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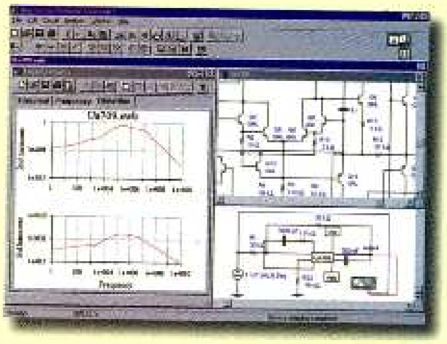

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ON-SCREEN GRAPHS	YES
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GENERAL

Integrated Tool: Fully integrated schematic editing, SPICE simulation and waveform generation and analysis. Supports modifications to the circuit during simulation. Circuit analysis through virtual test instruments or 6 analyses listed below.

Simulation Engine: Interactive 32 bit SPICE 3F5 enhanced with native-mode digital and mixed analog/digital support. Automatic insertion of signal translation interface. Supports multiple reuse of hierarchical blocks. GMIN stepping for better convergence. No preset limits on circuit size or complexity.

Schematic Capture: Click-and-drag interface, hierarchical workspace, automatic wire routing with ... automatic reference designation ... schematic size ... instruments for quick and simple analysis. Six analyses for on-screen graphs and more ... described below)

... All design information including ... configuration, SPICE parameters, setup and copies of all models stored in design file to ... and reuse

... export standard SPICE ... with other simulators or to reuse existing design elements. Imports manufacturer models and netlists into reusable Electronics Workbench components. Exports to standard PCB layout packages such as OrCAD, Protel and Tango.

ANALYSES

DC Operating Point: Calculates DC operating point and reports voltage at each node.

Transient: Circuit voltages and currents over time at any number of nodes. Specify start and stop times.

AC Frequency Sweep: Small signal gain and phase over range of AC frequencies at any number of nodes. Specify range, type (decade, octave or linear) and resolution (number of steps) of frequency sweep.

Fourier: Magnitude and phase of DC and Fourier spectral components of transient response. Specify fundamental frequency and an unlimited number of harmonics.

Noise: Resistor and semiconductor noise contribution reported as RMS sum. Specify device of interest, output and reference nodes, and range, type and resolution of frequency sweep.

Distortion: Small-signal steady-state harmonic and intermodulation products over a range of frequencies. Specify any number of nodes and sweep range, type and resolution. Optionally exclude devices on an individual basis.

VIRTUAL TEST INSTRUMENTS

Digital ... AC ... label ... square ... Hz to ... MHz. Adjustable duty cycle, amplitude and DC offset.

Oscilloscope: ... through time. Two digital cursors. Save data to ASCII file.

Bode Plotter: Plots magnitude and phase for a frequency sweep. Supports frequencies from mHz to GHz. Log or linear scales.

Word Generator: Acts as a digital stimulus editor to drive a circuit with up to 32K 16-bit words. Display and edit data as ASCII, binary or hex. Load, save, cut and paste words. Supports breakpoints and single step, burst and continuous modes. External trigger and data ready indicator for synchronization.

Logic Analyzer: Supports pre- and post-trigger. Internal or external clock, negative or positive edge. Clock qualifier to synchronize data. User-defined trigger patterns and trigger qualifier.

Logic Converter: Converts among gate, truth table and Boolean logic representations.

COMPONENTS

Sources: DC Voltage, DC Current, AC Voltage, AC Current, Voltage-Controlled Voltage, Voltage-Controlled Current, Current-Controlled Voltage, Current-Controlled Current, AM, FM, Vcc, Clock, Pulse Width Modulated, Frequency-Shift Keying, Polynomial, Piece-Wise Linear Controlled Voltage, Controlled Oscillator and Nonlinear Dependent

Basic: Resistor, Capacitor, Inductor, Transformer, Relay, Switch, Time-Delay Switch, Voltage-Controlled Switch, Current-Controlled Switch, Pull-Up Resistor, Variable Resistor, Resistor Pack, Polarized Capacitor, Variable Capacitor, Variable Inductor, Coupled Inductor and Nonlinear Transformer

Diodes: Diode, Zener Diode, LED, Shockley Diode, Diac, SCR, Triac and Full-Wave Bridge Rectifier

Transistors: NPN and PNP BJTs, N and P-Channel JFETs, 3 and 4 Terminal Enhancement and Depletion N and P-Channel MOSFETs

Analog ICs: 3 and 5 terminal Opamps, Comparator and Voltage Regulator

Mixed ICs: A-to-D Converter, D-to-A Voltage and Current Converters, 555 Timer and Monostable

Logic Gates: AND, OR, NOT, NOR, NAND, XOR, XNOR, Tristate Buffer, Buffer and Schmitt Trigger

Digital: RS, JK, JK, D and D Flip-Flops, Half and Full Adders, Multiplexer, Demultiplexer, Encoder and Decoder

Indicators: Bulb, Voltmeter, Ammeter, Probe, Raw and Decoded 7 Segment Display, Buzzer and Raw and Decoded Bargraph

Controls: Differentiator, Integrator, Gain Block, Transfer Function, Limiter, Multiplier, Divider and Summer

Other: Fuse, Lossy and Lossless Transmission Lines, Crystal, DC motor, Vacuum Tube and Buck and Boost Converter

74xx ICs: 7400 7402 7404 7405 7406 7407 7408 7409 7410 7411 7412 7415 7420 7421 7422 7425 7426 7427 7428 7430 7432 7433 7437 7439 7440 7442 7445 7447 7451 7454 7455 7469 7472 7473 7474 7475 7476 7477 7478 7486 7490 7491 7492 7493

74xxx ICs: 74107 74109 74112 74113 74114 74116 74125 74126 74133 74134 74138 74139 74145 74147 74148 74151 74153 74154 74155 74156 74157 74158 74159 74160 74162 74163 74164 74165 74166 74169 74173 74174 74175 74181 74190 74191 74192 74194 74195 74198 74199 74238 74240 74241 74244 74251 74253 74257 74258 74273 74280 74290 74293 74298 74350 74352 74353 74365 74367 74368 74373 74374 74375 74377 74378 74379 74393 74395 74445 74465 ...

4xxx ICs: ... 4008 4011 4012 ... 4028 4030 4040 ... 4069 4070 4071 4073 4081 4085 4086 4107 4019 4024 4027 40... 4050 4069 4072 4075 4077 4078 ...2 4503 4512 4516 40103

MODELS

Digital: Models for ICs, Gates and Flip-Flops in HC totem-pole, HC buffer, HC open-drain, LS totem-pole, LS buffer, LS open-collector and LS open-collector buffer configurations

Diodes: Over 1,300 models for Diodes, Zener Diodes, LEDs, Shockley Diodes and Diacs from Motorola, General Instruments, International Rectifier, Zetex and Phillips

Transistors: Over 1,400 models for NPN and PNP BJTs, FETs, MOSFETs, SCRs, Triacs and IGBTs from Motorola, National Semiconductor, International Rectifier, Toshiba, Harris and Phillips

Analog ICs: Over 1,200 models for Opamps, Comparators and Voltage Regulators from Motorola, Texas Instruments, Maxim, Elantec, Analog Devices, Zetex, Burr-Brown and Linear Technology

Other Models: a variety of Relays, Transformers, Vacuum Tubes, Transmission Lines and Crystals

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CIRCLE 13 ON FREE INFORMATION CARD

Popular Electronics®

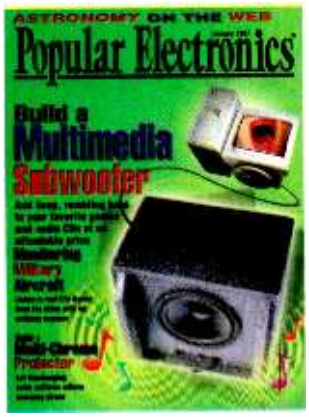
JANUARY 1997
Vol. 14, No. 1

A GERNSBACK PUBLICATION

COVER STORY

CONSTRUCTION

FEATURES



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POPULAR ELECTRONICS (ISSN 1042-170-X) Published monthly by Gernsback Publications, Inc. 500 Bi-County Boulevard, Farmingdale, NY 11735. Second-Class postage paid at Farmingdale, NY and at additional mailing offices. One-year, twelve issues, subscription rate U.S. and possessions $21.95, Canada $28.84 (includes G.S.T. Canadian Goods and Services Tax Registration No. R125166280), all other countries $29.45. Subscription orders payable in U.S. funds only, International Postal Money Order or check drawn on a U.S. bank. U.S. single copy price $3.50.

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JANUARY 1997

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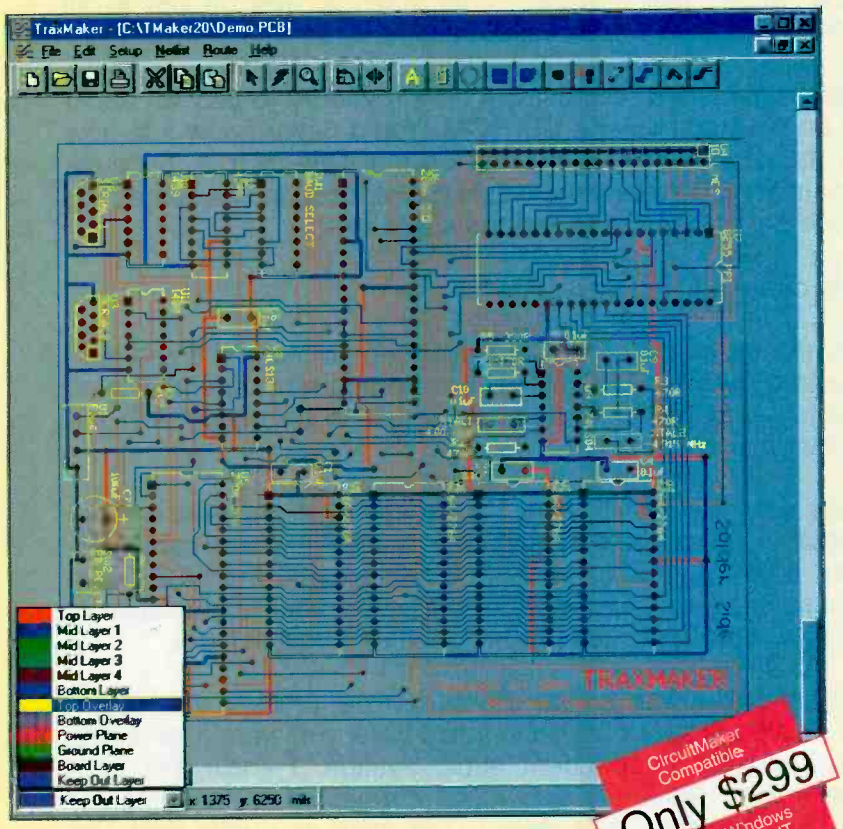

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CIRCLE 171 ON FREE INFORMATION CARD

Editorial

Bass Notes

Ask just about any audiophile and he or she will tell you what's most often missing from a poor-quality audio system—bass. When that booming quality is there, it only enhances a listening experience. But when there's very little bottom end to be heard, any serious listener will have a problem.

Now if you've ever used a standard, multimedia computer you should be able to appreciate that not only is there very little bass present, there's often *no* bottom end to the sound at all! Try playing a jet-fighter simulation game using standard multimedia speakers and you'll see what I mean. Often the explosions in such a game sound like little more than the white noise found on the dial between radio stations, and do not at all increase a player's "adrenaline rush."

Even worse is the sound you'll hear if you try to play an audio CD on your computer's CD-ROM. You'd never know just how rich the digital audio contained on that little disc is, because most multimedia speakers would make it sound like something played out of a pocket-sized transistor radio.

What can a computer-user do?

Well, the easiest thing to do would be to go out and buy a multimedia subwoofer. But unless you're prepared to spend at least a couple-hundred dollars, don't expect to be happy with the results you get.

That's why this month, **Popular Electronics** presents a more affordable, do-it-yourself approach to solving the computer-audio problem. For under $80 you can build the Multimedia Subwoofer—a unit that will really increase your appreciation of just how much bass does to enhance an audio system.

With the Subwoofer, sound effects will roar to life in your room, and music will sound so good you'd think you were listening to a high-quality, independent audio system. I know this from experience—I have the Subwoofer connected to my computer and I'm listening to a favorite CD of mine as I write this! The story begins on page 37.

Dan Karagiannis

Dan Karagiannis
Editor

How to make your car invisible to radar and laser...*legally!*

Rocky Mountain Radar introduces a device guaranteed to make your car electronically "invisible" to speed traps—if you get a ticket while using the product, the manufacturer will pay your fine!

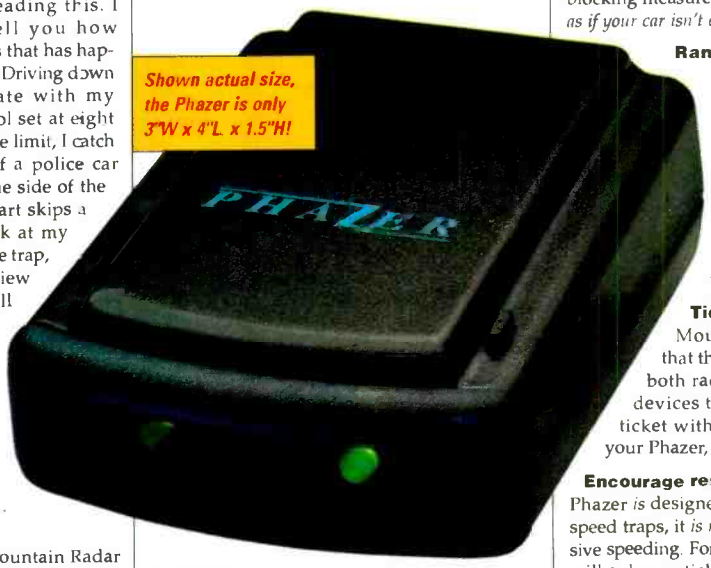
■ *The Phazer will "jam" both radar and laser guns, preventing police from measuring your speed.*

If your heart doesn't skip a beat when you drive past a speed trap—even if you aren't speeding—don't bother reading this. I can't tell you how many times that has happened to me. Driving down the interstate with my cruise control set at eight miles over the limit, I catch a glimpse of a police car parked on the side of the road. My heart skips a beat and for some reason I look at my speedometer. After I've passed the trap, my eyes stay glued to my rear view mirror, praying the officer will pass me up for a "bigger fish."

It seems that as speed-detection technology has gotten more and more advanced, speeding tickets have become virtually unavoidable. And although devices exist that enable motorists to detect these speed traps, they are outlawed in many states... including mine.

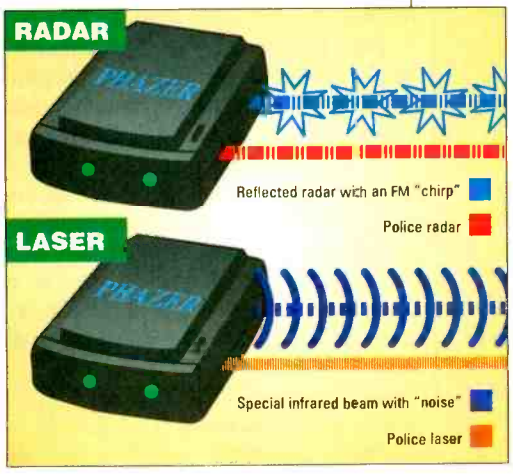
The solution. Today, Rocky Mountain Radar offers drivers like me a perfect solution—the Phazer. Combining a passive radar scrambler with an active laser scrambler, the Phazer makes your automobile electronically "invisible" to police speed-detecting equipment.

The radar component works by mixing an X, K or Ka radar signal with an FM "chirp" and bouncing it back at the squad car by way of a waveguide antenna, effectively confusing the computer inside the radar gun. The laser component transmits an infrared beam that has the same effect on laser Lidar units.



Perfectly legal. Some radar devices have been outlawed because they *transmit* scrambling radar beams back to the waiting law enforcement vehicle. The Phazer, however, *reflects* a portion of the signal plus an added FM signal back to the police car. This, in effect, gives the waiting radar unit an electronic "lobotomy."

Best of all, unless you are a resident of Minnesota, Oklahoma or Washington, D.C., using the Phazer is completely within your legal rights.



HOW TO MAKE YOUR CAR DISAPPEAR

Radar and laser scramblers are devices that foil speed traps by making vehicles electronically "invisible" to police radar. Radar scramblers mix a portion of the radar signal with background clutter and reflect it back to the squad car. This technique, pioneered by Rocky Mountain Radar, creates an unreadable signal that confuses the computer inside the radar gun.

The laser scrambler in the Phazer works in a similar manner. It transmits a special infrared beam with information designed to scramble the laser signal. The result? Readouts on police radar and laser guns remain blank. As far as the police officer is concerned, your vehicle is not even on the road.

■ *The Phazer makes your car invisible to police radar and lasers or the manufacturer will pay your speeding ticket!*

How it scrambles radar. Police radar takes five to 10 measurements of a vehicle's speed in about one second. The Phazer sends one signal that tells the radar the car is going 15 m.p.h. and another signal that the car is going 312 m.p.h. Because police radar can't verify the speed, it displays no speed at all. *To the radar gun, your car isn't even on the road.*

Works with laser, too! The Phazer also protects your vehicle from Lidar guns that use the change in distance over time to detect a vehicle's speed. The Phazer uses light-emitting diodes (LEDs) to fire invisible infrared pulses through the windshield. Laser guns interpret those pulses as a false indication of the car's distance, blocking measurement of your speed. *Again, it's as if your car isn't even on the road.*

Range up to three miles. The Phazer begins to scramble both radar and laser signals as far as three miles away from the speed trap. Its range of effectiveness extends to almost 100 feet away from the police car, at which point you should be able to make visual contact and reduce your speed accordingly.

Ticket rebate program. Rocky Mountain Radar is so confident that the Phazer will protect you from both radar *and* laser speed-detection devices that if you do get a speeding ticket within the first year while using your Phazer, they will pay your fine!

Encourage responsible driving. While the Phazer *is* designed to help you (and me) avoid speed traps, it *is not* intended to condone excessive speeding. For that reason, the manufacturer will only pay tickets where the speed limit was not exceeded by more than 30%, or 15 miles per hour, whichever is less.

■ *The Phazer is a completely legal way to protect yourself from speed traps (except in OK, MN and Washington DC).*

Risk-free. Thanks to the ticket rebate program, speed traps don't make my heart skip a beat anymore. Try it. Your car will be invisible to police radar and laser, or the manufacturer will pay your fine! It's backed by our risk-free trial and three-year manufacturer's warranty. If you're not satisfied, return it within 90 days for a full "No Questions Asked" refund.

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LETTERS

Metered Words

DIGITAL PANEL METER CORRECTION

I'd like to point out some minor additions and corrections to my article, "Using Digital Panel Meters," which appeared in the October 1996 issue of **Popular Electronics**.

The article states, "One-half- and one-tenth-percent resistors are manufactured, but are very expensive and difficult to find in small quantities." They are still expensive, but Mouser Electronics now sells one-tenth-percent resistors in single quantities. Holsworthy 0.1% resistors are listed in its current catalog at $1.08 each, in the same standard sizes as one-percent resistors.

When the article was written, I had never used the prototype Automobile Voltage Monitor in hot weather. I have found that if the DPM module used in the prototype is exposed to the summer sun in a closed car, the entire LCD readout turns dark. It returns to normal when the heat is reduced. I do not know if this would occur with other DPM models. It has happened several times, and there is no apparent damage.

There are two minor corrections. In the first, on page 39, the description of the 6929-ME DPM module says, "the input impedance is less than 100 megohms." That should be "greater than 100 megohms." This is important when a high-resistance voltage divider is used, as in Fig. 7.

For the second correction, on page 79 the stock numbers for low-current LEDs from Digi-Key Corp. should be HLMP-4700QT-ND for red and HLMP-471QT-ND for yellow.

Sorry about any inconvenience these errors might have caused.
—Bill Stiles

THINK TANK ADDITION

I just received in the mail today my November 1996 issue of **Popular Electronics**. It looks great.

However, I'd like to add something to my "Remote Tel-Bell Ringer" circuit, which is Fig. 5 in the *Think Tank* column of that issue (see pages 66 to 67 of the November issue for the circuit's description). Finding parts for a project isn't always the easiest thing in the world, so I thought I'd add some RadioShack part numbers for the components in the circuit.

For MOV1, you can use a RadioShack #276-568 varistor. The MOC3010 optoisolator (IC2) is available as part number 276-134. For neon lamps NE1 and NE2 you can use NE-2-type units.

Also, bridge rectifier BR1 can be obtained from RadioShack as number 276-1161. Finally, capacitor C1, the 1-μF, 200-volt unpolarized unit is available as part number 272-1055.

Of course equivalent parts are available from other sources, but these just happen to be the parts I used. I hope this helps.

Thanks for publishing my work in *Think Tank*.
—Craig Kendrick Sellen

Thanks for contributing, Craig. We always appreciate it when circuit designers offer advice on locating the parts used in their circuits.

I should also add, to all our readers out there, that if we ever run a project with a hard-to-find part, and you happen to come across another source for it besides the ones we list, feel free to send it in to Letters.
—*Editor*

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HAVES & NEEDS

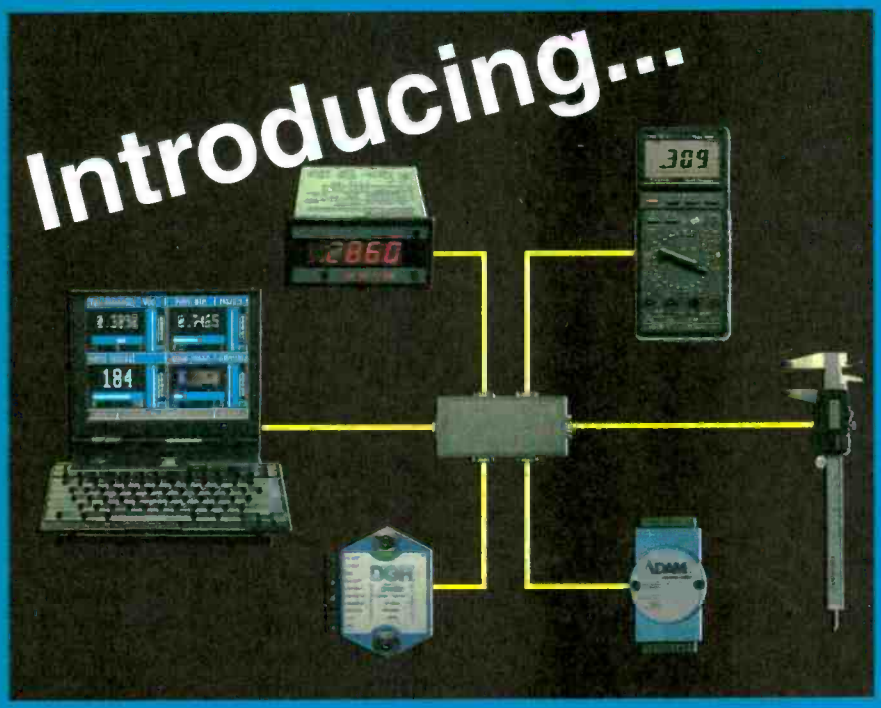
I need a circuit for Control-L or LANC. Do you know where or how I can obtain a circuit for the LANC Control-L for computer control of a camcorder or VCR. In particular, I need the VCR circuit, showing the schematic and connections, as well as an explanation of how it works. I would greatly appreciate any help.
WILLIAM CONLON
P. O. Box 364
Litchfield, IL 62056

I have a Hickok CRO 5000A oscilloscope and am looking for a replacement for its CRT. The CRT is a four-inch Brimar SE4D with the following specifications: an approximate length of 13.25 inches; unblanking DC; accelerating potential, 3.8 kilovolts; usable viewing area of 4.8 × 8 cm; phosphor, P.31. Some of the CRTs were manufactured in England by Thorn Radio Valves and Tube Ltd. in 1972. I wrote to the company twice, and did not receive a reply.
IVAN ZACHEV
4859 Elmwood Street
Muskegon, MI 49441

I have a question about a plug-in cartridge for a Commodore computer. I found a bunch of cartridges at a local hamfest, and one of them appears to be incorrectly marked. I opened it up and found inside a chip marked: "Ham tex C-64, board markings, assembly 325181-01, Fab 326182; a/w 326177 rev A."

Also printed on the case cover is "SYS 32768." When entered, the program seems to run, but I have no idea where to hook up inputs or outputs or what might be needed to isolate it from the transceiver. Any help with this, or any documentation that might be related, would be much appreciated.

