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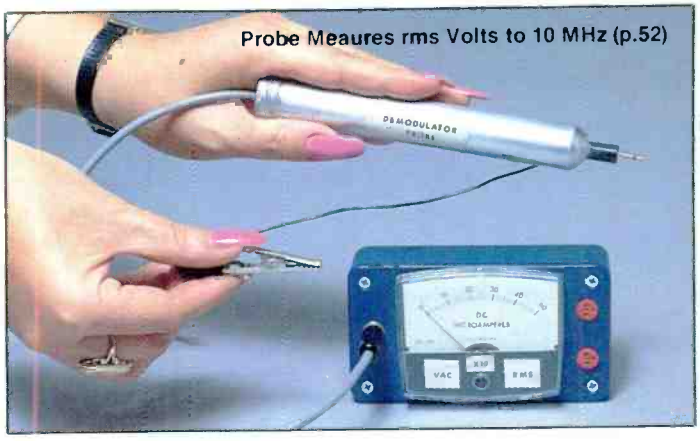

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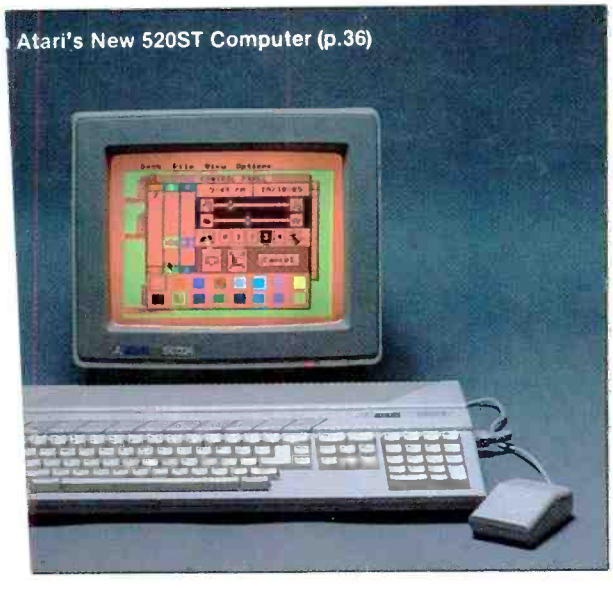

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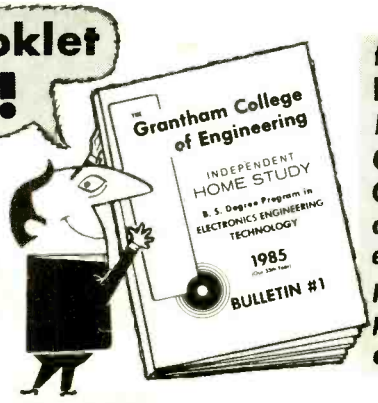

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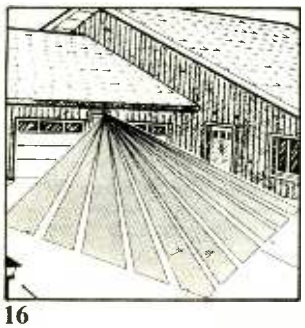
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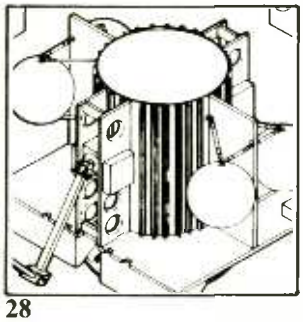
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FEATURES

PRODUCT EVALUATIONS

DEPARTMENTS

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NEW! Lower Price Scanners

Communications Electronics,™ the world's largest distributor of radio scanners, introduces new lower prices just in time for the holiday season.

Regency® MX7000-BB

List price $699.95/**CE price $379.00/SPECIAL**
10-Band, 20 Channel • Crystalless • AC/DC
Frequency range: 25-550 MHz. continuous coverage and 800 MHz. to 1.3 GHz. continuous coverage
The *Regency* MX7000 scanner lets you monitor military, F.B.I., Space Satellites, Police and Fire Departments, Drug Enforcement Agencies, Defense Department, Aeronautical AM band, Aero Navigation Band, Fish & Game, Immigration, Paramedics, Amateur Radio, Justice Department, State Department, plus thousands of other radio frequencies most scanners can't pick up. The *Regency* MX7000 is the perfect scanner for intelligence agencies that need to monitor the new 800 MHz. cellular telephone band. The MX7000, now at a special price from CE.

Regency® MX4000-BB

List price $629.95/**CE price $279.00/SPECIAL**
Multi-Band, 20 Channel • No-crystal scanner Search • Lockout • Priority • AC/DC Selectable AM-FM modes • LCD display
Bands: 30-50, 118-136, 144-174, 440-512, 800-950 MHz.
The *Regency* MX4000 is gives coverage in the standard VHF and UHF ranges with the important addition of the 800 MHz. and aircraft bands. It features keyboard entry, multifunction liquid crystal display and variable search increments.

Regency® Z60-BB

List price $379.95/**CE price $199.00/SPECIAL**
8-Band, 60 Channel • No-crystal scanner
Bands: 30-50, 88-108, 118-136, 144-174, 440-512 MHz.
Cover your choice of over 15,000 frequencies on 60 channels at the touch of your finger.

Regency® RH250B-BB

List price $613.00/**CE price $329.00/SPECIAL**
10 Channel • 25 Watt Transceiver • Priority
The *Regency* RH250B is a ten-channel VHF land mobile transceiver designed to cover any frequency between 150 to 162 MHz. Since this radio is synthesized, no expensive crystals are needed to store up to ten frequencies without battery backup. All radios come with CTCSS tone and scanning capabilities. A monitor and night/ day switch is also standard. This transceiver even has a priority function. The RH250 makes an ideal radio for any police or fire department volunteer because of its low cost and high performance. A UHF version of the same radio called the RU150B covers 450-482 MHz. but the cost is $449.00. To get technician programming instructions, order a service manual from CE with your radio system.

NEW! Bearcat® 50XL-BB

List price $199.95/**CE price $129.00/SPECIAL**
10-Band, 10 Channel • Handheld scanner
Bands: 29.7-54, 136-174, 406-512 MHz.
The Uniden Bearcat 50XL is an economical, hand-held scanner with 10 channels covering ten frequency bands. It features a keyboard lock switch to prevent accidental entry and more. Also order part # **B5** which is 5 AA ni-cad batteries for $13.00, a plug in wall charger, part # **AD100** for $14.95 and also order optional cigarette lighter cable part # **PS001** for $14.95.

NEW! JIL SX-400-BB

List price $799.95/**CE price $469.00/SPECIAL**
Multi-Band, 20 Channel • No-crystal Scanner Search • Lockout • Priority • AC/DC
Frequency range: 26-520 MHz. continuous coverage. With optionally equipped RF converters 150KHz-3.7 GHz.
The *JIL* SX-400 synthesized scanner is designed for commercial and professional monitor users that demand features not found in ordinary scanners. The SX-400 will cover from 150 KHz to 3.7 GHz. with RF converters. Order the following RF converters for your SX-400 scanner. **RF-1030-BB** at $234.00 each for frequency range 150 KHz. - 30 MHz. USB, LSB, CW and AM. (CW filter required for CW signal reception); **RF-5080-BB** at $194.00 each for 500-800 MHz.; **RF-8014-BB** at $194.00 each for 800 MHz.-1.4 GHz. Be sure to also order **ACB-300-BB** at $99.00 each which is an antenna control box for connection of the RF converters. The **RC-4000-BB** data interface at $259.00 each gives you control of the SX-400 scanner and RF converters through a computer. Add $3.00 shipping for each RF converter, data interface or antenna control box. If you need further information on the JIL scanners, contact JIL directly at 213-926-6727 or write JIL at 17120 Edwards Road, Cerritos, California 90701 U.S.A.

SPECIAL! JIL SX-200-BB

List price $499.95/**CE price $154.00/SPECIAL**
Multi-Band - 16 Channel • No-Crystal Scanner
Frequency range 26-88, 108-180, 380-514 MHz.
The JIL SX-200 has selectable AM/FM receiver circuits, tri-switch squelch settings -signal, audio and signal & audio, outboard AC power supply - DC at 12 volts built-in, quartz clock - bright vacuum fluorescent blue read-outs and dimmer, dual level search speeds, tri-level scan delay switches, 16 memory channels in two channels banks, receive fine tune (RIT) ± 2KHz., dual level RF gain settings – 20 db pad, AGC test points for optional signal strength meters all for this special price.

Regency® HX1000-BB

List price $329.95/**CE price $189.00/SPECIAL**
6-Band, 30 Channel • No Crystal scanner Search • Lockout • Priority • Scan delay Sidelit liquid crystal display • Digital Clock
Frequency range: 30-50, 144-174, 440-512 MHz.
The new handheld *Regency* HX1000 scanner is fully keyboard programmable for the ultimate in versatility. You can scan up to 30 channels at the same time. The LCD display is even sidelit for night use. Order **MA-256-BB** rapid charge drop-in battery charger for $68.95 plus $3.00 shipping/handling. Includes wall charger, carrying case, belt clip, flexible antenna and nicad battery. Order now.

NEW! Bearcat® 100XL-BB

List price $349.95/**CE price $209.00/SPECIAL**
9-Band, 16 Channel • Priority • Scan Delay Search • Limit • Hold • Lockout • AC/DC
Frequency range: 30-50, 118-174, 406-512 MHz.
The world's first no-crystal handheld scanner now has a LCD channel display with backlight for low light use and aircraft band coverage at the same low price. Size is 1⅜" x 7½" x 2⅞." The *Bearcat* 100XL has wide frequency coverage that includes all public service bands (Low, High, UHF and "T" bands), the AM aircraft band, the 2-meter and 70 cm. amateur bands, *plus* military and federal government frequencies. Wow...what a scanner!
Included in our low CE price is a sturdy carrying case, earphone, battery charger/AC adapter, six AA ni-cad batteries and flexible antenna. Order your scanner now.

NEW! Regency® HX2000-BB

The World's First 800 MHz. Handheld Scanner
List price $569.95/**CE price $244.00/SPECIAL**
7-Band, 20 Channel • No-crystal scanner Priority control • Search/Scan • AC/DC Sidelit liquid crystal display • Memory backup
Bands: 118-136, 144-174, 440-512, 800-950 MHz.
The HX2000 scanner operates on 120V AC or 6 VDC. Scans 15 channels per second. Size 3" x 7" x 1½." Includes wall charger, carrying case, belt clip, flexible antenna and nicad batteries. Selectable AM/FM modes.

SPECIAL! Bearcat® DX1000-BB

List price $649.95/**CE price $339.00/SPECIAL**
Frequency range 10 KHz. to 30 MHz.
The *Bearcat* DX1000 shortwave radio makes tuning in London as easy as dialing a phone. Features PLL synthesized accuracy, two time zone 24-hour digital quartz clocks and more. Add $12.00 for shipping.

NEW! Bearcat® 800XLT-BB

List price $499.95/**CE price $294.00/SPECIAL**
12-Band, 40 Channel • No-crystal scanner Priority control • Search/Scan • AC/DC
Bands: 29-54, 118-174, 406-512, 806-912 MHz.
The Uniden 800XLT receives 40 channels in two banks. Scans 15 channels per second. Size 9¼" x 4½" x 12½."

OTHER RADIOS AND ACCESSORIES

Panasonic RF-2600-BB Shortwave receiver $179.95
Panasonic RF-B300-BB Shortwave receiver $195.95
RD95-BB *Uniden* Remote mount Radar Detector ... $139.95
RD55-BB *Uniden* Visor mount Radar Detector $119.95
BC 20/20-BB *Bearcat* 40 channel scanner **SALE** ... $224.95
BC 210XW-BB *Bearcat* 20 channel scanner **SALE** ... $209.95
BC 260-BB *Bearcat* 16 channel scanner **SALE** $194.95
BC 300-BB *Bearcat* 50 channel scanner **SALE** $254.95
BC-WA-BB *Bearcat* Weather Alert™ $39.95
DX1000-BB *Bearcat* shortwave receiver **SALE** $339.00
PC22-BB *Uniden* remote mount CB transceiver $99.95
PC55-BB *Uniden* mobile mount CB transceiver $59.95
Z45-BB *Regency* 45 channel scanner **SALE** $169.95
R1060-BB *Regency* 10 channel scanner $98.95
MX3000-BB *Regency* 30 channel scanner $189.95
C403-BB *Regency* 4 channel scanner **SALE** $65.95
R106-BB *Regency* 10 channel scanner $99.95
RH250B-BB *Regency* 10 channel VHF transceiver ... $329.00
RU150B-BB *Regency* 10 channel UHF transceiver ... $449.00
RPH410-BB 10 ch. handheld no-crystal transciever ... $399.00
BC10-BB Battery charger for *Regency* RPH410 ..... $79.95
MA256-BB Drop-in charger for HX1000 scanner ... $68.95
MA257-BB Cigarette lighter cord for HX1000 ..... $19.95
MA917-BB Ni-Cad battery pack for HX1000 ..... $29.95
EC10-BB Programming tool for *Regency* RPH410 .... $20.00
SMRH250-BB Service man. for *Regency* RH250 .... $20.00
SMRU150-BB Service man. for *Regency* RU150 .... $20.00
SMRPH410-BB Service man. for *Regency* RPH410 ... $20.00
SMMX7000-BB Svc. man. for MX7000 & MX5000 .... $20.00
SMMX3000-BB Service man. for *Regency* MX3000 ... $20.00
B-4-BB 1.2 V AAA Ni-Cad batteries (set of four) $9.00
A-135C-BB Crystal certificate $3.00
FB-E-BB Frequency Directory for Eastern U.S.A. $12.95
FB-W-BB Frequency Directory for Western U.S.A. $12.95
TSG-BB "Top Secret" Registry of U.S. Govt. Freq. $15.00
TIC-BB Techniques for Intercepting Comm. $15.00
RRF-BB Railroad frequency directory. $10.00
CIE-BB Covert Intelligence, Elect. Eavesdropping ... $15.00
A60-BB Magnet mount mobile scanner antenna ... $35.00
A70-BB Base station scanner antenna $35.00
USAMM-BB Mag mount VHF/UHF ant. w/ 12' cable ... $39.95
USAK-BB ¾" hole mount VHF/UHF ant. w/ 17' cable ... $35.95
USATLM-BB Trunk lip mount VHF/UHF antenna ... $35.95
Add $3.00 shipping for all *accessories* ordered at the same time.
Add $12.00 shipping per shortwave receiver.
Add $7.00 shipping per scanner and $3.00 per antenna.

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To ***get the fastest delivery from CE*** of any scanner, send or phone your order directly to our Scanner Distribution Center.™ Michigan residents please add 4% sales tax or supply your tax I.D. number. Written purchase orders are accepted from approved government agencies and most well rated firms at a 10% surcharge for net 10 billing. All sales are subject to availability, acceptance and verification. All sales on accessories are final. Prices, terms and specifications are subject to change without notice. All prices are in U.S. dollars. Out of stock items will be placed on backorder automatically unless CE is instructed differently. A $5.00 additional handling fee will be charged for all orders with a merchandise total under $50.00. Shipments are F.O.B. Ann Arbor, Michigan. No COD's. Most products that we sell have a manufacturer's warranty. Free copies of warranties on these products are available prior to purchase by writing to CE. Non-certified checks require bank clearance.

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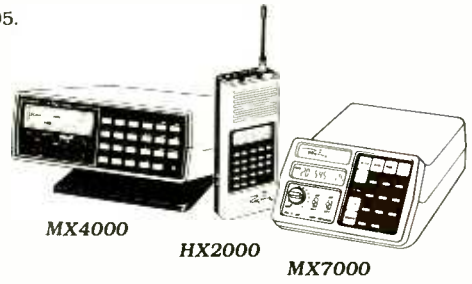

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EDITORIAL

Cellular Telephones

A telephone in every car is akin to a "chicken in every pot." Promises, however, don't make it come true. Cellular telephones are causing a boomlet in automobile phone communications today, but there are still problems now and on the horizon.

Firstly, they aren't cheap, ranging anywhere from just under $1,000 to a few thousand dollars if you want all the fancy works. Leasing softens the blow, of course. Moreover, communication facilities are not in all areas of the country by a long shot. If you do more than local travelling, therefore, your cellular car phone may not do you much good. Furthermore, cellular communications does not take well to hills and dales, so some fading and static might occur in certain areas.

Equally important, is cellular here to stay in its present form? This has been seriously questioned, most recently by International Resource Development, a Norwalk, CT market-research company. They say that it might prove to be an interim technology. The researchers point out that the telecommunications world is going digital, making cellular's analog networks obsolete. There's talk, too, about a satellite system being developed for mobile phone communications that would obsolete present systems.

For most people, it's not truly a necessity. Moreover, it's not a cost-effective product since you pay extra for each call as well as for standard telephone landline use. In other words, it's in the luxury category, which limits its utility.

Further, using a cellular telephone while cruising is dangerous. One needs his eyes and hands just to drive through traffic. Voice-activated mobile phones could well overcome this complaint, though.

Nonetheless, for people who can now easily afford the costs of cellular telephone for car, boat, and even portable communications, they can enjoy the luxury of reaching or being reached by telephone anywhere at any time—provided they're in an area covered by cells. They can even send computer data over the cellular phone if they wish. In fact, a "portable office" system that contains a cellular telephone, an Epson "Geneva" computer, Motorola "Datalink" cellular modem, an ac/dc rechargeable power system, and system software—all in a carrying case—is being marketed for $4,400 (Comm 88, Minneapolis, MN). So you can work while fishing, if you like.

It's great to be prosperous, I guess.

Art Salsberg

LETTERS

Peek & Poke

• Thank you for including the Tandy 100 and 200 in your review of portable computers, (*Modern Electronics,* August 1985) mentioned above. The article was very informative and interesting to read. The Model 200 does, however, support PEEKs and POKEs (as the author questioned.)

Fran McGehee
Radio Shack
Ft. Worth, TX

Print Plainly, Please

• I thoroughly enjoyed your November editorial, "Buying By Mail." As owner of a small company that sells light chasers, color organs, etc., through mail-order advertisements in magazines such as *Modern Electronics,* customer confidence in my company is a must. Educating the consumer on their rights as a mail order customer is the best way I know of to discourage those few individuals and/or companies that will try to exploit the buyer and consequently give the mail-order business a tarnished name. Since we are educating the customer on mail-order buying, I would like to pass on a valuable suggestion that I am sure will be supported by others. The mail-order customer should print very plainly or type all order information and not abbreviate any portion of an address. I get some catalog requests with the address so poorly written that the only thing I can do is throw it away and hope the irritated individual repeats their request more legibly.

David L. Holmes
Design Specialty
Huntington Beach, CA

Better Reliability?

• I believe I found a possible problem in Fig. 4 of "Electronics Notebook" October 1985. The potentiometer shown connecting between the supply voltage and pin 7 could be adjusted to zero ohms, thus damaging the 555 timer. Inserting a 10-k ohm fixed resistor in series with this potentiometer would produce a more reliable circuit without seriously altering its performance.

Michael F. Halbern
Electronics Instructor
Sierra College, Rocklin, CA

This raises an interesting point, particularly since I have used variations of the basic circuit cited in his letter for many years without damaging any 555 chips. Therefore, I conducted a few simple tests. When the potentiometer between the supply voltage and pin 7 is shorted, the current flowing into pin 7 of several standard 555s I tried ranged from 60 to 70 milliamperes. This much current should not damage a standard 555. I left a shorted 555 circuit switched on for an hour or so, and though the chip became warm, the circuit functioned normally when the short was removed. Of course, shorting the chip reduces battery life.

MOS versions of the 555 are another matter. Shorting the power supply voltage directly to pin 7 gives a current of several hundreds of milliamperes. Brief shorts will not damage the chip, but longer duration shorts will quickly cause the chip to become overheated.

My conclusion is that if the 555 circuit is intended for a commercial application or if a CMOS 555 is used, Mr. Halbern's suggestion should be heeded. For experimental applications with standard 555s, the use of the 10k series resistor is optional.—Forrest Mims, III

Kudos

• Since the old *Popular Electronics,* I have not found a magazine such as yours, where the news is always crisp and seems to be just the kind of things I want and need to know. The product evaluations are insightful and informative, giving me a complete overview of new products in a matter of minutes that would take me hours on my own, if I could get my hands on the equipment.

It is a rare issue of *Modern Electronics* that does not have at least one project I have been waiting to see. Each construction project seems to be carefully scrutinized for simplicity and ease of building. Each feature article gives me the important facts and cuts the heavy theory, yet always seems to reinforce the basics.

Of particular interest to me are Forrest Mims' and Don Lancaster's columns. My major in college was automated manufacturing, and I love information about making electronic circuits and computers control real-time events.

Wilson Cooper
Greenwood, SC

At Sea

• Re: "A °C/°F Thermometer Accessory," October 1985, the calibration section states: Then immerse the sensor probe in the boiling water and readjust *R9* to obtain 100 °C reading." That works fine at sea level, but not all of your readers live at sea level.

According to The World Alamanac 1985, the boiling point of water drops by 1 °F for each 550 feet in elevation above sea level. That would make it 1 °C for each 990 feet above sea level. Thus, here in Cody *R9* should be adjusted to obtain a 95 ° reading in boiling water, and 93 ° in Laramie, Wyoming.

Lowell Ray Anderson, C.D.P.
Cody, WY

MODERN ELECTRONICS NEWS

VIDEO GAMES LIVE! Who says that home video games are dead? Not INTV Corp., which has introduced its INTV System III "Intellivision" video game, a $59.95 machine that's compatible with all Intellivision game cartridges. You know Intellivision, the video game machine introduced by Mattel Electronics in 1980. Now owned by INTV Corp., their intention is to revitalize the video-game market since little competition exists now, only 20% of U.S. homes were penetrated with any video games, and there is a library of over 200 Intellivision games and educational software programs available. INTV forecasts 1985 delivery of 750,000 cartridges and 100,000 game machines. It plans to introduce a licensed version of "Karate Champ," the country's number-one arcade game.

SERVICING SCENE. A personal computer servicing network operation has been launched by PC ServNet, Westlake Village, CA (818-706-3113). Unlike a franchise, it offers PC service companies expertise in marketing, information and co-op resources, and purchasing services according to their needs with no royalty fees. PC ServNet also offers a New Business Development Package for those seeking to start a PC service business.

"A SIDE OF BEEF AND A SATELLITE TV SYSTEM, PLEASE." Amway Corp., which sells food, cleaning supplies, and a host of other products through its nationwide independent distributors, has added satellite TV to its line. The new Amway Satellite receiver is priced at $999.99 (let's call it $1000), and uses a six-ft. perforated dish that doesn't require professional installation.

DuPONT-PHILIPS OPTICAL DISC VENTURE. The world's preeminent supplier of optical discs is the stated goal of a joint-venture agreement between the DuPont Company and N.V. Philips. The market for these discs are expected to exceed $4-billion by 1990. The companies will combine all their existing compact disc and high-density information storage disc operations.

A single CD-ROM has the capacity of 1500 floppy disks or about 250,000 typewritten pages. A single CD can store all 26 volumes of the Encyclopedia Britannica and find all references in about five seconds, while five CDs could store all the telephone directories in the U.S. Moreover, a single 14" high-density optical disc used with a mainframe computer could replace 40 reels of magnetic type. Looks like lasers are "in."

PIRATE BROADCAST STATIONS. U.S. Marshals served a warrant and seized radio transmitting equipment from an unlicensed "pirate" radio station in Arkansas. The operation was broadcasting in the 6 and 7-MHz shortwave broadcast band, using a 7.744-MHz frequency and identifying as "KBBR." Other illegal transmissions made with the indentifications as "KRZY' and "Captain Crazy" were caught earlier, resulting in a $1000 fine. The new charge holds a maximum possible penalty of one year imprisonment, a fine up to $10,000, and forfeiture of equipment.

AM STEREO TEST. Kahn Communications, which produces the increasingly popular Kahn/Hazeltine AM Stereo transmission equipment, will be making a signal generator in cooperation with Boonton Electronics, in expectation of large-scale production of multi-system AM Stereo receivers that use newly developed multi-system ICs that can automatically switch from one type of stereo format being transmitted to another. Kahn/Hazeltine and Motorola are the big competitors here, with broadcasters able to choose either.

PHILIPS KEITHLEY WESTON NLS Non-Linear Systems Simpson B&K PRECISION LEADER

FLUKE 70 SERIES MULTIMETERS

77
- 0.3% Accuracy
- Manual or Autorange
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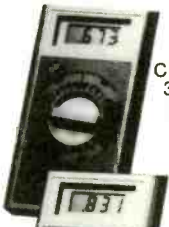
AVAILABLE NOW. . . .

$64.95
Circuitmate DM 20— 3½-digit, pocket-size multimeter; 0.8% Vdc accuracy, diode test, hFE test, conductance, 10 amps AC and DC ranges, auto-polarity auto-zero, auto-decimal

$79.95
Circuitmate DM-25— 3½ digit, pocket-size multimeter; 0.5% Vac accuracy, diode test, capacitance, continuity beeper, conductance, 10 amps AC and DC ranges, auto-polarity, auto-zero, auto-decimal



$69.95
Circuitmate DM-40 — 3½-digit multimeter; 0.8% Vdc accuracy, diode test, auto-polarity, auto-zero, auto-decimal

$89.95
Circuitmate DM 45 — 3½-digit multimeter; 0.5% Vdc accuracy, diode test,continuity beeper, 10 amps AC and DC ranges, auto-zero, auto-polarity, auto-decimal

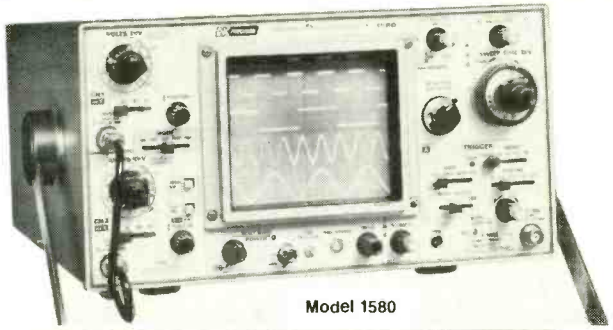
B&K PRECISION DYNASCAN CORPORATION

BREAKS THE PRICE BARRIER WITH THESE HIGH PERFORMANCE OSCILLOSCOPES

100 MHz Dual Trace/ Dual Time Base

- 1 mV/div sensitivity
- 23 calibrated sweeps
- Rectangular CRT with internal graticule and scale illumination
- Signal Delay Line

$995
Does not include probes
($60.00 a pair when purchased with scope)



Model 1580

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INDUSTRIAL TRANSISTOR TESTER

$219.95

MODEL 520B

- **Now with HI/LO Drive**
- **Works in-circuit when others won't**
- **Identifies all three transistor leads**
- **Random lead connection**
- **Audibly and visually indicates GOOD transistor**

B&K PRECISION

100 MHz Dual Time Base SCOPE MODEL 1590

$1395.00

PRICE DOES NOT INCLUDE PROBES

- 1mV/division sensitivity to 70 MHz
- 500 μ V/division cascade sensitivity
- Four-input operation provides trigger view on 4 separate inputs
- Alternate time base operation
- Switching power supply delivers best efficiency and regulation at lowest weight

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"Say You Saw it in Modern Electronics"

Learn robotics and you build this robot

New NRI home training prepares you for a rewarding career in America's newest high-technology field.

The wave of the future is here. Already, advanced robotic systems are producing everything from precision electronic circuits to automobiles and giant locomotives. By 1990, over 100,000 "smart" robots will be in use.

Over 25,000 New Jobs

Keeping this robot army running calls for well-trained technicians . . . people who understand advanced systems and controls. By the end of the decade, conservative estimates call for more than 25,000 new technical jobs. These are the kind of careers that pay $25,000 to $35,000 a year right now. And as demand continues to grow, salaries have no place to go but up!

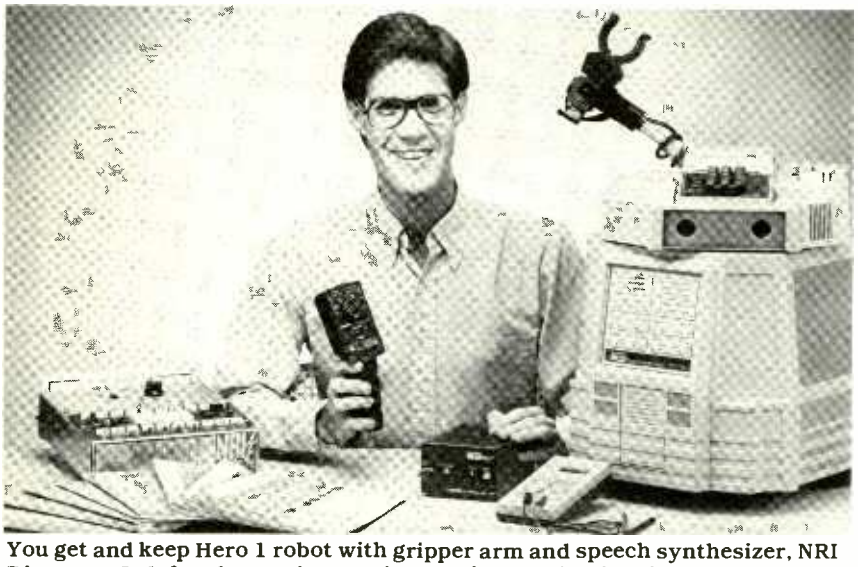
Build Your Own Robot As You Train at Home

Now, you can train for an exciting, rewarding career in robotics and industrial control right at home in your spare time. NRI, with 70 years of experience in technology training, offers a new world of opportunity in one of the most fascinating growth fields since the computer.

You need no experience, no special education. NRI starts you at the beginning, takes you in easy-to-follow, bite-size lessons from basic electronics right on through key subjects like instrumentation, digital and computer controls, servomotors and feedback systems, fluidics, lasers, and optoelectronics. And it's all reinforced with practical, hands-on experience to give you a priceless confidence as you build a programmable, mobile robot.

Program Arm and Body Movement, Even Speech

Designed expecially for training, your robot duplicates all the key elements of industrial robotics. You learn to operate, program, service, and troubleshoot using the same techniques you'll use in the field. It's on-the-job training at home!

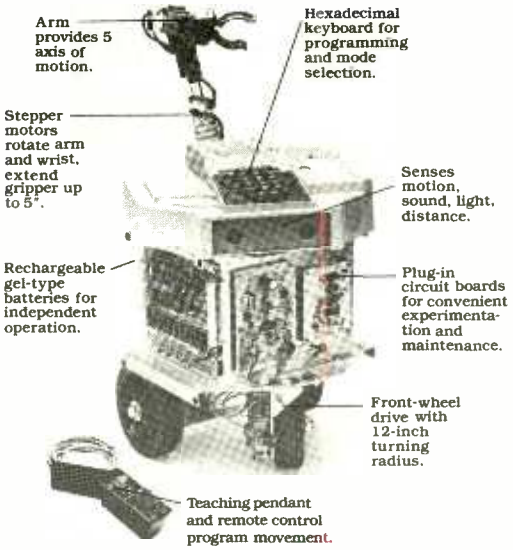


You get and keep Hero 1 robot with gripper arm and speech synthesizer, NRI Discovery Lab for electronic experimentation, professional multimeter with 3½-digit LCD readout, 51 fast-track training lessons.

industrial control as

Building this exciting robot will take you beyond the state of the art into the next generation of industrial robotics.

You'll learn how your completely self-powered robot interacts with its environment to sense light, sound, and motion. You program it to travel over a set course, avoid obstacles using its sonar ranging capability. Program in complex arm and body movements using its special teaching pendant. Build a wireless remote control device demonstrating independent robot control in hazardous environments. You'll even learn to synthesize speech using the top-mounted hexadecimal keyboard.



Your mobile robot duplicates functions of state-of-the-art industrial units.

Training to Build a Career On

NRI training uniquely incorporates hands-on building experience to reinforce your learning on a real-world basis. You get professional instruments, including a digital multimeter you'll use in experiments and demonstrations, use later in your work. And you get the exclusive NRI Discovery Lab®, where you examine and prove out theory from basic electrical concepts to the most advanced solid-state digital electronics and microprocessor technology. Devised by an experienced team of engineers and educators, your experiments, demonstrations, and equipment are carefully integrated with 51 clear and concise lessons to give you complete confidence as you progress. Step-by-step, NRI takes you from the beginning, through today, and into an amazing tomorrow.

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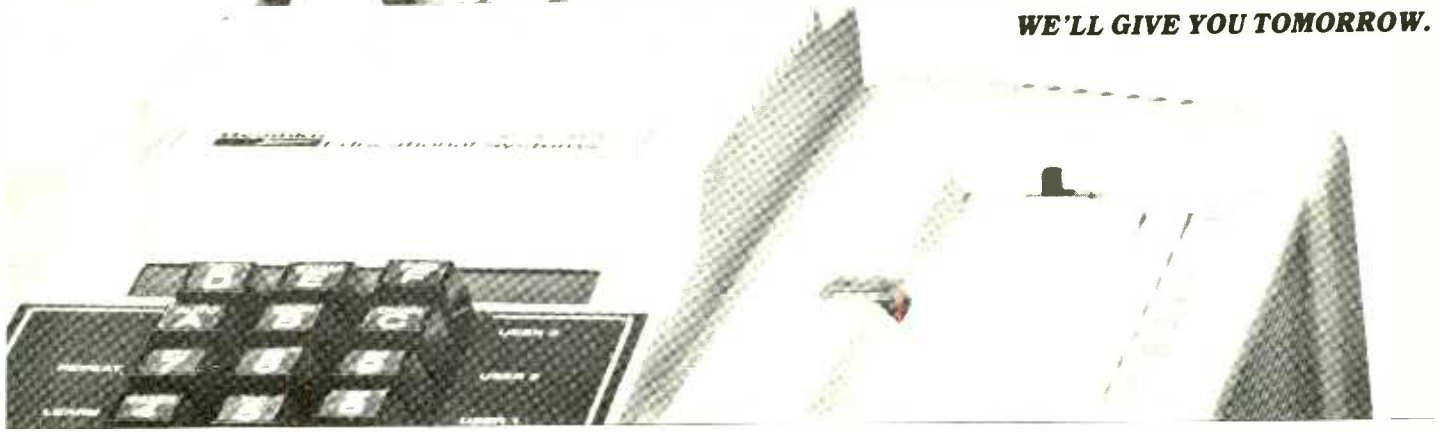
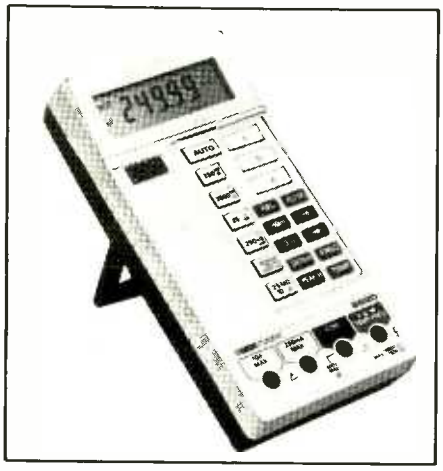


For more information on products described, please circle the appropriate number on the Free Information Card bound into this issue or write to the manufacturer.

Multi-Function DMM

B&K-Precision's 4½-digit Model 2820 true-rms digital multimeter has a built-in frequency counter and temperature and relative dBm measuring functions. The handheld DMM also offers peak- and data-hold, diode-test and audible continuity functions. Microprocessor



technology and pushbutton function selectors control everything.

Frequency counter range is 10 Hz to 99.999 kHz. Relative measurement values are displayed as deviations from a stored reference voltage, current or resistance. All dBm measurements (this function is calibrated at 1 mW into 600 ohms) are in a ratio between test and reference-level voltages over a −50.00- to +59.7-dBm range. The true-rms function accurately measures nonsinusoidal repeating waveforms.

Peak-hold works on dc and ac current, voltage and temperature, while data-hold works on the same plus resistance, diode-check and dBm.

Ac/dc voltage to 750/1000 volts, ac/dc current to 10 amperes and reistance to 25 megohms maximum can be measured. Rated accuracy is 0.04%.

CIRCLE 33 ON FREE INFORMATION CARD

Two-Speed, Full-Feature PC-Compatible Computer

New to the Heath line of IBM PC-compatible computer kits is the Model HF-158 that offers switchable 4/8-MHz processing. It features six expansion slots; composite monochrome and RGB color video outputs; and a redesigned keyboard with large L-shaped RETURN and double-

wide SHIFT keys located in the standard typewriter positions.

Supplied standard with this desktop computer are 256K of RAM (optionally expandable to 640K), RS-232 serial and parallel ports, a powerful 300-watt power supply, and a 5¼″ floppy-disk drive. Options include a second floppy drive, 10M and 20M hard-disk systems and monochrome and RGB monitors.

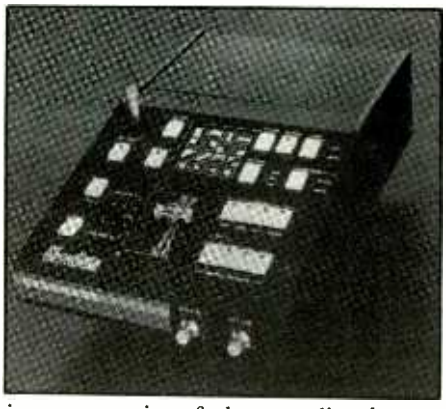
The computer has a 16.5″D × 16″W footprint and is 6.5″H, excluding keyboard. $1599 with one floppy disk drive; $1799 with two drives (both with MS-DOS).

CIRCLE 34 ON FREE INFORMATION CARD

Video/Audio Effects Generator

Showtime Video Venture's "Showmaster Creator" is a full-featured, low-cost special-effects audio/video generator for the consumer market. With this device, you can get such effects as edit, mix, dub and creat video art during playback, recording and live. There are no extras to buy, such as joysticks and other controls.

With Showmaster Creator, you can cut back and forth between video



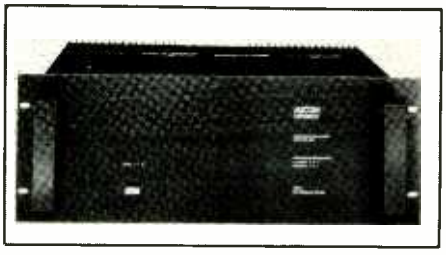
images or wipe, fade, cut, dissolve a picture or superimpose a picture on another with the touch of a button, joystick, slide controller or knob control. Special controls let you: create a black and white picture with no greys; create video art like inside-out psychedelic art you see in rock videos; create a black and white background with a brightly colored background.

Features include manual and automatic control that lets you push one image off the screen as you replace it with another in 36-plus pattern and directional variations; bouncing ball effect; zoom capability that allows you to change the size of the displayed graphics; a spotlight effect that brightens a selected area of the picture in four different shapes; a wide range of color controls; audio controls that allow you to select and or mix soundtracks from internal or external sources and create two-channel sound. $499.95.

CIRCLE 35 ON FREE INFORMATION CARD

Stereo Power Amplifier

Adcom's Model GFA-555 stereo power amplifier is specified at 200 watts rms per channel into 8 ohms from 20 Hz to 20 kHz at less than 0.09% THD. It is designed to remain



stable under extreme operating conditions, such as when a speaker presents a load that ranges from 40 to less than 2 ohms.

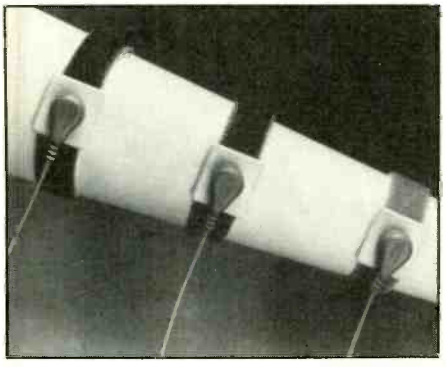
The amplifier's direct gain path has a minimum of components from input to output and is built around discrete components that are "tweaked" for optimum performance. A 700-watt toroidal transformer with two secondaries that function similarly to two separate transformers provide tight regulation and minimum interchannel crosstalk, vibration, hum and noise. A new current feedback technique provides highly stable bias circuitry for drive and output transistors. Benefits cited for these and other design approaches include lower distortion throughout the gain path, elimination of spurious oscillations, improved bandwidth into difficult loads, low phase shift and high damping factor. $599.95

CIRCLE 36 ON FREE INFORMATION CARD

Antistat Wrist Bands

For safe handling of static-sensitive devices, Charleswater Products, Inc., West Newton, MA, offers a line of electrically conductive elastic wrist bands in large, medium and small sizes. The Statfree (CP407) wrist bands are color coded for easy indentification. Small fits 4½" to 6" wrists, medium fits 5½" to 7¼" wrists and large fits 6½" and larger wrists.

