	○	☼	=	9

The BCD numbering system is very logical once you understand the binary sequence.

Once again, an example makes things clear. A lighted LED is "On," and represents the decimal number of its row, a 1, 2, 4 or 8. "Off" LED's represent a zero. Reading from left to right this time, the first column, tens of hours, is a 1. In the second column, unit hours, the 4 and 1 LED's are lighted, so the decimal digit is a 5. Taking the first two columns together, we have 15 hours (that's 3 PM in 24-hour format time). Column 3, tens of minutes, has LED's 2 and 1 lighted, giving a decimal 3, while the unit-minutes column has a 4 and 2 lighted for a decimal 6. Therefore, the minutes read 36. Similarly, the last two columns read 29 seconds. Now, that's not really so hard, is it? With a little practice, it's easy—and your non-technical friends will think you're a genius!

The Circuit. The integrated circuit, U1, is a clock chip with multiplexed BCD and 7-segment outputs. Only the BCD outputs are used in this clock. Twenty LED's are arranged in a matrix of six verical columns and four horizontal rows. The column-driver PNP transistors, Q1—Q6, are biased *on* when the corresponding digit outputs of IC1 (pins 20—25) are low. Simliarly, each row-driver PNP transistor, Q7-Q10, is biased on when the BCD output connected to its base goes low. Since each LED is in series with only one, row-driver and one column-driver, it only lights when *both* drivers are conducting. For example, LED6 lights *only* when Q8 and Q3 are biased on by low signal levels at pins 3 and 25 respectively.

"Multiplexed" means that each of the outputs are sequentially enabled by the IC circuitry at a speed controlled by R1 and C2—about 1,000 times a second. The IC time-keeping circuitry determines whether a high or low voltage appears at each BCD output as it enables (with a low) each digit output, S1 through H10 (in that order). In other words, as each time digit (column) output is enabled, only the BCD outputs (rows) are enabled (LO) that will indicate the proper decimal number for that digit. Using multiplexing,



This component location diagram shows where all the parts are located on the printed circuit board. The foil side is down in this view so don't worry about jumpers shorting. Although most LEDs are oriented as shown here, be sure to check the polarity.

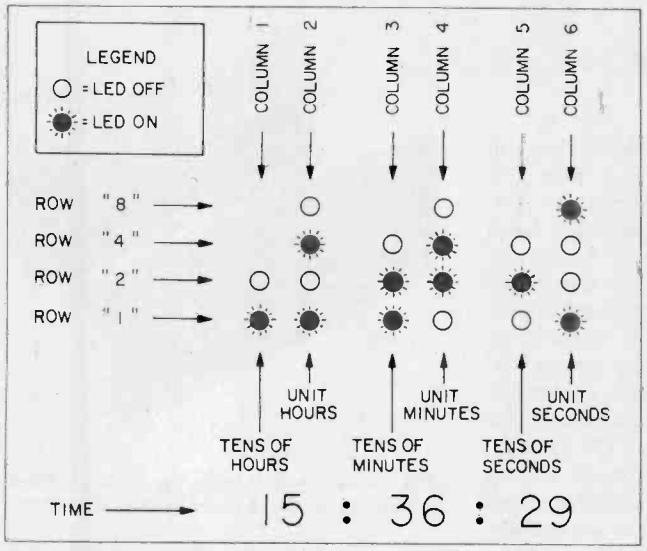
only 10 signal lines (6 columns, 4 rows) are needed to control 20 LED's. Otherwise, 20 signal wires would be needed. (Multiplexing shows an even greater advantage, for example, when using 7-segment digital displays, where 6 digits would require 42 signal lines (7 x 6) if non-multiplexed, but only 13 lines (7 plus 6) if multiplexed.)

Resistors R2, R4, R6 and R8 hold the bases of the BCD output transistors high, so they are positively biased off until intentionally pulled low by a signal. Resistors R3, R5, R7 and R9 hold LED current flows to safe limits. Transformer T1 provides AC power, which is converted to pulsating DC by full-wave bridge rectifiers D1–D4, and then filtered (smoothed) by electrolytic capacitor C1. The 50 or 60 Hz input frequency is also fed to pin 19 of IC1 to control timekeeping. Switches are used to set the time, or, if an MM5309 chip is used, to reset the time to zero.

Pin 14 is grounded for a 60 Hz input, or left unconnected for 50 Hz, which is used in many countries outside of the USA.

Construction. Although there are a lot of jumpers and solder connections, this is a simple project if assembled on the PC board available from the source shown in the parts list. You can, of course, build it on a perforated board with point-to-point wiring, but it's tedious and errors in wiring could be disastrous! Since all the parts are on one PC board, except for the transformer, assembly does not involve mating boards or complex intercabling.

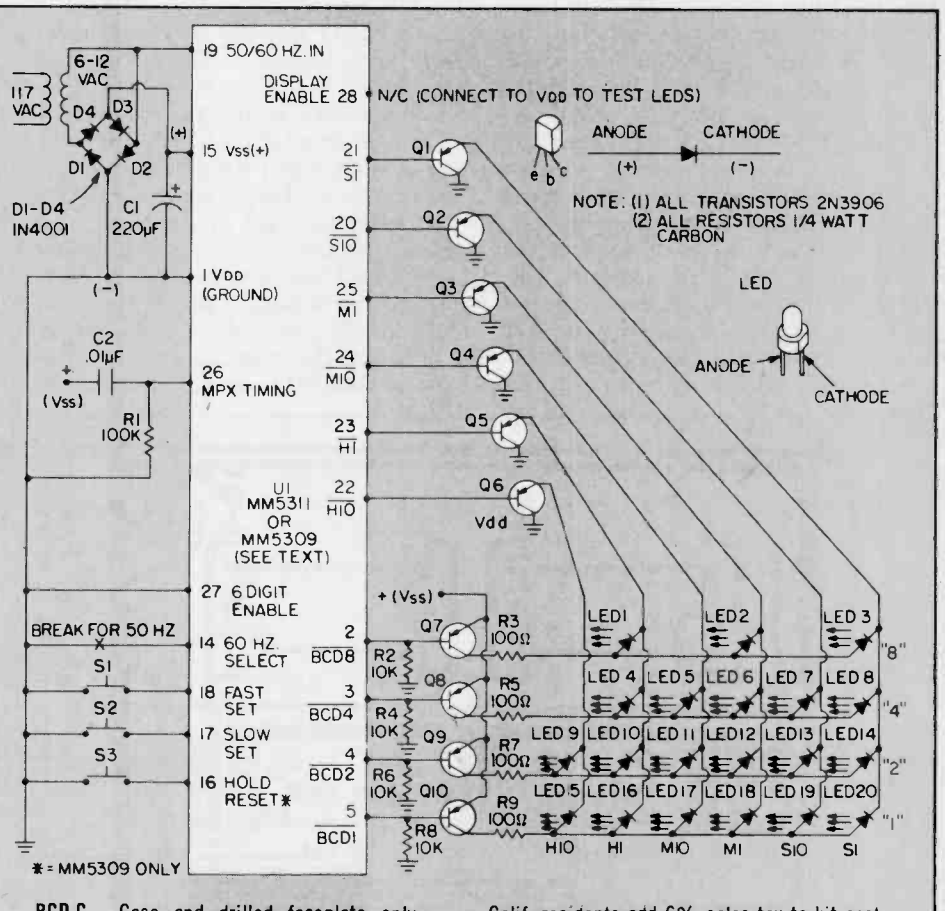
Use the PC board layout included in this article, foil side up, if you wish to make your own board. Locate all the parts according to the diagrams. Start by putting in the bare wire jumpers as indicated—there are 23 jumpers shown. If you will be using the clock overseas, on 50 Hz, delete the jumper at pin 14.



The clock numbers run from the bottom to the top, with the bottom row of LEDs representing (bit on or off respectively) 1 or 0, the second row 2 or 0, the third 4 or 0, and the fourth row 8 or 0. If there is a lit LED in the "1" and "4" rows then the decimal equivalent of that number would be 5(1+4). The unit seconds in this diagram is 9(1+8).

PARTS LIST FOR 24-HOUR BCD CLOCK

C1—220-μF, 25-volt electrolytic capacitor
C2—0.01-μF, 50-volt disk capacitor
D1, D2, D3, D4—1N4001 (1-amp, 50 PIV) diode
LED 1 through LED 20—red Light Emitting Diode
Q1 through Q10—2N3906 PNP switching transistor (or equivalent)
R1—100K, ¼-watt resistor
R2, R4, R6, R8—10K, ¼-watt resistor
R3, R5, R7, R9—100-ohm, ¼-watt resistor
S1, S2, S3—SPST pushbutton switch
T1—12-VAC wall-plug transformer (100 mA minimum)
U1—MM5311 or MM5309 integrated circuit clock (see text)
Misc.—Wire, perforated or PC board, cabinet, faceplate, 28-pin integrated circuit socket, solder and hardware.



Ordering Information

The following 24-hour BCD clock construction kits are available from:

West Side Electronics, Dept. EE
P.O. Box 636
Chatsworth, CA 91311

BCD-CK* A complete kit of all parts above, including an etched and drilled PC board, case and drilled faceplate—$22.95

BCD-PK* A partial kit of all the parts above, except the case and faceplate—$19.95

BCD-PC Etched and drilled PC board only—$5.95

BCD-C Case and drilled faceplate only—$4.95

Add $1 per order for shipping and handling.

Calif. residents add 6% sales tax to kit cost.

* MM5311 will be supplied unless MM5309 is requested.

Next insert and solder the resistors in the positions indicated, and then C2. Now install and solder diodes D1–D4, being very careful that the black-band end is oriented as shown. Insert the leads of capacitor C1 into the board and solder only after being certain the polarity is as shown. It should be mounted right against the top of the PC board. Next insert and solder the PNP transistors. All the transistors are the same, but two of them, Q9 and Q7, face in the opposite direction of the others. It is extremely important that you orient each transistor properly–looking at the flat side of the transistor, the leads are emitter, base, collector reading from left to right. The IC socket is soldered in next.

Before assembling each LED to the PC board, be sure you have the polarity correct. This depends on the specific LED's you use. You can test them with two flashlight batteries together with a 100-ohm resistor all in series with the LED lights, the anode is connected to the positive side of the batteries. Actually, most LED's have a notch or flat at the base of the cathode; however, if you're not sure, make the test above. If the LED's are installed "backwards" in this circuit, the relatively high inverse voltage could blow them all out! Doublecheck everything!!

All that needs to be added now are the switches and transformer. The switch terminals are inserted into the PC board from the component side and soldered to the PC board pads. Insulated jumper wires run from the IC to each switch. Solder the leads from the wall-plug transformer to PC board locations C and D–no polarity required. Now carefully insert IC1 in the socket, being sure all pins are seated and that pin 1 of the IC is properly oriented. Avoid excessive handling of the IC.

The circuit board switches fit into three mating holes in the red plastic faceplate.

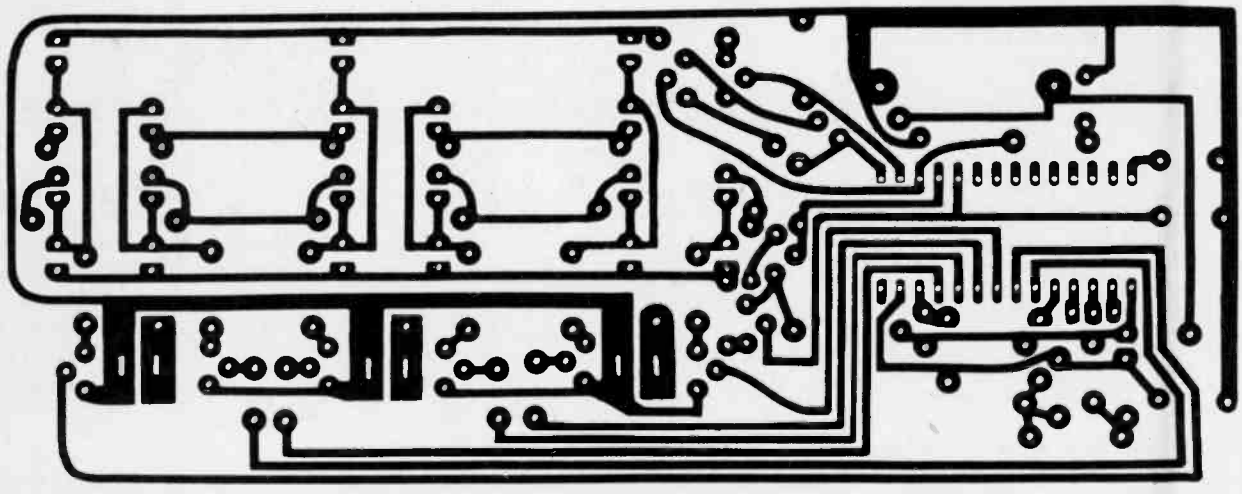
Testing And Operation. Now it's time for the well-known" smoke test." Plug it in and see what happens! If your clock is operating normally, all or most of the LED's will stay dark, except the far right column which will start "counting" by the second. Now press S1–the LED's in the two center columns will count furiously, finally lighting column 2 and then column 1. Actually, you are fast-forwarding the time display at the rate of one hour each second. Switch S2 advances the minutes (columns 3 and 4) at the rate of one minute per second while the last two columns (seconds) race madly. Switch 3 will stop the counting entirely if you use the MM5311, or will reset the display to all zeroes if you are using the MM5309 for an elapsed timer. Check to see that all LED's light, and in proper sequence. Connecting IC Pin 28 to ground (the negative side of C1) should light all the LEDs at once.

If a particular LED does not light at all, it may have been installed with the anode and cathode reversed–and if that's the case, it has probably blown out. Replace it, properly oriented. If *none* of the LED's light, check the voltage at IC pins 15 and 1. This should read around 12 volts, with pin 15 positive. If not, make sure the rectifiers, D1–D4, are not reversed. Also, check the polarity of C1, and be sure U1 has not been inserted into the socket with pin 1 on the wrong end! The transistors could also be installed backwards; reversing the emitter and collector leads is easy to do, but the circuit won't work properly if at all.

If only some LED's don't work, or there is generally erratic behavior, check your solder joints. If all else fails, carefully replace the clock IC; actually, this is the least likely cause of problems unless you've treated it carelessly in handling or installation.

Set the time by advancing the hours with S1 and the minutes and seconds with S2 until the BCD code reads slightly ahead of the real time. Now hold down S3 (if you're using the MM5311) to stop the count until the real time catches up with the displayed time, and then release S3. Remember, however, that if you use the MM5309 instead of the MM5311 then S3 will reset the entire display to zero.

Since the seconds count regularly from 0 to 59 you'll get plenty of practice reading BCD by just watching the seconds counting. ■



By using this full-sized printed circuit board template you can make your own BCD clock printed circuit board. Any one of the popular photo-etching techniques should work well for this board. Be careful to check the finished board for accuracy and solder bridges.

A Short Course in Understanding Shortwave Receivers

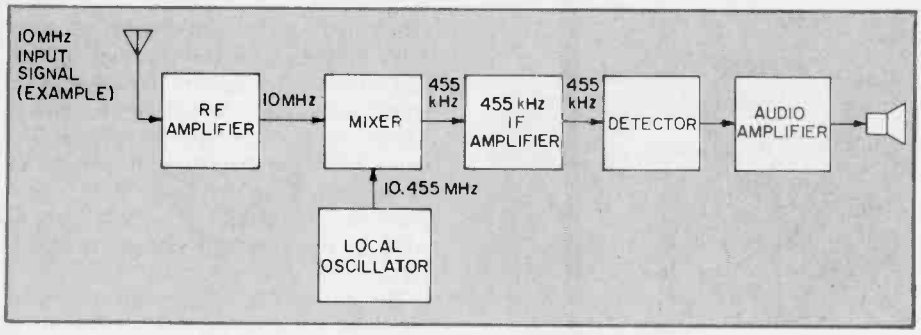
A guide to understanding and interpreting the specifications of modern shortwave receivers

by Morrie S. Goldman

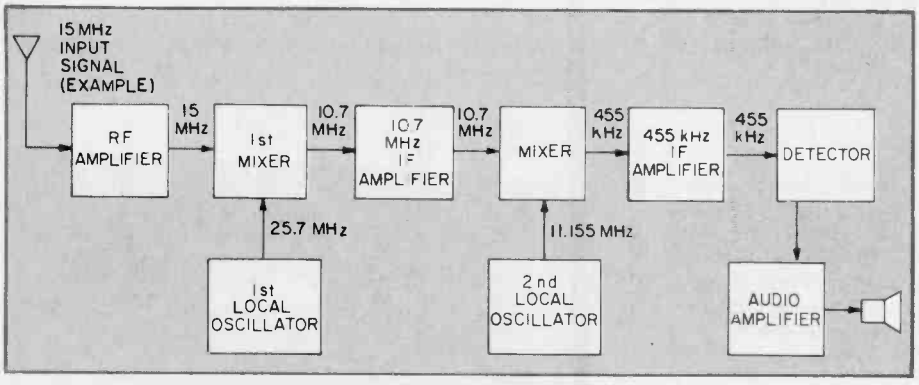
CIRCLE 32 ON READER SERVICE COUPON

WHAT DO SHORTWAVE RECEIVERS and automobiles have in common? They both come in many shapes, sizes, and price ranges. You can buy an economy price leader, a luxury model with lots of chrome trim, or even an exotic high-performance model. For the beginner, or even the experienced DXer, the question of which receiver to buy is often a difficult one. Most of us have a limited budget, so we can't order the $4000 receiver that the government may choose, but we do want to buy as much receiver as our funds allow. We will attempt to simplify that task by providing a basic explanation of common receiver features, specifications and designs. Finally, we will offer hints on how to get the best buy on a receiver and whether you should select a new or used model.

The "Inside" Story. The modern shortwave receiver has a great deal in common with an ordinary superheterodyne AM broadcast radio. As in any "superhet" receiver, the signal tuned in by the user is converted to a new frequency, called an intermediate or IF frequency. After amplification, the signal may be converted to a second IF frequency (such a receiver would be called a dual-conversion receiver) or it could be directly demodulated by the detector into an audio signal. A number of elaborate shortwave receivers feature triple-conversion designs. In such a design, the input signal is converted three times (three IF frequencies) before it's converted to audio. We'll talk more about IF amplifier circuitry later.



A single conversion receiver combines the incoming signal with the local oscillator's signal, to create a 455 kHz IF signal which can then be converted into an audio signal.



The dual conversion receiver features greater selectivity by narrowing the frequency width of the incoming signal in the second mixing stage, keeping out unwanted signals.

Most shortwave receivers fall into two categories—general coverage and limited coverage models. General coverage receivers are so named because they cover a general, or wide range of frequencies and are designed for a general purpose rather than a special application. It is common for a general coverage receiver to tune from the broadcast band through 30 MHz. Some receivers of this type also cover longwave frequencies (below the broadcast band) and the FM broadcast band.

Limited coverage receivers, such as ham band-only or shortwave broadcast band-only, do not offer the continuous tuning capability of general coverage receivers, but instead concentrate on a limited number of small frequency ranges or bands. There are many instances where a general coverage receiver may be a preferred choice to a limited coverage receiver. If on the other hand, you are hoping to make the grade as a ham and are not inter-

ested in foreign broadcast DX, it would be wise to examine ham band-only receivers.

Understanding Specifications. In order to compare one receiver against another, it's a good idea to have an understanding of the specifications used to describe the performance characteristics of each. Before we take a closer look at specifications, here's one caveat: As the audio industry discovered some years ago, the stating of specifications can be an exercise in a game called "specsmanship." In that game, manufacturers attempt to show that their receivers perform better than competitors' units by stating specifications in the most complimentary terms possible. Much of this problem has been routed from the audio field, but the communications receiver field is fair game. In most cases, there is no need for a manufacturer to actually lie about specs, because he could present data in a manner that makes clear comparisons virtually impossible. So, when you compare "similar" specifications, you may be comparing apples to oranges.

Signal-to-Noise Ratio. The first spec that we will dig into is signal-to-noise ratio. For a clear picture of this concept, imagine that you are using a shortwave receiver and have just tuned in a distant-sounding signal that is strong enough for you to understand what the announcer is saying, though weak enough that you also hear a background rushing noise. If the signal carrying the announcer's voice becomes stronger, the background noise drops lower. If the signal becomes weaker, the background noise grows stronger. The difference between the amount of signal you hear and the background noise is called a signal-to-noise ratio (abbreviated S/N). As with many other ratios found in electronics, signal-to-noise ratios are expressed in dB units. For instance, if the audio signal heard from the receiver is 10 dB stronger than the background noise, we say the received signal has a 10 dB S/N ratio. Every receiver has its own ultimate S/N ratio; that is, a point at which further increases in signal strength will no longer affect the difference between background noise and signal. In practice, this ratio is quite great and is seldom found on a specification sheet. S/N ratio specifications are based on the noise generated within a receiver and provide no indication as to how the recever will perform with added atmospheric or local man-made noise. Our understanding of S/N ratios will help us to interpret sensitivity specifications, which are commonly found on even the most basic specification sheets.

Impedance. Before we move on to sensitivity, we must also discuss input impedance. Input impedance simply describes what antenna impedance the receiver will perform most efficiently with. Every antenna has a "characteristic impedance;" for a receiver to make the most of the signal captured by the antenna, its input impedance should be close to that of the antenna. Some receivers feature a so-called *antenna tuner*, or *trimmer* which helps to match the input of the receiver to a wide range of antennas by correcting impedance mismatches at different frequencies. Some receivers offer two antenna input terminals, one optimized for 50 to 75-ohms and the second for 300-ohm line. As with the S/N ratio specification, an understanding of input impedance will help us to compare sensitivity specifications.

Sensitivity. Sensitivity is probably the specification that SWLs are most accustomed to using for receiver evaluations. Generally, sensitivity is expressed in microvolts (abbreviated μV), with smaller numbers representing better sensitivity. What is often overlooked however, is that the mere statement of a microvolt sensitivity number is meaningless. In addition to the microvolt number, a signal-to-noise ratio, an input impedance and a frequency range should be stated. In addition, a complete specification sheet would also list sensitivity for each mode of operation (such as AM, CW, SSB, etc.) provided by the receiver.

So what exactly does a sensitivity spec mean? When it is stated that a receiver has an AM sensitivity of 2 μV for a 10 dB S/N ratio at 50-ohms, it means that a received signal developed across the 50-ohm input of the receiver must be at least 2 μV in strength to produce a signal that is 10 dB stronger than the background noise. Because sensitivity may vary with frequency, the specification should identify what frequency bands the sensitivity figure relates to. If the frequency range is not specified, the sensitivity shown may be the best sensitivity of the receiver on its most sensitive band, meaning that other bands may offer considerably less performance. Worse yet, if the S/N ratio is not stated, it is impossible to know whether a 2 μV signal will produce a 10 dB S/N or an audio signal that is of such poor quality that all the listener could do is detect its presence.

Selectivity. The ability of a receiver to select one signal and separate it from other signals on nearby frequencies is called selectivity. Selectivity is closely related to another specification called bandwidth. Bandwidth and selectivity are expressed in dB units. Both selectivity and bandwidth are actually indicated in the standard selectivity specification for a receiver.

The bandwidth of a receiver reveals how wide of a signal can be passed by the IF stages with a maximum signal loss of −6 dB at its limits. For example, a 10 kHz bandwidth indicates that at plus-or-minus (±) 5 kHz off of the center frequency that the receiver is

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Panasonic's RF-2200 is an excellent example of a portable, general coverage SW receiver. The front end is a dual conversion type.

Yaesu's highly popular "Frog-7" receiver covers 500 kHz thru 29.9 MHz, and features a phased-locked loop (PLL) for superior frequency stability.

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tuned to, the signal strength reduction will be −6 dB. A 10 kHz bandwidth is wide enough to allow a broadcast music signal to be received with "high-fidelity" quality. This bandwidth would be too wide for serious DX listening on the crowded shortwave bands, however. As a result, it is the generally accepted practice to sacrifice some fidelity and use a narrower bandwidth to better separate one signal from others close-by. A 4-to-6 kHz bandwidth is acceptable for AM modulated signals; about 2 kHz for single-sideband (SSB) signals, and 150 Hz for CW (Morse code) signals. Some DXers prefer even narrower bandwidths. They are satisfied to listen to a somewhat distorted sounding signal, because it permits higher selectivity and more rejection of interference from signals on adjacent frequencies.

Now back to understanding selectivity. Two receivers may have exactly the same bandwidth, but very different selectivity characteristics. By examining at what frequency a signal will be reduced in strength (attenuated) by −60 dB at the bandwidth "skirts," we can learn the selectivity of the receiver. For example, a receiver selectivity specification may read: 6 kHz at −6 dB and 20 kHz at −60 dB. If you were using this receiver to listen to a signal on 14.250 MHz, and a second station was operating on 14.240 MHz (or 14.260 MHz), the second station would be reduced in strength by −60 dB relative to the desired signal. This specification does not however reveal what the bandwidth would be at −20 dB or −40 dB. That information can be obtained only by looking at a graphic illustration of the selectivity curves of the receiver (see illustration).

The NRD-505 by JRC (and available from Gilfer Associates), has digital readout for pinpoint tuning, and a CMOS memory for programming your favorite frequencies.

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The bandwidth and stability of a modern receiver is determined by the IF amplifier circuitry design. While older shortwave receivers obtained high selectivity by adding many hand-tuned IF transformers, modern receivers use "selectivity blocks." Such selectivity blocks are usually ceramic, or mechanical filters. Ceramic filters are most common. IF filters never require re-alignment, so maintenance costs are reduced. Filters also reduce labor costs for the manufacturer and thus reduce the net price of a receiver to the consumer.

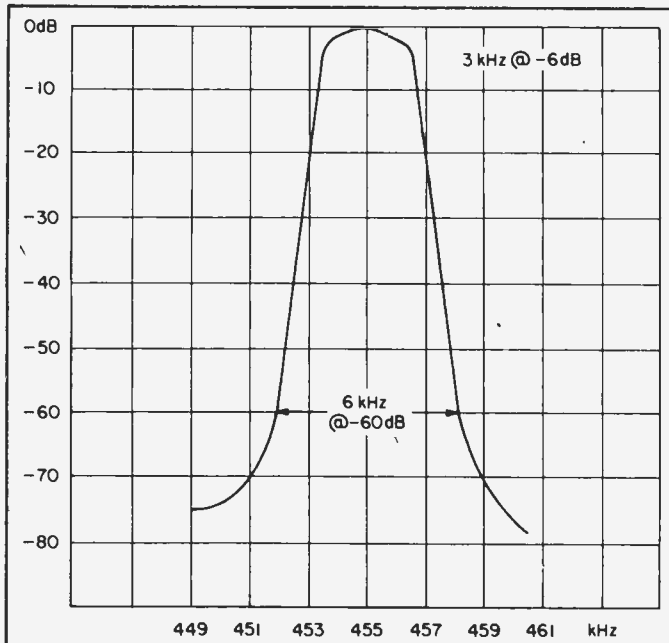
By building two or three filters into a receiver, the manufacturer can offer the receiver user a choice of broad and narrow selectivity positions for voice signals, and an additional very narrow position for CW reception.

Stability. Stability is one of the least talked-about specifications, and, with selectivity, is a key characteristic that separates expensive receivers from modestly-priced ones. The stability of a receiver reveals how well its local oscillator will maintain a constant frequency without drifting off the original setting. When stability is specified, the numbers usually indicate only electrical stability −that is, how much drift will occur over a given period of time because of changes in the electrical properties of components as their temperature changes. A warm-up period (before measurement is made) is also often stated. Mechanical stability, though seldom described, is also significant. If a receiver is gently bumped and the received frequency changes, mechanical stability is probably poor for that reciever. Likewise, if modest hand pressure is placed on the case, the frequency should not noticeably change.

Image Rejection. Image Rejection is still another of the specs that separate better receivers from their lesser counterparts. Image rejection is the ability of a receiver to reject an undesired "ghost" signal that is produced by the heterodyne (mixing) characteristics of every superheterodyne receiver. The image signal is separated from its true frequency by twice the first IF frequency of the receiver. Whether it appears above or below the true position of the signal, depends on whether a higher or lower local oscillator frequency is used. In some receivers (particulary ham band-only models), the local oscillator may be set above the tuned frequency on a few bands and below on others.

Let's look at one example of an image: Using a receiver with a 455 kHz first IF frequency (a common frequency), a strong signal transmitting on 18 MHz might also be observed with weaker strength at 18.910 MHz (18 MHz + (455 kHz × 2). Many better-quality receivers offer image rejection in excess of 60 dB (again a higher number indicates better performance).

To help achieve better image rejection, an ever-growing number of



RECEIVER BANDWIDTH IS 3kHz AND −60dB POINTS OCCUR AT A 6kHz BANDWIDTH.

The graph at left shows a typical bandpass response curve. Signals coming through at 455 kHz have 0 dB attenuation, but the attenuation rate increases sharply as the frequency moves up or down from the 455 kHz center bandpass frequency. The more sophisticated receivers have an adjustable bandwidth.

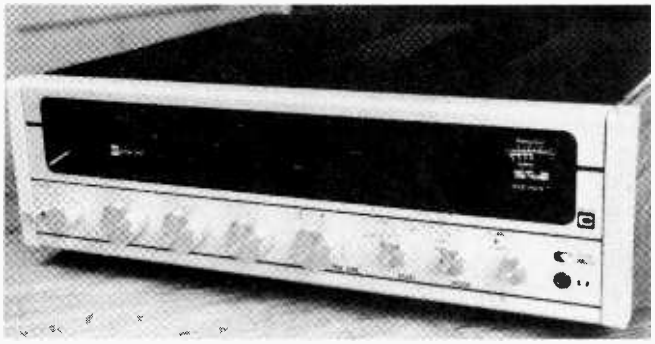
receivers are designed with dual conversion designs having a high first IF frequency of anywhere from 10 to 90 MHz. On dual-conversion receivers, the second IF frequency is usually the standard 455 kHz. (It is at 455 kHz that the selectivity of the receiver is built in.)

Feature Hunting. Most shortwave receivers have a certain number of features and controls in common. Among these are AF gain (volume) control, RF gain control, bandswitch, mode switch, tuning (often including fine tuning or "bandspread"), relative signal strength meter, headphone jack and built-in speaker. Other desirable "extras" include selectable IF bandwidth, digital frequency readout, selectable sidebands (USB or LSB), tunable preselector, noise limiter, noise blanker, antenna trimmer, tunable notch filter, variable AGC (automatic gain control) response, and AC or battery power.

Which Receiver to Buy? Remember our opening analogy about receivers and automobiles? Well, just as there is no one "right car" for everyone, there is also no one "right receiver" for everyone. Based on your own intended use and future use for the receiver, there are many elements worth reviewing. Consider where the receiver will be used (battery power capability needed?), how much it will be used, what you plan to listen to (ham band only or general coverage?); and of course, your budget. If you plan to be only an occasional listener, it is doubtful that you would benefit greatly by purchasing an expensive receiver. The complexity of some elaborate receivers may actually become a deterrent to the casual listener who cannot devote sufficient time to understanding the capabilities and operation of the receiver.

New or Used? There are no tires to kick or *Consumer Reports* "frequency of repair" records to compare, but you can still find a good buy on a used receiver. If you have less than $150 to spend on a general coverage receiver or less than $225 for a ham band-only receiver, you *should* consider buying a used receiver. "What to look for when buying a used receiver" opens up a lot of territory—enough for a complete article on that subject alone. In short form, here are some hints:

Talk to other SWLs and hams. Ask about which receivers in your price range are most desirable. DX club bulletins are another good source.



High performance does not come cheaply. The McKay/Dymek DR 33C pictured here, and little brother DR 22C are not aimed at the budget-minded. These are professional-quality communications receivers, whose performance justifies price tags and looks.

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Big brother to the FRG-7 is the FRG-7000, which features digital readout, and digital frequency programming to save you time.

Compare prices. Watch prices in classified ads (i.e., *QST* magazine), at hamfests, and at used equipment dealers. Amateur Electronic Supply (4828 West Fond du Lac Avenue, Milwaukee, WI 53216) offers a free listing of their extensive inventory of used equipment.

Dig deeper. Many manufacturers of older receivers are no longer in business, and replacement parts and proper repair service may be hard to come by.

Tubes? If you're interested in a tube-type receiver, be sure that it uses miniature tubes and not the older octal types.

Examine. Watch for damaged moving parts, such as rotary switches, variable capacitors and tuning-dial mechanisms. These parts may be difficult or impossible to obtain as replacements. Many odd frequency IF transformers are also difficult to find.

Stop. Avoid receivers that, when new, sold for under $100. There's a fine line between a good bargain on a cheaper rig, and throwing out money on a receiver that simply wasn't designed to do the kind of job you need for accurate monitoring. Spending a little now may save a lot more money on down the line.

The dealer connection. If you're not technically sharp (or you don't have a good friend who is), buy from a reputable dealer rather than an individual. You may pay more, but many headaches and dollars could be saved in the long run.

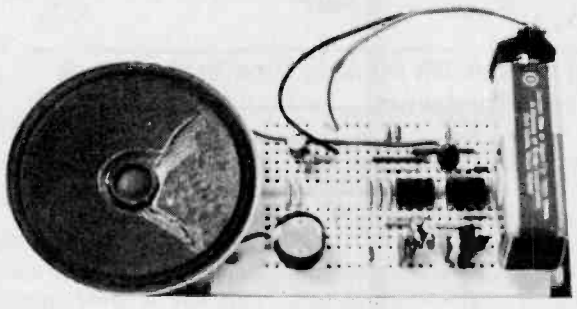
Beyond these steps, the same rules considered for any other used purchase apply. Be very sure you know what you're buying, what condition it's in, and what it's really worth. If you still have doubts, stick to new equipment.

What's New? General coverage receivers are making a comeback and many manufacturers are jumping on the bandwagon. Such manufacturers as Panasonic, Radio Shack, Sony, Sanyo, Standard, and Yaesu offer good-performing receivers in the $150 to $500 price range. One popular Panasonic receiver, the RF-2200, sells for around $175 and offers 10 kHz shortwave dial calibration, and dual-conversion design. Five years ago, a general coverage receiver with equal accuracy and features would have cost at least several hundred dollars more.