By the way, I'm running this on a Commodore SX-64, and it would be great for using when I'm camping or anywhere outdoors.
DANNY J. GADUT
8943 Cypress Avenue
Fontana, CA 92335 ■



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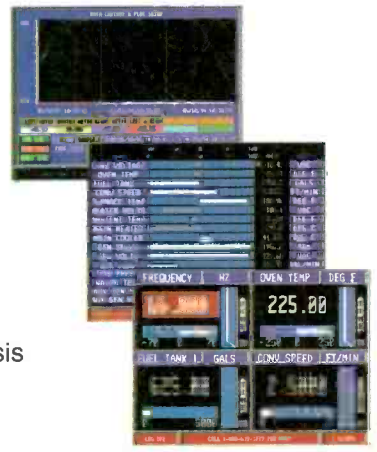
- ISO 9000 Testing
- Lab Data Collection



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NEW PRODUCTS

MULTIMEDIA DSVD FAX/MODEM

For economical desktop video conferencing or telecommuting, *Archtek America's SmartLink Mwave DocuPal* V.34 multimedia DSVD (Digital Simultaneous Voice Data) fax/modem allows two or more users to view and revise the same document on screen from various workstations at the same time. Revisions to the document can also be verbalized through the hands-free microphone. Designed to meet the growing needs of today's complex online communications and multimedia capabilities, the DocuPal also includes telephony and MIDI features.

At the heart of the fax/modem is DSVD technology, which multiplexes voice and data for simultaneous transmission over a single phone line. The DocuPal automatically regulates the stream so that data transmitting at 28.8 kbps drops to 14.4 kbps when voice is added. The auto-mode and dynamic rate renegotiation ensure the fastest available speeds, even when connecting with slower modems.

The DocuPal fax/modem also offers a full-featured phone and digital answering machine with remote message retrieval. A full-duplex microphone, which can be attached to the monitor, placed on a desk, or clipped to a lapel, assures the user of hands-free communication. The fax/modem automatically routes incoming calls to the proper function.

DocuPal comes with ArchShare proprietary software, which provides support for simultaneous communication between up to eight workstations, including full-featured whiteboard editing. Sound Blaster-compatible audio/MIDI functions support music, voice-over, and 3D effects. With CD-quality audio. DocuPal can transform a PC into a full-scale mixing board with simultaneous playback of multiple WAV files.

The DocuPal DSVD fax/modem has a suggested retail price of $439; an optional headset, with volume control, costs $25. For more information, contact Archtek America Corporation, 18549 Gale Avenue, City of Industry, CA 91748; Tel. 888-272-4835; Fax: 818-912-9700; Web: http://www.archtek.com.tw.

CIRCLE 80 ON FREE INFORMATION CARD

FIELD-SERVICE KIT

Fieldpiece Instruments' HS26K15 Fieldpack is a multifunctional, heavy-duty instrument kit designed to meet the needs of field-service technicians. It features the *HS26* top-of-the-line "stick"-style digital multimeter, which offers the 12 most popular ranges for use in the field. In addition to volts, ohms, and continuity, it performs capacitance tests and has a "hold" button. For measuring motor start current, it also has a max-hold function, which holds the highest reading.

The briefcase-style kit comes equipped with an array of test accessories, including a complete set of test leads, short and long probe tips, an alligator clip, and a full line of accessory heads; a clamp for measuring AC current, and dual-temperature, relative-humidity, and micro-amp heads. The accessory heads slip easily onto the top of the DMM to expand its test capability to meet almost any test condition. For remote access or hard-to-reach spots, an accessory head can be placed where it needs to be, attached by test leads to the meter in the technician's hand.

The AC current clamp converts AC current to AC millivolts, allows the meter to display readings to 0.1-amp resolution, and reads up to 300 amps AC. It also features built-in capacitance testing. The dual-temperature accessory head, which is accurate enough for HVACR applications, converts temperature to DC millivolts. It measures two temperature sources simultaneously for comparison and features calibration pots for ice-bucket calibration in the field for accuracy up to ±1°F. The relative-humidity head converts relative humidity percentage (RH%) to DC millivolts and displays RH% at 0.1% RH resolution. The micro-amp accessory head converts μA DC to DC millivolts. It measures current in a heater's flame safety diode circuit to determine if gas is lit, providing HVACR technicians with an added margin of safety.

The rugged case features clear-view pockets that hold and protect the instruments while allowing easy access, even when the case is hanging from the user's shoulder. Zippered back pockets and kangaroo pockets can be used to carry paperwork and other miscellaneous tools.

The HS26K15 Fieldpack costs $449. For more information, contact Fieldpiece Instruments, 231 East Imperial Highway, Suite 250, Fullerton, CA 92635; Tel. 714-992-1239; Fax: 714-992-6541.

CIRCLE 81 ON FREE INFORMATION CARD

ADJUSTABLE-DISPLAY MULTIMETER

Extech's Model 380206 multimeter features a display that tilts up to provide a wide viewing angle. The multimeter measures DC voltage up to 1000 volts with an accuracy of ±0.5%; AC voltage up to 750 volts; AC and DC current, resistance, capacitance; and temperature in Fahrenheit or Celsius. It can be used to perform diode and transistor tests, and audible continuity is also featured. Readings appear in

Does your scale measure your weight and body fat accurately?

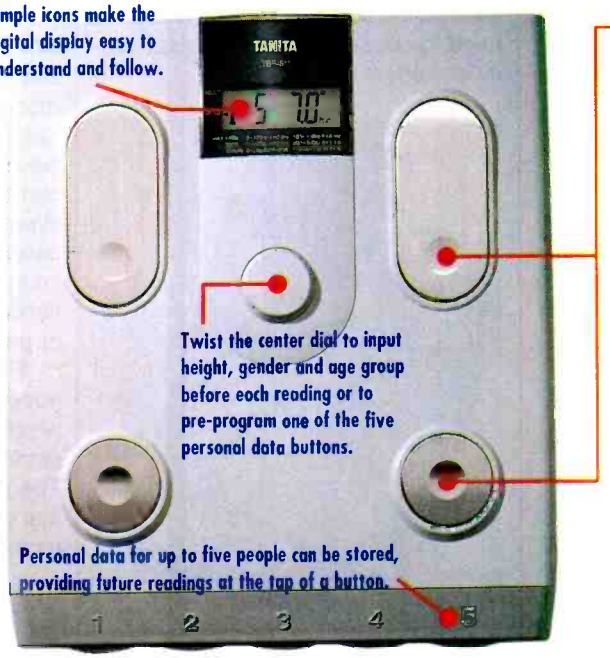
Tanita develops world's first integrated medical scale and body-fat analyzer.

by J. Emerson Brown

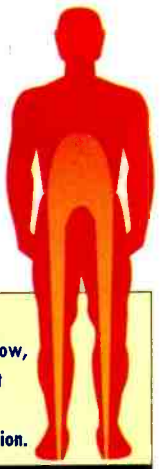
Fat! Everyone hates it. Everyone has it, but some people have more than others. Fat cells, which burn very slowly, are nature's way of sustaining us during periods when food is scarce. But times have change—we're pretty well fed these days. It shows around my waist, and it probably shows around yours, too. No wonder health professionals recommend that men maintain an ideal level of no more than 23% body fat and women a level of 27%.

What is body fat? Regardless of where fat is on your body or what it feels like, it's unhealthy. It should be kept in check. Now I can check both my weight and body fat in the privacy of my own bathroom with Tanita's Body Fat Analyzer/Scale.

The invisible enemy! Unlike weight, body fat can't always be detected by the naked eye, and it certainly can't be measured on an ordinary scale. A person may have a slender appearance and relatively low weight, yet believe it or not, still have an unsafe percentage of fat. Unfortunately, with age, this situation often grows worse. There's a lot you can learn from knowing body fat. In fact, it's one of the best ways to monitor a person's health at any age. Carrying too much fat makes people prime candidates for fat-triggered conditions such as heart disease, high cholesterol, high blood pressure, diabetes mellitus, digestive diseases and even some forms of cancer.



The patented "foot-pad" design sends a low, safe electrical current through the body to measure its composition.

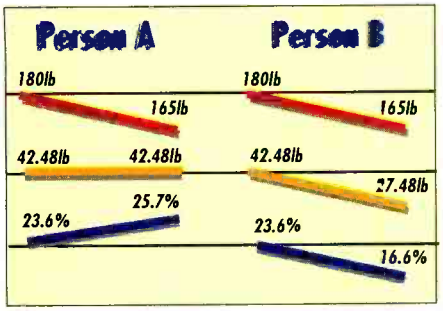


HEALTHY BODY FAT RANGE

	Under 30 yrs. old	Over 30 yrs. old
Males	14%-20%	17%-23%
Females	17%-24%	20%-27%

What's your body fat percentage?

Monitoring body fat should be a regular routine for anyone who is dieting or trying to reach goals in fitness programs.



Person A and B were the same height and weight and had the same percentage of body fat when they started to diet. Each lost a total of 15 pounds over the same period of time. Person A's diet consisted of simply cutting calories. He lost weight, but his percentage of body fat increased—he is actually "fatter." Person B's diet combined cutting calories with a program of exercise. In addition to the 15 pound weight loss, his body fat has dropped to 16.6%.

Simple to use. Weight and body fat readings are simultaneous and immediate, and the body fat correlation with the results of underwater weighing. To use the TBF-511, simply enter your sex, age and height into the monitor, step on the platform, and results appear in about 30 seconds. And, by storing your personal data, you can make future readings even easier.

How the TBF-511 works. Tanita has re-invented BIA (bioelectrical impedance analysis). Long recognized as one of the most accurate methods of analyzing lean and fat body mass, BIA is based on height, weight and the speed at which an electrical current passes through the body. Tanita's BIA method is a process that guarantees accuracy, convenience and speed. A patented "foot-pad" electrode sends a low, safe current through your body and your weight plus body fat are calculated automatically.

The TBF-511 gives you control. This dual purpose device gives you a more complete picture of the shape you're in by accurately measuring your body's fat and lean mass. Your weight-loss program becomes more effective when you know if you're losing pounds from fat or muscle. As for me, monitoring my body-fat percentage with the TBF-511 is now my regular routine (as it should be for anyone who is health-conscious or dieting) to make sure I'm losing, not gaining, fat. It gives me the facts I need to make the right decisions about diet and exercise.

Expert Evaluation. *"We have thoroughly evaluated Tanita's new BIA method and find the diagnostics of the analyzers strongly correlate with estimates made with both the DEXA and underwater testing methods. Our results suggest that it is a unique and valid method for measuring total body fat by weight and percentage and offers the advantage of increased speed and ease of measurement."* Dr. Steven B. Heymsfield, Associate Director, Obesity Research Center, St. Luke's–Roosevelt Hospital, New York.

Risk-free. The TBF-511 Fat Analyzer/Scale comes with our 90-day risk-free trial and a one-year manufacturer's limited warranty. Try it, and if you're not completely satisfied, return it for a full "No Questions Asked" refund.

** Do not use if you have a pacemaker.*

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the 0.98-inch, 3-1/2-digit adjustable display. Accessories include test leads, a 9-volt battery, and a rugged, drop-proof case.

The Model 380206 adjustable-display multimeter costs $99. For additional information, contact Extech Instruments Corporation, 335 Bear Hill Road, Waltham, MA 02154; Tel. 617-890-7440; Fax: 617-898-7864.

CIRCLE 82 ON FREE INFORMATION CARD

ROBOT KIT

OWI's Hyper Peppy robot kit is aimed at young hobbyists. It is easy for children to assemble, either alone or with their parents' help. Once assembled, the robot reacts to touch and loud sounds by changing direction. It is powered by two "AA" batteries.

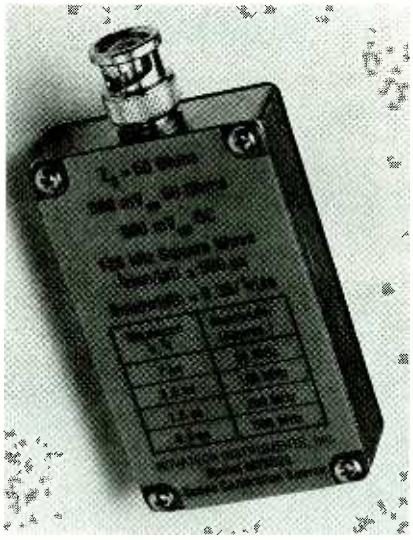
Last year, the Hyper Peppy kit was selected by the Institute for Childhood Resources as one of their Top Ten Creative Products and 100 Best Children's Products. Among the criteria used in the selection process were safety, age appropriateness, lasting play value, durability, good transition from home to school, educational value, and "just plain fun."

The Hyper Peppy robot kit (Model MV-969) costs $24.95. For additional information, contact OWI Inc., 1160 Mahalo Place, Compton, CA 90220-5443; Tel. 310-638-4732; Fax: 310-638-8347.

CIRCLE 83 ON FREE INFORMATION CARD

SCOPE CALIBRATION SOURCE

Novatech's Model MTS529 scope calibration source generates a crystal-controlled, 25-kHz square wave that has a fast rise time and calibrated amplitude. The front-panel decal contains all the information most users will need to check their oscilloscopes easily and effectively.



The palm-sized, battery-operated device can be used to test the horizontal timebase, the vertical amplifier, and the bandwidth of oscilloscopes. The period of the generated square wave has a time accuracy of 0.05% and is used to test the horizontal time base. The square wave rise time is less than 500 picoseconds, which allows the MTS529 to be used to test oscilloscope bandwidths beyond 500 MHz. The MTS529's amplitude accuracy is 5%, and can be used to verify the vertical amplifier of the oscilloscope.

The MTS529 scope calibration source costs $169 in single-unit quantities and $85 each in 1000-piece quantities. For additional information, contact Novatech Instruments, Inc., 1530 Eastlake Avenue East, Suite 303, Seattle, WA 98102; Tel. 206-322-1562; Fax: 206-328-6904; Web: http://www.eskimo.com/~ntsales.

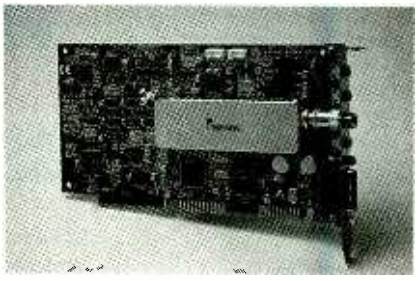
CIRCLE 84 ON FREE INFORMATION CARD

PC FM-RADIO CARD

If you like to listen to music while you work, but routinely tie up your CD-ROM drive with business applications, check out one of three *FM Radio Cards* for IBM-compatible PCs from *Paradise Multimedia Products*, a product group of Philips Electronics. They allow you to listen to your favorite tunes—or ball games, news programs, or talk radio—while you work at your computer.

At the heart of each card is the Philips-designed FM tuner module, which supports the Radio Broadcast Data System, or RBDS. The RBDS module allows your PC to receive FM radio programs, along with any channel, station, or programming information that is sent out along with the radio signal. The FM radio cards automatically scan and store FM radio station information so that you can select stations based on frequency, music type, or programming style.

The entry-level card features the easy-to-use Smart Radio™ interface, which looks like a radio console and stores up to 100 stations in memory. The software includes a built-in alarm that can be used to turn on the radio at a preset time.



The Sound and Radio Card adds SoundBlaster Pro capability. The 16-bit sound card is Windows 3.1 and Windows 95 compatible, supports General MIDI and the Windows Sound System, and meets MPC 3 requirements. Digital recording and playback is supported in 8- and 16-bit resolutions in either stereo or mono at up to 44.1-kHz sampling rates.

To that list of features, the top-of-the-line Wavetable, Sound & Radio Card also adds wavetable synthesis with 1-MB ROM of sound samples, 128 voices, and a drum kit.

Prices for the RBDS-compatible FM radio cards range from $59 to $139.

continued on page 72

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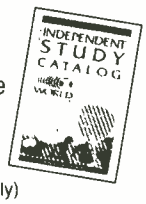

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Multimedia Watch

Speakers that Roar, and More

By Marc Spiwak
Technical Editor
Windows Magazine

I recently hooked up one of the best pair of multimedia speakers I've ever heard for a home computer or home entertainment system. The *ACS500*, from Altec Lansing, is one of the most adaptable multimedia speaker systems around. The system consists of two satellite speakers and a subwoofer. Each of the two satellites puts out 22.5 watts, and the subwoofer can belt out 40 watts of low-frequency energy, for sound you can really feel.

Within each satellite speaker, which towers nearly as high as a 20-inch monitor, are four drivers: two 3-inch midrange, one 2.5-inch full range, and one $^1/_2$-inch dome tweeter. The satellites respond to frequencies from 32 Hz to 20 kHz. The subwoofer contains a 6.5-inch long-throw woofer that grunts at signals from 35 to 250 Hz.

What's really neat, though, is how the satellite drivers are used. In addition to all the fancy drivers, the system includes Dolby Pro-Logic circuitry that can really enhance any sound output, but most effectively sound that's been Dolby encoded for surround sound. That's why the ACS500 is also the perfect set of speakers for a home entertainment system. And two separate inputs allow you to connect the system to both your computer and something else—more than likely your VCR right now. But with computers now being able to play Video CD movies using software MPEG decoding, who knows how long it will be before we all want surround sound on our computers. (Actually DVD will deliver all that, but it's hard to say exactly when.) The Dolby system even has a built-in signal generator so that you can properly adjust the volume of the audio channels.

The bottom half of each satellite speaker forms the traditional pair of multimedia speakers, with a 3-inch midrange and tweeter in each. The top half of each satellite houses two drivers. The 3-inch midrange driver on top is aimed outward providing surround-sound output, while the 2.5-inch full-range driver is aimed inward providing center-channel sound. In addition to the two separate inputs, line-level outputs for all signals are available on the rear panel of one of the speakers. That way you can use the Dolby decoding that the system provides for external speakers you want to position away from your computer.

Altec Lansing's ACS500 multimedia speaker system consists of two 22.5-watt satellite speakers and a 40-watt subwoofer. Dolby Pro-Logic circuitry is built in.

The guys at Altec Lansing have definitely done their homework on the ACS500, because the system really sounds great. I have no trouble recommending it to anyone wanting a high-end multimedia speaker system. You, however, might have trouble parting with the money for these speakers—the system has a $450 list price. But, hey, top-of-the-line stuff always costs more. And it's usually worth it.

A NEW MOUSE

Microsoft has combined a wheel and a mouse in a new kind of pointing device, the Microsoft IntelliMouse. The IntelliMouse looks and feels just like the Microsoft Mouse 2.0, except that there's a wheel positioned between the two familiar buttons. Depending on the application, the wheel will let you scroll and zoom. Of course, the only applications right now are for Microsoft's software. The IntelliMouse provides support for Windows 95 Explorer, Office 97, and Internet Explorer 3.0.

Rotating the wheel scrolls up or down. You can also press down on the wheel like a third button to activate var-

Down in the Dumps features the Blubs, thumb-sized extraterrestrials who crash land in a smelly dump on planet Earth.

Fifteen years of microelectronic research makes conventional antennas a thing of the past!

This little box uses your home's electrical wiring to give non-subscribers, cable subscribers and satellite users better TV reception!

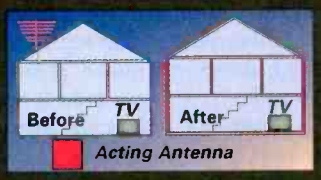
by David Evans

Technology corner

1. Why don't conventional antennas work as well as the Spectrum?

- When TV signals are tuned at the TV channel's center frequency, optimum tuning has been achieved.
- Other antennas can't offer center frequency tuning like the Spectrum Antenna can. They only offer such tuning up to the edge of the center frequency. As a result your TV picture remains snowy.

2. How does Spectrum use a home's electrical wiring as an antenna?



Believe it or not, the Spectrum Antenna simply "activates" the giant antenna that already exists in your home. Essentially, it uses all of the wiring throughout your home's walls and ceilings to make an antenna as large as your house for unbelievably clear reception of local broadcasting.

3. Spectrum antenna features

Parallel 75 ohm resistance
For minimum loss of signal

Signal search control
For selecting multiple antenna configurations

Polarized three-prong plug for grounding
For optimum signal grounding to eliminate noise and static

Resonant fine tuner control
For dialing in crisp, clear TV stereo reception, eliminates ghosting

Dual AC outlets with built-in surge protection
For plugging in additional TV/stereo equipment guarding against damage and electrical surges

Until recently, the only convenient way to guarantee great TV reception was to have cable installed or place an antenna on top of your TV. But who wants to pay a monthly cable fee just to get clear reception, or have rabbit-ear antennas that just don't work on all stations? Some people just aren't interested in subscribing to cable. Or they may live in an area where they can't get cable and TV-top antennas aren't powerful enough. And what about those people who have cable or satellite systems but still can't get certain local stations in clearly?

Now, thanks to fifteen years of microelectronics research, a new device has been developed that is so advanced, it actually makes conventional antennas a thing of the past. It's called the Spectrum Universal Antenna/Tuner.

Advanced technology. Just imagine watching TV and seeing a picture so clear that you'd almost swear you were there live. Just plug the Spectrum Antenna into a standard AC outlet and plug your TV into the Spectrum. You can remove the unsightly clutter of traditional TV-top devices gathering more dust than television signals. Get ready for great reception. Your TV will suddenly display a sharp, focused picture thanks to its advanced design "Signal Search" and "Fine Tuner" controls.

Who can use Spectrum?

- ***Cable users-You have cable but you can't get certain local stations in clearly.***
- ***Non-cable users-You don't have cable and want the stations to come in more clearly***
- ***Satellite users-You have a digital satellite system but can't get local stations in clearly***

Uses your home's electrical wiring. The Spectrum Antenna is a highly sophisticated electronic device that connects into a standard wall outlet. The outlet interfaces the Spectrum Antenna with the huge antenna that is your home wiring network. It takes the electrical wiring in your house or apartment and turns it into a multi-tunable, giant TV reception station which will improve your TV's overall tuning capability. The results are incredible. Just think how much power runs through your home's AC wiring system—all that power will be used to receive your local broadcasting signals.

How it works. Broadcast TV signals are sent out from the local broadcast station (ABC, CBS, NBC, etc.). They interface with your home's AC power line system, a huge aerial antenna network of wiring as large as your home itself. When the Spectrum Antenna interfaces with the AC line, the signal is sent to its signal processing circuit. It then processes and separates the signal into 12 of the best antenna configurations. These specially processed signals route themselves into 12 separate circuits. The Spectrum Antenna includes a 12-position rotary tapping switch, the "Signal Switch" control, which gathers twelve of the best antenna configurations.

The "Signal Search" offers varying antenna configurations for the user to select from the best signals of all those being sent. The signal then passes through the Spectrum Antenna's special "Fine Tuner" circuit for producing crisp, clear reception.

Risk-free offer. The Spectrum Universal Antenna/Tuner comes with our exclusive 90-day risk-free home trial and a 90-day manufacturer's warranty. Try it, and if you're not satisfied, return it for a full "No Questions Asked" refund.

WHERE TO GET IT

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ious functions. For example, AutoScroll automatically scrolls through a document at whatever speed you set. Bundled IntelliPoint software lets you customize the mouse functions. I'm comfortable with my old Microsoft mouse, and I usually stick with things that I'm comfortable with. However, people who are always looking for a new pointing device that will let them work faster will want to check out this unusual new mouse. IntelliMouse sells for about $85.

NEW STUFF

If you fantasize about being an investigator, you might be interested in Activision's new game, *The Pandora Directive*. You get to be Tex Murphy, searching for a missing person in April, 2043. That person happens to be an ex-military individual, and he knows exactly what happened with the rumored UFO crash at Roswell, New Mexico, back in 1947. But it's easy to get yourself in trouble when the government's biggest secret is loose. All live characters, famous actors, different levels, multiple endings, and more, turn your computer into a Hollywood novel.

I'm not much of a hockey fan, or a sports fan in general, for that matter. However, from what I can tell from a beta version of Virgin Interactive's new *NHL Powerplay '96*, hockey fans will really like this game. The graphics are fairly realistic, and the fluid action is fantastic. Once you you get used to the animated graphics you'll feel like you're participating in live hockey on TV rather than playing a game. All the realism of professional hockey is here, including the choice to play in season games, playoffs, and so on.

I received a pre-alpha release of *Down in the Dumps* from Philips Media, and it looks interesting—the final version should be on sale by the time you read this for $59.95. The Blubs are thumb-sized extraterrestrials who crash into a bunch of thugs in outer space. Both ships then crash land in a smelly dump on planet Earth. The Blubs have to find missing parts of their ship and repair the damage, but the thugs will do anything to prevent that. Your job is to help the Blubs out in any way you can. Really cool graphics bring this unusual game to life.

Three new games from LucasArts this month, *Mortimer and the Riddles of the Medallion*, *Afterlife*, and *Indiana Jones and his Desktop Adventures*. Combining action, discovery, and one of LucasArts' best gaming engines, Mortimer is an action game designed for kids ages 5 to 11. The game is based on the Rebel Assault engine, so the action is similar although it takes you to very different worlds.

Afterlife is the ultimate simulation game where players build and maintain heaven and hell. Souls must be kept happy in order for development to proceed without complications. Definitely an unusual game.

Indiana Jones and his Desktop Adventures lets you join Indy in literally billions of unique and varied mini adventure games. The games are highly suited for people who don't have the time required to play some of today's involved computer games. But each new Indy adventure, loaded with new characters, puzzles, and treasures, can be solved in about an hour. Set in Mexico in the 1930s, each game is rich with ancient Indian treasures that you and Indy must save for the world to enjoy.