The Statfree bands are breathable and washable and are claimed to be clean-room safe. Interwoven into the polyester bands are stainless-steel fibers. Each comes with a combination alligator clip and banana plug. Ground cords are available in 5-ft. straight and 6- and 10-ft. coiled lengths. From $15.



CIRCLE 37 ON FREE INFORMATION CARD

Isolation Transformers

Isolation transformers designed to provide a variety of 1.05-kVa isolated output options have been announced by VIZ Test Equipment. Called the WP-31 Series, the new transformers are available in four different models, designated by the same model number plus an A, B, C or D suffix. The Models WP-31 A and B offer fixed outputs, while the Models WP-31 C and D offer variable output. The transformers are claimed to have low harmonic distortion at 1.0 power factor and minimal leakage current (does not exceed 10 nanoamperes from any section to ground). Full load is 1% with overload protection provided by a thermal circuit breaker.

The Models WP-31 C and D have one isolated output each. A 117-volt ac unit, the Model WP-31 C provides 0-to-155- volt output range in 1-volt increments, while the 220-volt Model WP-31 D provides a 190-to-260-volt ac range in 2-volt steps. $179 for WP-31A; $179 for WP-31 B; $205 for WP-31 C; $209 for WP-31 D.

CIRCLE 38 ON FREE INFORMATION CARD

Synthesizer/Recorder For the Commodore-64

You can play, record and synthesize music on a Commodore-64 computer with Tech Sketch's Music Port keyboard and software system. A full-size 3-octave keyboard allows you to double-track music and create your own accompaniment and store 10-minute musical selections on disk.

Completely menu-driven, the system does not use the computer's keyboard. The program provides a symphony of preset instrument sounds, and user-friendly menus easily permit you to create and store an infinite variety of sounds. Special effects like vibrato, reverberation, phase shift, etc., are also easily achieved with Music Port.

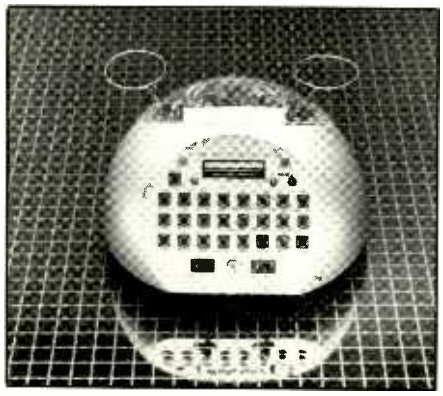
The 37-key, full-travel keyboard is not an overlay but a separate musical instrument that plugs into the computer's music port. Software permits fast access to all eight musical octaves and makes full use of the computer's sound interface device (SID) chip, including its ability to generate three tones simultaneously. The system even allows you to record music at one speed and play it back at another to change tempo. $149.

CIRCLE 39 ON FREE INFORMATION CARD

Educational Robot Kit

A new "WAO" (stands for Wise, Argent, Orb) kit has been added to OWI Inc.'s (Compton, CA) line of Movit educational robots line. Designed to

NEW PRODUCTS...



teach the fundamentals of computer programming, it can draw graphics and can be used to develop awareness of robotics.

WAO is built around a custom microprocessor. Its on-board computer stores a system program in a 2K ROM and has 128 bytes of 4-bit user RAM. This gives the robot the ability to execute programs entered via a keyboard on the rear of its domed enclosure. WAO can also communicate with selected personal computers via optional software and cable. Its "wisdom" extends beyond its computer electronics to its mechanical system. A pen holder at the center of its mechanism permits WAO to draw graphics patterns.

CIRCLE 4 ON FREE INFORMATION CARD

800-MHz Rooftop Antenna

A new 3-dB gain antenna suitable for 800-MHz radio systems, such as cellular telephones, has been announced by The Antenna Specialists Company. The Model ASPA1851N rooftop-mount antenna is said to be designed for optimum electrical performance in the 800-to-866-MHz range, where unacceptable noise levels can be generated from poor connections.

Positive r-f connection at the base of the antenna is accomplished with a male/female contact pair. Further integrity is achieved with low-noise crimp connections at both the mount and type-N male terminations of the 17-ft. Pro-Flex cable supplied with the antenna. The stainless-steel radiator comprises precision-tuned ⅝-wavelength upper and ¼-wave lower sectons that are separated by a precisely wound phasing coil. VSWR is rated at less than 1.5:1, bandwidth at 60 MHz.

CIRCLE 42 ON FREE INFORMATION CARD

Magnetizer/Demagnetizer

The Davle Tech Model 19-205 is an ac-powered magnetizer/demagnetizer that can be used with all types of hand tools and other steel objects measuring up to 3″ × 1½″ in cross-section. The unit is equipped with an on/off switch and an 8-ft. SJ line cord. Power consumption is 300 watts when operated from a 117-volt, 60-Hz ac line.

CIRCLE 43 ON FREE INFORMATION CARD

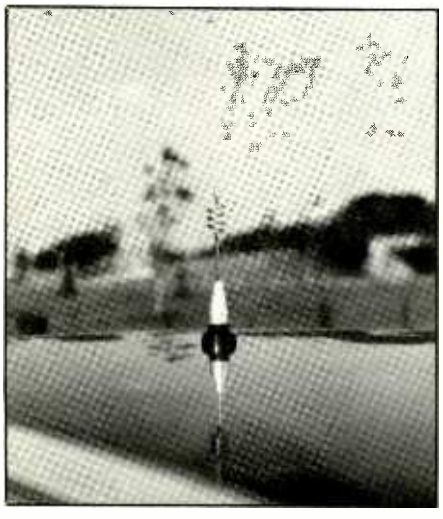
Satellite TV Receiver

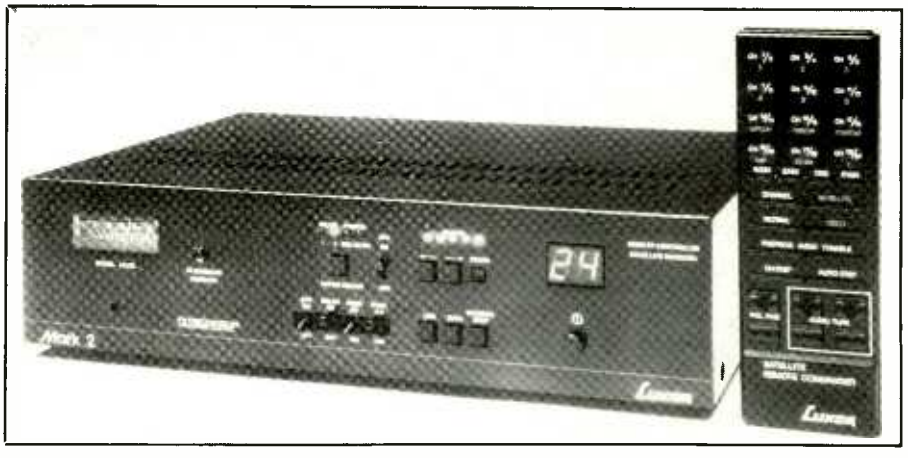
Luxor's Mark 2 remote-controlled satellite TV receiver has both C-band and DBS (Ku-band) capability. Low-noise block downconverters (LNBs) at the antenna convert the 3.7-to-4.2-GHz C-band signal or the 11.7-to- 12.5-GHz Ku-band signal to the Mark 2's 950-to-1750-MHz input frequency.

Block conversion allows several TV receivers or monitors to share a single antenna and gives each independent channel selection capability. As TV receivers and/or monitors are added, another Mark 2 gives independent program and format control.

Mark 2 is preprogrammed and operated by an infrared (wireless) remote controller. An optional Remote Infrared Sensor allows use of the remote in a room other than that in which the receiver is located. An antenna positioner can also be remote controlled. A built-in modulator is said to deliver sharp, clear, noise-free video, while automatic fine tuning maximizes video signals. $761.

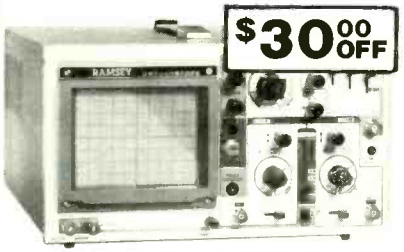
CIRCLE 44 ON FREE INFORMATION CARD





RAMSEY

THE FIRST NAME IN ELECTRONIC TEST GEAR



$30.00 OFF

Save $30 on the RAMSEY 20MHz Dual Trace Oscilloscope

Unsurpassed quality at an unbeatable price, the Ramsey oscilloscope compares to others costing hundreds more. Features include a component testing circuit for resistor, capacitor, digital circuit and diode testing • TV video sync filter • wide bandwidth & high sensitivity • internal graticule • front panel trace rotator • Z axis • high sensitivity x-y mode • regulated power supply • built-in calibrator • rock solid triggering

Was $399.95 NOW ONLY $369.95 high quality hook on probes included

NEW RAMSEY 1200 VOM MULTITESTER

Check transistors, diodes and LEDs with this professional quality meter. Other features include: decibel scale • 20K volt metering system • 3½" mirrored scale • polarity switch • 20 measuring ranges • safety probes • high impact plastic case

$19.95 test leads and battery included

NEW

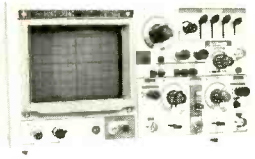
RAMSEY D-4100 COMPACT DIGITAL MULTITESTER

Compact sized reliability and accuracy. This LCD digital multitester easily fits in your pocket, you can take it anywhere. It features full overload protection • 3½ digit LCD readout • recessed input jacks • safety probes • diode check function • 2000 hours battery life

$22.95 test leads and battery included

NEW

35 MHz DUAL TRACE OSCILLOSCOPE



A heavy duty and accurate scope for service as well as production use. Features include • wide frequency bandwidth • optimal sensitivity • extremely bright display • delayed triggering sweep • hold off • ALT trigger • single sweep • TV sync • 5X magnification • XY or XYZ operation • HF/LF noise reduction

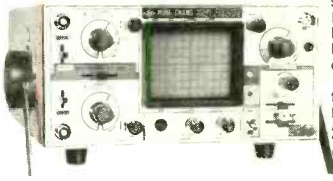
3500 Dual Trace Oscilloscope

$499.95 includes 2 high quality probes

ALL OSCILLOSCOPES INCLUDE 2 PROBES

NEW

15 MHz DUAL TRACE PORTABLE OSCILLOSCOPE



Ideal for field/bench applications, this scope can display up to 15 MHz signals. Internal battery pack allows up to 2 hours operation on a single charge. Features include • built-in battery charger • 5X horizontal magnification • high brightness CRT • front panel trace rotator • internal rechargeable battery pack

2500 Portable Oscilloscope

$449.95 includes 2 high quality probes

MINI KITS—EASY TO ASSEMBLE, FUN TO USE BEGINNERS & PROS WILL HAVE A GREAT TIME WITH THESE KITS

FM MINI MIKE

A super high performance FM wireless mike kit! Transmits a stable signal up to 300 yards with exceptional audio quality by means of its built in electret mike. Kit includes case, mike, on-off switch, antenna, battery and super instructions. This is the finest unit available.

FM-3 Kit $14.95
FM-3 Wired and Tested 19.95

Color Organ

See music come alive! 3 different lights flicker with music. One light each for, high, mid-range and lows. Each individually adjustable and drives up to 300 W. runs on 110VAC

Complete kit, ML-1 $8.95

Video Modulator Kit

Converts any TV to video monitor. Super stable, tunable over ch 4-6. Runs on 5-15V accepts std. video signal. Best unit on the market! Complete kit VD-1 $7.95

Led Blinky Kit

A great attention getter which alternately flashes 2 jumbo LEDS. Use for name badges, buttons, warning panel lights, anything! Runs on 3 to 15 volts. Complete kit, BL-1 $2.95

Super Sleuth

A super sensitive amplifier which will pick up a pin drop at 15 feet! Great for monitoring baby's room or as general purpose amplifier. Full 2W rms output, runs on 6 to 15 volts, uses 8-45 ohm speaker.

Complete kit, BN-9 $5.95

CPO-1

Runs on 3-12 Vdc 1 watt out. 1 KHZ good for CPO, Alarm, Audio Oscillator. Complete kit $2.95

FM Wireless Mike Kit

Tansmits up to 300' to any FM broadcast radio, uses any type of mike. Runs on 3 to 9V. Type FM-2 has added sensitive mike preamp stage.

FM-1 Kit $3.95 FM-2 Kit $4.95

Whisper Light Kit

An interesting kit, small mike picks up sounds and converts them to light. The louder the sound, the brighter the light. Includes mike, controls up to 300 W, runs on 110 VAC

Complete kit, WL-1 $6.95

Tone Decoder

A complete tone decoder on a single PC board. Features: 400-5000 Hz adjustable range via 20 turn pot, voltage regulation, 567 IC. Useful for touch-tone burst detection, FSK, etc. Can also be used as a stable tone encoder. Runs on 5 to 12 volts.

Complete kit, TD-1 $5.95

Universal Timer Kit

Provides the basic parts and PC board required to provide a source of precision timing and pulse generation. Uses 555 timer IC and includes a range of parts for most timing needs

UT-5 Kit $5.95

Mad Blaster Kit

Produces LOUD ear shattering and attention getting siren like sound. Can supply up to 15 watts of obnoxious audio. Runs on 6-15 VDC

MB-1 Kit $4.95

Siren Kit

Produces upward and downward wail characteristic of a police siren. 5 W peak audio output, runs on 3-15 volts, uses 3-45 ohm speaker.

Complete kit, SM-3 $2.95

60 Hz Time Base

Runs on 5-15 VDC. Low current (25ma) 1 min monin accuracy TB-7 Kit $5.50
TB-7 Assy $9.95

30 Watt 2 mtr PWR AMP

Simple Class C power amp features 8 times power gain. 1 W in for 8 out, 2 W in for 15 out, 4 W in for 30 out. Max output of 35 W, incredible value, complete with all parts, less case and T-R relay.

PA-1, 30 W pwr amp kit $22.95
TR-1, RF sensed T-R relay kit 6.95

Power Supply Kit

Complete triple regulated power supply provides variable 6 to 18 volts at 200 ma and +5 at 1 Amp. Excellent load regulation, good filtering and small size. Less transformers, requires 6.3V (a 1 A and 24 VCT. Complete kit, PS-3LT $6.95

MINI-100 FREQUENCY COUNTER

Features and capabilities of counters costing twice as much • compact • high sensitivity • low current drain • very accurate • leading zero blanking • field or shop use • 1 MHz to 500 MHz range • diode protected • 7 digit display

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RAMSEY

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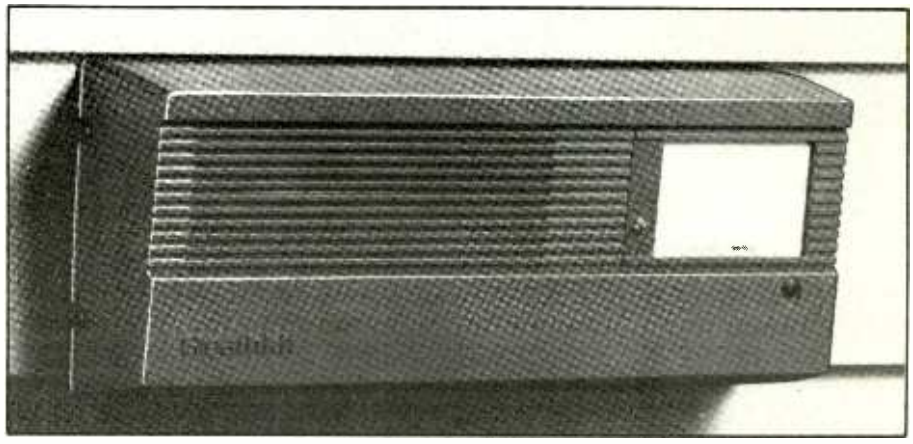
CIRCLE NO. 170 ON FREE INFORMATION CARD

Heath's New Verbal Warning/Light Controller

One night after you've retired, a burglar stealthily creeps up to your dark and quiet home. Suddenly, floodlights come on and a commanding male voice issues: "*Warning. You are entering a secured area. Please exit immediately.*" This is just one possible scenario if your home is protected by Heath's new Model GD-3810 Security Sentinel.

Security Sentinel is an automatic device that employs voice and light to scare away intruders. It uses infrared sensors to protect a surveillance area. When "tripped," its verbal message is generated electronically by an on-board ROM (read-only memory) integrated circuit, while up to 1200 watts of optional lighting that's equivalent to light 150-watt floodlights is activated.

The system, available only in kit form, costs $199.95.



General Description

This security device is housed inside a weather-resistant, neutral-color plastic enclosure. It measures 12.5"W × 5.5"H × 3.5"D and is designed to mount to an electrical junction box via a heavy-gauge steel backplate.

Inside the alarm are a printed-circuit assembly, a factory-assembled passive infrared sensor/lensing assembly and a weather-resitant oval loudspeaker. A phototransistor deactivates the floodlight-control system during daylight hours and arms it after dark; all automatically, of course.

The passive infrared sensor/lensing system "looks" out through a window cut into the front of the cabinet. It is protected from the elements by an optically opaque, infrared-transparent, "shade." This sensor is designed to detect body heat (rapid changes in temperature, or infrared energy) within its coverage area. The latter is adjustable over a fairly wide range of width and depth, to a maximum of 40 × 40 ft. Also adjustable is detection sensitivity, which can be tuned to disregard small animals.

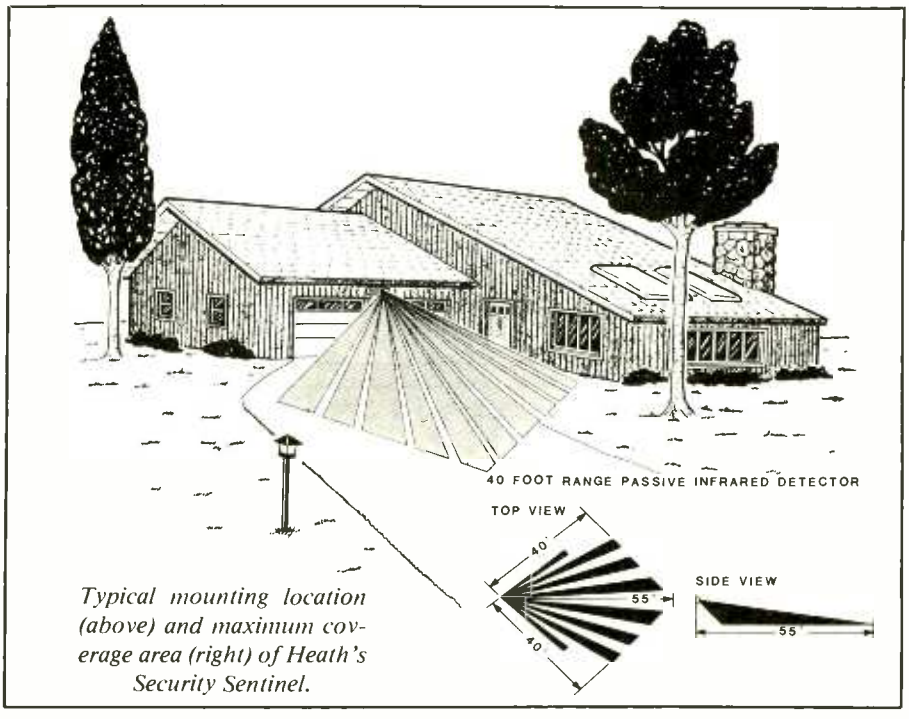
Three simple adjustments must be performed prior to installation. First, the reset delay must be set. Once the alarm is tripped and has cycled through the vocal message and activated whatever floodlighting is connected to it, you may wish it to keep the light on for a set period of time. During this period, any further activity within the area of surveillance will not retrigger the vocal message. Furthermore, any activity within this period triggers another equal-length delay. The system resets to active surveillance at completion of the countdown following the last detected activity. A wire jumper on the circuit board lets you program a delay of 4, 6 or 8 minutes.

You can disable the voice function for up to 8 minutes, providing automatic lighting for guests, if you wish to do so.

Next, you select how many times you wish the message to be vocalized after the sensor is tripped and the delay has counted down. Here, you have a choice of a single vocalization, two repetitions or four repetitions. Programming the number of vocalizations is also accomplished with a wire jumper on the board. The final pre-installation adjustment to be made is setting of the volume of the vocalized message. You do this by setting a trimmer potentiometer. Volume can be set from very soft to quite loud.

Installation and Setup

Where you install the Security Sentinel



Typical mounting location (above) and maximum coverage area (right) of Heath's Security Sentinel.

depends on the area you wish to keep under surveillance. You might select a location where it will provide front, rear or garage door protection. Or you might want to mount it indoors in a foyer or a special room or area in which are stored valuables. Whatever your choice, it's best to locate it about 8 ft. up on a wall, where it won't be easily accessible to unauthorized individuals.

Installation of the Security Sentinel should be done by a qualified electrician, since it entails direct connection to ac line wiring. Also, if you decide to have it control one or more floodlight accessories, direct connection between it and the floodlights must be made with electrically approved cable.

Mounting of the Security Sentinel is via its steel backplate, which is designed for installation on an electrical outlet or junction box. This puts all wiring inside the wall on which the alarm is mounted and places the alarm flush against the wall.

Once the Security Sentinel is mounted, you adjust the detector lens by rotating it to obtain the desired coverage pattern and by tilting it as necessary to obtain the desired distance. You then adjust the detector's sensitivity; the greater the sensitivity, the smaller the infrared-radiating object will trip the alarm.

Assembling the Kit

Unlike some of the Heath kits we've assembled in recent years, this one qualifies as a "true" kit in that it has only one subassembly that comes factory assembled. Otherwise, the entire kit must be assembled from discrete components. Lest you get the idea that this means a long stint at your workbench, however, we hasten to state that the entire kit can be assembled in a casual two evenings, even if you have minimal kit-assembly experience. In fact, a marathon-session kit builder can have this one ready for installation in a single session.

Much of the reason for speedy assembly of this kit is due to Heath's thoughtfulness in arranging resistors, diodes and small axial-lead capacitors on taped strips

(Continued on page 89)

THE MARK III

HV CIRCUIT SCANNER

- ★ Checks the horiz output circuit for open / shorts,
- ★ Checks the flyback, yoke, PC, and HV mult,
- ★ Checks all scan derived B + sources,
- ★ Checks all circuits that rely on scan derived B + voltage,
- ★ Checks for open safety capacitor,
- ★ Checks the emitter circuit of the horiz output,

THEN,

- ★ Provided the green normal light is lit, the Mark III will safely power up the TV set so that **you** can "look" for open circuits by examining the picture on the CRT.
- ★ Circumvents all start up and horiz drive related shut down circuits.

APPLICATIONS: The Mark III will analyze the horiz, flyback, hi-voltage, scan derived B + sources, yoke, pin cushion, HV multiplier circuits in any TV set that employs either an **NPN** transistor or a single **SCR** for its horiz output device. This applies to any age, any model, any chassis, any brand - - - including Sony.

In brief, the "test" function scans for shorts, the "run" function permits you to observe any "open" circuits via the symptoms that appear in the CRT screen.

HOOK - UP: Simply remove the set's horiz output device and replace it witn the scanner's interface plug. No wires to disconnect, no other connections required (not even a ground connection).

MISTAKE PROOF: No damage will result if an error is made during hook up. The scanner simply won't turn on until the error is corrected.

PUSH THE TEST BUTTON Just one of the four lights will lite.

RED OPEN LIGHT means the emitter circuit of the horiz output stage is open (no ground path).

YELLOW SHORT LIGHT means the flyback primary, HV multiplier, vertical output, horiz driver, and R-B-G color output stages are **not** shorted. Instead, a circuit that normally draws a small amount of current is shorted (i.e. the tuner, IF, AGC, video chroma, matrix, vertical or horiz oscillator).

RED SHORT LIGHT means either the flyback, the HV multiplier, the vertical output, horiz driver or one of the **R-B-G** output transistors is shorted.

GREEN NORMAL LIGHT means the TV set's entire flyback circuit is totally free of shorts. It also means that it is safe to power up the TV set with the "run" button so that you can look for open circuits by observing the symptoms on the CRT screen.

FEATURES: All **start up** circuits and all horiz drive related **shut down** circuits are automatically circumvented by the Mark III during all test and run functions. During the test function all flyback secondary output is limited to approx 80% of normal. 2nd anode voltage is limited to approx 5 KV.

This means all circuits that are not shorted will have some 80% of their normal B + voltage during the "test" phase. It also means that any shorted circuit will have zero DC volts on it. This feature makes any short easy to isolate.

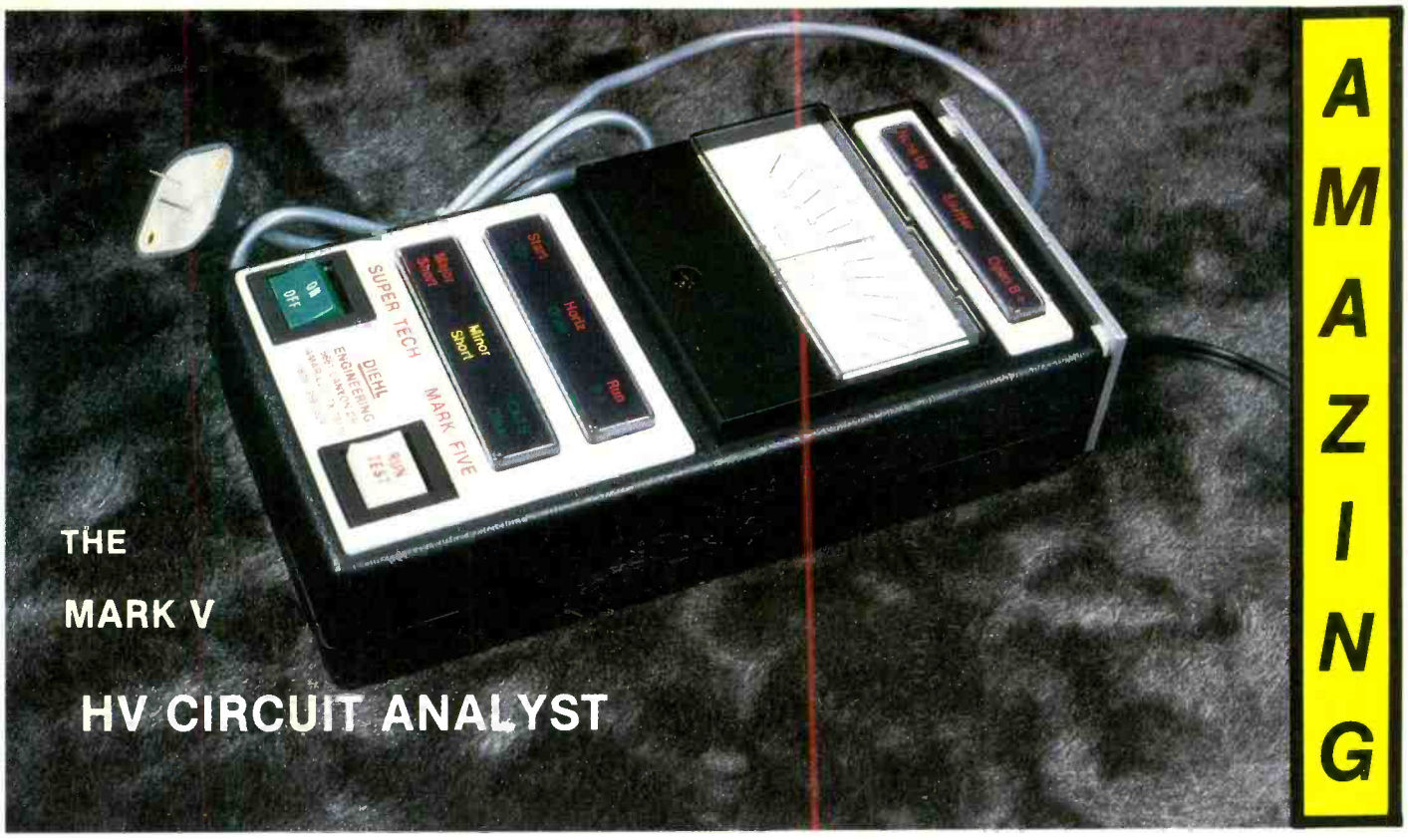
The MARK III sells for only $595^{00}

The money you are now spending for unnecessary flybacks alone will easily pay for your Mark III. Why not order yours today!

Visa and Mastercharge Welcome !

Diehl Engineering • 6661 Canyon Drive "F" • Amarillo, TX 79110
Phone: (806) 359-0329 or (806) 359-1824

CIRCLE 99 ON FREE INFORMATION CARD



- ★ Checks the horiz output stage for opens / shorts,
- ★ Checks flyback, yoke, PC, and HV mult,
- ★ Checks all scan derived B + sources,
- ★ Checks for open safety capacitors
- ★ Checks for open ground path for horiz output stage
- ★ Checks for open primary LV supply,
- ★ Checks for error in interface connections,
- ★ Checks for proper LV regulation,
- ★ Checks for proper start up circuit operation,
- ★ Checks for shorted horiz driver transistor,
- ★ Checks the operation of the horiz osc / driver circuits,
- ★ Checks B + "run" supply for the horiz osc / driver circuits,
- ★ Checks all circuits in the TV set that rely on scan derived B +,
- ★ Automatically circumvents all start up circuits and horiz drive related shut down circuits.

HOOK UP: (Identical to Mark III)

OPERATION: Turn the Mark V on, turn the TV set on, then, simply look at the lights.

RED "HOOK UP" LIGHT means that you have made an error in hook up. No damage has been done, correct the problem then continue.

RED "EMITTER" LIGHT means that the ground path for horiz output stage is open. Correct the problem then continue.

RED "B + OPEN" LIGHT means that the primary LV supply in the TV set is open. Correct the problem then continue.

No "top row lights" equals normal.

Look at the middle row of lights

RED "START UP" LIGHT means that the start up circuit in the TV set is not working (no start up pulse).

GREEN "START UP" LIGHT means the start up circuit in the TV set is working normally. Yes, it is 100% accurate. Even on Zenith's single pulse start up circuit !

RED "HORIZ DRIVE" LIGHT with a green start up light means that the horiz driver transistor in the TV is shorted (E to C).

GREEN HORIZ DRIVE LIGHT means that the horiz oscillator and driver circuits are operational.

READ THE DC VOLTAGE METER THEN,

PUSH THE TEST BUTTON

If the meter comes up to, or, falls back to, factory specified DC collector voltage, the LV regulator circuit is working. If it fails to do so, it is not working!

RED "B + RUN" LIGHT means that the B + source that normally keeps the horiz osc / driver circuits running after the start up B + pulse has been consumed has become open.

GREEN "B + RUN" LIGHT means that the B + resupply voltage (scan derived) is being provided. All is normal if all three lights are now green.

The scan circuit short detector in the Mark V is identical in all ways to that which is used in the Mark III. Operation is also identical. Both units are virtually indestructable when simple directions are followed. Both units carry a full year's warranty against defects in materials and workmanship (parts and labor). Either unit can be easily repaired by almost any technician in his own shop.

If the green "circuits clear" light is now lit

It is now safe to push the "run" button and examine the symptoms that appear on the CRT screen, for the purpose of isolating any "open" circuits.

Except for hook up and CRT filament warm up time, this test can easily be completed in two to five seconds!

The Mark V sells for only $995^{00}

Stop losing money on start up / shut down scan derived B + problems; order your Mark V today!

Visa and Mastercharge Welcome !

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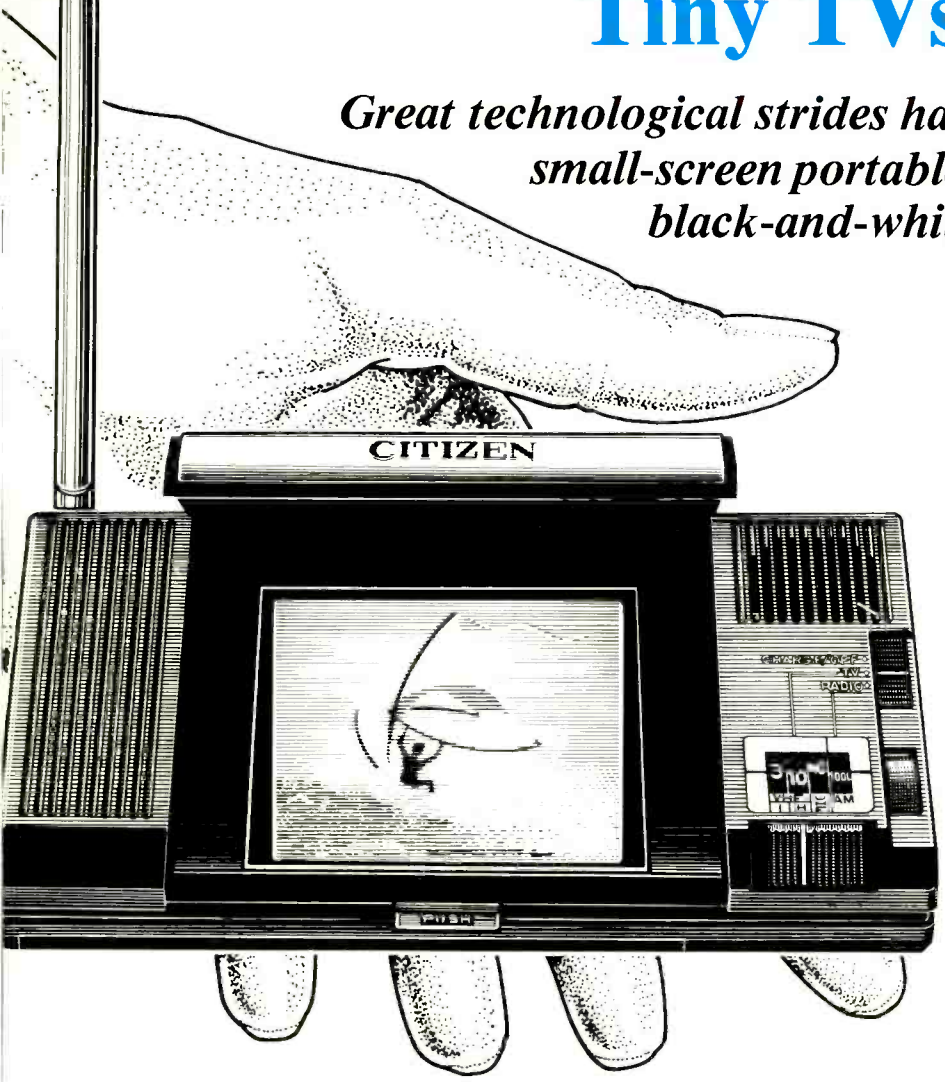
CIRCLE 49 ON FREE INFORMATION CARD

Tiny TVs

Great technological strides have been made in small-screen portable TV sets, both black-and-white and color



By Fred Blechman

Portable, tiny-screen TV receivers are increasingly popular. To underscore this, a bevy of manufacturers now market these Lilliputian TVs, sometimes called pocket TVs. Achieving diminutive size, low battery-power drain, and good-quality performance are technological hurdles that are still challenges.

For some background on these wonder products, Sony, which carved out its initial mark in the U.S. with small transistor radios, entered the micro TV market about three years ago with its 2″-screen Watchman. This originally sold for about $300, but now the earlier models sometimes are available at sell-out for about $100. Current models, with better battery life (about 4 hours) sell for $180-$240.

Sinclair Research, however, beat them to the punch by many years when it launched its Microvision 2″-screen TV in January 1977. It was larger than pocket-size, unless you had exceptionally large pockets, and also sold for $300. It was eventually discontinued, perhaps to make way for its flat-screen pocket TV that was being developed, but was a long time coming. Like most portables, Microvision battery life was limited to about two hours before recharging or replacement was necessary.

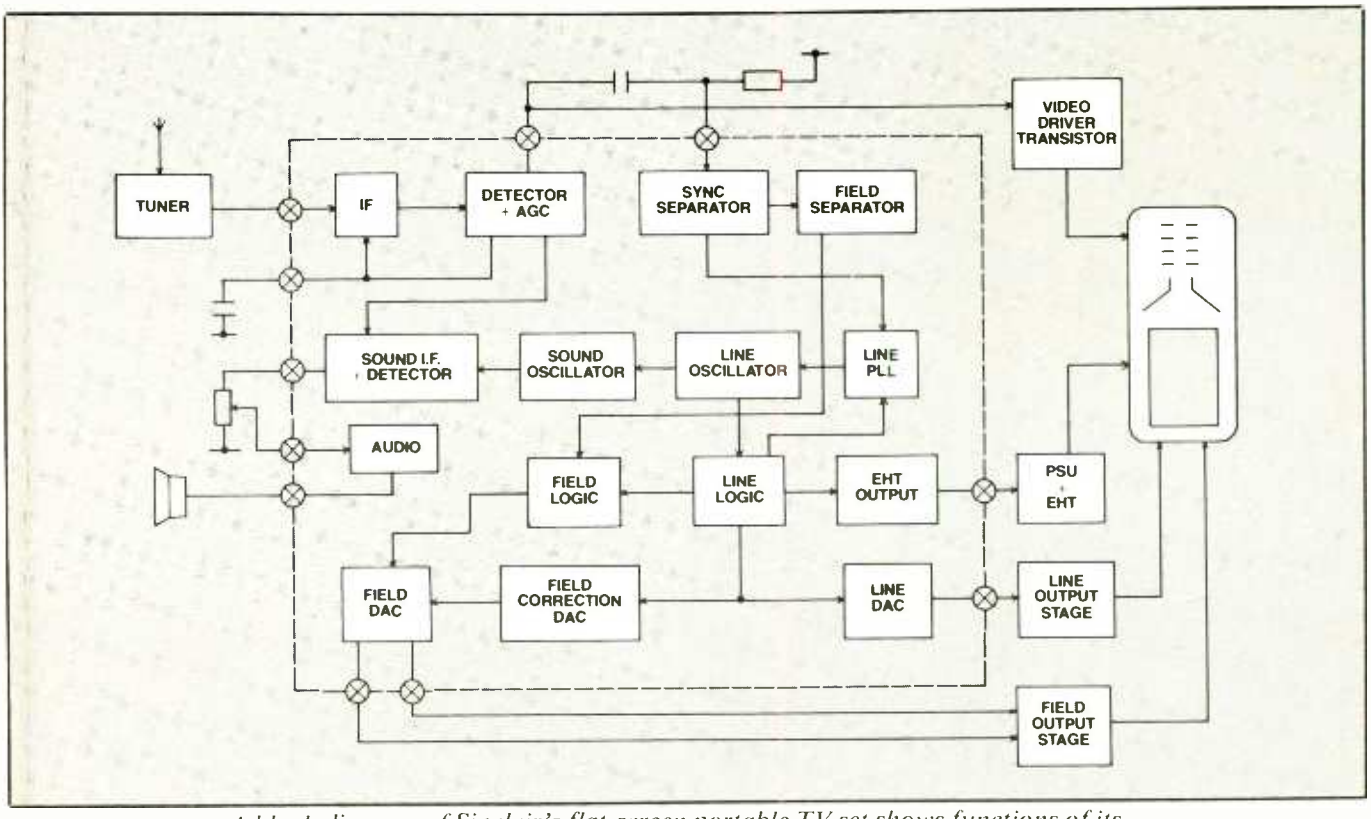
Sinclair's 2″ Flat-Screen Pocket Television, introduced September 1983 in England, has finally hit the American shores. It's the result of a six-year, $6-million development program, and is the first TV set ever to incorporate almost all its circuitry on a single chip. We'll examine this product more closely later in this article with a hands-on report.