The popular Yaesu FRG-7 and similar receivers from Radio Shack and Standard, use a frequency-synthesized design that results in excellent electrical stability. These receivers also offer a good range of features and good sensitivity. Beyond these units, there are a number of receivers at almost all price and performance levels. These include the McKay/Dymek DR-22C at $995, the (Gilfer) JRC NRD-505 at $2275, the (Rohde & Schwarz) Communications Products Corporation HF-1030 at $4500, and still others beyond!

Summary. Before you buy a receiver, be sure you understand all of the relevant specs and features. Spend a little time and decide what kind of receiver best fits your personal needs and budget, then spend more time comparing available receivers. Don't forget to ask about warranties. They typically range from 90-days to 2-years, and unlike car warranties, won't run out at 12,000 miles. Talk to other SWLs or read their comments on receivers in DX club bulletins. Word about an unsatisfactory receiver spreads even faster than word about a good one. Finally, there's no substitute for that test drive. If at all possible, try out the receiver you intend to buy, before you buy it. All in all, selecting the right receiver is almost as much of an adventure as using it. As an added dividend, careful receiver selection will add to your listening enjoyment for years to come. ■

FRIDGALARM



Keep your waistline and electric bill down with this door-ajar alarm.

by Winn L. Rosch

EVERY CREATURE IN THE WORLD has its natural enemies and the refrigerator is no different. Perhaps the most dangerous of the ice box invaders are dieters and children. Either is likely to lodge in front of the door and stare longingly inside, feverishly calculating which item would be least likely missed. Inevitably, as the hours of openness pass, a layer of permafrost grows inside that requires a chisel and a contingent of National Guardsmen to remove, and the electric bill rises ever the higher heavenward.

In our households, frugality is the mother of invention, so we followed our pursestrings to the workbench, grabbed a handful of parts, and created the Refrigerator Alarm. Now, should one of the pantry predators decide to camp out in a lean-to made from the ice-box door for longer than our preset interval, the alarm lets out a piercing squeal until all the cold is again locked safely within.

The Circuit. Our circuit is based on a pair of versatile 555 timer chips and a photoresistor, and offers not only a useful project, but also a quick and fun lesson on how each part works. One of the 555s is used to time the period before the alarm goes off (the filching interval). The other generates a tone that serves as the alarm proper.

Let's start at the beginning and see exactly what makes the alarm work. The photoresistor is used to detect the lamp that lights inside the refrigerator to let you see how good the pickings are. The circuit is sensitive enough, though, to trigger even if the bulb has burned out. Once the door is closed, the inside of the average refrigerator is dark, really dark, and opening it changes the light level enough that it can easily be electronically detected.

The photoresistor R6 is a light-sensitive resistor. The more light it sees, the less it wants to conduct electricity and the higher its resistance becomes. In total darkness, its resistance is low enough that it effectively shorts the base of transistor Q1 to ground so that Q1 will not conduct. (Q1 is actually operating as an inverting amplifier.)

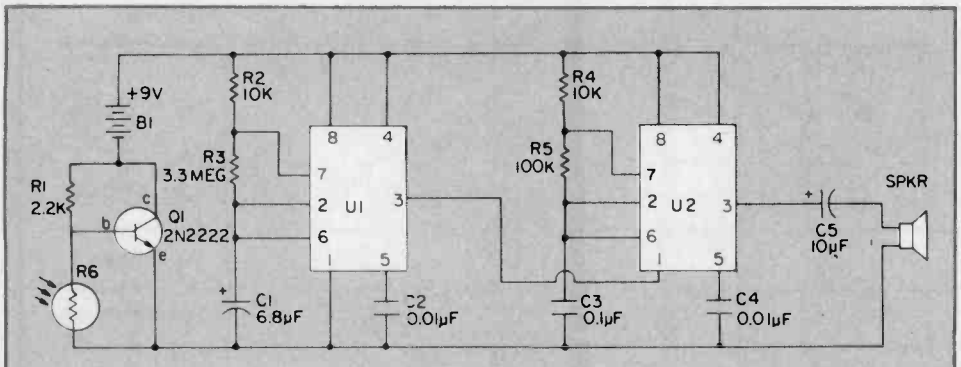
Resistor R1 limits the current through R6 and is effectively the only current-consuming element in the circuit when no light is present. The light sensitivity of the alarm can be adjusted to some degree by varying the value of R1.

When the light goes on, the resistance of R6 increases, and there is a corresponding voltage drop across it. When this voltage becomes great enough, Q1 begins to conduct and supplies current to the circuitry.

U1 is the timer, determining how much time must pass after the light goes on and Q1 turns on, before the alarm is triggered. U1 is set up for astable operation to conserve battery life once the alarm sounds. In other words, it functions as a long-period oscillator, turning the sound on and off.

The initial timing period is determined by the time it takes to charge C1 two-thirds of the way up through R2 and R3. (The regular on and off periods of the alarm are one-half this value, because the 555 only discharges C1 to one-third of its capacity, hence C1 oscillates in charge between ⅓ and

(Continued on page 82)



PARTS LIST FOR FRIDGALARM

B1—9-volt transistor radio battery
C1—6.8-uF tantalum capacitor, 25-VDC
C2, C4—0.01-uF ceramic disc capacitor, 100-VDC
C5—10-uF electrolytic capacitor, 15-VDC
Q1—2N2222 general purpose NPN transistor
R1—2,200-ohm, ¼-watt resistor, 10%
R2, R4—10,000-ohm, ¼-watt resistor, 10%
R5—100,000-ohm, ¼-watt resistor, 10%
R6—photoresistor (CdS type) 5-Megohm to 100-ohm resistance range—Radio Shack #276-116
SPKR—8-ohm PM miniature speaker
U1, U2—555 timer
MISC—battery clip, breadboard, etc.

A Guide to Propagation and

A look at ways to make the most of your DX hunting time in the shack

by Thomas R. Sundstrom

WHAT'S THE BAND LIKE? A knowledge of propagation is useful to the SWL and the radio amateur in hunting that elusive DX station. In a period of high solar activity—and 1980 is the peak in the 11-year sunspot cycle—band conditions can become quite variable. With a solar disruption on the sun's surface, blackouts of communication links on earth can disrupt radio worldwide.

The Old Method. The long range forecasts found in magazines, DX bulletins, and newsletters are estimates at best. With some variations, most are based upon projecting current activity against a 27-day solar cycle. For example, a solar flare that disrupts communications today will no doubt have some recurring effects in 27 days from now as the sun completes one revolution.

Long range forecasts are useful to do some long range planning, but current information is better. The National Bureau of Standards station, WWV, broadcasts propagation data at 18 minutes past each hour; the information is updated every six hours at 0000, 0600, 1200, and 1800 GMT.

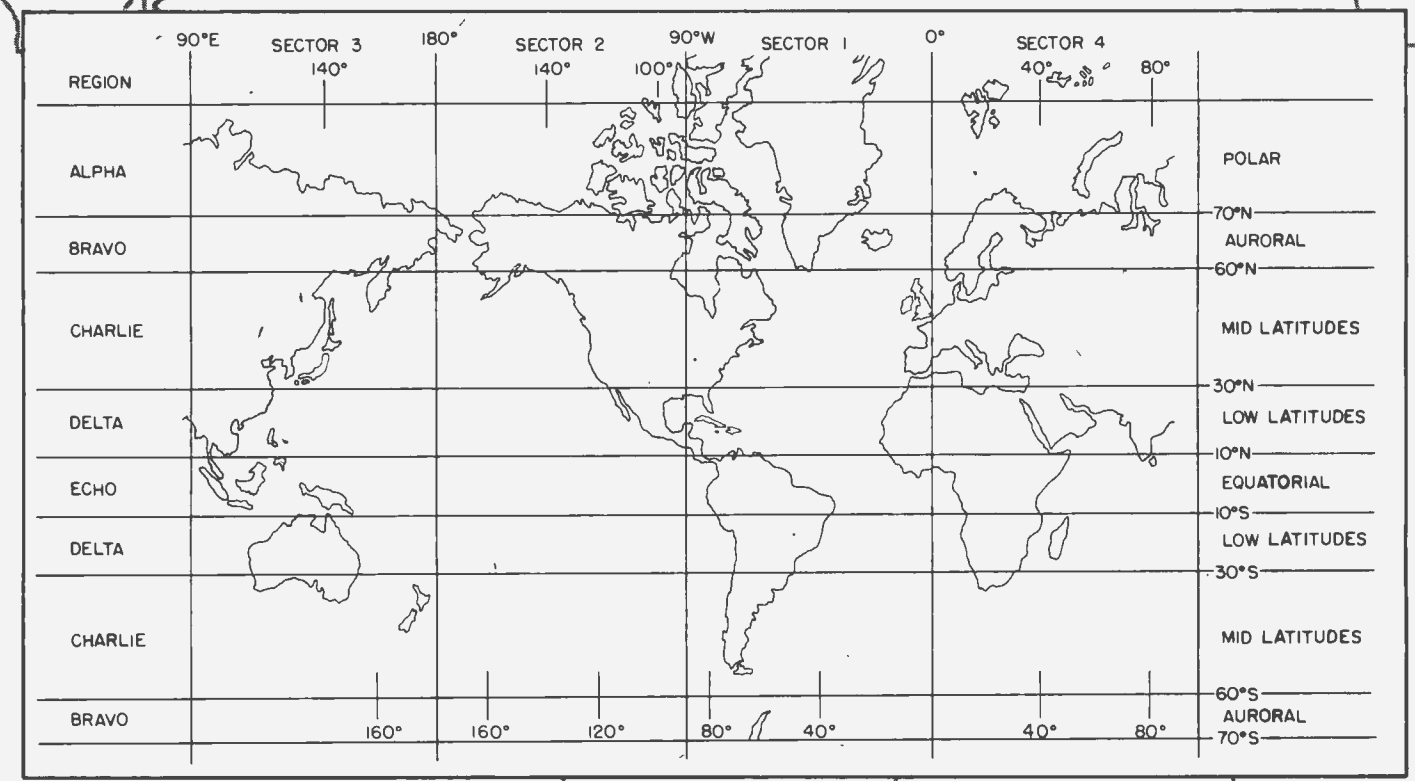
The first part of the WWV message contains a solar flux number (which is correlated to the sunspot number and the maximum useable frequency) and an "A" index (a daily measure of geomagnetic activity); these daily figures are changed at 1800 GMT. The "K" index is changed every six hours and is mathematically related to the "A" index. By tracking the daily flux and "A" over days and months, a relatively clear picture of the cyclical variations on a solar cycle can be seen; try graphing the data. A comparison of the latest "K" with a previous "K" or yesterday's "A" can tell you which way conditions are moving. (See the table.)

Ideally, a high solar flux number (to raise the MUF) and a low geomagnetic activity number (to minimize signal path absorption) should produce the best long-haul signal propagation on the higher bands.

The New Method. There is now a *second* propagation buleltin on the air. This one is aired by the United States Air Force and, like WWV, information is broadcast 24 hours a day, 7 days a week. Unlike WWV, however, the bulletin is aired twice an hour.

The USAF calls the broadcasts "Beer Can." The information is in coded form, and depends upon prior knowledge of the USAF operator to know what the predicted maximum useable frequency and optimum working frequency (90% of the MUF) were through previously supplied 30-day forecasts.

The "Beer Can" broadcasts occur at .15 and 45 minutes past the hour on 4590, 7540, and 13993 kHz on upper sideband (USB). The content of the bulletin is revised at 0000, 0600, 1200,



This mercator world projection shows the regions and sectors into which the Air Force has divided the world for purposes of the propagation forecasts. The phonetic sectors read downwards on the outside margins, the numerical regions read across the top.

Band Condition Reports

TABLE OF "A" AND "K" INDICES		
A	K	Geomagnetic activity classification
0	0	Quiet
3	1	Quiet
7	2	Quiet
15	3	Unsettled
27	4	Active
48	5	Minor geomagnetic storm
80	6	Major geomagnetic storm
140	7	Major geomagnetic storm
240	8	Major geomagnetic storm
400	9	Major geomagnetic storm

The WWV propagation broadcasts include both the A and K indices for calculations of the relative levels of geomagnetic activity.

and 1800 Zulu. Station AGA3HQ (Scott AFB, IL) broadcasts first, followed a minute later by station AIR (Bolling AFB, MD).

As the general public doesn't have access to the USAF long range propagation forecasts, we can substitute the WWV data recorded over a period of days and months and draw approximations from the flux data.

"Beer Can" broadcasts are divided into three parts: the maximum useable frequency, solar anomalies, and other phenomena. See the table for a full breakdown on their contents.

Part I of the broadcast will always be aired, Either *regions* (defined by horizontal latitudes) or *sectors* (defined by horizontal latitudes *and* vertical longitudes) may be referenced. The grid system and boundaries are illustrated by the map in Fig. 1.

Parts II and III will only be aired on an *exception basis;* either regions or sectors may be referenced.

An actual broadcast at 2015 GMT:

BEER CAN BEER CAN THIS IS AGA3HQ
ALPHA GOLF ALPHA THREE HOTEL QUEBEC
DO NOT ANSWER DO NOT ANSWER
ONE SIX ONE EIGHT ZERO ZERO ZULU BREAK BREAK
BRAVO THREE TANGO
QUEBEC ALPHA BRAVO ONE EIGHT
ROMEO ALPHA BRAVO ONE EIGHT
BREAK AGA3HQ OUT

Cracking the Code. Let's decode the message using Fig. 1 and the table. The message was prepared on June 16 (ONE SIX) at 1800 GMT (ONE EIGHT ZERO ZERO ZULU); note that the month is not given.

The signal path with a reflection point in the auroral zone over Siberia will handle frequencies up to 25 percent greater than the forcasted MUF; the rest of the world is "normal." The two part III messages indicate radio noise and signal fading worldwide (if just a sector or two were involved, a number of one, two, three, or four would have followed ALPHA or BRAVO) in the polar and auroral zones, commencing at 1800 GMT. Note that the last two numbers in the part II and III messages refer to the GMT hour.

This data, coupled with a solar flux that had been dropping for a couple of days (down to 161) and an "A" index of 18, would indicate no polar path signals and marginal and noisy signals from the middle and low latitudes.

Other examples to consider. if there is a part II message of HOTEL or INDIA, one would look for a JULIETT or KILO message in the next day or two. Coupled with that, VHF DXers of either the TV channels, the public service bands, or the 50 MHz amateur band, should be on the lookout for an OSCAR or PAPA message in sector CHARLIE ONE or CHARLIE TWO (for the United States and Canada).

A part II message of KILO CHARLIE ONE TWO THREE would decode to a probable ionospheric storm of more than 6 hours duration beginning at 2300 GMT in the sector over the east coast of the United States, the Atlantic, and extreme western Europe. That would be a good time for U.S. amateurs to start looking for DX out of South America, in a direction unaffected by the storm.

In conclusion, the "Beer Can" broadcasts can be very useful in short-run forecasting for the active DXer. The WWV data and the "Beer Can" data provide an instant picture of band conditions. Take a listen; it's a more efficient use of time than tuning randomly around the bands. ■

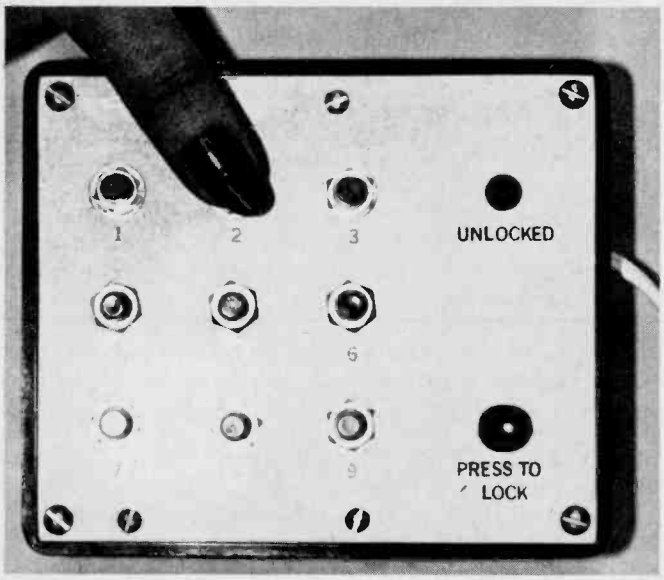
DECODING TABLE FOR "BEER CAN" MESSAGES	
PART I	**THE MAXIMUM USEABLE FREQUENCY VALUE CODE**
Sierra	Path MUFs Normal
Tango	Path MUFs High to 25%
Uniform	Path MUFs High to 50%
Victor	Path MUFs High to 75%
Whiskey	Path MUFs Low to 10%
X-ray	Path MUFs Low to 25%
Yankee	Path MUFs Low to 50%
Zulu	Radio Blackout
PART II	**SOLAR ANOMALY STATUS CHART**
Hotel	Probable significant SID (sudden ionospheric disturbance) of up to 30 minutes duration in sector ____ starting ____ hours Zulu time.
India	Probable significant SID of up to 1 hour duration in sector ____ starting ____ hours Zulu time.
Juliett	Probable ionospheric storm/PCA (polar cap absorption) of under six hours duration in sector ____ starting ____ hours Zulu time.
Kilo	Probable significant ionospheric storm/PCA of over six hours duration in sector ____ starting ____ hours Zulu time.
PART III	**OTHER PHENOMENA CHART**
Oscar	Moderate intensity Sporadic E in sector ____ starting about ____ hours Zulu time.
Papa	Blanking Sporadic E in sector ____ starting about ____ hours Zulu time.
Quebec	Significant radio noise in sector ____ starting about ____ hours Zulu time.
Romeo	Significant fading occurring in sector ____ starting about ____ hours Zulu time.

This is the table used for decoding the phonetic symbols used in the Air Force's Beer Can propagation broadcasts. Each part has its own phonetic code alphabet characters.

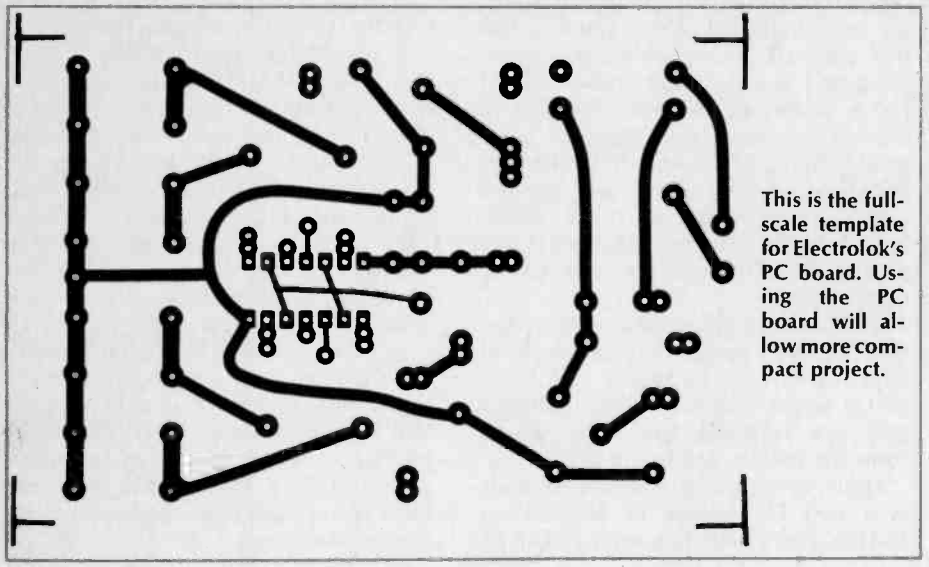
ELECTROLOK

HAVE YOU EVER stopped to consider just how many locks there are in the average house? Take a census in your own home; the number will probably surprise you. Most of the locks you find—in fact, probably all of them—will be mechanical. While such devices are fine for the majority of household applications, sometimes what you really need is an *electronic* lock. For example, suppose you have a favorite piece of electronic equipment; something that's expensive and delicate. To make sure that no one else can meddle with it—whether it be a photographic enlarger, an amateur transceiver, a stereo system or a computer—you need to prevent the power from being turned on. Although you might lock things up mechanically, an electronic lock is the easier, more effective solution.

Features. Presented here is a simple, inexpensive, electronic combination lock that's really tough to crack. To open the lock and turn on the protected apparatus, you must enter a 5-digit numerical code by means of pushbutton switches. If you enter the wrong code, the system will disable itself for about 15 seconds, during which time the lock cannot be opened even if the correct combination is entered. Furthermore, the code must be entered quickly; if someone dawdles more than a second or so between entries, the lock won't open, even with the right code. All these features add up to a system that is both convenient (no key) and difficult to beat.



Electrolok may be assembled in any convenient cabinet, or combined with an easily available surplus telephone-type touch-pad to give a real finished look. Make sure that the touch-pad you get has discrete-wired switches. Other types (matrix) might not be compatible with Electrolok's wiring arrangement.

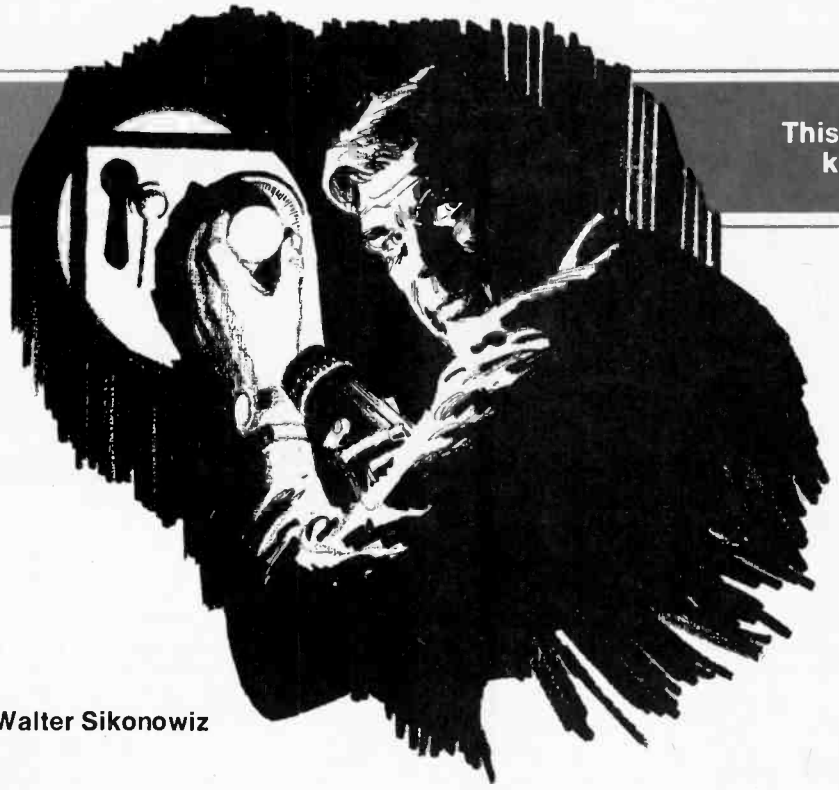


This is the full-scale template for Electrolok's PC board. Using the PC board will allow more compact project.

Circuit Function. Let's see how the lock works by taking a look at the schematic diagram. A half-wave-rectifier system consisting of T1, D1, and C1, supplies power to the lock. Resistor R1 and zener diode D2 do not regulate the supply voltage. Instead, they just clip any voltage spikes generated on the power line, thus protecting U1. You'll note that there is no power switch on the primary (117 VAC) side of T1. That's because standby power consumption is so minute, that a power switch was deemed unnecessary. (However, you might wish to include one. In that case, the primary power switch would have to be turned on before the 5-digit combination could be entered.)

Capacitor C3 is charged up by supply current flowing through resistor R2. Let's assume that enough time has elapsed after the application of AC power for C3 to have become fully charged. In that case, a logic "1" input is seen by pins 2, 5, 9 and 12 of the four AND gates comprising U1. The result is that each AND gate behaves as a very-high-gain amplifier. Specifically, if the voltage presented to the one remaining input of any gate exceeds half the supply voltage (approximately), the gate's output will be high (at supply potential). With inputs of less than half the supply potential, the output remains low (grounded).

In this lock circuit, the four AND gates are arranged to form a sort of "bucket brigade"—only it's not water that's being transferred, it's an electrical charge instead. When S1 is pressed momentarily, capacitor C4 charges rapidly to supply potential through R5. Once S1 is released, C4 begins to discharge through R6, taking a second or so to discharge half way. Since AND gate A's input (pin 1) reads the voltage on C4 through R5, we know that the gate's output (pin 3) is going to be high for about a second, which is



This electronic combination lock keeps your equipment safe

by Walter Sikonowiz

the time it takes C4 to discharge half way. Therefore, if we press S2 before the one-second interval has elapsed, it is possible to charge capacitor C5 to supply potential. (If we dawdle more than a second, however, gate A's output will have dropped to ground potential, and no charging of C5 will be possible.)

Assuming that C5 has been charged, it is obvious that gate B's output (pin 4) will remain high for the second or so that it takes R8 to discharge C5 half way. Therefore, we can now charge C6 by pressing S3 before another second goes by. Applying the same reasoning, it should then be possible to charge C7 if S4 is pressed quickly enough. Finally, pressing S5 within a second of S4 will send a current from U1-D's output (pin 11) through R13 into the gate terminal of the SCR (Q1). This causes Q1 to latch in a conducting state, thereby allowing current to flow through relay K1 and light-emitting diode LED1. Once actuated, the relay's contacts close and supply power to whatever device you wish to control. The lighting of LED1 alerts you to the fact that the circuit is unlocked.

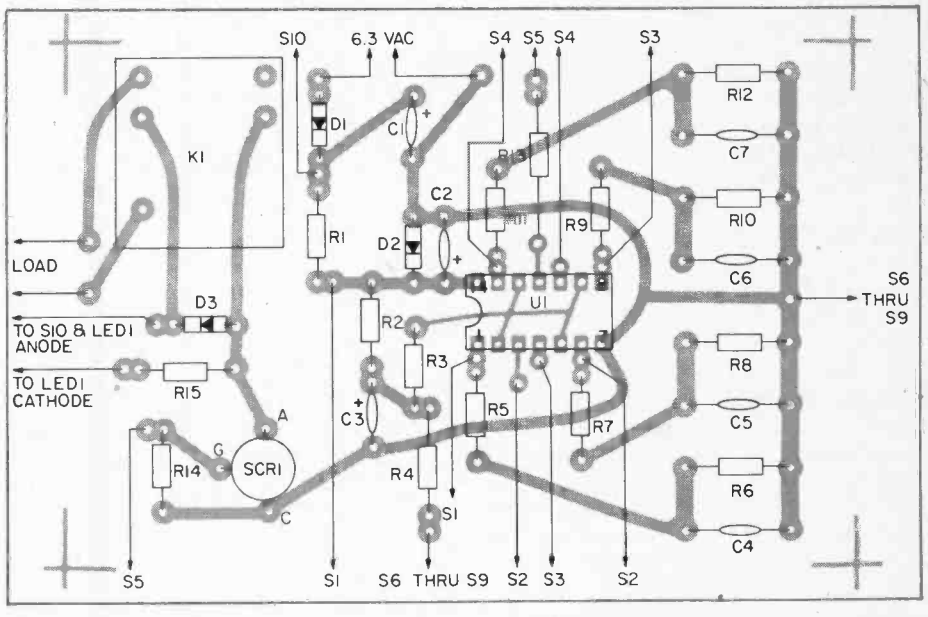
To lock the circuit once more, it's necessary to momentarily interrupt the flow of anode current through the SCR. This can be done by pressing S10. Once the anode current has been interrupted, Q1 will not conduct until the proper code has once again been entered.

From the schematic, you can see that besides the five pushbuttons required to open the lock, there are four extra dummy switches; S6 through S9. These serve the purpose of foiling any attempt to pick the lock. Whenever one of the four dummy switches is pressed, C3 gets discharged quickly through R4. While C3 is recharging through R2 to a potential greater than half the supply voltage—an interval of 15 to 20 seconds on the average—the bucket brigade remains disabled and all AND-gate outputs are locked at ground potential. Therefore, any code, even the correct one, entered while C3 is insufficiently charged, will have no effect. Once a would-be lock picker touches a dummy switch, it is very probable that he will press another dummy before C3 has been sufficiently recharged. This means that the bucket brigade remains inoperative for 15 seconds more. Consequently, the chances of cracking the code by punching in numbers at random are exceedingly slim.

Numbers may be assigned to S1 through S9 at will. Therefore, should someone break the code (an unlikely but still possible occurrance), you can easily change the combination by rewiring some of the switches.

Although the pushbuttons used in the prototype were small discrete units, you might wish to employ a calculator-type keyboard instead. If you do, make sure that the board you choose has individually accessible switch contacts. Some keyboards have switches wired in a matrix arrangement, which would be useless here.

Select a relay that can handle the maximum expected current drawn by the equipment you intend to control. The device used in the prototype is rated for an RMS current of one amp @ 117 VAC. For heavier loads, use the Circuit Specialists #D1-966, which can



Here's a top view of the PC board showing the component locations. All parts except F1, switches, LED 1, and power transformer mount here. We recommend use of an IC socket.

handle three times as much current. When using the latter relay, however, be sure to modify the circuit board, which was designed specifically to accommodate the pin arrangement of the prototype's Radio Shack device.

Construction. Construction of the lock should be simple; either perfboard or a printed circuit will do. For those who choose PC construction, suitable templates are featured elsewhere in this article.

Use a low-heat (25-watt or less) iron and resin-core solder for all the electrical connections. It is recommended that you *not* solder U1 directly into the circuit. Instead, use an IC socket, and install the integrated circuit into the socket only after all soldering and construction are completed. This will minimize the chances of accidentally damaging your IC.

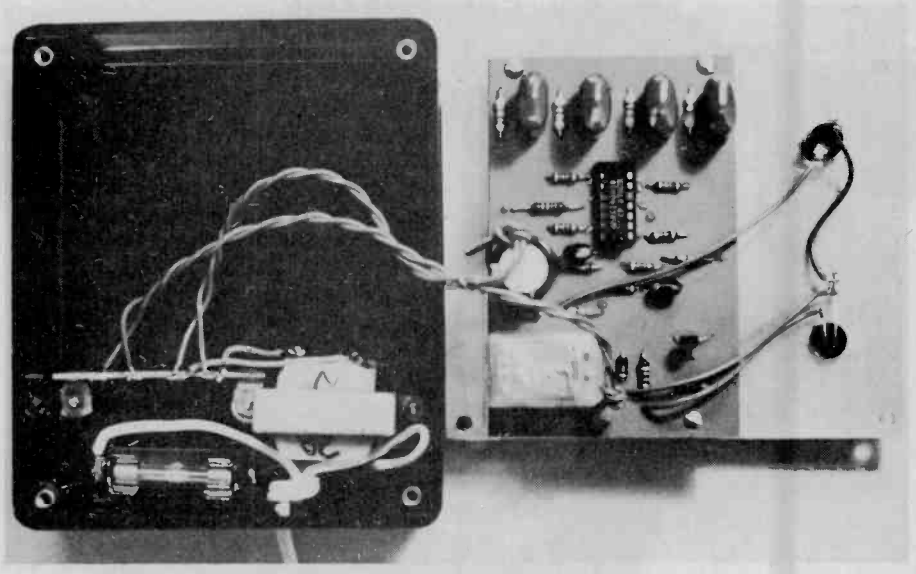
Be certain to observe proper polarities with all the diodes, Q1, U1, and all the capacitors.

Almost any small cabinet can be used to house the lock circuit. In the prototype, a 2 by 5 by 4-inch plastic cabinet was used, but if you lack experience in small-scale construction, you may be more comfortable with a larger box.

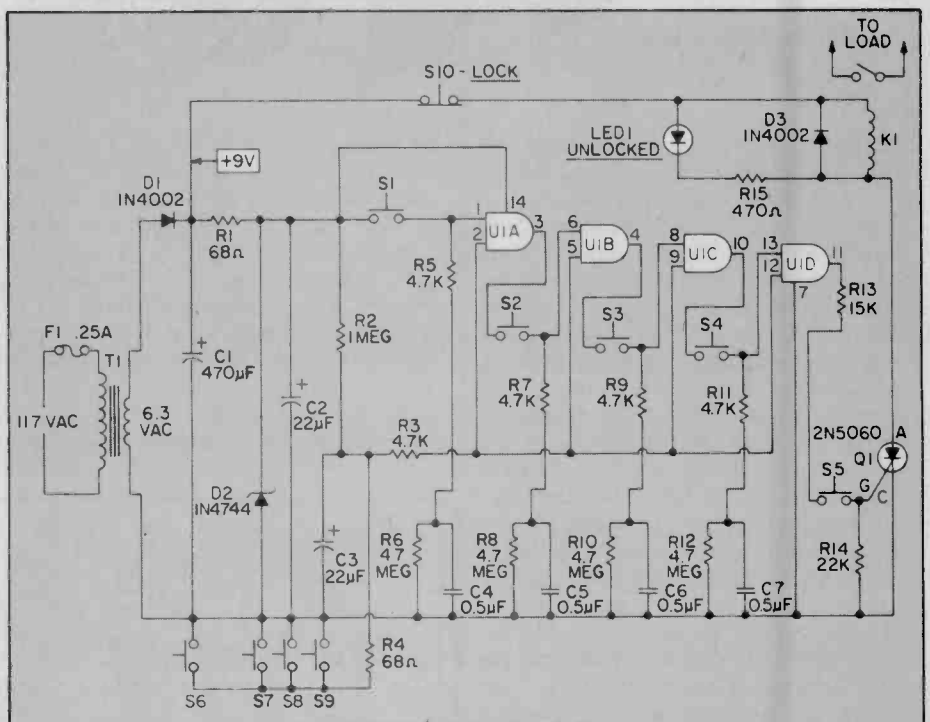
Operation. When construction is complete, you're ready to check out your work. In these initial stages of testing, do *not* connect any load to relay K1. Plug the circuit into the AC line, and wait one minute. This is more than enough time for C3 to charge up completely. Now, quickly punch in the correct combination (according to the way you've wired up the pushbuttons). After the entry of the last digit, LED1 should light up, and K1 should emit a faint "click" as it pulls in.