Chronicles of the Sword from Psygnosis is set in the year 420 AD, the era of Arthur, Merlin, Lancelot, and Morgana. You play Gawain, who is called upon to help defeat Morgana's lust for power and her attempt to overthrow Arthur's reign. There are hundreds of locations to explore and plenty of puzzles to solve along your journey from Camelot to the evil Morgana's Lyonesse castle. Magic and mortality surround you throughout the game.

If you're interested in learning how to play the guitar, then you might be interested in the *eMedia Guitar Method* CD-ROM, from eMedia. The title makes good use of a computer's multimedia capabilities. There are 60 lessons to teach you everything, starting with the basics like stringing a guitar. There are over 30 videos and more than 3 hours of audio, with an option for male or female vocals. A built-in recorder lets you record your own playing and compare it to the instructor's. An automatic tuning feature helps you tune your guitar visually by playing into your PC's microphone, and an electronic metronome helps keep tempo. This one will cost you around $59.95. ■

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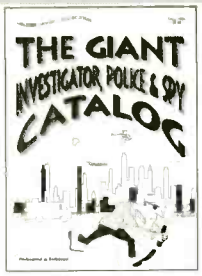

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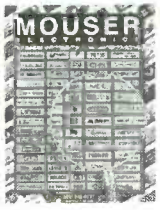

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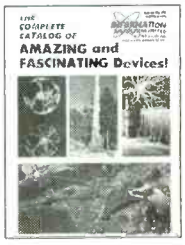

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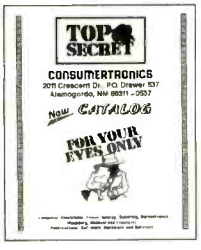

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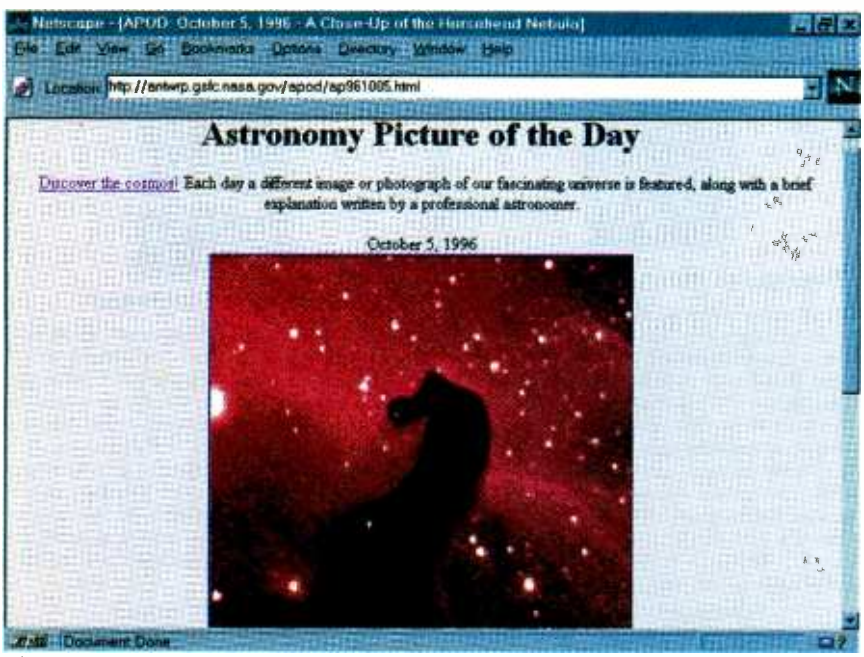
NET WATCH

Astronomy on the Web

BY DAN KARAGIANNIS

Winter brings with it the crispest night-time skies. Step outside on any clear evening, look up, and you'll notice that, as your foggy breath disappears in the increasing darkness, you'll become aware of an increasing number of stars.

Some of you who read this have access to a telescope, which means those stellar objects in the heavens will look even better. Of course, a telescope capable of gathering a lot of light, and as a result capable of resolving faint objects, can be quite expensive. So how do you see what treasures the night-time sky really has to offer?



This view of the Horsehead Nebula is only one of the many stellar delights available at the Astronomy Picture of the Day site.

Well, for starters, get in out of the cold. Make some hot chocolate, have a seat, and dial into your Internet account. Because, as you'll see, there's plenty of stargazing to be done on the World-Wide Web.

PICTURE OF THE DAY

The Astronomy Picture of the Day site is probably the best place to begin if you're looking for stellar objects in cyberspace. As its name implies, the site contains a new deep-space photograph each day. You'll find views of star clusters, nebulae, planets, etc. Best of all, they were not all taken in similar fashion. Some of the shots contain views of the universe from an X-ray point of view, etc. But no matter how they were taken or processed, the resulting images are all extremely crisp.

Each image is accompanied by a detailed description from a professional astronomer. That way you'll know more than just the name of the object you're looking at, but also its distance from Earth, how it was probably formed, its location in the sky, and so on.

Another useful feature of the site is its extensive archive. Pictures from days past are available, making a wealth of the night sky's most important and fascinating objects easily accessible on any day. Each photo's description is also automatically loaded with the image.

Just one note before we move on. This is an obvious site to bookmark, considering it's updated daily.

A ROBOTIC TELESCOPE

Looking at images stored in servers in cyberspace can be really interesting. However, sometimes you might want to experience the thrill of choosing an object, and pointing a telescope its way. If you feel that way, this next site is for you.

The University of Bradford Robotic Telescope is a totally autonomous, 46-cm telescope located high on the moors in West Yorkshire, England. This amazing observation device "decides" on its own when the conditions are clear enough to photograph the sky. But guess what? *You* get to decide what it photographs!

The University is kind enough to let anyone on the Internet register for viewing rights. You'll then be notified by e-mail that your password and registration went through. In that same message you'll also receive detailed instructions for how to place your observation request.

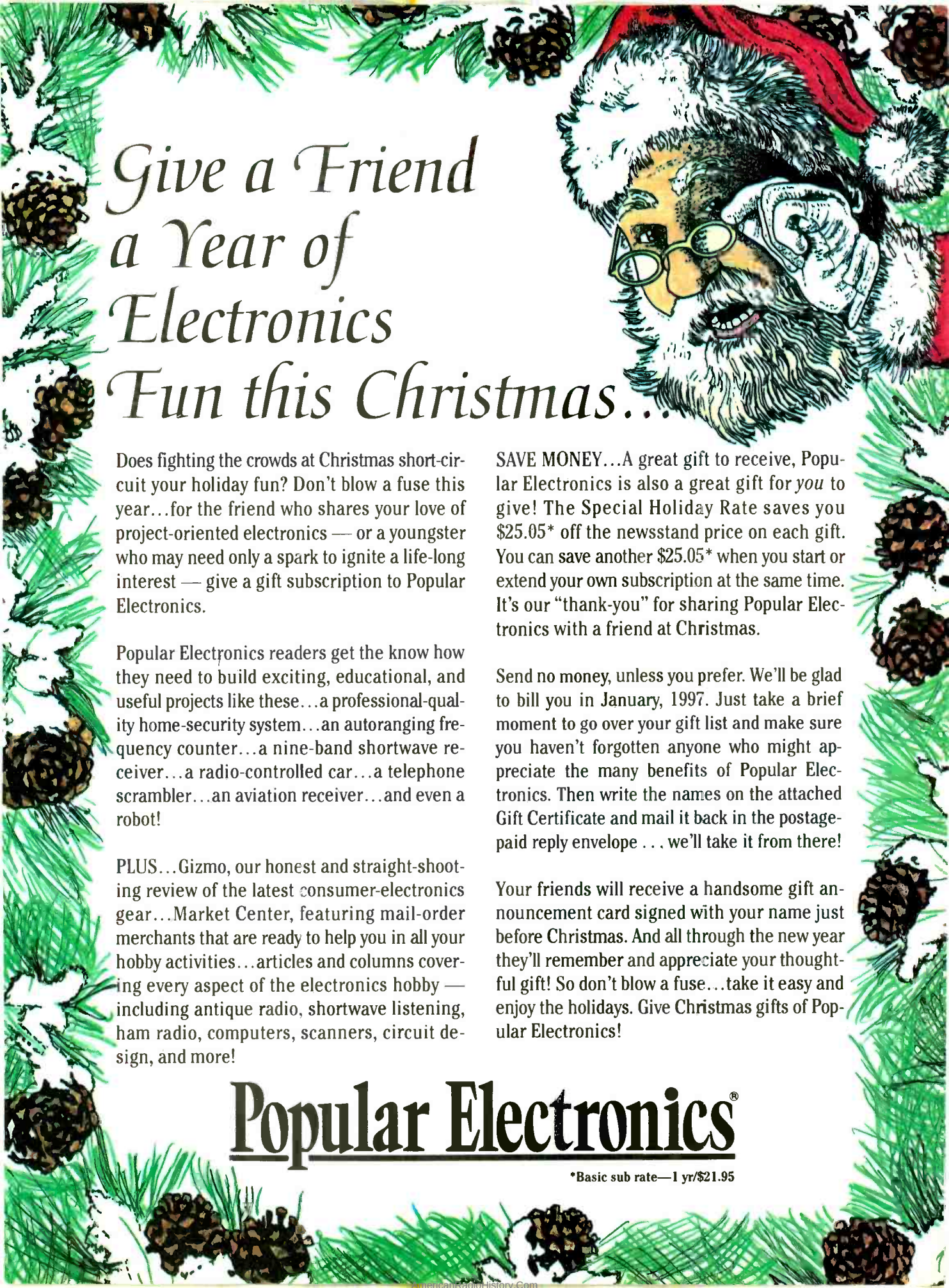
Basically, you'll be allowed to "ask" the telescope to look at any object in the northern night-time sky. Your request will be automatically scheduled and carried out by the telescope as time allows. When the object has been viewed, you'll be notified that it's ready to download.

Of course, just about any request you make will be of an object that is available somewhere on the Net. However, it's more fun to have your own personal view of the heavens.

And don't forget: things are always happening in the universe. This spring, for example, Comet Hale-Bopp is supposed to make an impressive appearance in the northern skies. It's safe to expect that this robotic telescope will be working overtime around then!

OUR OWN BACKYARD

So far, we've been talking a lot about distant, stellar objects. But don't forget that there are a lot of neat things to see right in the vicinity of this planet.



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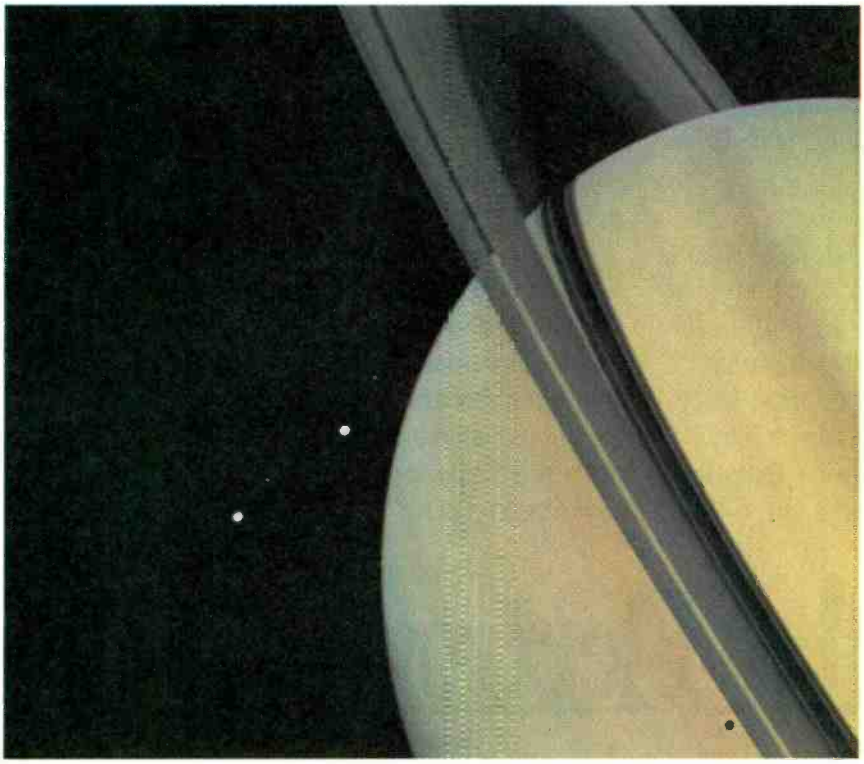
This image of Comet Hyakutake was taken by the Bradford Robotic Telescope, April 4, 1996, during the dark hour of the Lunar Eclipse. Comet Hale-Bopp this spring should be a popular target for the telescope.

In other words, within our solar system. The Views of the Solar System site quite nicely fills the need for an organized collection of images and information about the Sun, planets, moons, asteroids, comets, and meteoroids found within our own cosmic backyard.

If I had to choose one word to describe this site it would be: "immense." This hot spot contains over 220 HTML pages of information, 950 high-resolution images and animations, and 880 megabytes of data! If you can't find it here, it's probably not relevant to what circles our Sun.



Here's a view of Saturn and two of its moons, Tethys (above) and Dione, that was photographed by Voyager 1 in 1980. This and other planetary images are available from the Views of the Solar System site.

The site is designed like a tour. You can "travel" through space by simply clicking on a planet, or other object. Choose from the following links: Sun, Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto, Asteroids, Comets, and Meteoroids & Meteorites.

Clicking on an object takes you to a page containing information and images. While on each object's page, you can link to pages about its moons (if it's a planet) and other resources. Every bit of information is clearly explained on the pages (there are even links to a Glossary page that explains any unusual terms that are used in the text).

The History of Space Exploration contains information about rocket history, early astronauts, space missions, spacecraft and detailed chronology tables of space exploration. Check that link out if you would like to know more about what our predecessors have done to get closer to our planetary neighbors.

HOT SITES

Astronomy Picture of the Day
http://antwrp.gsfc.nasa.gov/apod/astropix.html

Bradford Robotic Telescope
http://www.telescope.org/rti

Views of the Solar System
http://128.165.1.1/solarsys

There's also a Table of Contents page with links to all of the various pages within Views Of The Solar System. That's useful if you'd like to jump straight to a topic of interest without following a series of links to get there.

Finally, a People link takes you to a fully indexed list of famous individuals in astronomy. I thought it was a nice touch to give an insight to those responsible for our knowledge of the solar system and the universe.

Well, that's it for this month. Until next time, I hope you enjoy the views of space on cyberspace. And while you're online, don't forget to visit our Web site at http://www.gernsback.com. Feel free to e-mail me at peeditor@gernsback.com or send snail-mail to *Net Watch*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. ■

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DX LISTENING

Winter DXing

BY DON JENSEN

This is the time of year when shortwave DX is at its best. The static levels are low, and the long hours of winter darkness mean improved signals on the lower SW frequencies.

But for those of us living in the northern tier of states, winter means frigid temperatures, blustery snow storms, and icy roads. It's a time when social contacts with our friends seem all the more important.

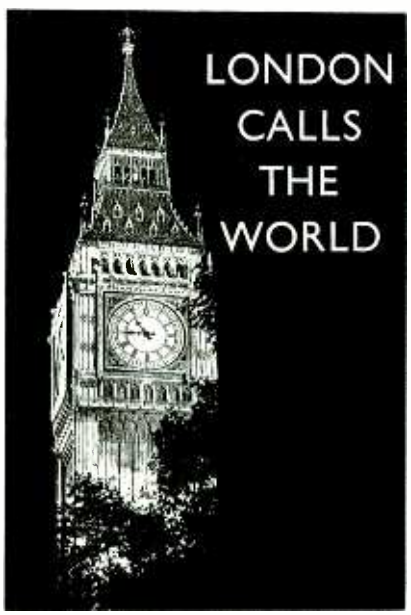
That's why, ten years ago, a couple of veteran shortwave enthusiasts launched *Winterfest*, a mid-season weekend get-together for radio listeners. Bob Brown, a Pennsylvanian who then headed one of the major SW listener clubs, and Harold Cones, a college professor and longtime DXer, first kicked around the idea. They were joined by a third listener, Kris Field, to form what they laughingly call, "The Gang of Three."

Plans for that first gathering advanced smoothly. Others heard about the winter retreat and announced their intention to attend as well. There were 40 radio-listener hobbyists who turned up at the Fiesta Motor Inn in Willow Grove, PA, that snowy weekend a decade ago.

They had so much fun that they vowed to do it again. And they did, leaving behind the Fiesta's infamous "beautiful pink and purple Pancho Villa Room," recalls Cones, for a more comfortable Holiday Inn at Kulpsville, PA, not far from Philadelphia. The DXer event has continued there every winter for 10 years.

This year, Winterfest is scheduled for March 14-16, 1997. Cones says that any and all listeners out there are invited to join the several hundred already expected to attend the tenth-anniversary gathering.

Last year, more than 250 attended—listeners of all stripes, shortwave fans, AM medium-wave listeners, scanner enthusiasts, beginners in the hobby, and longtime veteran tuners. Usually at least a few well known names in the SW broadcasting arena turn up. Jonathan Marks of Radio Netherlands and former Radio Canada International host Ian MacFarland are semi-regulars.



The Knights of Daventry, the transmitters at the BBC's longtime broadcasting center, aired London's SW programming to the world for many decades.

At first, Winterfest was just a place where a handful of SW types could relax and talk DXing for a couple of cold winter days and nights, sharing pizza and beer. Over the years, though, it took on a more organized character. Now there are programs, seminars, and forums on a wide range of topics of interest to listening hobbyists. The chip-in-and-buy pizza of the past has been replaced by a Saturday night banquet.

There are prizes to win, including shortwave receivers. Cones says there's something for everyone to enjoy, regardless of his or her experience in the hobby or particular listening interest. A special tenth-anniversary yearbook is planned. There are always receivers to tune and new equipment to view. Regulars say that Father John's DXers' prayer guarantees a good weekend of tuning.

Though Winterfest formally runs from Friday to Sunday, some early arrivals show up on Thursday, while others who can't arrange the time off limit themselves to Saturday and Sunday. For full details, send a stamped, self-addressed envelope to Winterfest, P.O. Box 591, Colmar, PA 18915. But time is short, so if you're interested, write soon!

"The 'Fest has grown to become a major international radio event," Cones commented. "But in spite of its growth, it still retains the atmosphere of a family reunion...and the original intent, to get together to `just talk radio' has not changed over the past decade."

It should be fun!

KNIGHTS OF DAVENTRY

I recall a phrase from a bit of verse I ran across in an old radio magazine from the 1930s. It was "The Knights of Daventry," a poetic allusion to the British Broadcasting Corporation's shortwave transmitters in the early days when Great Britain had an Empire and the BBC had its Empire Service (a forerunner to the familiar World Service).

The pioneer broadcaster's transmitters and antennas were located in the little Northamptonshire town of Daventry. Then, after 69 years of broadcasting to the world, the Daventry facility was closed down in 1992, its duties assumed by newer BBC transmitting sites elsewhere in England, at Skelton in Cumbria, Wooferton in Shropshire, and Rampersham in Dorset.

Only the huge concrete blocks that had anchored some of the 31 transmitting antennas (which once stood on Daventry's Borough Hill) remain. They're now protected by the British heritage organization as part of a historical site.

According to Dan L. Smith, writing in the Radio Topics column of *Contact*, the monthly publication of the World DX Club, part of the site later was taken over by the local authorities as a recre-

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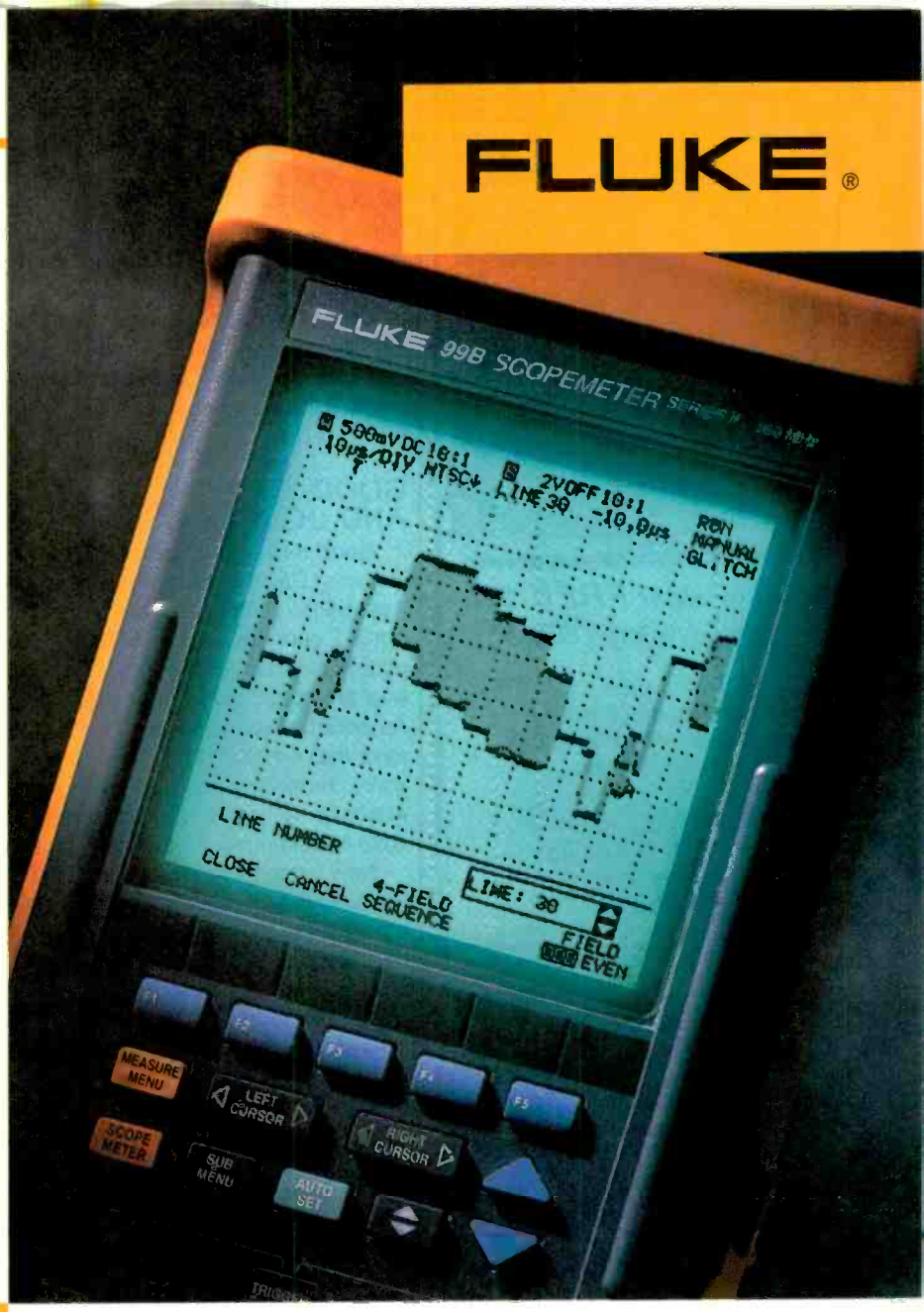

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ational area. Daventry's one-time BBC Club, a centuries-old, three-story building that served as a recreation center for Auntie Beeb's broadcasting engineers, is about to be converted into tourist-information and governmental offices.

Still in the planning stage, though, is a proposed $53 million theme park and interactive science center on some 67 acres of the old broadcasting site. Could this be a Daventry Disneyland?

GOOD, BAD, AND UGLY NEWS

Good news! From several sources, including David Clark of the Ontario DX Association, I've heard that the call to arms I sounded last month about a possibly endangered Radio Australia was premature and unnecessary. The Australian Broadcasting Commission says that it has not lost faith in shortwave broadcasting and that Radio Australia will continue operations in spite of continuing funding pressures.

Now some bad news, as reported by Hans Johnson's Cumbre DX and others. Despite indications to the contrary by station staffers, CKFX, Vancouver, B.C., Canada, reputedly the world's lowest powered SW station at a puny 10-watt output, is off the air for good. The difficult-to-hear station on 6,080 kHz was a terrific bit of DX for those listeners who, over the years, were lucky enough to catch its signals.

An investment of $1000 for a replacement transmitter was turned down by station management. The station, which went on the air decades ago, originally was intended to reach listeners in the more remote parts of British Colombia. Increasingly, AM and FM signals are reaching this audience.

And finally, some ugly news. The world of SWLing has always had a few hoaxers who concoct stories of rare and fabulous DX shortwave stations supposedly on the air. Decades ago, reports circulated among SW listeners about a Radio Nibi Nibi, said to be a rare Pacific outlet on a remote island of the same name. Its tuning signal, someone claimed, was the "sound of (falling) coconuts!"

Of course, some took these claims seriously and were furious when the hoax was finally exposed. Nibi Nibi has remained a legend among old-timer SWLs.

Now we have a neo-Nibi Nibi report circulating via some Internet postings. Supposedly, Radio Kiribati, the shortwave outlet of the tiny Pacific island nation of the same name, had set up a SW relay transmitter in Macedonia, formerly part of the now-fragmented Yugoslavia. These programs, it was claimed, were directed to the Kiribati troops in the UN peacekeeping force in the Balkan country.