Sinclair's 2" TV

Panasonic currently has four micro TVs with 1.5″ screens, selling for $200 and up. They are much too large to be called "pocket-size," their screens need magnifiers for effective viewing, and they gobble up batteries. The $470 CT-101 was the first color TV with this small size.

Up to this point, these micro-sized TVs offered CRT (cathode ray tube) screens only, and only in black and white (except for Panasonic CT-101). The conventional CRT offers a sharp picture but uses a lot of energy.

Now, Casio, Citizen, Epson, Radio Shack, Seiko and Zenith pocket TVs have appeared in the marketplace with LCD (liquid crystal display) screens in the 2″ range, both in color and black and white. The Radio Shack units appear to be private-label versions by Casio and Citizen. While LCD technology offers significant energy saving, the display has inherently low resolution and poor contrast compared to a CRT. (Table 1 gives addresses of the various manufacturers cited.)



A block diagram of Sinclair's flat-screen portable TV set shows functions of its single-chip circuit (dotted lines) and associated components.

Sinclair's American version of its 2" black-and-white flat-screen TV set is designated the FTV2A. It is currently selling for $100 in the U.S., but only to American Express Card holders at this time. Sinclair hopes to widen its marketing thrust, but since Sinclair Research Limited, UK, is presently in financial difficulty, the future of its flat-screen TV, is cloudy right now. The technology behind it and its performance is important nonetheless.

The FTV2A is housed in a black plastic case and measures just 5½" × 3¼" × 1¼". It weighs only about 10 ounces, including the battery. The 2" diagonal screen is recessed behind a magnifying Fresnel lens, and can be viewed easily from about 30-degrees left or right of center. A protective vinyl carrying case is included with the $100 unit.

A swing-out panel on the back of the TV case acts as an easel to provide comfortable desk-top viewing from one or two feet away. The TV's telescoping antenna is stored along the top of the FTV2A, but can be extended to 16½" and swung around for the best signal reception. Surprisingly, there is no external antenna input, and no direct video-input jack.

The Sinclair TV is very simple to operate since there are only three controls: an on-off/volume knob, a tuning knob and a TV band switch.

The band switch selects either low-band VHF (Channels 2-6), hi-band VHF (Channels 7-13) or UHF (Channels 14-83). A slide-indicator dial has markings in red (white would have been much easier to read!), giving only the upper and lower limits of each band.

One of the key design elements in the new TV model is Sinclair's revolutionary flat-screen CRT, which provides high brightness with little power consumption, and eliminates most of the depth exhibited by a conventional CRT. The screen is recessed to enhance brightness and contrast. (See Sidebar for details.)

Another key design element is the single integrated circuit designed by Sinclair Research and Ferranti Limited. This IC uses innovative digital techniques that automatically monitor video and audio inputs and adjust the receiver circuitry for local broadcast standards. Special features of the IC include sound selectivity, video innovations to eliminate image problems in UHF channels, and an advanced synthesized scan generator to control the complex waveforms needed to scan the flat CRT. It runs a check 50 times per second to ensure picture "hold." Because of these features, the common user-adjusted controls for horizontal hold, vertical hold, brightness and contrast are not included. (See another Sidebar for more IC details.)

Sinclair's flat-screen portable TV.

Sinclair has also designed an especially sensitive tuner. Moreover, it's unusually small, measuring just 31 × 23 × 11 mm. It uses advanced surface-mounting technology for its microminiature components.

A very small speaker is built into the case, but much better sound is available from a standard miniature monophonic earphone jack on the right side. A small 8-ohm earphone is supplied with the unit for private listening. I found no problem in using one of the popular miniature-plug stereo headsets with the FTV2A, although only one "side" was active.

Volume is controlled by the knob of the on/off switch. You roll the knob down to increase the volume, up to decrease it. This seems backwards to me, since most equipment uses "up" for "more."

Power

The FTC2A provides surprisingly high-quality video reception with very low power consumption. The average current drawn is only 80 milliamperes at 6 volts, or about ½ watt! A special Polaroid P500 Lithium Power Pack flat battery provides 15 hours of viewing, far more than its nearest competitor. The 3½" × 3" battery is 3/16" thick, and simply slides into a slot at the rear of the TV.

An alternate battery made by Polaroid is the P100, available at some hobby shops, for anywhere from $3.50 to $5 each. This is a zinc-manganese-dioxide battery with far less capacity than the P500, and will run the FTV2A for only about 2 hours. Therefore, the P500 is a much better choice, for which Sinclair charges $9.95 for three. Polaroid's retail price is $5, in contrast.

Better yet, I discovered a "free" battery source if you use Polariod 600 film. If you don't throw away the film packs after exposing the film, you can remove the battery from the film pack and get a powerful 6-volt, slightly-smaller version of the Polaroid P100 battery. Although the contacts are not in exactly the same place, I had no trouble at all in sliding this "used" battery into position, finding that it would run the FTV2A for more than an hour!

For nonportable desktop use, the FTV2A has a power-input jack on the side. Although the instructions that come with the set identify this jack, there is no information about polarity or voltage requirements. Furthermore, the jack is a rare coaxial-pin type, much smaller than the ones commonly used on cassette recorders. This is the U.S. model?

Obviously, 6 volts is required, since that's the voltage marked on the battery. Finding the mating plug and polarity was another story. I made my own coaxial plug from some brass and plastic tubing, and discovered that the plug tip required negative polarity. Using this home-brew plug and a nonregulated 6-volt ac-to-dc adapter, I had to add a 33-ohm resistor in series to control the voltage.

After all this trouble, I thought to contact Sinclair about the availability of an adapter from them. They don't offer one in the U.S. (the English adapter uses 220 volts input), but they suggested to me a Radio Shack #273-1650 "Universal ac-to-dc adapter" ($11.95). This adapter is switch-settable to supply various voltages and includes six different plugs. The design allows for plug polarity to be either tip-positive or tip-negative. One of the six plugs mates with the FTV2A power socket. I set the switch to 6 volts, installed the mating plug with tip-negative, and it worked like a charm!

Hands-On Testing

The real test of the FTV2A, of course, is how well it works. I'm located in a semi-fringe TV area of Southern California, with hills between me and the transmitters on Mount Wilson. Using an outside above-roof antenna, I can receive all the local channels reasonably well, but portable TVs on rabbit ears don't perform satisfactorily. I don't pay much attention to this since, I have cable TV and get a great picture on all

the cable-connected sets. Some of my non-cable neighbors have put up 30-ft.-high antennas, however, to capture better signals.

Therefore, it was amazing to see the FTV2A bring in *all* the local channels! On the VHF 2-6 band, it was sometimes necessary to move the set a few feet to another location or to reorient the whip antenna to improve the picture from poor to excellent. But this would be expected even in better reception areas than I have.

Tuning involves setting the range switch and rolling the tuning knob with your thumb—up to increase, down to decrease—just as it should be. The limit markings on the slide-indicator dial were the only guide, and they were not accurate. No problem, however, since the tuning range was broad enough to capture all the channels. Once captured, the signal is locked in, and you only need to fine-tune for the best sound.

I was particularly pleased with the picture quality on a good signal. One of the local UHF channels broadcasts stockmarket quotes on three crawling lines at the bottom of the screen. Even though this was on a UHF channel (usually weaker than VHF at this location), I was able to read all the stock quotes on the FTV2A screen! Also, all but the smallest text in commercials was easily readable.

As a matter of fact, it appears that UHF sensitivity of this set is better than its VHF sensitivity. The American version has had VHF tuning capability added. In the English unit, only UHF channels 21-69 are used since those are the frequency limits of most European TV transmissions.

The contrast and brightness in normal or subdued lighting was excellent. Of course, the picture washed out in direct sunlight, as with any CRT. But outdoor viewing in a shaded area was acceptable.

Video Monitor/Computer Use

I was curious about whether or not the FTV2A could be used as a video or computer monitor. Since there is no video input connector, this meant that an r-f modulator was required to feed the signal to the FTV2A antenna. For some strange reason, the FTV2A doesn't operate properly with the typical Channel 2/3/4 r-f modulators used in most American microcomputers. It did not provide anything approaching a clear signal from either a Timex Sinclair 1000 or a Timex Sinclair 2068 operating on either Channel 2 or 3. Possibly, this

Single-Chip Television

The first TV to use a single chip for most of its circuitry requirements, the new Sinclair flat-screen TV contains a single LSI integrated circuit (IC) to perform the majority of signal-processing.

Designed by Sinclair Research and produced by Ferranti Limited (using its FAB2 CD1 process), it is a complex linear/digital circuit with a number of original advanced features that are subjects of patent application.

The chip's principal function is to take the i-f output from the tuner, recover the video and sound signals, and feed them to the cathode-ray tube (CRT) and speaker, respectively. Additionally, information is extracted from the video signal to synchronize a multi-standard line- and field-scan system, which generates signals that enable correct picture display on the CRT. The system synthesizes scan waveforms digitally and accounts for the majority of the IC's logic.

Among the IC's principal innovations are:

1. Multi-standard capability: The Sinclair system caters to all 625-line systems (with an FM intercarrier frequency of 6.0 or 5.5 MHz) and the 525-line system.

A digital countdown circuit is employed that uses a high-frequency VCO locked to a multiple of received line sync pulses. Slaved from the line oscillaor, an identical VCO provides a local oscillator for the sound channel.

Timing components are contained on the IC, and VCO center frequency is derived from a single external resistor. The VCO is counted down to field rate, and on-chip logic determines reception of a 625- or 525-line signal, adjusting count number and VCO center frequency accordingly. Additional logic improves the noise immunity of line and field lock.

2. Synthesized scan generator: To display an orthogonal picture on the flat CRT, the field scan must be modulated by a correction wafeform at line rate. Both correction signal and field sweeps are generated digitally using digital-to-analog converters (DAC). Inputs are derived from the countdown system.

The use of DACs eliminated the need for set-up components and adjustments in generating the complex waveform. A further DAC generates a control signal for the line-scan output stage.

3. Video: The vision i-f signal emerges from the tuner at the unusually high frequency of 230 MHz—chosen to eliminate image problems in the UHF band.

After amplification in a 4-state agc-controlled amplifier, the signal is fed to a novel low-level envelope detector, with the recovered video going to a dc restorer for synce separation and an external amplifier to drive the CRT.

4. Sound Channel: An intercarrier sound signal, retrieved from the detector, is fed via a high-pass filter and converted to a 250-kHz i-f. Subsequently, it is passed through an ac-coupled limiting amplifier to a product detector for sound recovery.

All coupling, decoupling and phase-shift network components are integrated on the chip, providing integrated sound selectivity. The sound local-oscillator frequency is set to 5.75 MHz for 625 lines and 4.75 MHz for 525 lines, allowing demodulation of 4.5-MHz, 5.5 MHz and 6.0-MHz intercarrier sound without external switching. The audio signal is fed via the volume control to an on-chip audio amplifier.

was due to r-f interference from the computers themselves. I was, however, able to get a fine picture from the Channel 3 r-f outputs of a video recorder and a video camera.

I then switched to a UHF modulator that generates a signal on Channel 14. I connected the video output of the Timex Sinclair 2068 to the video input of the UHF modulator. The result was a nearly perfect, readable picture on the FTV2A tuned to Channel 14. Similarly, the video output of my Sanyo MBC555 was fed to the UHF modulator and produced a fine picture on the FTV2A, although 80-column text—as you would expect—was unreadable. Forty-column text was fine, though.

From the foregoing, then, the FTV2A can be used as a VCR or video camera monitor if a VHF or UHF modulator is used, and computer signals seem to work only through a UHF modulator, though with the latter it performs splendidly.

Comparisons

To compare the Sinclair Pocket TV with another tiny TV set, I bought a Citizen LC-TV Model 03TA-OA LCD Pocket Television/AM Receiver at a local store that was selling it for $99 instead of the regular $200 price. Apparently a new model is now available in the marketplace.

The snazzy-looking black-and-silver Citizen 03TA has a lot going for it. It is smaller than the Sinclair (3″ × 5¼″, but only 1⁵⁄₁₆″ thick!), it has a built-in AM radio, video input jack, and external-antenna jack. It uses standard batteries (4 AAA alkaline for 10 hours use), and a rechargeable battery pack is available. It comes with an earphone, external antenna wire, and external power supply. Coincidentally, the power supply has the same power plug, voltage and polarity as the Sinclair, which operates the Sinclair FTV2A perfectly!

The display technology of the Citizen, however, is LCD, which results in comparatively low image resolution. Unlike a black-and-white CRT, which has a continuous phosphor coating, and therefore resolution that's limited mainly by the electronics, an LCD screen has a defined number of "pixels" (picture elements). In the case of the Citizen 03TA, the pixel count is 148 across by 122 high. For comparison, a Timex Sinclair 1000 (and many other medium-resolution microcomputers) produce a picture with a resolution of 256 pixels across by 192 high.

Another severe disadvantage of the LCD display is that it requires external light since no light is generated (and that's why it uses so little power). This is great in sunlight, but not very good in poorer lighting conditions. A special backlight is required for dim-light viewing.

The Citizen 03TA is no slouch, though. Tuning is easy. Set a three-position band switch and move the power switch to TV (or Radio). The panel markings are much clearer and more accurate than the Sinclair unit's, and the built-in speaker

(Continued on page 96)

The Sinclair Flat-Screen CRT

The Sinclair flat-screen CRT tube measures 4¼″ × 1¾″ × ¾″. It is three times brighter than a conventional CRT with the same-size screen, yet requires only one-quarter to one-tenth the power and occupies half the space.

Developed by Sinclair Research and implemented by its subcontractor, Timex in Dundee (Scotland), this CRT is designed for automatic, low-cost, high volume manufacture. A major technical breakthrough has been the perfection of a new method of vacuum forming of glassware.

The tube itself is assembled from just two sheets of glass: a flat front plate and a vacuum-formed backing plate. The phosphor screen is coated on the interior of the backing plate and is viewed through the front face from the same side that the electrons strike. As a result, the brightness is up to three times that of a conventional CRT with the same beam energy.

The electron gun is set to one side of the screen, with its axis parallel to the screen. Two sets of electrostatic deflection plates in the gun assembly provide horizontal and vertical scanning, and a third set between the phosphor screen and front face bends the electron beam toward the screen.

Without this additional focusing field, the angle of beam incidence would vary across the screen, spreading the beam spot into an ellipse. The focusing electrode is formed on the front face by a transparent tin-oxide coating.

If uncorrected, folding the electron optics would distort the raster scan, producing a keystone-shaped frame in which the vertical edges are curved and the horizontal edges form the side of a trapezium. Both electronic and optical techniques are used to correct for this distortion.

First, the screen height is reduced by two-thirds, but the width is kept constant. This narrows the angle subtended by the electron beam onto the screen, reducing both the distortion and the deflection power. The picture height is restored optically by means of a Fresnel lens, which can be inexpensively formed in a flat plastic faceplate. Trapezium distortion is eliminated by applying correcting modulation to the vertical plates.

The tube assembly lends itself to low-cost mass production and has significantly fewer components than a conventional CRT. Connections to the electron gun and deflection assembly are screen-printed onto the faceplate, and the assembly is attached in a single operation by a conductive frit.

The cooling problems to prevent phosphor damage are severe in a conventional tube, but since with the Sinclair CRT the image is viewed from the side of the phosphor that the electrons strike, the other side of the screen can be connected to a heat sink.

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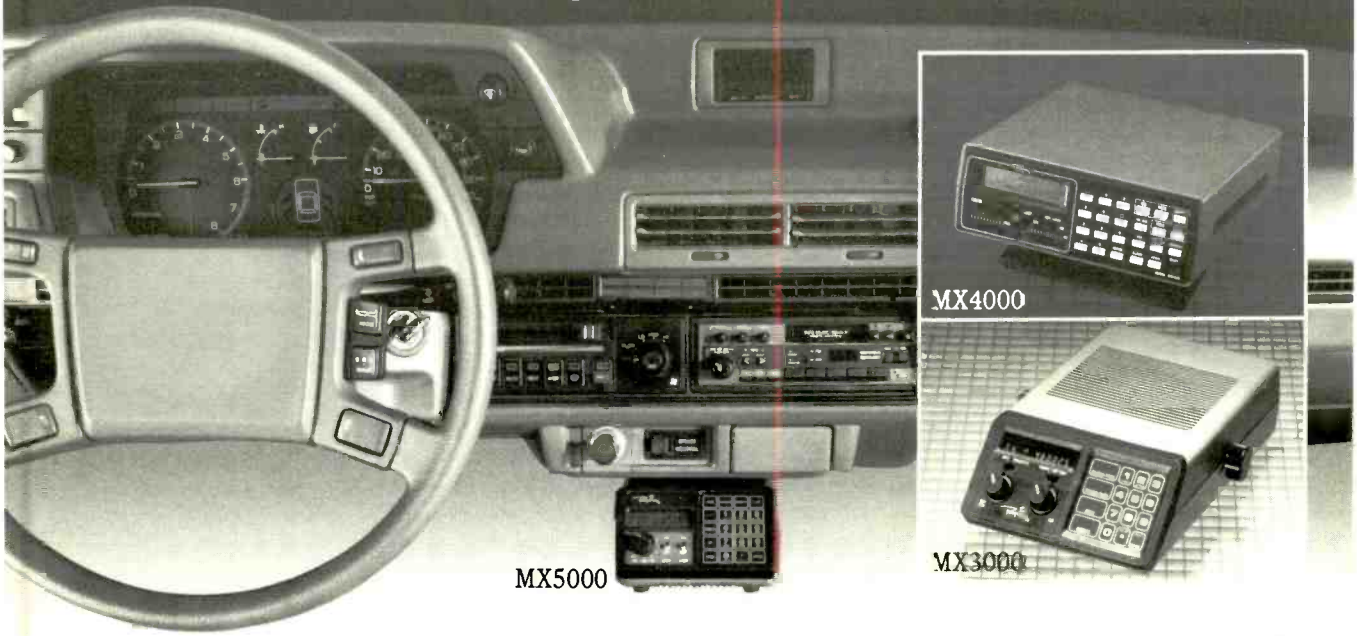

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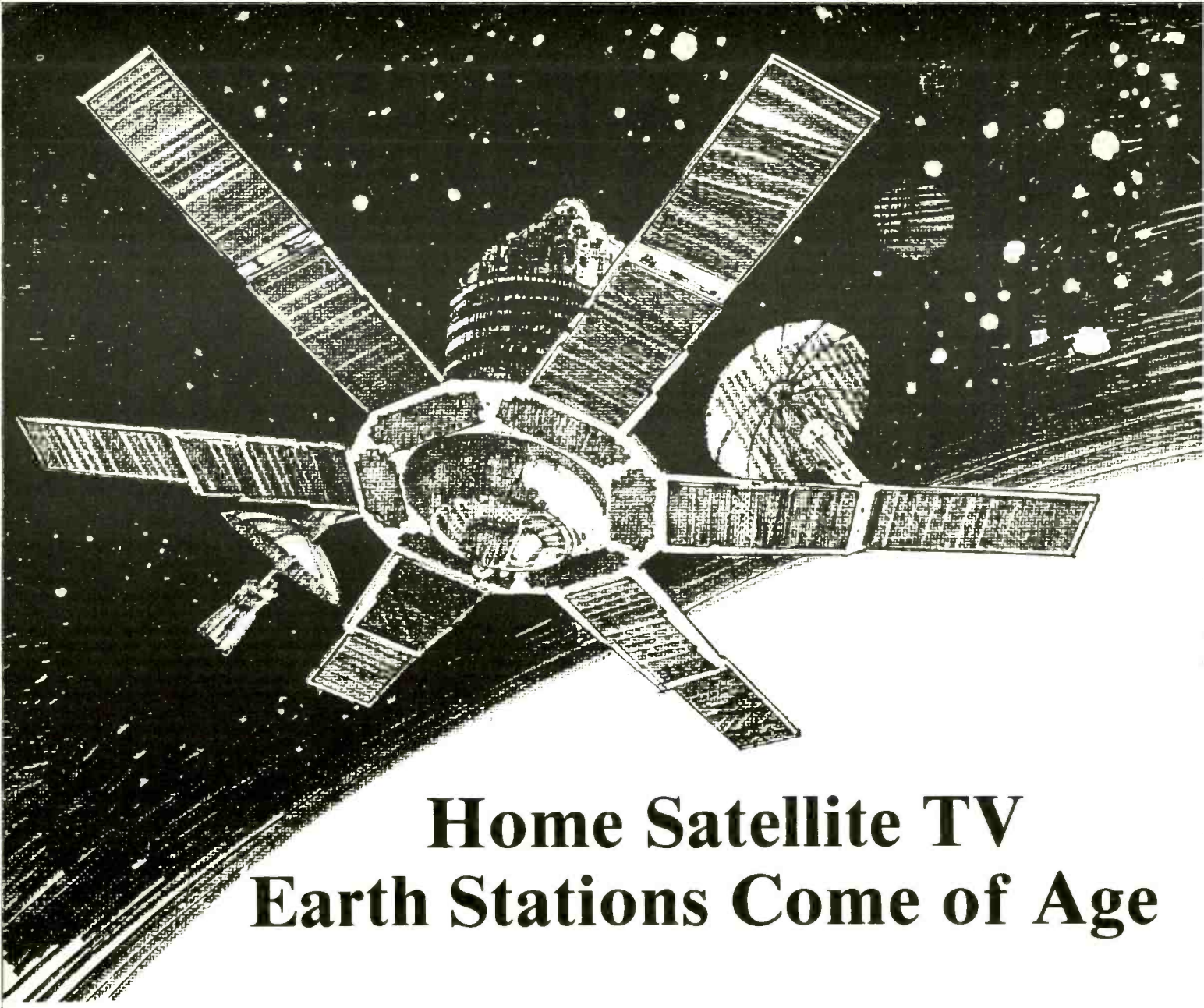


Home Satellite TV Earth Stations Come of Age

Television receive-only private earth terminals are more than a million strong and growing at an estimated 40,000 to 60,000 per month

By Stan Prentiss

Big-city dwellers and suburbanites may be largely ignoring home satellite TV receive-only reception, but the motion-picture, cable-TV and pay-TV industries certainly aren't. With more than 1.4-million TVRO installations already in place and an industry-estimated growth of as such as 60,000 new installations monthly, there's "gold in them thar hills!"

Satellite TV reception is especially attractive in remote and sparsely populated areas that are poorly served or not served at all by broadcast or cable TV. Large 10-to-12-ft., medium 7-to-9-ft. and small 3-to-6-ft. circular and rectangular receiving antenna "dishes" dot the countryside in many areas of the U.S. All are pointed to receive the mini-microwatt signals from geosynchronous satellites 22,300 miles in space. Those satellites, or "birds," are carrying more and more voice, data, telephone and video traffic formerly delivered over microwave links and land-lines.

Named the Fixed Satellite Service by the Federal Communications Commission (FCC), such satellites "uplink" traffic from Earth-based

broadcasters on either of two bands. The C band uses between 5.9 and 6.4 GHz, while the Ku band uses between 14 and 14.5 GHz.

In the near future, a K band, with uplinks on 17.3 to 17.8 GHz, may join the two already in service. This Direct Broadcast Service (DBS) will have fewer channels than the C and Ku bands, but it will beam down as much as 200 watts of microwave power per channel, which is a big jump up from the 5 to 45 watts per channel on the C and Ku bands.

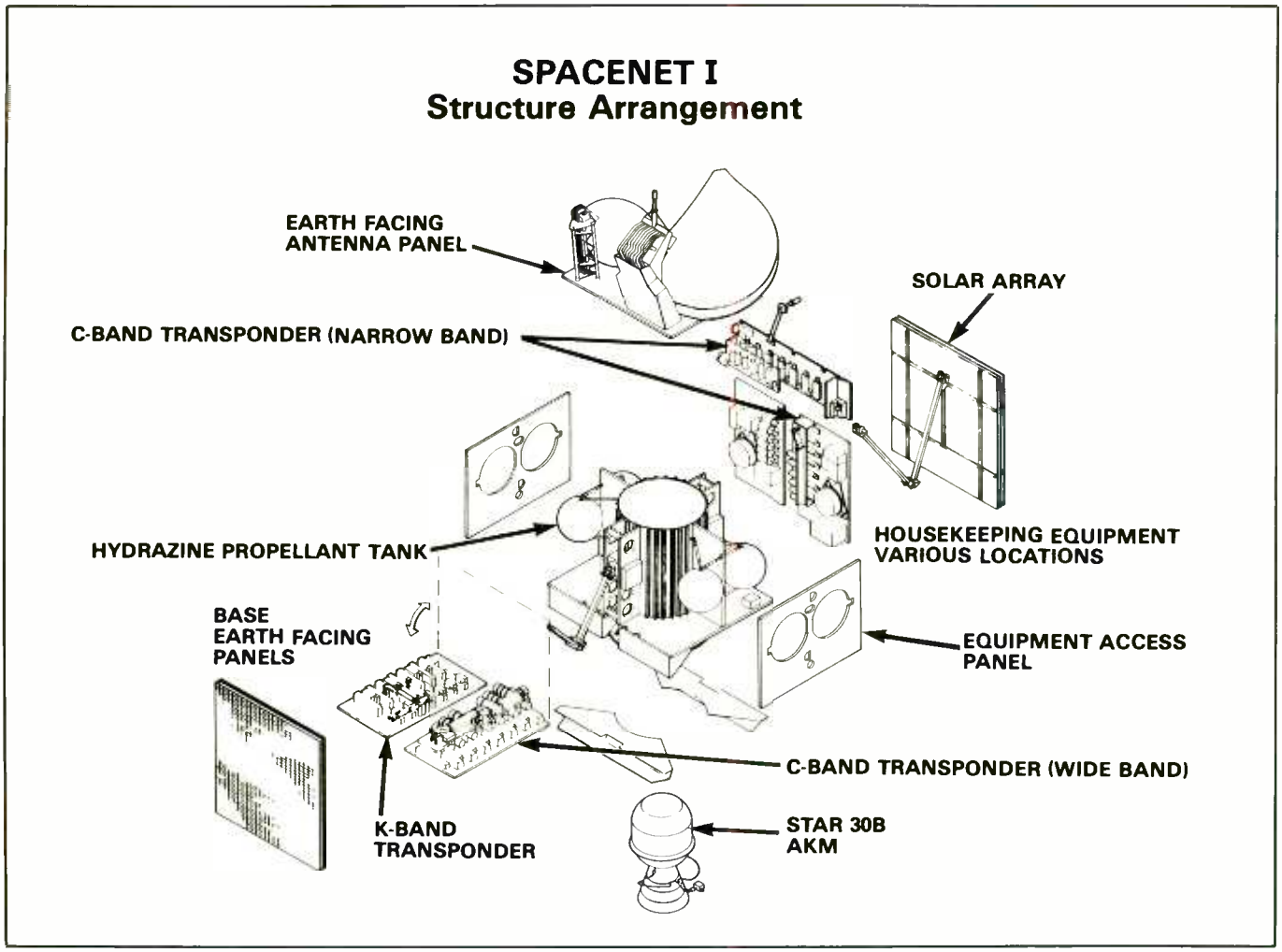
Spectrum space for the K band has already been allocated by the FCC for satellite-to-home service scheduled to start sometime in 1986 or 1987. Now all that awaits are entrepreneurs brave enough to attempt another DBS venture in the face of the collapse of USCI's demise on March 31 of this year.

The Downlink

While uplinks are vital to program originators, to the end user the downlinks are what TVRO is all about. To prevent interference (crosstalk) between uplinks and downlinks, satellites translate the uplink carrier frequencies to downlink carriers on 3.7 to 4.2 GHz for the C band, 11.7 to 12.2 GHz for the Ku band and 12.2 to 12.7 GHz for the K band.

In addition, "cross-polarization" directs transmissions horizontally or vertically to keep the various transponders and their channels full-frequency separated. Initially, such satellites had only 10 to 12 channels and occupied a single transmit/receive band. Today, larger satellites have as many as 24 channels, some broadcasting on both C and Ku bands, serving different audiences. While a number of transponders are currently for lease or sale, they'll all fill up as their usefulness is realized. Even more transponders will be available as C-band birds are gradually moved from 4- to 2-degree spacing—a distance of roughly 460 miles.

Some of the electronics and mechanisms that constitute a spacecraft.



Downlink transmissions begin in the Fixed Satellite Service at power levels of between 5 watts on the C and 20 watts on the Ku bands and arrive on earth in contour-shaped coverage known as EIRP (effective isotropic radiated power). Each satellite has its own contour, and signal strength may be generally predicted for whatever region it's intended to serve. In this way, satellite earth stations are designed and manufactured to receive certain EIRPs among the various localities depending on dish size, signal-to-noise (S/N) characteristics (more signal, less noise), and various manual or automated receiver operations that permit control of both receiver and dish mechanism. This allows the system to select any broadcasting satellites at whatever longitude it may be positioned.

At the present time, all skyways are "free" for the taking except for Home Box Office (HBO) and Cinemax, which may begin scrambling (encoding) even as this is written. The U.S. Congress and FCC are already taking certain steps to keep the airways open. Negotiations continue regarding possible compensation for descramblers, in the form of a monthly service charge, so that those who wish to watch the scrambled channels may do so for a stipulated fee. Even if HBO *et el* decide to scramble their programs, there will still be more than 100 "free" channels available for viewing.

Satellite Earth Stations

Having tracked the satellite signals down to earth, let's tune in a typical TVRO picture-and-sound station to see what it does and how it works.

You may have noticed that the spectrum bandwidth for each C- or K-band system amounts to 500 megahertz (MHz). Individual transponders, however, are limited to 36 MHz each for C band and 27, 43, 54 and 72 MHz for Ku band. A satellite receiver must have a bandwidth approaching these frequencies to supply better than mediocre reception and avoid certain undesirable reactions.

As the minuscule microwave signals reach Earth, they must be received and amplified to extract (demodulate) the information they contain and convert it back into its original audio, video and/or data form. This means that super-high-frequency carriers must be stripped from the frequency-modulated (FM) video/audio systems, and video must be converted to amplitude modulation (AM) so that it can be readily processed by an ordinary TV receiver, using special equipment.

First, there's the receiving dish, which may be in the form of an ellipse, parabola or rectangle—all with somewhat different characteristics, but doing the same job in the end. The dish antenna receives satellite signals and directs them to a "feed" arrangement positioned at its focal point. The feeds are usually circular, but some have a polarity changing mechanism that allows them to be matched to the vertical or horizontal transmission from the satellite.

Following the feed must be a low-noise amplifier (LNA) and frequency downconverter (LNB/LNC) so the receiver can process incoming information at frequencies between 70 and 1950 MHz, depending on the system. These initial amplifier/converters are crucial to the Earth station because they establish the critical gain over temperature (G/T) figure of merit, which is the *net* antenna system gain over temperature in degrees Kelvin. This merit figure and the antenna's specifications are really what determine how well an Earth station will perform. With an exceptional 80-to-90-degree K, 50-dB-gain LNA and a good 38-to-42-dB gain dish, virtually any reasonably matched receiver will perform satisfactorily, regardless of minor shortcomings.

A deluxe receiver with dual 6.2-to-6.8-MHz audio receive modes, 27-to-30-MHz-plus channel bandwidth, composite video and audio (baseband) outputs, variable skew (phase changing) for transponder polarity sensing, and microprocessor-controlled horizontal positioning and elevation for the disk antenna is decidedly desirable. You pay a premium for such a system, of course. Manual—but remote—dish pointing is considerably less expensive, and LED instead of LCD channel displays are also cash-conservative, as are simple hand-operated knobs with channel numbers imprinted from 1 through 24. Nonetheless, frequency synthesis within the receiver, accompanied by phase-locked-loop (PLL), crystal-controlled tuning assures drift-free operation for each channel assignment. You will also find that built-in stereo processors are less costly and considerably more effective than external additions.

Satellite receptors must be installed, as in the case with any other outdoor TV antenna. Larger dish supports must be set in concrete.

Wind loading factors must account for lift, drag and elevation. For example, a 3-meter (9.84-ft.) parabolic solid dish at 60 degrees elevation has a drag force of 3200 lbs. with wind blowing at 100 mph. A 4.6-meter array exerts a drag force of over 9000 lbs. Surprisingly, maximum drag is exerted when wind strikes an antenna from the rear. You'll want to consider all these factors in any installation.

Should you wish to save a few dollars and to do the job yourself, talk to a dealer or distributor first. Then find your particular longitude and latitude and angle of elevation to at least one satellite, compensate your compass for true north (variation) if you're installing the usual Kingpost, and go to it. Some of the newer rigs are supplying surprisingly accurate angles-of-elevation markers with their assemblies, and both the job of north-pointing and setting the angle between your particular earth location and the various satellites shouldn't be difficult at all.

By aligning your already-compensated azimuth polar mount for east-west extremes (between 60 and 150 degrees WL), the other birds should drop in nicely. If your Earth receptor doesn't have this feature, you'll have to find a carpenter's inclinometer. We won't discuss the early azimuth-elevation (AZ-EL) mounts since they're fixed and not adaptable to multi-satellite scanning; they're now used almost exclusively by commercial satellte installations.

With today's satellite TV receiving equipment, you'll find handy controls for sound, video, satellite dish positioning, channel tuning, SAT/TV switching and adjustable skew. The last is especially welcome for changing from Satcoms to Westars. On the receiver, relative signal-strength meters, video polarity selection, special audio tuning and large numeric channel displays all help you easily tune in satellite channels. A given receiver that doesn't have built-in descrambling will usually have on its rear panel loop-through connections for adding an external descrambler.

Installing It Yourself

If you're planning on installing a satellite TV system yourself, here are a few things you should know before you do. Don't try to "get by" with reduced antenna size where signal strength is critical. In northern New England, lower Florida, southern Texas and the Pacific coast of California, use a 10-to-12-ft. dish with 80-to-90-degree LNAs to assure adequate reception. Midwesterners who have excellent signal conditions might find a 6-ft. dish adequate—if they're willing to forego super signals and accept occasional "sparklies" (dashes of black and white noise in the picture).

Keep in mind that 35 dB signifies minimum signal-to-noise (S/N) threshold and that 54 dB represents studio broadcast quality. Any receiver whose output S/N is greater than 40 dB should generally be satisfactory.

Your choice of antenna location must be well-thought-out. Its view to the desired satellite must not be obstructed by trees, mountains, tall buildings, etc. You will find that GHz microwaves don't readily pass through obstacles the way lower r-f signals do.

Should you wish to operate several TV receivers from various transponders (channels) on any one satellite, you'll have to lay out more cash to buy additional equipment. Here's the setup.

- Using an ordinary LNA and a power splitter, you can connect several receivers—but all of the latter will be able to tune only the same channel.
- With an LNB (block downconverter) and a splitter, *several* TV receivers can access *any* satellite channel tuned in by a single TVRO setup as long as it has the same vertical *or* horizontal polarity.
- With dual LNAs and a two-phase (orthogonal) coupler and splitter, all TV receivers can tune into *any* channel of one particular satellite as long as signal strength is sufficient. If the signal level as received is too low, further amplification is called for (equipment for this is readily available), but expect an increase in noise.

Scrambling News Update

Certain movie channels are already using trick video inversion schemes and digitized audio to prevent unauthorized viewing of their programs on C band. This could soon work into a tiered and individually addressable system similar to those operated on CATV and become very difficult to decode. But with well over 100 channels still available, you might be able to live without HBO, Cinemax, The Movie Channel and Showtime (all threatening), or rent their decoders for "legal" viewing.

In the meantime, H. Taylor Howard, Stanford Professor Emeritus, Director of R & D at Chaparral Communications and Chairman of powerful SPACE (Society for Private and Commercial Earth Stations), is negotiating with film makers and distributors for citizen pay-viewing rights. He says, "What we have to demonstrate to programmers is that we're a good market, we're willing to pay and [we] want good video." Don Berg, Vice President of Channel Master Corp. Satellite Systems, thinks that film distributors may not conclude that "selling backyarders is a viable market." So if only Showtime and HBO scramble, it will be a relatively minor thing. Rick Schneringer, President of STTI says, "We're going to have the greatest sales year we've ever seen . . . . 1985 will be the biggest year for our manufacturers, distributors and dealers."

Schneringer, supported by SPACE Executive Vice President Chuck Hewitt, apparently read the tea leaves well. In April, SPACE/ STTI held the largest-ever satellite home terminal convention in Las Vegas. There were 15,000 registered attendees and 806 satellite antennas of every variety looking for a prosperous 1985 and new backyard locations across the country.

At the convention, Congressman W.J. (Billy) Tauzin (D., La.), who recently introduced a bill in the U.S. House of Representatives to guarantee Earth-station owners rights to access all scrambled programming at reasonable rates, exhorted the assembled listeners to repel the invasion of the encryptors with: "Join hands and never let the special [show and movie] interests turn the lights out." This bill is cosponsored by Representatives Charles Rose (D., N.C.), Robert McEwen (R., OH) and Robert Whittaker (R., Kan.).

All this follows the signing by President Reagan on October 30, 1984 of the Viewing Rights clause in the Cable Communications Act, legally permitting owners of noncommercial satellite Earth stations to receive free all

Comparing Programming

What's available on satellite channels? How does it compare to the usual broadcast/cable fare? Is it really worth investing as much as $5000 to set up a TVRO Earth station? Comparing programming is a good way to answer these questions. Let's take a brief look at the daily programming from a mix of just 11 of the many satellites now in service. Some people will find the varied fare a shock; for others, it will be an agreeable surprise.

Compare our random sampling with what's available on your local TV station (include cable if you wish). Then ask yourself what you'd do if you had a choice. The lineup is thought-provoking, to say the least. Before we get into the listing, let's identify the satellites:

Galaxy 1 (G1), 1340 WL
Anik D (AD), 104.50 WL
Comstar D4 (D4), 1270 WL
Satcom 1 (F1), 1390 WL
Satcom 3R (F3R), 1310 WL
Satcom 4 (F4), 830 WL
Satcom 5 (F5), 1430 WL
Spacenet 1 (S1), 1200 WL
Telstar 301 (T301), 960 WL
Westar 4 (W4), 990 WL
Westar 5 (W5), 1230 WL

First, let's try 8:00 AM on a Monday:

G1-18	Bewitched	F3-7	Business Times	G1-10	Romancing The Stone	F3-23	Krull
G1-3	Bozo Show	G1-7	Daybreak	G1-14	Baby, It's You	G1-4	Donald Duck
G1-15	Meet the Mayors	F3-8	Inch High	G1-5	Easter Bunny	D4-13	Puss In Boots
F4-19	Voltron	G1-2	Pickin'	F3-10	Bizarre	F3-16	Computers For Pros
D4-22	Plasticman	F3-6	Contempo: Music-Lifestyles	G1-23	Local Hero	T301-10	Good Morning America
F3-9	Cartoon Express	F3-17	Every Baby	F3-13	Walter Mitty	T301-2	DBS Morning News
AD-2	Top Rank Boxing	F3-24	La Boheme	G1-9	Gandhi	F1-8	Today

Same day at 8:00 PM:

F1-8	TV's Bloopers	G1-24	Donald Duck	W4-15	Ancient Lives	F3-8	Monroes
T301-2	Scarecrow & Mrs. King	G1-4	Running Brave	F3-24	One By One	G1-7	Primenews
T301-10	Hardcastle & McCormick	F3-24	Hound of the Baskervilles	F3-17	Regis Philbin	F3-7	Cheerleading
F3-16	Hard To Hold	G1-19	Gandhi	F3-6	Hello Jerusalem	AD-2	Rugby Union
D4-13	Wargames	G3-13	Local Hero	G1-2	Be a Star	F3-9	Johnny Tiger

These programs represent what's available at prime time on just one particular morning or evening. They don't include a host of other programs that are there for the tuning. Network/local broadcast programming simply doesn't begin to offer the number of channels and variety currently being beamed down from satellites in space. If variety is the spice of life, satellite TV is the technology that makes it possible.

unscrambled programming. And now the FCC has voted 5 to 0 to propose a rule banning all unreasonable local zoning Earth station restrictions.