Once you have successfully unlocked the device, press switch S10. The circuit should return to its locked state, and LED1 should cease to glow. Next, hit one of the dummy switches, followed by the correct combination. Your circuit should be unaffected by the code and remain locked.

Final Touches. When proper operation of the lock has been verified, you can proceed to wire K1's contacts into the load circuit. In addition to the applications already suggested, you might consider using the lock to control an electronic garage-door opener or burglar-alarm system. In fact, there are so many ways to use the circuit, that you may wish to build several units—each with a different combination. ■



The prototype Electrolok with the cover removed, shows the placement of the PC board and off-board components. No power switch is used, as idle current is very low in the operating mode. You can add an SPST switch in series with a transformer primary lead.



PARTS LIST FOR ELECTROLOK

C1—470-uF electrolytic capacitor, 35-VDC
C2, C3—22-uF tantalum capacitor, 25-VDC
C4 to C7—0.5-uF mylar capacitor, 25-VDC
D1, D3—1N4002 diode
D2—1N4744 zener diode
F1—0.25-amp fuse (3AG type)
K1—relay with 6-VDC, 500-ohm coil (Radio Shack #275-004 or Circuit Specialists #D1-966—see text)
LED1—small LED rated 20-mA @ 1.75-VDC
R1, R4—68-ohm, ½-watt resistor, 10%
R2—1-megohm, ½-watt resistor, 10%
R3, R5, R7,
R9, R11—4,700-ohm, ½-watt resistor, 10%
R6, R8, R10, R12—4.7-megohm, ½-watt resistor, 10%
R13—15,000-ohm, ½-watt resistor, 10%
R14—22,000-ohm, ½-watt resistor, 10%
R15—470-ohm, ½-watt resistor, 10%
SCR1—2N5060 silicon-controlled rectifier
S1 to S9—SPST normally open pushbutton switch
S10—SPST normally closed pushbutton switch
T1—power transformer; primary rated 117-VAC, secondary rated 6.3-VAC @ 100-mA
U1—Motorola MC14081B quad AND gate
MISC.—suitable enclosure, line cord, IC socket, hookup wire, solder, etc.

(Note: U1 is available from Circuit Specialists, Box 3047, Scottsdale, AZ 85257.)

USING ANTENNA TUNERS

by Ed Noll
W3FQJ

Learn why they are needed and what they do

AN ANTENNA TUNER CAN GIVE your ham operations new versatility. Acting as a matching interface between antenna and transmitter, a tuner permits multiband operation with a simple antenna. A tuner permits an antenna cut for optimum operation on one segment of a band, to operate over the entire band. You can use a tuner to match a random length of wire or a compromise indoor antenna to a transmitter. Tuners provide an extra versatility for low-power (QRP) operation. Tuners minimize harmonic radiation from a transmitter. When used for reception, they block certain types of off-frequency interference.

There are two things that tuners do not do. *Tuners don't reduce the standing wave ratio* (SWR) *on a transmission line.* Rather, they act as a match between the complete antenna system and the transmitter. What a tuner *does* do for you is to make certain that the transmitter operates into its proper resistive load. Thus the transmitter operates in optimum fashion, delivering its rated output power to the antenna system.

A tuner does not improve the performance of an antenna system to which it is connected. What it *does* do, is to permit you to connect an antenna to your transmitter that would otherwise present an improper load to the transmitter.

The high standing wave ratio on a transmission line can be a disadvantage if a very long length of coaxial transmission line is used. The signal attenuation along the line, of course, increases with length of line, frequency and the standing-wave ratio. This is not significant when using high-impedance, flat and open-wire lines, or when using a random length of wire antenna.

Tuners themselves are rated in terms of the power they can handle. Most are rated for 200 to 300-watts. A few high-powered ones with ratings up to 3 kW PEP are available.

Basic Circuits. Three networks that are common in modern tuners are given in Figure 1. The simple L-network of example A is used most often to match the low impedance transmitter output to the high impedance of a random wire antenna. The LC combination tunes out the reactance of the antenna and provides an impedance transformation between the resistive output impedance of the transmitter and the resistive component of the input impedance of the antenna.

In general, the lower the frequency of operation, the more inductance and capacitance are needed. However, actual values depend upon the actual length of the random wire and, therefore, the amount of reactance that it reflects to the antenna terminal of the tuner. The network is, of course, tuned to resonance. However, that resonance also consists of the reactive components contributed by the antenna itself.

If a match is to be made to a very low impedance antenna, such as a mobile whip, the transmitter and antenna connections should be interchanged. Supply the output of the transmitter to the capacitor side of the LC network and connect the antenna to the inductor side.

Examples B and C are of the more versatile tee-network types, having three variable elements that can be adjusted for a very minimum standing-wave ratio at the transmitter. The three variable elements are better able to juggle the relative reactances and re-

e/e ANTENNA TUNERS

The Apollo Systems' Transmatch is an excellent example of a full-power, high-quality antenna tuner. It also comes in kit form.

sistances to obtain a better match. In the arrangement of B, both stator and rotor plates of the two capacitors are above ground and must be insulated from ground. However, one side of the inductor can be grounded. The arrangement of C permits one side of the capacitor to be grounded. However, two variable inductors are required, with both their ends isolated from ground.

Types of Antenna Tuners. The simplest type of antenna tuner, Figure 2, is one that matches a random-wire antenna to the transmitter. Such a wire has a high impedance and the inductor-

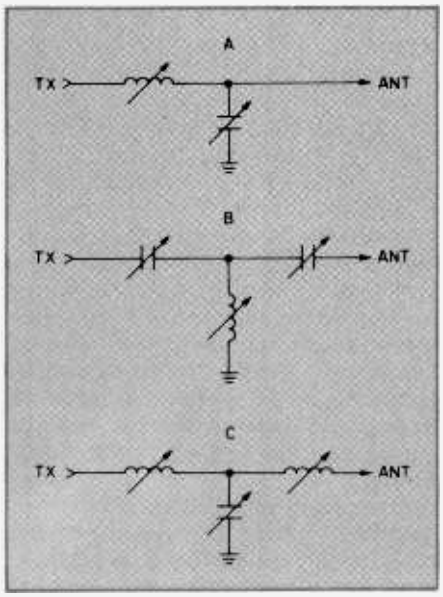


Fig. 1. These are the three basic circuit configuartions for antenna tuners. Type A is an L network, B and C are T networks.

capacitor combination must act as a high-to-low impedance transformer. At the same time, it must tune out the reactance of the random wire so as to reflect a resistive impedance to the transmitter output.

The SST Electronics 10-through-160 meters T-1 model, Figure 3, uses a tapped toroid inductor and a variable capacitor. It is mounted at the transmitter with an SWR meter inserted between the transmitter output and the input of the tuner. A neon lamp output indicator is also included. In most situations, it is only necessary to tune the L and C controls for minimum SWR and maximum brilliance. Minimum SWR is the important consideration. The neon lamp glows in accordance with available power and length of the antenna wire.

In connecting the tuner, make certain that there is a ground connection between the tuner and the transmitter. Since SWR meters have coaxial inputs and outputs, there must be a coaxial line between the tuner and the SWR meter and between the SWR meter and the transmitter. The outer conductor of the coaxial line can serve as the interconnecting ground among the three units. Of course, the transmitter or transceiver should be connected to the nearest good-quality ground in any case.

A larger tuner is the SST Electronics T-2, (Figure 4) a tee-network type. It consists of two variable capacitors and a tapped toroid inductor. It is a more versatile type, and accommodates antennas that require a coaxial transmission line as well as a random wire antenna. Three adjustable controls permit you to obtain a minimum SWR reading.

Again, your SWR meter must be inserted between the transmitter and the input side of the tuner. This type of tuner is used widely for matching dipoles, beams and other center-fed antenna systems. For example, using an 80-meter dipole, proper adjustment of the tuner results in a low standing-wave ratio on any band frequency.

Tuner manufacturers make available a variety of the basic types of tuners. Choose one according to your needs and pocketbook. An example of a deluxe tuner is the MFJ-949 tuner of Figure 5. This model includes a built-in SWR meter, as well as a switching arrangement that permits a choice of one of two antennas. It also incorporates a dummy load and an RF power meter.

Tuning the Tuner. Position the tuner near the transmitter, and make the appropriate coaxial connections among the tuner, SWR meter, and transmitter (Figure 6). If the tuner or the transmitter includes an SWR meter, it is only necessary to make a coaxial interconnection between the transmitter side of the tuner and the transmitter output. Connect the appropriate antenna to the antenna side of the tuner. If a dummy load is not included with the tuner, use an external one that can be connected conveniently to the transmitter output.

Connect the dummy load to the transmitter output. Tune up the transmitter on the desired frequency. This step makes certain that the transmitter has been adjusted for matching a 50-ohm load. Transmitter controls need not be adjusted again. The objective now is to adjust the tuner in such a manner that the antenna is matched to this pre-set 50-ohm load.

The next step is to find an approximate setting of the tuner controls without applying power to the transmitter. This can be done by using the receiver mode, and adjusting the antenna tuner's capacitors half way open by setting the controls to near mid-scale. Rotate the inductor control until maximum signal and background noise are heard in the receiver output. You may wish to adjust the transmitter and antenna capacitor controls to peak this background noise level. Keep in mind that the lower the frequency of operation, the greater is the required inductance. Remember that this receiver adjustment is just a preliminary setting, although in some instances it may be very close to the final optimum setting of the controls.

The next step is to set up the SWR meter for proper operation. Flip the SWR meter to its SET position. Set the transmitter to its TUNE or LOW-POWER output position. Vary the sensitivity control of the SWR meter to obtain the full-scale SET reading. If

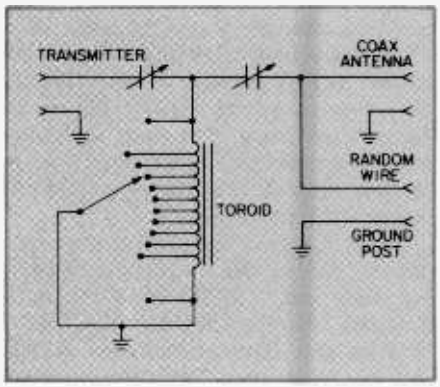


Fig. 2. This is a simple schematic for an antenna tuner showing the tapped inductor, and outputs for longwire and coax-fed antennas. You can see that this is based on example B in Figure 1. This is probably the most popular design for the smaller types of commercial antenna tuners sold.

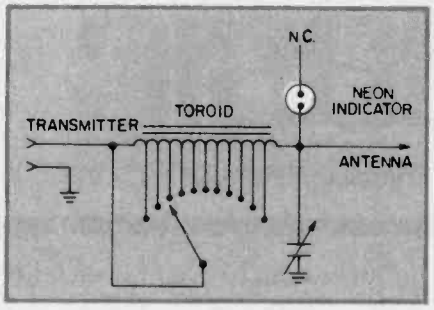


Fig. 3. SST's T1 antenna tuner uses an L network, as seen in example A of Figure 1. The neon bulb shows relative RF transmitter power being fed to the antenna.

you switch over to the SWR position, you will now obtain the standing-wave ratio reading.

The next procedure is to obtain a minimum SWR reading at the same time that proper power is being delivered to the antenna. Alternately adjust the transmitter and antenna controls (variable capacitors of the tuner) for a minimum SWR. Since the two controls interact, you must jump back and forth between them several times

Fig. 4. SST's T2 tuner utilizes T network design. The two variable capacitors allow you to tune out virtually all reactance.

to obtain the very minimum SWR. Usually the best procedure is to vary the transmitter control a small increment at a time and then rotate the antenna control for minimum SWR. Repeat until a very minimum SWR is indicated. If a minimum 1:1 ratio is not obtained, you may wish to try the inductor settings immediately on each side of the present setting. Occasionally, it is necessary to readjust the SWR meter sensitivity control to its full-scale SET position when you are making an actual SWR reading.

The next procedure is to make a final adjustment of the tuner controls with full transmitter power. Of course, never apply any more power to the tuner than the amount for which it has been designed. Set the SWR meter to its SET position. Apply full transmitter output to the tuner and adjust the sensitivity control for a proper full-scale SET reading. On its SWR reading position, it will now read the actual standing-wave ratio when applying full power. It may be necessary to readjust finely the antenna and transmitter controls of the tuner for a minimum SWR reading. When a good match is obtained, the SWR reading will be very near 1:1. However, depending upon tuner design and your particular antenna system, it may not always be possible to obtain this very low reading. SWR readings of up to 2:1 are considered acceptable. However, a tee-network tuner will, in most situations, present an SWR reading considerably below this value. A low SWR reading of 1:1 can sometimes occur at more than one setting of the inductor. This is unimportant if the transmitter power output is normal. If the transmitter power has decreased substantially, try another setting of the inductor control.

Some patience is required in finding optimum settings for each band of frequencies to be used. Also, readjustment of the transmitter and antenna controls may be needed when changing operation from one band end to the other.

Do not expect a tuner to improve your antenna. Its responsibility is simply to load that antenna system to the transmitter.

Again, and we cannot overemphasize this point, if you are currently plagued with poor performance from your antenna system, do not expect miraculous improvements in transmission and reception efficiency. You may experience some reception improvements if you use a transceiver, since the receive adjustments will be able to be optimized for the specific frequency in use. Formerly, you had to accept some detuning in order to accommodate the transmitter tuning adjustments. Nevertheless, it always helps to check every part of your coax and antenna for breaks, etc.

Also, when purchasing a tuner, plan for the future. If you contemplate moving up to a kilowatt in the near future, it pays you to buy a unit that will accommodate that power level now. Prices can only be going up in the future, and you'll end up kicking yourself for trying to save a few dollars now, when you'll have to pay much more later.

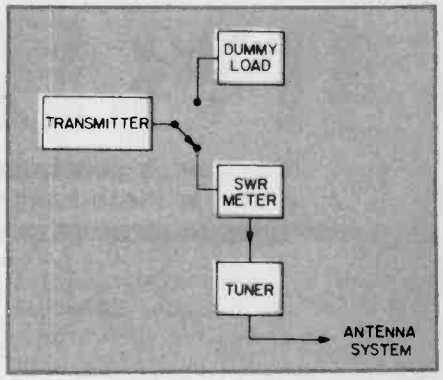


Fig. 6. This shows the basic configuration of the antenna line circuit with antenna tuner and SWR bridge in position on one side, and the dummy load (for tune-up purposes) on the other side of the coaxial antenna switch. See the text for all details.

Of course, if you plan to remain at your present power level, or even drop down to QRP, then one of the lower power, compact models will serve you well, and offer the same degree of matching efficiency as the larger ones do.

Conclusion. Tuners provide excellent all-band performance and are essential when used with such long-wire antennas as vee-beams and rhombics. They also work well with multi-band beams when you want to obtain the very lowest possible standing-wave ratio. They also permit you to obtain the very lowest standing-wave ratio with a dipole when that dipole is to be used from one end of the band to the other. To sum it up, a tuner does not improve an antenna but it does provide operating versatility and, when properly tuned, keeps a proper load on the transmitter. ■

Fig. 5. An example of one of the deluxe antenna tuners on the market today is MFJ's model 949 Versa-Tuner. It includes a built-in SWR bridge and relative metering setup.

IT'S SIMPLY BASIC

Use "block construction" to program these handy audio formulas

by Larry Friedman, WB2AHN

WHILE A COMPUTER is capable of storing and processing almost endless amounts of data, it is also extremely efficient when you must make many calculations using the same formula, or information.

This rapid processing, combined with *continuous* printed ouptut of the calculations is used in this month's program "Audio Designer," intended expressly for the audio experimenter and hobbyist. It is particularly handy when plotting amplifier input sensitivity and output power charts or curves, or when designing or calculating filters, the effects of capacitance versus resistance when plotting frequency cut-offs, etc.

The program features continuous recycling. Once a reference value for a problem is entered, the computer automatically prints the solution when an unknown value is entered, and it is immediately ready for another unknown.

Block Construction. The program uses "block construction," so it can be easily modified to do other calculations. For example, if you want to calculate for L, or X_L (inductance and inductive reactance) simply tack it on the end of the program as "block 4000," or "the 4000 series." Also, be sure to change line 410 to accommodate the added programming blocks, and include, at line 250, updated instructions.

"Audio Designer" was written for the Radio Shack TRS-80 with Level II BASIC. Take extra careful note that some TRS-80's print the exponentiation up-arrow (↑) as a bracket ([). The fact that a bracket is shown does not mean there is a print or programming error. The result during a program run is exponentiation regardless which symbol is shown.

Also, the TRS-80 tends to show three or more decimal place numbers in scientific notation.

To exit the program, type BREAK on the TRS-80. Other computers will require their normal interrupt statements, such as CONTROL-C. ■

AUDIO DESIGNER

```
115 REM      BY LARRY FRIEDMAN
120 REM      WRITTEN FOR TRS-80
130 REM      LEVEL 2 BASIC
135 REM
140 REM NOTE: ON SOME TRS-80 COMPUTERS
141 REM A BRACKET ([) IS PRINTED
142 REM INSTEAD OF AN UP-ARROW TO
143 REM SHOW EXPONENTIATION.
144 REM
145 REM THIS PROGRAM IS WRITTEN FOR
146 REM 40 CHARACTER LINES. IT CAN
147 REM BE EXTENDED TO 72 CHAR. IF
148 REM DESIRED
160 REM
165 CLS
170 INPUT "NEED A FORMULA CHART(Y/N)";Y$
180 IF Y$="N" THEN 400
190 PRINT:PRINT
200 PRINT "1.  DECIBELS (FOR VOLTAGE)"
210 PRINT "    DB = 20*LOG(E1/E2)"
215 PRINT
220 PRINT "2.  DECIBELS (FOR POWER)"
230 PRINT "    DB = 10*LOG(P1/P2)"
235 PRINT
240 PRINT "3.  CAP. REACTANCE"
242 PRINT "    (ENTER C IN MFD)"
250 PRINT "    X(C) = 1/(6.28*F*C*10[-6)"
270 PRINT
400 PRINT "ENTER NUMBER OF DESIRED"
405 INPUT "FORMULA  (1, 2, OR 3)";R
410 ON R GOTO 1000,2000,3000
1000 PRINT "DECIBEL FORMULA"
1005 PRINT "(FOR VOLTAGE)"
1010 INPUT "E1 = ";E1
1020 INPUT "E2 = ";E2
1030 IF E1=0 THEN 1200
1035 PRINT "E2";TAB(10);"DECIBELS"
1040 INPUT E2
1050 D=20 * LOG(E1/E2)/ LOG(10)
1066 PRINT " ";E2;TAB(10);D
1070 GOTO 1040
1200 PRINT "E1";TAB(10);"DECIBELS"
1210 INPUT E1
1220 D=20 * LOG(E1/E2)/ LOG(10)
1230 PRINT " ";E1;TAB(10);D
1240 GOTO 1210
2000 PRINT "DECIBEL FORMULA (FOR POWER)"
2005 PRINT "ENTER KNOWN POWER"
2010 INPUT "P1 = ";P1
2020 INPUT "P2 = ";P2
2030 IF P1=0 THEN 2200
2035 PRINT "P2";TAB(10);"DECIBELS"
2040 INPUT P2
2050 D=10 * LOG(P1/P2)/ LOG(10)
2060 PRINT " ";P2;TAB(10);D
2070 GOTO 2040
2200 PRINT "P1";TAB(10);"DECIBELS"
2210 INPUT P1
2220 D=10 * LOG(P1/P2)/ LOG(10)
2230 PRINT " ";P1;TAB(10);D
2240 GOTO 2210
3000 PRINT "CAP. REACTANCE FORMULA --"
3005 PRINT "DO YOU WANT TO"
3010 INPUT "SOLVE FOR X(C), F, OR C";Y$
3020 IF Y$="F" THEN 3200
3030 IF Y$="C" THEN 3400
3040 REM SOLVING FOR X(C)
3045 INPUT "F (IN HERTZ) = ";F
3047 INPUT "C (IN MFD) = ";C
3050 IF C=0 THEN 3100
3055 PRINT " F";TAB(10);"OHMS (X(C))"
3060 INPUT F
3070 X=1/(6.28*F*C*10[-6)
3080 PRINT F;TAB(10);X
3090 GOTO 3060
3100 PRINT " C";TAB(10);"OHMS (X(C))"
3110 INPUT C
3120 X=1/(6.28*F*C*10[-6)
3130 PRINT C;TAB(10);X
3140 GOTO 3110
3200 INPUT "X(C) = ";X
3210 INPUT "C (IN MFD) = ";C
3220 IF X=0 THEN 3300
3221 PRINT " C";TAB(10);"FREQUENCY"
3222 INPUT C
3225 F=1/(6.28*X*C*10[-6)
3230 PRINT C;TAB(10);F
3240 GOTO 3222
3300 PRINT " X(C)";TAB(10);"FREQUENCY"
3310 INPUT X
3320 F=1/(6.28*X*C*10[-6)
3330 PRINT X;TAB(10);F
3340 GOTO 3310
3400 INPUT "X(C) = ";X
3410 INPUT "F (IN HERTZ) = ";F
3420 IF X=0 THEN 3500
3430 PRINT " F ";TAB(10);
3435 PRINT "CAPACITY (IN MFD)"
3440 INPUT F
3450 C=1/(6.28*F*X*10[-6)
3460 PRINT F;TAB(10);C
3470 GOTO 3440
3500 PRINT " X(C)";TAB(10);
3505 PRINT "CAPACITY (IN MFD)"
3510 INPUT X
3520 C=1/(6.28*F*X*10[-6)
3530 PRINT X;TAB(10);C
3540 GOTO 3510
9999 END
```

SAMPLE RUNS OF "AUDIO DESIGNER"

```
>RUN
NEED A FORMULA CHART(Y/N)? Y

    DECIBELS (FOR VOLTAGE)
    DB = 20*LOG(E1/E2)

    DECIBELS (FOR POWER)
    DB = 10*LOG(P1/P2)

    CAP. REACTANCE
    (ENTER C IN MFD)
    X(C) = 1/(6.28*F*C*10[-6)

ENTER NUMBER OF DESIRED
FORMULA  (1, 2, OR 3)? 1
DECIBEL FORMULA
(FOR VOLTAGE)
E1 = ?
E2 = ? 200
E1        DECIBELS
? 100
  100          -6.0206
? 400
  400           6.0206
?
BREAK IN 1210
READY
>RUN
NEED A FORMULA CHART(Y/N)? N
ENTER NUMBER OF DESIRED
FORMULA  (1, 2, OR 3)? 3
CAP. REACTANCE FORMULA --
DO YOU WANT TO
SOLVE FOR X(C), F, OR C? X(C)
F (IN HERTZ) = ? 1000
C (IN MFD) = ?
 C        OHMS (X(C))
? .001
 1E-03          159236
? .002
 2E-03          79617.8
? .0005
 5E-04          318471
?
BREAK IN 3110
READY
>RUN
NEED A FORMULA CHART(Y/N)? N
ENTER NUMBER OF DESIRED
FORMULA  (1, 2, OR 3)? 3
CAP. REACTANCE FORMULA --
DO YOU WANT TO
SOLVE FOR X(C), F, OR C? F
X(C) = ? 159235
C (IN MFD) = ?
 C        FREQUENCY
? .001
 1E-03          1000
? .002
 2E-03          500.002
? .005
 5E-03          200.001
?
BREAK IN 3222
READY
>
```

Hobby Computing on a Budget

CIRCLE 35 ON READER SERVICE COUPON

By Gordon Sell

Low-cost computer from Ohio Scientific lets you start cheap and has room to grow

MOST BARGAIN COMPUTERS end up costing a lot of money. First you buy a microprocessor board that only talks back in binary code and can't remember a thing. Then you try to get it to speak BASIC, add on some interfaces, a few memory boards, and seemingly endless miles of ribbon cable and connectors. On top of all this you still need a keyboard, power supply, video modulator, and a TV. By the time you're done, and a great many people give up long before this, it has cost you almost as much as a ready-made plug-it-in-the-wall computer.

Well, there's one big exception to the rule—the Ohio Scientific Superboard II/Challenger 1P. For $279 the Superboard is a complete computer on a board with 8K BASIC in its permanent ROM memory, a powerful 6502 microprocessor and 4K RAM. All that has to be done is to hook up a five-volt, three-amp power supply, plug it into a cassette deck and a video modulator and you are ready to display your programs on your home TV set. If you don't own a suitable power supply or you would like your computer enclosed in a nice cabinet then you can buy the Challenger 1P for $349. It's the exact same computer but with a case and built-in power supply.

Easy to Use. While it's not quite as easy to set up as one of those computer-plus-monitor plug-in-the-wall units, it certainly isn't $200 harder. In fact it should take you no more than 10 minutes the first time you put your system together, and more like two minutes once you get the hang of it. All the cassette and video modulator connection cables are included so you don't have to do any soldering or wire wrapping.

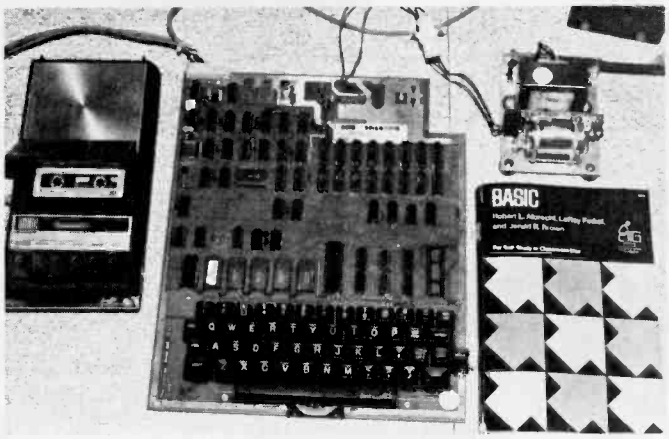
One extra item you will have to buy is a video modulator. In case you are not familiar with these interesting devices here is some background information. A computer generates a signal suitable for video display which can then go straight into a computer video monitor. But a video monitor costs about $200 to $250 and there goes your budget system. However, if you take the video signal and put it through a small, cheap TV frequency transmitter (video modulator) and transmit the signal a few inches to your home TV set then you can eliminate the video monitor and save over $200. Unfortuately this small TV transmitter comes under the domain of the Federal Communications Commission (FCC) and the FCC is restricting them because they cause interference on nearby TV sets. Computer manufacturers don't add video modulators to the computer because then it would be a TV transmitter and probably require licensing. To avoid this can-of-worms the manufacturers have left purchase of a modulator to the buyer. We bought a popular video modulator called a MicroVerter. It transmits to one of four possible unused UHF channels. Other modulators transmit on unused VHF channels such as 2 or 3 depending on your area.

If you keep your Superboard well-fed with peripherals it may grow up to be the equivalent of a Challenger 1P-MF microcomputer.

Great Features. As computers go the Superboard II/Challenger 1P is a great machine. It comes with 8K Microsoft BASIC in ROM and 4K RAM workspace. The RAM is expandable all the way to 32K and a disk drive, printer and other peripherals can be added on as your interest and budget expands. The QWERTY keyboard is easy to use, although some of the keys could be better labeled to mark their secondary functions. The computer has full alphanumerics plus upper and lower case. For number crunching it has non-integer BASIC so that you can work with decimal and fractional numbers as well as whole numbers. Once you get the hang of them there are a few nice programming short cut features that you'll really appreciate.

If you've ever written programs on some computers you've probably said

e/e BUDGET COMPUTER

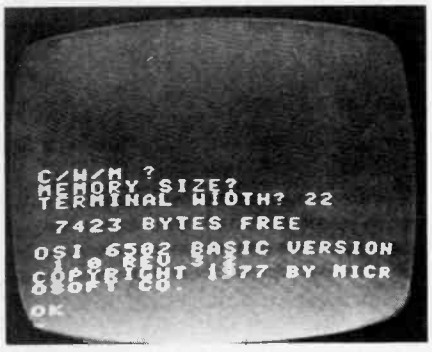


Learning to program a microcomputer can be a lot easier if you have an easy-to-use machine like the Superboard and a well-thought-out program of instruction such as is found in the book BASIC, published by John Wiley and Sons.

"I'll scream if I have to write out LET or PRINT again." Well, on the Superboard the LET statement can be left unsaid and the computer will add a PRINT statement if you type in a question mark. The most annoying problem with the keyboard is the *break* key. It's right next to the *return* key and it doesn't have a safety lock. If you miss the *return* key and hit *break*, you wipe out everything in RAM and you have to start again. A simple cure is to wedge a small piece of wood or plastic under the key so it can't be accidentally keyed. This is a fault that could have been corrected at the factory.

Graphics. The black and white 256-point by 256-point graphics are very good for a computer under $1,000 and outstanding for an under $300 machine. Ohio Scientific has a graphics demonstration program on tape, plus lots of games that take full advantage of the machine's capabilities. Once you have the hang of basic BASIC programming you can get into some graphics programming, and get the machine's resident graphics program to sketch things the way you want them.

With a video monitor you can get 30 rows of 30 characters on a single screen, while with a TV set you have 24 rows with about 24 characters per row. You can set the line length anywhere from 16 to 64 characters in length. This is a great feature when using a TV set since you can eliminate the common problem of characters being lost off the righthand side of the picture. The characters are easy to read but, the ROM programmers could have put a bit more vertical spacing between the lines.



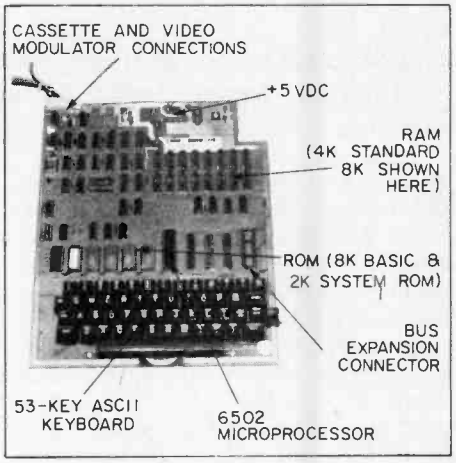
Overscanning, shown in the top photo, is easily cured by setting a shorter terminal width that will fit on the screen being used.

Learning How. If you've never used a computer before then this might be the one for you. The large instruction manual includes directions on using BASIC plus graphics programming, and full technical data sheets. Your best bet for learning, however, is to pick up a copy of *BASIC* by Albrecht, Finkel and Brown published by John Wiley and Sons, Inc. This self-teaching guide makes learning BASIC a breeze when used in conjunction with a small computer such as the Superboard. After you've mastered the points in this book you will be well equipped to go on to more advanced texts.

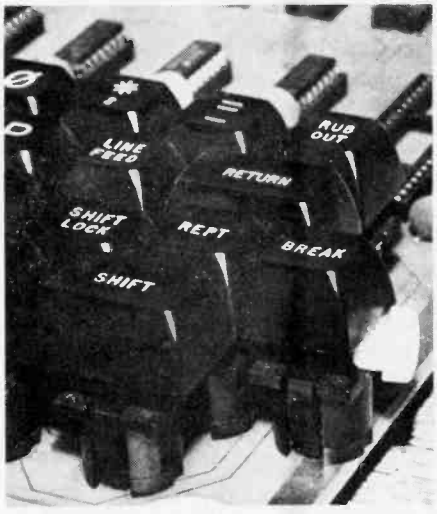
Expansion. This is another great feature of the Superboard II/Challenger 1P. It can grow along with your interest in the hobby. On the Superboard's board you can add an additional 4K of RAM for a total of 8K and expansion to 32K is possible with extra boards. Up to two mini-floppy disk drives can be added, along with a printer and modem. In fact, the Challenger 1P MF (A Challenger 1P with, 10K ROM, 12K RAM and 1K display plus a disk drive) is the industry's first under $1,000 disk based computer system.

There is a large library of canned software available for the Superboard II and Challenger 1P on both cassettes and disks from Ohio Scientific and dozens of indepedent software development outlets. There are also many programs published every month in computer magazines that are written in standard BASIC that can be easily keyboarded into the computer.

All in all, this is a hard system to beat if you want to start cheap and grow. If you would like to find out more about the Superboard and Challenger 1P then write to: Ohio Scientific, 1333 S. Chillicothe Road, Aurora, OH 44202, or circle number 35 on the reader service coupon. ■



Everything is on one board with room to grow. You might want to build a small case to protect the Superboard II from damage.



The BREAK key is just too easy for a hunt-and-peck typist to hit at the wrong time. Wedge a small piece of plastic under it.

Kathi's CB Carousel

by Kathi Martin, KGK 3916

Antennas that'll help you find gas

IT'S CB TO THE RESCUE AGAIN! To be more precise, it's CB and the truckers comin' fast to save the old homestead.

Back during OIL SHORTAGE I, it was the long-haul truckers who exposed the connivance of OPEC for the oil shortage and runaway prices. Using CB to organize demonstrations, the truckers brought the advantages of CB before the public, starting the great CB Boom.

Well, here we are in the midst of OIL SHORTAGE II, and again it's the truckers representing *our* interests. The price of diesel fuel is so high, a long-haul private trucker can't make a go of it no matter how hard he works. So the truckers blocked the truck stops in protest against OS II.

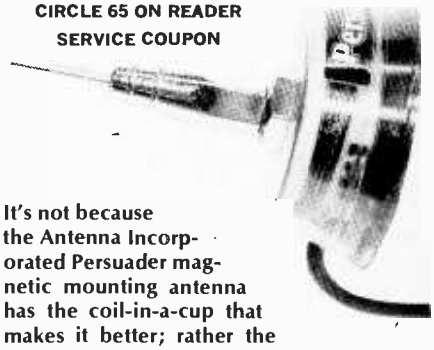
In less than 24 hours after the truckers blocked the fuel stops, it was announced that we were now saving at least 600,000 gallons of fuel per day and the crisis wasn't all that bad; the refineries which were alleged to be working near capacity would now *really* work near capacity; and maybe the summer wouldn't be so bad because there would be more gas than anticipated before the private truckers pulled their blockade.

Once again, the truckers with their CBs were the only ones who could deliver for the rest of us working folk. In the same line of thinking, Radio Shack is now advertising CB as a vital necessity for those who travel on weekends because it's hard to find an open gas station in many Metropolitan areas on a Sunday.