Suspicious SWLs soon confirmed that there were no such programs and no such relay station. In fact, not only are there no Kiribati troops with UN forces in Macedonia, there isn't even a Kiribati army.

"A good joke, though," comments Al Quaglieri in his Listener's Notebook column in *The Journal* of the North American Shortwave Association.

DOWN THE DIAL

Looking for some SW targets to tune? Try these:

DOMINICAN REPUBLIC—6,235 kHz. Radio Quisqueya in Puerto Plata can be heard afternoons and evenings until signoff about 0420 UTC. Programming features mostly Latin popular music and ballads, with periodic Spanish and English identifications.

GUYANA—5,950 kHz. Guyana Broadcasting Corporation is back on shortwave with new 5-kilowatt transmitters and refurbished antennas. Programming from this station on the northeastern coast of South America is mostly in English. It is scheduled on this frequency from 0900 to 2100 UTC, and on 3,290 kHz from 2200 to 0900 UTC.

IVORY COAST—7,215 kHz. Radio Cote d'Ivoire is a French-speaking West African shortwave station that also returned to the air after a long period of silence. This was logged during the afternoon hours until sign off about 2400 UTC. Also look for it after 0600 UTC.

MOLDOVA—7,520 kHz. Radio Moldova International, which broadcasts from a corner of what was once the USSR, is heard signing on in English at 0330 UTC with a newscast and commentary.

SUDAN—7,200 kHz. Republic of Sudan Radio has been heard with Arabic programming, signing on at 0251 UTC with a xylophone interval signal and anthem. After a brief Islamic religious segment, the program continued with a news broadcast. It also operates on a parallel frequency of 9,024 kHz. ■

GIZMO®

Desktop World Traveler

DX-394 COMMUNICATIONS RECEIVER. From: RadioShack, 700 One Tandy Center, Fort Worth, TX 76102; Tel. 800-THE SHACK. Price: $299.95.

As the world changes, so does worldband or shortwave radio. Gone are the days when Radio Habana Cuba would broadcast a program called the *Voice of Viet Nam*. Gone are the propaganda broadcasts of the Cold War. Gone, for the most part, is the intentional jamming of foreign broadcasts.

Shortwave broadcasting remains an efficient way of reaching a mass audience, and most countries remain intent on promoting their culture through the broadcasts. That's not universally true, of course. Radio Canada International has seen its funding shrink continuously, reducing the capabilities and the stature of one of the best programmers present on the shortwave dial.

That's not to say that shortwave radio has lost its edge. In fact, it occurred to us recently while listening to an essay on international treaties and Islamic nations—followed by a rendition of the 1970's hit "Hotel California"—on Radio Kuwait, that if you're not familiar with shortwave listening, you're missing out on some pretty interesting stuff.

So how do you get into the action? There are many receivers available for both beginners and experienced shortwave listeners, and many decisions to be made before buying. One of the first decisions to be made is whether you want a portable unit or a desktop receiver.

In many respects—especially with mid-priced receivers—the issue is not one of quality, but one of user preference. We've used miniature receivers in the past that had excellent performance, and were ideal for traveling, but were not a pleasure to operate at home.

When we're sitting at home, looking forward to a lengthy session of listening or DXing, we prefer a tabletop receiver like *RadioShack's DX-394*.

The DX-394 is a general-coverage communications receiver with a frequency coverage from 150 kHz to 30 MHz. It measures about 3½ × 9 × 8 inches and weighs in under 4½ pounds. Two flip-down feet raise the front of the receiver up to a comfortable reading angle. As its name implies, the unit is perfect for a desktop.

The receiver is powered from the AC line through a fixed power cord, but a rear-panel jack allows it to be powered by 13.8-volts at 450 milliamperes for mobile operation via a car's power system. Other rear-panel features are a phone plug for an external speaker, an RCA phono jack for audio line-level output, an SO-239 jack for 50-ohm antennas, and an RCA phono jack for high-impedance antennas. A 20-dB attenuator for the 50-ohm antenna input can be called on with a rear-panel slide switch mounted on the rear panel.

For our tests, we found that the included 2-foot telescoping whip antenna—which mounts to the receiver through a hole in the top panel—was sufficient for most general listening to international shortwave broadcasts. And that's exactly what the DX-394 is designed for, at least if its front-panel features can be taken as any indication.

The front-panel controls are separated into three main groupings. The POWER button is located in the top right corner, in a grouping with nine other buttons for dimming the display, setting the clock and timers, changing the tuner step size, storing frequencies in memory, turning the noise blanker on, and locking (disabling) the tuning knob and other buttons so they can't be accidentally operated.

Below that grouping is a 20-button tuning keypad, right next to the large, central tuning knob.

To the left of the tuning knob are four other rotary controls and switches for setting the volume, the RF gain, receiving mode (AM, LSB, USB, CW1, CW2), and

fine tuning.

The top left of the receiver holds the lighted LCD readout. Its main function is as a tuning display, but it also indicates a host of other settings, signal strength (by a LCD S meter), clock, and more.

Tuning can be accomplished in several ways. The BAND button switches between long-wave (150–510 kHz), medium-wave (510–1730 kHz) and shortwave (1.73–30 MHz) coverage. When tuning shortwave frequencies, the METER button makes it easy to select one of the international shortwave bands. When pressed, the band indicator flashes on the display. While it is flashing, a press of one of the keys on the numeric pad will bring you immediately to either the 120-, 90-, 75-, 60-, 49-, 41-, 31-, 25-, 21-, 19-, 16-, 13-, or 11-meter band. (The band indicators are on the front panel above the numeric keys). When this method is used to tune to a band, the main rotary tuning control can be used to tune only throughout the band—when you tune above the top band edge, the receiver beeps, and the tuner wraps around to the bottom edge. It is also possible to set any two frequencies in memory to limit your tuning range. When either limit is passed, the tuning frequency wraps around to the other limit.

The FREQUENCY button allows you to directly enter a frequency of your choice, say, 11,730 kHz. If you tune that way, and then use the rotary tuning control, you can tune without regard to band edges. So when you get to the top of the 25-meter band, you can just keep on going to try to find out-of-band broadcasters.

To make that tuning method faster, the tuning control is speed sensitive—the faster you turn it, the larger the tuning steps. The tuning step can also be chosen manually with the two STEP buttons. Possible step sizes are 0.1, 1, 5, and 10 kHz. A FINE TUNE rotary control always tunes in 0.1-kHz steps.

The receiver recognizes the ham (amateur-radio) bands, also—at least in regard to tuning steps. If you set the tuning step to, for example, 0.1 kHz inside of a ham band, the tuning step will automatically be set to 0.1 within each and every one of the ham bands.

The tuning step in the medium-wave (AM broadcast) band is 10 kHz by default. It can be set to 9 kHz for use outside North America.

The DX-394 also features 160 memories—in 16 banks of 10 memories apiece—to facilitate easy tuning. There is also a search tuning capability, but no memory scanning.

The front panel of the DX-394 is uncluttered and easy to use, thanks to controls that are grouped logically for operation.

The front-panel LCD provides a very readable display of receiver functions, and includes a liquid-crystal S meter.

Available modes are AM, single sideband (lower sideband, or LSB, and upper sideband, or USB), and CW (continuous wave) for Morse code reception. Reception filters are not user-selectable, but are fixed to the mode. Two CW modes or filters are available.

The 160 memories retain only the frequency, not the mode. The memories are segmented into 16 ranges. Ten frequencies can be stored in each of the 13 broadcast bands (120–11 meters), plus 10 each in the long-wave, medium-wave, and shortwave bands. Storing memories is quick and easy—just press the METER button and the selected band. Then just dial the frequency, press the program (PGM) button, a memory-channel button, and the enter (ENT) key.

Recalling a memory is a simple matter of pressing the BAND (toggling to LW, MW or SW) or METER button, then a button 1 through 0 (corresponding to memories 1 through 10).

Five timers are available, as is a 30- or 60-minute sleep timer. Unfortunately, there is no way to control an external tape recorder. It seems a little strange to include five timers—a healthy number that would provide a convenient way to record multiple programs—without including a control output. We suppose that a voice-operated (VOX) recorder could be used with the timer outputs, but that wouldn't be our preferred method.

The DX-394 is a very sensitive receiver and performs well when compared to other receivers in its price class—and even some more expensive ones. In strong signal areas—such as our location in metropolitan New York, a long wire antenna seemed to be a little bit of overkill. Although the receiver wasn't prone to overload, we noticed more adjacent-channel interference with strong shortwave signals when a long-wire antenna was used, unless we switched the rear-panel attenuator on.

While the DX-394 is a fine shortwave receiver, it isn't cut out for other radio hobby uses. For example, it has no digital RTTY (radio teletype) or fax modes. Of course, external decoders can still be used to receive and decode RTTY and fax, but the filter bandwidths are, in most cases, too wide for good results.

The DX-394 also lacks features that can be found on more expensive receivers: passband tuning, AM synchronous modes, tone control, bandwidth and AGC (automatic gain control) selections, and computer control.

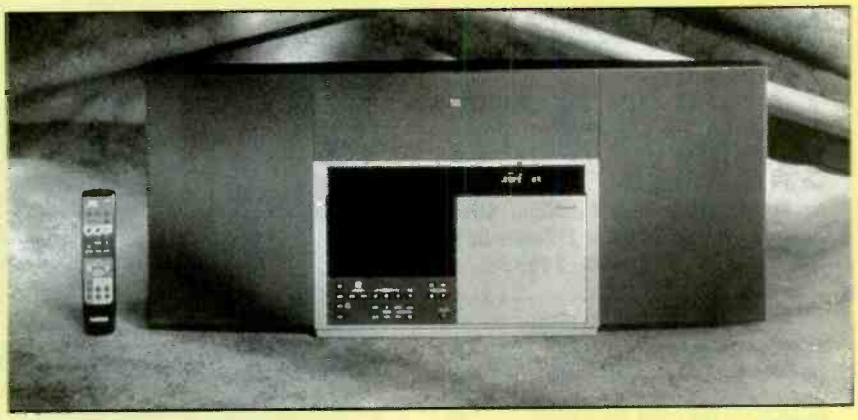
RadioShack's DX-394 provides good performance and is a reasonably good value for the shortwave listener who is looking for an entry-level tabletop receiver. However, experienced listeners and DXers who are continually searching for the difficult, hard-to-hear stations won't be happy with it. Radio amateurs, and those seeking utility signals, will also be disappointed with the unit.

No receiver can be everything to everyone, of course, and it's probably good that the DX-394 doesn't try to be. The features that we'd like to see in a tabletop receiver would probably boost the cost of the DX-394 out of the range of many of the entry-level listeners who the radio is designed to attract. ■

Gizmo is published by Gernsback Publications, Inc., 500 Bi-County Blvd., Farmingdale, NY 11735. Senior Writers: Christopher Scott and Teri Scaduto.

Just Hangin' Around

GOLDSTAR MODEL F-191 WALL-HANGING AUDIO SYSTEM. From LG Electronics U.S.A., Inc., 1000 Sylvan Avenue, Englewood Cliffs, NJ 07632; Tel. 201-816-2000; Manufacturers suggested retail price: $599.



For the past couple of decades, home audio systems have been shrinking. Gone are the '70s, when we all had at least one wall devoted to components, tower speakers, and milk crates full of albums. Today—unless you're an avowed audiophile—it's quite unlikely that your stereo is actually the focal point of your living room.

In these days of microelectronics, mini systems have become increasingly popular. They're small, yet many of them sound big—and they take up less shelf space than your old LP collection once did.

But what do you do when all your shelf space is spoken for? After all, your CD collection demands some space, as do your books and magazines, videotapes, software, and perhaps some photographs or knick-knacks. What if you're in a dormitory room or studio apartment where you have precious little shelf space to begin with.

Perhaps your minimalist decorating scheme simply doesn't call for any sort of shelving. What about music then? You could put the stereo in another room and install remote in-wall speakers in the living room. A simpler solution would be to mount the *Goldstar Model F-191 Wall-Hanging Audio System* on any wall in the room.

The F-191 comes with a bracket and all of the necessary hardware for affixing the stereo system to any wall in your home. Of course, if space allows, the audio system can be more traditionally placed on a shelf or table.

The F-191's crisp, modern European styling is at home in any contemporary setting. Its look is unique. The one-piece unit measures just under 31 inches wide, 13 inches high, and less than 5 inches deep. The AM/FM radio, CD player, and cassette deck are located in the lower center. They are flanked by two-way speakers covered in the user's choice of grille cloths—black ("dark gray"), bright red, and fashionable hunter green panels are included. Hidden behind a matching grille cloth, the system's electronics are housed above the radio, CD player, and cassette deck, forming a visual "bridge" between the speakers.

The control panel has a clean, spare look. The silver-toned cover of the CD compartment accounts for half of it; the black cassette deck covers another third. A slim panel that stretches above those is home to, from left to right, the standby indicator, the function display, the remote sensor, and a smaller display that indicates tape or cassette mode. All controls are located in the bottom right sector of the front panel.

In all, there are 23 buttons squeezed into a 2⅓ × 6¼-inch control panel. We could discern no particular logic to their placement. They weren't grouped by component; frequently used buttons were placed along side those that we rarely touched; and the PLAY, PAUSE, STOP, FAST-FORWARD, and REWIND buttons were scattered among two rows.

The controls were particularly difficult to use in low-light situations. Although the power button is located somewhat apart from the others, in the lower left corner, when we tried to use the system in a darkened room before we were familiar with it, we kept trying to use the lighted standby indicator to turn it on. We also kept hitting the MEMORY SCAN buttons instead of the TUNE UP/DOWN buttons. When we wanted to play a CD, we had to turn on the lights.

Fortunately, the remote control is quite a bit better designed. The round POWER button sits alone above the others, which are separated into distinct groupings for selecting the function and controlling the tuner, CD player, and tape deck. Oval-shaped VOLUME CONTROL, MUTE, and EQ buttons form another set.

The remote control also offers automatic function selection. If you're listening to a CD, for instance, and want to switch quickly to the radio to catch the weather report, you can just hit one of the radio memory preset keys, and the system goes into tuner mode. The same automatic switching principle applies when you press either of the cassette PLAYBACK buttons, or the PLAY/PAUSE or RANDOM CD-control buttons.

Up to 30 station presets can be stored into the AM/FM tuner's memory. AM and FM stations are not separated into different banks.

FM reception was good. Even with the supplied "T" pole antenna, we were able to capture all of our favorites—even the out-of-area low-power college and community stations. Weak FM signals can be improved by pressing the STEREO/RIF (radio interference filter) button, which simply switches the receiver to mono mode.

AM reception was quite a bit better than what we usually find in consumer-grade receivers. We applaud Goldstar for taking the broadcast band seriously. We were using the F-191 during the last few weeks of the 1996 baseball season. Our favorites, the Yankees, were just a few games ahead of the Orioles in the race for the Eastern Division title, and every game counted. ESPN wasn't carrying the White Sox-Orioles game. Rather than watch the sports ticker on CNN Headline News or wait for the half-hourly updates on an all-news station, we tuned in WMVP from Chicago, and listened to the whole game. A couple of nights later, we listened to a game being played in Detroit. Talk about hearing "away" games!

Impressed by the ease with which we tuned in out-of-town sports, we tried some informal DXing—something that normally frustrates us with most consumer gear. However, we picked up AM stations from as far away as Des Moines, Iowa, using only the loop antenna provided with the F-191. You should be pleased with how easily you'll pick up "exotic catches" from the airwaves.

Moving from the tuner to the CD player is just a matter of pressing the CD OPEN/CLOSE button, which causes the CD compartment lid to swing up like a garage door. Discs are placed on a spindle, label-side out. The door shuts automatically when you press PLAY, or you can close it deliberately using the CD OPEN/CLOSE button.

CD play options include repeat playback of a track, random playback of all

(Continued on page 28)

Street Smarts

MODEL RDL/712SW SUPERWIDE 4 RADAR/LASER COMPLETE DETECTION SYSTEM WITH DIGITAL DATA DISPLAY. From Cobra Electronics Corporation, 6500 West Cortland Street, Chicago, IL 60635; Tel. 312-889-8870; Fax: 312-794-1930. Price: $199.95.

"Never has there been a product with more potential to save lives and avoid accidents with less cost and trouble," says Bill Lewis, Chief of Police of Cape Charles, Virginia. "[It's] the best highway safety improvement I've seen in years."

Care to guess what product he thinks so highly of? A louder siren? Brighter warning lights? A much more powerful radar gun?

If you went with the radar gun, you'd be close. Chief Lewis was, in fact, talking about a "smart" radar detection system called *Safety Alert*, that uses radar detectors to warn drivers of road hazards. Developed by *Cobra Electronics Corporation*, the Safety Alert system uses special transmitters, mounted in police cars and emergency vehicles, to warn drivers of potentially dangerous fast-moving vehicles or stationary problems such as construction sites. Smart radar detectors use LEDs, LCD readouts, and audio signals to alert drivers to the type of hazard to expect.

Chief Lewis was speaking from personal experience. A few hours before dawn one rainy summer morning, he responded to a report of an accident. Due to highway flooding and poor visibility, two cars had skidded off the highway and were blocking the passing lane. Lewis positioned his cruiser, lights flashing, in front of the cars, and lit flares to warn on-coming traffic. Despite those precautions, several passing cars came close to hitting the police car. After about a half hour, a tractor trailer approached, creeping along at about 5 miles per hour. When the driver reached Chief Lewis, he told the officer that he was driving so cautiously because his radar detector had warned him of trouble ahead, and he offered his help at the accident site. Lewis had the truck driver block traffic until the accident could be cleared safely from the road.

Chief Lewis could have given that truck driver a ticket—radar detectors are illegal in Virginia. That doesn't stop drivers traveling through the state—and some Virginians, from using them, however. In the interest of public safety, Lewis felt that the Safety Alert system deserved a test. And, from his point of view, it passed with flying colors.

Lewis didn't even have to turn on the transmitter on that stormy night. The Safety Alert device was connected to his lightbar; when the lights were flashing, the transmitter powered up automatically, and made contact with the trucker's radar detector. "By alerting just one driver, it made my job safer and it helped the people behind the truck avoid accidents ... maybe even saved some lives. In my opinion, the risk of additional accidents on that rainy morning was great, and the signal transmitter reduced that risk."

HOW SAFETY ALERT WORKS

The Safety Alert is a two-part system, consisting of a transmitter and a receiver. Developed by Cobra, and built by Alpha Industries, Inc. (a commercial wireless-semiconductor, integrated-circuit, and ceramic-component manufacturer in radio, microwave, and millimeter-wave frequencies), the transmitter is intended primarily for installation in police cars and emergency vehicles. Connected to the vehicle's lightbar, it begins transmitting as soon as the lights are turned on. The transmitter stops sending its signal when the emergency lights are turned off. It can also be used in public-utility and road-construction vehicles—or even on stationary construction barriers—all of which usually rely on their flashing yellow lights to warn drivers of construction sites.

The FCC-approved Safety Alert transmitter sends out K-band signals that can be picked up by any radar detector within a ¾-mile range. If the signal is intercepted by one of the approximately 20,000,000 radar detectors currently in use, the detector will respond as it would to any K-band radar gun, in most instances, by sounding a warning beep and flashing an LED. The driver won't know whatever he's about to encounter a high-speed police chase, an ambulance making haste toward the hospital, or road construction around the next bend. But, to avoid getting a speeding ticket, he will most likely respond by moving out of the left-hand lane and slowing to within a few miles of the speed limit. Driving slower, and being on the lookout for a speed trap, gives him a double advantage. First, driving at a slower speed gives him a longer response time when the hazard comes into his field of vision. Second, he is more alert to what is happening around him. As an added bonus, other nearby drivers are likely to slow down when they see one car doing so, figuring that the driver might have a radar detector and be aware of a police car up ahead.

If the radar detector on the receiving end is Cobra's *Model RDL-712SW*, however, the driver will know in advance just what to expect. The radar detector is equipped with an LCD readout on which two different types of Safety Alert messages might be displayed. When the police car or emergency vehicle is hurtling down the road, it sends an "Emergency Vehicle" warning. When it reaches its destination—the accident that Chief Lewis responded to, for instance—it transmits a "Road Hazard" message. A third signal will be used to warn drivers of approaching trains; the RDL-712SW is already programmed for the train signal.

Of course, the radar detector can warn drivers of road hazards only when Safety Alert signals are being transmitted. As we go to press, Safety Alert transmitters are in use in various locales in more than 30 states. That's not to say that entire states,

or even cities, are covered. For instance, there are 50 transmitters currently in use in Portland, Oregon; Indianapolis, Indiana; and Columbus, Ohio. That's not enough to blanket the metropolitan areas with Safety Alert signals; local police departments and emergency agencies will determine the areas most in need of such a warning system.

USING THE RDL-712SW

Why buy a Safety Alert radar detector if the system isn't in use in your area? First, more and more localities are adopting the system all the time. Second, the RDL-712SW offers everything else you'd ever want in a radar detector. It detects all speed-monitoring devices now being used—X, K, Ka Superwide, and Laser guns—and adds a few features not found on the standard radar detector. The alpha-numeric display that shows Safety Alert messages also keeps you posted as to what type of monitoring device is being used, and provides other status reports. And special circuitry reduces false alarms and reduces the chance of the unit being located by a radar-detector detector.

Let's take it for a test drive.

The radar detector can be mounted on the windshield using the included suction-cup bracket. A bracket-release button makes it easy to remove the detector if you want to use it in another vehicle, or drive through a state where detectors are illegal. For dashboard mounting, self-stick Velcro-type material is also included. It's important to make sure that the lens located on the rear panel has a clear "view" of the road to sense laser guns.

The RDL-712SW is a bit larger than most, but at approximately 3 × 5 × 1 inches, it's still quite compact. Its most distinguishing feature is its 2- × ½-inch, two-line × 16-character, backlit display, which dominates the front panel. Next to it are MUTE and DIM buttons. Along the left side are jacks for a cigarette-lighter plug and an external speaker, the POWER/VOLUME thumb-wheel control, and HIGHWAY/CITY slide switch.

As soon as the RDL-712-SW is powered up, it performs a "power-up self test," or POST, of its internal laser optics and signal-scanning computer. As part of the POST, a test pattern sequence—laser, K-band, Ka-band, and X-band, is displayed as audio tones sound, to let the user know which tones are associated with each band. After a successful test, the detector goes into standby mode, and the LCD is blank unless you have selected city mode, in which case it reads "city."

When a signal is detected, the display will let you know if it is K-band, X-band, Ka-band, or Laser. If two sources on two different bands are detected simultaneously, the one with the highest priority will be displayed. The order of priority is: Laser, Ka-band, K-band, and X-band. Accompanying the text warning is a tone that gradually increases in volume.

The MUTE button can be used to silence the detector as soon as the warning tones start. "Mute" will appear on the display. The audio resets four seconds after the signal disappears, so that it is ready to warn you the next time a signal is detected. By pressing and holding the MUTE button for two seconds, automute mode is activated, and the volume of the alert is automatically reduced to its minimal level after four seconds. "Automute" appears on the display. To disable the feature, the MUTE button is pressed and held again.

The RDL-712SW also provides "Instant-on" warnings. When a police officer isn't just monitoring the traffic flow, but turns on his radar gun when he spots your car, the detector sounds a full-strength audible warning, rather than the gradual build-up of sound. It lets you know that immediate action is required.

Finally, the radar detector provides Safety Alert warnings on its LCD: "Emergency Vehicle" or "Road Hazard" is displayed, depending on the situation.

Radar detector false alerts can be extremely annoying when you're driving. To filter them out, the RDL-712SW uses, according to Cobra, "the same advanced technology that the military uses to distinguish enemy aircraft from friendly aircraft. The Digital Signal Processing circuitry continuously samples radar signals 50,000 times each second, looking for only true radar signals."

Two (out of three) types of false alerts are filtered out by special circuitry. When the RDL-712SW picks up a signal produced by either an out-of-band signal or a "noisy" radar detector, the LCD displays the following message: "Rejecting false signal."

First, "lockout" circuitry rejects out-of-band signals—harmonics of signals that are broadcast at frequencies outside the radar bands, yet create signals within the X, K, or Ka bandwidth. Second, Cobra's Stealth V-C-O technology rejects false alerts caused by "dirty" radar detectors. Every radar detector—like any radio receiver—has an internal oscillator, which is used for detection. It also leaks out of the detector, in effect, turning the radar detector into a radar transmitter. That's why the police's VG2 guns are able to detect radar detectors.