Obviously, a scrambler or two isn't going to bring anyone's world to a traumatic end, now or in the forseeable future. There's far too much Federal legislative and executive department opposition to overcome, and considerable doubt if scrambling for both the broadcaster and receiver is actually worth the considerable expense. Consumer cost for an HBO descrambler, for instance, has been quoted at $395 apiece. Just think what the uplink cost must be!

Comments & Suggestions

A poor Earth station system is little better than no system at all, while a good one can become an electronic device of joy. Prices range from $1400 to $2400 for the middle class, and from $2500 to $3400 for the upper class equipment with at least 8-to-10-ft. receiving dishes, good feeds, prime LNAs (or LNBs or whatever), receivers and remote-controlled receptor positioning. Installations usually average some $200 to $300 extra.

For the single-set group, we still recommend a block down converter, a 950-to-1450-MHz if receiver with at least 27-MHz bandwidth, stereo sound, automatic polarity and skew correction, and whatever else is available at a modest price of approximately $2000. If you're willing to go the limit, we suggest all of the above plus dual LNAs and orthogonal feeds for the C and Ku bands and both polarities without switching, a deluxe receiver of at least 27-to-30-MHz bandwidth, with polarity switch for Ku band reception, a signal-strength meter, variable audio/stereo tuning, function displays and remote controls that do everything. For the dishes, fiberglass or stainless steel (with adequate coatings) are recommended over the rest, unless certain of the new plastics have outstanding specifications and are already proven in field tests.

Then, to enjoy all this to the utmost, we'd suggest a new TV receiver/monitor to ensure that you're extracting the maximum in video and audio performance. Of course, to assure the latter, you really should use a pair of good external speaker systems—especially if you plan on taking advantage of the sound available from stereo programs.

To really do the job right, retail costs can run you as much as $5000. But if you're a true videophile, first class is the only way to go! **ME**

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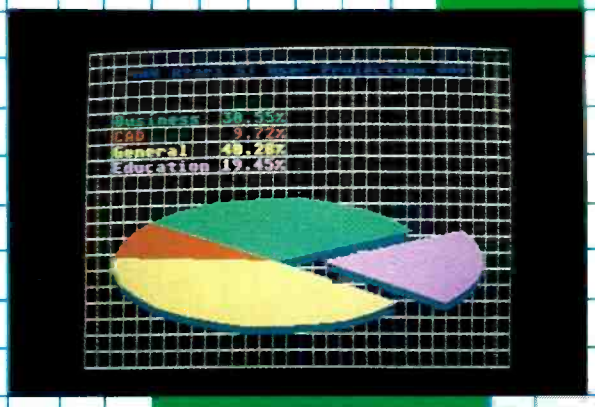
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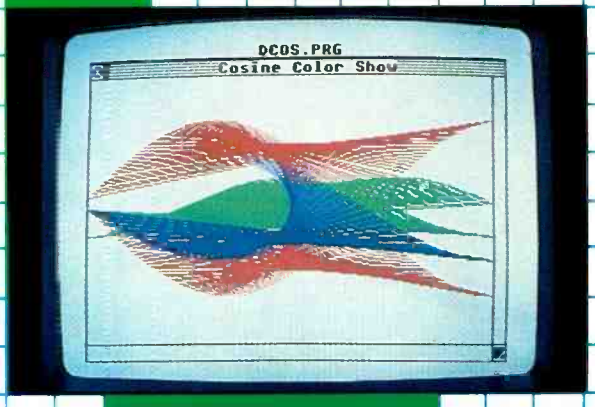
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ATARI

The New Atari 520ST

Is this truly the machine meant for the rest of us?

By Joseph Desposito

When Jack Tramiel, the former head of Commodore International, purchased Atari from Warner Communications, he was faced with a formidable task. He had to turn Atari around from a company that lost in excess of $300-million in one year and try to restore it to the glory days it had once enjoyed.

To accomplish this, Atari has produced the 520ST microcomputer—nicknamed Jackintosh because of the similarity of its user interface to Apple's Macintosh, prefaced by Atari's new leaders first name—which Atari hopes will stir the imaginations of enough current or would-be computer users to restore the company to profitability.

The 520ST comes in two configurations: a monochrome system and a color system. The one that we reviewed is the color system. It includes the sleek, wedge-shaped computer keyboard unit; a 3.5 disk drive; RGB color monitor; mouse; system disk; and Logo disk. Suggested retail price of the color system is $999.95; the monochrome system, $799.95.

520ST Overview

The Atari 520ST uses a Motorola 68000 microprocessor running at 8 MHz. This processor is not a true 32-bit cruncher due to its 16-bit data bus. But it does have a 24-bit address bus and 17 general purpose 32-bit registers (8 data, 7 address, stack pointer, and program counter). The 68000 has 56 instructions and supports seven levels of interrupts, 14 addressing modes and five data types. The chip's sophistication will probably cause most programmers to develop software in a high-level language such as C.

The computer comes with 512K RAM standard and can accommodate 192K ROM on board, though currently it uses only 16K ROM. It is expected that the operating system and possibly the user interface will be included in ROM at a later date. A cartridge slot at the left hand side of the computer allows expansion of the ROM by an additional 128K.

The 520ST uses four custom chips: a graphics chip, DMA chip, memory manager chip, and a device called Glue. Glue replaces a number of off-the-shelf chips and is responsible for the timing of the whole machine. Unlike the Macintosh, which burdens its microprocessor rather than using custom chips, the Atari 520ST can take full advantage of the power and speed of the 68000, though it's not quite a match against a Commodore Amiga.

Most essential computing features are standard. There are serial RS232 (DB25 male) and parallel Centronics (DB25 female) ports. There are connectors for floppy and hard disk drives and for monochrome or color monitors. For music enthusiasts, there are Midi (in and out) ports. A two-button mouse plugs into a port at the right hand side of the computer. This port and a second one (both DB9 connectors) can also be used for Atari-type joysticks. A reset button resides on the rear panel. The computer is powered by an outboard power supply, which connects to the rear panel. All connectors mentioned are clearly labeled with both pictures and words.

The 520ST is a "closed system," as is the MAC. So internal changes, such as adding a new board, is not a feature.

All the keys you could want

The Atari 520ST keyboard is integral to the main computer unit and contains a smorgasbord of keys. There's a standard QWERTY keyboard, which has the IBM Selectric layout. The keys are the full-travel kind, but have a spongy feel to them. To the right of the keyboard is a cursor keypad and to the right of that is an 18-key numeric keypad. Along the top, above the main keyboard, are 10 parallelogram-shaped function keys. The keyboard is controlled by its own 6301 microprocessor.

A variety of special keys—including Help, Undo, Control, Alternate, Insert, Delete, Clr/Home, and Enter—enhance the keyboard. The cursor keys are four individual keys marked with arrows. A keyclick can be enabled and disabled, if desired, through the operating system.

A full-color Jackintosh

Atari 520ST users can view their programs in either monochrome or color on a 32K bit-mapped display. There are three graphics modes. The low-resolution mode is 320 × 200 pixels in 16 colors; the medium resolution mode is 640 × 200 pixels in 4 colors; and the high-resolution mode is 640 × 400 pixels in monochrome. In color modes there is a palette of 512 colors available, 8 levels each of red, green and blue.

In the text mode, 25 lines by 40 characters or 25 lines by 80 characters can be displayed. In monochrome

mode it is even possible to display 50 lines by 80 characters.

Atari has two monitors available for the system: the SC1224 color monitor and SM124 monochrome monitor. The SC1224 is an analog RGB color monitor that can display the low- and medium-resolution color modes. It also has a volume control. The SM124 monitor displays the high-resolution mode in black and white. It uses a refresh rate of 70 Hz rather than the conventional 60 Hz. Both have 12″ screens.

With the range of colors available, dramatic color pictures can be displayed. Though you are limited to using four or 16 colors at a time, depending on the mode you are in, these colors can be changed during the course of a program so that all 512 can be displayed on one screen.

Atari 800 programmers may be dismayed to find out that the 520ST does not have sprite graphics. Instead, the ST uses a special bit-stock transfer command. This technique allows a programmer to designate parts of memory as shapes. These shapes can then be manipulated on the screen independent of the background field and without limits to their size and color.

Storing bucketfuls of bits

A standard feature of the Atari 520ST is a 3.5″ microfloppy disk drive. This plugs right into the back of the computer. If you want to expand to a second floppy drive, that drive would plug into the first drive in daisy-chain fashion. The computer will support just two floppy drives. The drives are single-sided double-density types (double-sided drives are expected soon). Data transfer rate of the drives is much faster than that of the Apple Macintosh drives, since the Mac disk interface sacrifices speed for disk capacity.

If you want to expand to a hard-disk drive, Atari manufactures a 10-megabyte drive that connects to the back of the computer and has a transfer rate of 1.33 megabytes per second (the transfer rate for most hard disks used with pc's is currently 0.625 megabytes per second).

The microfloppy disks for the 520ST are 3.5″ single-sided double-density disks that store 360K bytes of formatted data. These disks are fairly common and are the same ones used on several portable computers. Disks can be ejected from the drive by pushing a button.

Power for the disk drive is provided by a separate outboard power supply that plugs into the back of the drive. So if you were to expand your mass storage to include two floppies and a hard drive, you would have three power supplies in addition to the one that powers the computer.

One of the most interesting features of the floppy drive is that it uses industry-standard signals. This means that the 520ST can read and write IBM PC disks (data compatibility). Atari does not support this feature, but it is not overly difficult to connect a 40-track 5¼″ disk drive to the machine.

Atari has announced a CD ROM mass storage device that is expected to retail for $599. The CD ROM player uses compact disks that store 540 megabytes. Since a CD ROM player is read-only device, what can it be used for? One company, Activenture Corp. (Monterey, CA), has put the Grolier Encyclopedia on a compact disk. Additionally, they have included a database manager that finds all references for any word in the encylopedia in about three seconds.

A Sound Choice

For those who want to listen as well as watch, the Atari 520ST includes a General Instruments sound chip, the AY-3-8910. It has three voices, each with 4,096 different pitches. There is full control over the ADSR (attack/decay/sustain/release) envelope, and frequency can be controlled from 30 Hz to above audible range (125 kHz). Besides pure tones, the chip can also generate noise. Sound is programmed using 16 8-bit registers.

For those whose musical interests take them beyond the capabilities of the built-in chip, there is a Midi interface (see sidebar "What's it all

What's It All About, MIDI

The musical instrument digital interface (MIDI) is a specification standard for digital communication between intelligent musical instruments. It encompasses both hardware and software.

Eleven manufacturers agreed to the standard in January, 1982. Among the manufacturers using the MIDI standard todays are Sequential Circuits, Inc., Roland, Yamaha, Kawai, Casio, Seiko, PPG, Ensonic, Oberheim, and Korg. The Prophet 600, a keyboard produced by Sequential Circuits, was the first to use the MIDI interface in 1983.

Computers as well as musical instruments can use the MIDI interface and that is why it is supplied with the Atari 520ST. With appropriate software, the computer can actually control a MIDI instrument. Another possibility is that the computer can function as a multi-track recorder. It can store the digital music sent to it by serveral MIDI instruments. The musical "tracks" can then be manipulated with the computer and played back through the instruments.

MIDI is a serial interface that operates at 31.25 kilobaud. The specification calls for 1 start bit, 8 data bits and 1 stop bit for an effective transfer rate of about 3 kilobytes per second.

MIDI input ports are receivers, while MIDI output ports are transmitters. Some MIDI devices also contain a MIDI Thru output, which acts as a repeater. The Thru output of one MIDI device can be daisy-chained to the input of another MIDI device until a maximum of 16 receivers are connected (giving 16 voices). Though there can be 16 receivers, there can only be one transmitter in the interface system.

about, Midi''). This interface can be used to control external music synthesizers.

A GEM of an interface

The Atari 520ST interacts with the user much like Apple's Macintosh does. But rather than using a proprietary system, the 520ST uses Digital Research's Graphics Environment Manager (GEM). This is an icon-based system that uses windows and pull-down menus, as illustrations pictured here reveal.

Although the interface is similar to the Macintosh one, it doesn't work exactly the same. For example, the disk icons are actually file cabinets. And they are not necessarily associated with a particular disk. If you eject a start-up disk, for instance, and insert another disk, the second disk can take over the icon that was used for the first disk. Pull-down menus come down and stay down just by pointing at the menu choice. To close a menu, you click the mouse controller outside of it or pull down a different menu. Whenever the passage of time needs to be displayed, as in loading a file, a butterfly appears on the screen.

Up to four windows can be opened on the GEM desktop. With window controls, you can change a window's size, scroll through it, open it to full screen size, or close it. Windows open and close very quickly.

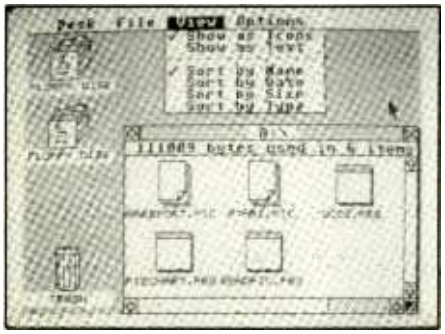
The trash icon is used for deleting files, but has a serious drawback—it is unforgiving. If you put a file in the trash, it is gone! So much for hi-tech garbage picking.

I found the GEM interface to be less responsive than the Mac interface. Sometimes, if I double-clicked an icon to open it, it didn't open. Even after adjusting the response on the control panel, I still had trouble. Often, when I clicked the close box of a window, it didn't close. This problem could be the fault of the interface or the mouse. One time, the desktop environment actually ''hung'' and the computer had to be reset. An Atari spokesman said that there's a learning curve for clicking the right way to avoid such problems. Nonetheless I've got 'em and I don't with other mouses, so maybe my test sample has a special bug.

The mouse is a two-button model. However, I would guess that 98 percent of the functions used the left button. The right button may find more uses as new applications programs are developed.

A user can interact with GEM through the keyboard instead of the mouse. For example, pressing the ALTERNATE and UP-ARROW keys simultaneously will move the arrow 8 pixels up; using SHIFT with these keys will move the arrow one pixel up.

One question at the time of this writing was the effect on GEM of the threatened lawsuit by Apple over the ''look'' of the user interface. According to an Atari spokesman, there will be minor visual changes only made in the GEM desktop graphics. Everything else will remain the same. The changes will be made to comply with the agreement that Digital Research has made with Apple.



Not a Bundle of Software

There are two disks provided with the Atari 520ST. One is the operating system disk, TOS (Tramiel Operating System?), and the other is a language disk. When you boot the system with the TOS disk, a screen appears that shows the GEM desktop.

Atari 520ST Specifications

Microprocessor: Motorola 68000, 8 MHz
Memory: 512K RAM, 16K ROM (expandable to 192K), 128K ROM cartridge port
Operating System: TOS
User Interface: GEM
Disk Drive: 360K single-sided double-density 3.5" floppy drive
Monitor: RGB analog; high resolution b/w monochrome
Keyboard: QWERTY keyboard; numeric keypad, cursor control keys; function keys
Graphics: high resolution, monochrome, 640×400 pixels; medium resolution, four colors, 640×200 pixels; low resolution, 16 colors 320×200; 512 color palette; 32K bit-mapped screen
Sound: General Instruments sound chip, 3 voices; MIDI interface
Interfaces: RS232 serial; centronics parallel; floppy disk, hard disk; two joystick ports, one configured for a two-button mouse
Languages: BASIC or Logo
Dimensions: 18.5"W×9.5"D×2.5"H
Weight: approximately 5 lb.
Price: $799.95 monochrome; $999.95 color

A menu bar offers four choices: Desktop, File, View and Options. Under the Desk menu you can set the RS232 parameters and install your printer. You can also open the control panel. The control panel allows you to set the built-in clock, adjust the colors of the desktop, and make adjustments to the mouse and keyboard. A VT52 emulator is also available from this menu. It lets you send and receive information through the RS232 port.

With the other menus, you can perform common operating system procedures such as formatting disks, opening and closing files, printing the screen, and checking disk space.

You can create folders with a menu item called New Folder, which is under the File menu. The 520ST has a true hierarchical file system (unlike

The Software Cometh

You may be wondering what kind of software is in the works for the Atari 520ST. Listed below are the categories, names and manufacturers of software currently under development:

Word Processing: GEM Write (Digital Research); HabaWord (Haba Systems, Van Nuys, CA)
Graphics: GEM Paint, GEM Draw (Digital Research); drawing program (Batteries Included, Richmond Hill, Ontario, Canada)
Database: database from Stoneware based on DB Master; HabaFiles, a file and report manager (Haba Systems).
Integrated Software: VIP Professional, a 1-2-3 workalike, including macros (VIP Technologies, Santa Barbara, CA); HabaCalc 'n' Graph, a spreadsheet with graphics (Haba Systems); the IS line of integrated software from Batteries Included will feature a word processor with built-in spelling checker, combined spreadsheet and graphics, and a database manager. Additionally, it will include the Lee Isgur Portfolio Management system.
Personal Productivity: Financial Cookbook (Electronic Arts, San Mateo, CA); Haba Check Minder (Haba Systems).
Communications: HabaCom (Haba Systems); Omega (Microbits Peripheral Products, Albany, OR)
Games: Entire line of Adventure/Fantasy games (Infocom); Sundog; Frozen Legacy, a role-playing space adventure that teaches economic priciples (FTL Software, Cupertino, CA); Jet, a flight simulator (SubLogic, Champaign, IL); Gato, a submarine simulation, Ultima II, Kings Quest (Sierra Online, Coarsegold, CA); Joust (Rugby Circle, Bloomfield Hills, MI); Star Raiders II (Atari); Zorrp and Goonies (Datasoft)
Languages: 83 Standard Forth System, three packages including Forth with and without GEM calls, and an optimizer to enhance the speed of programming code (Dragon Group, Elkville, WV); DRI-C (Digital Research); Hippo-C (Haba Systems)

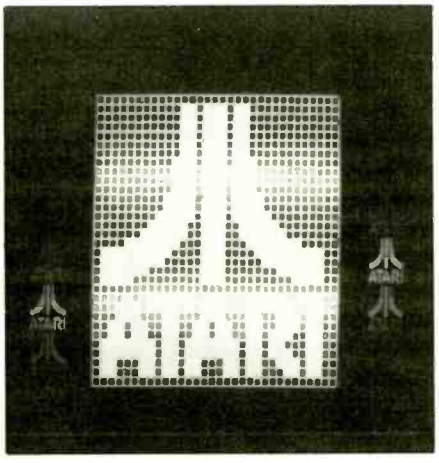
In addition to these software packages, there will be an entire operating system/applications port done by Rising Star Industries. Valdocs 2 will be ported from the Epson QX-10 to run on the 520ST. Valdocs includes a word processor, spreadsheet, database, communications and graphics. It will make some use of the GEM environment. Also, an Atari spokesman said that they have an agreement with BOS (Business Operating System) to produce software for its 520ST. This company is said to be "big" in Europe and popular with value-added people for vertical-market applications.

And don't forget the public-domain software available from places such as the Atari SIG on CompuServe.

the Macintosh). This means that files are assigned path names by the operating system. However, I had trouble both creating folders and creating folders within folders. Any time I tried to create a folder, I got a message stating that the name had already been used—then the folder appeared. If I tried to create a folder within a folder or move a file into a folder I couldn't do it. This is another example of the bugs that exist(ed) in the system I got for review.

TOS is made up of six program modules: the Desktop for windows and icons, DOS manager for the disk drives, the BIOS and BDOS system modules, a virtual device interface (VDI), and an applications environment service (AES).

The language disk supplied with the review system was Logo disk. This version of Logo is much easier to use than versions I have tried on the Apple II series of computers. Logo runs under GEM and this includes pulldown menus and windows. Commands entered in the



Logo dialogue window can be viewed simultaneously in the graphics display window.

Other than these two disks, no other software is supplied with the system. And at the time of this writing not much software was available. However, applications for business, entertainment and education are on the way (see sidebar "The Software Cometh"). Also by the time this review appears, Atari will ship the machine including BASIC and ST Writer, which is similar to the Atari Writer word-processing program for its 800 machine. They will also include a sampler called Neo-chrome, which is a color paint program. It reportedly has approximately 80 percent of the capability of the full-blown program. (The complete program will retail for $49.95.)

Documentation for the system consists of a 79-page owner's manual and a language manual. Though both are excellent, they fail to cover the system in any depth. I assume that in-depth manuals will be available from outside sources, as has been the case in the past under Tramiel-run companies.

Conclusions

Working with the Atari 520ST gave me a sense of what the perfect computer system would be like. It combines ease-of-use with raw power at

(Continued on page 91)

Audio Amplifier Specifications

How measurement standards are used to obtain performance specifications

By Leonard Feldman

If you went shopping for an audio amplifier back in the early 1970s, chances are you were faced with an array of performance claims. The most confusing of these was the likely power specification. At that time, it was possible that one manufacturer's amplifier, rated at 10 watts per channel, was able to deliver as much musical sound power as another amplifier rated at 20 watts, 50 watts, or even "100 watts peak instantaneous power."

Of course, this didn't make things easy for the typical consumer. As more and more manufacturers figured out new ways to exaggerate their amplifiers' power claims, the dedicated high fidelity component manufacturers attempted, in vain, to standardize the test methods whereby power of an amplifier should be specified. Though they met with some success, it took Uncle Sam, in the guise of the Federal Trade Commission, to finally end the chaotic state of amplifier power reporting.

In 1974, the FTC issued its Rule, entitled Power Output Claims for Amplifiers Utilized in Home Entertainment Products. Suddenly, amplifiers that had been rated at all sorts of incredibly high power levels were tamed and their power specification became more realistic. In 1975, the Institute of High Fidelity (now a division of the Electronic Industries Association) undertook the task of writing a more comprehensive set of measurement standards for audio amplifiers. Although the efforts of the FTC were certainly recognized and appreciated, the IHF knew that there was much more to specifying the performance of an amplifier than just telling how much power it was able to deliver. The standard was

completed in 1978, and in 1981 it was adopted as an interim Standard by the EIA. Since then, it has become a permanent EIA Standard. Though essentially a U.S. measurement standard, manufacturers around the world who want to sell their products in the U.S. often utilize this standard and continue to refer to it as the IHF Amplifier Standard.

Mandatory Specifications

Any manufacturer who wants to conform to the EIA Amplifier Measurement Standard must measure and publish at least five specifications for a basic power amplifier. For integrated amplifiers (those containing both preamplifier and power amplifier sections), seven specifications must be listed, while for separate preamplifier units, a total of seven "specs" must be measured and listed. Several of the specifications that apply to power amplifiers also apply to integrated amplifiers and to preamplifiers, as you will see. The five basic power amplifier specs you should look for when considering the purchase of a base audio amplifier are: "Continuous Average Power Output," "Dynamic Headroom," "Frequency Response," "Sensitivity" and "A-weighted Signal-to-Noise Radio." Let's take a look at these first.

Continuous Average Power Output

This specification parallels requirements of the FCC rule. It is the number of watts that an amplifier can deliver to a specified load impedance, over a specified bandwidth, at no more than a rated value of harmonic distortion. Using a continuous sine-wave tone, the amplifier has to be able to deliver the rated power for at least five minutes. A typical legal continuous power rating might read:

Power Output: 50 watts continuous average power per channel, 8-ohm loads, from 20 Hz to 20 kHz, with no more than 0.1% total harmonic distortion.

This single statement imparts a great deal of information and prevents many of the deceptions that were common before the rule was promulgated. Notice that the statement includes the words "per channel." That's because in the old days, some manufacturers had the habit of doubling the power rating of an amplifier. The argument they put forth was that since the amplifier was a stereo unit, the power outputs of both channels should be added together. Of course, the more scrupulous manufacturers who were careful to specify power on a per-channel basis were at a distinct disadvantage.

Specifying the load impedance is important, too, since most solid-state amplifiers deliver greater power at lower impedances than they do at higher impedances, such as 8 ohms or 16 ohms. Thus, a manufacturer who wanted to come up with the highest number of watts possible would measure the power using 4-ohm loads. There's nothing wrong with that, so long as the 4-ohm load is specified. The knowledgeable consumer will then realize that if he or she uses 8-ohm speakers, the power rating will be less.

It's also a fact that amplifiers have an easier time delivering their maximum power at middle audio frequencies than they do when attempting to reproduce very low bass or very high treble frequencies. So, the manufacturer measures power only at 1 kHz. For example, the rating might be considerably higher than if the measurement were made at 20 Hz or 20 kHz. Now that manufacturers have to specify the range of frequencies at which the product will deliver its rated power, the user can easily figure out that a 50-watt amplifier with a specified bandwidth from 20 Hz to 20 kHz is preferable to another 50-watt amplifier with a specified bandwidth from 100 Hz to 10 kHz.

Another way in which some manufacturers were able to inflate their power figures years ago was by failing to publish the distortion level at which the power was being delivered. Obviously, if an amplifier can deliver 50 watts at less than 1% total harmonic distortion, if you "push" the amplifier a little harder, it might well deliver 55 watts, 60 watts or even more at, say, 10% total harmonic distortion. Requiring that the distortion figure be published along with the power figure makes it easy to judge between amplifiers of similar power ratings but differing distortion ratings at that power level.

Dynamic Headroom

While the FTC rule standardized the way in which all manufacturers measured *continuous* or sine-wave power, it's obvious that most people don't listen to sine waves or continuous tones. It's not as obvious, but true nevertheless, that when an amplifier is called upon to reproduce musical waveforms, it can usually deliver somewhat more power than it can when it is fed with continuous test tones.

The standards committee felt that the ability of an amplifier to deliver more than its rated power under actual use conditions was useful information to prospective purchasers. However, they didn't want to confuse the issue with a second power spec, given in watts per channel. That sort of thing is what caused the confusion over power before the FTC rule was issued. So they created a term known as Dynamic Headroom, and it's quoted in decibels or dB. They also devised a special standard test signal designed to approximate what happens when an amplifier is handling musical signals. The test signal, shown in the 'scope photo of Fig. 1, consists of 20 alternations of a 1-kHz signal at full amplitude, followed by 480 alternations of the same

1-kHz signal. Total duration of the signal is 500 milliseconds, so that the signal has a repetition rate of twice per second.

To measure Dynamic Headroom, we first apply a steady-state 1-kHz signal to the amplifier, increasing its amplitude until the rated continuous power output is reached. An oscilloscope is calibrated to that amplitude. Next, the special test signal is applied and the output of the amplifier is increased until there is obvious clipping of the higher-amplitude (20-alternation) section of the special signal. That amplitude is compared with the earlier-calibrated amplitude of the steady-state signal and the resulting ratio is expressed in dB. For example, if the steady-state signal was set up as four divisions on the 'scope face and the peak amplitude of the special test signal was 5 divisions at clipping, the ratio 5/4, expressed in dB, turns out to be 1.94 dB. The Dynamic Headroom that would therefore be listed would be 1.94 dB.

How much Dynamic Headroom and amplifier has depends primarily on how its power supply is designed. A high level of Dynamic Headroom is not necessarily a measure of quality. Rather, it simply tells the user that, under musical conditions, the amplifier is likely to "sound" louder, or is able to handle shorter peaks without overloading the amplifier.

Frequency Response

Frequency response of an amplifier is measured in much the same way it is for any other audio component. In the case of power amplifiers, the frequency response is measured over the rated bandwidth of the amplifier and is expressed as a deviation, in dB, using 1 kHz as the 0-dB reference point. A typical statement of frequency response for an amplifier might read:

Frequency Response: 20 Hz to 20,000 Hz, ±0.5 dB.

More often than not, the manufacturer will specify frequency response

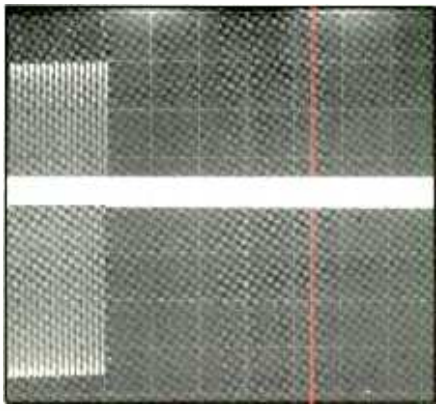


Fig. 1. A special test signal used to measure Dynamic Headroom of an audio amplifier is displayed.

by means of a continuous curve or graph. The "smoother" the frequency response curve of the amplifier the better. Some manufacturers measure frequency response at low power output levels—usually 1 watt per channel. Under those conditions, most amplifiers will have extended response to well beyond their power bandwidth. For example, an amplifier whose power bandwidth is stated as from 20 Hz to 20 kHz (for full power output), may well have a frequency response (at a lower power level) that extends from well below audible frequency limits (e.g., 5 Hz) to way beyond the audio frequency range (e.g., 100 kHz or even higher).

Sensitivity

You would think that a simple specification that is designed to tell you how much input you need to apply to an amplifier to get a given amount of output would not lead to ambiguities, but that was not the case in the early days of high-fidelity. Manufacturers then (and, to some degree, even now) insisted upon quoting input sensitivities for full rated output instead of for an agreed-to standardized level. Here's an example of the confusion that resulted.

Suppose a 100-watt amplifier had a sensitivity rating of 1 volt for *rated output,* while another, 10-watt amplifier, also had a sensitivity rating (for its full output) of 1 volt. If you were to feed a one volt signal into each amplifier would they produce the same level of sound? Of course not! The 10-watt amplifier would not sound nearly as loud as the 100-watt amplifier, yet each has a "sensitivity" of "1 volt." To prevent this kind of misunderstanding, the standard measurement method requires that input sensitivity be given as the number of volts or millvolts needed to produce 1 watt of output, regardless of the full power rating of the amplifier or integrated amplifier. In the case of separate preamplifiers, the standardized sensitivity rating is that amount of input which will produce 0.5 volt at the output.

A-Weighted Signal-to-Noise Ratio

Statements of signal-to-noise ratio can be equally meaningless unless everyone quotes S/N in the same way —that is, referred to a given input and referenced to a standard output. If manufacturers insist upon quoting S/N with respect to maximum rated output, as some still continue to do, in order to come up with higher dB numbers, here's an example of what can happen.

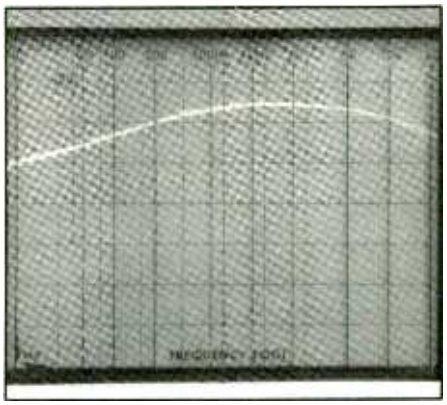


Fig. 2. An A-weighting network has its frequency response shown in this spectrum-analyzer sweep. The vertical scale is 10-dB per division while sweep is from 20 Hz to 20 kHz.

Let's consider the same two amplifiers again; one rated at 10 watts the other at 100 watts per channel. Suppose both manufacturers decide to quote S/N with respect to rated output and that each lists the signal-to-noise ratio as 90 dB. For the 10-watt amplifier, the residual noise will be 90 dB below 10 watts, or 0.01 microwatt, while for the 100-watt amplifiers, the hum and noise would amount to 0.1 microwatt or fully ten times as much. Additionally, the input sensitivity of the amplifiers may be different and this would further confuse the issue.

The EIA Amplifier Measurement Standard requires that all S/N measurements be made with respect to an output of 1 watt (or 0.5 volt, for separate preamplifiers). In addition, gain controls on the amplifier should be set so that an input of 0.5 volt applied to a high-level input of the amplifier (such as "Tuner" or "Aux" in the case of integrated amplifiers or preamplifiers) produces that standard 1 watt (or 0.5 volts for preamps) output. S/N numbers are then referred to those levels of input and output. To be sure, the numbers usually come out smaller, but at least we are comparing figures in a meaningful way.

As for the "A-weighting" part of the measurement, that refers to a system of giving heavier weighting to those noise frequencies which have been found to be most audible and most objectionable by human listeners. An A-weighting filter, inserted in the measurement path, has its own distinctive response curve, as shown in Fig. 2. Full weight is given to frequencies in the vicinity of 2 kHz, while extreme low frequencies and extreme high frequencies contribute less to the final overall signal-to-noise reading.

Additional Integrated-Amplifier Measurements

Since integrated amplifiers are nothing more than preamplifiers combined with power amplifiers, the five specifications we have discussed so far apply to these combination amplifiers as well. In addition, two more specifications need to be disclosed for integrated amplifiers. These are "Maximum Input Signal" and "Input Impedance." Both of these specifications are not required to provide the user with a measure of quality, but rather to facilitate proper matching of other components to the integrated amplifier.

For example, if the maximum input voltage is an "Auxiliary" input on an amplifier is only 1.5 volts (before overload of the input stage), that input may not be suitable for use with modern Compact Disc players, which deliver 2.0 volts or more when reproducing peak digitally recorded levels. Similarly, the input impedance of the high-level inputs of an integrated amplifier's various inputs should generally be much higher than the output impedance of the program source connected to them. On the other hand, the input impedance of magnetic phono inputs should match the requirements (usually around 47k ohms) of the cartridge used.

Additional Preamplifier Measurements

For separate preamplifiers, a manufacturer must measure and publish a couple of extra specifications as well. Since a preamplifier is not governed by the "FTC Power Rule," the manufacturer is required to state the rated harmonic distortion level of the preamplifier. (Normally, the THD figure would have been part of the rated power disclosure in an amplifier or integrated amplifier.)

Another required specification is "Maximum Output Voltage." The reasoning here is much like that for the "Maximum Input Voltage" specification applied to integrated amplifiers. It needs to be stated so that outputs of preamplifiers can be properly matched to inputs of integrated amplifiers or power amplifiers. In addition to these extra specifications, a manufacturer of a separate preamplifier is expected to provide specifications for frequency response, sensitivity, and A-weighted signal-to-noise ratios, as previously described.

Secondary Disclosures

The specifications discussed so far are all mandatory for those manufacturers who want to say that they are following the EIA measurement standard. In addition to these few required disclosures, however, there are some 21 secondary disclosures, any or all of which a manufacturer may publish if he wishes to. Space does not permit a full description of what each of these specifications is all about and how each is measured. In many cases, the titles of the specifications themselves tell you what they are about. The full list of secondary specifications follows:

Clipping Headroom, Output Impedance, Wideband Damping Factor, Low Frequency Damping Factor, CCIR/ARM Signal-to-Noise Ratio, Tone-Control Response, Filter Cutoff Frequency, Filter Slope, Crosstalk, A-Weighted Crosstalk, CCIR/ARM Crosstalk, SMPTE Intermodulation Distortion, IHF Intermodulation Distortion, Transient Overload Recovery Time, Slew Factor, Reactive Load, Capacitive Load, Separation, Difference of Frequency Response, Gain-Tracking Error, and Tone Control Tracking Error.

If you are interested in exploring the details of these additional specifications, you may want to obtain a complete copy of the EIA Amplifier Measurements Standard. Its number is RS-490 and it's dated November, 1981. The EIA offices are located at 2001 Eye Street, N.W., Washington, DC 20006 and the direct phone number to the Engineering Department of EIA is 202-457-4975. **ME**

BOOKS

Dick Smith's Fun Way Into Electronics (Vols. 1, 2 and 3). (Soft cover. Vol. 1—72 pages, $4.95; Vol. 2—128 pages, $6.95; Vol. 3—100 pages, $6.95.)

Building circuits that actually do something meaningful is by far the best part of the electronics hobby. A good way to start this adventure is with these three books, printed in large, 8½" × 11" format. They provide you with a total of 50 fun projects to build.

Volume 1 gives you 20 simple projects you can breadboard in no time at all. A short sampling include: a continuity indicator, a transistor tester, a water indicator, an electronic siren, a sound-effects generator, and a "beer-powered" radio.

Volume 2 offers 20 more advanced projects, including: a universal Morse code trainer, electronic dice, a touch switch, a mosquito repeller, a sound switch, and a car/home burglar alarm. Additionally, it has Understand Electronics, Milestones in Electronics and Pioneers in Electronics sections.

Volume 3 picks up where the other two leave off with 10 still more advanced projects, including: a mini stereo amplifier, a mini color organ, a combination time lock and a mini synthesizer. This volume also tells you what tools are needed, about components that will be used, how to read schematics, assembly procedures, how to use a multimeter, how to solder and how to make printed-circuit boards.

Most projects include assembly instructions and how-it-works information, the latter providing a technical education unto itself. Complementing the text are especially well-drawn schematics, assembly drawings, and photographs.

1985 Space Satellite Handbook. Edited by A.R. Curtis. (ARCsoft Publishers. Soft cover. 80 pages. $10 + $1 S&H.)

This book is a one-stop reference for locating and identifying satellites lofted into space since 1958 and still in orbit. Except for a three-page introduction, it consists entirely of tabular listings of the various satellites by name, country of origin and launch date. Accompanying this information are orbital parameters, including period, inclination, apogee and perigee. The data included in the listings was obtained from NASA, NORAD and the Smithsonian Observatory.

Also included is a listing titled "Country Scoreboard," which compares satellites of the 12 space-faring nations and five international organizations. Another short listing gives the transmitting frequencies for satellites monitored by the NASA Space Flight Tracking & Data Network. This section will be of particular interest to those people who want to tune in on still-active satellites.

Using Your Meter. By Alvis J. Evans. (Radio Shack. Soft cover. 144 pages. $3.95.)

There is more to using a multimeter than just connecting its probes to a circuit and reading a measurement. To effectively use a multimeter, you should understand its basic design concepts. This book begins with technical descriptions of the traditional analog-meter VOM (volt/ohm/milliamter) and numeric-display DMM (digital multimeter). It then goes on to discuss the compromises common to all meters and the types of errors you can expect as a result of these compromises. You learn how to compensate for designed-in deficiencies to maximize measuring accuracy.

More than half of this book is devoted to detailed instructions on how to use a multimeter on components both in- and out-of-circuit and on making measurements around the home.

The text is written in an easy-to-understand style and is well-illustrated with schematics, drawings and photos.

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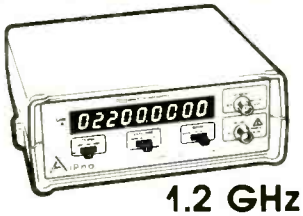

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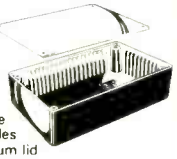

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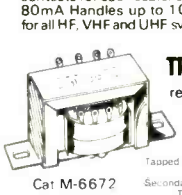

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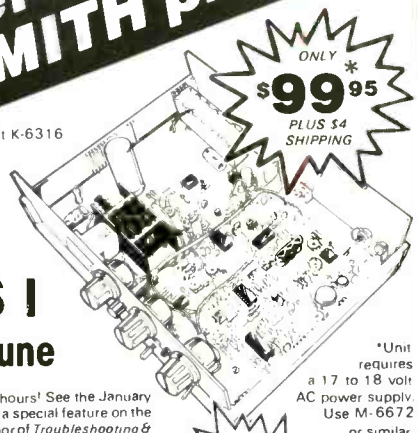

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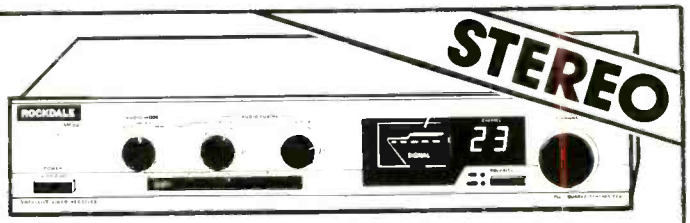

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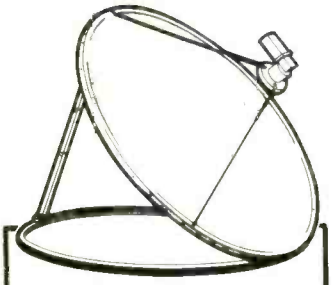

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CIRCLE 172 ON READER SERVICE CARD

Frequency Division With Shift Registers

A simple approach to dividing by even and odd numbers while maintaining 50% duty cycle

By W.L. Hoffman

Over the year, many schemes have been developed for dividing frequencies by such odd numbers as 3, 5 and 7. The basic division isn't much of a problem since this can be obtained in a number of ways. The problem is in obtaining a symmertically square wave with a 50% duty cycle after division. This article explores the use of shift registers and exclusive-or (XOR) gates as both even- and odd-number frequency dividers that do just this.