The way Radio Shack tells it, you'll need CB to find out who and where is selling gas. I go along with this thinking 100%. CB is an even greater necessity now than it was three years ago. Fact is, because you'll be looking for gas and not local assistance, you're going to need all the range you can get—the open gas station might be five or ten miles away. And, if all is well when you read this, what about OS III?

Now is the time to check out your mobile for maximum efficiency, and replace anything that's cutting down on your signal. In particular, I'm talking about antennas.

CIRCLE 65 ON READER SERVICE COUPON



It's not because the Antenna Incorporated Persuader magnetic mounting antenna has the coil-in-a-cup that makes it better; rather the loading coil is made of heavy stabilized wire that helps to cut copper losses and detuning losses. This also keeps the SWR at a very low level.

We all know ordinary road corrosion slowly reduces a mobile antenna's performance. Even more important, however, great improvements have been made in mobile antenna design over the past several years, and a new mobile antenna can add miles to your expected coverage. One thing to keep in mind when looking at the new antennas is that the extended performance is in all directions. That means that if you push your signal out one mile extra in front of the car, truck, or RV, it goes out an extra mile to the rear and sides. That's quite a substantial improvement in coverage, and you might need every bit of it when calling for "info on gasoline."

I can't suggest any particular brand or design, because every mobile installation can be different, depending on the antenna mounting, its location, and the user's personal preference in size. There are some general rules, however, which are almost universally applicable.

Firstly, buy U.S.A. manufactured antennas! They are, almost without exception, well-made and suffer the least road corrosion; they give the maximum number of years of reliable service. While there is some good stuff made offshore, there are also low-value antennas made

(Continued on page 79)

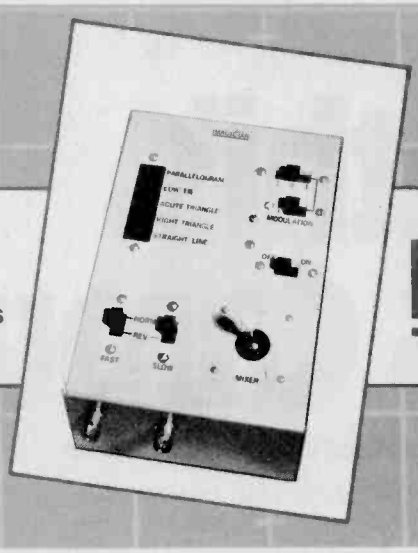
Trucks and vans without Hollywood mirrors often don't have room for a decent CB antenna; the best location has generally been used for the AM radio whip. The Antenna Specialists' M-517 handles this "toughie." As shown, it has a waterproofed side body mounting with an internal steel backup plate for extra rigidity. A pre-tuned CB/AM coupler allows the antenna to be used for both CB and AM radio

CIRCLE 70 ON READER SERVICE COUPON

CIRCLE 67 ON READER SERVICE COUPON

Another great mounting problem solver is the Avanti Astro Fantom. The antenna can be mounted on glass or plastic without having to cut a hole through for the wire. A coupler mounts on the inside and transmits and receives right through the glass. It will also work through on the fiberglass deck of a boat. The 22-inch antenna is a half-wavelength long and comes with the coupler and coaxial cable assembly.

With a little help, your scope becomes an electronic canvas



IMAGICIAN

by Walter Sikonowiz

HOW WOULD YOU LIKE TO be able to generate beautiful geometric line drawings electronically? And what if these figures could be made to look 3-dimensional, with forms that expand, rotate, and flow under the command of a joystick? Sounds expensive and complicated, doesn't it? If you've seen some of the graphics produced by hobby-type digital computers, you're probably skeptical and rightfully so. Small digital computers generate simplistic graphics with a chunky appearance. Generating smooth lines and complex figures with a digital computer requires much more memory than most computer hobbyists can afford.

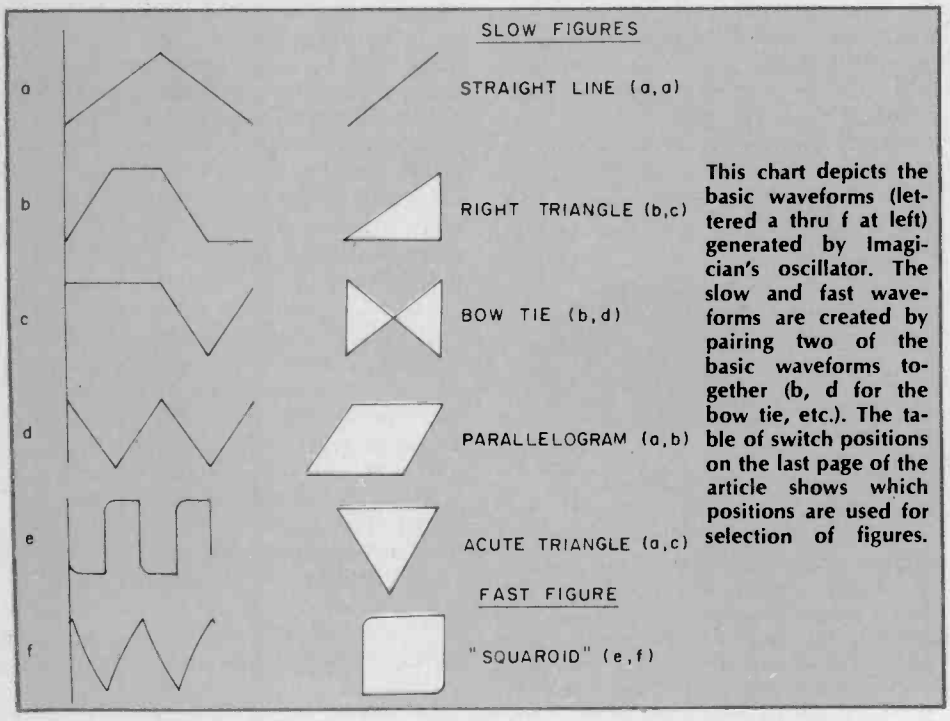
But if a few ideas are borrowed from the *analog* computer, a device rarely mentioned anymore, it's possible to generate dazzling graphics with simple, inexpensive circuitry. That's the principle of the Imagician, a simple, two-IC project that transforms your oscilloscope's screen into a window on a magic land of animated geometric figures.

The Lissajous Figure. Before delving into the workings of the Imagician's circuit, let's talk about Lissajous figures. If you own a scope, no doubt you are familiar with them. A Lissajous figure is a closed curve that results when two harmonically related signals are applied to a scope—one signal to the vertical input, the other to the horizontal input. The most familiar figure occurs when a sine wave is applied to one input, and a phase-shifted sine of the same magnitude and frequency is fed to the other input. On the scope's screen there appears either an elliptical or circular trace, depending upon the phase relationship between the two signals. With non-sinusoidal waveforms driving the X and Y inputs, other geometrical displays can be created.

Let's examine the various waveforms synthesized within the Imagician (Figure 2). From just these six signals, thousands of fascinating displays can be produced. Waveforms *a*, *b* and *c* all oscillate at 60 Hz; signal *a* is a triangle wave, *b* is a symmetrically clipped triangle, and *c* is trapezoidal. Signal *d* is another triangular waveform, but with a frequency of 120 Hz. For reasons that will be apparent later, let's call figures *a* thru *d* "slow" figures.

It stands to reason that there must be some fast signals, too. Waveforms *e* and *f* are the fast ones, with a frequency equal to 3840 Hz (64 times faster than 60 Hz). Signal *e* might be called a "soft-shouldered square wave," while *f* just begs to be called a "shark-fin wave."

What are the simplest Lissajous figures that can be generated by selected pairs of the above six waveforms? Figure 3 shows these fundamental figures along with the X and Y components necessary for their generation. It is assumed that the X and Y components are of equal magnitude; if such is not the case, the shapes will be distorted to new forms. Note that these fundamental Lissajous figures are segregated into slow and fast classes. The slow figures have slow waveforms (*a* through *d*) as components, while the fast figure has fast components (*e* and *f*). The slow figures include familiar geometric shapes: a straight line, a right triangle, a parallelogram, an acute triangle and the perhaps not-so-



This chart depicts the basic waveforms (lettered a thru f at left) generated by Imagician's oscillator. The slow and fast waveforms are created by pairing two of the basic waveforms together (b, d for the bow tie, etc.). The table of switch positions on the last page of the article shows which positions are used for selection of figures.

familiar bow tie. Were it not for a slight slope to the sides and a pair of rounded corners, the fast figure would almost appear to be a square. In recognition of the similarity, let's call the fast figure a "squaroid."

New complex Lissajous figures, some of which will appear to be 3-dimensional, can be synthesized by adding together one of the slow figures and the squaroid. This is accomplished by summing the X- and Y-component waveforms of the two figures independently. Furthermore, it's not necessary to mix signals in a one-to-one ratio. Different mixing ratios yield new and fascinating displays in a manner that's often hard to predict. As a final touch, the components of the fast figure (squaroid) can be amplitude-modulated. The type of modulation used here was specifically chosen to enhance the illusion of perspective in those displays that appear 3-dimensional.

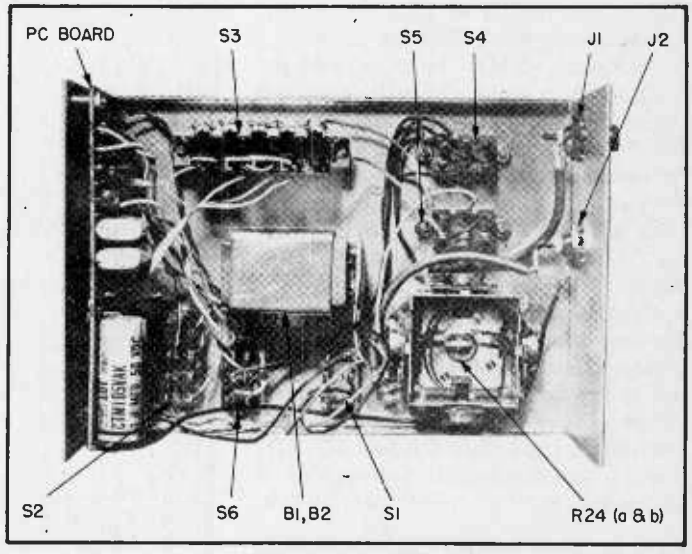
The Circuit. Let's consider the Imagician's circuit in detail. Two batteries, B1 and B2, provide +9V and −9V supply potentials for the circuit when power switch S1 is closed. Diodes D1 and D2 protect the ICs from incorrect battery installation and also drop the supply potential slightly, which is desirable here. Capacitors C1 through C4 provide supply bypassing.

Q1, a programmable unijunction transistor (PUT), works together with R1, R2, R3 and C5 to form an oscillator that feeds pulses to the clock input (pin 1) of U1, a 4024B seven-stage binary frequency divider. U1 divides the input frequency by 2, seven times in succession to yield seven harmonically related square-wave outputs. We need harmonics in order to generate Lissajous patterns, but square waveforms do not yield interesting displays. Consequently, the greater portion of the Imagician's circuitry is devoted to the shaping of square waveforms into other more useful signals.

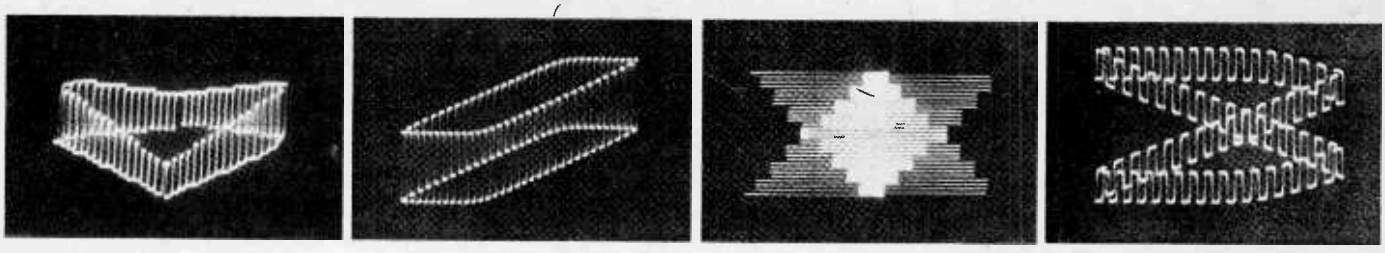
At pin 3 of U1, we find the lowest-frequency square wave (60 Hz), while pin 4 supplies the second harmonic (120 Hz). R15 and C6 integrate the 60 Hz signal to a triangular waveform (*a*). Diodes D3 and D4 together with integrating network R16/C7 produce the symmetrically-clipped 60 Hz triangle (*b*). Driven by both the 60 and 120 Hz signals, the D5/D6/R17/R18/C8 network yields a 60 Hz trapezoid (*c*). Finally, the last slow waveform, triangle wave *d*, is generated when R19 and C9 integrate the 120 Hz square-wave signal.

Fast waveforms *e* and *f* are formed with the aid of shaping networks R22/C10 and R23/C11, respectively. When S6 is flipped to the left, as indicated in the schematic, amplitude-modulated currents at 3840 Hz are fed to the shaping networks just discussed. As a result, waveforms *e* and *f* are also amplitude-modulated. The manner in which modulation is obtained here requires further explanation: U2, a 4070B quad EXCLUSIVE-OR gate, taps harmonically related signals from frequency divider U1. The gates within U2 are connected so as to yield a sort of digital multiplier when the various outputs are summed together (by R5/R9, and R10/R14). Switch S2 controls the shape of the modulation envelope, with three choices available. If S6 should now be flipped to the right, an unmodulated 3840 Hz square-wave current will be fed to each R/C shaping network. Consequently, signals *e* and *f* will be of constant amplitude.

The rest of the circuitry serves only to combine signals *a* through *f* in various ways. Switch S3 selects pairs of X and Y components for the 5 slow Lissajous figures. These signal pairs are routed to the vertical (R24a) and horizontal (R24b) mixers via reversing switch S4. (When a Lissajous figure's X and Y components are interchanged, it flips to a new orientation on the screen.) Switch S5 performs the same function as S4, but it operates on the components of the fast figure instead. Addition of the X components of the slow and fast figures occurs in the horizontal mixer; the vertical mixer sums their Y components. R24a and R24b are part of a joystick assembly; north-south movement of the stick controls R24a, while east-west motion affects R24b. Thus, a single control manipulates two pots independently of one another. If desired for reasons of economy, however, two separate potentiometers could be used for R24a and R24b. Jacks J1 and J2 send the mixer output signals to the appropriate high-impedance (1 Megohm) scope inputs.



This underside view of the chassis shows the positions of the panel switches and joystick control. As usual, this should only serve as an example of how you can go about building your own model. There are no critical component placements in Imagician.



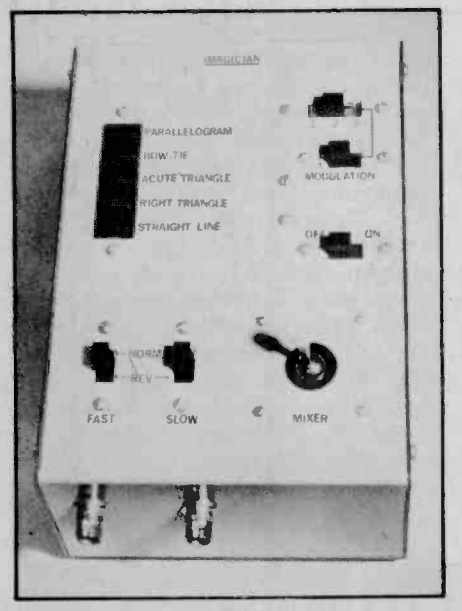
Here are a few examples of the designs which can be produced by mixing of the basic waveforms. What we can't show are the moving figures and the shifts which are possible. From left to right are: acute triangles, parallelograms, inverted acute triangles, and a double bow tie formed in a dot pattern instead of solid lines. With experimentation, you can come up with many more.

e/e IMAGICIAN

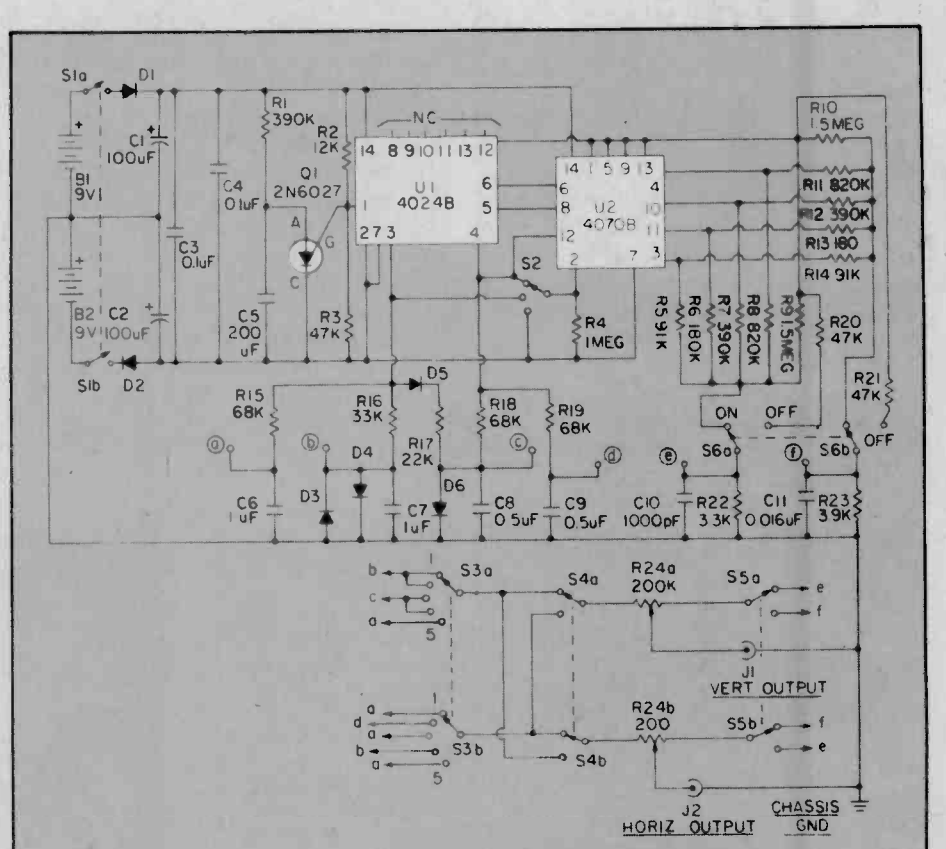
Construction. Printed-circuit construction of the Imagician is recommended, and complete details of the board can be found in Figures 4 and 5. For the sake of shielding, an aluminum cabinet should be used to house the circuit. Furthermore, the chassis should be connected to system ground at some point. Connections between the Imagician and your oscilloscope should be effected by means of relatively short, (18-inches or less) shielded cables.

As usual, solder joints should be made with a small, 25-watt iron and resin-core solder. Sockets are required for the two CMOS ICs, which should be installed only after all soldering is finished. Be certain that U1 and U2 both have the "B" suffix—devices with an "A" suffix will not work in this circuit.

Capacitor C5 must be a polystyrene (or mica) unit to ensure that your oscillator's frequency is close to that of the prototype. Be careful with those devices requiring proper orientation—electrolytic capacitors C1 and C2, Q1, the ICs, and the diodes. Although S3 is shown schematically as a rotary switch, it's obvious from the photos that a push-button unit was used in the prototype. You can use whatever is most convenient.



This front panel closeup shows the relative positions of all the controls, and the dry transfer lettering we utilized to achieve a more professional appearance for the prototype. We positioned the input and output coaxial jacks at the bottom front rather than at the top, so as to minimize the effects of body capacitance when one's hand is brought into proximity of the input and output cables. This feature also allows much more freedom of access to the controls as opposed to top mounting of the jacks.



PARTS LIST FOR IMAGICIAN

B1, B2—9-volt transistor battery
C1, C2—100-uF, 16-VDC electrolytic capacitor
C3, C4—0.1-uF ceramic disc capacitor, 100-VDC
C5—200-pf polystyrene capacitor 100-VDC
C6, C7—1.0-uF mylar capacitor, non-polarized
C8, C9—0.5-uF mylar capacitor 100-VDC
C10—1000-pf polystyrene capacitor 100-VDC
C11—0.016-uF mylar capacitor 100-VDC
D1 thru D6—1N914 diode
J1, J2—BNC jack
Q1—programmable unijunction transistor—2N6027, 2N6028 or HEP S9001. (Note: 2N6028 Available from SOLID STATE SALES, BOX 74A, Somerville, MA 02143.)
R1, R7, R12—390 K, ½-watt resistor, 5%
R2—12 K, ½-watt resistor, 5%
R3, R20, R21—47 K, ½-watt resistor, 5%
R4—1 Megohm, ½-watt resistor, 5%
R5, R14—91 K, ½-watt resistor, 5%
R6, R13—180 K, ½-watt resistor, 5%
R8, R11—820 K, ½-watt resistor, 5%
R9, R10—1.5 Megohm, ½-watt resistor, 5%
R15, R18, R19—68 K, ½-watt resistor, 5%
R16—33 K, ½-watt resistor, 5%
R17—22 K, ½-watt resistor, 5%
R22—3300-ohm, ½-watt resistor, 5%
R23—3900-ohm, ½-watt resistor, 5%
R24a, b — two, linear-taper 200K-ohm pots mounted in a joystick assembly (Herbach & Rademan #TM21K167; address is 401 E. Erie Ave., Philadelphia, PA 19134)
S1—DPST slide switch
S2—SP3T rotary or slide switch
S3—DP5T rotary or pushbutton switch
S4, S5, S6—DPDT slide switch
U1—4024B binary ripple counter
U2—4070B quad EXCLUSIVE-OR gate
Misc: aluminum cabinet, IC sockets.

Note: An etched and drilled printed circuit board for the Imagician is available from *LECTROGRAPHIX* P.O. Box 537, Auburn, NY 13021, for $5.90 postpaid to U.S. and Canadian residents. Foreign and overseas orders should include an additional $1.50 for postage and handling, and should remit the cost in the form of a money order or other drafts payable in U.S. currency. Allow 2 to 3 weeks for delivery. NY residents add 7% sales tax.

Current consumption is on the order of 1-milliampere, so batteries will last a long time. Be sure that both batteries are fresh—if they are not, lop-sided displays will result.

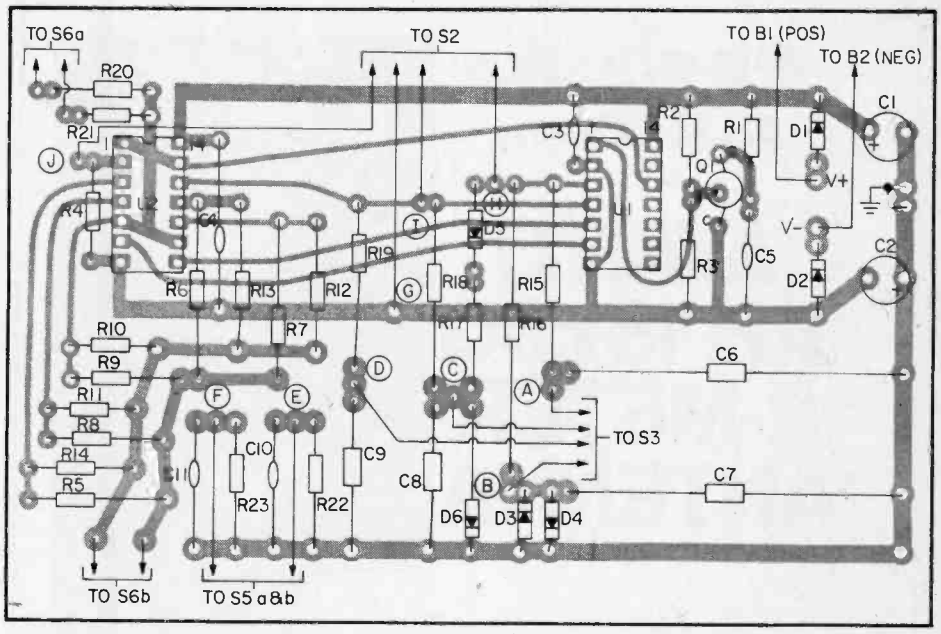
When wiring the joystick, you'll find that it comes equipped with four pots. Use any two pots on adjacent sides of the square support assembly. The potentiometers on opposite sides are ganged together and cannot be adjusted independently.

Checkout and Operation. After construction is complete, the circuit should be given a thorough workout to make sure that everything is in order. Begin by turning on your scope and allowing 15 minutes warm-up time. If the grati-

cule on your scope is removable, as on the older Heath and B&K models, it might be a good idea to take it off; the gridwork of lines serves no useful purpose in this application, but it may distract attention from the display. If the graticule cannot be removed, just turn the GRATICULE ILLUMINATION control completely off.

Both the X and Y inputs should have an impedance of about 1-Megohm. This almost universally is the case, but check your scope's specifications to be sure—especially if a very old model is being used. With the horizontal and vertical inputs grounded, center the dot on your screen. Signals from both channels of the Imagician have peak-to-peak amplitudes of 1.2-volts; set your vertical and horizontal gain controls so that a 1.2-volt signal would roughly span the screen.

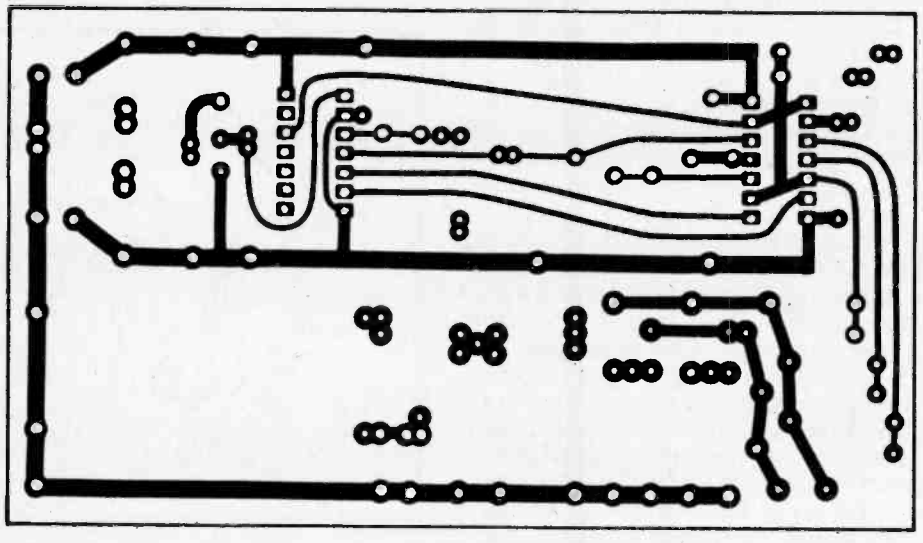
On the Imagician, turn MODULATION switch S6 to OFF, and set SLOW-FIGURE SELECTOR S3 to its PARALLELOGRAM position. Connect the outputs of the Imagician to the appropriate scope inputs with short shielded cables. After turning on the power with S1, you should see an image of some sort on your screen. The display will probably be faint, so rotate your scope's INTENSITY control to maximum. (However, when centering the dot as described above, you should use only *minimal* intensity to avoid burning the scope's screen.) Now, readjust the scope's vertical and horizontal gain controls so that the image just fills the screen. Finally, adjust the ASTIGMATISM and FOCUS controls, if your scope has them, for an image that is sharp and clear at all points on the screen.



This is the component location guide used with the printed circuit board. Just about all of the components used in Imagician, with the exception of the switches, jacks and R24, are mounted directly on the board. Use IC sockets and be sure to orient them properly. Take special note of the takeoff points that lead away to the switches.

S1—Power
S2—Modulation Selector
S3—Slow-Figure Selector:
1 = parallelogram
2 = bow tie
3 = acute triangle
4 = right triangle
5 = straight line
S4—Slow-Figure Reversing Switch
S5—Fast-Figure Reversing Switch
S6—Modulation ON/OFF
R24a, b—Mixer

This table shows which switches perform what functions and, for S3, what figures are generated in each switch position.



This is the etching guide for the PC board, shown in exact scale. If a project of this magnitude is beyond your abilities, you can obtain a ready-made circuit board from LECTROGRAPHIX. Their address and ordering information is shown beneath the parts list.

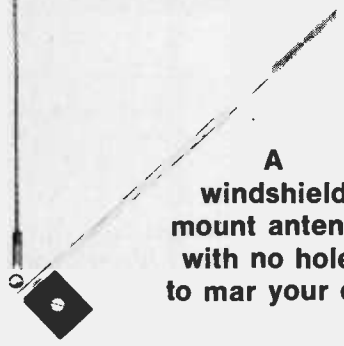
Bend your Imagician's joystick until you reach the position where a simple parallelogram fills the screen. Next, flip S3 to its four other positions so that the rest of the slow figures may be observed. After viewing them all, return to the parallelogram. Use the joystick now to create new images. Note that this is a "high-powered" control—a seemingly slight adjustment can lend a whole new character to the display. With practice, you'll learn to make images dance and change form at will through skillful manipulation of the stick.

Still using the parallelogram, adjust the joystick until the resultant display has a 3-dimensional character. Turn on the modulation via S6, and check out the various effects produced by MODULATION SELECTOR S2. Manipulate the joystick, too, in order to get different views.

Conclusion. By now, you should be somewhat familiar with the controls on the Imagician. You can proceed to create 3-D patterns based on the remaining four slow figures. Also, check out the effects of the reversing switches, S4 and S5; the effects of S5 are subtle and depend upon the setting of the joystick, so watch closely. If you wish, it's possible to capture some of your prize creations on film with the aid of a Polaroid scope camera, which you might be able to borrow from a school science department. With a little imagination in the photodeveloping process, you may become the first electronic Picasso! ■

e/e checks out the...

AVANTI AH 151.3G 2-METER ANTENNA



A windshield mount antenna with no holes to mar your car

CIRCLE 70 ON READER SERVICE COUPON

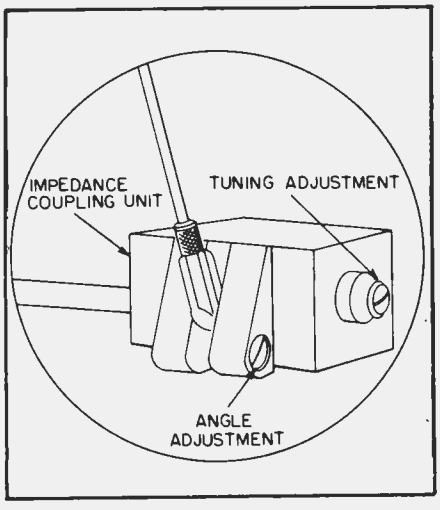
THERE ARE PROBABLY one or two of you out there with second thoughts about drilling antenna holes into the roof of your shiny new car. Yet any antenna engineer will tell you that whether you're an Amateur Radio Operator, CBer, or even have a mobile radiotelephone, the most effective mobile antenna must utilize the automobile body as a ground plane, and the best way to do that is to mount it smack in the middle of the roof. At least that *has been* the only optimum way until now. Now Avanti has come up with an antenna that offers rooftop performance without the roof-top—and, for that matter, without even a sheet-metal hole. The antenna comes in various models for Amateur or CB use. The one we've tested is the Model A 151.3G, designed to work on the two-meter Amateur Radio band.

Looks Are Deceiving. The first thing you notice about the A 151.3G is that it's small, especially compared to the average 5/8-wavelength, two-meter mobile whip. The unit comprises a short (33-inch) stainless steel whip, a very small metal swivel mount, a small capacity coupling box, a length of coax, and some adhesive. When installed, its not entirely invisible, but it's sure not very noticeable either. Mounting is simple. Following the positioning instructions, you use the epoxy adhesive to glue the swivel mount and capacity coupling box to each side of either the front windshield or the rear window of the car. That's right—you glue them right onto the glass! Of course there are no holes to drill (luckily) since the mounts on either side of the glass form a miniature coupling transformer which transfers the signal directly through the glass. Once the epoxy is set, simply route the coax on the least visible path in the interior of the car, connect to your rig, and you're on the air.

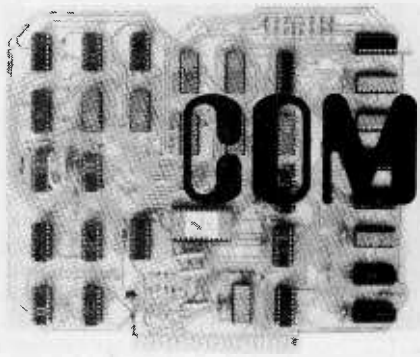
Does It Work? You Bet! The manufacturer claims performance equivalent to that of a roof-mounted 5/8-wavelength whip. That means a virtually omni-directional radiation pattern, and a gain of about 3-db over a reference dipole antenna. We were able to verify the gain figure, and the radiation pattern was so close to omni-directional that we wouldn't quibble a bit about it. On a real car, with all of the varying shapes, no antenna displays a completely circular radiation pattern. We were able easily to better the manufacturer's claim of a 1.5 to 1 standing wave ratio—ours was down to 1.2 to 1, which is a very respectible figure. In actual, on-the-air contacts, the AH 151.3G consistently outperformed the usual rear deck mounted 5/8-wavelength whip, and equalled the performance of our magnet mount 5/8-wavelength roof-top whip.

CB Version. The differences between the two-meter Amateur Radio antenna and the CB version center mainly on the design of the actual whip. As was said, the two-meter antenna uses a stainless steel whip, while the CB model employs a fibreglass-based helically wound stick. The helical winding provides a longer electrical length, which is necessary to resonate at the lower CB frequency.

In Conclusion. This revolutionary little antenna is certainly a satisfactory answer for anyone wanting high performance on the two-meter Amateur Radio Band, combined with an exceptionally unobtrusive appearance. With all kinds of high speed and rough road vibrations, the epoxy adhesive gave no signs of weakening, and of course since all the coax cabling and electrical contacts are on the inside of the car, there is no possibility of corrosion or weathering. Most interesting of all, this is a ½-wavelength antenna, so it's independent of any ground planes. You can use this antenna on a fiberglass body car, like the Corvette, where other whips won't work at all! And don't worry about the glue on your glass—the manufacturer gives easy instructions about removing it when necessary. A very interesting product; the price is $33.95. Avanti's address is: 340 Steward Ave., Addison, IL 60101. For more information circle number 70 on the Reader Service Coupon. ■



The coupling unit of the Avanti AH 151.3G includes a tuning adjustment, working it into the tuned circuit, can lower the SWR.