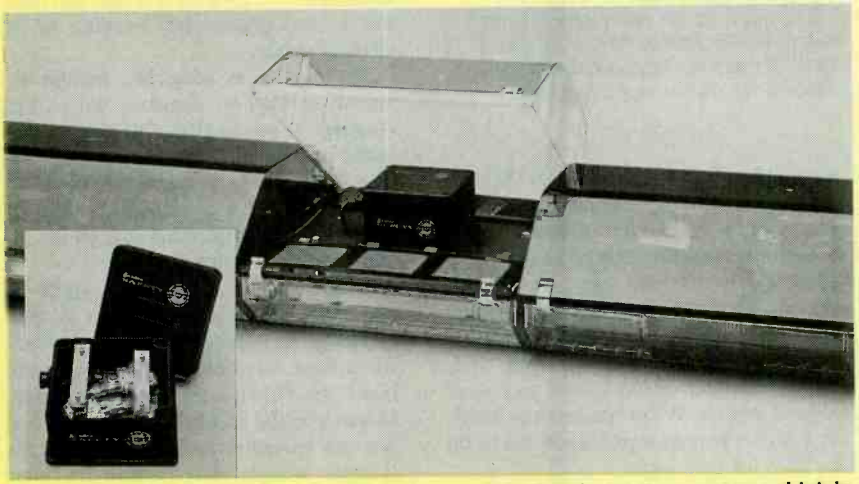
Stealth V-C-O technology not only reduces the number of false alerts caused by other drivers' radar detectors. It also reduces by 80%–90% the chance of your RDL-712SW being detected by a VG2 gun, commonly called a radar-detector detector.

The radar detector cannot reliably discern and reject in-band signals, however. In-band signals use the same frequency band (the X band) as some police radar guns. They are most often transmitted by the proximity detectors commonly used in shopping malls for automatic door openers, as well as some security systems and vehicle-avoidance systems.

When you're driving in heavily populated and commercial areas, in-band false alarms happen quite frequently. Switching the detector to the city mode helps a bit by reducing its X-band sensitivity. The sensitivity of the other three bands is not affected at all.

The RDL-712SW's LCD readout can also help you distinguish false alerts from the real thing. While the display's top line tells you what type of signal is being detected and whether the mute or automute modes are in effect, the bottom line depicts additional information, gleaned by the radar detector's Hypersweep Frequency Scanner, or HFS.

A "bar-graph" symbol appears in a different place on the display's bottom line,



The Safety Alert Transmitter (inset) is shown installed in an emergency vehicle's lightbar.

THE SAFETY WARNING SYSTEM

Cobra's Safety Alert was the first "intelligent" radar system to be approved by the FCC and to hit the marketplace. But it isn't the only one available today.

In fact, Safety Alert faces some stiff competition from the Safety Warning System, or SWS. Although it is still awaiting final FCC approval as we go to press, it has the backing of some heavy hitters. Safety Warning System supporters include several radar-detector manufacturers (Bel-Tronics Ltd., Sanyo Tecnica USA Inc., Uniden America Corp., and Whistler Corp.) and the Radio Association Defending Airwave Rights, or RADAR, a group representing the interests of radar-detector owners and manufacturers. In addition, the U.S. government is funding research by the Georgia Tech Research Institute (GTRI), which developed the SWS transmitter.

Like the Safety Alert system, SWS transmitters send preprogrammed warning messages to specially equipped radar detectors, and send K-band alert signals to standard detectors. The Safety Warning System, however, sends more detailed messages than the three transmitted by Safety Alert.

There are 64 standard, preprogrammed SWS messages, in five categories. Fast/Slow-Moving Vehicles includes such messages "police in pursuit" and "oversize vehicle in transit." Under Travel Information/Convenience, drivers are told of upcoming rest areas, traffic jams, tolls, and inspection stations. Weather-Related Hazards include blowing dust or sand, high winds, heavy fog, and snow white out. Highway Construction or Maintenance advise of upcoming work zones, lane closings, and detours. Besides warning drivers of accidents, train crossings, and dangerous intersections, Highway Hazard Zone Advisories include everything from "deer/moose crossing" to "drawbridge up."

Two SWS messages can be combined to further clarify the situation. For instance, "pay toll ahead" might be followed by "expect 20 minute delay."

The Model 1490 radar detector from Whistler is compatible with the Safety Warning System.

A transmitter left unattended, at a construction site, for example, can have its message changed remotely. The programmer could dial in a different warning during the hours when laborers were working at the site than at night, when only their equipment was at the scene. By adding weather sensors, transmitters could be programmed to send signals only when conditions such as heavy fog or high winds were detected. A transmitter that is equipped with speed-radar circuitry could send a message to any vehicle traveling above a pre-determined speed, and warn drivers that they are traveling too fast. That might be especially effective if another option is in place: a voice synthesizer to announce the message.

The Safety Warning System proponents are already actively demonstrating the system not to individual municipal police stations and emergency services, but directly to the people in charge at the state and federal levels. They have met with the Pennsylvania Turnpike Commission; The New York Thruway Commission; the Department of Transportation of Ohio, Massachusetts, Illinois, and Oklahoma; the Federal Highway Administration; and the National Highway Traffic Safety Administration. And two models of "smart" detectors, equipped with the Safety Warning System, are currently available under the Whistler brand.

It remains to be seen which smart radar system catches on in a big way. If either of them do, however, the biggest winners will be America's motorists.

depending on which band (X, K, photo radar Ka or Stalker KA) is being used by the police. The symbol changes according to the strength of the signal being detected. The stronger the signals, the higher the peak; the weaker the signals, the lower the peak. Those extra visual clues can help you determine if there really is a police gun triggering the alert. Who knows? The feature could save you some wear and tear on your brakes!

Cobra gives the following example: When you drive to and from work each day, X-band signals are always picked up near a local shopping center. After a while, you recognize the pattern (the bargraph appears to the left of center on the bottom line) and the strength of the signal generated by the non-speed-monitoring devices. One day, the bar graph symbol looks different—its peak is much higher. The probable cause? The police are "hiding" a speed trap among known sources of X-band signals. When you become familiar with the normal signals, you can be on the alert for such tricks.

Now, that's what we'd call a smart radar detector. ■

JUST HANGIN' AROUND

(Continued from page 25)

songs without repeating the same track, repeat play of the entire disc in random mode, and programmed play. Up to 20 CD tracks can be programmed in any order.

The F-191 also provides CD synchro recording to tape, allowing you to record automatically the entire disc, or programmed selections, to tape. To make those dubs sound better, the auto-reverse cassette deck is equipped with Dolby B-type noise reduction.

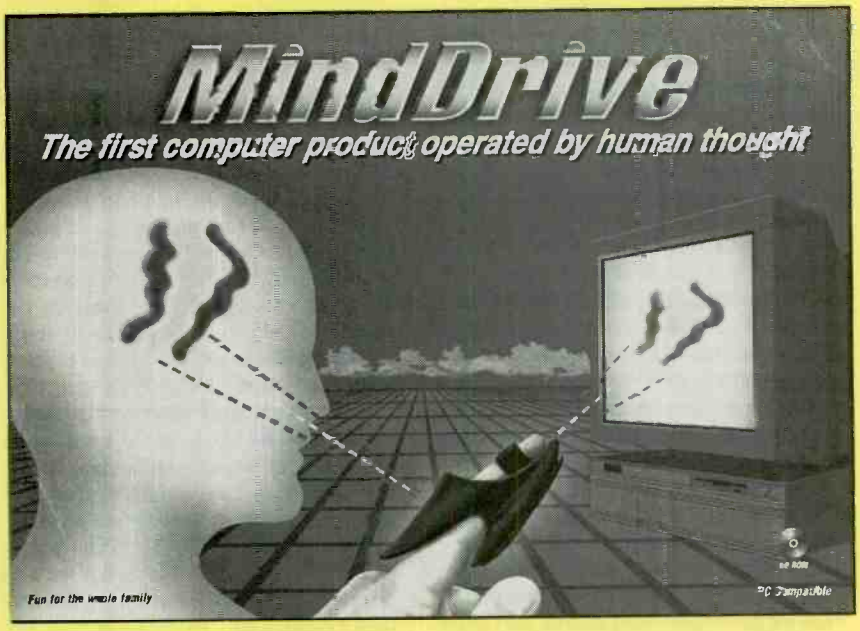
We tried programming a CD before using synchro recording to tape selected tracks. The process was simple—except that the disc had no track times printed on it or the liner notes (an unfortunate, but not uncommon, occurrence). While the F-191 ordinarily displays the remaining time on a disc, when in program mode, it shows the remaining track time. It's possible to program a disc, advance to each selected track in turn, and jot down on paper the remaining time before the song starts. Then you can add up all the times, determine how many songs will fit on each side of the tape, and, if necessary, rearrange the order of the programmed tracks—not the most convenient method of recording. If you don't mind a bit of blank time at the end of a tape, or a song ending in the middle (the F-191 will automatically record the song in its entirety on the other side when that happens), you can just wing it.

The Wall-Hanging System offers a 20-watt, multi-driving, four-channel amplifier. A press of the UBB ("Ultra Bass Booster") button maximizes the bass. A built-in equalizer provides four preset listening modes; flat, pop, rock, and classic. Repeatedly pressing the EQ button scrolls through the four equalizer options. The manual suggests that you choose flat to hear the recording as is, pop for less bass and less treble, rock for less bass and more treble, and classic for listening to orchestral music.

The manual is adequate, though obviously written by someone whose first language is not English ("If you wish to install on a wooden wall, unscrew only on it.") Perhaps it is fortunate that the F-191 doesn't offer any potentially confusing, super-advanced functions that would require extensive written backup.

It does, however, offer just about all you'd need from a basic stereo system, including an input jack for an auxiliary component. Its sleek, unusual design will make the F-191 a conversation piece. Mount it on the wall behind your sofa, and you can leisurely reach up and press the controls without even sitting up. How much more convenient than that can you get? ■

Mind Over Matter



MINDDRIVE THOUGHT-DRIVEN SOFTWARE. From The Other 90% Technologies, Inc., 2505 Kerner Blvd., San Rafael, CA 94901; Tel. 415-460-1010; Fax: 415-460-1919; e-mail: info@other90.com. Price: Hardware, $139; Application titles, $24.95 to $39.95.

You're playing a simulated skiing game on your PC. As you maneuver your way down a tricky slalom course, you make your turns not with your joystick or mouse—but simply by *thinking* which way you want to go. Science fiction, right? Not anymore, thanks to the *MindDrive from The Other 90%*.

Actually, the concept of manipulating inanimate objects with your thoughts or emotions is nothing new. Beside those countless science fiction tales, remember mood rings? On the more practical side, how about lie detectors?

The concept behind polygraph tests is that telling a lie is stressful, and stress stimulates certain detectable biological changes. A polygraph works by charting such parameters as a subject's normal heart and respiration rates during a series of innocuous, non-threatening questions. Then, when the tougher questions are asked, an answer that is accompanied by any anomalies in the established patterns is considered to be a false statement.

Lie-detecting is viewed as an inexact science. That's why polygraph results are not accepted as evidence in a court of law.

That our thoughts and emotions produce measurable bio-electric signals is, however, an indisputable fact. Different bio-electric patterns are generated by various mental activities, such as analyzing, remembering, and relaxing. Creative brain functions cause different physical reactions than do analytic functions; positive and negative thoughts also register differently.

Traditional bio-feedback techniques measure the conductivity and electrical activity of the skin in an attempt to determine what is going on in a subject's brain. Biofeedback measurements are known as galvanic skin response (GSR) and electrodermal reflex (EDR).

Those techniques work, but two problems keep them from being put to practical use, at least in terms of translating thoughts into signals that can be used to control devices or computers. First, there is a delay of 2½–3½ seconds between the time a thought occurs and the traditional measurement of the skin's reaction. Second, the human body does a good job of keeping physiological parameters in balance. When thoughts or emotions trigger changes in heart rate, blood pulse volume, and temperature, the autonomic nervous system leaps into action, trying to pull them back to normal.

According to The Other 90%, its patented MindDrive technology overcomes those obstacles. It provides almost instantaneous measurements. And it is able to decipher the difference between physiological signal generated by a volitional thought (transmitted through the central nervous system) and a physiological signal that has been changed by the autonomic nervous system. The MindDrive supposedly filters out those changes triggered by the autonomic nervous system, leaving only those signals generated by cognitive/volitional thoughts.

The company says that the MindDrive sensor measures not just heart, temperature, and blood pressure, but also something called composite neuro activity, or CNA—a complex of intricate electrical signals. The MindDrive automatically and continuously analyzes five CNA signal components: Amplitude (the output and strength of signals); velocity (the speed at which the signals change); attenuation (the size of the changes); the "delta" or asymmetry of the CNA signals as compared to each other; and a combination of the phasic (rate of change) and tonic (absolute measurement) signals.

By studying the CNA signals in greater detail than has been possible previously, and combining the translated CNA signals with information from the heart and other biological indicators, the MindDrive can chart a variety of mental and emotional states. For example, anger causes the heart beat and blood pulse volume to rise, reduces temperature, and creates a distinct CNA pattern. The MindDrive uses its catalog of charted states and a proprietary artificial-intelligence program not only to "read" a subject's thoughts and emotions, but also to help the subject create and replicate a variety of desired mental skills and emotional states.

It all sounds good on paper, doesn't it? But does it work? We were highly skeptical, even after a demonstration by a representative of The Other 90%. He asked us to jot down a number from one to ten on a piece of paper. While wearing the MindDrive sensor, we answered a series of questions he posed: "Is the number one? Two? Three? Four?" By reading the MindDrive's interpretations of our bio-electric signals, he properly guessed the right number each time.

Okay, that was sort of neat. But we remained dubious about how the device would function as a software interface, and even more so of the company's claims that "the MindDrive is able to help users develop and replicate optimal learning, thinking, and emotional skills and states." But, hey, we're always willing to give a new Gizmo a try.

The MindDrive consists of a small sensor sleeve that fits onto any of the user's fingers, and an interface that plugs into a PC-compatible computer. Minimum system requirements are a 486 CPU, DOS 5.0, a double-speed CD-ROM drive, one available 9-pin serial port, and a SoundBlaster or compatible sound card.

The manual suggests wearing the sensor on any of the three middle fingers of your left hand (unless you're a southpaw), leaving your right hand free to use a mouse or arrow keys, if necessary. A Velcro strap is used to prevent the MindDrive from slipping off, and to keep the center of your fingertip resting lightly on the sensor. It

takes just a few seconds for the sensor to "read" you, and then you're ready to go.

We started with *MindSkier*, a CD-ROM game that allows you to shuss down the slopes using your mind to make you control your skis. You have a choice of four different courses, slalom, grand slalom, downhill, and a combination that includes one run on each of the courses. There are beginner and advanced levels of play.

In MindSkier as well as the other beta-version MindDrive games we sampled, the overall quality is adequate, but certainly nothing to write home about. Installation is pokey; graphics and sound are basic. The games work only with the MindDrive interface—you can't fall back on your trusty joystick. But, we reasoned, the technology itself is so new and exciting, why quibble over the small stuff?

We strapped on our sensor (it was *much* easier than gearing up for the real thing), and hit the slopes—and also hit the course markers, every patch of ice, the side of a ski jump, exposed rocks, and an innocent group of spectators at the bottom of the hill. No matter how hard we concentrated, the game proceeded as if we weren't there. In fact, when we closed our eyes, said a prayer, and just went for it (sort of like our first real-life ski experience) we actually logged one of our all-time high scores.

Switching to beginner mode, we gave it another shot. Our performance improved, but not significantly. After a few hours of skiing every run available, changing our speed, and adjusting the sensitivity level, we were left wondering why the ski patrol hadn't arrived to pick up the pieces.

Next, we decided to go with a slower, safer sport—*MindBowling*. It wasn't quite as exciting as the downhill action, but we did manage to consistently improve our game with practice. Not only did we steadily raise our score (from 72 on our first try to 205 after an hour's play), but we also made sure that our imaginary opponent didn't break a 10.

Unfortunately, it wasn't our minds that were being honed with practice. We learned, quite accidentally, that applying pressure to the sensor made the ball move to the left; reducing pressure moved it to the right. As directed, we'd strapped the sensor onto a finger on our left hand. It was just natural to lean right—and reduce pressure—when we wanted the ball to move that way, and lean left—and press down—when we wanted it to go left.

When we purposely put on the pressure, the results were pretty impressive. A heavy hand put our opponent's ball in the left gutter on almost every throw. And a bit of fingertip maneuvering gave us a strike or a spare in almost every frame. But we were using our hands to do it, not our minds.

Perhaps, we postulated, every game depends on the same (presumably) inadvertent pressure on the hand—like using a Ouija board and unwittingly moving the pointer to the letters that spell the answer you want to hear.

We decided to give skiing another try, to see if the technique could improve our times. It didn't.

When we practiced at the top of the course, the game seemed to respond to hand pressure in much the same way that MindBowling did. Once we started moving downhill, however, the results became exaggerated, sending us careening from one edge of the course to the next, but never where we wanted to go. Our scores actually got worse!

We were tempted to go back to MindBowling to try for a perfect game (and a perfect 0 score for our imaginary opponent). Instead, we moved on to ***FIB***, a lie-detecting game with several variations.

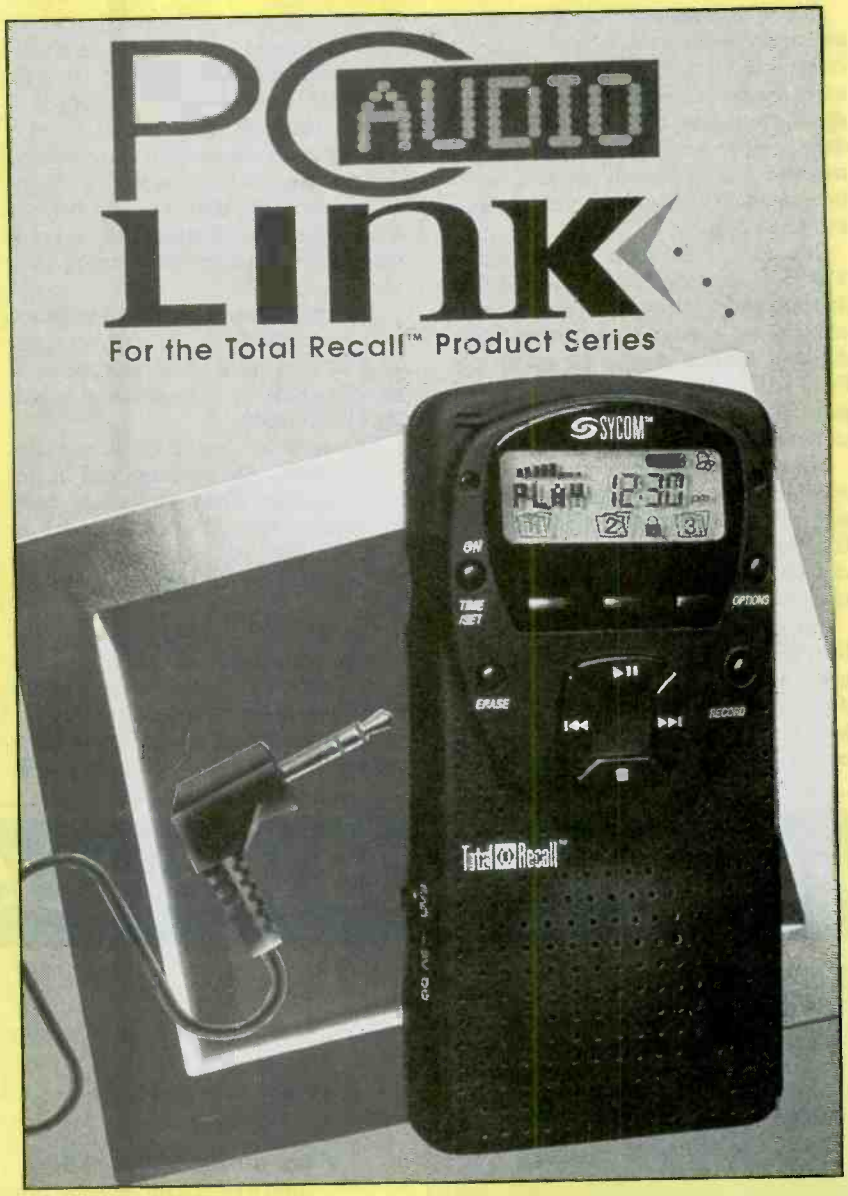
FIB requires two players, the Examiner and the Responder. The Examiner asks a series of questions, called the "Comparative Question Technique." As in a standard polygraph test, the Responder's answers are judged true or false based on bio-electric readings. In this case, when the Responder tells a fib, the reading should shoot into the "red" zone.

Four FIB games are provided. "MindReader" is a guessing game in which the Responder selects one of five items shown on screen. The examiner must then guess the secret item. In "Quiz Me," one question is repeated five times, with a fill-in-the-blank difference—for instance, "Your favorite pizza topping is _____." The Examiner asks the question five times, filling in "pepperoni," "anchovies," "peppers," "sausage," and "onions." The Responder answers yes or no to each; again, the Examiner must determine which responses are true. In "Cross Examination," the Examiner gets to ask ten questions to determine what item the Responder is thinking of, knowing beforehand the item's general category. Finally, there's "Free Form Fib," in which

(Continued on page 32)

Now Hear This

TOTAL RECALL DIGITAL VOICE RECORDER. From Sycom Technologies, P.O. Box 2600, Bala Cynwyd, PA 19004; Tel. 610-660-5770. Price: $199.



We love electronic gizmos—obviously. We wouldn't be writing this if we didn't have a special place in our hearts for them. But some electronic products—we hate to admit—have always struck us as being, well, a little silly.

Electronic memo recorders were one of those devices that we didn't quite get. We know that some people find them to be lifesavers, but most people—us included—could probably get by with just a pen and scrap of paper, or even tying a string around a finger as a reminder.

Recently, however, we had the opportunity to try out the Total Recall digital recorder from Sycom Technologies, and it changed our minds.

Everyone, of course, is different, and everyone has different needs. As writers and reporters, we can't work in a vacuum. We need to talk to a lot of people, and to remember what they say.

One of our main tools has been a small microcassette recorder, which travels with us in our briefcase as we head out to press conferences, product announcements, and interviews. It's been invaluable. We like to be accurate, but we can't write fast enough—or neatly enough—to quote speakers verbatim. The recorder lets us go back over a discussion at our leisure, and transcribe accurately.

Microcassette recorders aren't perfect. (Show us any product and we'll find *something* to complain about!) We seem to end up with lots of tiny cassettes strewn around the office with only cryptic notes indicating what they are. Just trying to find a ten-minute conversation that we had last week with a product manager for a new camcorder line could take three times longer than the actual conversation!

Sycom's Total Recall digital voice recorder isn't perfect, either. But it has proven itself to be far more useful than we expected it to be. We didn't use it to record such inane messages as "Don't forget to pick up milk on the way home." Instead, we used it as we would normally use our microcassette recorder, to record conversations and speeches.

The Total Recall is small, with its face measuring just 2¼ × 4½ inches. The unit is, for the most part, about ¾-inch thick, but it bulges to about an inch at the battery compartment.

At the top of the unit is a small but readable LCD. Below that are three buttons that select message "folders." Eight other buttons round out the unit's front-panel controls. Four buttons, arranged in a square, are used to play and pause message replay, and to move back and forth between messages. Four other buttons are used to start recording, erase messages, select options, and turn the power on.

Recording a short message is simple: Just press and hold the RECORD button, and speak. A red LED lights to indicate that recording is in progress. Release the button, and recording stops. By default, the message is stored in folder 1 unless a different folder was selected before the recording is begun.

Longer messages can be stored by tapping the RECORD key. Tapping it a second time stops the recording.

Messages are time and date stamped when they're made—that's the only way that they're identified. So if you had a lunchtime conversation with a client on Tuesday, you'd be able to find it easily by time and date. Other messages might be more difficult to locate if they were recorded at random times.

The total message time available on our recorder model, which was equipped with two megabytes of RAM, was 23 minutes. Sycom makes three other models, with recording capacities of 11, 35, and 47 minutes. For recording memos and conversations, the quality of the recordings were more than adequate. However, quality can be improved—at the expense of capacity—through the options menu. Three higher quality recording modes would reduce the overall capacity of our 23-minute model to 17, 14, or 12 minutes.

Twenty-three minutes was not quite long enough for us—we would prefer at least a half hour—like we can get on one side of a microcassette. But we managed by being a little more selective and by judicious use of the pause control.

One of the most important attributes of our microcassette recorder is the ability to create archives just by throwing the tape into a drawer. It's not always easy to find a specific recording, but we know that it's in there somewhere. What can you do with messages that are digitally recorded? Store them on your PC, of course, with Sycom's *PC Audio Link*.

The PC Audio Link, which costs $59.95, is a reasonably simple application that runs under Microsoft Windows. Interestingly, the messages aren't transferred digitally. Instead, they're fed out to the PC's audio card through the earphone jack. The PC then re-digitizes the messages and stores them on its hard disk.

For all practical purposes, it would be possible to record messages onto a PC with any audio-recording software. The Total Recall software, however, has the advantage of making it easy to group messages in "folders."

One of the handy features provided by Total Recall for reviewing messages is a audio scan. In that mode, the recorder plays the first few seconds of each note in the selected folder. It's a convenient way to find a message when you can't remember the time or date it was recorded. It's even more convenient if you identify each message when you begin to record it—then the feature becomes a kind of subject scan.

Even better, messages can be edited—you can insert comments into recordings, and partially delete sections of messages. (A counter on the display helps when partially deleting messages.) This makes it especially convenient for dictating messages.

The recorder can be password-protected to safeguard the privacy of your messages. Another convenient feature that conserves recording time is a voice-activated recording (VOX) mode.