How Shift Registers Divide Frequencies

Figure 1 illustrates a generic type serial-in/parallel-out (SIPO) shift register. This type of shift register (hereafter referred to by its initials "SR") accepts binary data one bit at a time at its input and "shifts" it one position down the line of its Q outputs for each rising clock-pulse edge.

For example, if a binary 1 is applied to the input, the 1 will appear at the Q1 output following the rising edge of the next clock pulse. After the rising edge of the second clock pulse, the 1 shifts to output Q2 and output Q1 receives new data from the input. For each successive input clock pulse, data moves down the Q output line one position, with data applied to the input shifted to the Q1 output each time.

To make the SR into a frequency divider, you connect an inverter from one of the Q outputs to the input terminal, as shown in Fig. 2. Clearing the SR before applying clock pulses sets all Q outputs to 0, with a binary 1 fed back to the input. For the first three clock pulses, 1s will shift into the SR making Q1, Q2 and Q3 all 1s, with 0 at the input. The fourth, fifth and sixth clock pulses shift a string of 0s into the SR.

As the clock continues, alternating strings of three 1s and three 0s move down the register and appear at the output as a square wave with a frequency of one-sixth the clock frequency. If the inverter had been connected at Q4, the clock frequency would have been divided by 8, while connecting it at Q5 would divide by 10, and so forth. So far, you've seen

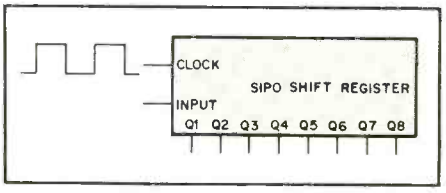


Fig. 2. Shift register frequency division occurs when the input is its own inverted output.

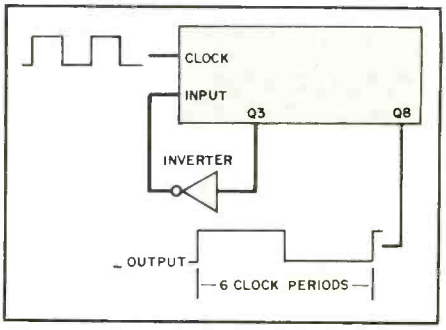


Fig. 1. A typical serial-in/parallel-out (SIPO) shift register.

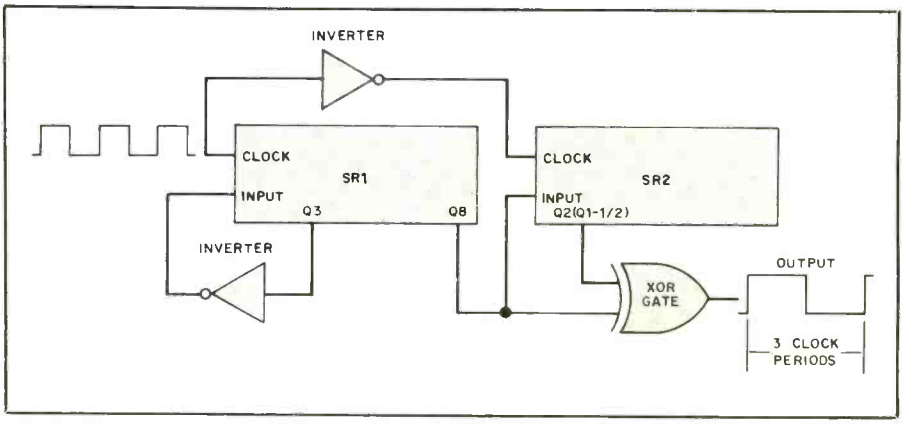


Fig. 3. The inverted clock makes the output of the second shift register equivalent to half positions of the first shift register's outputs.

how a single SR can work as a frequency divider for even numbers that are equal to twice the Q position used for feedback.

Dividing by Odd Numbers

If you want to divide by an odd number, you might think that you need an SR with half positions! You don't. By adding another of the same type SR and inverter arrangement as used in Fig. 2, you can obtain division by odd numbers. Such an arrangement is shown in Fig. 3. Here the output at Q1 of SR2 is identical to the SR1 output but is delayed by half a clock period because SR2 is driven by the inverted SR1 clock. This causes the positions on SR2 to be equivalent to half positions on SR1. Therefore, you can consider the SR2 positions as Q½, Q1½, Q2½, etc. instead of Q1, Q2, Q3 . . .

Notice on the timing diagram of Figure 4 that the waveform from Q8 of SR1 differs by 1½ clock periods from the waveform of Q2 of SR2. The XOR of these two waveforms is the third line of Fig. 4 and has the desired divide-by-3 frequency of the clock with a 50% duty cycle.

To divide by other odd numbers, you can move the feedback connection to the corresponding Q number on SR1 and change the XOR input to the appropriate half position of SR2. For example, to divide by 5, move the feedback to Q5 of SR1 and the XOR input to Q3 (Q2½) of SR2.

To divide by even numbers, remove the XOR input from SR2 and tie it to the + V supply rail. Place the feedback position at an output number on SR1 that is half the divide-by number.

Figure 5 is a complete schematic of a circuit built around shift registers and XOR gates for dividing by odd numbers up to 15 and even numbers up to 32. Notice that XOR gates replace the inverters and an additional SR follows SR1 to extend the division range. **ME**

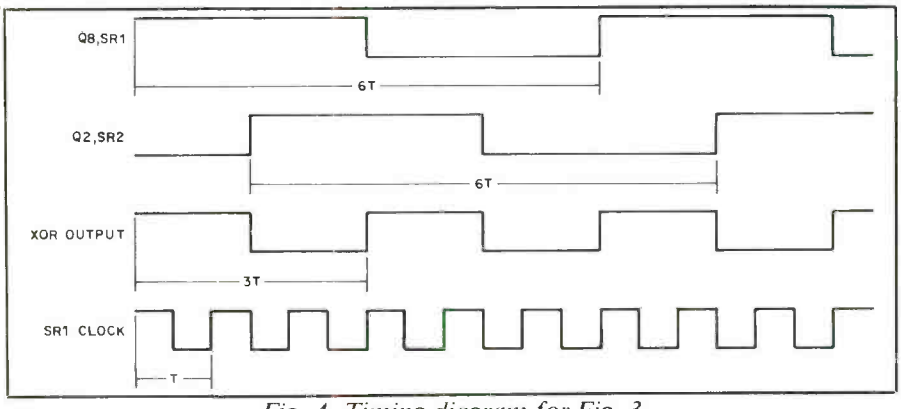


Fig. 4. Timing diagram for Fig. 3.

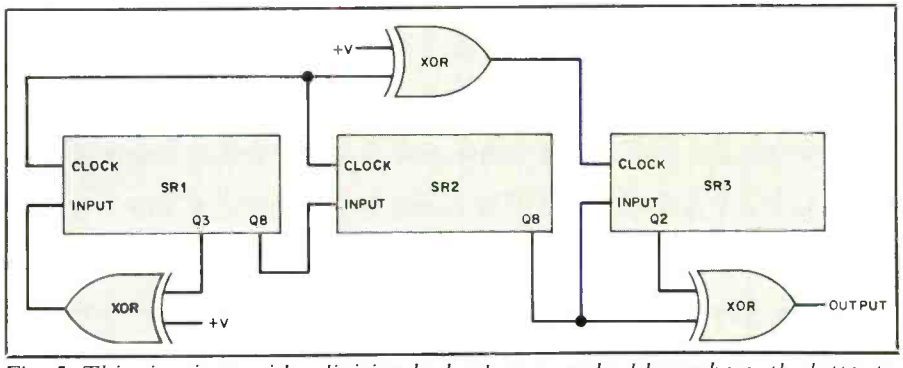
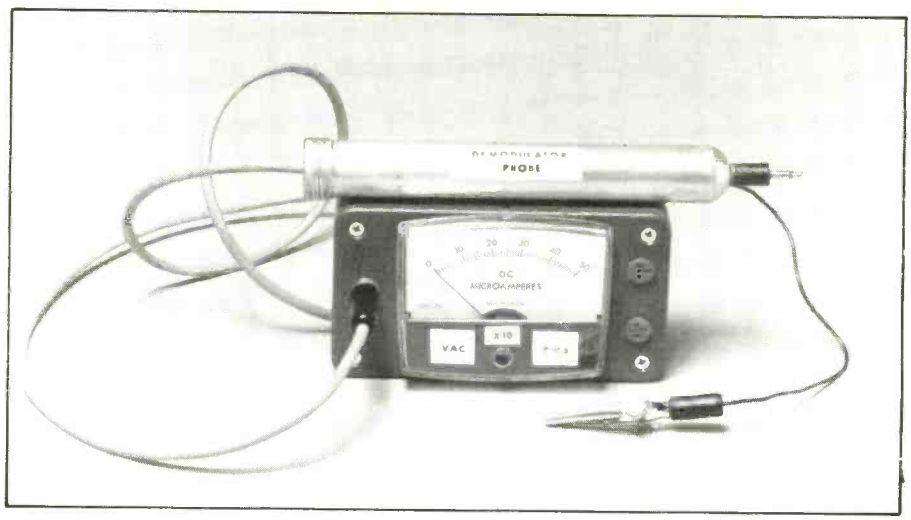


Fig. 5. This circuit provides division by both even and odd numbers, the latter to a maximum of 15. The arrangement shown divides by 3.

Measure High-Frequency AC Volts

Probe/voltmeter measures rms volts from 10 Hz to beyond 10 MHz and also functions as an amplitude-modulation detector

By Duane M. Perkins



New test instruments are as simple in design and easy to use as the AM demodulator probe. Consisting of a half-wave rectifier and low-pass filter, it processes an r-f input signal to deliver a dc output voltage that varies with the r-f signal amplitude. The average dc output voltage from this setup is proportional to the average ac input voltage.

A demodulator probe is very useful when experimenting with low-level r-f. It's a practical necessity for signal tracing in TV, AM and FM receivers. The output from the probe can be fed to an oscilloscope, audio amplifier or ac voltmeter to let you see, hear or measure the signal being demodulated.

Being a very simple test instrument, you can build the demodulator probe and companion ac rms voltmeter described in this article in just a few hours. It contains only inexpensive and readily available parts that won't break the bank.

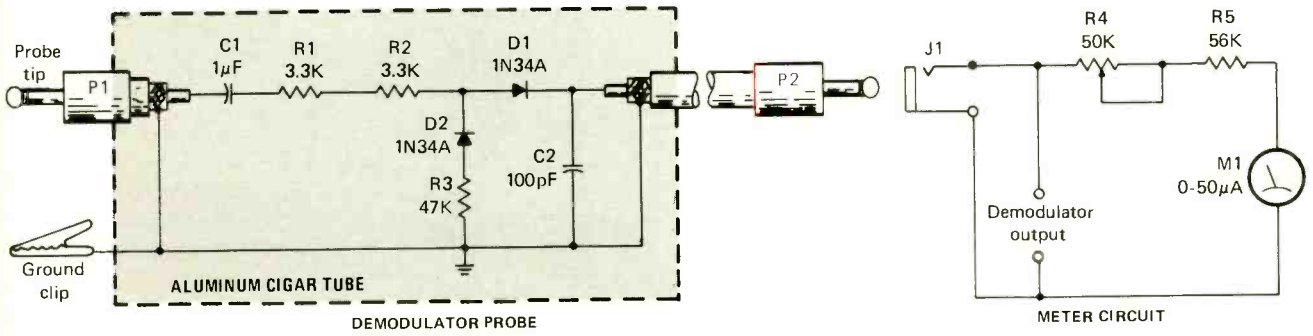
About the Circuit

Referring to Fig. 1, you will note that the probe and companion meter circuits are totally passive. Therefore, no internal power source is required for the project. The demodulator circuit shown at the left is a half-wave voltage doubler. Its high series resistances assures high input impedance for minimal loading on a circuit being tested. When the probe is plugged into the meter circuit shown at the right, the resistors provide scaling to give rms voltage readings.

This probe circuit has two principal advantages. Capacitor *C1* blocks any dc between the probe and the signal source. Since the signal source may have a significant dc component of either polarity, *C1* should be a nonpolarized capacitor. The output of the probe increases as the load is reduced and approaches the peak-to-peak ac input voltage when the load is on the order of 10 megohms, making it about 3.5 times as sensitive as when used with the meter circuit in Fig. 1.

With the probe plugged into the meter, a significant voltage is dropped across *R1* and *R2* as a result of the current required to recharge *C2*. The voltage across *C2* will peak at about 80 percent of the rms input voltage. Trimmer potentiometer *R4* is adjusted to calibrate the meter for rms volts (one-tenth of scale). This requires that *R4* + *R5* provide a series resistance of about 80,000 ohms, which puts *R4* at about center of rotation.

Filter capacitor *C2* in parallel with the capacitance of the shielded cable results in negligible ripple at radio frequencies (200 kilohertz and higher) but ripple increases and average dc output voltage drops at lower frequencies. However, the probe can be used to measure very low-frequency ac voltages simply by connecting a larger filter capacitor across the DEMODULATOR OUTPUT terminals in



PARTS LIST

C1—1-μF nonpolarized capacitor
C2—100-pF disc capacitor
D1,D2—1N34A signal diode
J1—Subminiature phone jack
M1—1-to-50-μA meter movement (Radio Shack No. 270-1715 or similar)
PL1,PL2—Subminiature phone plug
R1,R2—3300-ohm, ¼-watt resistor
R3—47,000-ohm, ¼-watt resistor
R4—50,000-ohm trimmer potentiometer
R5—56,000-ohm, ½-watt resistor
Misc.—Aluminum cigar tube; transistor socket; pin jacks or 5-way binding posts; miniature alligator clip, preferably with insulating hood; shielded cable; utility box for meter movement Radio Shack No. 270-222 or similar); terminal strips; epoxy cement; hookup wire; solder; etc.

Fig. 1. Overall schematic diagram of both basic probe and metering circuits. Both are completely passive, eliminating need for internal source of power. Probe's high input impedance minimized loading of circuit under test.

the meter circuit. With a 10-μF capacitor, calibration remains correct down to 10 Hz, but below 10 Hz, the reactance of *C1* becomes the limiting factor. Since the polarity of the output is always positive, *C2* can be an electrolytic capacitor.

Construction

An aluminum cigar tube makes a good housing for the probe. The components can be soldered together to make an assembly that will slip neatly inside the tube, as shown in Fig. 2. A 3/32" subminiature phone plug cemented into the tip of the tube can be used to directly contact the signal source or be plugged into a matching jack connected to the signal source.

Drill the hole for the plug just large enough for a tight fit around the plastic part of the phone jack and apply a small amount of epoxy cement around the hole inside the tube. Drill a hole in the end cap for the shielded cable. There is usually a plastic disk inside the end cap and a paper liner inside the tube. Leave these in to provide insulation and drill a hole in the plastic disk that will fit tightly around the shielded cable. Keep the ground wire with the alligator clip as short as practical to minimize impedance.

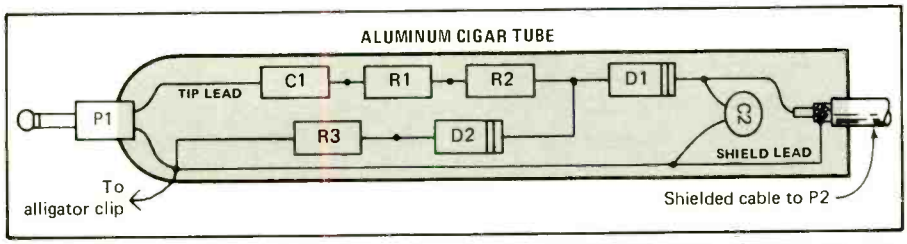


Fig. 2. Construction details for probe portion of project. Note that all components are self-supporting and require no other mechanical elements during wiring. When installing circuit inside tube, do not remove paper or wood liner.

You can mount the meter in any type of enclosure into which it will comfortably fit, though the Radio Shack No. 270-222 plastic case specified in the Parts List is almost ideal for the specified meter movement with a ⅛" mini phone jack on one side and a socket on the other side for access to the output signal. In the author's prototype two transistor sockets were used for output signal access, though you can use pin jacks or 5-way building posts if you prefer. An external filter capacitor can be plugged directly into the socket or jacks. You can mount a terminal strip on one of the meter mounting screws to mount *R5* and *R6*. Use a ⅛" miniature phone plug on the end of the shielded cable.

Checkout and Use

The two units can be tested with the output from a low-voltage power

(Continued on page 89)

A Versatile Security Alarm Controller

System uses "area-of-value" concept to protect homes/offices and motor vehicles

By F. Dale Williams

Intruder and theft deterrence has become a flourishing business in recent years. Manufacturers cater to the marketplace with a plethora of commerical alarm systems designed to meet the differing needs of users whose requirements range from sophisticated systems costing $1000 or more to the more mundane $20 or so bicycle alarm. The sheer variety of alarm types can be very confusing when the time comes to make a buy decision. You can clear the air by *building* an alarm that suits your particular needs, such as the Versatile Alarm Controller described here.

This project's "versatility" comes from the fact that it can be adapted to provide premises or vehicle protection with no modification of the basic circuit.

The controller serves as an electronic control center that can be activated by any type and variety of sensors commonly used in commercial alarm systems. When tripped, it completes a circuit to any audible alerting device of your choice. For premises protection, it uses the "area-of-value" concept to provide continuous electronic surveillance of a selected area or room in which valuables are usually used and/or stored. By equipping each such area with its own separate but inexpensive alarm, sensitive areas can be protected without the necessity of complete—and usually costly—full-premises wiring, as would normally be the case with commercial alarms.

When used to protect a car, van or truck, the controller uses the vehicle's horn to sound the alert. This eliminates an extra-cost audible alerting device. In a premises-protection system, you can have the alarm generate unique sounds for different protected areas. You can do this with either a combination of bell, siren, buzzer, Sonalert®, etc., or by changing the rates at which the audible alerting device is pulsed on and off.

Operationally, the alarm draws very little current when in the standby mode, making it economical to use. It also automatically resets, with noncontinuous cycling dependent on sensor activation. Finally, installation is easy to perform, since wiring is limited to just the protected area.

About the Circuit

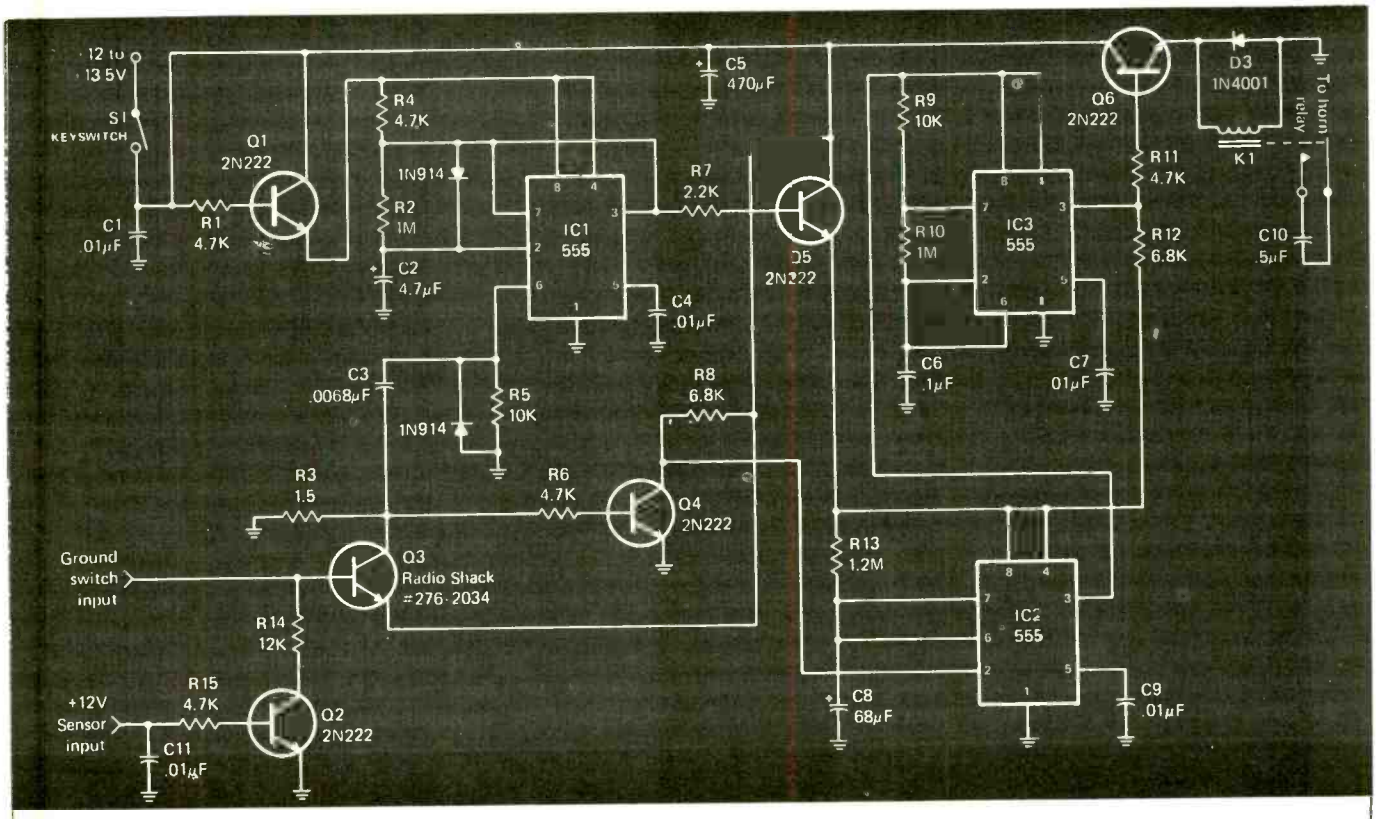
In Fig. 1 is shown the entire schematic diagram of the controller. To keep it universally adaptable to use in a home/office or vehicle, the alarm is powered from a 12-to-13.5-volt dc source. When power is first applied to the circuit, by closing keyswitch *S1*, the alarm goes into standby. Power is then routed as needed by each stage through *Q1*.

Transistor *Q5* keeps *IC2* and *IC3* from operating when no intrusion has been sensed and for 5 seconds after a sensor has been tripped. This delay prevents the alarm from sounding immediately when a sensor is activated. To operate properly, all doors (when the alarm is used in a vehicle) must connect to the courtesy- or dome-light circuit.

Transistors *Q2* and *Q3* activate the alarm when the courtesy light in a vehicle is turned on by opening one of the doors or when a sensor in a premises system is tripped. When an input sensor is connected and *S1* is set to on, tripping the sensor causes *Q3* to deliver a turn-on pulse to pin 6 of *IC1*. Then *IC1* operates as a delay timer that removes supply voltage from *IC2* and *IC3* for 5 seconds.

The trigger pulse from *Q3* is also applied through *Q4* to *IC2*. After the 5-second delay countdown, reapplying supply voltage causes pin 3 of *IC2* to go high and turn on *IC3*. In turn, this causes relay driver *Q6* to conduct and energize relay *K1*. When *K1*'s contacts close, the alarm sounds.

Timer *IC2* maintains supply voltage to *IC3* for approximately 2 minutes, during which time, *IC3* pulses *Q6* at a rate of two times per second. When the 2-minute countdown ends, *IC2* shuts off and the circuit automatically resets itself and is ready for the next time a sensor is tripped. If the sensor remains activated, how-



PARTS LIST

Semiconductors
D1,D2—1N914 diode
D3—1N4001 or similar 1-ampere rectifier diode
IC1 thru IC3—555 timer
Q1,Q2,Q4,Q5,Q6—2N2222 npn transistor
Q3—General-purpose pnp transistor (Radio Shack No. 276-2034)

Capacitors
C1,C4,C7,C9,C11—0.01-μF disc
C2—4.7-μF, 15-volt electrolytic
C3—0.0068-μF disc
C5—470-μF, 15-volt electrolytic
C6—0.1-μF disc
C8—68-μF, 15-volt electrolytic
C10—0.5-μF disc

Resistors (¼-watt, 10% tolerance)
R1,R4,R6,R11,R15—4700 ohms
R2,R10—1 megohm
R3—1.5 ohms
R5,R9—10,000 ohms
R7—2200 ohms
R8,R12—6800 ohms
R13—1.2 megohms
R14—12,000 ohms

Miscellaneous
K1—12-volt dc spst relay (see text)
S1—Keyswitch (Radio Shack No. 49-515) Printed-circuit board or perforated board and solder posts; suitable enclosure; sockets for IC1 through IC3 (optional); machine hardware; hookup wire; solder; etc.

Fig. 1. This is the overall schematic diagram of the controller module. Not shown are the sensor circuits or hookups, which are different for home/office and vehicle setups.

ever, the alarm will continue to sound. (If the sensor is a motion detector, the alarm will recycle 2 minutes after the last detected motion.)

Shown in Fig. 2 are two methods for using normally-closed switches, such as the magnetic variety commonly used to protect windows and doors, to activate the control module when they are tripped. In Fig. 2(A), when all door and window and the SET switches are closed, the LED lights to indicate that the system is ready and the *S1* keyswitch (installed outside the protected area) can be turned on.

When the alarm control module is activated and the keyswitch is subsequently turned off, it takes a few seconds for the filter capacitor to bleed off its charge. Turning on the keyswitch before the voltage on the capacitor is allowed to decay activates the alarm.

The circuit shown in Fig. 2(B) is the same as that in Fig. 2(A), except that it uses a switching transistor in place of the relay.

When using multiple control modules in separate rooms or areas, the repetition rate of the pulses from *IC3* delivered to *K1* (see Fig. 1) can be adjusted so that the alarm sound from

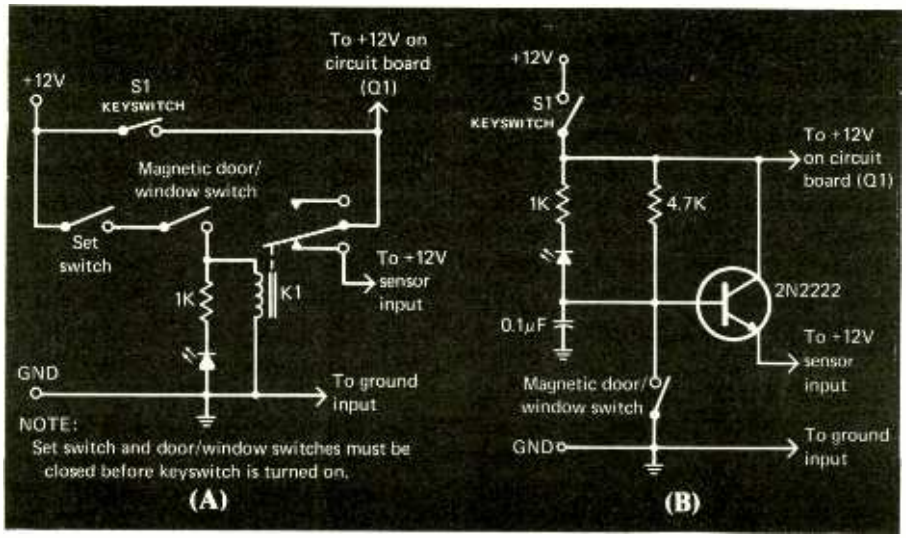


Fig. 2. Two methods of using normally-closed sensors to activate the controller module. In circuit (A), connection to the controller is via a relay; in circuit (B), the relay is replaced by a switching transistor to provide the same result.

each area is readily distingishable. Changing the value of *C1* or *R10* in the *IC3* circuit alters the repetition rate at which *IC3* pulses *K1*.

Any of the audible alarm devices on the market can be used with the controller. These include audio transducers, sirens, bells, horns, etc. Those alarms that require ac line voltage to operate or draw more current than is safe for *K1*'s contacts to handle will require an additional switching relay following the dc relay specified for *K1*.

Construction

Circuit board assembly is recommended for this project. You can use either a printed-circuit board of your own design or perforated board and Wire Wrap hardware or solder posts. In either case, size the board to fit into a standard aluminum or plastic utility box.

When assembling the board for home/office use, you can use sockets for the ICs if you wish, though they are not really needed. If you plan to use the control module in an automotive environment, however, do *not* use sockets, since mechanical vibrations may cause the ICs to work loose. As you wire each component into place, make sure you observe proper polarities and orientations. Double-check before soldering the connections.

Selection of the audible alarm device's relay depends on the device you use. If *K1*'s contact rating is insufficient for the device chosen, follow this relay with one that has a greater contact-current rating. If you substitute a different relay for that specified for *K1*, make sure *Q6* is able to handle any extra current drawn by the substitute relay.

When using the controller in a vehicle, wire *K1*'s contacts parallel with the vehicle's horn relay coil, one lead to the steering-column horn button wire and the other to −12 volts or chassis ground, depending on the make of the vehicle (normally a chassis connection). If your vehicle does not use a horn relay, you must install one in the engine compartment. The relay's +12-volt contact goes to the +12-volt horn wire, and its coil terminals connect to +12 volts and one contact of *K1*. The remaining *K1* contact then connects to the vehicle's chassis ground.

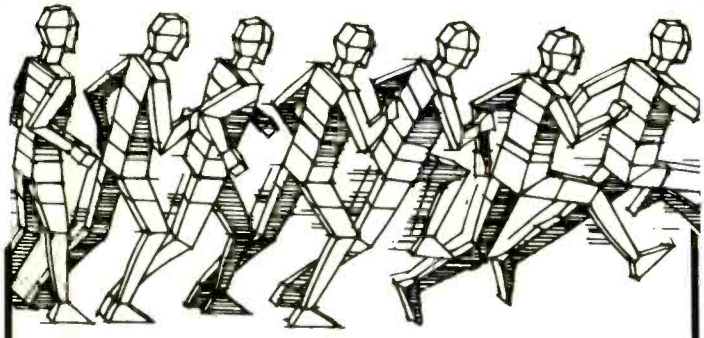
To determine which type of courtesy-light system your vehicle has, open the dome-light assembly and remove the bulb. Use a meter to check for voltage on both contacts with all doors closed. If no voltage is present, the door switch provides continuity to the +12-volt side of the electrical system when a door is open. In this case, connect a wire between the ground input of the alarm control module and the door switch wire that has voltage on it only when the door is open.

If voltage is present on the courtesy-light contacts when the doors are closed, the door switches provide continuity to chassis ground when any door is open. In this case, connect between the ground input of the alarm control module and the door switch wire that indicates voltage when all doors are closed. Do *not* connect a wire to the unused circuit-board sensor input. This precludes stray capacitance from falsely triggering the alarm.

Once you have assembled the project and test connected it to its sensor(s), mount the control-circuit board inside its utility box, using spacers and machine hardware. You can have the wires enter the box through a rubber-grommet-lined hole or via an optional screw-type barrier block. Mount keyswitch *S1* wherever convenient outside the protected room or area in a home or office on the outside of your vehicle. Hide all wiring from and to the control module wherever possible.

In Closing

As you can see from the foregoing, protecting a home or office or a vehicle from intrustion and theft can be a relatively simple and inexpensive proposition. The Versatile Alarm Controller described here is inexpensive enough to allow you to use separate and independent systems in each area to be protected. **ME**



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Discover the "Hidden World" of FM Broadcasting

(Part 2, Conclusion)

Project lets you tune in on SCA subchannels with almost any FM-stereo tuner or receiver

By Gary McClellan

Part 1 of this article discussed the technical aspects of SCA broadcasting and dealt with a description of the Explorer SCA adapter's circuitry. In this concluding part, we will tell you how to build, set up and use the Explorer.

Construction

Use of a printed-circuit board is mandatory for this project because of the high-gain circuitry that requires tight component layout. Also, the board is used as a heat sink for *IC2*. Do not expect this project to work if you plan to breadboard it. Either fabricate your own pc board using the actual-size etching-and-drilling guide in Fig. 3 or buy one ready for wiring from the source given in the Parts List.

Interior view of assembled Explorer shows components mounted on the pc board, plus how switches, controls and LED mount on front panel.

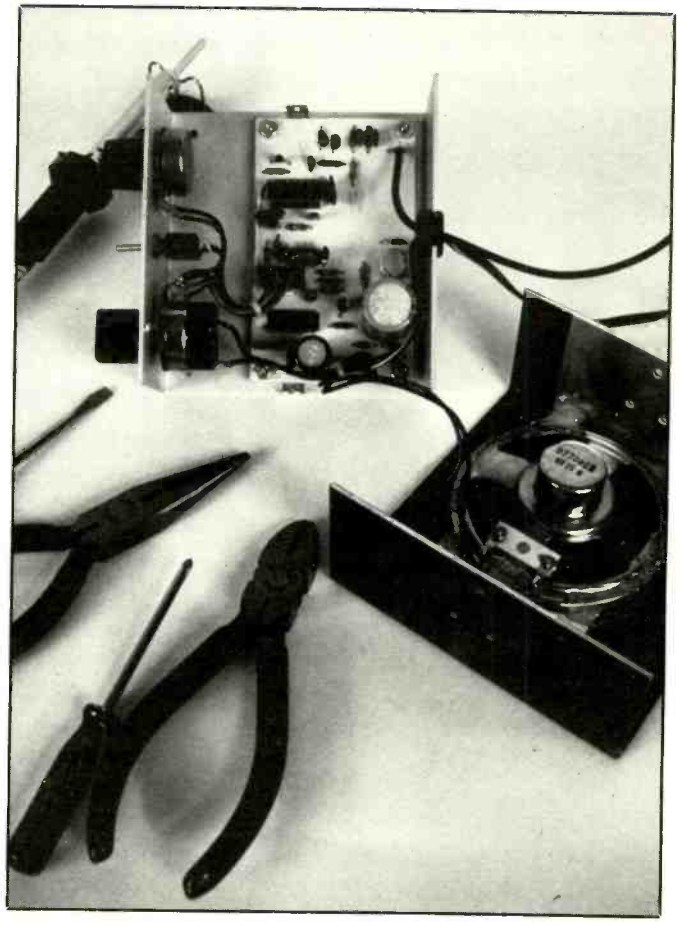
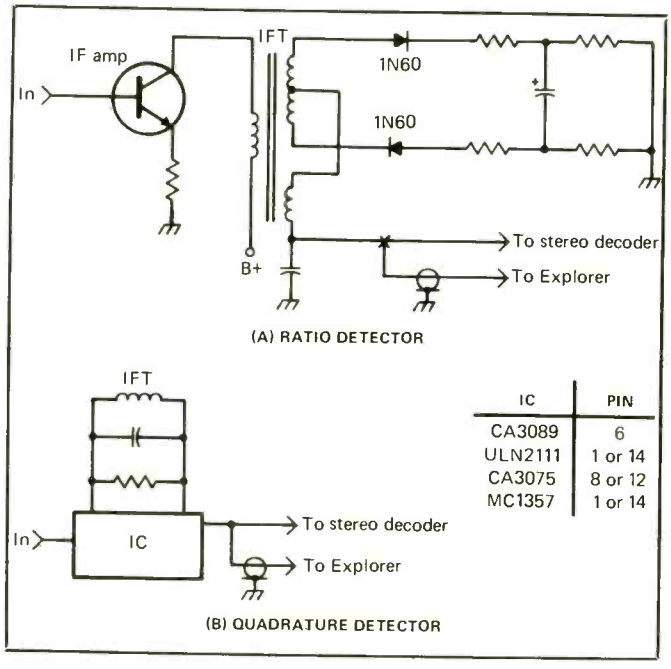


Fig. 4. Diagrams illustrate to which points in an FM receiver's detector circuit to connect Explorer. Ratio detector (A) appears in older and low-cost newer receivers, quadrature detector (B) in late models.



IC	PIN
CA3089	6
ULN2111	1 or 14
CA3075	8 or 12
MC1357	1 or 14

Start wiring the board by installing a socket (not the integrated circuit) in the *IC1* location indicated in the components-placement diagram in Fig. 3. Do *not* use a socket for *IC2*, since you want the board to serve as a heat sink for this device. You will note that there is no hole in the pc board for pin 16 of *IC2*. Therefore, clip off pin 16 near the body of the IC before installing it on the board.

Continue wiring the board as shown, paying careful attention to the orientations of the diodes, transistors and electrolytic capacitors. Also, be sure to wire in the jumper from one pad labeled J to the other pad labeled J on the board. Use solid hookup wire for the jumper.

You have the option of connecting stranded hookup wires from the pin holes on the pc board labeled for *J1* and *J2* to the off-the-board components or make the connections via the *J1/P1* and *J2/P2* connectors specified in the Parts List. If you go the latter route, install the *J1* and *J2* connectors exactly as shown in the components-placement diagram in Fig. 3. Make sure the plastic tabs, indicated by heavy black lines, are oriented exactly as shown.

Next, prepare a preferably metal (to keep interference pickup to a minimum) box measuring 4″ × 4″ × 2″ minimum to house the project. A two-tone box like that shown in the lead photo will dress up the project and save you the work of painting it.

Mount the controls on the front panel via appropriate-size holes; provide access for the input and wall-transformer cables through a hole in the rear wall of the box; and drill the mounting holes for the pc assembly in the floor of the box. Line the cable-access hole with a rubber grommet. Then use a dry-transfer lettering kit to label the controls. Spray two or three light coats of clear acrylic over the entire surface of the front panel, waiting for each coat to dry before spraying on the next, to provide protection for the lettering.

Mount *S1*, *R16/S2* and *R17* (POWER switch, VOLUME control/MUTE switch and TUNE control, respectively) on the front panel. If there is a connector at the end of your wall transformer's cable, cut it off. Then carefully separate the two cable conductors for a distance of about 4″ and trim ¼″ of insulation from each. Twist together the fine wires in each conductor and sparingly tin.

Strip 1″ of outer insulation from both ends of a 36″ to 48″ length of RG-174 coaxial (or shielded microphone) cable. Separate the shield from the inner conductor at both ends of the cable, all the way back to the remaining outer insulation. Then strip ¼″ of insulation from the inner conductor at both ends of the cable. Feed both the transformer and coaxial (or microphone) cables through the rubber grommet in the rear wall of the box. Tie a knot in the cable pair about 5″ from the inside end to serve as a strain relief. Connect and solder the inner conductor of the coaxial (or microphone) cable to the HOT and the shield to the GND INPUT pads on the pc board. At the other end of this cable connect and solder a phono jack. Make sure the inner conductor goes to the tip contact and the shield goes to the outer contact of the jack. If you wish, you can slip onto the cable a 1″ length of heat-shrinkable tubing, make the connections, and then shrink the tubing around the *P3* phone plug and cable.

If you have decided not to use the *J1/P1* and *J2/P2* arrangement, cut nine 4″ lengths of stranded hookup wire. Strip ¼″ of insulation from both ends all nine wires, twist together the fine wires and lightly tin with solder. Insert one end of these wires in the *J1* and *J2* holes in the board and solder into place. The only unoccupied hole in this group should be *J2* hole 2. Insert one of the transformer cable's conductors into this hole and solder into place.

If you elected to use the *J1/P1* and *J2/P2* arrangements, connect and solder 4″ lengths of prepared stranded hookup wires to all six contacts on *P1* and contacts 1, 3 and 4 of *P2*. Solder one conductor of the transformer's cable to contact 2 of *P2*.

Referring back to Fig. 2, connect and solder the wires coming from the *J1* holes on the board or from *J1* itself to the appropriate lugs on *S2*, *R16* and *R17*. Run another 4″ stranded wire from the junction of *R16/R16/P1*, contact 5 to a No. 6 solder lug. Connect and solder the wire coming from *P2* contact 1 or *J2* hole 1 to one lug on *S1*. Then connect and solder the remaining conductor of the transformer's cable to the other lug on *S1*.

Carefully drill a dozen or more 3/16″ or ⅛″ holes in a circular pattern in the center of the top half of the box to provide a means for the sound to escape from the speaker. Deburr the holes and test fit the speaker in the

(Continued on page 90)

Happy Birthday, SCA!

The "hidden" SCA broadcasts on FM stations are now celebrating their 30th birthday. Way back in 1955, the Federal Communications Commission (FCC) authorized SCA transmissions, allowing broadcasters to lease their subcarriers for broadcasting special-interest programs to paying subscribers.