COMPUTER READOUT

by Tom Williams

Computer graphics—a picture is worth a thousand bytes

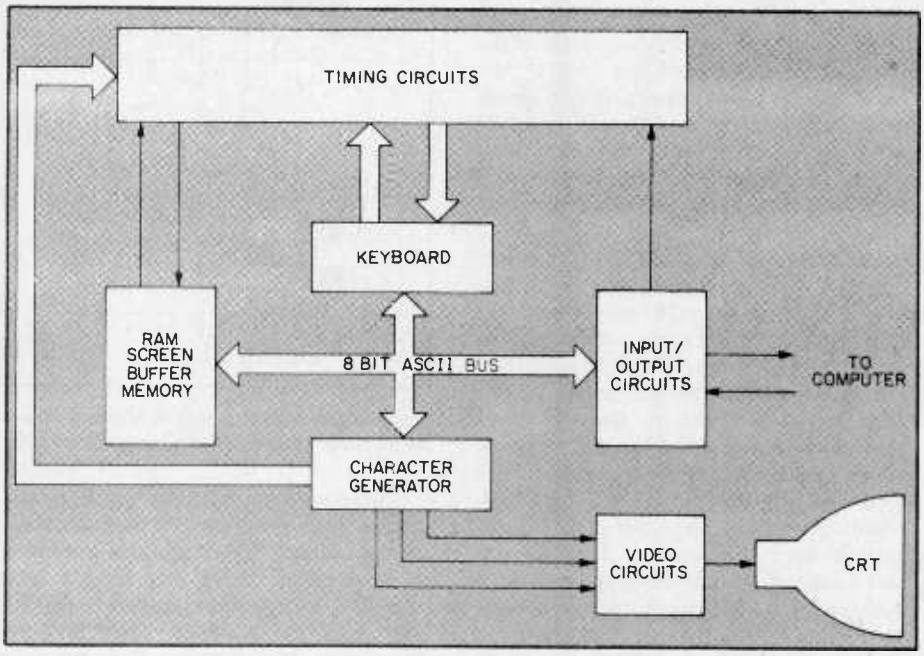
THE CRT TERMINAL is well known to computer enthusiasts as a fast and economical means of communicating with their machine. Mostly, the terminal accepts and displays information in the form of letters and numbers which are translated into ASCII (American Standard Code for Information Interchange) that the machine understands.

But the CRT screen, which is also used in television, is capable of displaying more than just alphanumeric information. Many home computers are supplied with a built-in graphics capability and many more have accessories available with which graphics can be added by the owner.

TV/CRT. How does the CRT terminal display information, and how can it be made to do all the spectacular graphics that are becoming increasingly common in today's home computers? The cathode ray tube in a computer terminal is no different than the one in a TV set, so theoretically it should be able to display the same sort of picture information as a TV. In fact, many CRT displays are converted television receivers, and some personal computers output a video signal which can be sent via an RF modulator directly into the home TV set.

An electron beam is swept back and forth across the screen from top to bottom in just the same way as in a TV. Many displays meant especially for computers increase the sweep frequencies to give the display a greater "bandwidth," enabling them to display more information, but the principles are exactly the same. This means a CRT terminal requires vertical and horizontal sweep circuits just like a television.

It also means that a video signal is required to deliver information to the display. The video signal is usually supplied by a circuit board inside the terminal, but in some cases it is generated by a video display board connected to the computer's bus.



This block diagram shows the specialized circuitry used for graphics generation. Note the screen buffer; this stores the contents of the screen while allowing local updates.

In either case, the similarity to television ends here. When we get to the point of modulating, superimposing information onto that video signal, we enter a totally digital world. In television, the strength of the electron beam varies continuously as it sweeps across the screen giving black, white, and varying shades of grey. In color TV it's three electron beams for red, green, and blue. But in a computer display, that beam is either on or off: there are no shades of grey.

If we assume that our video circuits are exactly the same as a television set, we will have 525 scan lines per frame. What the computer does is supply information to turn the beam on and off at selected times so it will paint letters, numbers, or pictures on the screen. And that's really all there is to understanding computer graphics.

Screen Buffer. I'm kidding, of course, but in a sense it is true. The CRT displays information, and any information it does display must be in the computer's memory in binary form. The memory where alphanumeric and graphic information is stored is called the *screen buffer,* or sometimes the *graphics buffer.* A buffer is any distinct area of computer memory which is set aside for a specific purpose, in this case, the storage of display information. Most terminals today are at least partially "intelligent," which means they have a memory area for storing display information that is separate from the computer's main memory.

As it sweeps the electron beam across the screen, the terminal repeatedly looks at the information in the screen buffer to know what it is to display, when to turn the beam on and off. If the information in memory changes, the display on the screen will change the next time the terminal looks at that location.

In order to understand how all the stuff the computer has to display is organized, we have to think of the screen as a matrix with X and Y axes. If you are thinking of buying a terminal, this

will be an important concept to know. You will want to know how much information your terminal will be able to display at any one time.

For displaying text, 24 lines of 80 characters each is considered a good size. But terminals with 16 lines of 64 characters, 16 lines of 32 characters, and so on are also available with corresponding differences in price.

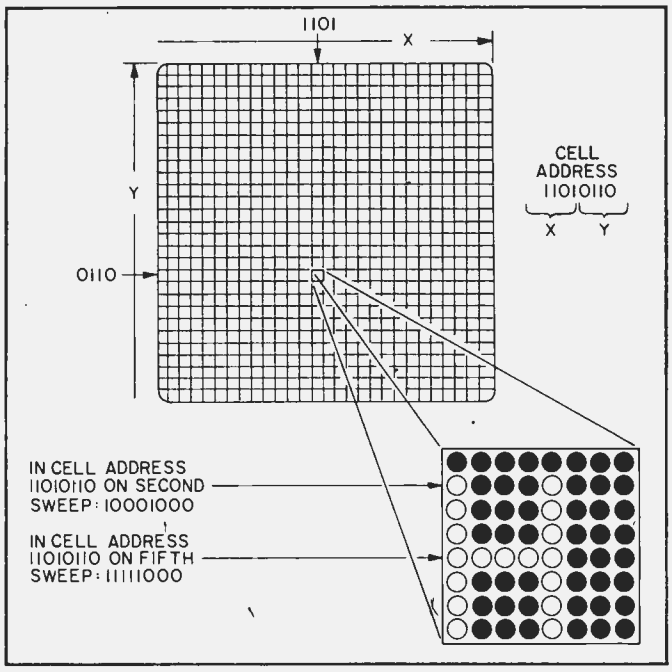
Resolution. When evaluating the graphics capability of a terminal, the matrix will refer to its *resolution*, that is, how many individual zones the screen is divided into which can be individually turned on and off. For home computers, a relatively high resolution screen may have something like 192 by 256, or 49,152 individual "cells" or "pixels," whereas a lower resolution display may have something like 48 by 100, or 4800 points. As we shall soon see, there doesn't have to be a location in memory for every point on the screen. One location can tell the terminal to turn on a certain area of the CRT display screen.

On a low-resolution display, the figures will look angular and blocky, while a high-resolution display will show finer detail and smoother curves. Of course, a high resolution display will require more memory for its screen buffer and will cost more than low resolution, and for color graphics, even more memory space is required.

The method mentioned above of turning on a certain area of dots on the screen, such an area is referred to as a *dot matrix*. By using dot matrix, a computer terminal can generate a given set of letter and number characters. It can also generate a set of graphics characters and thereby save on the amount of memory it needs for fairly high resolution graphics. Here's how it works:

Characters. Inside the terminal, there is a special IC called the *character generator*. Actually, it is a ROM, or Read Only Memory, which contains codes for a given set of characters that the terminal is able to display. A dot matrix with a character in it is shown in Figure 2 along with the binary codes that turn on the proper dots.

Obviously, the electron beam can only write one row of a character on each sweep. Now remember, each cell location corresponds to an address in the screen buffer. If that cell is 8 lines high, the terminal looks at its address for 8 sweeps of the electron beam before going on to the next row.



A video terminal screen is divided into thousands of cells which are in turn divided into dots. A cell is called a character matrix. The one illustrated here is an '8-by-8' matrix. The matrix, which is identified by an address, is scanned eight times, once for each row of dots.

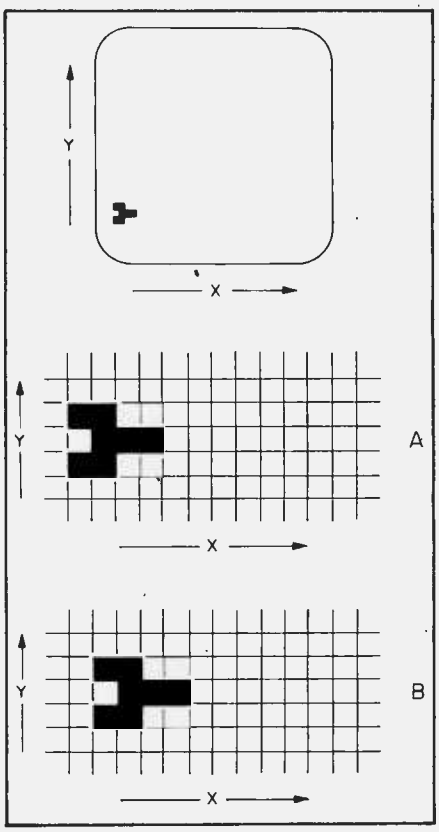
Our good old character generator sends out 8 different bytes for each cell on the screen. They go to the same location in memory because the beam has to go by 8 times to display one character. So to paint a single character, our terminal has looked at one memory location 8 times, but each time its contents were updated.

O.K. that's all very detailed and it will do simply to think of the CRT as being capable of showing distinct areas of dots that can be on or off in any combination. We can make letters and number with them as just described, we can put together a Russian alphabet if we want, or we can create odd shapes.

Some personal computers, such as the Commodore PET and the Exidy Sorcerer, have an additional graphics mode where by pressing a shift key, the user can type a set of graphics characters, which are really just different dot combinations in the CRT's cells.

Saves Memory. There is always a tradeoff for this method. We get better graphics than if we only had the option of turning whole cells on or off. We can combine the graphics characters to form lines and curves at dot resolution, but we're limited to the combinations defined on our system. On the other hand, we've saved valuable memory which would have been required to give us control over every single dot.

But enough of electronics. Let's proceed to some concepts of how we use and program computer graphics. We'll assume for our purposes that our graphics system is one that does not use the special graphics characters described above, but is one with moderate, say 100 by 200, resolution.



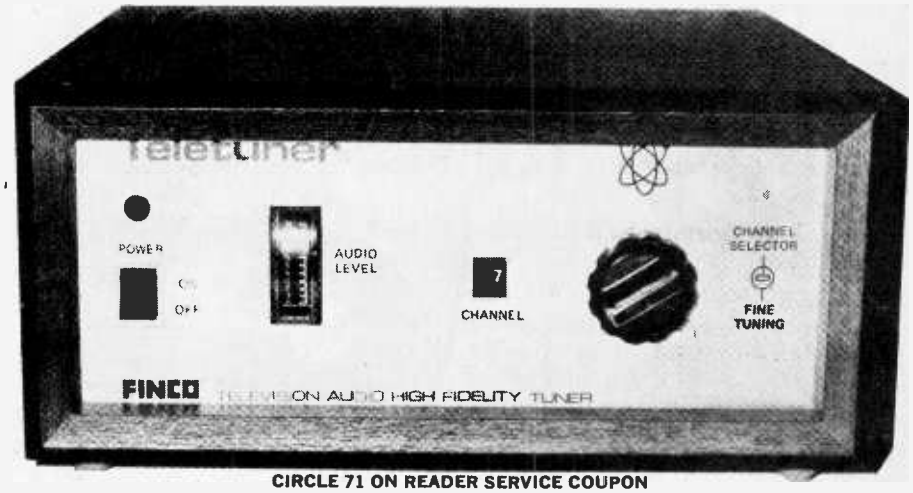
A computer moves a rocket across a screen by turning on the neighboring set of cells.

There are a number of graphics languages and programs written in them on the market. There are also a number of versions of BASIC which have been modified to include commands for the control of the graphics. They all have two things in common: they must be able to turn a given cell on the screen

(Continued on page 81)

e/e checks out the...
FINCO T-82 TELETUNER

Bring hi-fi sound to your TV



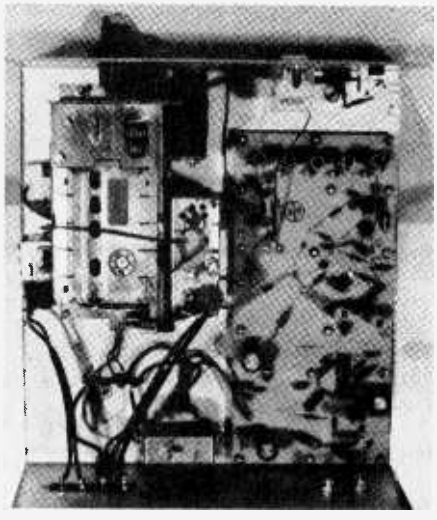
CIRCLE 71 ON READER SERVICE COUPON

THAT TINNY, SQUEAKY SOUND coming from your TV's speaker didn't start out that way. Back at the station, the audio technical standards are essentially the same as they are for FM broadcast stations: at least 50 to 15,000 Hz frequency response, low distortion, etc. When you *see* a rock group jamming, or a concert orchestra, or any performer, the associated sound is generally broadcast in hi-fi. It's your TV that's lousing it up; particularly the miniature speaker that's often the same type used in a pocket radio.

A Better Way. However, if you have a hi-fi system, it's easy to hear TV sound as broadcast: simply connect a Finco *Teletuner* to any amplifier "line" or "auxiliary" input and dial the *Teletuner* to the station being viewed. You'll see glorious color (or glorious black and white as the case may be) on the TV, and hear glorious, full-range TV sound from your hi-fi.

The Finco *Teletuner* is basically an all-channel TV tuner with an associated sound IF strip and detector. The detector's output is fed to two jacks labeled "left" and "right," meaning they connect to an amplifier's left and right auxiliary inputs. Actually, the jacks are internally strapped together, because TV sound is monaural.

Description. The *Teletuner* is housed in a wood cabinet approximately 9⅞-inches wide, by 4⅝-inches high, by 11-inches deep. The front panel has a power switch and LED power indicator, an "audio level" meter, a channel selector with a concentric fine tuning knob, and a channel indicator.



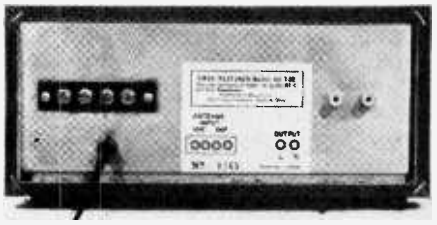
The T-82's tuning capacitor is at top left, and the receiver's PC board at lower right.

The rear apron has left and right output jacks, and VHF and UHF antenna input terminals.

Operation. To receive TV audio, you adjust the channel selector for the desired channel and then adjust the fine tuning for maximum meter indication. That's it. The sound heard through the hi-fi speakers will be the TV sound as transmitted by the station, with full fidelity and low distortion.

About the only thing different in tuning a station with the *Teletuner* is *interstation muting*. As you undoubtedly know, if you tune the TV to an unused channel, you get "snow" on the screen and ear-jarring noise from the speaker. When you tune the *Teletuner* to an unused channel, you don't hear a sound because the *Teletuner* output is muted unless a station is detected. As you flip from channel to channel, there's no sound until you come to a channel that's actually in use. This feature will help save your speakers from potentially damaging transients.

Hookup. Probably the easiest method for connecting the *Teletuner* to your antenna line is to utilize a two-set coupler at the television, with one output going to the set, and the other to the *Teletuner*. Buy a type with provisions for UHF as well as VHF. This will minimize the number of jumpers you'll need to have in back of the set, as well as minimize loss of signal strength through the unnecessary jumpers. If you live in a fringe area, and are using some form of antenna amplification, the above setup will also apply. Let the amplifier work for the *Teletuner* as well as the television.



The rear panel view of the T-82 shows the dual antenna input jacks and the two audio output RCA-type jacks. You'll need a coupler to feed the antenna to both the TV and the T-82. Circle 71 on reader service card.

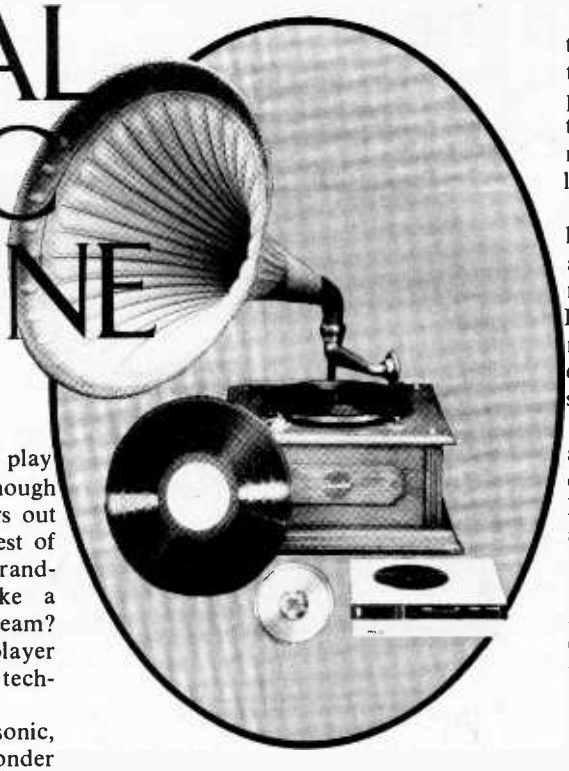
Alternatively, if you have a pair of "rabbit ears" stashed away in the attic gathering dust, you may be able to use them to feed the *Teletuner,* thereby foregoing the expense of a new coupler. Experiment before you buy a coupler or splitter, and you may be able to save some money.

For maximum enjoyment of hi-fi TV sound, we suggest you move one or two speakers near the TV so that you hear the sound from the same direction as you view the TV picture. It's sort of disconcerting to hear the sound from the rear or side when you're looking straight ahead.

The Finco T-82 *Teletuner* is priced at $189.95. For more information, contact: The Finney Company, 34 West Interstate St., Bedford, OH 44146, or simply circle number 71 on the reader service coupon which you will find on pages 47 and 48 of this issue. ■

DIGITAL MUSIC MACHINE

by Gordon Sell



The record player of the future... a sneak preview

Imagine a record album that will play non-stop for an hour, is small enough to fit in a coat pocket, never wears out or deteriorates with abuse, and, best of all, produces music that makes a brand-new direct-to-disc LP sound like a worn-out 78. An audiophile's dream? No, it's a new type of audio player that combines computer and laser technology to make beautiful music.

Now, don't throw your supersonic, direct-drive, semi-automatic, wonder turntable in the garbage just yet. It has still got quite a few years to go and it will probably never be completely replaced. The new system, called Compact Disc (CD) by its developers N.V. Philips of Holland, is not yet available to consumers.

Video-Disc Spin-off. The technology involved was first developed by Philips for the new TV video disc players which have been on the market since late last year. The picture and sound information are digitally recorded on the disc by billions of small pits and spaces that represent binary zeros and ones. The binary codes are then translated to an analog voltage level. When these tens of thousands of sequential voltage levels are detected every second you have a signal that can carry audio and video information. The video discs are about the size of a standard LP while the Compact Discs, for audio only, are only 4½ inches in diameter since they don't need to carry as much information.

The demonstration prototype of the Philips Compact Disc player looks rather plain for the forerunner of an audio revolution. The controls parallel those of a regular record player except for the search controls.

What is outstanding about the CD system is the sound quality. The dynamic range and signal-to-noise ratio are 85 dB as compared to 60 dB for a good quality LP, channel separation runs a phenominal 80 dB while an LP is hard pressed to get much more than 30 dB. With pre-emphasis the S/N ratio can go as high as 92 dB, according to Philips.

Surface noise is nonexistent since there is no physical contact between the disc and the player. The binary pits are read by a photodiode that detects the presence or absence of light reflected off the pits from a low-power laser diode.

Unlike regular players the pickup head starts near the center of the disc and moves out to the rim. The disc rotates at 500 RPM and slows to 215 RPM as the laser moves towards the rim. This keeps the binary data rate constant without having to change the spacing between pits.

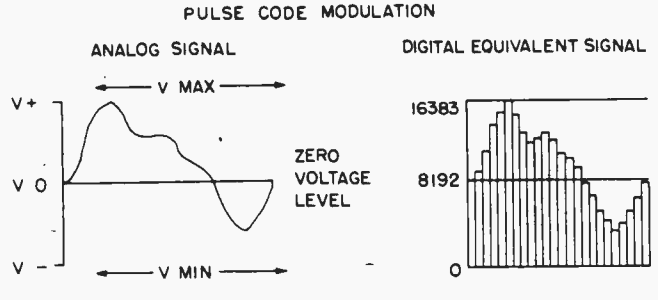
PCM. The technique used to store and play the musical information is called Pulse Code Modulation (PCM). Forty-four thousand, three hundred and thirty times each second the player reads a 14-bit binary number. This 14-bit number can represent any decimal number from zero to 16,383, and each of those numbers represents a positive or negative voltage level, with 8,192 being zero volts. It is this large number of possible signal levels that allows the large signal-to-noise ratio. Since the sampling rate is at a higher than audible frequency the transitions don't create any audible distortion.

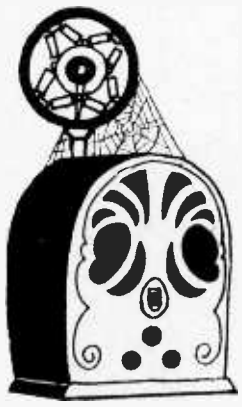
The player that was demonstrated was an early prototype with its circuits breadboarded. Eventually Philips plans to put most of the circuitry on a integrated circuit chip. The drive unit and laser heads were in the display chassis like the one in the photographs. It appears that all that is needed is to get the details finalized and into production.

Once this happens Philips will begin offering a long list of classical, popular, rock, western and jazz recordings. They are already one of the worlds largest producers of traditional record albums.

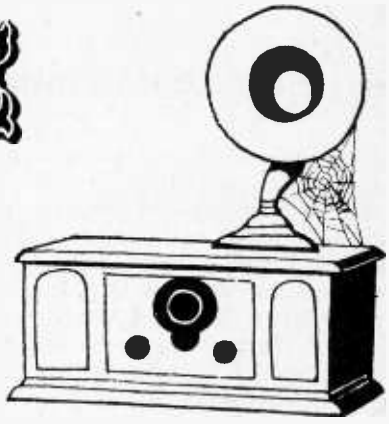
Keep on the lookout for these machines. Once they hit the market place, hi-fi will never be the same again. While the initial use will be for home systems, it's easy to see how CD players could be used in cars, or even portables since the pick-up head is under positive control, not dependent on gravity and sliding styli. ■

To understand PCM compare the chart on left with the one on the right. As the analog voltage level changes with time, level is sampled and converted into a binary number. Here, binary equivalent of 8192 represents a zero signal level.





ANTIQUE RADIO CORNER



Put those old-time speakers back in action

James A. Fred

Many of the letters I receive are from readers seeking information about how to replace the electro-dynamic speakers in their old 1928 to 1942 radios. An electro-dynamic speaker is one that has a field coil to supply a magnetic field whereas a PM (Permanent Magnet) speaker has a permanent magnet to supply the magnetic field. Since electro-dynamic speakers are no longer made there are two basic ways to get that old radio to play again.

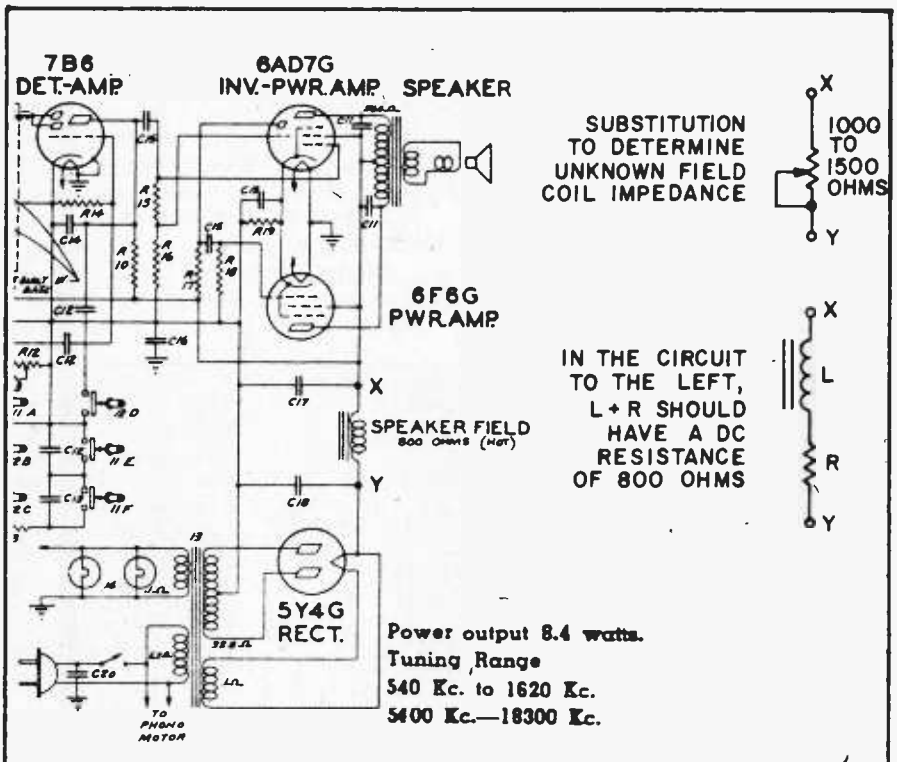
1. Have the original speaker repaired, i.e., replace the cone or have a new field coil installed.
2. Replace the old speaker with a new modern permanent magnet type.

To enable you to make an intelligent choice, I will present a detailed account on how to replace the original speaker. Having the original rebuilt means sending it off to a mail order repair shop. But first, let's review the loudspeaker, story and refresh your memory on the different types of speakers usually found with antique radios.

Early Speakers. First of all, there are two basic types of speakers found in radios made between 1920 and 1950. The first radios only used headphones, sometimes called earphones. Headphones limited the number of persons that could listen to a radio at one time. They were reasonably sensitive, worked with crystal radio sets, or with 1-tube battery-operated radios. The basic design of an earphone consisted of two coils of fine wire, with laminated cores inside the coils, surrounded by a horseshoe-shaped magnet. Suspended a few thousandths of an inch above the coils was a very thin, soft iron diaphgram that vibrated in unison with the received audio frequencies. The diaphgram produced sound waves.

Quite soon, someone mounted the earphone on a horn and the sound was then loud enough for the whole family to enjoy. Soon manufacturers were making larger headphone units to be mounted on larger horns. Distortion was a problem with the limited power handling ability. The next step was to build a cone type speaker, and the center-pin driven reproducer. The above types all fall into the category of Magnetic Speakers. Meanwhile out in California, Magnavox began to build a horn-type dynamic loud speaker. This speaker produced more power and better tone. Since the battery sets of that time used a 6-volt storage battery for the tube filaments, the speaker field also operated on 6-volts. The biggest drawback to the dynamic horn speaker was its size. The consumer was asking for radio that was self-contained with speaker and set all hidden inside a wooden cabinet. The dynamic cone speaker was introduced about the same time that AC operated radios became popular.

Dynamic Speakers. As you can see from the illustration, the dynamic speaker had a paper cone with a voice coil cemented to its center. The voice coil was a cylinder of paper from ½ to 2-inches in diameter, depending on the power handling design of the speaker. One or more layers of insulated mag-



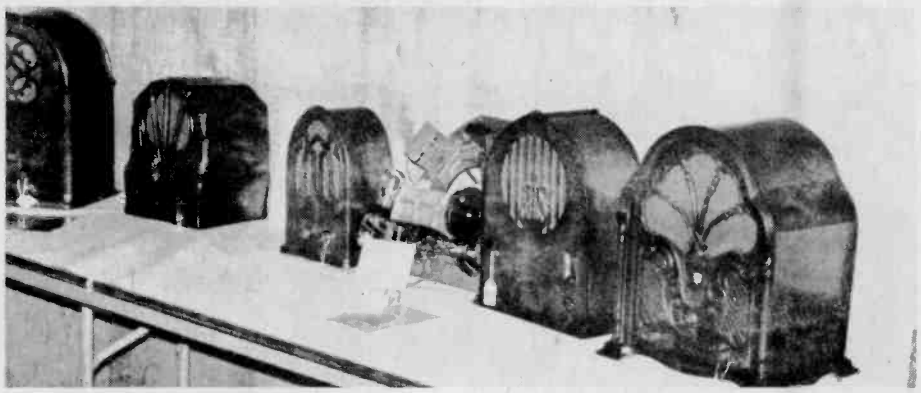
When you want to substitute a modern speaker for an old one that had a speaker field coil, you need to replace the lost impedance in the circuit. Unlike this schematic of a Zenith Model 7S681/2 many old-time schematics don't always include the value of the coil. Determine this with the top circuit and replace it with the bottom one.

net wire was wound on the voice coil and ultimately connected through an impedance matching transformer to the audio output stage of the radio receiver. Centered inside the voice coil was a soft iron pole piece which in turn was surrounded by a field coil wound with thousands of turns (except in car radio speakers) which when connected into the radio high-voltage circuit produced a magnetic force in the pole piece. This speaker was called an electro-dynamic speaker. The illustrations show the various types of speakers we discussed plus a typical radio circuit diagram using an electromagnetic dynamic speaker. It took a lot of electrical power to magnetize the pole piece, so when more efficient permanent magnets were developed most manufacturers began to make PM dynamic speakers.

The EM dynamic speakers used in auto radios, at this time, had only 4 or 6-ohms resistance, and it took 1 to 1.5 amperes to excite the field. If you remember the automobiles that had 6-volt ignition systems you will also remember that they were never too good in winter.

When the PM speaker was introduced, auto radio manufacturers were the first to use them. Later they were used in portables and house radios. Alnico V was the magnet used most successfully in speakers. Generally speaking, a larger magnet will permit the speaker to handle more power. Thus a small 4-inch speaker may have a half-ounce magnet while an 18-inch speaker may have a 2- to 3-pound magnet. Replacing a PM speaker is no problem since replacements are readily available at all radio parts stores.

Replacing an EM or field coil speaker



When you repair old speakers try to use as authentic a grill cloth as is possible. Note the fine restoration work on these cathedral radios displayed at an Illinois exhibition.

is another problem. To start with, the field coil had a certain amount of inductance and therefore it acted as a filter choke in the "B" power supply circuit. The resistance of the field coil was also the resistance that determined the "B" supply voltage supplied to the tubes in the radio. So when replacing an EM speaker with a PM we have a couple of important factors to consider. The first factor is physical size. Whenever possible, always use the largest PM speaker that will fit the allotted space. The larger speaker will reproduce bass notes more efficiently than a small speaker. If you use a smaller than original size speaker, you will have to make an adapter board with the proper size hole for your new speaker and make it large enough to cover the old hole. Without going into acoustic theory, I would advise you to never leave an opening around the speaker cone. To produce the same amplitude and frequency tone range as the radio did when new, you should try to return the set to its original baffle condition.

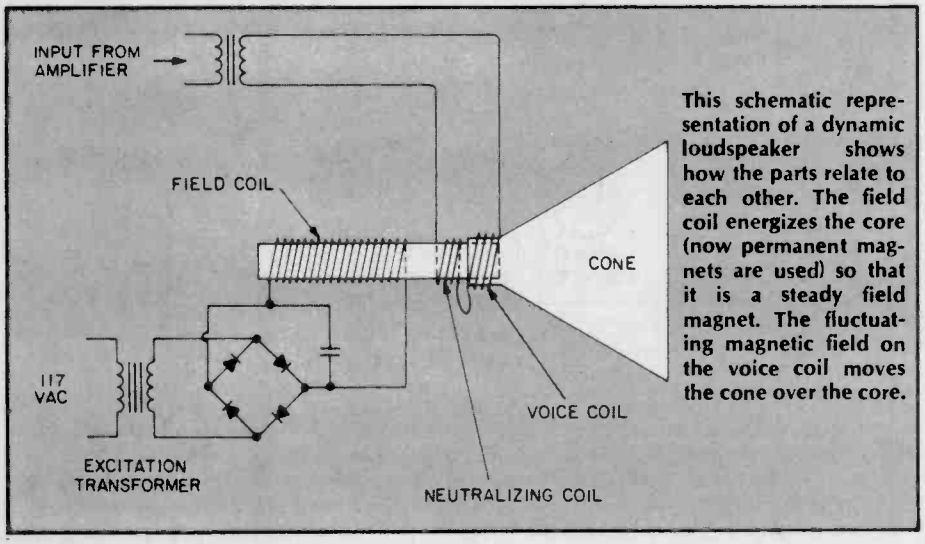
Choke. The second factor is to introduce some inductance into the power supply circuit in place of that lost by removing the speaker field winding. If you are replacing the speaker in a console radio, you may have room to leave the field coil connected and place the coil in an out of the way spot. Mount the new speaker in the proper place and use the old output transformer with the new speaker. If there isn't room, as in a table model radio, then you can use a small inductor and resistor to get the correct impedance.

The rectifier tube changes the 60 cycle AC voltage into 120 cycle pulsating DC. The filter capacitors and inductance (speaker field or choke coil) work together to smooth out the pulsations so the net result is hum-free DC. Since the inductance of a speaker field coil varies according to the number of turns of wire in the winding it is difficult to place a value on every speaker field. I have found that a 1.5 to 2 Henry choke will usually suffice. If you salvage parts from old TV sets, you will find a filter choke that will work fine. The choke should be capable of carrying 150 to 200 milliamperes of current.