The recorder features wake-up and voice alarms. Any message can be selected for either alarm. Conversely, every message can be used as a voice alarm, so you can program dozens or even hundreds of reminders to bug you throughout the day.

The Total Recall digital voice recorder is a sensible product that we've begun to carry with us at all times. Even though it'll never completely replace the microcassette recorder in our work, it sure gives it a run for the money. ■

MIND OVER MATTER

(Continued from page 30)

the Examiner uses the comparative questioning technique to ask the Responder anything. Recommended as a party game, it could be the computer version of "Truth or Dare"—supposedly with the added bonus of knowing what the truth was.

Once again, however, we didn't do very well. Our true and false responses were difficult to tell apart—some of each went into the red zone, others didn't.

Finally, we sampled *PinballMind*, another MindDrive game in which we should have been able to control the movements of the ball and activate the flippers using our brain power. The game seemed to have a mind of its own, however, and it was definitely overpowering ours.

After performing so poorly in all those games, we were quite glad to note that manual definitively states: "Thought signal strengths and intelligence are in no way connected." Phew! We were beginning to get concerned. We'd like to think that the problem lies not in our heads, but in the MindDrive and its software. ■

ELECTRONICS WISH LIST

Aiwa Front-Surround CD Boom Box

Front-Surround Boom Box

Aiwa America Inc.'s (800 Corporate Drive, Mahwah, NJ 07430) *Model CSD-ES60* CD boom box features a front-surround system that delivers full, room-filling sound. The front speakers are supplemented by a top-mounted pair, which, by virtue of their placement, provide a slightly delayed signal in a typical listening situation. The result is the open, spacious sound associated with true surround sound. A switch allows the surround speakers to be turned on and off. The boom box features a three-position preset equalizer, 20-track random programming, bass boost, an auto-reverse cassette deck, and a remote control. Price: $170.

Panasonic AM/FM Headphones

"Shock Wave" AM/FM Headphones

AM/FM headphones are a popular musical source for fitness buffs. The *Model RF-SW150 "Shock Wave"* headphones from *Panasonic* (Matsushita Consumer Electronic Company, One Panasonic Way, Secaucus, NJ 07094) are built to stand up to jogging, roller-blading, biking, or rock-climbing. The water-resistant, bright yellow and black headphones are made of durable ABS plastic. To make sure they stay comfortably in place during any activity, the two-piece headband is adjustable. The AM/FM tuner has a built-in antenna. The tuner dial and volume and tuning controls are located on the right earpiece. Price: $59.95.

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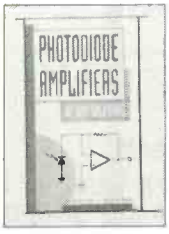

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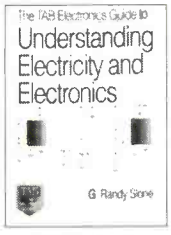

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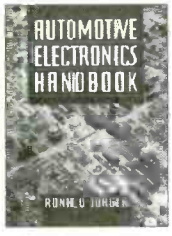

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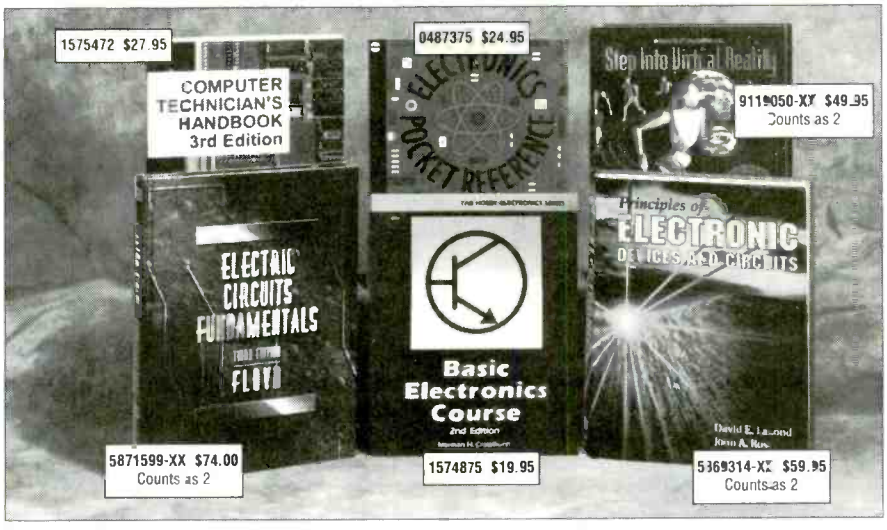

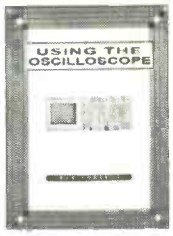

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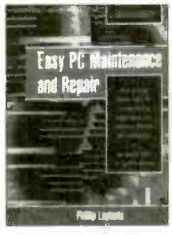

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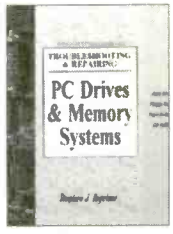

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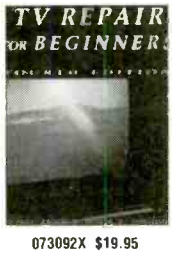

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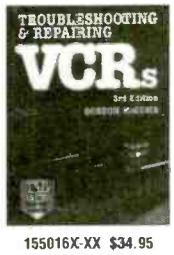

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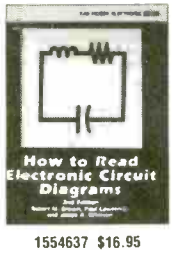

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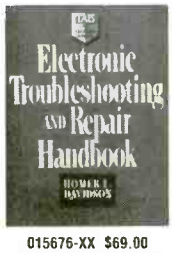

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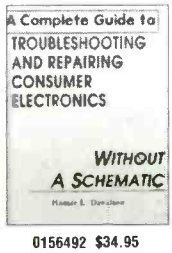

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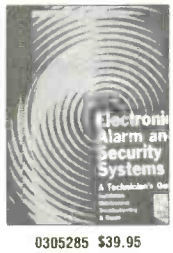

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William Elec & Ind Supply
803 Davis Blvd.
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BUILD A MULTIMEDIA SUBWOOFER

Add deep rumbling bass and excitement to your favorite computer games and music CDs.

BY RODRICK SEELY

As you probably know, faster computers and CD-ROM drives have paved the way for a huge selection of impressive multimedia software. Video games and interactive-audio and music-studio programs are incorporating more impressive music and sound effects than ever before.

As a result, better audio systems for computers are rapidly gaining popularity. Unfortunately, even moderate- to high-priced computer speakers cannot reproduce the deep bass or volume necessary to make audio music CDs and computer games sound really great. Although some computer-speaker manufacturers are now offering small subwoofer speakers, it can be difficult to find a good subwoofer without buying a whole set of speakers and software titles packaged together. Worst of all, good quality subwoofers can be very expensive.

The *Multimedia Subwoofer* described in this article provides deep, solid bass for your computer, and costs less than $80 to build! The unit features a built-in, 12-dB-per-octave, active bandpass crossover, as well as a 20-watt power amplifier and 6-inch speaker. Two 3.5-mm phone jacks allow easy connection to virtually any sound card and multimedia speakers.

When the Subwoofer is installed with multimedia speakers, its volume relative to the satellite speakers is controlled by a volume adjustment on the Subwoofer, while the volume of all the speakers together is controlled by the adjustment on the multimedia speaker. This allows the Subwoofer to be concealed under a computer table or desk and controlled remotely.

Circuit Description. Figure 1 shows a schematic diagram of the Subwoofer circuit. At the heart of the circuit is IC1, a TL072 dual JFET op-amp. Op-amp IC1-a forms a high-pass filter with capacitors C2 and C3 and resistors R2 and R3, while IC1-b forms a low-pass filter with C4, C5, R6, and R7. The cutoff frequency for this type of filter is calculated using the formula:

$$f = 1/(2\pi RC)$$

With the values shown, the high-pass filter cuts off at about 34 Hz, and the low-pass filter cuts off at about 150 Hz. The gain of the filter stages is set by resistors R4 and R5 for the high-pass, and R8 and R9 for the low-pass.

Jacks J1 and J2 are connected in parallel to allow the Subwoofer to be installed between the right and left satellite speakers. As mentioned, this installation lets you control the Subwoofer volume by the powered speaker. Resistor R15 and potentiometer R16 form an adjustable voltage divider to set the Subwoofer volume. This adjustment is provided to balance the system when it is initially installed.

The amplification for the Subwoofer is made simple by IC2, a 20-watt power-amplifier integrated circuit. Capacitors C6 and C7 provide input coupling. Two electrolytic capacitors are used in this configuration to save the cost of a single non-polar electrolytic capacitor. Gain is set by resistors R11 and R12.

This amplifier can draw idle current of up to 100 mA. As a result it gets **hot** even with no load, so it is very important to use a heatsink—the bigger the better (more on that later). Using a heatsink and silicone grease will be necessary even though the circuit does use internal thermal protection.

The power supply consists of a 36-volt, center-tapped transformer (T1), a bridge rectifier (BR1), and two filter capacitors (C10 and C11). The transformer and bridge should be rated for at least 1 ampere. The rectified and filtered output is about ±25 volts. Note that the power supply for the op-amp is regulated to ±15 volts by Zener-diodes D1 and D2, and resistors R13 and R14.

The Cabinet and Speaker. The cabinet for the Subwoofer is a bandpass-style speaker enclosure designed with the aid of computer software. This enclosure consists of a 10- × 10- × 5.75-inch (0.33 cubic feet) sealed compartment behind the speaker cone, and a smaller, 0.1-cubic-foot ported enclosure in front of the

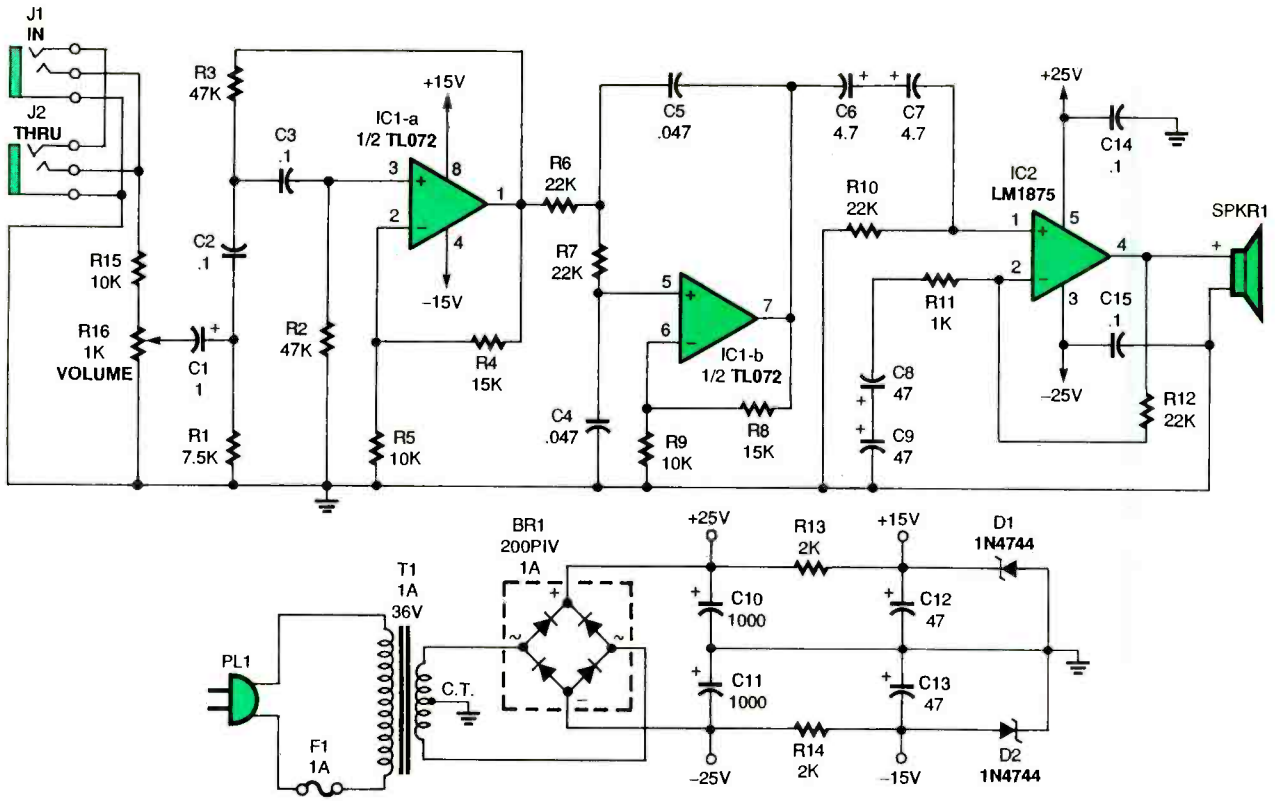


Fig. 1. Here's the schematic for the Multimedia Subwoofer. The circuit is greatly simplified by the use of an integrated 20-watt amplifier, IC2.

PARTS LIST FOR THE MULTIMEDIA SUBWOOFER

SEMICONDUCTORS

IC1—TL072 dual JFET operational amplifier, integrated circuit
IC2—LM1875T 20-watt power amplifier, integrated circuit
BR1—Full-wave bridge rectifier, 200-PIV, 1-ampere (DB103 or equivalent)
D1, D2—1N4744 Zener diode, 15-volt, 1-watt

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1—7500-ohm
R2, R3—47,000-ohm
R4, R8—15,000-ohm
R5, R9, R15—10,000-ohm
R6, R7, R10, R12—22,000-ohm
R11—1000-ohm
R13, R14—2000-ohm
R16—1000-ohm miniature potentiometer, horizontal PC-mount

CAPACITORS

C1—1-µF, 50-WVDC, electrolytic
C2, C3, C14, C15—0.1-µF, Mylar or metalized polyester
C4, C5—0.047-µF, Mylar or metalized polyester
C6, C7—4.7-µF, 35-WVDC, electrolytic
C8, C9, C12, C13—47-µF, 35-WVDC, electrolytic
C10, C11—1000-µF, 35-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

SPKR1—6-inch woofer (MCM Electronics Model 55-170 or equivalent)
J1, J2—3.5-mm stereo phone jack, PC-mount
T1—36-volt transformer, 1-ampere, center-tapped
F1—1-ampere fuse, 250-volt
PL1—AC plug, 2-terminal
Printed-circuit materials, AC line cord, strain-relief bushing, assembled speaker enclosure, aluminum chassis and heatsink, fuse holder, nylon spacers, wire, solder, hardware, etc.

Note: The following items are available from Lynn-Eren Electronics (17093 SW Lynnly Way, Sherwood, OR 97140; Tel. 503-625-2205; http://www.teleport.com/~lynneren): complete kit of parts including etched and drilled PC-board, aluminum chassis and heatsink, speaker, and assembled cabinet (unpainted)—$79; assembled and tested Subwoofer unit—$99; PC board only—$20. Check, money order, VISA, and MasterCard are accepted. Add $10 shipping and handling to orders that include cabinets or speakers. Assembled units are black.

speaker cone. The ported-front enclosure is achieved by facing the speaker downward, and holding it about two inches above the floor with rails on two sides. This technique simplifies assembly of the cabinet, and installation of the speaker cone.

The speaker used in the Subwoofer is a 6-inch MCM Electronics Model 55-1170. Of course, a similar woofer can be used.

Construction. For best results, the Subwoofer power supply, crossover, and amplifier should be built on a double-sided, printed-circuit board. You can either etch your own from the templates provided in Figs. 2 (solder side) and 3 (component side), or order a board from the source mentioned in the Parts List.

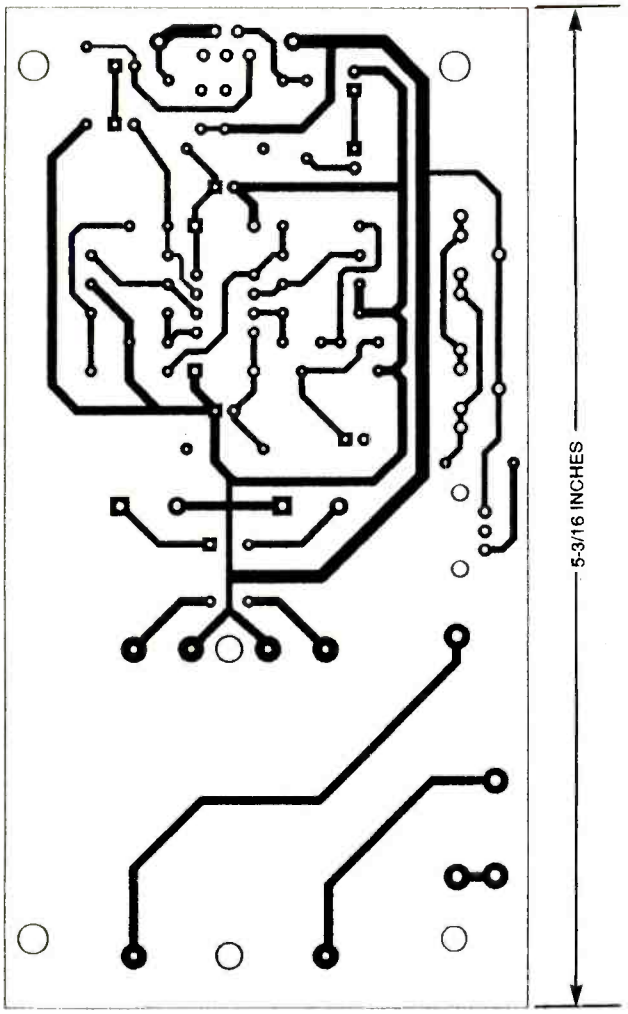


Fig. 2. This is a template of the component side of the Subwoofer PC board, shown full size.

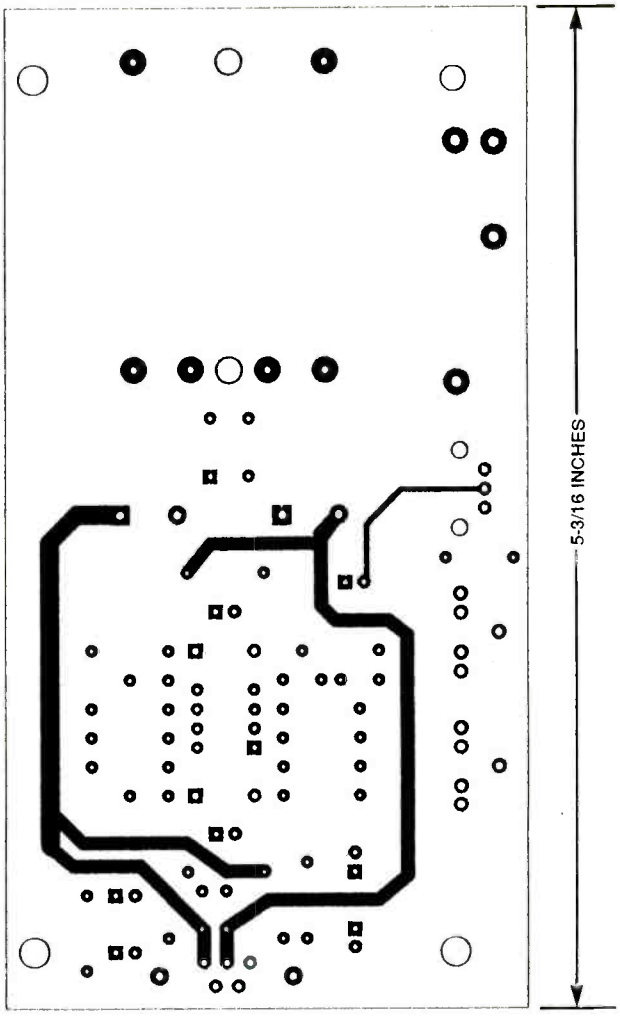


Fig. 3. Here is the solder side of the double-sided PC board.

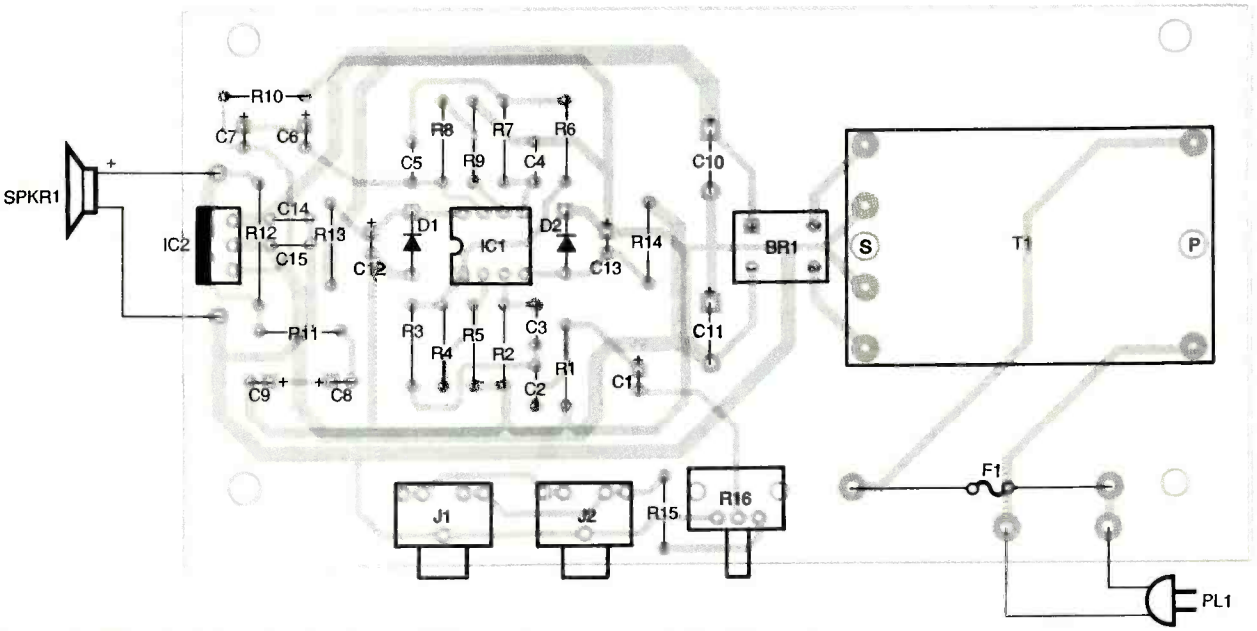


Fig. 4. Building the Subwoofer circuit on a PC board is recommended. Use this parts-placement diagram as a guide when doing so.

There are a couple of reasons why a PC board is recommended for the project. One reason is to prevent the noise and self-oscillation problems that can occur in audio projects using other building techniques. Also, using a PC board simplifies assembly, and usually gives you a better chance of having your project work on the first try!

Use the parts-placement diagram shown in Fig. 4 as a guide when assembling the circuit on the Subwoofer PC board. Begin by installing a socket for IC1. Mount all fixed resistors and capacitors, noting proper polarity for the electrolytics. Install the PC-mount jacks, potentiometer, and transformer next.

As you go along, be sure to solder on both sides of the circuit board wherever necessary. Install a fuse holder for F1. Then solder D1, D2, BR1, and IC2 to the board, making sure they are oriented properly. Attach speaker wires to the circuit board and speaker as shown in the parts-placement diagram. Then double-check component placement and soldering before connecting the AC line cord.

Note: If your line cord is already connected to an AC plug (PL1), do not connect it to the board at this time! You will instead need to pass it through the chassis first (more on that in a moment). To complete the assembly, insert IC1 into its socket.

The prototype circuit board was mounted in a three-sided aluminum chassis, measuring 5.5 × 3 × 1.5 inches. This chassis serves as a front panel and part of a heatsink. You can make a similar chassis from a 0.0625-inch-thick aluminum sheet. If you do so, you will need to drill holes that accommodate the PC-mount jacks and potentiometer, IC2's heatsink tab, the line cord, screws for mounting the chassis to the Subwoofer cabinet, and screws for mounting the board to the chassis (we'll cover, in turn, where each of those holes are). Of course, you can also order the chassis as part of the complete kit that is available from the source that's mentioned in the Parts List.

Once you have the aluminum chassis, mount the circuit board using spacers and screws to the 3- × 5.5-inch side of the chassis. The jacks, potentiometer, and line cord should then come out of openings in the 1.5- × 5.5-inch side. As noted earlier, you might need to pass the line cord through the chassis and connect it to the circuit board at this point.