Information on the early technical details is sketchy, but it appears that the first use of SCA was to mute the output of an FM receiver when commercials were broadcasted. Later on, programs were broadcast on a 41-kHz subcarrier. When stereo entered the picture in 1961, the subcarrier frequency was raised to 67 kHz to avoid interference with the stereo subcarrier at 38 kHz. Surprisingly, both frequencies are still currently in use, although 41-kHz activity is as rare as the few remaining monophonic FM broadcasters.

Today, there are a wide range of users who lease SCA space. They range from Muzak, which broadcasts "mood" music for factories, stores and restaurants, to the Physicians Radio Network, which broadcasts medical news to subscribing doctors.

VCR Remote Controller Is A TV Turn-On

Simple modification lets you use your VCR's wireless remote controller to turn on/off power to any manually-operated TV set

By Charles Nicol III

I recently purchased a videocassette recorder that has a full-feature wireless remote-control system. However, this great convenience was somewhat diminished by the TV receiver with which I planned to use the VCR. It does not have a remote-control capability, requiring me to still get up from my viewing chair to turn off my TV set when I was finished viewing. To circumvent this problem, I devised a modification of my VCR that would let me control ac power to my TV receiver.

My solution entails modifying some of the basic electronics inside most modern VCRs. If you are faint of heart or if your VCR is still within its warranty period, I do not suggest that you make the modification to be described. Otherwise, this may be a practical solution to a problem similar to mine. To perform this modification, your VCR must have on its rear panel a convenience ac receptacle that is powered at all times, regardless if your VCR is turned on or off. In addition, you need only three commonly available electronic components.

The Circuit

Shown in Fig. 1 is the circuitry needed to accomplish the modification, along with instructions on where to install it. The main element in this circuit is the Motorola SC141B triac (Radio Shack No. 276-1001), which is triggered by the MOC3010 optical triac trigger (Radio Shack No. 276-134). The 180-ohm resistor simply reduces the 117-volt ac line power to a safe level for the triggering device.

The triac operates as a bidirectional thyristor that can be gate triggered to be fully on or fully off (in this application). The SC141B in this circuit is rated at 200 volts, 6 amperes with proper heat sinking. It is ideal for switching ac voltages. In the Fig. 1 circuit, it is used to switch on and off the ac voltage to the receptacle on the rear panel of your VCR.

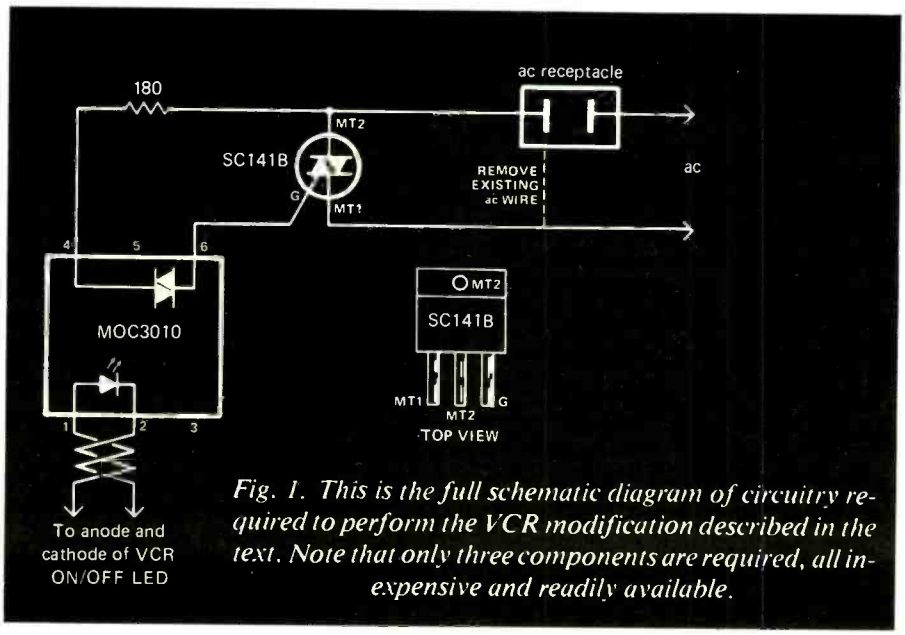


Fig. 1. This is the full schematic diagram of circuitry required to perform the VCR modification described in the text. Note that only three components are required, all inexpensive and readily available.

As shown in the diagram in Fig. 1, inside the MOC3010 optical triac trigger are a gallium-arsenide infrared emitting diode that is light coupled to a silicon bilateral switch. It takes a forward current of between 5 and 15 mA for the internal IR diode to trigger the bilateral switch. (For a slight increase in cost, the MOC3012, which triggers at 5 mA, can be substituted for the MOC3010.)

Triggering of the MOC3010 is ac-

complished by passing a current from the VCR's POWER LED through its internal IR diode. When the LED is on (indicating power is applied to the VCR), current flows through the internal LED and triggers the built-in triac. This in turn applies a voltage to the triac's gate terminal, triggering it on and applying full 117 volts ac to the VCR's accessory receptacle.

Installation

A 2" × 1" perforated board is of sufficient size to accommodate the triac, triac driver and resistor. A socket is recommended for the triac driver. Install a pair of solder pins on the board near the triac's MT1 and MT2 (main terminals 1 and 2) terminals. Wire the components together on the underside of the board, using solid hookup wire for all interconnections except those from the triac's MT1 and MT2 terminals. Use heavy-duty stranded wire for these interconnections. Then connect and solder appropriate lengths of the same stranded wires to the solder pins on the top side of the board. Solid 22-gauge hookup wire is sufficient for interconnections between the triac driver and VCR's POWER LED. Clip a Radio Shack No. 276-1367 heat sink onto the triac.

Installation of the circuit requires that you open your VCR's cabinet to gain access to the connection points. Before you proceed, however, make sure that the VCR's power cord is unplugged from the ac line. Once the cabinet is opened, determine the best procedure for accessing the ac receptacle's wiring and the connection points to the POWER LED.

Determine where you will mount the board, selecting a location where it will not interfere with the VCR's electronics or mechanical elements. Mount the board with the aid of one or two sets of machine hardware and spacers.

Next, loosely twist the solid wires coming from the triac driver and route them to the POWER LED. Make sure that these wires do not interfere with the elements inside the VCR. Tack-solder the wires to the appropriate terminals on the LED. Then cut through the wiring to one of the lugs of the ac receptacle and strip ¼" to ⅜" of insulation from the cut ends. Tightly twist together the wires from MT2 of the triac and the wire connected to the lug of the receptacle and secure the connection with a wire nut. Do the same with the MT1 wire and the wire formerly connected to the ac receptacle's lug.

Checking it Out

Plug your TV receiver's power cord into the VCR's accessory receptacle and the VCR's power cord into an ac wall outlet. Turn on your TV set and then your VCR. The latter's POWER LED should light and then, after a short interval, a picture should appear on your set's screen (you should hear sound immediately) if everything is okay. Then step across the room and turn off and then on and off again the VCR with its remote controller. The VCR and TV receiver should both turn off, on and then off, signalling that everything is operating as it should.

Once you are satisfied with the modification's operation, disconnect power to the VCR and reassemble its cabinet. Then make all cable connections between VCR and TV receiver and antenna. Plug the VCR's power cord into the ac line, and your system is ready for use.

In Conclusion

It should be noted that various makes and models of VCRs are different and that you may have to do some improvising to take advantage of the modification described here. For example, your VCR may not even have an accessory ac receptacle on its rear panel. In this case, you would have to install one. **ME**

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Linear & Interface Selector Guide. Motorola's new 76-page selector guide provides summary data on all current linear and interface ICs, including a new section on telecommunications devices. It has been revised to include updated information on the company's line of linear ICs, including analog, power-supply, consumer, automotive and communications circuits. A free copy of the "Linear and Interface Integrated Circuits Guide" (No. SG96) can be obtained from any Motorola distributor or by writing to: Motorola Semiconductor Products Inc., P.O. Box 20912, Phoenix, AZ 85036.

All About Disks Booklet. A 32-page illustrated booklet from Fuji, titled "The Floppy Disk Story," introduces computer users of all ages to the floppy disk. It traces the adventures of two inquisitive youngsters who experience various encounters of the floppy kind and discover the inner workings and proper care of floppy disks and the key to safe storage and retrieval of data. The booklet details "10 Tips on Handling a Floppy Disk" and concludes with a brief glossary of technical computer terms. For a free copy, write to: Fuji Photo Film, Promotion Dept., P.O. Box 9870, Westerfield, CT 06109.

Helpful Electronic Aids

Here are some interesting products that can be very helpful to many electronics and computer enthusiasts. Two solve tricky problems, one in ac power-line monitoring and the other in computing. The remaining two items fall into the "Why didn't I think of that?" category.

Printer Adapter Kit

From *L-Com Data Products* (1755 Osgood St., N. Andover, MA 01845) comes a really useful do-it-yourself printer adapter kit that lets you custom interface Centronics parallel printers to a serial interface. The kit contains a pre-assembled DB-25 RS232 connector to which are attached 25 "flying" leads. The leads have pretinned ends for fast, easy soldering to the mating 36-pin Centronics connector as required by your printer. Whatever leads aren't used during configuration are simply clipped off or jumpered.

When you finish soldering your required wiring pattern, you place the connector assembly inside the two halves of the plastic cover and snap closed. That's all there is to it. All necessary polarization hardware is provided in the kit.

Cost for the printer adapter kit is $24.95, which is a lot less than what you'd have to pay for a commercial cable.

Ac Power Line Monitor

If you have an oscilloscope, you don't need an expensive power-line monitor to safely observe the current waveform of loads on the line. With the Line Viewer 103 from *Oneac Corp.* (2207 Lakeside Dr., Bannockburn, IL 60015) you can view the power-line waveform. Furthermore, an optional Current Viewer Adapter Kit lets you observe the current waveform while simultaneously viewing normal- and common-mode noise.

Teamed together, the Line Viewer 103 and Current Viewer Adapter Kit can serve as an economical monitoring system for diagnosing power problems and determining the effectiveness of power conditioners. Also, the current viewer helps identify operational problems due to ground current.

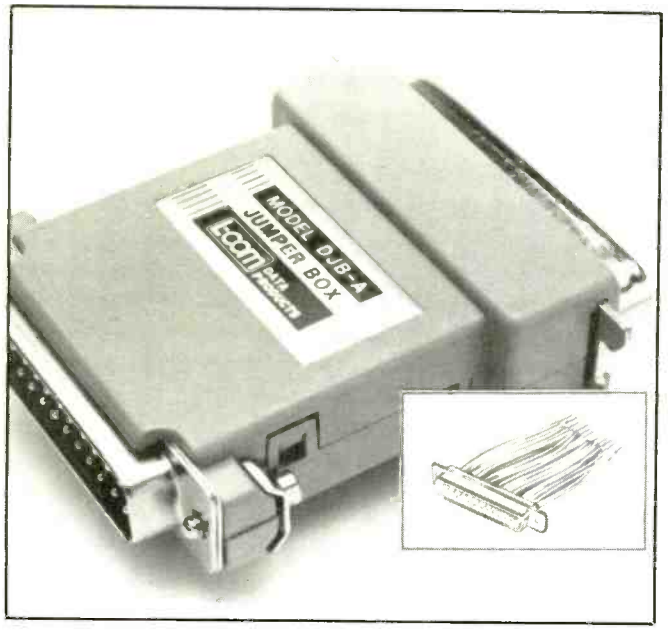
The Current Viewer Adapter Kit (also available separately from the Line Viewer) comes with a break-out cable that gives easy access to the three ac conductors, a clip-on current probe and a terminating adapter.

Now Why Didn't I . . .?

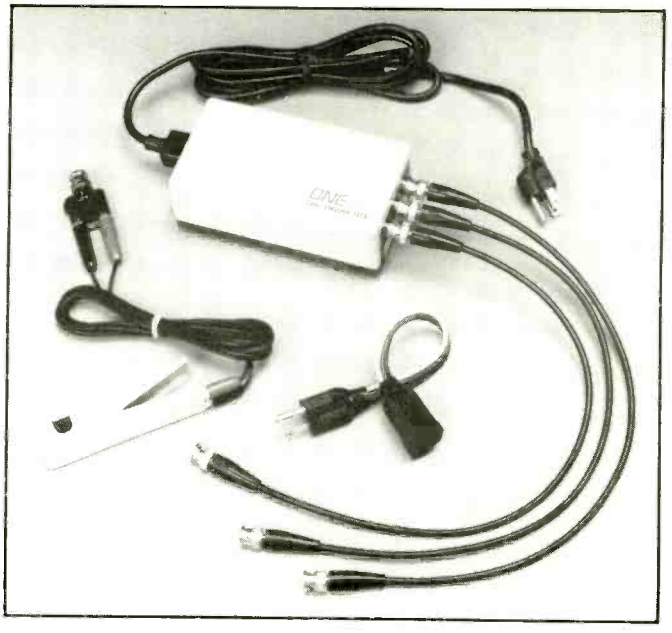
Twist a strip of spring steel into a kinky shape and what do you have? Answer: A unique spring clip that securely mounts flat semiconductors to extruded heat sinks without the need for additional hardware. This is just what *Aavid Engineering, Inc.* (One Kool Path, P.O. Box 400, Laconia, NH 03247) has done. The 5330-33 heat-sink/clip arrangement is specifically designed for use with tab-mount, plastic-case semiconductors.

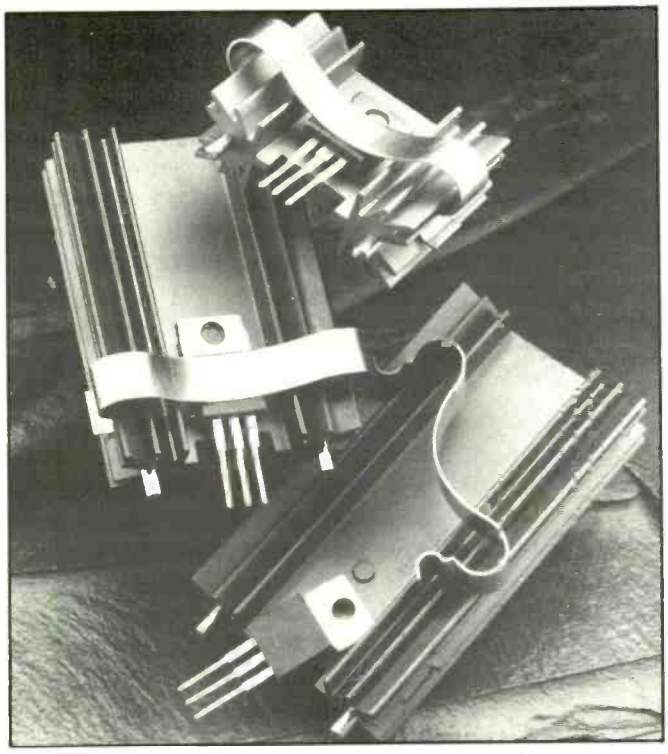
Using the Aavid system, the spring-action clip is said to eliminate the problem of gaps when the machine hardware that holds the semiconductor to the heat sink is too tightly torqued. The spring-action clip applies even pressure to the semiconductor to improve heat dissipation by

L-Com printer interface "customizer."



Oneac power-line monitor for scopes.





Aavid Engineering no-screw heat sink.

Neonic Design bar-code wand holder.

providing maximum metal-to-metal thermal contact between heat sink and semiconductor tab.

Aavid's heat-sink/clip system isn't exactly a home experimenter's way to go—not unless you're willing to buy 1000 units at a time. Manufacturers of electronic products will find them interesting, however, since they cut assembly time and reduce labor costs.

If you use a bar-code reader or a light pen, you needn't run the risk of damaging it by laying it down on your work surface. Holster it in *Neonic Design*'s (P.O. Box 1067, Maitland, FL 32715; Attn. Bruce McPherson) handy "Wand Holder." With the Wand Holder, you can store your reading device in a manner that permits easy retrieval and immediate use.

The Wand Holder, made from a tough thermoplastic, can be mounted in a variety of positions and is furnished with a sponge rest-pad that resists skidding and won't mar surfaces. For permanent locations, you can affix to the bottom of the holder a supplied adhesive disc or screw-mount it within easy reach of where you work. An optional weighted base is also available. Cost of the Wand Holder is only $10.35.

—Alexander W. Burawa

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Experimenting with CW Laser Diodes (Part 2)

By Forrest M. Mimms III

The new generation of highly coherent CW (continuous wave) laser diodes designed primarily for use in audio-disc players opens up many fascinating applications. Only a few years ago, laser diodes with the coherence properties of these new devices cost many hundreds or even thousands of dollars. Now such lasers can be purchased in single quantities for as little as $26 each, a price that is likely to fall even more in coming years.

In Part 1 of this column, I described the operation of these new highly-coherent CW laser diodes. I also discussed in some detail the handling, operation and safety precautions associated with their use, and I presented the construction details for a miniature laser diode pulse transmitter.

In this column I'll describe how to operate in a continuous mode CW laser diodes that are equipped with a monitoring photodiode. I'll also described in detail the construction of two different CW laser-diode illuminators and a portable battery pack suitable for operating them. Finally, I'll discuss some applications for these amazing new lasers.

Operating Precautions

Being a frequent user and sometimes zapper of laser diodes since 1967, I've learned firsthand that it is absolutely essential to be aware of the idiosyncrasies of these fascinating devices before attempting to use them in actual circuits. You must also be aware of the possible safety hazards associated with their use. Both these topics were covered in detail in Part 1 of this column. It is important that you review that information before you attempt to work with actual laser diodes.

A summary of the various precautions associated with the use of CW laser diodes is included here. This summary, however, is *not* a substitute for the detailed precautions given in Part 1 or those given in the descriptive literature for a particular laser diode.

Handling precautions:

(1.) CW laser diodes are susceptible to damage from electrostatic discharge and must be stored and handled like MOS semiconductor devices.

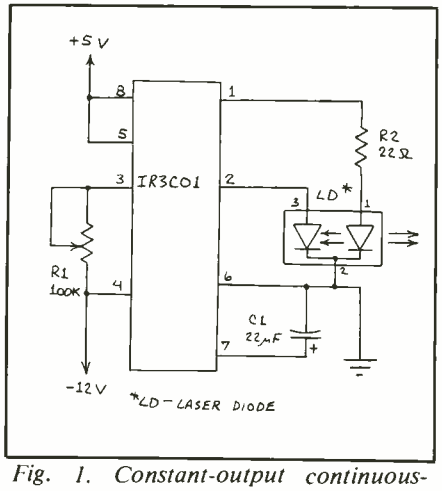

Fig. 1. Constant-output continuous-wave laser-diode driver circuit.

(2.) Avoid touching or scratching a laser diode's glass window. Should it become dusty, clean it with a cotton swab soaked in ethanol.

(3.) Never solder, cut, drill or machine a laser diode package.

Operating precautions:

(1.) Never connect the probes of a multimeter across the leads of a laser diode.

(2.) Always observe polarity when connecting the leads of a laser diode.

(3.) Never connect a CW laser diode to a battery through a series resistor. Instead, use a current driver circuit or IC designed for laser-diode operation.

(4.) Never connect a CW laser diode directly to the leads of a line-operated power supply. Voltage spikes generated when the supply is switched on can destroy the laser.

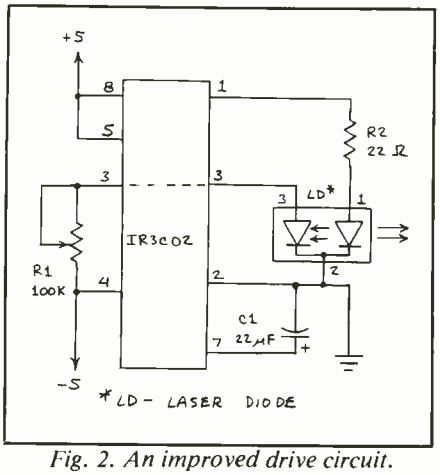

Fig. 2. An improved drive circuit.

(5.) When testing or troubleshooting a laser-diode drive circuit, use great care to avoid shorting the leads of the laser to other circuit leads.

(6.) Always use the minimum heat sinking recommended by the manufacturer.

Safety Precautions:

(1.) Avoid staring at the raw beam from a low-power (>5-milliwatt) laser diode closer than arms length.

(2.) Never stare at the beam of a laser diode whose emission has been focused into a narrow beam by a lens.

(3.) Never point the beam from a collimated laser diode toward the eyes of onlookers or toward specular surfaces that might reflect it toward you or others.

(4.) Observe the beam from a laser diode with an infrared image converter or infrared phosphor screen. You can safely observe the visible red beam from CW laser diodes that have a wavelength of 780 nanometers by projecting their beam toward a white card (matte, not glossy, surface) in a dark room.

These safety rules must be viewed with common sense in mind. For example, the collimated beam from a 780-nanometer laser diode can be safely viewed from a distance, but only if the beam has expanded so that only a small fraction of the light can enter the pupil or your eye.

For additional laser safety information, obtain a copy of "Performance Standards for Laser Products" (21CFR 1040) from the National Center for Devices and Radiological Health (8757 Georgia Ave., Silver Spring, MD 20910) and "ANSI Standard for the Safe Use of Lasers" from the American National Standards Institute (1430 Broadway, New York, NY 10018).

Constant-Output CW Laser Drivers

The optical output of a laser diode increases as temperature decreases. Many different circuits have been developed that monitor the optical output from a laser diode and then regulate the drive current so that the output remains con-

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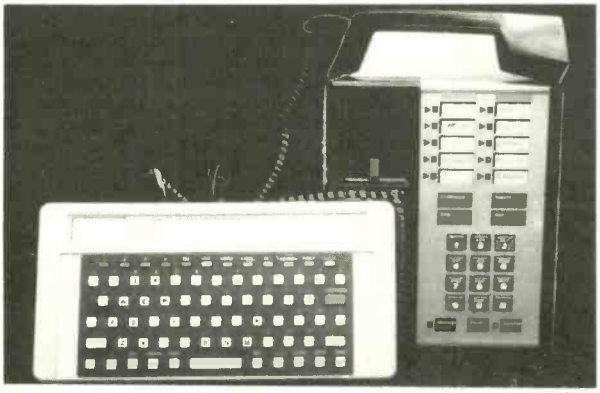

These are brand new, portable communications terminals made by Lexicon, complete with a 40 character LCD display. The original model no. was Lex 31. This is a great tool for off line text editing, uploading and downloading of text to various computers as well as a professional device for communications w/data banks such as Dow Jones, Compuserve, the Source, electronic mail systems, computer board message systems and other comm. oriented services. Some of the various IC's in tis machine are a text editor, time of day clock with alarm, calculator, 14K RAM text space with battery backup and 16K ROM.

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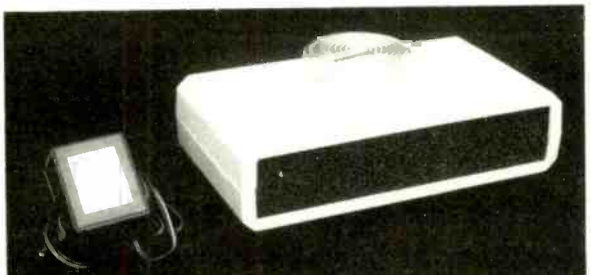

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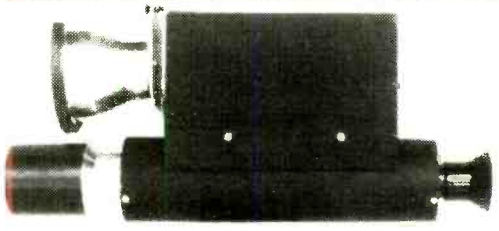

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stant. Among the simplest such circuits are a pair of laser-diode driver chips made by the Sharp Corp. (10 Sharp Plaza, Paramus, NJ 07652) and available from Sharp distributors.

Figure 1 shows how one of the Sharp chips, the IR3C01, is used in a practical circuit. This chip is supplied as an 8-pin mini-DIP and costs only $1.18 in single quantities.

Referring to Fig. 1, note how the internal monitor photodiode installed in the laser package is connected to the IR3C01 to form a closed-loop feedback system. The current output terminal of the IR3C01 (pin 1) is connected to the anode of a CW laser diode through series resistor *R2*. Though the chief function of *R2* is to limit the current through the laser diode, it can also be used to monitor the current flowing through the laser.

Potentiometer *R1* controls the current delivered to the laser at pin 1. When the circuit is operated with a new laser for the first time, *R1* should be adjusted for its highest resistance. As the resistance of *R1* is decreased, the current from pin 1 will be increased.

Pin 5 permits the laser to be gated on or off. When pin 5 is connected to +5 volts, the laser is on. Connecting pin 5 to ground switches the laser off.

The chief drawback of the Fig. 1 circuit is that it requires supplies of +5 and −12 volts. Sharp has recently announced a new laser-diode driver chip, the IR3C02, that operates from supplies of +5 and −5 volts. Figure 2 shows a working circuit for this new chip. Other than the change in the negative supply voltage, the circuit is very similar to the one in Fig. 1.

The IR3C01 is available both in 8-pin mini-DIP and miniature surface-mount packages. Thus far, I have been able to order only the surface-mount version and have not yet assembled a working circuit using the IR3C02. However, I have assembled several different CW laser-diode circuits using the IR3C01 driver, two of which are described next. Since these circuits both require +5 and −12 volts, you may prefer to wait for the IR3C02 to become available, since it requires a supply that delivers only +5 and −5 volts.

Suitable CW Laser Diodes

Both the IR3C01 and IR3C02 will drive any of the laser diodes currently available from Sharp. The least expensive such lasers are the LT020MC and the LT022MC. Both devices cost only $26 in single quantities. These lasers have a typical output power of 3 milliwatts and emit radiation having a wavelength of 780 nanometers at the far end of the visible spectrum.

The LT020MC is a single-mode, highly coherent laser designed for general use. Applications include measuring instruments, communications, readout devices, etc. The LT022MC is a low-noise device specifically designed for use with compact disc players. The output from CW laser diodes can fluctuate (become noisy) when some of the radiation is reflected back into the laser by the highly reflective surface of a compact disc. One way to reduce the effect of external reflections is to slightly increase the thickness of the pn junction region so that several longitudinal modes, each having a slightly different wavelength, can propagate within the laser.

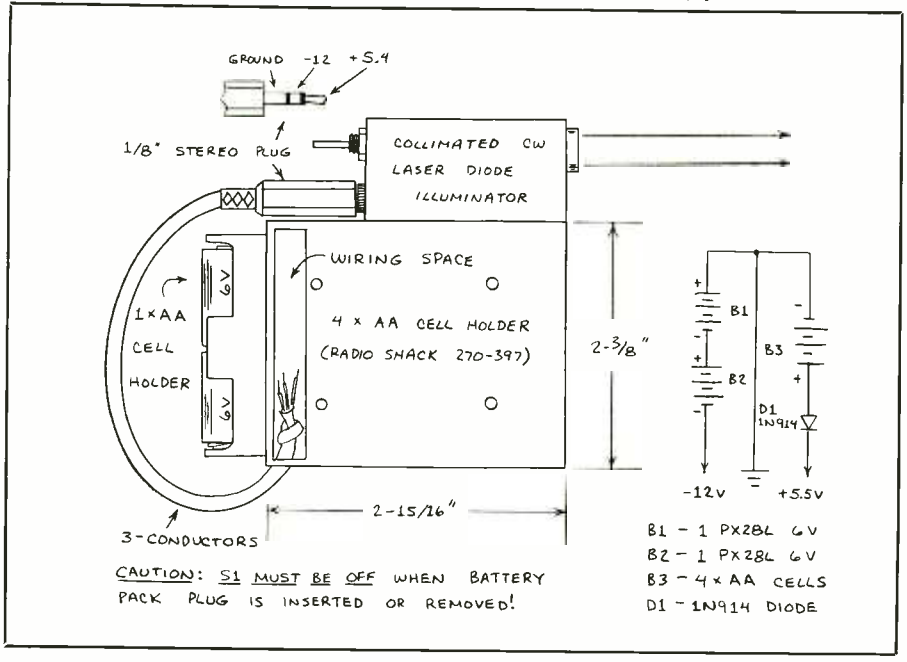
A Laser-Diode Battery Pack

Both the laser illuminators described below are best powered by batteries. Figure 3 is an outline view of a compact battery pack you can assemble from two battery holders available from Radio Shack.

The battery pack shown in Fig. 3 provides +5.4 and −12 volts and is intended for use with the IR3C01 driver chip. The −12-volt supply is obtained from two 6-volt lithium or silver-oxide cells (PX28 or similar) installed in series in a single AA penlight cell holder. The 5.5-volt supply is provided by four AA penlight cells in series. A 1N914 diode drops the voltage from 6 volts to about 5.4 volts. Penlight cells are used for this supply since it must provide 50 to 65 milliamperes of current.

The two battery holders are fastened together with 2-56 hardward or plastic cement and then wired as shown in Fig. 3. A stereo phone plug serves as the power output connector. CAUTION: When the batteries are installed, slip the end of the phone plug into a piece of plastic tubing to prevent an inadvertent short.

Fig. 3. Laser-diode illuminator installed on battery pack.



Miniature Collimated CW Laser System

Figure 4 is a drawing of a miniature CW laser-diode illuminator I have assembled.

Though I used an IR3C01 driver chip, an IR3C02 can be used instead.

A clear plastic box measuring 2″ × 1″ × ¾″ will house the entire system. Suitable boxes are available from arts and craft stores and specialty shops. The circuit is assembled on a perforated board measuring ½″ × 1 1/16″.

Potentiometer *R1* is a miniature 100K cermet trimmer (No. Q0G15) available from Digi-Key (P.O. Box 677, Thief River Falls, MN 56701). Other trimmers can also be used (see the next transmitter), but this particular one is very compact.

Figure 5 shows how the circuit board is connected to the dpdt power switch and a miniature stereo jack that serves as a power connector. Use wrapping wire to make the connections between the circuit board, switch and jack.

The prototype illuminator I assembled uses a Sharp LT020MC laser diode. Referring to Fig. 3, observe how the laser fits snugly in the end of a solderless Push-F-Type RG59/U television coaxial cable connector, such as Radio Shack's No. 278-215. At least two different versions of this connector are available. For best results, use the longer and saw off the knurled end just beyond the internal collar.

The sawed-off RG59/U connector fits nicely within a ¾″ length of 7/16″ inside-diameter brass tubing available from a hobby shop. A 10 mm-diameter lens with a 10-to-15-mm focal length will fit inside this tube. The lens should be held in place by a pair of rings cut from 7/16″ outside-diameter brass tubing slipped in the end of the larger tube. Figure 3 shows how the lens fits between these two rings. Suitable lenses are available from Edmund Scientific (101 E. Gloucester Pike, Barrington, NJ 08007).

Carefully insert the laser into the expansion end of the RG59/U connector. The opposite end of the connector is then slipped into the brass lens tube. The connector and lens tube double as a heat sink for the laser.

CAUTION: The laser diode may be destroyed by electrostatic discharge. Ground your body to remove any residual charge before touching the laser. (Touch a cold water pipe or the metal case of a grounded electrical applicance.) Before installing the laser diode and switching the circuit on for the first time, use a multimeter to determine which direction to rotate *R1*'s wiper to give the highest possible resistance. Trimmer *R1 must* be set for highest resistance before the laser is installed.

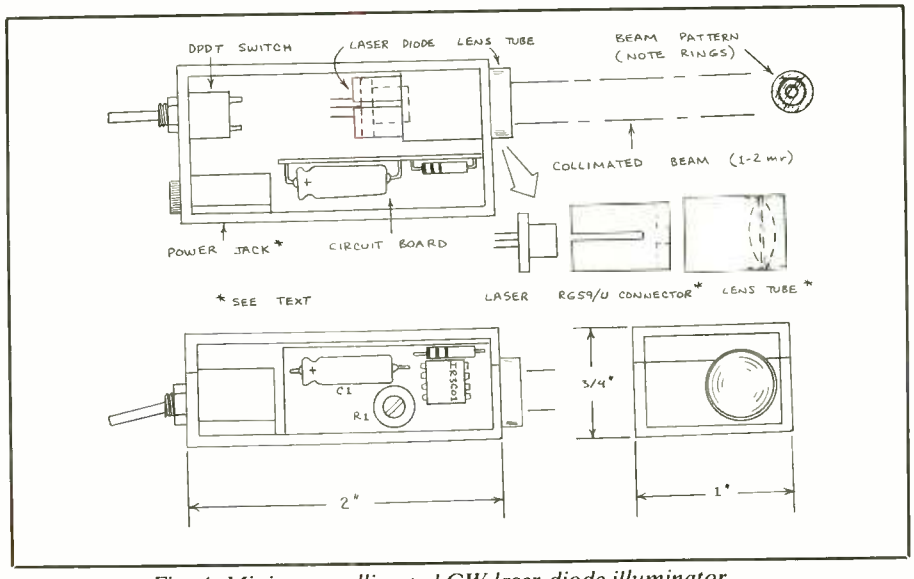
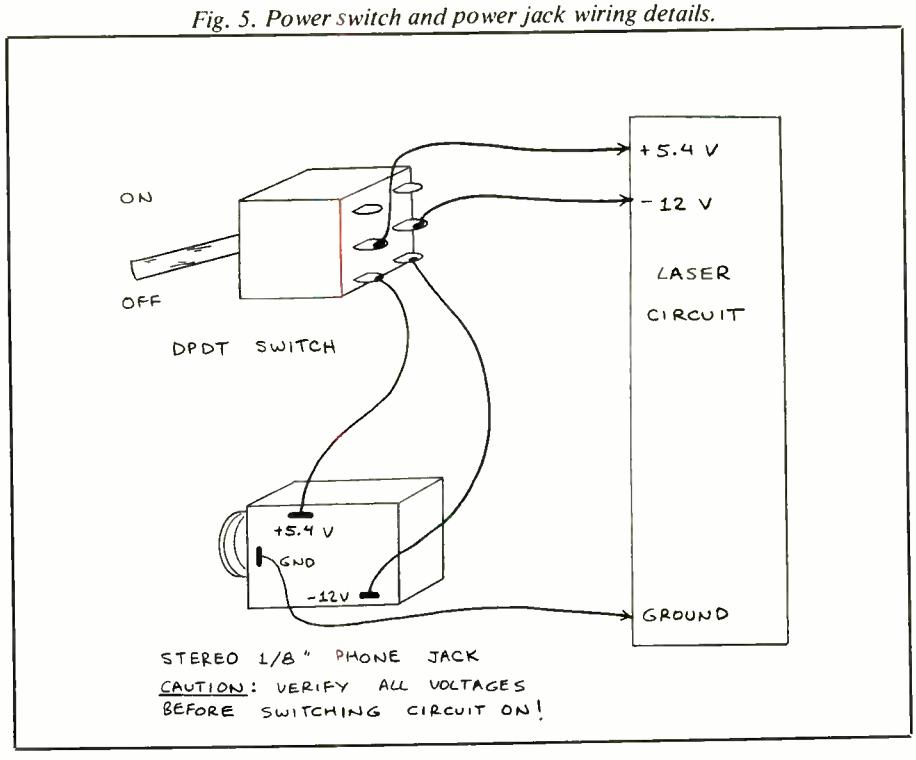


Fig. 4. Miniature collimated CW laser-diode illuminator.

Figure 6 shows the pin outline of the laser diodes made by Sharp. Being sure to follow the precautions given above, attach lengths of color-coded wrapping wire to each of the three leads of the laser diode. If you use a wrapping tool, be sure none of the free ends of the wrapped con-

Fig. 5. Power switch and power jack wiring details.



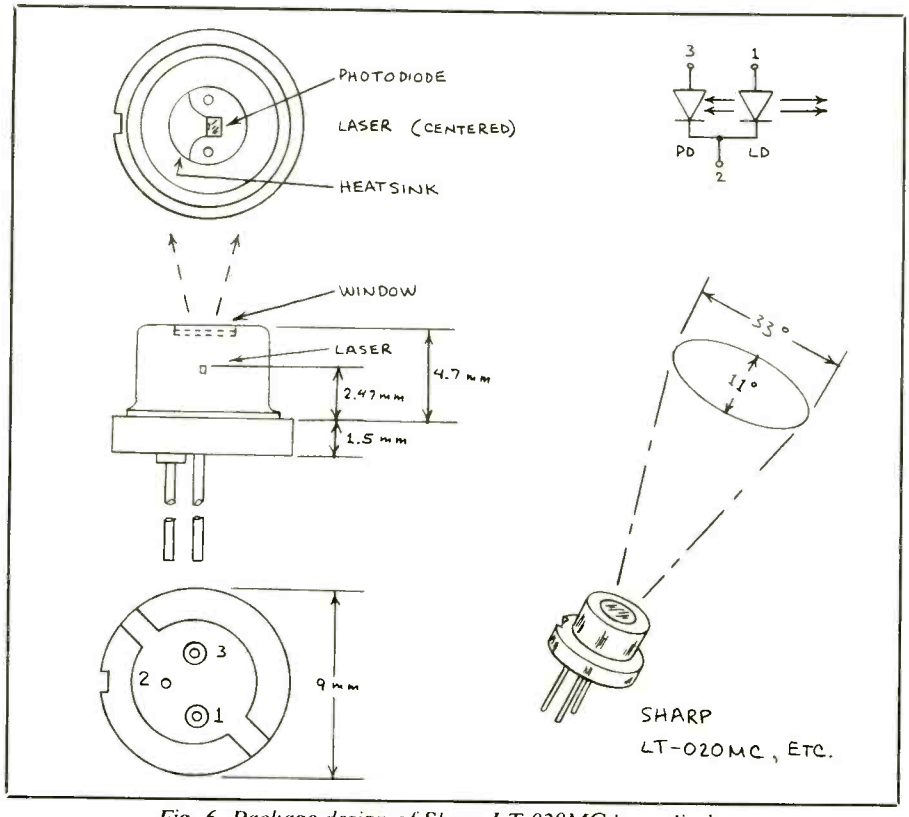


Fig. 6. Package design of Sharp LT-020MC laser diode.

nections can short against each other! If you use a soldering iron, make sure it doesn't expose the laser to line voltage.

Double check all the wiring connections for possible errors. Also, again make sure *R1* is set to give a resistance of 100K. Finally, make sure the power switch is in the OFF position. You are now ready to connect the battery pack to the laser for initial current adjustment.

Spread the various portions of the circuit slightly outward on a nonconductive surface. Plug the power pack plug into the circuit's power jack. Then connect the probes of a multimeter across *R2*, using great care to avoid touching any other leads or parts of the circuit.

Refer to the data supplied with the laser connected in the circuit to determine its threshold and operating currents. Use Ohm's law to calculate the voltage across *R2* that will coincide with the desired operating current.

For instance, one of my lasers has a threshold current of 48 milliamperes and an operating current (for 3 milliwatts output) of 60 milliamperes. To be on the safe side, I operate this laser at a forward current of 55 milliamperes. According to Ohm's law, the voltage across *R2* equals the current through *R2* times its resistance. Therefore, for a current of 55 milliamperes, the voltage across *R2* should be 0.055 ampere times 22 ohms which equals 1.21 volts.

After you calculate the voltage across *R2* for your laser, switch on the power to the circuit. Then gradually lower the resistance of *R1* until the voltage across *R2* begins to approach the value calculated. Very carefully continue adjusting *R1* until the desired voltage is reached.

To verify that your laser is lasing, place a white card near the lens and switch off the room lights. If the room is sufficiently dark, you should see a dim but distinct red spot on the card. Switch off the laser and remove the battery pack plug. Then form holes in the plastic box for the lens tube, switch and power jack and carefully install the circuit inside the box. Before again operating the system, inspect the circuit for shorts or broken wires.

Adjusting the lens to provide the tightest possible beam is difficult if you don't have access to an infrared image converter or a closed-circuit TV camera that is sensitive to near-infrared. In either case, point the lens tube toward a matte white surface and move the RG59/U connector back and forth slightly until a spot about the diameter of the lens is formed. Then move the card farther away and repeat the adjustment until the spot is again about the size of the lens.