Since the choke will usually have less resistance than the field did, you must add resistance in series with the choke coil. The total resistance of the choke and resistor in series must equal the speaker field resistance. If this isn't done all the "B" voltages will be too high. Higher than original "B" voltages can lead to blown out capacitors, overloaded resistors, and tubes being operated beyond their ratings. For example, if the speaker field measures 750-ohms and your choke coil measures 150-ohms, you will need a 500-ohm resistor in series with the choke coil. Use a 25-watt, 500-ohm wire-wound power resistor. If the resistance value had turned out to be a non-standard value you could have used an adjustable, wire-wound resistor.

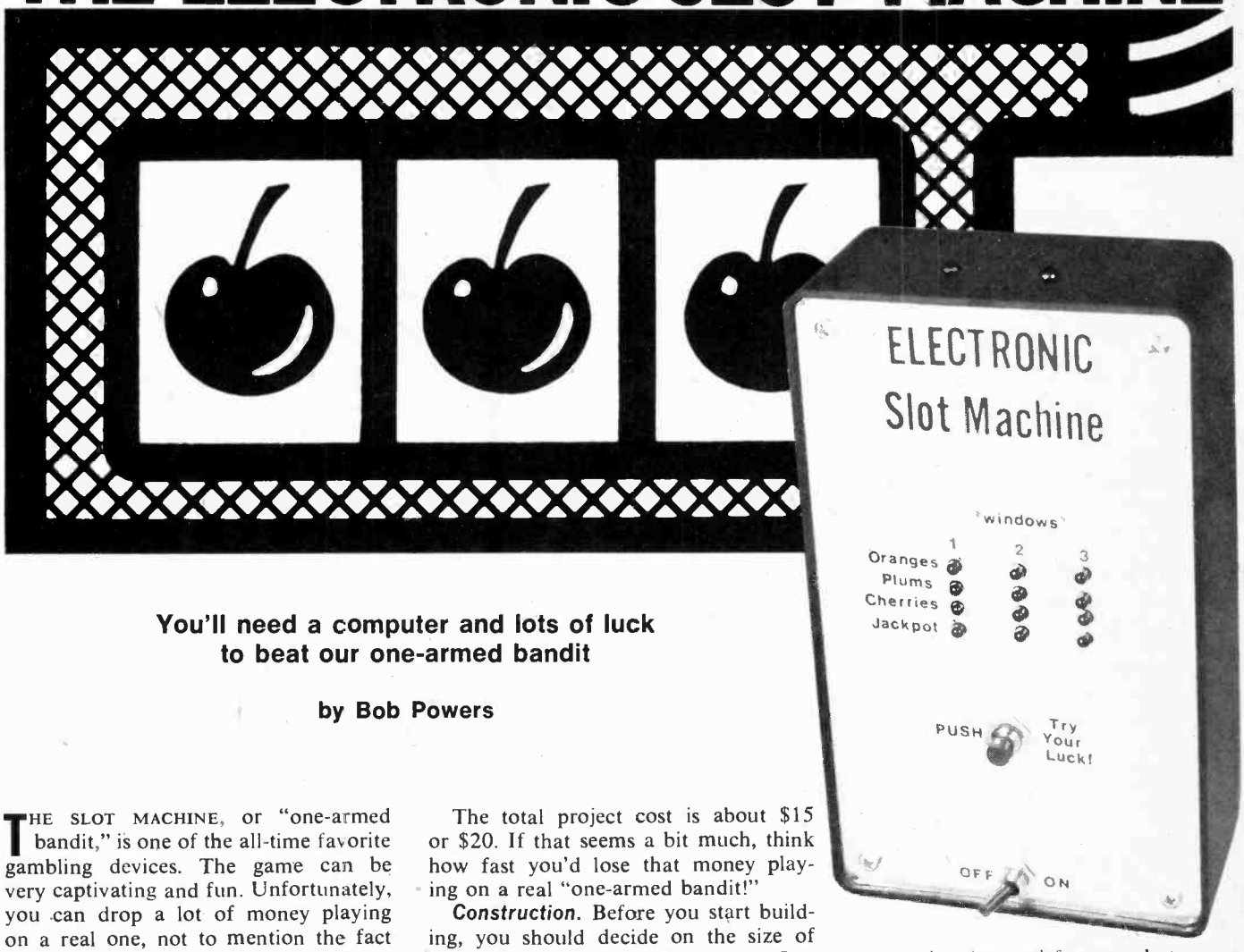
If, after you replace the EM speaker in the manner we just described, the hum level in the speaker is higher

(Continued on page 79)



This schematic representation of a dynamic loudspeaker shows how the parts relate to each other. The field coil energizes the core (now permanent magnets are used) so that it is a steady field magnet. The fluctuating magnetic field on the voice coil moves the cone over the core.

THE ELECTRONIC SLOT MACHINE



You'll need a computer and lots of luck to beat our one-armed bandit

by Bob Powers

THE SLOT MACHINE, or "one-armed bandit," is one of the all-time favorite gambling devices. The game can be very captivating and fun. Unfortunately, you can drop a lot of money playing on a real one, not to mention the fact that you have to go to either Las Vegas or Atlantic City to play one. You don't have to lose your shirt to have fun playing our Electronic Slot Machine.

The unit performs virtually like the real thing. Three rows of LEDs simulate the 3 windows of a real slot machine. When you push the button(S2), each of the 3 rows flash the LEDs in a cascading manner that simulates a rolling wheel. After a couple of seconds, the first row "window" will stop rolling and only one "fruit" will remain lit. In the same manner, "window" 2 will stop rolling and only one "fruit" will remain lit. Another second later, row 3 will stop.

Should you happen to have three LED "fruits" lit horizontally in a row, you're a winner! If you're lucky enough to land 3 LEDs in the "jackpot" row, then you've won a 4-to-1 payoff! Hint: It's harder than you think, because naturally, the odds are with the house. However, that's what makes this game so fascinating and worthwhile to build.

The total project cost is about $15 or $20. If that seems a bit much, think how fast you'd lose that money playing on a real "one-armed bandit!"

Construction. Before you start building, you should decide on the size of the enclosure that you wish to use. This is largely determined by the battery pack, as 4 "C" batteries are used, and they take up a bit of room. You don't necessarily have to mount the batteries in the project box itself, but it's nice to have one self-contained unit. The prototype is housed in a cabinet with dimensions of 3¾-inches wide, by 6¼-inches high, by 2-inches deep.

Use the low-power Schottky ICs as recommended in the parts list. Don't worry, these Schottky ICs are as easy to get as standard TTL types.

The project can be built on a piece of perfboard as shown in the photograph. P.C. board construction is rather impractical, because of the amount of connections between the ICs.

Notice that IC sockets are used on all ICs. This makes for easy replacement and really makes wiring up the project a lot easier. Using wirewrap IC sockets and a wirewrapping technique, you can wire up the sockets in no time. Point-to-point wiring with solder is also satisfactory, but more time-consuming.

IC sockets, cut in half, were used for mounting the LEDs to the circuit board. While this is not necessary, it *does* make the LEDs easier to mount, especially if you want to have a faceplate that fits flush over the LEDs, as shown in the photo of the prototype. Switches S1 and S2 can be mounted right on the board to eliminate unnecessary stray wires in the cabinet.

Install the ICs in the sockets only after all of your wiring is completed. Make sure that the pin orientation is correct. Observe polarity on the tantalum capacitors. Even though they're less than 1-μF, they are polarized units, and care should be taken with them. When mounting the LEDs, make sure that you get their polarity (anode and cathode) correct as well.

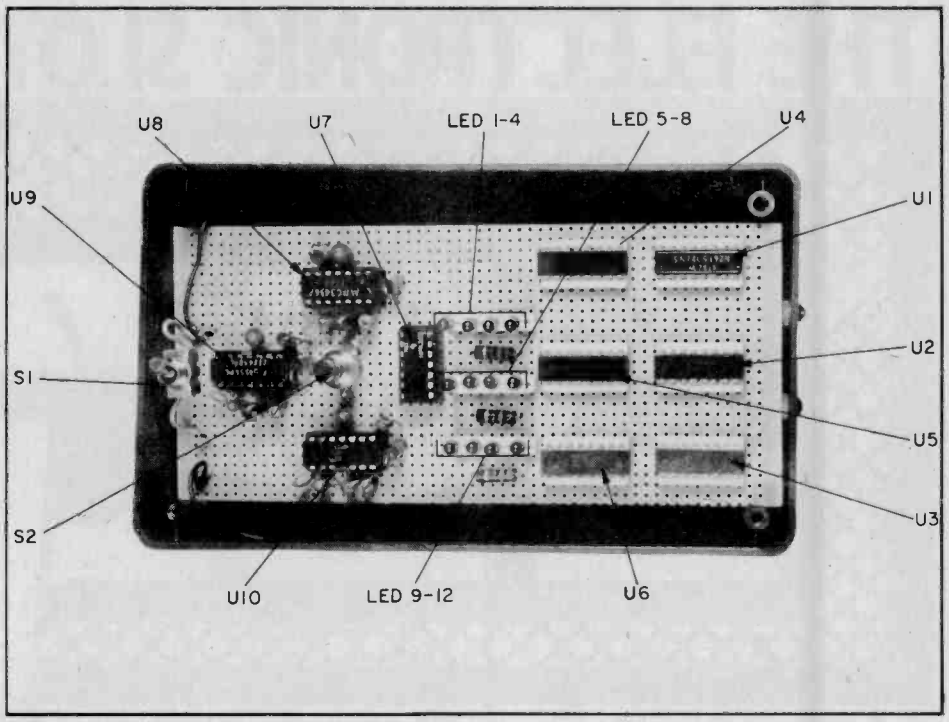
Double check all of your wiring carefully. Everything look OK? Then let's try it out!

Testing and Operation. Connect the

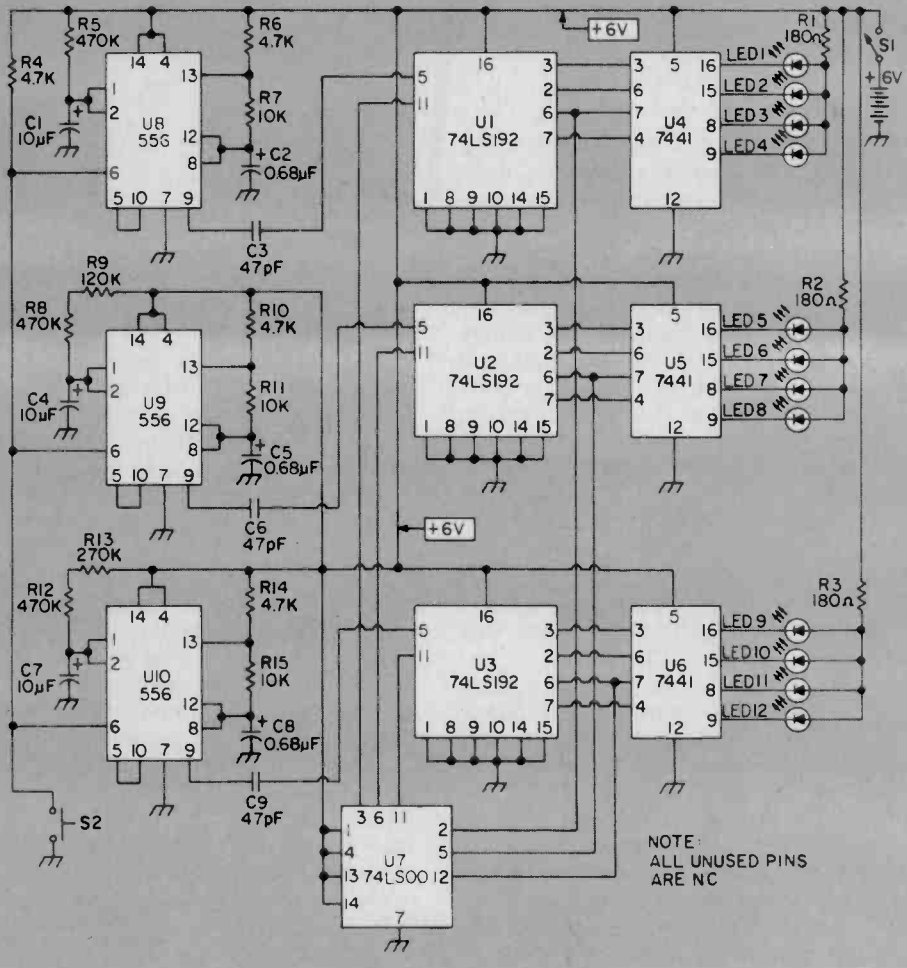
batteries, and turn the unit on by throwing switch S1. All 3 rows of LEDs should "roll" sequentially. If they don't, push switch S2. If the LEDs still don't roll, then turn the unit off and check for a wiring error. If the unit is performing correctly, all 3 rows of LEDs will "roll," and then they will stop in order, 1-2-3.

Troubleshooting. If you're sure your wiring is right, but one of the rows still won't flash correctly check the corresponding chip of the non-working row with one of a working row. (U1 controls row 1, U2 controls row 2, etc.). This switching around can reveal if the trouble is in your wiring or in the chip itself. If the display flashes erratically, fresh batteries are required.

Conclusion. Whether you use our Electronic Slot Machine for fun or profit, we're sure you'll agree that for the value returned, the relatively small amount of time and money invested is well worth it. ■



We cut some surplus DIP sockets in half to hold the rows of LEDs. If you don't care to ruin your sockets, wire the LEDs directly to the perfboard, using tie points to raise the LEDs up off the surface of the board so that they can protrude through the faceplate.



PARTS LIST FOR ELECTRONIC SLOT MACHINE

C1, C4, C7—10-uF tantalum capacitor, 16-VDC
C2, C5, C8—0.68-uF tantalum capacitor, 16-VDC
C3, C6, C9—47-pF ceramic disc capacitor, 100-VDC
LED 1 to 12—LED rated 20mA @ 1.75-VDC
R1, R2, R3—180-ohm, ¼-watt resistor, 5%
R4, R6, R10, R14—4,700-ohm, ¼-watt resistor, 5%
R5, R8, R12—470,000-ohm, ¼-watt resistor, 5%
R7, R11, R15—10,000-ohm, ¼-watt resistor, 5%
R9—120,000-ohm, ¼-watt resistor, 5%
R13—270,000-ohm, ¼-watt resistor, 5%
S1—miniature SPST toggle switch
S2—miniature SPST momentary-contact push-button switch
U1, U2, U3—74LS192 decade counter
U4, U5, U6—7441 decimal decoder/LED driver
U7—74LS00 2-input, quad NAND gate
U8, U9, U10—556 timer
Misc.—4, "C" batteries, perfboard, cabinet, IC sockets, solder, hookup wire, battery holder, etc.

A drilled and labeled printed circuit board for this project is available for $5.50, postage included, from Niccum Electronics, Box 271B, Stroud, OK 74079. Please allow 3-4 weeks for delivery.

e/e checks out the...

Yaesu FT 101 ZD SSB Transceiver

A compromise rig that doesn't compromise value or performance

CIRCLE 81
DN READER SERVICE
COUPON

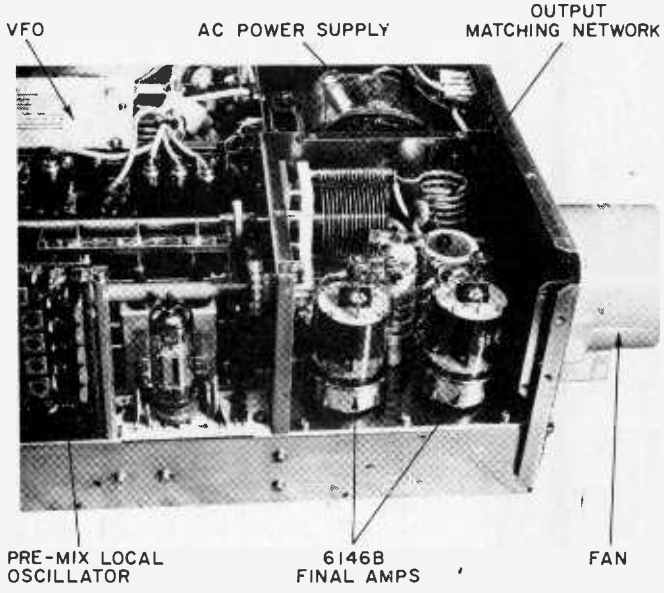
BUYING A HIGH-PERFORMANCE all-band Amateur transceiver is a very personal thing. The unit bought is a reflection of the personality of that of the radio operator. Some modern transceivers are rather stodgy. Others are quite flashy. But perhaps the best all-around compromise that gives the most feature-per-dollar, is the Yaesu FT 101 ZD. This unit is a precision-engineered, high performance, high frequency transceiver of advanced design, providing all-band coverage from 160 to 10 meters, with a power input of 180 watts DC—all in a fourteen by six by twelve-inch, thirty-three pound package. Before going into specifics about how Yaesu has achieved its design goals, let's outline some general transceiver qualities that are desirable.

What You Need. There are certain design criteria that must be built into a transceiver for it to be acceptable for Amateur service. First, it must have "rock" stable VFO control. Second, it must provide extremely accurate frequency readout. Third, it should be reasonably portable, efficient, and capable of being supplied by both 13.8-volt DC and 120/240-volt AC power sources. Fourth, it should match a fairly wide range of antenna loads and be capable of withstanding large voltage standing wave ratios (VSWR) for appreciable periods of time. Fifth, it should have a power output capable of driving a full 2 KW PEP linear amplifier. Last, it should be dependable, easy to service, and be constructed of components that are readily available. Any transceiver that meets all these criteria is truly a remarkable piece of equipment. The Yeasu FT 101 ZD is such a radio.

Yaesu has decided to remain with vacuum tube final amplifiers in spite of the modern trend toward broadband, all transistorized, high power transceivers. This decision was based upon the simple fact that tubes are "forgiving," whereas transistors have a memory. A tube-type final amplifier will tolerate long periods at high VSWR, detuning, power overload, and general abuse that the transistor will not stand. Furthermore, if the tubes have to be replaced, watt for watt, an equivalent set of high power tube finals is approximately one-fourth to one-fifth the cost of transistor equivalents, and replacement can be accomplished without ripping the whole final apart.

In designing the new FT 101 ZD series, the Yaesu engineers have moved from reliance on television sweep tubes and changed to commercially-available industrial-type components. Specifically, the 6146 B presently used in the final amplifier section is known for its dependability, reliability, lower output capacitance on 10 meters, and ability to take punishment.

Specifications. Now let's go to specifics. The Yaesu FT 101 ZD receiver is outstanding. We found the sensitivity to be better than the stated 0.25 microvolts for 10 dB signal to noise ratio. The main tuning dial was conveniently located, and had no backlash. The digital read-out was bright and with easy to read adjustable dimming, and matched the frequencies of our external frequency counter. The preselector con-



This closeup photo of the business end of the Yaesu FT 101ZD shows the two rugged 6146B final amplifiers nestled next to their pi-network at the right rear of the rig. In this photo, we've already installed the optional cooling fan through the rear chassis wall. We consider the fan a "must" option to protect the finals from overheating. The integral AC power supply is seen in the top right.

trol was easy to use, and the RF/AF gain controls were smooth in operation. A 10 and 20 dB input attenuator is available to prevent overloading. The automatic gain control had fast and slow settings with an excellent dynamic range, despite the high sensitivity of the receiver; at no time was the AGC action "loose." The image rejection varied from 55 dB on the high end of the 10-meter band, to better than 80 dB at the low end of 160-meters. IF rejection was found to vary from 65 to 85 dB, depending upon the band chosen.

The really exciting feature of the Yaesu FT 101 ZD receiver is its continuously variable IF bandwidth control. Variable IF passband is achieved by use of two, eight-pole crystal filters. One filter is fixed and presents a boundary for the bandwidth. The center frequency is then varied across the passband of the second filter using a mixing scheme that provides no change of pitch in the received signal. The result is a continuously variable bandwidth from 2½ kHz down to approximately 300 Hz. The net result of this is to provide a degree of versatility that is new to Amateur transceivers. The unit we tested did not have the 600 Hz optional CW filter. However, we found that with proper use of the variable selectivity control, such a filter was not really needed for CW operation. Independent receiver and transmitter incremental tuning provided an added touch of elegance. The audio quality of the receiver was adequate. Variable noise blanking was provided for elimination of pulse noises, and worked well.

No problems with stability were noted with the VFO when the optional cooling fan was installed. In this configuration, drift was less than 200 Hz from cold warm-up and after a thirty minute warm-up, was typically 50 Hz on our external frequency counter. Without the optional fan, the transceiver tended to drift upward during the transmitting phase and approached the upper limits of 300 Hz from cold start and 110 Hz after a thirty minute warm-up. We feel that the frequency stability of the VFO only approached "rock" stability with the optional fan, and therefore the FT 101 ZD should be purchased with this option. Although the unit tested was not equipped with the FV-901 DM synthesized scanning external VFO, provisions were made for this option on the chassis, along with two optional crystal-controlled channels. Transceiver incremental tuning is available as a standard feature. Since both receiver and transmitter frequencies can be made independent of each other, true offset operation can simply be obtained with the frequency counter reading the difference between receiver and transmit frequencies. A maximum 5 kHz separation can be obtained.

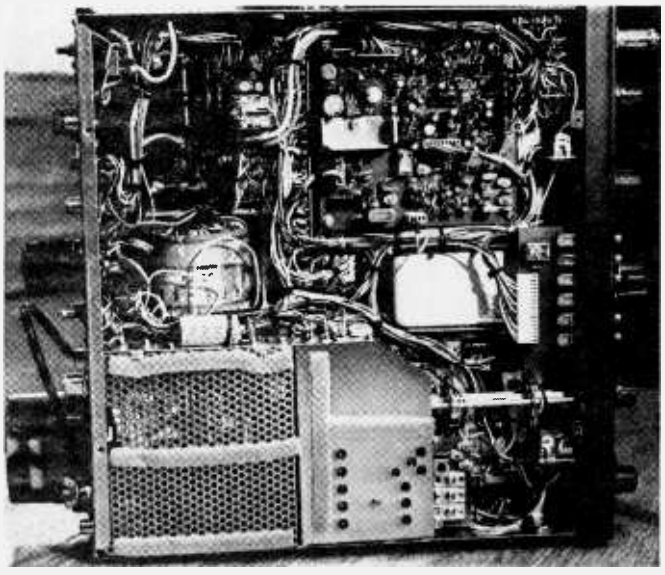
The transmitter section of the transceiver was a bit awkward to use. For those familiar with broadband transistor-type finals, the necessity of adjusting four controls on CW operation and SSB operation with the speech compressor, and three controls for simple SSB operation, is a bit of a chore. Not only must the preselector be peaked on each band and frequency, but also the plate and loading controls. The drive control must be adjusted properly for CW and speech processing SSB operation. We were easily able to exceed the 180-watt DC power output on all bands in a test setup, and on 80, 40, 20, 15, and 10 in actual operation. Carrier suppression was measured to be a minimum of 50 dB on any band, with unwanted sideband suppression and spurious radiation better than the 40 dB specifications listed in the manual. No difficulty was encountered using a 52-ohm unbalanced coaxial feeder to dipoles on 80, 40, 20, and 15, or a four-element 10-meter beam. The speech processor was easy to actuate and measurably improved the capabilities of the transceiver during marginal band conditions or heavy QRM. The VOX gain and delay controls were conveniently mounted and easily adjusted to compensate for various backgrounds and voice characteristics. No difficulties were encountered adjusting the delay and gain controls to achieve a natural type of transmission for most speech patterns. CW operation was effortless, and key up voltage was measured to be 7-volts, and key down current 1.5 mA, featuring a semi break-in type of operation. A hint to the wise—be sure your electronic keyer's output switch will handle these levels. The usual 800 Hz side-tone made keying less of a chore. A volume control for this side-tone oscillator was present in the rear of the chassis.

One meter was used for power output, signal strength, grid drive, and automatic loading control. Front panel controls include: a mode switch, IF band width, VFO select switches, preselector, band and clarifier controls, AF and RF gain controls, loading, plate tuning, main tuning knob, VOX gain end delay, final amplifier drive, microphone gain, noise blanker threshold, and compression level. Various function switches control the speech processor, attenuation, AGC speed, heater power, power on, and final output meter position. Jacks for the headphones and the mike connector are mounted in the front of the panel. The rear apron contains the various accessory plugs, output jacks, power socket, options for the external cooling fan, and the key jack.

The AC power consumption was 85 volt/amps in the receive mode with the final heaters on, and 330 volt/amps during transmitting. If DC operation is contemplated, the DC-to-DC converter requires 21-amps at 13.5-volts during transmission.

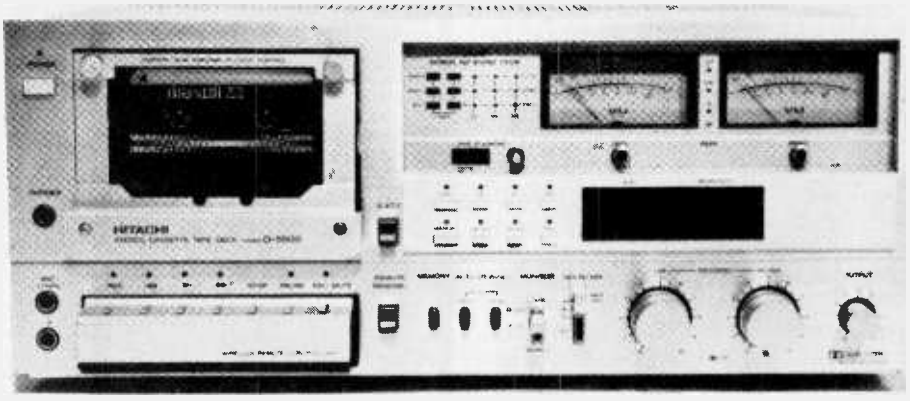
The Yaesu FT 101 ZD is built like a tank. All circuit boards are conveniently placed and require a minimum of effort to get at individual components. Fusing is adequate. Power supplies are rugged and the transformer did not hum. All components seemed to be of high quality and adequately spaced,

(Continued on page 82)



As is evident from this view of the Yaesu's underside, there is no wasted space on the chassis. All wiring harnesses are neatly arranged and tied off. Connections to the various PC boards are accomplished through removable plugs, an answer to a service technician's prayer. For more information on the FT 101ZD, circle number 81 on the reader service coupon.

Computerized Cassette Decks Are Here



CIRCLE 48 ON READER SERVICE COUPON

Computer controlled bias and equalization adjustments get maximum performance from any tape

by Herb Friedman

THE BIGGEST OBSTACLE to getting high fidelity performance from a cassette system is the tape-to-recorder match. Unless the characteristics of the two are matched in terms of bias, equalization, and Dolby level sensitivity, there are certain to be bumps, dips, and rolloff in the playback frequency response, not to forget "headroom" and signal-to-noise ratio problems.

Tape-to-machine matching is usually a hit or miss affair even when the manufacturer specifies a particular type of tape, for there are great variations between tapes of even the same general family type.

But now, thanks to the microprocessor—or microcomputer as it's more commonly called—you can pop a tape into a recorder and be almost certain you're going to get not only optimum results from the tape, but optimum performance in terms of high fidelity sound.

Magic Machine. The machine that performs this magic is the Hitachi Model D5500 Stereo Cassette Deck, which is basically a front-loading, two motor, three-head system (simultaneous record/playback), Dolby cassette recorder for *Normal* (ferric), *Chromebias*, and *Ferrichrome* tapes. It has two calibrated VU meters, a three-step peak record level indicator (0 +3, +7 dB), and microphone/line input mixing. And that's about all it has in common with other high fidelity/high performance cassette decks. The microprocessor—actually the machine has two microprocessors—takes it into a new dimension of high fidelity performance.

The D-5500's main computer system automatically determines the optimum bias, record equalization for both the mid and high frequencies, and sensitivity for virtually any tape through a built in test system. It works this way. The user loads the tape, "punches in" the tape type (sometimes it's done automatically), starts the machine in the record mode, and then punches a *Test* button. The recorder runs for a few seconds, during which the computer tests the tape and adjusts the recorder for optimum bias, equalization and sensitivity. Then the tape rewinds back to where the test started and the machine is ready for use.

A memory "remembers" the test results so that even if the power is turned off the adjustments hold until the recorder is again turned on for use. The non-volatile memory is provided through a battery back-up of two AA cells in a compartment on the rear of the deck. The memory is reprogrammed whenever a *Test* is run.

For the stereophile who uses more than one type of tape the adjustments can be programmed into three direct-access memories labeled *M1, M2, M3*. After a *Test* is run the results can be entered into any of the three direct memories. The user can then call up any of the memories by simply touching the appropriate memory button. For example, a user might store the adjustments for Maxell UD/XL in *M1*, those for Fuji-FX in *M2*, and those for TDK-SA in *M3*.

Beyond Help. When a tape's characteristics are outside the test limits the computer gets an information underflow, it defaults, and a front panel indicator LED blinks to warn the user the machine cannot find the proper adjustments. This never happens with standard brand tape; we have had the underflow occur with several tapes of the three-for-a-$1 variety.

The Hitachi computer is so accurate it creates a problem: that of finding a tape good enough for the machine. If the tape is not consistent the computer will "lock the adjustments" to a non-optimum value such as you might get as the "factory setting" on a non-computer recorder.

This is illustrated in Figure 1., which shows the frequency response attained

Each tape type can be manually selected, or the parameters for each tape type can be computer-optimized by pressing the Test button. The set of indicators directly aboue the Test and memory selectors (M1, M2, M3) indicate which tests are being run by the computer, also the tape type adjustments are stored in each of the memories

from two "top rated" brands of tape on three consecutive *Tests* followed by a 20-20kHz frequency sweep. The total tape length for three tests of each tape represents less than 1-minute of tape.

The tape illlustrated by the top set of traces shows considerable variation in sensitivity (about 2 dB at midband) and in high frequency response between 10kHz and 15kHz. The tape illustrated in the bottom set of traces really falls apart on the high end, with a difference of 5 dB at nominally 10kHz. Either of these two "top rated" tapes will confuse the computer.

Now look at the same tests illustrated in Figure 2. From top to bottom the tapes are Maxell UD/XL Type I, Maxell UD/XL Type II, TDK-AD, and TDK-SA. Note how closely the three *Test* passes resemble each other, illustrating the excellence of performance when the tape coating is consistent.

In Figure 3 we've simply slapped some well-known tapes in the Hitachi deck and let the computer do its own thing. Except for the bottom tape, a three-for-a-$1 type illustrating computer underflow and default, any would be considered good to excellent results. From top to bottom the tapes are Scotch Master I, Sony LN, Meriton, Memorex MrX$_2$, Fuji FX, and "el cheapo." There is no way any non-computer machine could handle this variety of tape brands and type and deliver totally acceptable results.

Matching and Dolby. In Figure 4 we show how the Hitachi computer handles both tape matching and Dolby sensitivity. The top trace is the response from TDK-AD tape using the machine's *Normal* (non-computerized) factory adjustment for "normal" (ferric) tapes. Note how the high frequency response of the low cost TDK-AD tape trails off because the machine is factory aligned in the *manual* mode for a tape with a "hotter" high end—such as the Maxell UD types. The second trace from the top is the same TDK-AD tape after a computer alignment through the *Test* mode—a real winner if you're looking to save on tape costs.

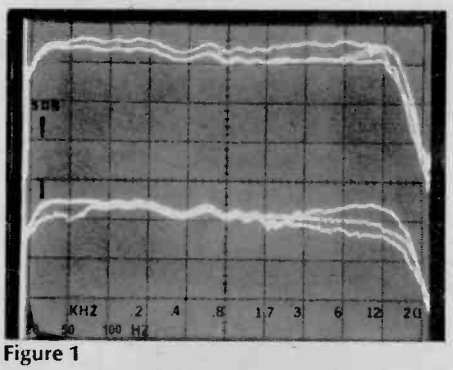


Figure 1

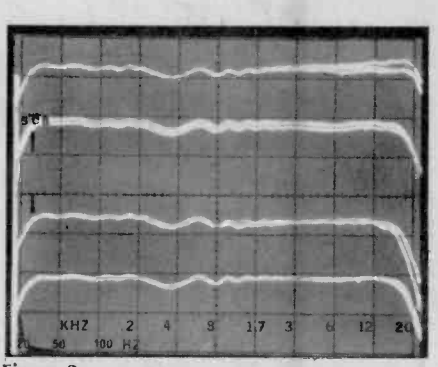


Figure 2

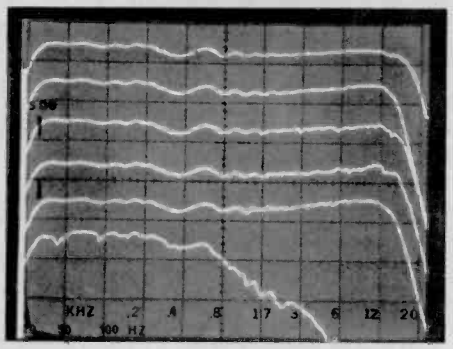


Figure 3

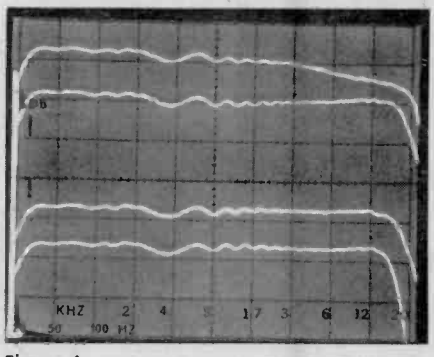


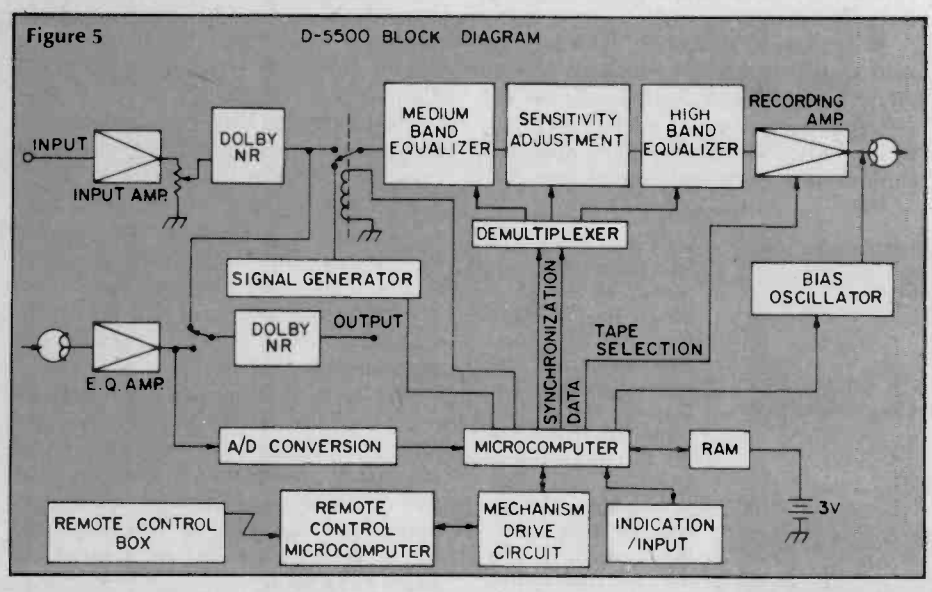
Figure 4

The third trace down in Figure 4 is TDK-SA chrome-bias tape *without Dolby* as computer aligned. The bottom trace is the same TDK-SA tape *with the Dolby turned on*. Note there is essentially no difference in response out to 14 000 Hz; the reduced response at 15kHz in the Dolby mode is typical of most Dolby systems. This is fantastic Dolby tracking by any standards. (With some other tapes the "dead accurate" Dolby tracking goes out to slightly beyond 15kHz, but we consider 15kHz the test limits for any high fidelity recorder.)