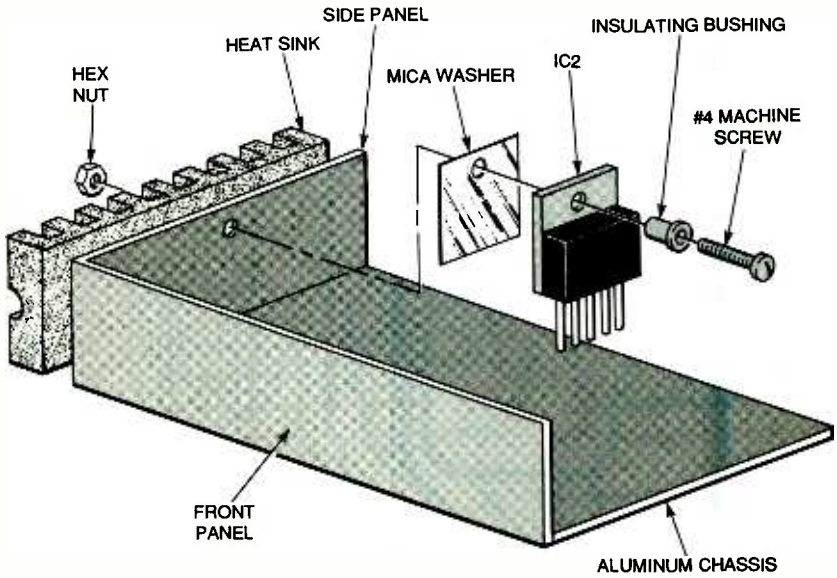


Fig. 5. It is important to electrically insulate IC2 from the chassis and heatsink.

Make sure that IC2's heatsink tab is flush with the remaining side of the chassis (the side measuring 1.5 × 3 inches). Mount the heatsink tab to the chassis and a separate heatsink as shown in Fig. 5. It is very important to electrically insulate IC2 from the metal heatsink using a mica washer and insulating bushing. To ensure good heat transfer, it is also a good idea to use silicone grease between IC2 and the heatsink.

Preliminary Testing. Before installing the circuit in the Subwoofer cabinet, it is a good idea to perform a few simple tests. Make sure that the line cord is installed properly, and component leads on the circuit board are trimmed so they do not touch the metal chassis.

The first step is to check the power supply. Verify that +25 and −25 volts are supplied to IC2 pins 5 and 3, respectively, and that IC1 has +15 and −15 volts on pins 8 and 4, respectively. Also make sure the DC voltage across the speaker is less than 0.1 volt. If there is too much DC voltage on the speaker, or if other voltages are not correct, disconnect the power and double-check the component placement.

Cabinet Assembly. If you are going to build your own Subwoofer cabinet, instead of ordering one, make sure its inside dimensions are close to 10 × 10 × 5.75 inches. The prototype cabinet was built from ½-inch particle board, but any sturdy sheet stock such as plywood or even Plexiglas will work. The bottom panel should have a 5¾-inch hole for mounting the 6½-inch speaker, and a 3¾- × 1-inch rectangular cutout for the chassis. You can make rails to hold the Subwoofer above the floor out of particle board or 1- × 2-inch furring strips.

To ensure that your cabinet does not rattle and buzz while operating, every seam should be glued, nailed, and sealed with silicone caulking. Assemble the sides and bottom panel first, so that the seams can be easily sealed. The top panel should be fitted last; that way it can be accessed through the speaker cutout for sealing. Finally, the rails can be added to the bottom panel. After the glue and caulking have dried completely, you can then proceed to sand and paint the cabinet.

Mount the chassis assembly in the cabinet using the speaker cutout for access. The front panel (the one with access to the jacks and potentiometer, and with the line cord coming out of it) should be fastened tightly against the cutout in the box to prevent any unwanted rattling or buzzing noise. Use screws that go through the cabinet and the chassis front. Finally, mount the speaker using short wood screws.

(Continued on page 100)

BUILD A MULTI-CHROME PROJECTOR

Use it as a biofeedback stress reliever, or any time you need a light source of various colors.

BY SKIP CAMPISI

You see the illusion every time that you watch your color TV set: The mixing of the three primary colors (red, green, and blue) in the proper combinations can produce any color in the visible spectrum. Of course, mixing red light with green light, for example, does not actually produce light with a wavelength typical of yellow light; however, your eyes will interpret the result as yellow.

This effect occurs because we have three types of color sensitive "cones" in our eyes. One type is sensitive to low frequencies (red light), one type is sensitive to middle frequencies (green light), and one type is sensitive to high frequencies (blue light). By stimulating the three types of cones with these "additive" primary colors, we can also view the "subtractive" primary colors of yellow (red + green), magenta (red + blue), and cyan (green + blue). Also, by varying the intensities of each additive primary color, any color in the spectrum can be seen as long as they are "mixed" before the light enters the eye. White light results when all three additive primary colors are mixed in equal intensities.

Whether you have a technical application for multi-colored light, or would just like to enjoy the soothing effects that such light can have, the aforementioned characteristics of the human eye make it possible to build a multi-chromatic device using light sources of only three colors. The *Multi-Chrome Projector* described in this article is just such a device. It utilizes a technique called rear projection to produce a continuously variable color display.

The Projector. Two assemblies make up the Multi-Chrome Projector. We'll call them the MCP tube and the MCP generator.

The MCP tube includes four LEDs (one red, one green, and two blue units) that are clustered together in a "diamond," or square pattern, at one end of the tube. These LEDs are aligned to illuminate a rear-projection screen located at the opposite end of the tube. The screen mixes the colors so a uniform light enters your eyes.

The LEDs in the Projector were selected for maximum screen intensity. All have a standard T-1¾ case size, and water-clear lenses. They have viewing angles of about 15° to 25° for proper coverage of the screen area.

The MCP generator includes digitally controlled LED current sources. Those sources are sequentially strobed to light the proper LED combinations to produce a full spectrum of color change in a repeating cycle of about 20 to 30 seconds. Properly adjusted, the unit will display color that continuously changes from red, to yellow, to green, to turquoise (cyan), to blue, to purple (magenta), and back to red again, with every in-between shade appearing. The MCP tube is mounted on a gimbal on the generator for easy alignment with your angle of vision.

Circuit Description. The schematic for the Projector circuit is shown in Fig. 1. It's a hybrid analog/digital design that utilizes components selected for minimum current drain. A TLC555 CMOS timer, IC1, is configured as a ULF squarewave generator that has an adjustable time period of about 2 to 7 seconds. That output drives IC2, a CD4017 CMOS Johnson counter, which provides the six decoded output steps necessary to trigger the three additive and three subtractive primary color combinations.

A CD4025 CMOS triple 3-input NOR gate, IC3, gates the six outputs to the proper LED current sources, thereby maintaining the correct color-mixing sequence. Four MPSA64 PNP Darlington transistors (Q1–Q4) are configured as gated current sources, with capacitors C4–C7 providing long time constants that allow LED1–LED4 to ramp up and down in intensity. This allows the color changes to be continuous, rather than in six abrupt steps.

Power for the circuit is provided by a

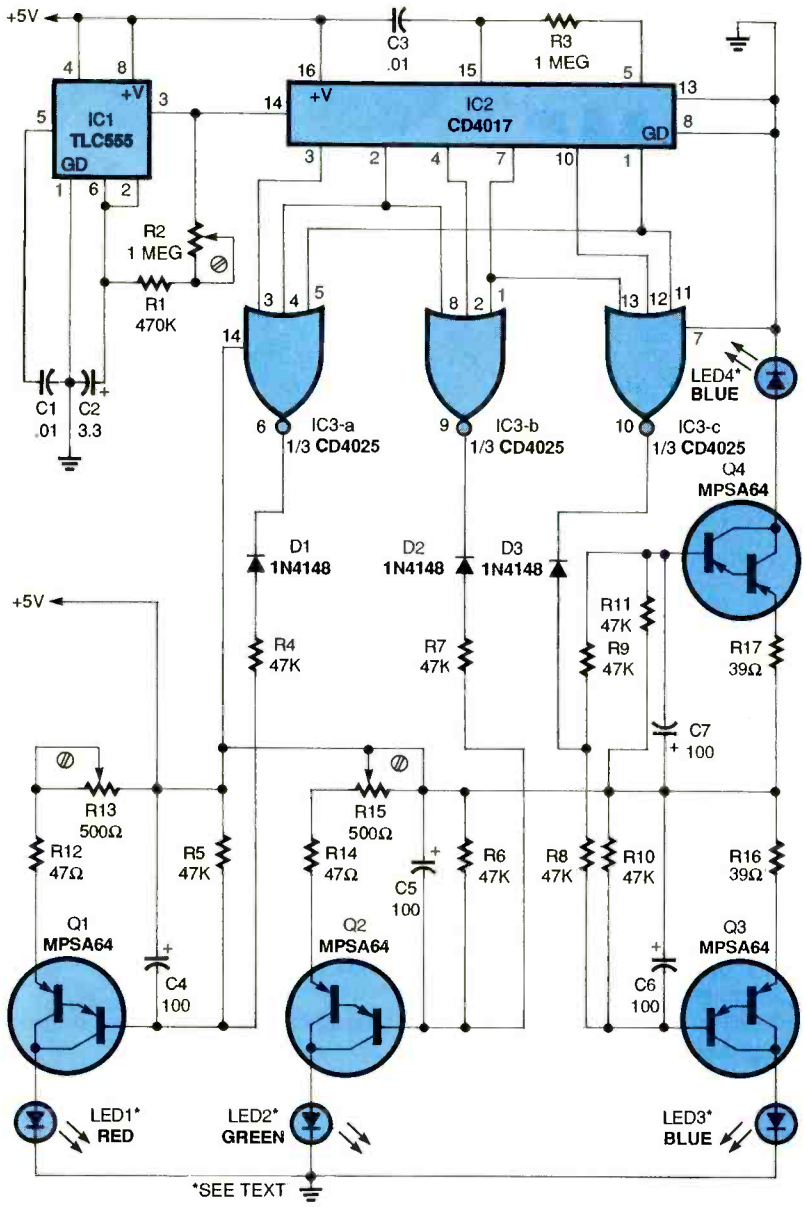


Fig. 1. Here's the schematic for the Multi-Chrome Projector. All the colors of the rainbow are created using combinations of LED1–LED4.

5-volt supply (see Fig. 2). Transformer T1 steps down the voltage from a wall outlet to 6.3-volts AC. That voltage is then rectified by BR1 and regulated by IC1, a 78L05. This circuit is optional, however, as any 5-volt, 100-mA supply will work.

Construction. Because the Projector is a very low frequency device, layout is not critical. Any project-building method that you prefer can be used with equally good results, as long as the circuit-board layout is neat.

Although the author's prototype consists of a separate optics tube and generator enclosure, you have the option of assembling the entire unit in one cabinet. Simply follow similar dimensions for the spacing of the optical components as used in the prototype MCP tube (we'll get to that in a moment).

Before you begin, make sure you have the correct type of LEDs specified in the Parts List. You can get the four LEDs from Mouser Electronics (Tel. 800-346-6873), DC Electronics (Tel. 800-467-7736), JDR Microdevices (Tel. 800-538-5000), and Alltronics (Tel. 408-943-9773).

All of the components (except LED1–LED4) are mounted on a piece of perforated board, using point-to-point wiring. Keep the components shown in Fig. 1 on one side of the board, so that you can mount the power-supply components at a little distance. Begin by installing DIP sockets for IC1-IC3 of Fig. 1. Then wire the rest of the circuit from those points. Install the resistors and trimmer potentiometers first, then go on to add the capacitors, noting the polarity of the electrolytics. Solder the transistors and diodes to the board next, making sure they are oriented properly as well.

PARTS LIST FOR THE MULTI-CHROME PROJECTOR

SEMICONDUCTORS

IC1—TLC555 CMOS timer, integrated circuit
IC2—CD4017 CMOS Johnson counter, integrated circuit
IC3—CD4025 triple 3-input NOR gate, integrated circuit
Q1–Q4—MPSA64 PNP Darlington transistor
D1–D3—1N4148 switching diode
LED1—Super-bright light-emitting diode, red, 100-mcd, water-clear lens, T-1¾ case (Mouser 509-EBR5304S, or equivalent)
LED2—Super-bright light-emitting diode, green, 100-mcd, water-clear lens, T-1¾ case (Mouser 509-EPG5304S, or equivalent)
LED3, LED4—Silicon-carbide light-emitting diode, blue, 16-mcd, water-clear lens, T-1¾ case (Mouser 5879-5318, or equivalent)

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1—470,000-ohm
R2—1-megohm trimmer potentiometer, single-turn
R3—1-megohm
R4–R11—47,000-ohm
R12, R14—47-ohm
R13, R15—500-ohm trimmer potentiometer, single-turn
R16, R17—39-ohm

CAPACITORS

C1, C3—0.01-µF, monolithic ceramic
C2—3.3-µF, 35-WVDC, solid tantalum electrolytic
C4–C7—100-µF, 16-WVDC, aluminum electrolytic

ADDITIONAL PARTS AND MATERIALS

Perforated board, plastic enclosure, penny coin tubes (2), automotive-type hose clamp, microphone flange adapter, microphone holder, plastic enclosure, IC sockets, microscope slide or ground glass, emery paper, plastic cement, wire, solder, hardware, etc.

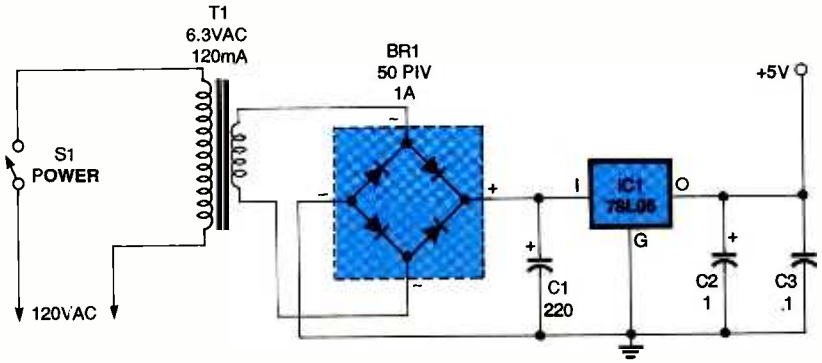


Fig. 2. This circuit will provide a 5-volt, 100-mA supply for the Projector circuit.

Mount the power transformer and other power-supply components at the other end of the board. Make sure the polarized components are also wired correctly. Solder an AC line cord and switch S1 to transformer T1. Note that this on-board power supply is only an option. However, if an external supply is used, capacitors C2 and C3 (shown in Fig. 2) will have to be included right on the Projector circuit board.

The author's prototype for the Projector was housed in a 1½- × 2½- × 4¾-inch plastic cabinet, with the power cord and power switch mounted at one end. The top cover was ventilated by punching ten, ⅛-inch-diameter holes in two columns. You can do the same, depending on the type of enclosure you use. You will have to run leads from the MCP tube into the case as well. Let's now get to building the tube.

Obviously, the "heart" of the Multi-Chrome Projector is the MCP tube. In the author's prototype, the tube was made from two penny coin tubes, which are available from your local coin dealer. These tubes are about 3-inches long and ¾-inch wide, and are used to hold a roll of pennies. They are made of transparent styrene and have a nylon, screw-on cap.

Attach a standard, automotive-type hose clamp about 1/16 inch from the closed end of one of the tubes. Make sure that the clamp is square with the end, then use a "razor" saw to cut off the end, using the clamp as a guide. File the end of the tube flush with the clamp. Remove the cap and relocate the clamp to the threaded end of the tube, and cut off 1/16 inch from that end, also. You will end up with an open tube with threads on one end.

The next step is to cut off some of the threaded end of the other tube. Place the clamp on the threaded end of that tube so that after you cut, about 1/16 inch of the threaded section will remain on the tube. Then discard the second tube and sand the cut end of the threads square. Using plastic cement, glue that threaded section to the open end of the first tube. You will then end up with an open tube having equal-length threaded sections on each end. Set it aside to dry completely.

Cut a scrap piece of 0.1-inch-grid perforated board (the type with copper foil pads) to a size of ⅝-inch square. You will now have a board containing six rows of six holes each. Lightly sand the four corners of the board so that it just lies flat when dropped into one of the nylon screw caps. Don't remove too much off the corners, as the board must be "captured" between the cap and the threaded end of the tube when assembled. Drill a ⅛-inch hole dead center in the board, and install a 1½-inch-long #4-40 machine screw in this hole. Fasten the screw with a #4-40 nut. The screw will aid in aligning the LEDs.

PARTS LIST FOR THE 5-VOLT POWER SUPPLY

CAPACITORS

C1—220-μF, 16-WVDC, aluminum electrolytic
C2—1-μF, 35-WVDC, solid tantalum electrolytic (see text)
C3—0.1-μF, monolithic ceramic (see text)

ADDITIONAL PARTS AND MATERIALS

IC1—78L05 5-volt regulator, integrated circuit
BR1—Full-wave bridge rectifier, 1-ampere, 50-PIV
T1—6.3-VAC, 120-mA transformer
S1—SPST toggle switch, 1-ampere
AC line cord with plug, grommet, wire, solder, hardware, etc.

Install LED1–LED4 as follows: Slip a ¾-inch length of spaghetti tubing onto the cathode lead of one of the blue LEDs. Then install its anode lead into one of the outside corner holes, with the cathode lead in the next inside hole on the diagonal towards the screw. Lean the LED against the screw; the spaghetti tubing will set the correct angle, and a small rubber band will clamp the LED in place. Solder both leads to the foil pads and remove the rubber band. Similarly, solder the second blue LED in the opposite corner.

In the same fashion, solder the red and green LEDs in the remaining adjacent corners of the board and remove the #4-40 screw and nut from the assembly. Connect all four of the LED cathodes together with a piece of bus wire. Using 26- or 28-gauge insulated hookup wire, cut 12-inch-long pieces of the each of the following colors: black, red, and green. Then cut two 12-inch-long pieces of blue wire. Solder one end of the black wire to the common-cathode bus connection, and route the other end out through the ⅛-inch center hole through the back of the perforated board.

Solder the red wire to the anode lead of the red LED, and in a similar way, solder the remaining green wire and blue wires to their appropriate anode leads, routing them through the same hole as the black wire. Drill a ⅛-inch hole through the center of one of the nylon screw caps; route the five wires through this hole allowing the board to nest in the cap.

Slip the already prepared tube over the LED assembly. Screw on the cap, capturing the board at the threaded end of the tube. You can now look down the center of the open end of the tube to check the alignment of the four LEDs. They should all be pointing towards the center of the open tube end. If necessary, gently bend the LED leads to achieve alignment. When satisfied, secure the cap in place with small screws or glue.

Cut a piece of black construction paper to 1½ × 2½ inches and roll it

into a 1½-inch-long tube. Insert this paper into the open end of the MCP tube for a glare stop, letting it snap open to hug the plastic walls. Secure it with a small piece of tape. Punch a ½-inch-diameter hole, or using a hobby knife, cut a ½-inch square hole in the center of the remaining screw cap. Paint this cap flat black and set it aside to dry.

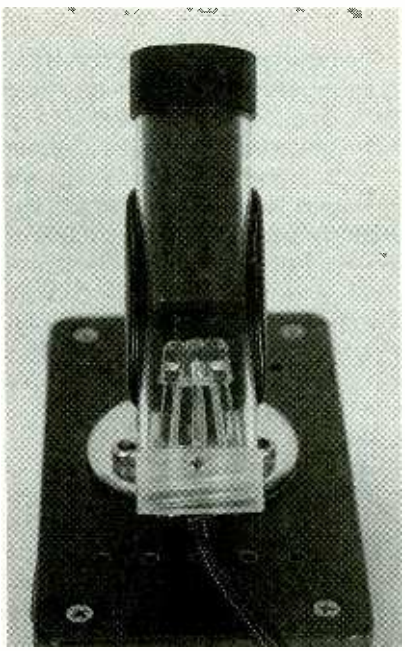
The "key" element of the MCP tube is the rear-projection screen. Many materials can be used, such as frosted glass or plastic, textured plastic, and even tracing paper! However, the brightest image is obtained using "ground" glass, which was used in the author's prototype. If you don't have access to any ground glass, you can make your own by following the directions in the following paragraphs. If you do have ground glass, do all the mentioned scribing on the smooth surface, only.

Obtain a piece of thin glass such as a standard 1- × 3- × 0.040-inch microscope slide. Using a metal straight edge as a guide, scribe a line parallel to the edge across the 1-inch width, exactly ⅝ inch from the edge, using a standard carbide-tipped scriber. (Note: Unless you are an expert, a standard glass cutter is useless on a small piece like this!) With the scribed line on top, lay the slide on top of a toothpick (or similar object) aligning the toothpick with the line. Place your thumbs on the slide, on each side of the line, and push down. The glass will snap and leave a neat, clean edge. Repeat this process to obtain a ⅝-inch square piece of glass.

Using a piece of 600-grit or finer emery paper laid on a flat surface, or a fine-grit whetstone, bevel the edges of the glass slightly to remove sharp edges. In a similar manner, round the corners slightly (as was done with the LED assembly) so that the glass will be able to fit within the remaining screw cap.

Now moisten the paper or stone with water or saliva and place the glass flat on the surface. Using your finger, push the glass around on the grit in a circular motion, adding water as needed for lubrication. Continue until you get an even, frosted-looking surface on the glass. Only one side needs to be ground. Wash off the glass and "tack" it in place in the black cap, using small dabs of silicone sealant to align it with the ½-inch hole, if necessary. The smooth side of the glass should be facing outwards. Screw the assembly onto the other end of the MCP tube, and fix it in place with small screws or cement. The MCP tube is now ready for mounting.

An excellent mount can be assembled from standard microphone components. Install a ⅝-inch microphone flange adapter on the Projector cabinet. On that flange, install a standard microphone holder, whose female threads will match the adapter. The MCP tube will then "snap" nicely into the holder, allowing you to pivot the tube up or down. Bring the leads into the cabinet through a grommet, and connect them to the circuit board, leaving some slack for tilt adjustment of the tube.



Here's a view of the tube assembly, showing how the four LEDs are mounted.

Setup. Adjust trimmer potentiometers R2, R13, and R15 to their mid positions, and apply power to the circuit. Looking at the screen, you'll see the red LED rise in intensity as the color-mixing process begins. Observe two or three complete cycles and then begin adjusting R13 and R15 to match the intensities of the red and green LEDs with that of the blue LEDs. The settings vary for different individuals and ambient-light conditions.

Once you are satisfied with the colors, begin adjusting R2, which controls the cycle time of the mixing. That setting should be made so that just as one LED fades out, the next should begin intensifying. Thus, there is no pause at any one color, or any overlap of colors. The prototype runs at about a 20-second cycle time. Close up the enclosure when you're satisfied with the settings.

Using the Projector. As you may have already surmised while setting up the unit, the display screen has a rather "hypnotic" effect on your eyes! This is caused by your brain's natural tendency to sense the repeating pattern of color change, and anticipate those changes. However, when properly adjusted, the unit's color change is continuous and never really pauses at one particular color, thus your brain never quite catches up with the sequence!

This can best be demonstrated in subdued lighting. Be seated in a relaxed position with the MCP tube angled towards you so that you are looking squarely at the screen and down the axis of the tube. This will provide the highest intensity image. You are now ready to turn on the power and concentrate your attention on the projector screen.

Let your mind follow the ever-changing color sequence. Shortly, your brain will begin anticipating these changes automatically. Relax and let it happen—you will be entering the alpha-wave state of meditation! This effect can actually provide some stress relief, just as when you pet your dog or cat, or other favorite companion. Your eyes may tend to go out of focus, and you may also find yourself becoming quite drowsy while concentrating your attention on the display screen.

Most people viewing the prototype in action simply could not take their eyes off of the display! It sort of "pulls" at your attention area, directing you to concentrate only on the display colors.

Of course, if you are not interested in biofeedback techniques, the Multi-Chrome Projector can still be used just as an extremely interesting and unique display device. Be the first on your block to own a multi-color, single-source light display! ■

MONITORING MILITARY AIRCRAFT

Use an ordinary scanner and these listening tips to follow the exciting transmissions of our nation's military pilots.

BY LAURA QUARANTIELLO

His voice is strained, guttural, and groaning. He sounds like he's bench-pressing 400 pounds and his arms are about to give out. Only its not 400 pounds, it's more like 1440. A force eight times that of gravity is crushing this naval aviator into his cockpit seat, flattening his eyeballs, and breaking blood vessels across his nose and cheeks as he pulls hard into a left break turn. His vision dims and he's on the ragged edge, trying to put his airplane's nose on a target that is four miles away—an F-16 adversary painted Saudi-blue.

Your scanner radio screams out his words: "Fox Two on the left hand F-16!" Suddenly, halfway through the sentence, all the strain leaves his voice in a rush. Though you can't see him, can't see his airplane, can only hear his voice over a speaker, you know he's unloaded the airplane, released the crushing g forces, and rolled back to straight and level flight.

"You're a kill. That left hand F-16 is a kill!" he exults, but the jubilation is over as quickly as it began.

"Hawk, break right, break right!" It's his wingman's over-stressed voice, waking his partner up to the fact that the fight isn't finished. In fact, the fight isn't even real, but from the sounds and the wound-up taut voices, you'd never know it.

Call to Glory. Every working day in America, over every state, military aircraft take to the skies. Their missions are to train for war, and they do it from the cool of the early pre-dawn hours far into the drawing blackness of night. They work way beyond the usual nine-to-five day, and they can often be found trading simulated shots on a Sunday afternoon when the rest of us are enjoying a day off. From sod level to the high skies, our military aviators are active at the controls of everything from helicopters to fighter jets to air refueling tankers. They train and they wait for the call to duty.