If the RG59/U connector is difficult to move, try moving the lens itself by changing the position of the rings that hold it in place. After you have adjusted the lens for the tightest possible beam, you may want to secure the lens tube and its lens with a small drop of cement.

Be sure to allow plenty of time for the focusing procedure. The beam from the prototype circuit is only about 10 inches across at a distance of 436 feet. From this distance on a dark night, the laser appears as a very bright red light in the distance. It is particularly spectacular when viewed with an image converter. CAUTION: *Never* view the collimated beam from the laser unless it has spread to a safe viewing size.

Miniature Uncollimated CW Laser System

Some applications for CW laser diodes require that the uncollimated beam be available. The laser system in Fig. 7 accomplishes this purpose. Circuitry, wiring details, and adjustments are identical to that of the previous system.

The absence of a lens system is the only significant difference between the system in Fig. 7 and the one in Fig. 4. Therefore, it is essential to provide a heat sink for the laser diode when the unit is in operation. Sharp recommends a piece of aluminum or copper measuring $20 \times 30 \times 2$ mm for its higher power lasers that operate at a current of about 100 milliamperes. The LT020MC and LT022MC operate at a little over half that current, so less heat sinking is necessary.

Several heat-sink options are available.

Finned heat sinks designed to fit on a TO-5 transistor case can be used. So can an RG59/U connector, though long versions of this connector may have to be sawed off as described above to give full access to the laser beam.

CW Laser Applications

The collimated laser in Fig. 4 can be used for many of the experiments and demonstrations for which helium-neon lasers are ordinarily used if you have access to an image converter. Since the light is highly coherent, you can use the laser in conjunction with a simple interferometer to create interference patterns. With such a device, you can detect movements of less than half the 780-nanometer wavelength of the laser.

The uncollimated laser in Fig. 7 can also be used for many experiments that usually specify a HeNe laser. Since the fan-shaped beam is very uniform, it should be possible to make holograms using this laser. Another possibility is fiber-optic sensors that require a coherent light source for proper operation.

Figure 8 shows a very simple way to connect a plastic multimode plastic fiber to the laser in Fig. 7. For best results, use the RG59/U solderless connector like the one illustrated. (The long version of this connector is used for the laser in Fig. 4.) Cut the end of the fiber with a hobby knife and polish it with ultra-fine sanding paper. If the fiber is jacketed, remove a portion of the jacket(s) as shown in Fig. 8. Otherwise, wrap an inch or so of plastic tape around the fiber a short distance from its polished end.

Insert the end of the fiber into the large end of a plastic wall anchor previously trimmed to fit inside the threaded end of the coax connector. Twist the anchor firmly to secure the fiber in place. Ideally, the fiber should be perfectly centered in the hole inside the connector. When the laser is inserted into the open end of the connector, its window should just touch the end of the fiber.

Coherent light passing through a multimode fiber encounters considerable interference. The result is a microscopic pattern of speckle at the output end of the fiber. If the end of a fiber connected to the laser in Fig. 7 is caused to illuminate the lens of a phototransistor connected to the input of a high-gain audio amplifier, a speaker connected to the amplifier's output will emit a low hiss if the fiber is perfectly motionless. If, however, the fiber is barely moved, the interference pattern will move also and the speaker will emit a different sound.

Depending upon the degree of movement, the sound may range from a quiet "pock" to crashing twangs and drum-like sounds. The fiber is so sensitive that this system will respond to a puff of air! A level-detector connected to the amplifier will allow an alarm to be triggered when the signal from the fiber exceeds a preset level. Used in this mode, the fiber could be concealed under a carpet or even buried in a driveway and used to detect the presence of visitors or intruders.

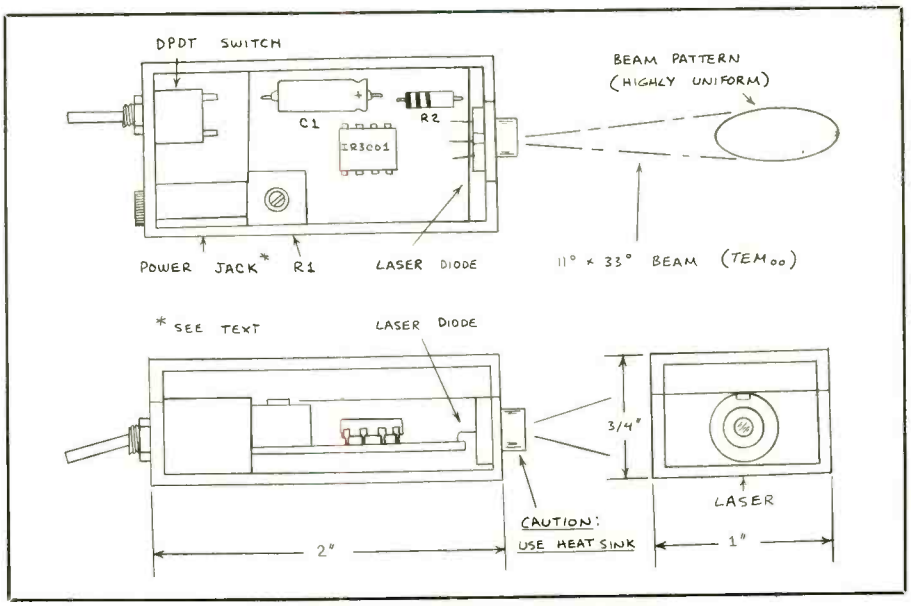
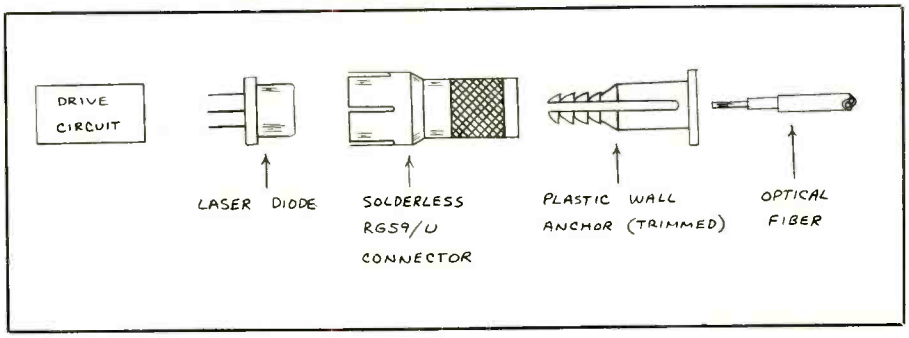


Fig. 7. Miniature CW laser-diode source.

Going Further

The applications for the CW laser-diode circuits presented in this two-part column are limited only by your application. Pulsed lasers are ideal for communications and instrusion alarms. CW lasers are well-suited for interference experiments, holography and fiber sensing. If you wish to know more about lasers and laser diodes in particular, visit any good technical library and begin exploring the many books and technical papers on this fascinating subject. **ME**

Fig. 8. A simple laser-optical fiber coupler.



More on laser printing and bar codes, how stream gauges work, 256K RAM upgrades, and understanding ASCII control codes.

By Don Lancaster

Laser printers are such a major breakthrough in personal publishing power that there is absolutely no way they can be ignored. To quote the obvious: "The power of the press lies in owning one." Yes, their prices are still a tad on the steep side. But prices are dropping dramatically, and there are unlimited opportunities out there. These opportunities include both custom local printing, as well as showing others what can be done with these landmark products. I've got a free demo pack showing that I'd be pleased to send you. Just call or write.

Here's a little more info on bar codes, over and above what we looked at two months ago. There's apparently a magazine called *Bar Code News*. They have separately published a book called *"An Introduction to Bar Code Technology"* that sells for $16.95. Authors are Craig Harmon and Russ Adams.

Another new book I just received is called *The Commodore Ham's Companion*, self-published by Jim Grubbs (L9E1) at *Q-Sky Publishing*. Included are lists of suppliers, organizations and magazines of interest to both ham radio operators and Commodore owners.

On to this month's goodies . . . .

How does a Stream Gauge Work?

Ben is the honcho at our local United States Geological Survey (USGS) office. Every once in a while, he calls with an offer I just can't refuse. Such as "Let's go to Lower Eagle Creek for the day."

You see, it is Ben's job to maintain the stream gauges that accurately measure the water flow in Southwestern canyons, washes, stream, and rivers. Knowing how much water you get when is crucial in any arid land. Stream flow measurement in any area is very important for such things as flood warnings, dam and lake supervision, irrigation allotments and water resource management in general.

So how does a stream gauge work?

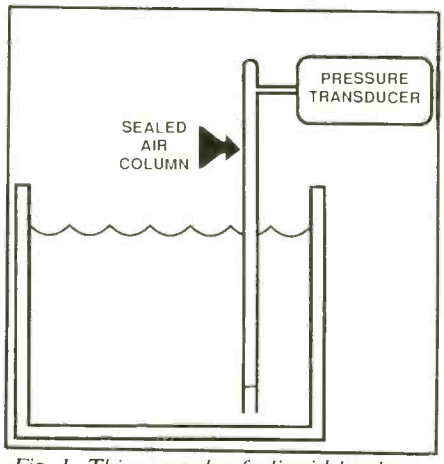


Fig. 1. This example of a liquid-level sensor has no moving parts.

On a small creek, all you need is a concrete structure called a "V-shaped weir." This is nothing but a flat channel with a Vee-bottom. Given the viscosity and temperature of a fluid, the flow rate will be proportional to the depth of the liquid in the weir. All you have to do is measure water depth and then consult a flow rate table. You do have to keep the weir clean and mud-free. The results aren't too accurate when dealing with muddy water or flood runoff.

Things get much messier much faster when dealing with a river. Besides temperature extremes, you have to contend with mud, channel movements, vandalism, access, long term reliability and many other hassles.

The flow-measuring idea remains the same. You measure the depth of the stream. You also do what is known as a "stream profile" once each month or so. This means you wade out into the stream or use the cable car to drop a flow meter into the stream along a bank to bank grid. The flowmeter is nothing but a small propeller that closes a contact for either a beeper for a counter. Flow is measured as beeps or pulses per minute. Calibration depends on propeller size and shape.

Modern stream gauges use a novel water-measurement scheme we will look at shortly. It can be located in an unobtrusive location well above and fairly far away from the water.

Today's stream gauges are usually solar powered and directly "talk" to a satellite by way of a microwave link. This link gets briefly activated every time the satellite whips on by. This eliminates the need for a chart recorder. More importantly, you find out about a flood when it is about to happen, rather than a month later. Malfunctions are also instantly spotted, rather than waiting weeks to find out you forgot to wind the chart drive mechanism or replace the paper.

Back to our original question. How do you remotely and reliably sense the height of water in a stream?

Figure 1 shows us one approach. Its the old "put your finger over the straw" method. As water height changes, pressure in the pipe changes. Measure the pressure, do some calculations, and you have the stream height.

There are some obvious problems with this method. The air pressure in the pipe may change with temperature, or may simply diffuse through tiny leaks. Worse yet, if the pipe is much longer than the depth of the fluid, the percentage change in pressure you would get with a change in stream height would end up so low that you could not reliably measure it. Instead, Fig. 2 shows some refinements on the "finger over straw" stream height measurement.

So what does all this have to do with hardware hacking? Just this. These dudes go for $22,000 each!

You wouldn't believe the Rube Goldberg method currently used to actually measure the pressure. A big tank of mercury is run up and down a steeply slanted mechanical rack. A motor repeatedly moves the mercury up and down the rack to exactly balance the mercury pressure against the nitrogen pressure in the pipe. Since mercury is much denser than water, a few inches of vertical mercury motion corresponds to several feet of change in water height.

Complex electrical connections are made and broken every now and then to

balance the mercury tank against the pipe pressure. The *position* of the mercury tank on the rack is then measured and either sent to a chart recorder or routed directly to a microwave satellite transceiver.

At one time, measuring small changes in small pressures was tricky and expensive. Particularly if you were to eliminate any "stiction" or "hysteresis" in your readings. In theory, such a klutzy servo system can be extremely accurate, as it tends to cancel out its own nonlinearities.

In this day and age, any hacker can go out and buy a 0-to-7.5-psi temperature-compensated pressure transducer for well under $30 in singles from *Motorola, Microswitch* or any of several others. In quantity, they cost less than $5.

So, what is the simplest and cheapest way you can come up with to measure pressure over a 0-to-7.5-psi range? How compact can you make it? How cheap? How low in power consumption? This is an exercise for your hacker skills. Put on your thinking cap and let us know what you come up with.

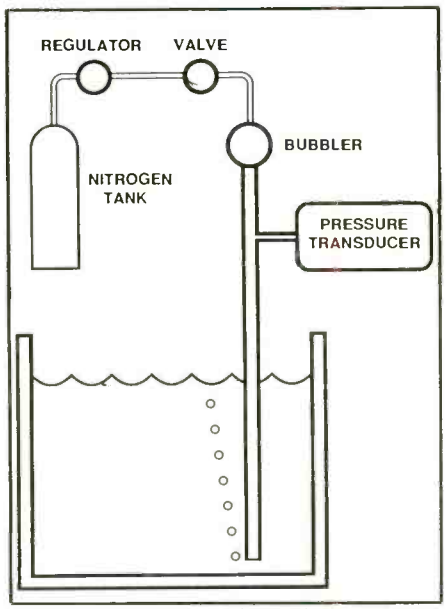


Fig. 2. This improved liquid-level sensor permits remote level sensing.

Upgrading from 64K to 256K RAMs

Your challenge depends entirely on the system you are trying to update. If the system was set up and designed for 256K RAMS in the first place, all you need do is change a jumper or two and directly swap the chips. For instance, the *Macintosh* upgrade is simply and easily done this way. The biggest hassle here is unsoldering the old chips. On other systems, an upgrade is probably far beyond the abilities of most beginning hardware hackers and definitely should *not* be attempted.

There are at least five major problems involved in expanding memory with 256K RAMs. The first and most obvious question is: "Where are the extra address lines going to come from"? If the rest of the system does not have the ability to address this much memory (most 8-bit systems do not), then where are you going to connect your new address lines?

One route to upgrading an 8-bit system is to use bank switching. With bank switching, you select one of four possible 64K banks of memory at any one time. But who is going to flip this bank switch? You or the CPU? How? How will you prevent the program you are reading from vanishing when a switch is flipped?

The second hassle with dynamic RAMs involves a concept called "pin multiplexing." There are not nearly enough pins on a 16-pin integrated circuit package to handle all of the address, data, control and power lines at once. So, many pins serve double duty and are used for two different purposes.

For instance, a typical address pin is time-shared between two address lines called the row address and the column address. A very elaborate, precise and time critical switching sequence is required. This address pin multiplexing can be handled by individual logic gates, by a special RAM controller chip, or sometimes by the microprocessor itself.

Adding an extra multiplexer for another pin can be a real hassle. Unless there is already enough address pin multiplexing provided for in the original circuit design.

Also, the "dynamic" in dynamic RAM means that the data will go bye-bye if you do not continuously refresh it. Many systems are not set up for refresh beyond 64K. It may take lots of extra parts and effort to provide for it.

Furthermore, you have to be sure that either the operating system or the individual software you want to run knows how to check and find out how much of this new memory is available. Otherwise, your new memory might just sit there unused, just out of reach.

Finally, there's the warranty problem. Many dealers refuse to service a system that has been obviously modified. Many customers will refuse to do such an upgrade for just this reason.

The bottom line: If you are an advanced hacker and are thoroughly checked out with an oscilloscope, you could possibly do a 64K to 256K expansion on your own. But do not expect to be able to do it simply, quickly or with nothing but a few chip swaps.

Leave this one alone unless you want to get into it in a really big way. Or wait until someone else offers a specific kit or detailed instructions.

The difference between a formfeed, ASCII $0C, CHR$(12), [L], FF, and <control-L>

This is really a software question, but it comes up over the help line so often that we really should look at it. It turns out that these are all *exactly* the same. That is, all are different ways of showing ASCII control commands. Control commands are the bottom 32 codes in the standard ASCII character code. These control commands are used for such nonprinting things as carriage returns, formfeeds, bells, escapes, linefeeds, and so on.

Unfortunately, there are many different ways of showing ASCII control commands. There are also many different ways of accessing them from a program. Figure 3 shows five of the more popular ways of naming ASCII control com-

mands. It also shows how to access them from various programs.

The ASCII column tells you the mnemonic for each control command. For instance, CR is a carriage return, FF is a formfeed, BEL is a bell, and BS is a backspace. This mnemonic is a reference for people only, and is not recognizable by a personal computer.

The Hex Code column shows the same ASCII code in hexadecimal, as it would be accessed by a machine language program or subroutine. Here CR is a $0D, FF is a $0C, BEL is a $07, and BS is a $08. You are likely to see this hex notation when reading files associated with machine-language programs.

The Dec Code column shows the very same ASCII codes in decimal, as would be needed by Applesloth or another higher-level language. Here CR is a 13, FF is a 12, BEL is a 7, and BS is an 8. Many printer manuals show their control codes in decimal.

As decimal use examples, you might do a PRINT CHR$(13); CHR$(4) during a disk access to output a carriage return followed by a "<control-D>" DOS access command. Or, you might do a POKE 28756, 13 to force a carriage return into a text file. The 28756 is the address of the particular location in which you want to place the carriage return. This, of course, changes with your application. The 13 here is the actual carriage return.

As an imbedded printer code example, a PRINT CHR$(27);M will switch a Diablo 630 daisywheel printer into automatic microjustification.

The Apple Keys column shows how you would enter a certain control code from the Apple keyboard. As an example, a [L] means to press the control key, hold the control key down, press shift and L, release shift and L, and then release the control key. This gives you a formfeed entered into your text file or whatever.

Some word processors will want you to use a verbatim entry mode. For instance, to put a formfeed into an Applewriter file, press [V] [L] [V]. The first [V] says to begin verbatim entry. This means that what follows is to be put directly into the text file, rather than immediately acted upon. The [L] is the formfeed that gets placed into your file. The final [V] cancels verbatim entry so that any new control characters can actually be used for control purposes, rather than going into a text file for later use.

Finally, the Original Use column shows what the intended purpose of the control command was when ASCII was standardized. Most of the original uses still apply today. It would be extremely stupid to redefine a carriage return as anything else. On the other hand, the oddball and obscure commands, such as the group separator or range separator, are easily diverted to special commands that better suit certain personal computers or software routines.

ASCII	HEX	DEC	KEY	ORIGINAL USE
NUL	$00	0	[@]	Do nothing or null
SOH	$01	1	[A]	Start of heading
STX	$02	2	[B]	Start of text
ETX	$03	3	[C]	End of text
EOT	$04	4	[D]	End of transmission
ENQ	$05	5	[E]	Enquiry
ACK	$06	6	[F]	Acknowledge
BEL	$07	7	[G]	Bell or alarm
BS	$08	8	[H]	Backspace
HT	$09	9	[I]	Horizontal tab
LF	$0A	10	[J]	Line feed
VT	$0B	11	[K]	Vertical tab
FF	$0C	12	[L]	Formfeed
CR	$0D	13	[M]	Carriage return
SO	$0E	14	[N]	Shift out
SI	$0F	15	[O]	Shift in
DLE	$10	16	[P]	Data link escape
DC1	$11	17	[Q]	Device control #1
DC2	$12	18	[R]	Device control #2
DC3	$13	19	[S]	Device control #3
DC4	$14	20	[T]	Device control #4
NAK	$15	21	[U]	Negative acknowledge
SYN	$16	22	[V]	Synchronous idle
ETB	$17	23	[W]	End block transmit
CAN	$18	24	[X]	Cancel
EM	$19	25	[Y]	End of medium
SUB	$1A	26	[Z]	Substitute
ESC	$1B	27	[{]	Escape
FS	$1C	28	[|]	Form seperator
GS	$1D	29	[}]	Group seperator
RS	$1E	30	[^]	Range seperator
US	$1F	31	[_]	User seperator
DEL	$7F	127	[DELETE]	Delete

Fig. 3. Standard ASCII control codes can be shown in many different ways.

Names and Numbers

Bar Code News
174 Concord Street
Peterborough, NH 03458
(603) 924-7136

Motorola Semiconductor
Box 20912
Phoenix, AZ 85036
(602) 244-6900

Microswitch
11 West Spring Street
Freeport, IL 61032
(815) 235-6600

Q-SKY Publishing
Box 3042
Springfield, IL 62708
(217) 753-1995

Howard W. Sams
4300 West 62nd Street
Indianapolis, IN 46206
(800) 428-SAMS

Synergetics
Box 809
Thatcher, AZ 85552
(602) 428-4073

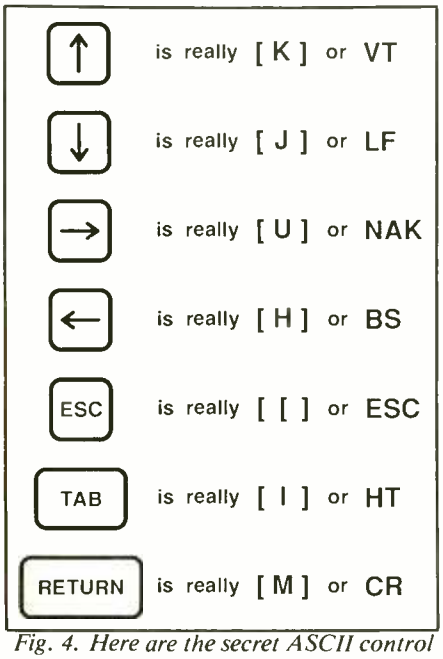


Fig. 4. Here are the secret ASCII control codes for the special Apple keys.

Some of the Apple keys are really "hidden" control keys. Figure 4 shows some of these. For instance, the [tab] key is really a [I] HT or horizontal tab command.

Just to thoroughly confuse you, ASCII is a 7-bit code that has only 128 defined states. Since most personal computers work with eight data bits at once, the remaining most-significant bit (MSB) is free for special use by the system designer. This eighth MSB can be used to tell the difference between a key pressed and not pressed, between normal and inverse text on a screen, to mark the end of a word-processing screen line, to tell the difference between Applesloth tokens and real text, or in any of the many other ways the system designer may choose.

Thus, there are two different ASCII codes, depending on who uses the MSB for what. If the MSB is zero, we are using low ASCII. Low ASCII is often used for standard non-Apple text files, and for Apple text files under the ProDOS operating system.

If the MSB is a one, we are using high ASCII. High ASCII is common in older Apples, both for the normal screen display and for DOS 3.3 text files. Since many third-party printer cards expect high ASCII as input, the ProDOS Applewriter 2.0 had to be upgraded to version 2.1 to make sure these cards will not get confused. Note that high ASCII and low ASCII differ by hex $80 or decimal 128. A high ASCII carriage return is a $8D or decimal 141. **ME**

NEED HELP?

Phone or write your *Hardware Hacker* questions directly to:

DonLancaster
Synergetics
Box 809
Thatcher, AZ 85552
(602) 428-4073

First Impressions: Anex Technology's "Doctor DOS" Patches, STB's Chauffer Video Board & Ann Arbor Software's Textra 3.1

By Eric Grevstad

January is a time for beginning anew. Even though I'm writing this January column in early October, I'm making a fresh start in some ways: I just completed my biannual purge, reformat, and refill of my Tandy 1200 hard disk, changing from MS-DOS 2.11 to PC-DOS 2.10. Why not the newer, bulkier DOS 3.1? Because I don't have an AT and I wanted an extra 10K of user memory to test a new utility—which promised to let me do some things almost as fast as an AT anyway.

In addition, I bought a new video adapter to see both sharper text and a better graphics display than the one I've been complaining about. And, though it won't help my editors who demand WordStar-formatted files, I've found a program that tempts me to change word processors. Once I find a 1986 wall calendar, I'll have changed almost everything in my computer room.

Hello Central, Give Me Doctor DOS

If you want your car to perform much better, you might put in a bigger engine; if you want it to perform a little better, you might put in some premium gas. Something like the latter is the idea behind Doctor DOS ($49.95), Anex Technology's patches to DOS versions 2.0 and above—a driver to add to your CONFIG.SYS file and an activator program for AUTOEXEC.BAT, taking just 8K of memory not counting the extra disk buffers Anex recommends.

Doctor DOS adds several enhancements to the BIOS (basic input/output system) code, such as a 160 instead of 15-character type-ahead buffer. With it you can flail at the keyboard, typing commands during disk access or a directory scroll, and your PC won't fall behind or beep in protest. The patch also prevents dual-ported color boards like IBM's from flickering or showing snow (alas, you must choose one benefit or the other), and proved compatible with all software I tried except last month's Multiple Choice memory partition. It proved incompatible with Tandy 1000 hardware, turning the keyboard into an IBM layout with arrows on the keypad.

Doctor DOS specializes in improving character I/O and system calls, the ways DOS sends text to the screen. It's not a CPU speedup and won't make all your software run at AT rates; off-screen activities such as spreadsheet recalculation are no faster, and neither are graphics programs. DOS-level text, however, flies by, with DIR and TYPE commands at 1.8 to 2.4 times normal speed (a directory took 3.6 instead of 8.8 seconds, for example). In fact, you'll need the DIR/P or MORE commands to read what you see. Doctor DOS is so fast that Control-S, usually used to pause a scroll, stopped the screen in the middle of redrawing (i.e., blank) about half the time.

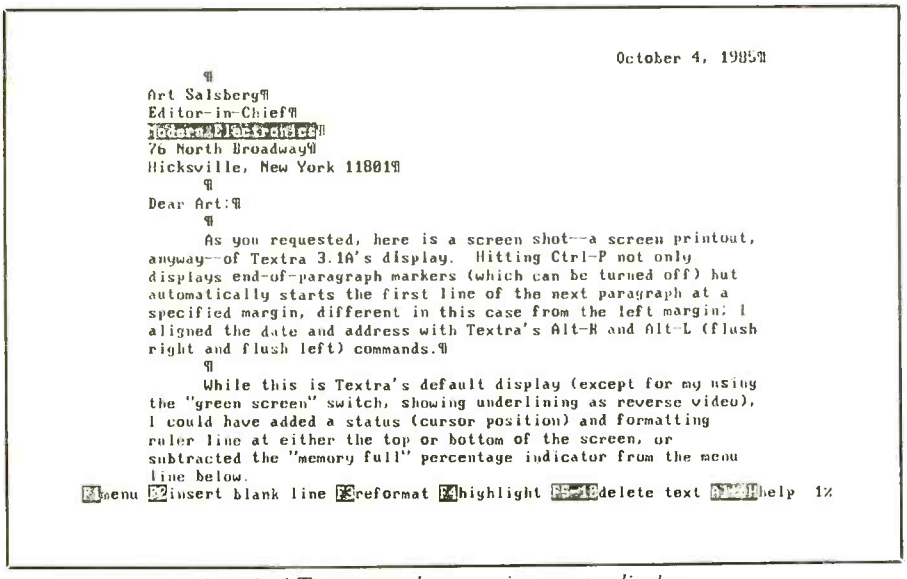
Unfortunately, I could rarely match such gains with applications software, though an Infocom adventure game did fetch text from memory and disk roughly 30 percent faster. Using an IBM with color monitor and DOS 2.10, PFS:File retrieved screens at the same speed. Scrolling with the down arrow or paging commands was no quicker with WordStar or either the "PC video RAM" or slower generic version of Newword.

Depending on your word processor or database, Doctor DOS may do better; if you use a spreadsheet all day, it won't. It appeals to me as a low-cost, low-memory upgrade. The type-ahead buffer and supercharged directories are almost worth the price of admission. But I won't keep it on my hard disk. Indeed, thanks to the product discussed below, I can't.

Shades Without Color

The best ideas are the simplest: to see a spreadsheet with numbers and text as sharp as the IBM Monochrome Display Adapter's, then load a graphics program and see it on the same screen—with no need to load any special drivers or "graphics-mode" software. It's a pleasure long enjoyed by Compaq owners, but now other PCs can match it with STB's Chauffer video board ($395, clock/calendar $29.95 extra).

Like other monochrome boards, the Chauffer plugs in easily, includes a parallel port, and connects to any TTL moni-



A typical Textra word-processing screen display.

tor. Like most, it has a pleasantly sharp display—characters as crisp as the IBM standard, not the fuzzier text of most graphics boards. Its video memory is available for system bus access at any time, without putting snow in the picture; my Tandy couldn't run IBM Newword without a blizzard before.

Load a program meant for the IBM Color/Graphics Adapter, and the Chauffer shifts gears: at any I/O signals to the color rather than monochrome card's CRT register addresses, you've got compatibility with any program, from Flight Simulator to GEM Draw, that fits the standard 640 × 200 (two-color) and 320 × 200 (four-color) resolutions, with colors drawn with 16 shades of gray.

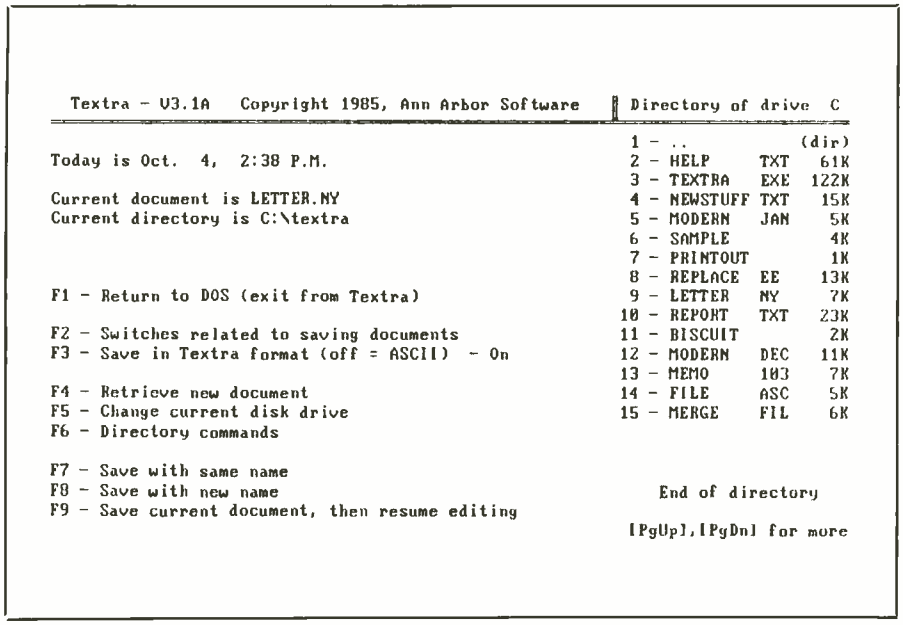
If you've envied other monochrome boards' higher resolution and don't mind using software drivers, STB supplies patches that run 1-2-3, Symphony, and Framework, in enhanced (640 × 352) resolution. Framework looked like a whole new program, the PC character set replaced by elegant pixel-thin letters. I'm torn between hoping STB adds more drivers and endorsing the Chauffeur's usual swap-and-go convenience.

Any problems? Well, while text mode supports on-screen boldface and underlining, my word processors see the Chauffer as a color board and show underlined text as blue—which is a fainter gray on the monochrome screen. Doctor DOS, which modifies the video BIOS in ways the Chauffer doesn't expect, crashed and locked up with the card installed. And STB's free PC Accelerator software—a print spooler, RAM disk, and reset that leaves RAM disk contents intact—failed on my 1200, but worked fine on an IBM.

Otherwise, the Chauffeur is almost a no-compromise compromise—less fancy than IBM's Enhanced Graphics Adapter, but ready to show almost any off-the-shelf software, ASCII or graphics, on a monochrome monitor. Who needs RGB?

0 to $30 in 3 Seconds

You've probably heard about the low-end word processing wars, MicroPro's new Easy ($150) challenging Software Publishing Corp.'s newly revised PFS:Write ($140). Scan the mail-order ads, however, and you'll find a third contender: a program that's as simple for beginners as either of them, that has more advanced formatting features, and in-



Textra's save menu. A similar opening menu retrieves a document by typing its number.

credible performance—over 20 times WordStar's speed—for under $30.

Textra 3.1A ($29.95) is the latest update of Ann Arbor Software's Textra 3.1, sold for $13.95. (Prices include shipping; AAS plans other low-cost upgrades, such as a spelling checker, in a classic example of razors-and-blades marketing.) Both combine a one-line command menu with a few full-screen menus for file handling and printing; the cheaper model is surprisingly competent except for bare-bones formatting and some laborious stepping in and out of menu levels, but 3.1A is a wonder.

Textra's opening menu saves typing, letting you retrieve a document by entering its number in an on-screen directory. (Other commands let you print a file, peak at its first 20 lines before fully loading it, or change the logged drive or directory display). Textra loads a file as you left it, with the cursor where it was and your printing and "switches" menu choices, from margins and spacing to saving options—Textra or ASCII? Backup or not? Automatic save at specified intervals?—intact!

The PC's function keys and a bottom-line menu guide you through editing choices and subchoices (such as F1 and F3 or Shift-F3 for Search, then F6 to ignore case and F8 to search backwards). The Esc key serves as an "oops" function, restoring text if pressed immediately after you make a deletion.

The F3 key realigns a whole paragraph (not just lines south of the cursor, as with WordStar's Ctrl-B); one switch makes reformatting automatic as the cursor's moved after an insertion or deletion. The penalty is that Textra merges separate paragraphs into one, unless you put blank lines between them or end them with Ctrl-P instead of the Enter key.

There aren't "expert" shortcuts around the function-key commands, but they're not needed. Besides its easy menus and excellent help screens, Textra is a screamer, a flat-out match for XyWrite as the speed demon of PC word processing. Scrolling is instantaneous. A strenuous search and replace, 1 minute and 51 seconds for WordStar (with video update disabled for maximum speed), took 4.5 seconds for Textra. Reformatting a five-page file with wider margins and right-justified instead of ragged text, 1:03 for WordStar, occupied Textra for only 3 seconds.

With performance like that, I can forgive the lack of mail merge, multi-line headers or footers, and files limited to 20 single-spaced pages on a 256K machine. I can forgive the minor bugs in my pre-release copy of 3.1A, which never damaged text but occasionally scrambled a screen menu. I'd even forgive a $150 price. But Textra costs one-fifth that! If you're looking at low-end word processors, you can't afford to pass it up. **ME**

Names and Addresses

Anex Technology Inc.
151 N. Route 9W
Congers, NY 10920
914-268-2400

STB Systems Inc.
601 N. Glenville, Suite 125
Richardson, TX 75081
214-234-8750

Ann Arbor Software
407 N. Main
Ann Arbor, MI 48104
313-769-9088

Transfer Files to and from IBM and Apple Computers

By Paul M. Danzer

APPLETURNOVER/Vertex Systems, 6022 W. Pico Blvd. #4, Los Angeles, CA 90035/$279.50./For IBM PC or compatibles and Apple II Plus, IIe, IIc

An Apple at home and an IBM PC at work. Wouldn't it be nice if you could take the floppy from one and use it on the other! Recognizing this, Vertex Systems, whose specialty is disk format translation, offers a package of software and hardware called "Appleturnover."

Attractively packaged in a combination plastic shipping box and manual binder, Appleturnover consists of an expansion board, cable, and floppy that install in the IBM PC. This makes it somewhat attractive for those who work for large companies which might be willing to pay the cost of an expansion board for their IBM machine so that you can take work home to do on your Apple.

Installation in the PC is similar to installation of any expansion card, using a few retaining screws. A flat cable connects the disk drive board to the disk drives. Within five minutes you can plug the Appleturnover board, change the disk drive cable from the original cable into the new board, and insert the jumper cable supplied.

Software

After copying the disk supplied as part of the package onto a "FORMAT/S" disk (and it is probably a good idea to copy the IBM "COMMAND.COM" program on the same disk) you are ready to run the system. Four programs are supplied in the package: AT INIT, AT READ, AT WRITE, and AT SIFT. As supplied, there are no spaces in the program names, but by inserting the spaces you can guess the function of each program. AT INIT initializes a blank disk, and is very handy when you forget to bring an Apple-formatted disk from home. You have a choice of formatting the disk either to DOS 3.3 or Microsoft Apple CP/M.

AT READ takes any Apple disk and transfers the contents to an IBM-formatted disk. Wordstar files from the Apple transfer directly to Wordstar files for the IBM, and ASCII files from any Apple word processor also transfer directly to IBM ASCII files. MBASIC programs, written under Apple CP/M, and saved under the —SAVE "MYFILE.BAS",A — command (ASCII option with the ,A added) transfer directly and run very nicely under the IBM BASICA system (once the small differences in syntax are ironed out). Transfer of APPLESOFT BASIC programs are a little trickier. First you must change the APPLESOFT file, as seen on the Apple catalog as an 'A' file, to an ASCII or 'T' file. The short program given on page 76 of the DOS 3.3 manual does this little job perfectly, and the resulting file on the Apple disk is changed by AT READ to a BASIC file, which also runs under BASICA on the IBM PC.

AT WRITE, as the name implies, is the inverse of AT READ and transforms IBM files for use on the Apple. IBM Wordstar text files and BASICA files go directly into Apple CP/M text and MBASIC files without any trouble, as does IBM ASCII files to Apple text files.

Unfortunately, IBM BASICA files include an extra line feed after the combined line feed/carriage return at the end of each BASICA program line, which your Apple does not like to see. However, the last of the programs supplied in this package, AT SIFT, is a set of utilities that includes one that is expressly designed to take care of this little problem. Therefore, all you do is take the BASICA file on the PC, run it through AT SIFT to get rid of the extra line feeds, and then transfer it to an Apple text file with the AT WRITE program. On your Apple, the command EXEC will bring it from the disk into memory, and the command LIST or RUN will provide you with a perfectly usable APPLESOFT program. Once again, you must change any syntax differences, but unless you use a large number of TAB and screen commands you should not have much of a problem.

For some reason you must give the command LIST or RUN twice, ignoring the SYNTAX ERROR message you might get the first time. The reason for this program is not clear, but once you get a listing on your Apple screen you can save the program as a standard Applesoft file ('A' designation in the CATALOG listing) and the problem disappears.

AT SIFT has a few other capabilities. One option allows you to strip the high bit on a Wordstar file, transforming it into a standard ASCII file. Thus, you can go from Apple Wordstar to IBM ASCII and back to Apple ASCII, if you wish. A similar feature of this set of utilities clears the extra 128 bit from protected Apple text files so that these can be read directly on the IBM PC screen. An additional capability allows you to do simple search and replace in a file if needed to change any other characteristics.

Documentation

Saving the worst for last, the manual is terse, concise—and tells you almost nothing. It omits the extra line feed problem you will run into, and ignores the need to save the IBM BASICA and Apple MBASIC programs as ASCII files. Furthermore, the menus in the manual do not match the menus you get on the screen, and generally does not present half of the good features of the package.

Ignoring the manual, and the fact that this is a new product that is not totally debugged (occasionally you get dumped back to the system level out of the program when you give the machine an answer it does not expect) Appleturnover works . . . and works well! With its handy utilities you can transfer Apple files and IBM files back and forth without too much fuss and with apparent accuracy at a cost far less than buying another IBM or IBM clone for home use or another Apple for use at work. When purchasing it, however, make sure you get version 1.2 or later, which removed a few bugs. ME

Scanner Chatter

By Ed Noll, W3FQJ

Are we inclined to operate our modern scanners, with their programmable keyboards and digital frequency displays in much the same way as old scanners that required individual crystals for each frequency desired? I think many of us do.

We put the local area police, fire, ambulance, paramedics and other local services in memory and not much more. We turn on the scanner and wait for something to happen. After several months, boredom often sets in because the scanner is not being used to its fullest capacity. Scanners can be tuned in to many additional radio activities, of course. The very quest for locating that can give you lots of information and entertainment is an interesting challenge.

Much scanner listening is devoted to the pickup of radio stations that are assigned to the FCC private land mobile radio services. These include the public safety (fire, police, etc.), land transportation (railroad, taxicab, etc.), industrial (business, manufacturers, etc.) and special services (medical, rescue, etc.). The four VHF/UHF bands assigned to these radio services are 30-50, 144-174, 540-512 and 800-950 MHz. Practically all scanners operate on the first three bands, while the newer ones are on the last band. (Converters are available for updating scanners that operate only on the first three bands.)

The various radio services are pretty much intermixed on each of the bands, although attempts are being made to establish more organization on the 900-MHz band. One exception is the marine VHF assignment, which falls between 156-162 MHz on the 150-MHz band.