Remote Control. As you can see, the electrical performance of the Hitachi D-5500 is both astonishing and outstanding, but there's more. The second computer circuit is part of a full-feature wireless remote control. By pushing a button on the front panel a hand size "box" with all the tape transport operating controls pops out of the cabinet. This is a battery powered (four AA cells) infrared remote control. (The unit is powered by the recorder, not the batteries, when the control is inserted into the recorder.) Since the remote also provides remote record selection there must be protection against false tripping by "noise," such as the infrared output of a lamp. The protection is provided by a computer that "tests" the remote's signal for proper encoding. If the computer does not unscramble a correct code it prevents any changes in the operating mode.

(Continued on page 80)

Figure 5 D-5500 BLOCK DIAGRAM



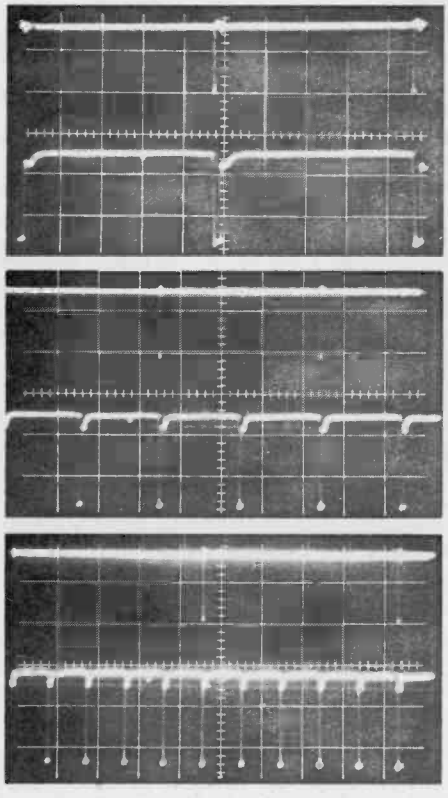
The microcomputer is the heart of the D-5500's systems. It automatically controls the test sequence and determines the correct bias level. The computer has two microprocessors.

HertzMarker

SWL's marker generator makes radio tuning a cinch

by Ed Noll W3FQJ

DID YOU EVER WISH you could tune your old (pre-digital display) shortwave or ham receiver like a TV set—just click, click, click from one channel to the next. Well, tuning a SW receiver may never be that easy but you can get almost the same effect by building and using HertzMarker, the calibrated marker generator. HertzMarker will sound off with a sharp tone each time you tune through a preset band spread on your tuning dial. If you set HertzMarker up for a 100-kHz marker you will, for example, hear a tone five times if you tune from 2000 to 2500 kHz.



These three oscilliscope photos show the clock signal (top trace) and the resulting marker signal (bottom trace) for 100 kHz, 50 kHz and 20 kHz outputs respectively.

Just nine components make up HertzMarker so you should be able to throw it together in next to no time. You can use a solderless breadboard, perfboard or even design your own printed circuit board. The completed unit is small enough to fit almost anywhere.

How it Works. The combination of timer and decade divider permits the construction of a simple and inexpensive marker generator. Divider chains and complex switching are avoided. Output pulses are of very short duration and have a high harmonic content. Thus strong and very discernible markers can be heard even at very high frequencies. A 555 timer and 74192 programmable decade divider are combined to generate these calibration marks. Separation between markers is programmed with a set of four switches connected to the binary input pins of the 74192. Important frequency spacings that can be obtained are 100, 25, 20, 12.5 and 10 kHz. Marker tones come through loud and clear up to 30 MHz. One need only position the calibrator near the receiver. Several turns of wire wrapped around the outside of the antenna lead-in wire and connected back to the calibrator output provides improved coupling of signal into the receiver.

Timer Oscillator. The 555 timer IC is crystal-controlled on 100-kHz. Its RC (R1 & C1) time constant is set near to this desired frequency of operation. However, the presence of the crystal stabilizes operation on the 100-kHz crystal frequency. For more precise adjustment of the 100-kHz frequency a small, optional, variable capacitor is connected across the crystal. Precise tuning can then be obtained by tuning the calibrator signal with WWV signal on 5, 10, 15, or 20 MHz.

A short-duration negative pulse is obtained from the pin 3 output of the 555 timer. This output is connected directly to the pin 4 input of the 74192 decade divider.

Calibrator output is taken from the borrow pin 13 of the divider. The actual output frequency depends upon the settings of the four ABCD switches. When a switch is closed it is set to logic *zero;* open, to logic *one*. In the first four columns of binary switching chart you will recognize the binary-coded numbers zero to fifteen. For example, what number does the code 0100 represent? It represents no eights, one four, no twos, no ones, or the number 4. Note that this is the number given in the N column. In a similar manner 1010 represents the number ten because it consists of one eight, no fours, one two and no ones.

The switches shown in the schematic can set up this code. As shown, switches D, C and B are set to logic 0 and switch A to logic 1. This represents the numeral 1. In the case of the decade divider it means that the input signal is divided by a factor of 1, and

HertzMarker Switch Positions

D8	C4	B2	A1	N	Frequency (kHz)
0	0	0	1	1	100
0	0	1	0	2	50
0	0	1	1	3	33.3
0	1	0	0	4	25
0	1	0	1	5	20
0	1	1	0	6	16.69
0	1	1	1	7	14.29
1	0	0	0	8	12.5
1	0	0	1	9	11.11
1	0	1	0	10	10
1	0	1	1	11	9.09
1	1	0	0	12	8.33
1	1	0	1	13	7.69
1	1	1	0	14	7.14
1	1	1	1	15	6.67

e/e HERTZMARKER

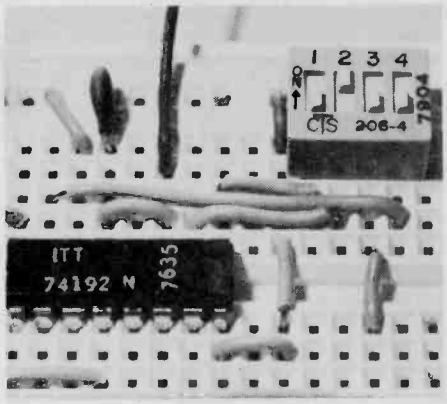
the output frequency and input frequency are the same. The output wave is also the same frequency as the crystal, namely, 100-kHz. If you wish to obtain a marker each 20 kHz it is necessary to divide the input frequency by a factor of 5. This is accomplished by setting the switches to the binary code for 5(0101).

The three dual-trace oscilloscope patterns show the 74192 input (bottom trace) and output (top trace) pulses for divisions of 1-to-1, 2-to-1, and 5-to-1. In the latter case you can observe that there is one output pulse for each five input pulses. The input is at 100 kHz in each photo.

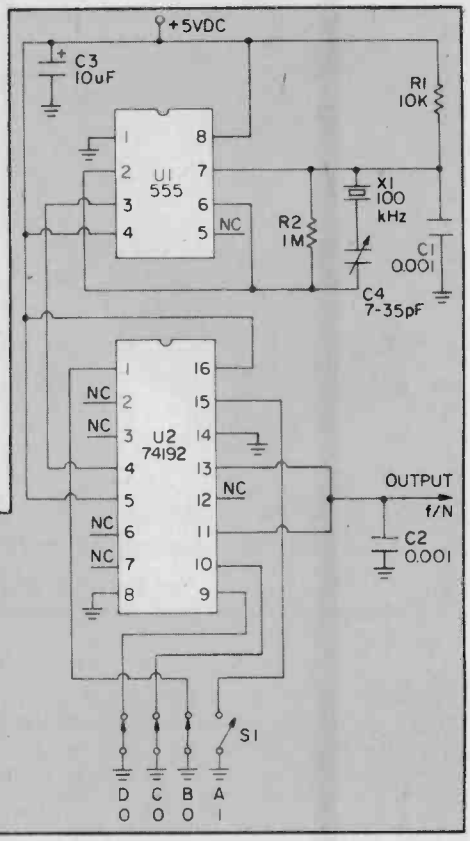
Construction. HertzMarker was assembled on a solderless breadboard although any method could be used. Dip switches are easily available and a four-switch unit (8-pin dip) was a convenient method of obtaining the required binary switching. After you check it out you can then make use of the type of permanent mount you prefer. After construction use an oscilloscope or multi-band receiver to check out performance. Start with a 100-kHz output and check on one of the WWV frequencies. Calibrate if desired.

Now tune over the frequency spectrum from low to high listening for the tone at each 100 kHz. Locate a quiet 100-kHz section of the spectrum and begin to program other frequency divisions. Note for the 0010 (2-to-1) division to 50-kHz that you can now find an intermediate marker between the two previous 100-kHz positions. Go to a 4-to-1 division and you will hear tones each 25-kHz over the 100-kHz section of the spectrum. Try various other programmable divisions as well to help pinpoint odd frequencies.

With a little bit of practice you'll soon be able to tune in SW stations with speed and accuracy you never thought possible. Just count out those marker signals and HertzMarker will help you find your way. ■



The heart of the circuit is the 74192 IC chip and the DIP switch that controls it.



PARTS LIST FOR HERTZMARKER

C1, C2—0.001-μF capacitors
C3—10-μF electrolytic capacitor 6-12V
C4—7-35-pF NPO trimmer capacitor (optional)
R1—10,000-ohm, ¼-watt resistor
R2—1 megohm, ¼-watt resistor
S1—four-section, SPST, DIP package switch
U1—555 timer
U2—74192 decade counter
X1—100-kHz crystal
Misc.—Solderless breadboard, wire jumpers, 5-VDC power supply or weak 6-VDC battery

THE SOURCE

Low-cost home computer network brings the world into your CRT

The first nationwide telecomputing network, called The Source, was recently inaugurated by the Telecomputing Corporation of America (TCA). This network makes a massive data base and program bank available to home computeristis at a low cost. The Source can be accessed by telephone in more than 200 U.S. cities at a cost of $2.75 per hour between the hours of 6:00 p.m. and 7:00 a.m. and any time on weekends and holidays.

The Source provides over 2,000 programs and data bases, ranging from old favorites such as Startrek and Adventure, to United Press International's entire daily file of world, regional and local news, sports and financial information as well as a major subset of the New York Times Information Bank. Airline schedules and the ability to make travel reservations and order tickets are also included. Real Estate can be bought and sold through the Source, and a large number of sophisticated business application packages, including payroll, accounts receivable and general ledger systems are also available. Users can run their biorhythms and horoscopes, take a full course on wine appreciation, prepare their income tax returns, or check Ticketron show reviews and schedules for most major cities. A nationwide restaurant guide will also be provided. Programming languages include FORTRAN, COBOL, Extended Basic, RPG and assembly language, as well as powerful

(Continued on page 80)

e/e BASIC COURSE IN ELECTRICITY & ELECTRONICS

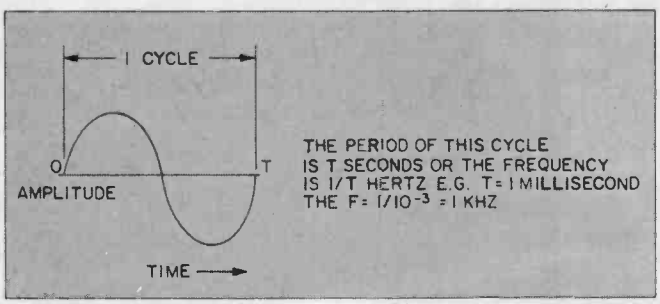
The Frequency Counter is a sophisticated test instrument with uses in virtually every electronics area, such as transmitter and receiver alignment, and audio and hi-fi equipment service. In this first of a series of test equipment articles, ELEMENTARY ELECTRONICS describes the origin, theory, and uses of the Frequency Counter.

THIRTY YEARS AGO FREQUENCY counters were large expensive devices reserved for colleges, the military service, and those repair facilities that had the funds to afford a counter. Most frequency measurements were done rather crudely with oscilloscopes using either Lissajous patterns or a calibrated time base sweep circuit. In any event exact frequency measurements were rarely available to the average experimenter. With the technological explosion promoted by the ever expanding consumer electronics market the need to accurately determine frequency has become apparent. Digital display of frequency or time which was once a rarity has now become commonplace.

HOW THEY WORK

The unit of frequency measurement is the Hertz. Frequency also implies time since the Hertz by definition is a cycle per second. Therefore, the period of a given frequency is defined as the reciprocal of that frequency. This can best be visualized by examining this diagram.

THE CYCLE



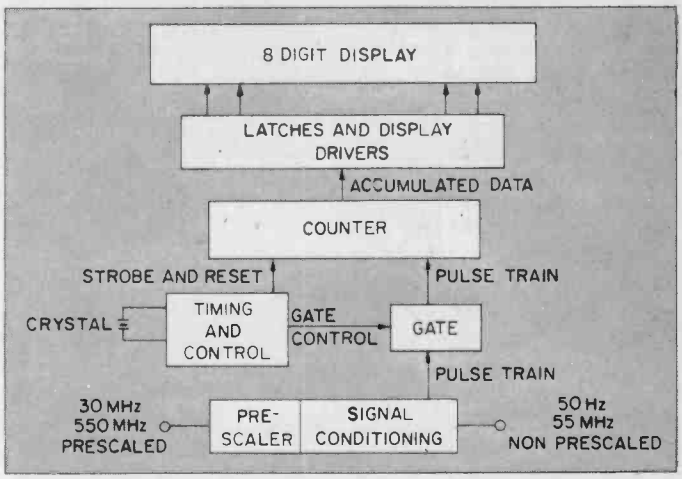
The simplest serial counter is one made up of two bistable devices known as "flip flops". This two bit serial counter has four distinct states. It is important to note that this device counts in the binary number system. Adding an additional flip flop will yield 2^3, or eight states, and adding N flip flops serially will yield 2^N states. Unfortunately our number system uses the base ten, not the base two. For example, the number ten in our decimal system would be 1010 in the binary or base two system. Any base ten number has an equivalent "binary coded decimal" (BCD) number.

GLOSSARY OF TERMS

BCD	Binary Coded Decimal
CMOS	Complementary Metal Oxide Semiconductor
DTL	Diode Transistor Logic
FET	Field Effect Transistor
FF	Flip Flop or Bistable Multivibrators
LED	Light Emitting Diodes
LSI	Large Scale Integration
RTL	Resistor-Transistor Logic
SSI	Small Scale Integration
TTL	Transistor-Transistor Logic

If a precise gate interval is used in conjunction with the counter just described, frequency could be determined from the number of cycles counted during the gate period. A gate period of one second would yield a frequency equal to the number of cycles counted during this gate period. Likewise, if the gate period was .1 second, then the frequency would be 10 times the number of counts. After counting the number of pulses or counts in a gate period, some method must be devised to display and store this information until the frequency is updated during the next counting period. The scheme then consists of a clock oscillator which generates the

COUNTER BUILDING BLOCKS



gate period, a decade counter, and latch and digit driver elements plus the actual digital display.

ACCURACY

The frequency counter's accuracy is a function of its time base stability (accuracy of the gate period), which is dependent on the quality of the quartz crystal. Most counters use either the readily-available color burst TV crystals (3.579545 megahertz) or other specially designed crystals in the 4 to 10 megahertz range. To achieve a 1 part per million accuracy in the count frequency requires that the crystal oscillator have no more than 1 part per million drift over the temperature range 20 to 40 degrees centigrade (ambient temperature). Stability is achieved by pre-aging this crystal.

In the past, discrete digital elements were required in the design of a frequency counter. These sub-units were formed of "small scale integration" (SSI) building blocks of individual "diode transistor logic" (DTL) or "transistor-transistor logic" (TTL) circuits. With the advent of "large scale integration" (LSI) circuitry, it is possible not only to include a decade counter and gate within a single chip but also to place the latch circuitry and "light emitting diode" (LED) segment drivers all in one module. A typical example of such an LSI chip is the 7208 manufactured by the Intersil Corp. The maximum signal frequency which a typical LSI decade counter chip can handle is between 6 and 7 megahertz. This device is not designed to handle sinusoidal inputs as are commonly encountered during servicing applications. Also, frequencies up to 600 megahertz are now in common use.

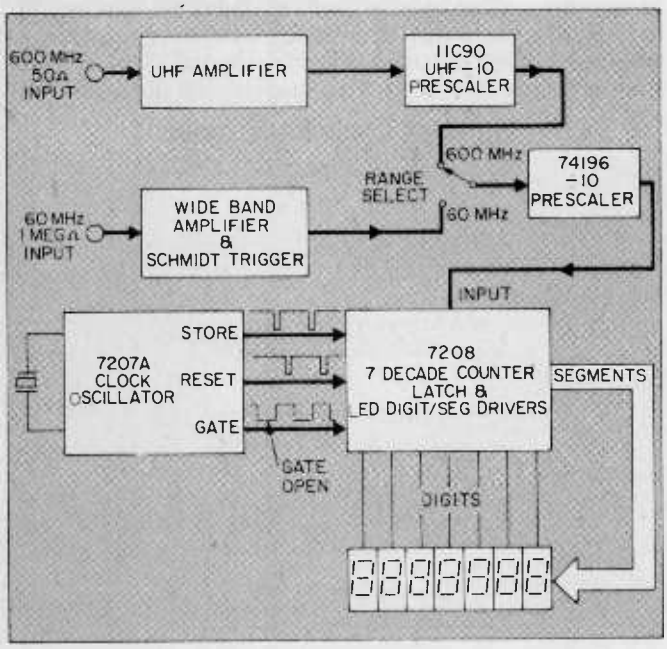
VERY HIGH FREQUENCIES

The usefulness of a given counter chip can be extended by prescalers. A prescaler is a BCD device which counts an input frequency and divides it or prescales it to a desired output frequency. For example, if a 60 megahertz signal is to be counted by a device whose maximum frequency is in the 6 megahertz range, then a divide-by-ten circuit is necessary for useful counts to appear. Prescalers usually are SSI devices which consist of a number of flip flops that divide the incoming frequency, "square it," and present a pulse for every tenth cycle of the original frequency. Extension of the frequency range to the 600 megahertz region can be obtained by coupling additional prescalers that are specifically designed to work at these frequencies. Useful input impedances and high sensitivities are obtained by placing amplifiers in front of the prescaler.

The input impedance of the wide-band mid-frequency amplifier is typically 1 megohm and obtained by bipolar "field effect transistors" (FET's). Amplification is then achieved by a broad band multi-stage receiver that commonly has a Schmidt trigger to "square up" the output.

The advantage of high input impedance in this frequency range is quite evident, since most harmonic oscillators will cease to operate or shift frequencies when loaded by a few thousand ohms. UHF prescalers have reasonable sensitivity without pre-amplification but again some means of impedance matching must be obtained. This is commonly done with a high frequency RF transistor and special UHF techniques to keep self inductance at a minimum and prevent possible attenuation. High input impedance in the UHF/VHF range is not desirable since the reactance of shunt capacitance is present in coaxial input cables, jacks, and various leads. Therefore, a nominal input impedance of 50 ohms is used for counting in the UHF/VHF range.

PRESCALER AMPLIFIERS



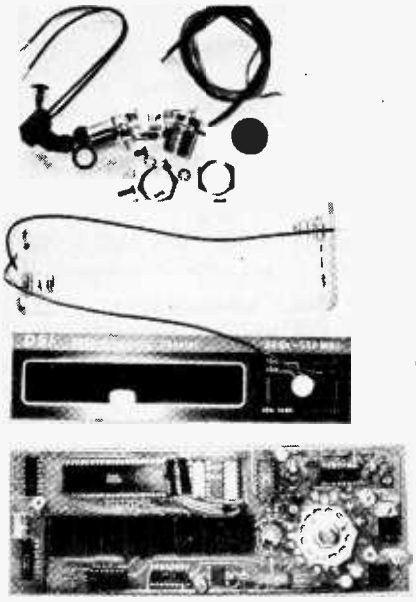
CHOOSING A COUNTER

Frequency counters are available both in kit and assembled forms and, depending on the price range, various options are available including initial zero suppression, gate indicators, AC and portable DC operation, attenuators, and temperature compensation of the crystal oscillator.

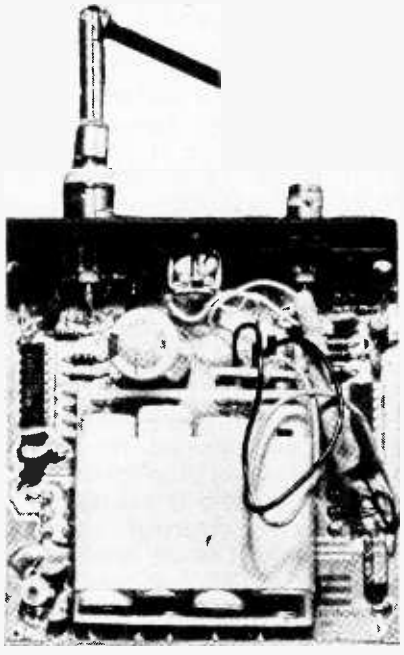
Two well designed kits that use state-of-the-art "com-

The DSI Model 3550K Frequency Counter kit is an eight digit unit with one hertz resolution on frequencies up to 55 megahertz and ten hertz from 55 to 550. Circle numbers 58 on Reader Service Card.

plementary metal oxide semiconductor"-"large scale integration" (CMOS-LSI) principals are the DSI Instruments model 3550 and the Optoelectronics model 7000. Both of these units have a price tag of less than $100 and offer features and portability that were unobtainable several years ago. Both are easily constructed, supplied with quality components, and should provide the casual builder with no particular construction problems. Their specifications are more than adequate, impressively covering most frequencies encountered by the experimenter, repair man, or technician. On the 8-digit DSI model resolution is 1 hertz with signals up to 55 megahertz, and 10 hertz from 55 to 550 megahertz with the prescaler in operation. It also has a pre-amp to boost weak signals. The Optoelectronics 7000 has 7 digits and a 10 Hertz resolution to 60 megahertz with an upper limit of 600 megahertz.



The complete DSI Model 3550K kit. As you see, the single PC board is completely preassembled and tested. You can see the LSI at the upper left and the eight digit displays in the center. All the builder has to do is wire the coax sockets and the white, snap-in battery holder and power switch. It worked like a charm first time for us. The kit price is $99.95.



The Optoelectronics Model 7000 is a very compact Frequency Counter kit with seven digits and a resolution of 10 Hertz up to 60 Megahertz. It covers up to 550 Megahertz. This photo shows the upper side of PC board, including the battery pack. A good amount of wiring mounts on the other side of the board too. Price is $79.95. For more information circle 68 on the Readers Service Card.

Any counter will perform properly when connected to the output of a pure sine wave signal generator. In many instances, however, frequency measurements must be made on complex electrical signals. In general, a signal may have an irregular wave shape containing noise and harmonics. It may also be combined with higher and/or lower frequency signals of reduced amplitude. When noise spikes and interference are present, the count may appear unstable and a significant amount of error can result. Noise or interference therefore can be seen by the counter as a signal and an erroneous reading may occur.

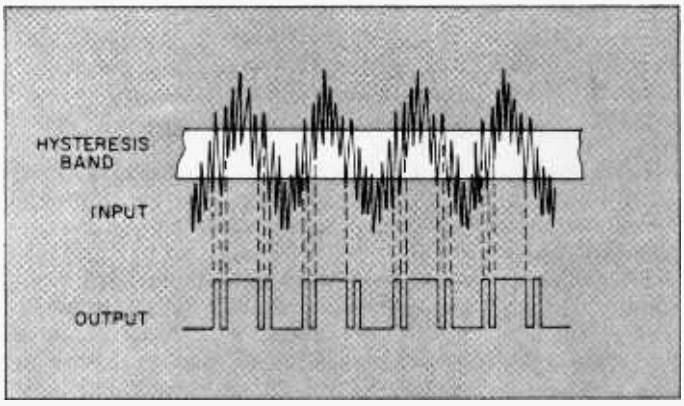
THE WRONG NUMBERS

Some inexpensive frequency counters have a remarkable tendency to display totally inaccurate counts that are both stable and reproducable. This condition can occur when the input signal level is just below the counter's sensitivity threshold. The counter's input amplifier tries to amplify and convert this low level signal into a countable square wave. Unfortunately there may be no indication when this condition occurs because the frequency displayed can be higher, lower, or fairly close to the actual frequency. Some high priced counters have a feature called clean drop-out, where all zeroes are displayed whenever the input signal is less than the counter's sensitivity threshold. Special precautions must therefore be taken when using inexpensive counters and measuring complex signals that are at or just above the threshold sensitivity. Accurate measurements can only be made with some knowledge of the counter's characteristics.

Most counters use Schmidt triggering circuits to "square up" input signals before counting takes place. Such a trigger has a hysteresis band between triggering points. Counter circuits usually trigger on the trailing edge of a square pulse.

Commonly used methods to prevent these problems consist of attenuation of the signal with significant noise, removal of dc components, increasing the signal to the counter when there is significant harmonic distortion, and eliminating ringing by the proper selection of a series damping resistor. Analyzing a few of these meth-

DERIVING SQUARE WAVES



ods may prove useful in developing a practical approach to the problem of frequency measurement.

COUPLING

Let us assume that we have a signal that has ringing. This ringing will cause false triggering at every crossing of the hysteresis band as shown.

A series damping resistor which acts as a low pass filter will effectively diminish the amplitude of the rining while leaving the basic frequency of the fundamental component unchanged.

The effect of such a series damping resistor can be analyzed as follows: for frequencies less than 60 megahertz, most counters have an input impedance of approximately one megohm and require a 10 millivolt signal for a consistent count.

The easiest method of coupling an unknown signal to the counter is by means of a short length coaxial cable. A 2½-foot length of coaxial cable has a shunting capacity of approximately 80 picofarads. The input capacitance of most counters is approximately 20 picofarads. Since these two capacitances are in parallel, the total capacitance seen by an external load is approximately 100 picofarads. A simple resistance in series with the coaxial cable will form a voltage divider. The voltage across the shunt capacitance would be equal to:

$$V_{counter} = V_{signal} / (R_{Damping} WC + 1) \text{ where } W = 2\pi f$$

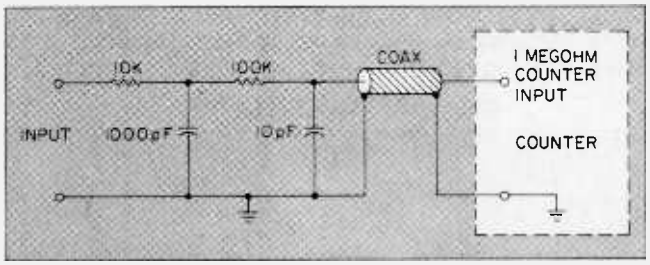
Maintaining a voltage of approximately 10 millivolts across the input of the counter will then require a damping resistance of the order of

$$R_{Damping} = V_{signal} / WC^{x10^2} \text{ if } V_{signal} >> 10^{-2} \text{ Volts}$$

A good compromise is to place a ten thousand ohm resistor in series with the coaxial cable for adequate damping of most signals.

When signals in the audio range are analyzed, a more elegant low pass filter should be placed in series with the probe. A two-stage filter with a 12 dB per octave final band pass attenuation is seen in the next figure.

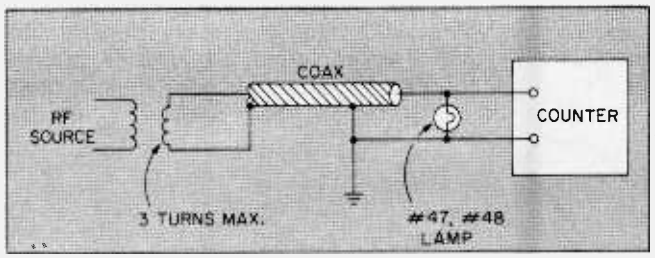
LOW PASS PROBE



Here, the two cut-off frequencies are arbitrarily chosen at 10 kilohertz and 100 kilohertz and may be changed by varying the resistor-capacitor combinations of (R_1, C_1) and (R_2, C_2).

RF measurements in the high frequency to ultra high frequency range can be accomplished either through use of small whips, "rubber duck" antennas, or more elaborate coupling techniques. Feed-through terminators such as the Heath SU 511500 or Hewlett-Packard 10100-C are specifically designed to couple a counter to an RF source. A home brew RF coupling technique is shown in the following diagram.

RF PROBE CIRCUIT



Three turns of number 18 gauge wire is fed by a suitable length of coaxial cable that is terminated in a number 47 lamp. This lamp will act as a 50 ohm termination for the coax. Such a scheme will work at the counter's one megohm or 50 ohm input impedance sources.

PUTTING THEM TO WORK

Now let's look at a couple of practical applications of frequency counter techniques. You are a licensed technician and a citizen's band transceiver is brought to you because of claimed frequency deviation from the desired channels. All frequencies have been found to be in error by the user. The frequency counter can make your trouble shooting much easier.

First, using an RF probe and having the transmitter keyed, the frequencies of the various channels can be measured. If an error exists and the channels are 10 kilohertz apart, then the problem is not in the dividing circuit of the phase lock loop circuitry but rather in one of the harmonic oscillators. On the other hand, if the frequencies are not ten kilohertz apart, the problem is in the phase lock loop circuitry.

The proper probe for measuring the frequency of an oscillator consists of a voltage divider formed of two capacitors. If one uses a high impedance probe directly, the oscillator may be loaded down and a false reading obtained. As we have discussed, 10 millivolts are required for accurate counting. Since the impedance of a 2½-foot long piece of 52-ohm coaxial cable combined with the input capacitance or shunting capacitance of the counter is a total of 100 picofarads, a 5 picofarad series capacitor will form a 1/20th voltage divider which should convert each volt of oscillator signal to a 50-millivolt signal across the input of the frequency counter.

If the problem is with the balanced mixer circuit, and the first IF frequency of the transceiver is known, the balanced mixer oscillator should be adjusted accurately to this frequency. If the problem is with the phase loop oscillator, then the reference oscillator should be checked and adjusted. By using these techniques, accurate frequency alignment can be made within 60 hertz with commonly available counters and 6 hertz in counters with temperature control units.

Another application would be to measure the frequency response of an audio amplifier. With a suitable low pass filter installed in series with the input probe, an inexpensive audio oscillator can be made of a pair of

moderately priced operational amplifiers. The RC oscillator need not be calibrated since the frequency counter will serve as the reference for your measurements. A simple audio volt meter can then be used to measure the amplitude variation as a function of frequency. The frequency counter therefore has allowed an inexpensive device to become a very accurate frequency generator.

Similar technique can be used to calibrate AM and FM receivers. Low cost oscillators can be made from UHF and VHF transistors or TTL circuitry. The output of these inexpensive RF sources is then fed into the frequency counter and circuit to be aligned. The accuracy of these frequencies is determined by the accuracy of the frequency counter. IF and RF frequency circuits can be aligned by monitoring the AGC voltage, audio output, or signal strength on the output meter of the receiver. This technique can also be used to evaluate and adjust sonar, depth finders, and fish finders. From the above discussion, it is clear that any inexpensive signal generator becomes a precision piece of equipment when it is used in conjunction with a frequency counter.

Frequency counters may also be used as signal detectors. Present day state-of-the-art devices have sensitivities in the order of 10 millivolts for signals of from six hertz to sixty megahertz. Therefore, they may be used to detect strong sources of RF radiation, trouble shoot individual oscillators in a given complex piece of equipment, or even detect the source of unwanted, spurious, or parasitic oscillations.

Thus, it is clear that a modern portable inexpensive counter is an indispensable tool to anyone interested in electronics. Considering their capabilities, frequency counters are a splendid "buy" and in kit form within the pocket range of most hobbyists. They are accurate, stable, sensitive, and compact, and their number of uses are only limited to the imagination of their user. Creative designers and LSI circuitry have thus opened another door in the development of imaginative electronics. ■

Kathi's Carousel

(Continued from page 55)

on the other side of the big pond, and it's hard to tell the difference looking at them through blister packaging. So play it safe. Buy U.S.A. The slight difference in cost won't mean anything when your gas gauge is ready to drop to zero.

Next, keep in mind that when considering similar designs, the longer it is, the better it is. A 60-inch base-loaded whip will outperform a 48-inch whip of similar design and construction.

Finally, size for size, the higher the loading coil on the whip, the greater the signal radiation.

Of course, you must customize the antenna to your particular needs. For example, a base-loaded whip is often easier to handle if stored in the trunk, so it might be preferred over a top loaded whip. On the other hand, few antennas mounted in the center of the roof will outperform a top, or continuously-loaded whip.