Frequency modulation (FM) is dominant on scanners. Many scanners also include the aviation radio band, 108-136 MHz. The interesting activities on this band require that your scanner be able to demodulate amplitude modulation (AM) signals. Some scanners provide the frequency coverage needed to receive the various government stations that operate between 138-144 and 380-420 MHz. There are scanners, too, that include a few or all of the ham-radio bands that have active FM operations, such as the popular 2-meter FM band. (Most amateur-radio allocations are AM, though.) These are 29.3-29.7, 50-54, 144-148, 220-225 and 420-450 MHz. There are some top-level scanners that provide continuous coverage in two bands from 25 to 550 MHz and 800 MHz to 1.3 GHz.

Listening on the aero and marine bands is popular and very rewarding if you prepare your scanner's memory well for your particular operating locations. Examples are shown in Tables 1 and 2 that are related to two of my scanner listening activities. Take time to prepare similar tables for your location. Such organization is well worth the effort.

The frequencies of Table 1, inserted into the 16-position memory of my scanner, provide good aero listening from my location 30 miles north of center Philadelphia, PA. You can prepare a similar log for your area. Select several close-by small airports and a big one, too, if you are so lucky. My home area is a bit too far from the main Philadelphia airport to hear their ground stations, although I can hear aircraft in contact with their tower.

Simplex operation is universal on the aero band, which means that both aircraft and ground stations operate on the same frequency. However, the ground stations operate with low power and can be heard only a short distance from the field by your ground-level scanner. Air-

Here's an example of a scanner that does double duty. It's Fox Marketing's Model EMP 10/60 that can be used as a shoulder-strap-carried portable scanner (left) and a removable mobile scanner (right photo).

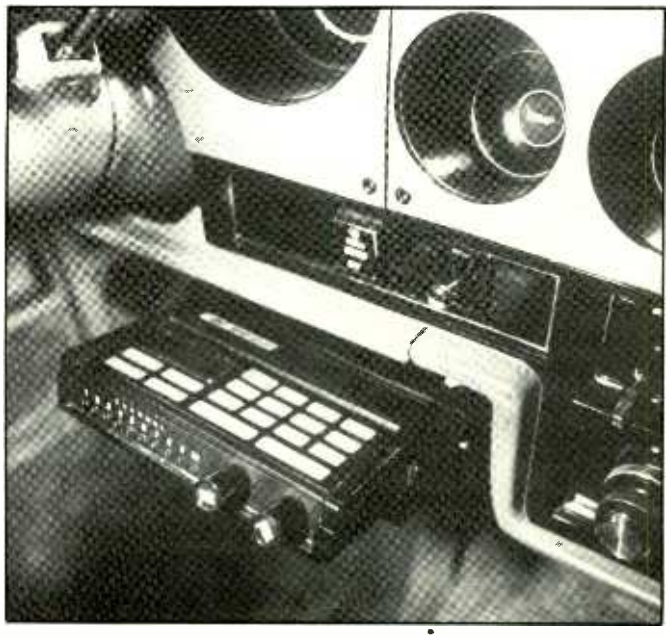


Table 1. Sample Memory Group for Aero Listening

On Route
Phillipsburg, NJ 132.125 MHz
Millville, NJ 127.7
Morgantown, W. VA 125.1
Ship Bottom, NJ 128.3
Towers
International, Phila. 118.5
Trenton, NJ 120.7
Military Field 119.35
Ground Control
Military Field 121.8
UniCom
Wings Field 123.0
Doylestown, PA 122.8
Allentown, PA 122.7
NE Phila, PA 122.95
Arrival/Departure
123.8-124.35-128.4-120.7

Table 2. Memory Group for Auto Trip to Shore

Mem.	MHz	CH.	Activity
1	156.8	16	Calling and Emergency
2	157.1	22A	Coast Guard Liaison
3	156.4	9	Commercial and Non-Comm. Public Docks and Marinas
4	156.6	12	Post Operations (also 14 & 20)
5	156.35	7A	Commercial Ship (also 10 & 18A)
6	156.425	68	Non-Commercial (also 69 & 70)
7	156.525	70	Non-Comm. Intership (also 72)
8	162.475	WX-3	Phila. Weather
9	162.00	28	Marine Op. Delaware
10	161.975	87	Marine Op. Atlantic City
11	161.95	27	Marine Op. Toms River
12	161.90	26	Phila. Marine Operator (also New York)
13	453.05	—	Phila. Police
14	500.937	—	Phila. Taxi
15	146.61	—	Ham Radio Repeater
16	128.3	—	Ship Bottom Remote of New York FAA Center

craft communications come through loud and clear, though. The tower of a military field nearby is readable and, on occasion, I hear the Tenton, NJ tower, which is about 20 miles east.

In my location, both ends of a contact are best heard on the Unicom channels. These are assignments widely used by private airports and aircraft. Often, several airports in a vicinity operate on the same frequency. For a close-by airport you will hear both ends of a conversation. However, the same frequencies are distributed about the region and you will often hear aircraft that are in contact with Unicom stations some distance away. Although the Unicom frequency is the same as that assigned in your immediate vicinity, you will be too far away to hear the ground station. Early evening hours are often better for the reception of more distant ground stations, and into the night if the airport remains open.

The first Unicom frequency I placed in memory is the local Wings Field. This is the same frequency of several other fields in the vicinity. Both ends of the conversations can be heard. The same applies to the neighboring Doylestown airport. The last two Unicom frequencies include a number of the regional cities of southeastern Pennsylvania. The best aid you can possibly have in sorting out the frequencies of your area and organizing a scanner chart is *Air-scan Guide to Aeronautical Communications,* published by CRB Research, PO Box 56, Commack, NY 11725 ($10.95 plus $1 shipping).

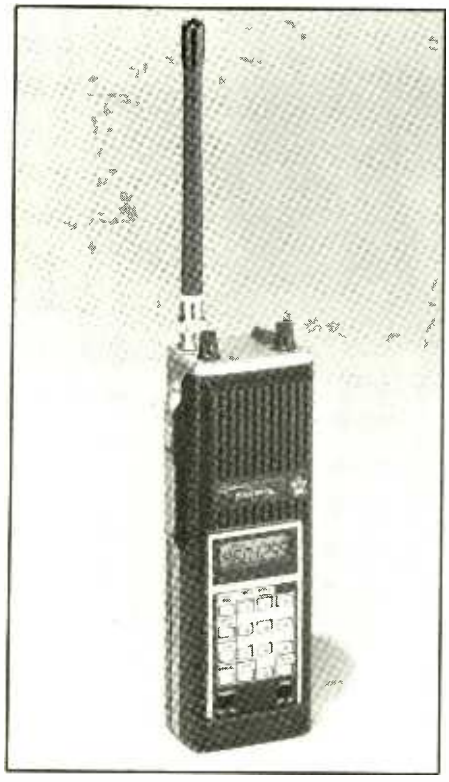
After an aircraft has left the control of the airport, flight instructions are obtained from arrival/departure (A/D) ground stations. Pilots can report their positions and other information to these stations and they will keep you posted on flight conditions and traffic. Eventually, you are guided to the destination airport; often, its tower frequency will be given when it is time to change over to airport tower control. Four active A/D frequencies are given for this area. I often hear both ends of the conversation.

The Federal Aviation Administration (FAA) provides air route traffice control along the airliner flyways. There are such traffic control centers spaced across the country. Associated with each traffic control center are remote locations that transmit on their own assigned frequencies to maintain good contact with airliners in flight from each center. These traffic control centers and remote locations have low-power directional patterns that provide the very best service along the individual flyways. They can be heard well from the air, but are difficult to receive on a land-based scanner. Unfortunately, I am not near such remote locations. However, I can hear the airliner chatter and often listen to their on-route contacts with the remote locations given in Table 1. Three of them are associated with the New York center, while the Morgantown remote location is controlled from the Cleveland center and often permits reception of airliner communications a considerable distance away.

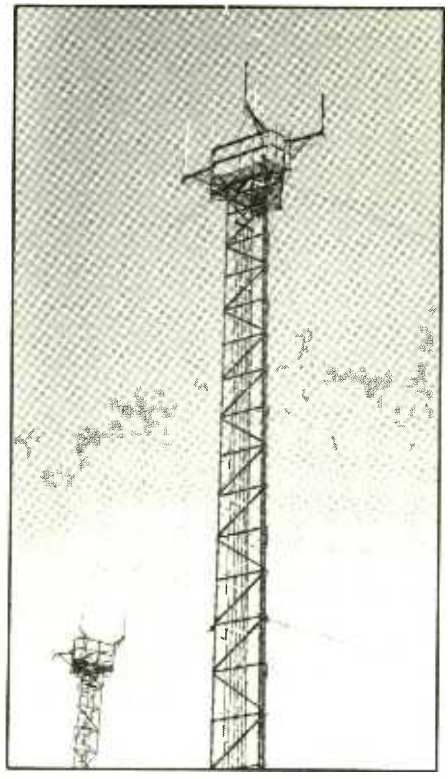
The foregoing is just a start for you in aero listening. There are many frequencies to scan. I was lucky to hit 132.15 one bad-weather day when aircraft were stacked over New York's Kennedy Airport. In this circumstance, I was able to hear both airliners and advisory instructions from the ground.

On-the-Road Scanning

Marine radio listening is a localized activity for those who live near the ocean, the Great Lakes or a major traffic-active river. Others can attach antenna to the car, pack a scanner, and set a heading toward the shore. We did just that, taking off for Long Beach Island on a beautiful day just two days before Hurricane Gloria smashed along the Atlantic coast.



A 30-channel handheld digital LCD readout scanner from Regency Electronics (Model HX1000 is pictured).



Here's what an FAA Traffic Control Center directional antenna at a remote location looks like.

This was the day the hurricane *watch* went into effect on the Island. There was plenty of scanner activity.

Plan ahead and select suitable frequencies for the scanner memory. The prepared Table 2 worked out very well for me. During the day, there was some activity on all but one of the preselected frequencies. The Table also indicates the types of communications assigned to various marine channels. A big assist is the $7.95 publication *Marine Radiotelephone Users Handbook* (available from the Radio Technical Commission for Maritime Services, P.O. Box 20036, Washington, DC 19087).

Note that the four last listings of the Table were non-marine. Memory 15 was a ham radio repeater. Memories 13 and 14 were 450-MHz Philadelphia police and taxi frequencies. I wanted to check out range at which they would drop out using a short roof-mounted antenna. It turned out to be in excess of 15 miles.

Remember in the previous discussion I had mentioned that I could not hear from home any of the FAA air traffic remote locations? Interestingly, at the shore I was able to pick up the New York Center's Ship Bottom remote and listen to both ends of a number of airliner-to-control center contacts via the remote site.

Marine listening continued at home for two days after the trip as "Gloria" traveled north. Some of the marine channels were kept in memory and there were activities on both channels 16 and 22A. I was able to pick up the Gloucester City Coast Guard on the Delaware River. The three NOAA marine weather channels were placed in memory. There was almost continuous traffic through the Philadelphia Marine operator on channel 26. During the storm, I could hear the New York marine operator on the same channel when the Philadephia marine operation was not busy. All this provided me with a vivid memory of the storm and an appreciation for the life-saving and helpful contributions of radio.

A fun and instructive activity is to listen to ham radio operations with your scanner. The 144-148-MHz (two-meter) band is alive with action that peaks during commuter hours, early evenings and weekends. Just listening, you can keep abreast of all the electronic events and developments in your area and far afield, including on-the-spot traffic conditions. Know the when and where of all the hamfests and flea markets, too, to add to your fun.

It pays to prepare a memory chart for all the 2-meter repeaters in your area. You can go out 40-50 miles because many operate at good power from very high locations. A useful book for this is the *Repeater Directory,* published by the American Radio Relay League, 225 Main Street, Newington, CT 06111 ($3.00). While you prepare the order, send an extra dollar for an ARRL Grid Locator for North America. This chart divides the country into close-space numbered grids. During contests, radio hams exchange grid numbers when the try to contact as many other hams as they can and as far out as possible. Tune in during one of these contests and find out just how far a 150-MHz signal can travel with good propagation conditions. Club networks can often be heard over the repeaters and you can eavesdrop on them. You will soon learn just how many persons are enjoying ham radio in your immediate area. Many are also scanner and shortwave listeners, too.

A more recent opportunity for interesting scanner listening is picking up cellular mobile telephone conversations. They operate on the 800-MHz band, so be sure your scanner incorporates this frequency if you want to expand your activities. **ME**

Special Notice

The Communications Act of 1934 states that no person not authorized by the sender shall divulge the existence, contents, substance, purport, effect or meaning of such intercepted radio communication. Above shall not apply to radio communications transmitted by any station for use of the general public which relates to ships, aircraft, vehicles or persons in distress, or which is transmitted by amateur radio or citizens band radio operators. Study Sec. 605 of the Communications Act in detail. Send for a copy to the Federal Communications Commission Washington, DC 20554. Ask for a copy of 605 extracts as they appear in "Study Guide and Reference Material for the Marine Radio Operator Permit."

Measure High-Frequency AC Volts *(from page 55)*

transformer, provided that a voltage divider is used to obtain less than 5 volts rms. For example, two 100-ohm resistors in series across a 6.3-volt secondary would provide about 3.15 volts from the center of the divider to either side. If this results in meter movement, the units are working.

Next, the meter must be calibrated. This requires a known voltage of 2 to 3 volts rms. If you have an ac voltmeter known to be accurate at this voltage, use it to measure the voltage from the divider and select resistors to obtain about 2.5 volts, using values in hundreds of ohms to assure a low-resistance source. If you have only a dc voltmeter, use a 1N34A diode to rectify the ac and a 10,000-ohm resistor load to ground. Measure the dc across this resistor and multiply the reading by 2.22 to correct for rms volts. With a known voltage applied to the input of the probe, adjust *R4* so the meter reads the known voltage.

It should be recognized that the meter reading will be correct only if the ac input is a sine wave (although a constant dc offset will have no effect). This is true for most ac voltmeters. It must also be remembered that the meter puts a load on the source and will reduce the voltage if the source impedance is high. The load is about 40,000 ohms.

One interesting application for this project is to receive local AM broadcasting in the manner of the old crystal sets. This requires only a coil and a 250-to-365-pF tuning capacitor attached to a long-wire antenna. The inductance of the coil should be as required to permit tuning the AM band with the capacitor to be used and should be tapped at about 50 microhenries for connection to the antenna and demodulator probe. Connect an earth ground to the bottom end of the coil, and use any handy insulating cylinder for the coil form. Coil winding formulas are shown in the box. **ME**

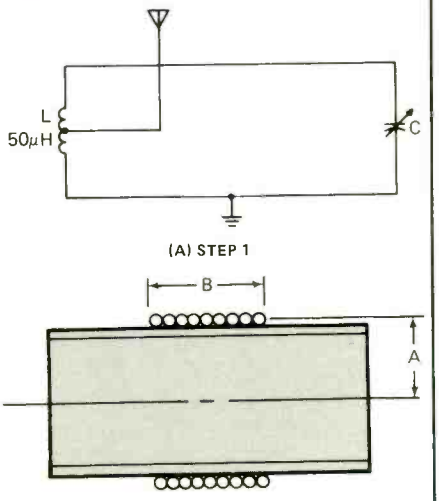
How To Wind a Coil For AM Broadcast Reception

If you wish to use the probe described in the main text of this article for receiving AM broadcasts, you must add an antenna/tuner circuit to it, as shown in circuit A. Your first step here is to calculate the inductance required, using the formula: $L = 1/[C(2\pi F_O)^2]$. Here, L is inductance in microhenries (μH); C is capacitance in picofarads; F_O is resonant frequency in kilohertz (kHz); and 2π is 6.28, an approximate constant.

An example of how to use this equation is as follows. Assume that C = 365 pF and F_O = 550 kHz. Using these figures, we obtain $L = 1/[365(6.28 \times 550)^2] = 230$ μH (approximately). Using the result calculated from this formula, you can wind the coil needed.

Your next step is to calculate the number of turns needed for the coil, based on its calculated value. You obtain this from the formula: $N = [L(9A + 10B)]/A$. Here, N is the number of turns; L is the inductance in μH; A is the radius of the coil in inches; and B is coil length in inches.

Assume now the $L = 230$ μH, $A = 0.5''$ and $B = 1.8''$. Using this information, we obtain: $N = \{230[(9 \times 0.5) + (10 \times 1.8)]\}/0.5 = 144$. To determine where to tap the coil at the 50-μH point,



use the same formula: $N = \{50[(9 \times 0.5) + (10 \times 0.5625)]\}/0.5 = 45$. This tells you that the coil must be tapped approximately 45 turns from one end.

For a close-wound coil, B = N/T, where T is the number of turns per inch for the wire gauge. Our example assumes 80 turns per inch, which is attainable with AWG #30 wire without being too careful.

You can use any handy insulating cylinder with the appropriate diameter on which to wind the coil.

PRODUCT EVALUATIONS . . . *(from page 17)*

in the order in which they are called for in the assembly instructions. This eliminates much of the time that would normally be wasted in sorting through a bunch of like-size components for the one called for in each step. Another timesaver is the separate Illustration Booklet that accompanies the assembly manual.

As is usual for Heath, and a foundation on which the company has built its fine reputation, the assembly manual is excellently written and illustrated. Not only does it give clear and concise step-by-step assembly instructions, it contains introductory material on assembly notes, parts identification and soldering instructions. It also contains helpful In Case Of Difficulty and Circuit Description sections for the technically minded builder.

Working at a leisurely pace, we were able to assemble the Security Sentinel in just five hours, including initial testing to make sure it operated as described in the manual. The only tools needed were a soldering pencil (Heath supplies the solder), a Phillips screwdriver, diagonal cutters, longnose pliers, and slip-joint pliers.

Assembly proceeded without a hitch. We encountered no difficulties, either with part identification or mechanical elements that wouldn't line up.

Conclusions

This product is well worth investigating, given the high incidence of burglary today. It does what Heath claims it does and does it admirably. The vocalization is very realistic, with excellent pronunciation and inflection.—*Al Burawa* **ME**

CIRCLE NO. 135 ON FREE INFORMATION CARD

FM Subchannel Programming Explained

Programs hidden on FM broadcast subchannels are collectively known as SCA that, in turn, stands for Subsidiary Communication Authority. These subchannel broadcasts serve a wide range of interests, depending on the cities from which they are broadcast. For example, in Los Angeles, listeners can choose from several types of commercial-free music, cultural events in different foreign languages and more.

For the professional, there may also be appropriate programs. For example, doctors can listen to their own network to keep abreast of the latest medical findings, new medicines, etc., while the clergy can tune in to programming dealing with the current events in the religious world.

High technology has also invaded the world of SCA programming. Some new stations broadcast stock quotation service, requiring a specially equipped computer to receive them. And the future looks promising for a proposed one-way paging system for busy people to keep in touch with home base.

Still another subcarrier (although not SCA) includes the new ARI (Automobile Road Information) service that alerts drivers to road hazards via their car FM radios. The ARI service is explained in more detail in the "Timesaving Service for Motorists" box.

If you wish to receive these programs, you need a special decoder, which can be rented for a nominal fee from many sources. This is the preferred way to go, since with payment of the rental fee, you get material, such as program guides. The ARI and professional-services broadcasts are available to only dues-paying subscribers. However, you can home-brew a lost cost SCA adapter like the "Explorer" described in the main text to receive SCA broadcasts.

center of the pattern area. Mark the tab mounting hole locations for the speaker and then drill these holes. Mount the speaker in place with No. 6 machine hardware.

Mount the circuit board assembly on the floor of the metal box, using ¼" spacers and 4-40 machine hardware. Slide the No. 6 solder lug at the end of the wire coming from *R16* and *R17* between one of the spacers and the bottom of the metal box before affixing the hardware.

The final bit of wiring is to the speaker. Connect and solder one of the wires coming from *P2* contact 3 or *J2* hole 3 to either lug of the speaker. The final wire goes to the other lug of the speaker. This done, assemble the metal box and affix four rubber feet on its under side. Finally, put control knobs on the *R16* VOLUME and *R17* TUNE controls.

Setup and Use

It is important that you use a suitable FM receiver or tuner with the SCA Adapter. It should be a good-quality stereo type, in good condition and be of solid-state construction. Cheap monophonic table radios and most portables will not work, because their i-f sections have restricted i-f bandwidth. Transformerless and tube models should also be avoided, because they can be a shock hazard. However, if you have an old tube-type tuner with a stereo jack, you can use it and save yourself the effort of having to dig into its circuitry.

You might consider purchasing an FM unit to use just for SCA reception, rather than digging into your family's receiver. You can often pick up a used receiver or tuner for just a few dollars. In fact, even a stereo car radio will do for this application. With these thoughts in mind, let us proceed with installation.

Before you do anything else, make sure that the ac plug is pulled from the wall receptacle for both receiver or tuner and SCA Adapter. Then remove the receiver's cabinet and anything else you must to gain access to its FM i-f amplifier section. Now locate the output of the FM detector, which presently connects to a stereo decoder. The parts for this circuit are usually located near the edge of the circuit board. It helps if you have the schematic diagram for the receiver or tuner you are using.

Determine what type of detector you are dealing with. If you have a pre-1970s receiver or tuner or a more recent cheapie model, it will usually have the ratio-detector circuit shown in Fig. 4(A). Newer models use the Fig. 4(B) quadrature detector.

A quadrature detector always uses an integrated circuit. The table accompanying Fig. 4(B) lists some common U.S. IC types. All have Asian equivalents that can be found in a cross-reference guide but are too numerous to list here. Typically, if the IC is a 16-pin device, like the CA3089, the detector's output is pin 6. If it is a 14-pin device, like the ULN2111, the output is most likely pin 1 or 14.

Some ICs have internal audio preamplifiers and two outputs. Which output is used depends on whether or not the preamplifier is used. Generally, though, it should not matter which connection *you* use. However, if you experience any difficulty, try tapping the other output.

If you doubt where to make the proper connection, refer to the receiver's or tuner's schematic diagram. If you do not have a schematic, power the unit and use an audio signal tracer to locate the proper pin of the IC in the quadrature detector.

Whichever type of detector your receiver or tuner has, once you locate the correct connection point, connect a length of shielded cable between it and ground. Then route the cable through the back of the unit's cabinet and terminate it in a phono jack. Make sure you use the inner conductor of the cable as the signal "hot" carrier, the shield the signal ground carrier at both ends of the cable.

Reinstall the parts removed during disassembly of the receiver or tuner.

Plug the phono plug at the end of the SCA Adapter's cable into the newly installed jack on the receiver's or tuner's cable. Set the Adapter's TUNE control to mid-rotation and MUTE switch to OFF (pushed in). Power both the Adapter and the FM unit. Tune in a strong local FM station. Turn up the Adapter's VOLUME control until you hear static and possibly distorted bits of program. Adjusting the TUNE control should reveal whether or not the tuned station is transmitting SCA. If it is, you should hear the program. Set the MUTE switch to ON to listen.

Try tuning in other FM stations, keeping a log of those that carry SCA programming. As you tune from station to station, always first turn off muting and then tune in the station. You will discover that tuning SCA signals is more critical than regular stereo programs. So take advantage of any tuning aids your receiver or tuner has or tune for least noise by ear.

Parting Comments

Remember that with SCA you are listening to programs intended for someone else and must abide by the law. Therefore, listen to these programs only in private, do not make copies, and do not divulge what you hear to other people.

You will probably notice that SCA reception tends to be rather noisy. You can reduce this noise by connecting your receiver to a directional antenna and exercising care in tuning.

Finally, if your TV receiver or VCR has a stereo multiplex output, connect the SCA Adapter to it. In some areas in which are broadcast stereo TV signals, you can receive SAP (Second Audio Program) broadcasts and listen to programs dubbed in foreign languages. This is a great way to sharpen your language skills without having to buy an expensive stereo decoder. **ME**

The New Atari 520ST *(from page 40)*

an affordable price. But I couldn't experience the power since very little software is available for the machine. This would be true of any computer at this stage of its development, but I have some serious reservations. Is there enough programming talent out there to develop the kind of programs soon enough that will make this computer really excel? And can Atari sustain itself long enough for that to happen?

It is evident from the software that has been developed for the Macintosh that even reputable software publishers are having a difficult time tapping the full power of that machine. As for the Atari, the GEM software included with the machine appears to need some fine tuning before it will work perfectly. We'll just have to wait and see if the 520ST will attract top software developers.

Apparently, the 520ST has been a big hit with computer dealers. An Atari spokesman indicated that over 1000 dealers have been signed up through October 1985. It won't be sold through the mass market outlets such as Toys R Us.

Summing up my "hands-on" experience and personal views, I think that the Atari 520ST is the epitome of the ideas of a machine "made for the rest of us." It includes almost everything a computerist would want as standard features and at an attractive price. Its color is dazzling and little touches like standard I/O ports and connectors are well appreciated. Of course, you do give up some things, such as a top-flight keyboard. But if you were to try to duplicate the 520ST features with any other machine on the market, you would find that either you couldn't do it at all (as with an Apple IIe and Macintosh) or it would cost much more to do it (as with the Amiga and IBM PC).

The graphics-oriented competitors, the MacIntosh and the Amiga, won't let Atari rest easy. Mac does not feature color, of course, though third-party conversions are said to be in the works. And the Atari 520ST costs much less. The Amiga has a lot going for it, including the quickest operational speed, but its monochrome mode is not as good as the Atari's which is priced lower, too. To make an IBM-PC or compatible satisfactorily graphics oriented costs a little bundle to do, so this would put it into a different price class altogether.

Thus, the Atari 520ST is fully in the race for what it is: a personal computer contender for people who think of themselves as "the rest of us," whether for home, school, or small business. The owner base is just starting now as it is for the Amiga. So who knows what software people will be developing for such a machine . . . and when?

Whether or not this machine can survive in the marketplace, though, is a key question. The current climate in the microcomputer industry seems as though it might stifle this machine's growth before it could evolve to its full potential. But, frankly, I think the 520ST has too much going for it to die. I expect it to be around, assuming sufficient Atari funding. **ME**

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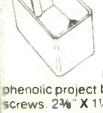

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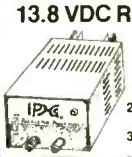

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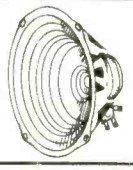

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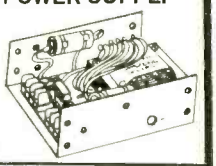

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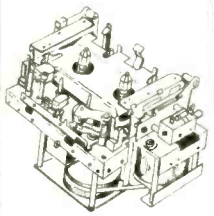

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sounds much better than the FTV2A's. A slide-control on the side sets the volume.

The picture reflects from the actual flip-up screen to a mirror for comfortable desktop viewing. A brightness control on the side helps to maintain adequate contrast for different lighting conditions.

When you look at the picture on the Citizen by itself, it's not too bad. The pixels make the display resemble a newspaper photo. Instead of a continuous image, it resembles a photo that has been "half-toned" with a screen of about 70 lines per inch, which is rather coarse. The contrast ratio is poor, but the picture is undeniably there. Only large screen text is readable. All in all, if you didn't compare it with the Sinclair, however, you'd be favorably impressed.

Place the Sinclair FTV2A and the Citizen 03TA side-by-side with the same picture on their screen, however, and the difference heavily favors the Sinclair. There's nothing like a CRT at this time.

I was able to easily input video signals to the Citizen from a VCR, video camera and computers since it has a video input jack. The VCR and camera yielded an adequate picture for monitoring, but computer text was totally unreadable. The low screen resolution won't allows even 32-character lines. I was able to display a large graphic logo, but normal text is out for this type of display.

I suppose, in the final analysis, the picture is what counts, and the Sinclair FTV2A is the hands-down winner there. But the convenience of the Citizen's video and antenna inputs, the better speaker, the smaller size, the included power supply, and the availability of rechargeable batteries are definite "pluses."

It would be nice if Sinclair and Citizen got together and designed a unit with the best of both. But the LCD display world is too far away in quality at this time. Both CRT and LCD displays are making great strides, though. Sanyo, for example, has a prototype 1.7" CRT that generates a 3"-diagonal screen. And gas-electron-phosphor displays promise an alternative to both the CRT and LCD for flat-screen pictures. Meanwhile, "flat" is apparently the wave of the future. **ME**

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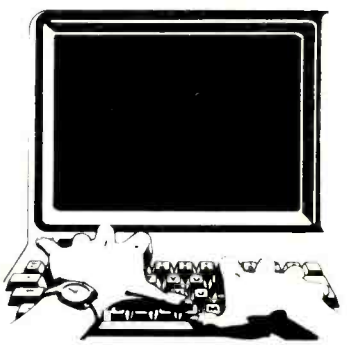

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Readers can obtain free information on products advertised by the above companies, as well as for some editorially mentioned products. Simply circle the appropriate number printed below an advertisement onto the Modern Electronics "Free Information Service" card bound into this issue. After filling in your name and address, just mail the postpaid card. Your request will be forwarded directly to the advertiser with a mailing label prepared by our reader-service department to ensure speedy response.

COMPUTERS AT WHOLESALE !!!

Deluxe Diskette File

Holds 100 5 1/4" diskettes. Easy access handle for opening and carrying. Comes with lock and key for security. #90060 **$8.50**

MURA MODEM MM-100

Sends and receives at 300 baud. Selectable originate/answer modes. Full duplex operation. Direct connect to phone. Bell 103 compatible. Comes with AC adapter. Compatible with all computers having RS 232 port. #10005 **$18.00**

SmarTEAM 103/212A Modem

Operates at 300 baud and 1200 baud Bell 103 and 212A compatible. Hayes compatible. Auto answer, dial and redial. External speaker for monitoring of calls. AC adapter supplied. Uses RS 232-C connector. #91990 **$179.95**

Shielded CABLES

Full end-to-end shield. Hand soldered.

Model 8510 - 6 ft. IBM computer to printer. DB25 pin male to 36 pin Centronics male. #90230 **$9.90**

Model 8511 - 6 ft. RS 232 DB25 pin female to female. #90270 **$9.90**

Model 8512-25 - 6 ft. Centronics 25 pin wired male to male. #90265 **$9.90**

Model 8512-36 - 6 ft. Centronics 36 pin male to male. #90260 **$11.90**

Model 8513 - 6 ft. RS 232 DB25 pin male to female. #90280 **$9.90**

Model 8514 - 6 ft. RS 232 25 pin male to male. #90240 **$9.90**

Model 8515 - 6 ft. IBM computer to modem. DB25 pin male to female. (Pins 1-8, 12, 20, 22 wired) #90250 **$8.50**

All Cables Available In 10 ft. & 15 ft. Lengths

BUILD YOUR OWN PC!

IBM® PC/XT-Type Mother Board

16 bit 8088 processor; optional 8087 IBM PC-XT keyboard port. 8 expansion slots. 8K-Bios ROM installed. 128K RAM installed, expandable to 640K #92250 **$175.00**

IBM® PC/XT-Type Case

Accepts XT-type mother board and eight expansion boards. Side mount for power supply. Flip up cover with locking hinges. #90180 **$49.00**

IBM® XT-Type Keyboard

5150 keytronic type. Fully IBM-XT compatible. Cherry brand keys. LED caps & Num lock. #90130 **$59.00**

150 Watt SWITCHING POWER SUPPLY

Will power hard drive, 4 disk drive power cable. Same dimensions & power plugs as IBM. #90155 **$95.00**

Floppy Disk Drive Controller Board

Includes cable for 2 drives. #92260 **$39.00**

Monochrome Graphic Printer Board

Parallel printer port. Text mode: 80x25; Graphics: 720x348. #92270 **$85.00**

Disk Drives

5¼" Half Height Drives From Teac, Mitsubishi & More! #93140 **$85.00**

IBM Type Add On Boards

Multi function board expandable to 384K. 1 serial port, 1 parallel printer port, 1 Joy stick port. Clock and calendar w/Ni-Cad battery back up. #92290 **$99.00**

Color Graphics Board
RGB color port. Light pen interface. Graphic mode 320x200 (color); 640x200 (B &W). Text mode: 40x25 (low res.); 80x25 (high res.) #92280 **$80.00**

512K RAM Expansion Board
Upgrade RAM memory in 64K increments. Fully buffered. #92300 **$59.00**

RS-232 Serial Board
Provides a RS 232 serial port. Fully buffered. #92310 **$35.00**

Game I/O Board
Provides two joy stick ports. #9285) **$29.00**

Parallel Printer Card #92700 **$29.00**

Hard Drives

10 MEG Hard Disk Drive With Controller #96200 ..... **$449.00**

20 MEG Hard Disk Drive With Controller #98600 ..... **$649.00**

IBM XT-AT TYPE KEYBOARD

#5060AT **$99.95**

IBM XT-5151 TYPE KEYBOARD

#5151 **$89.95**

MAGNAVOX HIGH RESOLUTION

#928050 **$123.00**

BROTHER DOT MATRIX PRINTER

#96220 **$99.00**

EASY DRAWER

Slide drawer for your keyboard. Includes platform to support your computer. Drawer holds a keyboard up to 2 3/4"(L) x 19 3/4' (W) x 9 1/2"(D). #90190 **$49.00**

Swivel Base Monitor

Swivels 360°. Tilts up/down 12.5°. Two sizes.

12" #89980 **$9.90** 14" #89990 **$11.90**

MULTIPLE OUTLET POWER STRIP

Features Surge Protectors. 6 outlet 3-prong plug. 6' cord & 15 amps!

#90140 **$13.00**

ANTI-GLARE SCREEN

Reduces eye strain & glare.

Monochrome Monitors #90210 **$13.95**

Color Monitors #90220 **$16.95**

THE WHOLESALE OUTLET

MasterCard VISA

Dept. ME, 2 Interstate Avenue, Albany, NY 12205. To order call: 1-800-344-4387 (Non-NYS Res.) or 518-459-7883 (NYS Res.) Customer pays freight & handling FOB Albany, NY. Non-credit card order shipped UPS, C.O.D.. Minimum order $25.

Dealer and large quantity orders call: 518-459-7883 ask for Computer Department.

Some Items Not As Pictured

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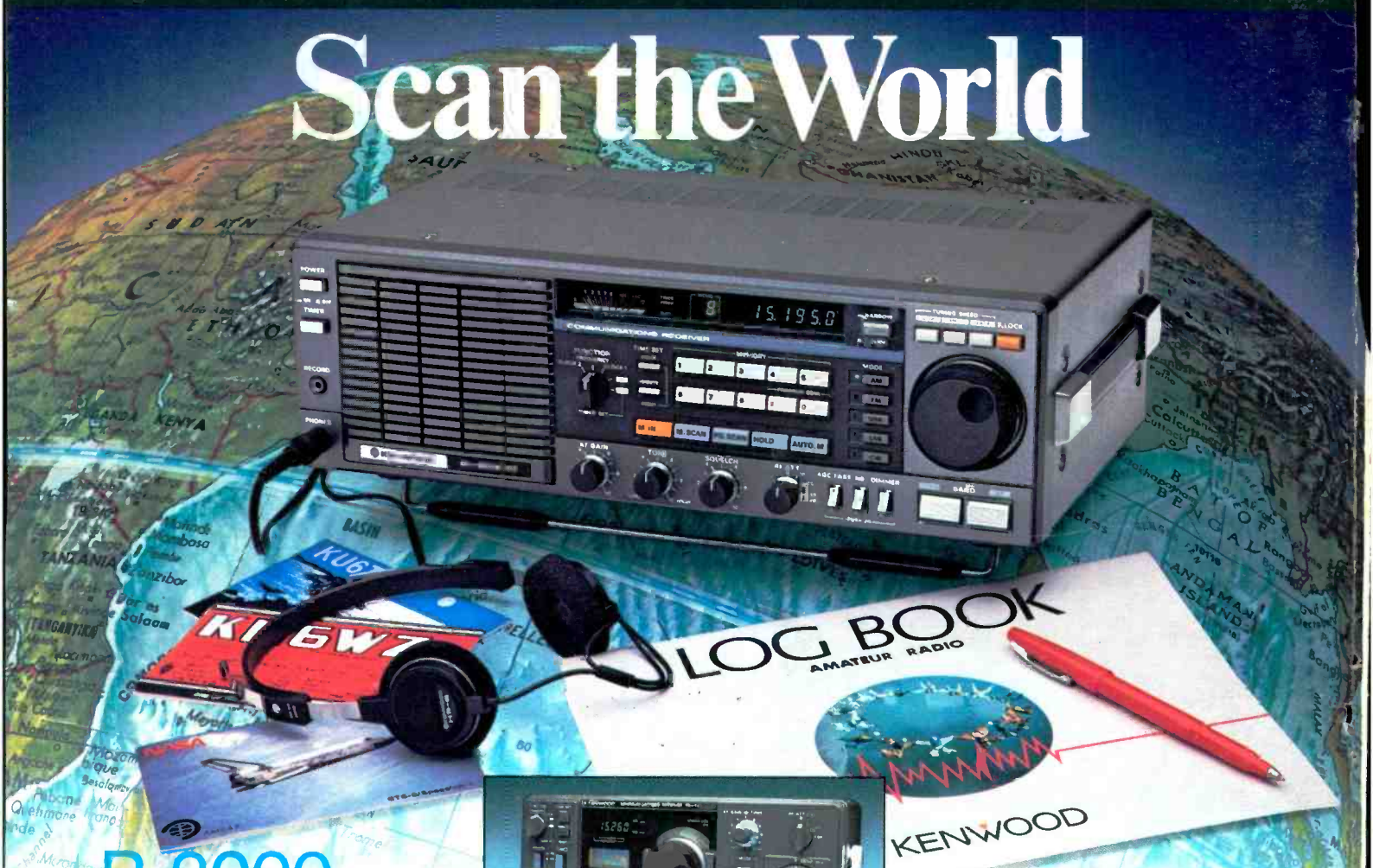
CIRCLE NO. 151 ON FREE INFORMATION CARD

KENWOOD

...pacesetter in Amateur radio

Scan the World



R-2000

All-mode receiver.

- Covers 150 kHz—30 MHz in 30 bands.
- All mode: USB, LSB, CW, AM, FM.
- Digital VFO's. 50-Hz, 500-Hz or 5-kHz steps. F. LOCK switch.
- Ten memories store frequency, band, and mode data. Each memory may be tuned as a VFO.
- Lithium batt. memory back-up.
- Memory scan.
- Programmable band scan.
- Fluorescent tube digital display of frequency (100 Hz resolution) or time.
- Dual 24-hour quartz clocks, with timer.
- Three built-in IF filters with NARROW/WIDE selector switch. (CW filter optional.)
- Squelch circuit, all mode, built-in.
- Noise blanker built-in.
- Large front mounted speaker.
- RF step attenuator. (0-10-20-30 dB.)
- AGC switch. (Slow-Fast.)
- "S" meter, with SINPO scale.
- High and low impedance antenna terminals.
- 100/120/220/240 VAC operation.
- RECORD output jack.
- Timer REMOTE output (not for AC power).
- Muting terminals.

Specifications and prices subject to change without notice or obligation.

R-1000 High performance receiver • 200 kHz-30 MHz in 30 bands • AM, CW, SSB • 3 IF filters • noise blanker • RF attenuator • S-meter • 120-240 VAC • muting terminals • built-in speaker • digital display/clock/timer

R-600 General coverage receiver • 150 kHz-30 MHz in 30 bands • AM, CW, SSB • IF filters • noise blanker • RF attenuator • S-meter with SINPO scale • front mounted speaker • 3 antenna inputs • 100-240 VAC operation • record jack • muting terminals • digital display

Optional accessories:

- VC-10 VHF converter for R-2000 covers 118-174 MHz
- YG-455C 500 Hz CW filter for R-2000
- HS-4 Headphones
- HS-5 Deluxe headphones
- HS-6 Lightweight headphones
- HS-7 Micro headphones
- DCK-1 DC cable kit for 13.8 VDC operation
- AL-2 Lightning and static arrester
- Service manuals are available for all receivers and most accessories.

Additional information on Kenwood all-band receivers is available from authorized dealers.

KENWOOD

TRIO-KENWOOD COMMUNICATIONS
1111 West Walnut Street
Compton, California 90220

CIRCLE 139 ON READER SERVICE CARD