Pick what you want, but *do* replace your antenna equipment with a new design, or a modern version of what you already have. You can only gain extra performance; the extra edge you'll need as you pass station after station with full gas tanks displaying the "closed" or "no gas" signs. ■

Antique Radio Corner

(Continued from page 66)

than normal, then you will have to put additional filtering in the set. Try a 20 μF., 450-volt DC capacitor connected between the junction point of the choke coil and resistor, and "B–." There will be special cases in which the speaker field will have a tapped winding. Use what you have learned and use two resistors if necessary. Remember to connect one of the choke leads to the same point the field coil connected to, i.e., the rectifier filament or cathode.

Find the Value. There will be isolated cases where the speaker field coil is burned out and no value is listed on the schematic drawing or you have no schematic. In this case, use a power rheostat of 1000 to 1500-ohms at 100 watts and connect it in place of the field coil. Adjust the rheostat until the voltage readings on the audio output tube plates are normal, and then connect a choke-resistor combination in the circuit. If you don't have a schematic that shows the proper tube voltages use the data in a tube manual.

If you follow these suggestions, you should have no problem replacing the Electro-dynamic speaker in your radio with a permanent magnet type.

Wire Wound Resistors. Over the past years I've covered the problems of replacing, repairing, or restoring most of the parts in the old radio sets. One item I don't recall writing about is wirewound power resistors. In the beginning, (1921) all radios built had one or more wirewound filament rheostats. The filament rheostat controlled the amount of voltage applied to the tube filaments. The value of the rheostat was usually between 6 and 30-ohms. The end result was that the rheostat controlled the volume of the radio. It was also found that the tube lasted longer if the filaments were operated at a lower voltage. The only other resistor in these old sets was the Grid Leak. Its resistance was usually between 100,000 and several million (megohms) ohms. When "B" battery eliminators were introduced that operated from the 115-volt AC line, it became necessary to divide the high voltage into several lower voltages. The battery sets of the early 20's used as many as 5 different voltages. Some of these voltages were 22½, 45, 67½, 90, and 135-volts. At first, variable carbon potentiometers, i.e., Bradleystats, were used. Soon, fixed wirewound resistors replaced these variable resistors.

When AC operated sets were introduced, several wirewound resistors were needed in each set. Wirewound resistors have two important ratings to consider. One is the resistance value in ohms, and the other is the power dissipation in watts. Some power resistors have the resistance wire wound on ceramic tubes with terminals at each end. These resistors operate at extremely high temperatures and you must be careful to dress wires away from them or the wire insulation will melt.

You will find several other kinds of wirewound resistors in the old radios. A "Candohm" is a resistor with resistance wire wound on a fiber strip and encased in a steel housing. The steel helps radiate heat so the resistor doesn't burn up in normal use. Low power resistors are wound on fiber or phenolic strips.

(Continued on page 80)

Antique Radio Corner

(Continued from page 79)

Vitreous enamel resistors have wire wound on ceramic tubes and are then dipped into enamel. Vitreous enamel is made from several ingredients including clay. The wound resistor is dip coated and fired in a furnace at 750 degrees Centigrade. This temperature vitrifies the enamel and turns it into a type of glass. Vitreous enamel resistors will operate at temperatures as high as 350 degrees.

Most wirewound resistors are wound with uninsulated wire, in a single layer, with spacing equal to several wire diameters. The winding machine uses several gears to get the proper number of turns-per-inch for the desired resistance. The wattage rating is provided by using larger diameter wire for larger wattage resistors. Resistance wire comes in several different alloys, and many different sizes. Wire is available in diameters less than .001-inch to ribbon wire ⅛-inch or more wide. Low power wirewound resistors used as meter multipliers are wound with cotton covered insulated wire.

You will see resistors in the old Atwater Kent radios using resistance wire wound on phenolic strips with solder lug terminations. If you don't care how the radio looks and just want it to play, you can use carbon composition types as replacements. The purist, however, will either make new ones just like the originals or rewind.

So long for now. I hope many of you remembered to attend the AWA convention in Canandaigua, New York. ■

Computer Network

(Continued from page 74)

text editing and correspondence maintenance systems.

Toll Free. Any personal computer equipped with a 300-word per minute telephone interface (modem) can gain toll-free access to the system by paying a one-time registration charge of $100. For those not yet equipped with a personal computer, TCA provides a wide variety of low-cost commercial quality Source series telecomputers for connecting to the network starting at $595 for a keyboard, telephone coupler and video display.

Once granted access to the network, any TCA subscriber can use the electronic mail system to communicate with any other subscriber, regardless of make or model of his terminal or personal computer. The Source features both store and forward mail capability (*Mailcall*) as well as the ability to communicate interactively (*Chatting*). Electronic mail to the outside world is provided via *Datapost*, and messages can be left for subscribers.

TCA plans to open local franchises in the top 200 markets in the United States; franchises have already been sold or committed for portions of Washington, D.C. and other heavily populated metropolitan areas. For further information, write to TCA, 1616 Anderson Road, McLean, Virginia 22102. ■

Computer Cassette Decks

(Continued from page 72)

The block diagram in Figure 5 shows how the computer systems work. We'll follow the circuits that establish the tape parameters. One equilization value, for the lower medium (mid) band, and the approximate bias are set as in the *Manual* mode (factory setting). The computer establishes the midband equalization to a 7kHz reference, the high band equilization to a 14kHz reference, the bias level, and the sensitivity (output level from tape to Dolby.

The test signal(s) are provided by the signal generator. On simultaneous playback from the three-head system the computer first sets the recording level through "feed back" of the playback signal through the A/D converter (Analog-to-Digital). Then it adjusts the bias level for maximum output from the tape, doing the test two ways to average out any possible errors. Once the bias is set the computer reruns the sensitivity (recording level) test and makes the necessary corrections to attain the "reference" level. Then the computer tests and corrects the medium and high band equalizers.

To do all this manually would take a test bench full of instruments, considerable time, and a good knowledge of tape recorder alignment. The computer does it all automatically in a few seconds and then rewinds the tape back to wherever the testing started so you record your program over the test signals.

In addition to the computerization the D-5500, which retails for $1,000 is jam-packed with other features. We've touched only on the computerized tape matching, which we consider the most outstanding feature of the machine. You can get all the details by circling No. 48 on the reader's service coupon. ■

Computer Readout

(Continued from page 62)

on or off, and they must provide a means of referring to each cell by location.

Graphics in BASIC. Now comes the fun part. To demonstrate how a graphics capability can work, we will use two hypothetical commands built into BASIC to draw a simple picture of a spaceship and then "fly" it across the screen. The commands are ON(X,Y) and OFF(X,Y) where X and Y stand for the screen coordinates of the cell location. ON and OFF simply means that that location is lit (ON) or not lit (OFF).

The first thing we do is turn on the cells we wish to represent our spaceship in its starting position. We have to name each cell in terms of its X and Y coordinates and tell the computer to turn it on. The computer then tells the CRT terminal to turn on the locations in its screen buffer that will light the corresponding areas on the screen.

We then see displayed on the left side of the screen our little spaceship. How do we make it fly? Simple. We tell the computer to turn off the leftmost cell in each row of our picture (that is, of our spaceship) and turn on the next cell to the right. When it has done this the spaceship will appear to have moved one increment to the right.

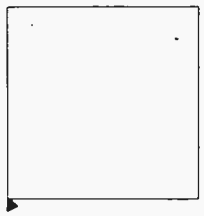
This is because when the terminal scans its screen buffer it will now see that the cells we want turned on have all shifted one place to the right. If we repeat this process by successively adding 1 to the X coordinates of those cells we want lit, our spaceship will appear to move across the screen.

We can control the speed of the spaceship by having the computer wait some fractions of a second before changing the contents of the screen buffer. Since the CRT displays 30 frames per second, the same as a television, motion can be very rapid and smooth, or very slow.

Lines and Curves. In the same way we can draw a line or a curve on the screen by turning on cells or dots in succession and leaving them on. Some graphics systems allow you to specify a direction in degrees from a starting point and the number of "steps" you want your line to take. In this way, pictures and geometric figures can be formed conveniently.

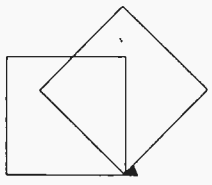
One graphics system uses the concept of the *naki*. The naki is a little mouse or turtle which can move in specified directions on the screen. It can be told to move leaving a "trail" or line, or to move without drawing a line. For instance, the following short program would draw a square with its sides the length N.

```
10 INPUT N
20 DRAW
30 AHEAD
40 RIGHT 90
50 GO TO 30
60 END
```

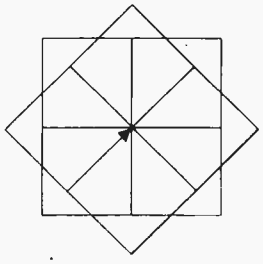


Very complex figures can be drawn by modifying and combining these simple commands, and by utilizing the computer's ability to repeat operations many times. In the case above, the computer would go on drawing the same square until it was turned off.

If at one point, we added a command that added 45 degrees to the naki's direction, the second time around the figure would look like this:



And after 6 times, like this:



Some home computers provide for control of their graphics by means of a joystick. This consists of two potentiometers which represent the X and Y axes. The computer reads the different voltages output by different positions of the potentiometers. These are then referenced to the locations in the screen buffer memory which are loaded (turned on or off) with whatever information the program dictates.

Computer graphics is an exciting way to present information and it is appearing with increasing frequency as an integral part of home computer systems. One of the best comments on the value of graphics for conveying information is the name of a San Francisco Bay Area graphics consulting firm which calls itself "1K Graphics." . . . because a picture is worth a thousand words. ■

FT101ZD

(Continued from page 70)

with a logical placement of these components on the printed circuit boards. The wiring harnesses and cabling were all properly placed in a highly professional manner.

Performance. Quality construction and design must necessarily lead to quality performance, and this was borne out by how our Yaesu FT 101 ZD performed. We tried the Yaesu on 80, 40, 20, and 15-meters CW operation, and 15 and 10-meter phone operation. In every instance, the performance of the transceiver was superb. We initially encountered some grounding problems on 10-meters, that cleared with the installation of a heavy, short ground wire to the equipment when it was in close proximity to the antenna. We strongly suggest that your Yaesu be properly grounded to prevent RF feedback from distorting the audio during SSB operation. No problems whatsoever were encountered in the CW mode of operation. On phone, the usual comments about the audio were "superb," "piercing," "cutting," and "high quality." As stated earlier, some drifting was noted on warm up without the cooling fan. In fact, the whole transceiver became unacceptably warm without this option and therefore we strongly recommend it. CW operation is easy, and the variable IF selectivity is a dream. The receiver is truly outstanding with low noise, high sensitivity and selectivity, and ease of operation. We had no difficulty in picking DX signals out of the mud. Within a few short weeks, we literally worked the world with our Yaesu FT 101 ZD. Five-nine reports were received from stations in Asia, Africa, and Australia on 10-meters, and 5 by 7 reports from Tahiti and South America on 15-meter phone, all with our simple dipole antenna.

Conclusion. The FT 101ZD is without significant flaws, works efficiently and well, and is a joy to use. We can recommend it without reservations. It sells for $895, and the fan that our review unit was equipped with is an additional $20. Yaesu Electronics Corp. is at 15954 Downey Ave., Paramount, CA 90723. For more information, circle number 81 on the reader service coupon. ■

Fridgalarm

(Continued from page 41)

⅔, its most linear region.) As C1 reaches a charge of two-thirds of its capacity, the output of U1 (at pin 3) goes low, near ground, and thereby completes the voltage supply to U2 which also operates as an astable oscillator but with a much shorter period. As U2's output swings between high and low, it creates the sound that is coupled through C5.

Operation. With the values shown, the alarm will trigger about thirty seconds after the refrigerator door is opened, and sound for about fifteen seconds, then cycle on and off every fifteen seconds until the door is closed. Should you prefer the alarm to sound continuously until the door closes, remove the connection between pin 2 on U1 and the rest of the circuitry. This prevents the timer from resetting until supply voltage is removed by closing the door.

Should the tone we've chosen not be noxious enough for you, you can change its pitch by varying R5 (which changes the frequency of U2's oscillations), to a higher value producing a *lower* frequency, or by changing C3 to a lower value, producing a *higher* frequency. Similarly, the timing period before the alarm sounds can be varied by changing either C1 or R3.

Construction. We built our project on a Continental Specialties Corporation Experimenter 350 solderless breadboard, which enabled us to jockey the parts around.

Conclusion. Since both our electric bills and the weights of our wives are down, and we must no longer regularly treat the kids for frostbite, we feel secure in calling the Refrigerator Alarm a chilling success. ■

Hey, Look Me Over

(Continued from page 27)

CIRCLE 39 ON READER SERVICE COUPON

is changed to halt the program and put the Apple into BASIC mode without losing program instructions or data), and Easy Screen Editing (cuts screen editing keystrokes up to 80 percent, resulting in faster and simpler program editing). The Apple II Plus is available from Apple dealers. The systems are priced as follows: 16K, $1,195; 32K $1,345; 48K, $1,495. Write to Apple Computer, Inc., 10260 Bandley Drive, Cupertino, CA 95014 for the complete facts. ■

ELEMENTARY ELECTRONICS HOBBY MART

ELEMENTARY ELECTRONICS INDEX TO ADVERTISERS

Bookmark

(Continued from page 17)

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CIRCLE 53 ON READER SERVICE COUPON

Telephones that explores all these possibilities and more—what the FCC says can and can't be done, what is available now, and what one needs to know to use it. Yes, anyone can own his own telephone system; no longer must people rent from the telephone company! How does one go about getting his own? What can one get? Where does one get it? The answers are all here! The reader learns exactly how each part of his telephone system works, how telephones and computers work together, and which of the FCC's rules and regulations apply to computers and which apply to the telephone company and the manufacturer—all written in plain English! Published by Tab Books, Blue Ridge Summit, PA 17214. ■

DX Central

(Continued from page 22)

as not favoring an expansion of the International Broadcasting frequencies. As most SWLs know, the USSR already is squatting on many out-of-band frequencies and apparently is reasonably happy. If there is no expansion, and the smaller countries vote themselves a larger share of band space, the loss would be felt mostly by the NATO bloc of countries.

DXers, though, can hope that something like the U.S. proposal emerges at the end of WARC-79: more band space for the real DXing targets, the small Tropical Band outlets around the world, and also more room for our favorite major SWBC voices, with less band crowding and more reasonable transmitter power limits.

At this writing, it is too early to say, of course, what WARC-79 will bring. You may shortly be reading summary accounts of the conference in your daily newspapers. Whatever happens, don't expect major changes in the shortwave bands overnight; it may be several years before changes are really felt by the SWL.

In subsequent DX CENTRAL REPORTING columns we'll be talking more about the outcome of WARC-79—and what it will mean in the next several decades. Stay tuned!

What's New. What's new? For one thing, a new station from the West African country of Nigeria.

For some months, SWLs have been hearing a mysterious shortwave station on 4,755 kHz in the 60 meter band. During the afternoon period until 2300 GMT, and sometimes again around 0400 GMT or so, a fairly strong signal was noted with music, a mixture of African highlife rhythms and soul sounds. There was much speculation about its identity, but that's all there was, speculation. The station featured no announcements of any type.

Finally, though, the mystery was solved when the following bit of information was given at sign off: "Imo State Broadcasting Service," at Owerri, Nigeria. The station announced the transmissions were tests. Regular service was expected to begin shortly.

This 'n' That. Most folks are interested in freebies. ANDEX International, an SW club, falls in that category and is a bonus for SWLs who listen to HCJB in Quito, Ecuador.

ANDEX is operated by Clayton Howard, host of HCJB's regular "DX Party Line" program and a true friend of SWLs. If you're not familiar with the Party Line, tune in on 9,745 or 11,915 kHz, 0230 GMT on Tuesdays, Thursdays or Sundays. (Remember, because of the difference between your local time and GMT, those days—in North America—will be the evenings of Monday, Wednesday and Saturday.) For more information on ANDEX International, write: c/o HCJB, Casilla 691, Quito, Ecuador.

Now and again we get requests from SWL readers asking about call letters for monitors. While DX CENTRAL does not issue call letters nor SWL designators for listeners, there is an outfit that has been doing just this for years.

The DX Monitor Program, operated by longtime SW club editor Hank Bennett, issues the WDX calls to SWLs.

For full details, send a large self-addressed, stamped envelope to DX Monitor Program, P.O. Box 3333, Cherry Hill, NJ 08034.

Your editor has been WDX9EZ for many, many years. The Boss claims the call is too appropriate; says I spend too much of my time taking it "EZ."

Back Talk. More letters in the mailbag this month, so let's get right to them.

"Some of your New England readers may wish to know that the NOAA weather station in Boston has changed its frequency and format," writes Dlana Yevza, who neglected to include an address, though the postcard was cancelled in Boston.

"The Boston weather station changed from 162.470 to 162.475 MHz, to reduce interference with signals from the Providence, RI, weather station."

Reader Yevza adds that a new NOAA weather station for Central Massachusetts began operations recently. The Worcester weather station broadcasts on 162.55 MHz. 'Til next time then, 73 and DX to all. ■

LITERATURE LIBRARY

389. You can't buy a bargain unless you know about it! *Fair Radio Sales'* latest electronics surplus catalog is packed with government and commercial buys.

388. SWLs need *Gilfer's* Shortwave Mail Order Catalog for economy one-stop armchair shopping. From top-notch rigs to reporting pads, Gilfer supplies all your hobby needs.

372. *Olson* continues to amaze hobbyists with their jammed packed 48-page newspaper catalog. It's a bargain buyer's bonanza.

327. *Avanti's* new brochure compares the quality difference between an Avanti Racer 27 base loaded mobile antenna and a typical imported base loaded antenna.

382. A new catalog crunched full of military, commercial and industrial surplus electronics for every hobbyist is offered by *B&F Industries*. 44 pages of bargains you've got to see!

384. *B&K-Precision's* latest general line catalog lists instruments locally stocked at distributors' throughout North America. Standard and new products are featured.

310. *NCE (Newman Computer Exchange)* has just issued their Spring/Summer 1979 "Mini-Micro" catalog, and it's full of hard-to-find equipment. Money-saving offers are listed on such items as all Data General and LSI-11 equipment.

322. A new 20-page, full-color TRS-80 Microcomputer Catalog has just been issued by *Radio Shack*. The catalog includes complete, current information on the TRS-80 Microcomputer, its peripherals and accessories with plain-language descriptions.

386. If you're lookng for books on computers, calculators, and games, then get *BITS, Inc* catalog. It includes novel items.

335. The latest edition of the *TAB BOOKS* catalog describes over 450 books on CB, electronics, broadcasting, do-it-yourself, hobby, radio, TV, hi-fi, and CB and TV servicing.

338. "Break Break," a booklet which came into existence at the request of hundreds of CBers, contains real life stories of incidents taking place on America's highways and byways. Compiled by the *Shakespeare Company*, it is available on a first come, first serve basis.

345. For CBers from *Hy-Gain Electronics Corp.* there is a 50-page, 4-color catalog (base, mobile and marine transceivers, antennas, and accessories).

393. A brand new 60-page catalog listing *Simpson Electric Company's* complete line of stock analog and digital panel meters, meter relays, controllers and test instruments has just come out.

385. Amateur Radio buffs and beginners will want the latest *Ham Radio Communications Bookstore* catalog. It's packed with items for the Ham.

373. 48-page "Electronic Things and Ideas Book" from *ETCO* has the gadgets and goodies not found in stores and elsewhere.

382. Buys by the dozens in *Long's Electronics* super "Ham Radio Buyer's Guide." Good reading if you're in the market for a complete station or spare fuses.

383. If you're a radio communicator, either ham, SWL, scanner buff or CBer, you'll want a copy of *Harrison Radio's* "Communications Catalog 1979." Just what the shack book shelf needs.

380. If your projects call for transistors and FETS, linear and digital ICs, or special solid-state parts, then look into *Adva Electronics'* mini-catalog for rock bottom prices.

301. Get into the swing of microcomputer and microprocessor technology with *CREI's* new Program 680. New 56 page catalog describes all programs of electronics advancement.

302. Giant savings are what *Burstein Applebee* has in store in their latest mail order catalog. Everything from CB test equipment to name brand audio wares are advertised.

305. A new 4-page directional beam CB antenna brochure is available from *Shakespeare*. Gives complete specs and polarization radiation patterns for their new fiberglass directional antennas.

371. Your computer system needn't cost a fortune. *Southwest Technical Products* offers their 6800 computer complete at $395 with features that cost you extra with many other systems.

306. *Antenna Specialists* has a new 32-page CB and monitor antenna catalog, a new amateur antenna catalog, and a complete accessory catalog.

307. *Atlas* calls their 210X and 215X the perfect amateur mobile rigs. Their 6-page, full-color detailed spec sheet tells all. Yours for the asking.

330. There are nearly 400 electronics kits in *Heath's* new catalog. Virtually every do-it-yourself interest is included—TV, radios, stereo and 4-channel, hi-fi, hobby computers, etc.

392. The opening of the new Software of the Month Club has been announced by *Creative Discount Software*, which is giving out membership enrollment applications now. The Club plans to have separate branches for users of the Apple II, TRS-80, Ohio Scientific, Exity, Pet and CP/M based systems.

312. *E.D.I. (Electronic Distributors, Inc.)* carries everything from semi-conductors to transformer/relays to video cameras. In prices ranging from 19¢ to $500, products appear from over 125 electronic parts manufacturers.

390. *Whitehouse & Co.*, your "hard to find parts specialist," offers over a dozen parts and kits in their latest catalogue, featuring an entire section on gunnplexers for Amaeur Radio buffs.

318. *GC Electronics* offers an "Electronic Chemical Handbook" for engineers and technicians. It is a "problem solver" with detailed descriptions, uses and applications of 160 chemicals compiled for electronic production and packaging.

313. Get all the facts on *Progressive Edu-Kits* Home Radio Course. Build 20 radios and electronic circuits; parts, tools, and instructions included.

320. *Edmund Scientific's* new catalog contains over 4500 products that embrace many sciences and fields.

321. *Cornell Electronics'* "Imperial Thrift Tag Sale" catalog features TV and radio tubes. You can also find almost anything in electronics.

328. If you are into audio, ham radio, project building, telephones, CB or any electronics hobby you'll want *McGee's* latest catalog of parts and gadgets.

333. Get the new free catalog from *Howard W. Sams*. It describes 100's of books for hobbyists and technicians—books on projects, basic electronics and related subjects.

354. A government FCC License can help you qualify for a career in electronics. Send for Information from *Cleveland Institute of Electronics*.

355. New for CBers from *Anixter-Mark* is a colorful 4-page brochure detailing their line of base station and mobile antennas, including 6 models of the famous Mark Heliwhip.

391. A new software products catalog for the Apple II Computer has just been issued by *Charles Mann & Associates*. The booklet contains business accounting, accounts receivable, inventory, BASIC teaching and other special purpose business applications.

359. *Electronics Book Club* has literature on how to get up to 3 electronics books (retailing at $58.70) for only 99 cents each . . . plus a sample Club News package.

375. *Compucolor Corp.* has a personal computer system with an 8-color integral display, a typewriter-like keyboard, and a mass storage device. Programs are ideal for checkbook and income tax figuring.

377. We can't enumerate all the products in *John Meshna, Jr.'s* catalog of surplus electronic parts: power supplies, computer keyboards, kits for alarms, clocks, speakers, and more.

311. *Midland Communications'* line of base, mobile and hand-held CB equipment, marine transceivers, scanning monitors, plus a sampling of accessories are covered in a colorful 18-page brochure.

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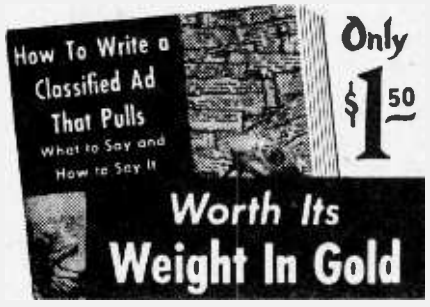

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Ground on Ground

About 30 feet behind my summer cottage is a hill, a few feet taller than my roof. I'd like to install an old ¼-wave stainless steel whip antenna on the hill for the season next year. A friend says it will do no good because I have no ground plane. What should I do?

—J. N. Elkhart, IN

Lay out a plane of chicken wire to cover a circular area of about 100 inches diameter or more. Solder the sections of the chicken wire together and anchor in place with wooden pegs. Connect the ground plane to the antenna mount frame—and good luck. By the following year the chicken wire would have rusted away, and the wooden pegs, rotted. Great for the ecology.

Aeradio

Hank, I'd like to QSL Gander Aeradio and New York Aeradio. Do you know the addresses?

—O. Y., New City, NY

Sounds like you're doing some areoband listening—something I haven't done in a long time. I always liked late afternoons for listening, between four and six when most of the planes were coming in. Add some rain and low ceiling and the band becomes very active. The addresses you asked for are:

Gander Aeradio
Chief Communications Officer
Meteorological Agency
Gander International Airport
Gander, Newfoundland, Canada

New York Aeradio
Federal Aviation Administration
I.F.S.S.
North Passenger Terminal, Hanger 11
JFK International Airport
Jamaica, NY 11430

Specific Gravity

I've been using a hydrometer to check the state of my boat's battery. Come to think of it, I don't know how it works. Can you help?

—J. K., Provo, UT

A piece of wood would float higher on a pool of mercury than water. That's because the weight of a unit volume, or specific gravity of the mercury is much heavier than water. Your hydrometer would read 1.000 when the float is immersed in pure water. Sulphuric acid is much heavier, and when mixed in the correct proportion in a lead acid battery, the electrolyte should have a specific gravity of 1.260. As the battery is drained of energy, the specific gravity is reduced because the sulpuric acid is used up. Recharging the battery reconstitutes the acid. A completely discharged battery should have a specific gravity of about 1.135. Values in between indicate percent of charge.

What is Black

Is the black wire always the ground lead?

—A. S., Skokie, IL

No! Years ago you could trace a radio circuit by the color of the lead's insulation. Whenever practical, some manufacturers continue to do so. Black was the ground potential lead. Then came WWII and AC/DC circuits in radios. The black lead may have been RF ground, but it was also one side of the AC line. Since plugs were not polarized, you had a 50-50 chance of meeting your maker. Further, scarcity of wire during and after the war resulted in manufacturers using what they had on hand. Also, many color-blind persons previously screened out of the industry were now employed. Thus, if the wire insulation is black, you can be sure it's black and that's it. Electricians always used white as the ground return circuit and black as the hot lead. Some people have to be different!

Disc Choice

I saw a "parts list" for a project where the volatge rating for a .01 disc ceramic capacitor was rated for several hundred volts, and the circuit used a nine-volt battery. Why the "over-specing"?

—W. M., Pleasanton, TX

You didn't tell me what kind of circuit it is, so my answer takes two parts. First, a 200-volt disc capacitor is larger and cheaper than a 15-volt unit. If physical size is not important, the 200-volt capacitor will be easier to find and less expensive. In fact, almost any .01 disc capacitor could be used. The second part of the answer has to consider the possibility of the capacitor being part of a resonant circuit or inductive circuit where high voltage spikes are possible. You could rectify the voltage across a bell's solenoid, rectify it and come up with several hundred volts D.C. (at a very low current level). Stick with the cheaper and higher voltage capacitor. By the way, the .01 uF value is uneffected by the voltage across the capacitor.

Long Sun

Hank, I really understand about live voltage drop. I took a very large spool of 4-lead telephone wire and hooked up the leads into one very long one-lead cable. Then, fusing the circuit for 2 amperes maximum, I illuminated a 100-watt lamp with the long spool of wire in the series circuit. The bulb glowed a dull yellow-red light expected. You know, Ohm's law really works.

—S. M., Encino, CA

It sure does. I like the idea of fusing the circuit. Always approach circuit construction, testing and experimentation with safety as the prime thought. In your experiment, you must have had several miles of #22 wire (or smaller-size wire) which can add up to several ohms. Thus, the spool can become warm, even hot. So, if a reader performs this experiment, leave the lamp on for only a few moments, and do not touch the spool of wire with its usual metal spool, when power is connected to both or either lead.

Antenna Tuning

I say a transmitter must be tuned to the antenna, and my friend says that the antenna should be tuned by itself. No way, I say. Who's right?

—J. N., Fargo, ND

An antenna is a resonant circuit. For maximum performance, it must be tuned to resonance for the same reason that the transmitter output circuit must be tuned to resonance. When the transmitter frequency is changed, it is standard practice to "dip the final." The antenna resonant frequency should also be changed if maximum performance is desired. This is not practical or necessary in CB because the loaded antennas, even the ¼-wave whip, are broad banded considering how narrow the CB band is. Not so for amateurs.

Sun Power

I need 1.5 VDC at 3 mA from a photocell or group of solar cells. How do I hook them up?

—K. R., Oroville, WA

The solar cell is a photovoltaic cell (silicon photodiode) designed to respond to sunlight. Cells are typically ¼-inch square and in average sunlight (about 3000 lumens per square foot) generate about ½-volt DC. Connected to a 100-ohm load, the output current is about 3 mA. Connect three solar cells in series observing polarity and you've got it. If, under load, the solar cell bank cannot deliver enough voltage or current under average light conditions, additions are in order. To step up voltage, add a solar cell in series. If the current supplied is too low, add solar cell branches in parallel to the original series string of solar cells. Remember, each branch should have the same number of solar cells. ■

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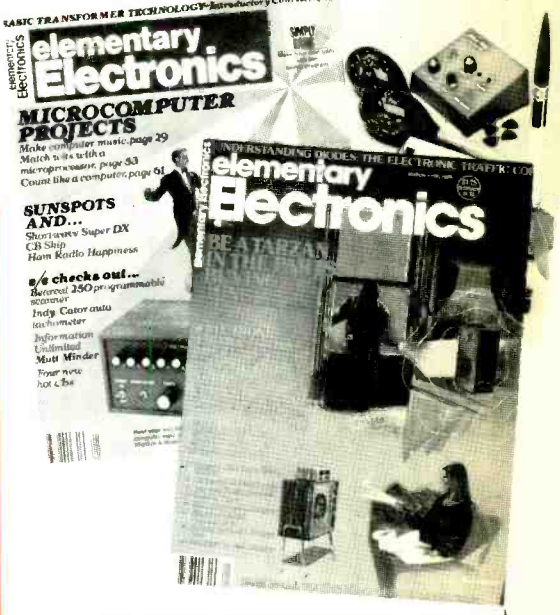

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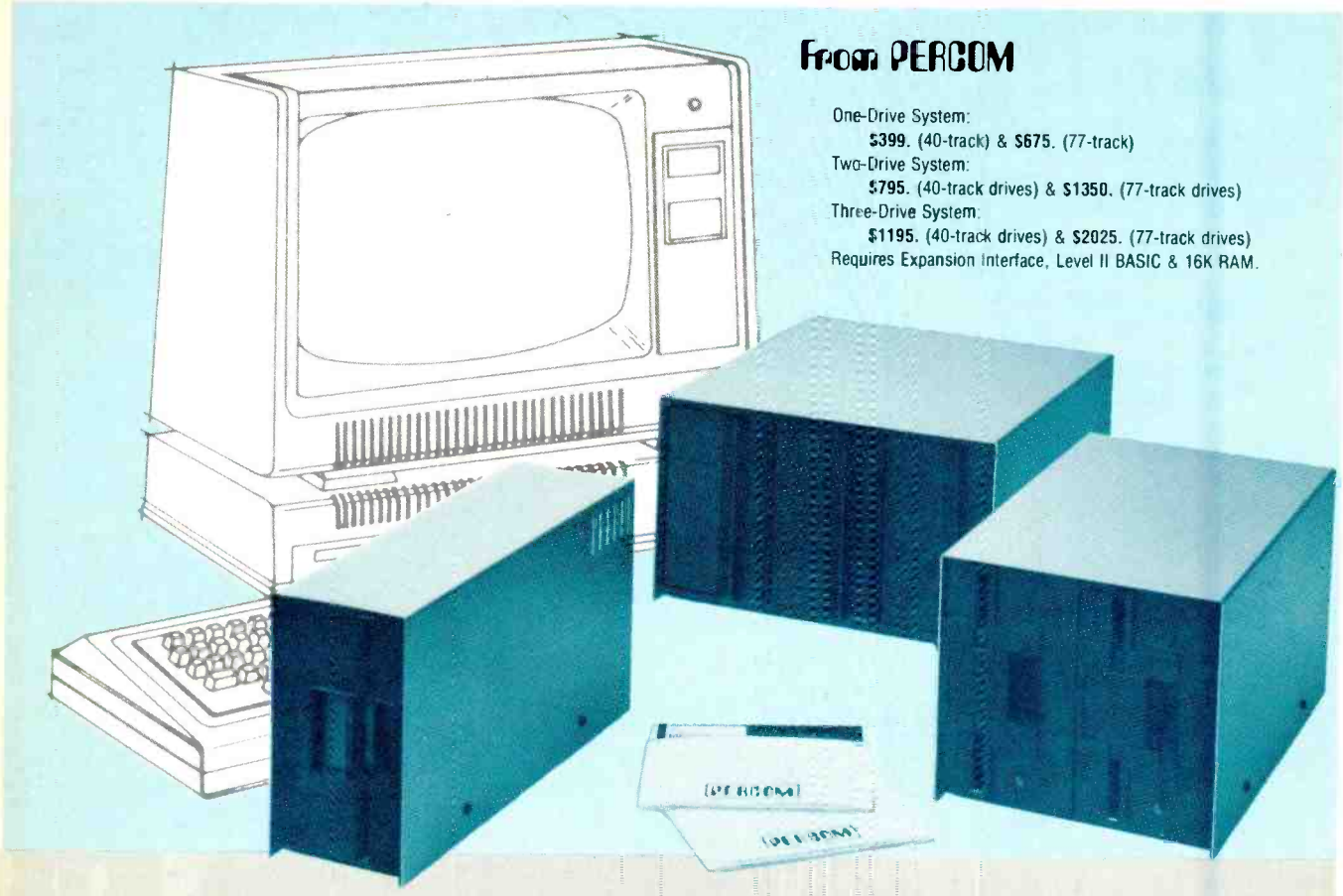

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