Each year it seems that call comes, from places with names like Kuwait, Bosnia, and Iraq. Lonely outposts where men and women are summoned to serve their country's interests. But the official missions we see these professionals fly overseas are backed by hundreds of hours spent in friendlier skies, learning tactics and rules designed to keep them alive when their real call to glory comes, and the ground under them suddenly isn't Kansas or California anymore.

A United States military aviator isn't born,;he or she is made. They are taught, shaped, and honed in a peculiar kind of purgatory the military calls *training sorties*. Best of all, they have all those experiences close to home. That's where scanner enthusiasts come in.

A listener who knows where to tune can find a little bit of heaven from a scanner speaker. In fact, monitoring military aircraft can result in an experience more supercharged than a medic ambulance on a Code Three run.

Scanning for Aircraft. Military pilots practice their art in the secure en-

Two sure winners for scanner fans who want to monitor military aircraft are the Uniden Bearcat BC-200XLT (left) and Radio Shack PRO-43 (right).

virons of Military Operating Areas (MOAs), Warning Areas (Whiskeys), and Restricted Areas. You won't see these places by looking up into the sky, but you will see their outlines traced on aviation charts. These areas with invisible geographic boundaries keep high-speed, maneuvering military aircraft safely away from transiting civilian air traffic. Chances are better than good that you have a military operating area within fifty miles of your location. Here are some tips for finding military aircraft on the airwaves:

Your first target when searching for milair (military aircraft) communications should be *Air Route Traffic Control Centers* (ARTCCs). There are twenty Centers located throughout the United States, each divided into sectors for the positive control of aircraft, and overseen by military air-traffic controllers. Military aircraft moving to and from special-use airspace (such as military operating areas and warning areas) that serve as their private playgrounds keep in contact with Center controllers.

Each VHF Center frequency in the 118–137 MHz band is paired with a UHF frequency. The controller simulcasts on both frequencies, but the pilots in military aircraft usually are only heard on the UHF side. Check a frequency book for a listing of Center sector frequencies near you, then tune in and listen. Follow the hand-offs from one frequency to another until you either lose reception of the aircraft because of distance, or it arrives at this operating area.

The second place to check for milair are the ground-control, tower, and approach/departure frequencies of military air bases or airports with Air National Guard units aboard. Here again you can follow the aircraft as it is handed off from frequency to frequency en route to its destination.

Another good bet for milair communications are warning, restricted-area, military-operating-area, or range-control frequencies. A good frequency book will guide you to the proper frequencies, but as a general rule, look for Army and Marine Corps air units in the 30- to 50- , 136- to 144-, and 148- to 150.8-MHz ranges, and Marine Corps, Navy, and Air Force units in the 225- to 400-MHz range.

Finally, if you're near a base or other military operating area with no book to guide you, try searching through the above bands. Yes, it's a large chunk of frequency space to check, but systematic listening of a small portion at a time should help. In fact, the only true way to find those unpublished air-to-air frequencies is by listening for them. Good areas of the spectrum to check for hot activity are 136–137, 138–144, 233–236, 300–308, and 310–312 MHz.

Military aircraft chat with air-traffic controllers while approaching and departing airports, and flying to and from operating areas. However, they also use tactical and air-to-air frequencies. These discrete channels are where the bulk of the interesting communications take place. Finding them is often a job, but once you do, you'll open a treasure trove of fascinating transmissions.

Generally, tactical frequencies are used to coordinate different flights of aircraft engaged in common maneuvers, or to connect aircraft working with ground or afloat units. Air-to-air frequencies connect pilots in the same flight of aircraft, and pilots from different flights working in tandem. Again, you never know what you'll find, you'll just have to go searching.

What You'll Hear. If a military service flies it, you can hear it. A scan through the band (see the "Military-Air Frequencies" box) might reveal a Marine Corps A/V-8B Harrier working close air support for troops in contact on the ground. You'll hear the soldiers shouting for help so loudly over the radio that you would actually think they were in harm's way, and the only saving grace was on the stubby wings of a Harrier jump jet.

A little farther down the band you may find a gaggle of Navy jets dogfighting, with pilots screaming "Fox Two" to indicate a heat-seeking, sidewinder missile launch. Keep searching and you can come across Air Force F-15's and F-16's turning and burning, A-10 Warthog tank killers

MILITARY-AIR FREQUENCIES (kHz)

40.500—Army Search and Rescue/FM Emergency.
41.500—Army Control Towers.
126.200—Military Control Towers VHF.
130.650—Air Mobility Command (AMC) Primary.
134.100—Military GCA Radar.
140.100—FM Tactical.
236.600—Military Control Towers UHF.
239.800—PMSV Metro Weather.
241.000—Army National Guard.
242.200—US Air Force Air Combat Command (ACC).
243.000—Guard Emergency.
252.100—Air Force Air Refueling.
255.400—FAA Flight Service Stations.
255.400—USSTRATCOM Air to Air.
257.800—Military/Civilian Control Towers.
270.800—USSTRATCOM Air to Ground.
282.500—ACC.
283.700—ACC.
297.000—AMC.
304.800—USAF Hurricane Hunters.
305.600—ACC.
311.000—USSTRATCOM Primary.
340.200—USN Control Towers.
341.200—USSTRATCOM Air to Air.
342.500—PMSV Metro Weather.
343.000—ACC.
344.600—PMSV Metro Weather.
349.400—USAF Control Towers.
360.200—USN Control Towers.
372.200—Military Dispatchers.
375.200—PMSV Metro Weather.
375.700—USSTRATCOM Air Refueling Anchor.
376.200—ACC.
381.300—USSTRATCOM Command Post.
381.400—USSTRATCOM Air to Air.
387.900—ACC.
390.900—AMC.

MILAIR GLOSSARY

ACM—Air Combat Maneuvering.
AIC—Air Intercept Control.
ARTCC—Air Route Traffic Control Center.
ATC—Air Traffic Control.
BANDIT—Enemy aircraft.
BREAK—A hard turn left or right to disengage a pursuing enemy or missile.
BOGIE—Unidentified aircraft.
BOGIE DOPE—Request for position, altitude and speed of bogie.
BUG OUT—Leave the fight.
BUTTON #—Indicates preset radio frequency.
CIC—Combat Information Center (ship based).
DISCRETE—Private frequency for-air-to-air communications not monitored by ATC.
FLIGHT JOINED—Indicates that wingmen have formed up with leader.
FOX 1—Voice call indicating launch of radar-guided missile.
FOX 2—Voice call indicating launch of heat-seeking missile.
FOX 3—Voice call indicating use of aircraft-mounted guns.
G—An expression of the force of gravity (*i.e.*, "4 g's").
GREEN 'EM UP—Arm weapons.
HOT—Active.
INTERROGATIVE—Question follows.
IP—Initial point.
IR—Instrument route.
JOKER—Minimum fuel.
MERGE PLOT—Radar data plots have merged on controller's radar screen; usually indicates two aircraft in close proximity to each other (within visual range).
MILAIR—Military Aircraft.
MOA—Military Operating Area.
MODE 3—Radar transponder mode.
MOTHER—Aircraft carrier; also base ship for helicopters.
NOSES COLD—Radar off.
POSIT—Position.
PUSH—Proceed.
RTB—Return to Base.
SAY STATE—Request for an aircraft's fuel situation.
SHOOTER—Attacking aircraft.
SPLASH—Voice call indicating an enemy aircraft shot down.
SPLIT—Separation.
SQUAWK—Refers to radar transponder code that identifies aircraft on controller's radar display.
START YOUR MUSIC—Activate radar-jamming pods.
SWITCHES SAFE—Weapons secured.
TALLYHO—Target in sight.
TONE—Audio warning indicating missile lock ("good tone").
UNIFORM—UHF frequency.
VICTOR—VHF frequency.
WEAPONS FREE—Aircraft has been cleared to use weapons.
WEAPONS TIGHT—Aircraft has not been cleared to use weapons.
WINCHESTER—Out of ammunition.

With your scanner radio, you can hear helicopters like this AH-1 Cobra in training. Just tune in between 138–144 MHz.

Always up, always working! The only time you get to see an E-2 Hawkeye is at air shows; otherwise they are up as the eyes of a fleet, and home for AIC fighter controllers.

searching for prey down close to the hills and valleys, F-14's trapping aboard aircraft carriers, fighters calling refueling tankers on tactical frequencies and being vectored in by the tanker pilot for a drink, and around the corner, just a megahertz away, maybe helicopters removing "wounded" soldiers or transferring cargo to and from a ship located offshore.

In addition, you'll also be privy to military pilots chatting with each other on air-to-air frequencies. You may be treated to a running commentary on the scenery, the latest ready-room gossip, or an in-depth discussion of how to fly and fight a Harrier. Without a doubt, what you'll hear will entertain you, maybe give you a laugh, and possibly provide a heart-stopping moment when you wonder if what you're hearing could be real. From one minute to the next, one frequency to another, you never know what you will come across.

Bugging Out. It's true that military pilots speak in a language all their own. As a result, listeners often tune in air-to-air transmissions that are, for the most part, cryptic and hard to follow. More than any other factor, this failure to understand what's being said drives scanner listeners away from a fas-

(Continued on page 50)

BUILD A TEMPERATURE ADAPTER FOR YOUR DMM

Use this circuit and an ordinary DMM to measure temperature.

BY MARC SPIWAK

I'll bet there are plenty of times when you are working at your test bench and wish you knew what the temperature was. Whether it's the temperature inside an amplifier chassis, of a component, or in a room, you need something to measure how hot or cold it is. Of course a thermometer is always useful, but you don't always have one with you. Besides, glass thermometers are quite fragile, and they don't give you a digital readout like the multimeter you always have with you.

Some of today's multimeters can measure a lot more than just voltage and resistance. Fancy ones can measure capacitance, inductance, frequency, and so on. However, it is rare that a DMM can measure temperature. If it can, it probably requires a temperature probe of some sort. So if you are already able to measure temperature with your multimeter, chances are you have a rather high-end DMM. However, we're going to show you how to build a circuit that lets you measure temperature with any digital multimeter.

The *Temperature Adapter* described in this article is a simple add-on circuit that will show right on the display of your DMM how hot or cold something is. All you have to do is plug the unit into your meter's inputs. The only catch is that you must have a digital multimeter (DMM) with a fixed input impedance of at least 1 megohm. Analog meters will load down the circuit and give inaccurate results.

The Adapter can be built practically for free if you have all the parts in your junk box. And that's quite possible considering that the most exotic component in the circuit is an LM1458 dual general-purpose op-amp. Or, if you prefer, the circuit can be purchased as a kit from the source mentioned in the Parts List.

The Basics. The Adapter add-on circuit allows your DMM to measure from −40 to +300 degrees Fahrenheit. It provides you with a digital readout, and its range is a lot greater than that of most glass thermometers. Because the temperature sensor (a modified transistor) can be located remotely and wired to the rest of the circuit, neither you nor your multimeter have to be exposed to the temperature extremes you're measuring. How hot is it under the hood of your car while the engine is running? It's easy enough to find out. And all you have to do is sit back in your air-conditioned car while monitoring the under-hood temperature on your DMM.

With a bit of thermal grease applied to it, the small body of the temperature-sensor transistor can be used to pinpoint temperature along a surface, from component to component, and so on. Just try doing that with a thermometer!

A transistor modified to behave as a single diode is used as the temperature sensor. The voltage drop across a diode junction is inversely proportional to the temperature of the junction. Basically the Adapter circuit just amplifies and scales up that junction voltage to a DC voltage that your DMM can display, and one that directly corresponds to temperature, with an accuracy of 0.1 degree.

Glass thermometers can be very accurate, but everyone knows how fragile they are. However, the biggest disadvantage to a glass thermometer is that you must observe the thermometer's reading and then record it somewhere. This can lead to human errors in observation and recording that later get into calculations, thus throwing them off slightly. Spring-activated mechanical thermometers have analog needle displays, but accurate models are expensive and the moving parts can be quite delicate.

An electronic thermometer, on the other hand, usually has an indisputable digital temperature readout that can be misinterpreted only by recording the display readout improperly or by poor eyesight. Another advantage with an electronic thermometer is that detecting small temperature variations is easier than with most glass thermometers. A digital display, depending on accuracy, can indicate temperature to the nearest degree, or tenth of a degree in the Adapter circuit. Of course there are thermometers that are much more sensitive, depending on your budget. Also, because an electronic thermometer has no moving parts, it's better suited for harsh environments

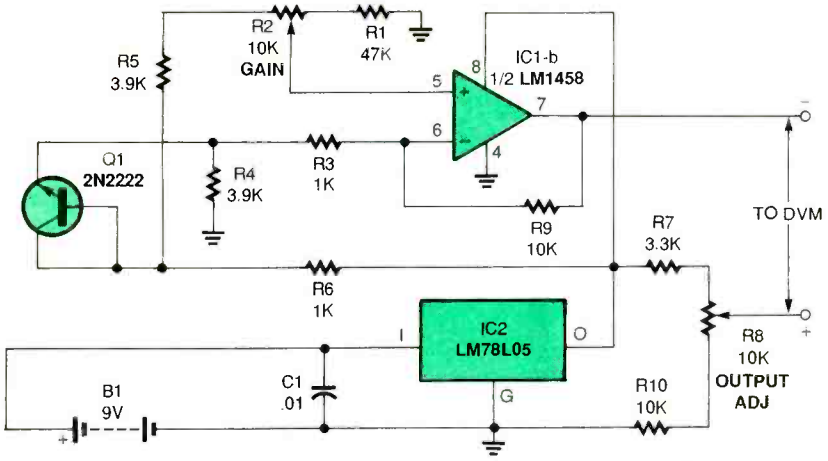


Fig. 1. Here's the schematic for the Temperature Adapter. The circuit allows your DMM to measure from −40 to +300 degrees Fahrenheit.

PARTS LIST FOR THE TEMPERATURE ADAPTER

SEMICONDUCTORS

IC1—LM1458 dual general-purpose op-amp, integrated circuit
IC2—LM78L05 (or LM7805) positive 5-volt regulator, integrated circuit
Q1—2N2222 or similar NPN transistor

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1—47,000-ohm
R2, R8—10,000-ohm, trimmer potentiometer
R3, R6—1000-ohm
R4, R5—3900-ohm
R7—3300-ohm
R9, R10—10,000-ohm

ADDITIONAL PARTS AND MATERIALS

C1—0.01-μF, ceramic-disc capacitor
B1—9-volt alkaline battery
Printed-circuit materials, enclosure, 9-volt battery connector, banana plugs, thermometer (for calibration purposes), wire, solder, hardware, etc.

Note:

The following is available from Marlin P. Jones & Associates, Inc. (P.O. Box 12685, Lake Park, FL 33403-0685; Tel. 800-652-6733): kit for the Adapter, including everything except a battery, case, and connectors for your DMM—$8.95 plus $4.50 shipping and handling. Florida residents please add appropriate sales tax.

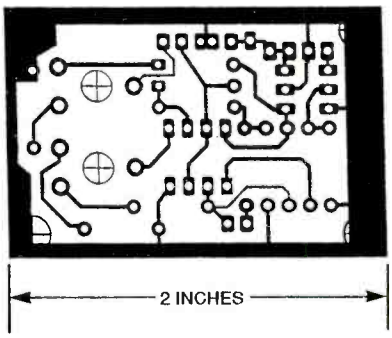


Fig. 2. You can use this foil pattern to etch your own PC board for the Adapter.

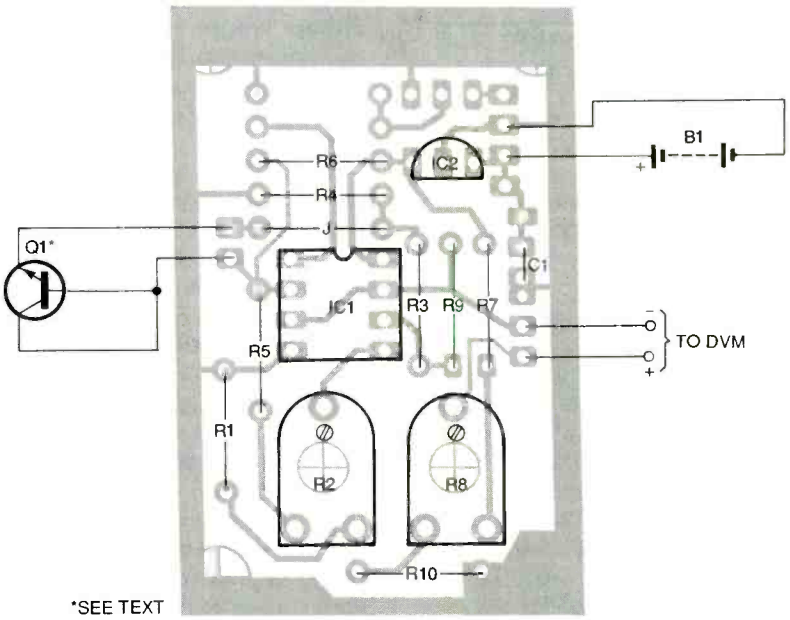


Fig. 3. If you're building the Adapter on a PC board, use this parts-placement diagram as a guide.

where moving parts might get gummed up or corroded.

Circuit Description. A schematic for the Temperature Adapter is shown in Fig. 1. The circuit outputs 0.01 volt per degree Fahrenheit. That's the actual voltage that's displayed on your DMM, within the aforementioned range of −40 to +300 degrees Fahrenheit. To determine temperature you ignore the decimal point in the display, and the temperature readout is to the tenth of a degree. For example, if the temperature in a room is 75.5 degrees, your DMM would read +0.755 volt.

The voltage input for op-amp IC1 is obtained from a transisor Q1 used as a diode in this application. The voltage drop across a silicon diode, while generally about 0.7 volt, depends more precisely on the temperature of the diode junction and the current that flows through it. A silicon diode has a negative temperature coefficient, meaning that as the temperature rises, the voltage drop falls, and vice-versa. The linear voltage drop is measured and used to indicate temperature. The reason the circuit uses an NPN transistor with its base shorted to its collector is because it will provide a more linear response over a wider temperature range than will a single diode.

The circuit is powered from a 9-volt battery, B1. LM78L05 (IC2) low-power regulator provides a fixed 5-volt source for the circuit. That regulated supply is applied via R6 to the joined terminals of temperature-sensor transistor Q1. The voltage drop across Q1 is

detected and amplified by IC1, an LM1458 op-amp. The output of IC1 is then fed to the input terminals of a DMM. Potentiometer R2 controls the gain of the circuit, while potentiometer R8 adjusts the output reading.

Construction. The Adapter circuit is simple enough that you can use point-to-point wiring to build it. If you prefer, you can also make a PC board from the foil pattern shown in Fig. 2, or you can buy the kit that comes with one (see the Parts List for more information).

If you're building the circuit on a PC board, you can use the parts-placement diagram shown in Fig. 3 as a guide. Begin assembly by installing a socket for IC1; make sure it is oriented properly. Then go on to solder the resistors and capacitor to the board, followed by the wire jumper (J). Mount the two potentiometers next.

Solder a 9-volt battery connector to the board, paying attention to its polarity. The DVM connectors you attach should match whatever jacks are on your multimeter. We used banana jacks that plug right into a multimeter's sockets.

As mentioned before, the temperature probe is simply a modified transistor. As shown in Fig. 4, short the base of Q1 to the collector with a drop of solder. Do that right near the transistor body. You will then have a two-lead transistor. Slip some thin heat-shrink tubing over those two leads, and solder each lead to an insulated wire. Then shrink the tubing; that will make sure the leads do not short together or to anything else. Place larger-diameter tubing over the entire assembly (as shown) to strengthen, protect, and water-proof it. Connect the two wires to the board as shown in Fig. 3.

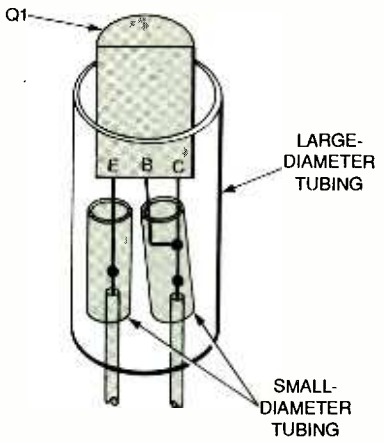


Fig. 4. Use heat-shrink tubing to make the temperature probe water-proof, and to keep shorts from occurring.

To complete assembly of the board, solder IC2 to the board, observing correct polarity, and insert IC1 into its socket. You can install the board in whatever case you like, or use it without one.

Calibration and Use. After carefully checking your work for bad solder shorts, connect a 9-volt battery to the connector. Put the positive lead of a voltmeter on pin 7 of IC1, and the negative lead on ground. Adjust R2 for a reading of 2.5 to 3 volts. Now connect the output of the Adapter circuit to a voltmeter set to the 2-volt DC scale. Adjust R8 so that the multimeter reads the same as a stabilized thermometer in the same vicinity as the temperature probe (ignore the decimal point).

With that done, your electronic thermometer setup should now be as precise as the calibration thermometer you used at the given temperature, and pretty accurate over its entire range. Now you'll always know the temperature at your test bench, or wherever else you decide to place the probe. ■

MONITORING AIRCRAFT

(Continued from page 47)

cinating and highly exciting facet of monitoring.

If you're feeling dazed and confused, don't tune out, try checking out our list of terminology in the "Milair Glossary" box. My book *AirWaves* (Tiare Publications), available from most radio-book dealers, will also help you sort out what's being talked about on air-traffic-control frequencies. Realize that most transmissions are, by necessity, quick and to the point. Things happen much too fast in the air for pilots to waste precious seconds by talking. Nearly everything is abbreviated, but as you'll find out, each word serves a distinct purpose.

How do you know when you've caught a military aircraft transmitting? Your first clue is the call sign. Delta, American, and United are as common as Cessna, Piper, and Learjet on the airwaves, but military call signs are a breed apart. Lion, Black Sheep, Knight, Irish Mist, Starfire, Shooter—these names are the nomenclature of military air, and they serve to alert listeners to a good catch.

The call sign is more than just a name, however. With a little practice, you'll discover that the same name is often used to describe particular squadron aircraft. For instance, VMGR-352—an air refueling squadron flying KC-130's from MCAS El Toro, California—has the squadron name "Raider." This is also the squadron's over-the-air call sign. Anytime I hear an aircraft identifying itself as Raider followed by two or three numbers, I know I'm hearing a Marine Corps KC-130. Find out the squadron names of the units in your area and you'll have a jump on covering who's transmitting.

Understanding what you're hearing takes time. Don't become discouraged. Instead try taping a few minutes of communications so that you can play it back later and study what's being said. Write down words or phrases that you don't understand and listen for other occasions in which they're used. If you're having trouble, drop me a letter care of this magazine, or e-mail me at 73733.1653@compuserve.com and I'll try to steer you right. Keep in mind that only time and patience will make seemingly cryptic communications become clear.

Remember that military air listening is nothing like police and fire chatter. The communications aren't non-stop and they don't clutter the band. This type of listening is a hunt, and the prize is an inside look at our finest airborne warriors at work. Each catch is like a nugget of gold gleaned from a hill of sand, a peek into a world where the smallest mistake can mean disaster, where living on the edge at Mach One is common. If you're looking for a challenge, a facet of listening barely touched by the common scanner listener, then look no further—this is it. Just one warning, however: monitoring military aircraft isn't only wild, it's downright addictive. ■

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The Denver Post

Independent study from CIE will give you the skills you need to win your own independence in a successful career.

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Abbreviations: (AR)Antique Radio, (C)Construction, (CB)Computer Bits, (CC)Circuit Circus, (D)Department, (DX)DX Listening, (ED)Editorial, (G)Gizmo, (HOR)Hands-on Report, (HR)Ham Radio, (LET)Letters, (MW)Multimedia Watch, (NW)Net Watch, (PTR)Product Test Report, (SS)Scanner Scene, (TT)Think Tank

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Think Tank

Semiconductors and a Look Back

BY JOHN J. YACONO
TECHNICAL EDITOR
WINDOWS MAGAZINE

This month I'd like to start discussing components that boosted the electronics revolution like no other: semiconductors. Semiconductors have provided a light-weight, low-power, low-heat, small-scale, inexpensive solution to building circuits that have replaced tube technology in all but a few very specialized applications.

As their name implies, semiconductors aren't quite insulators of conductors. They can be made to conduct very well, but only under the right conditions. What distinguishes them from insulators and conductors is their atomic structure.

A conductor typically has close to eight electrons in its outer or "valence" shell. Eight being the maximum number of electrons an atom can have in a shell, the electrons are only loosely held in place, so it takes only a little nudge to make them migrate through the material.

Insulators classically have less than four outer electrons. The atoms are covetous of their few outer electrons and it would take quite a jolt to get them flowing. When current does flow through such a material, it typically damages it.

Man-made semiconductors are based mainly on two materials: silicon and germanium. However, silicon is more popular because it's stable over a wider temperature range. They both have four outer electrons, which makes them "tetravalent" materials, and they're poor as either insulators or conductors. But these materials only form the base or substrate used in a semiconductor material. Impurities called "dopants" are added to a substrate to alter its characteristics, transforming it into a semiconductor.

Common dopants have either five outer electrons (making it a "pentavalent" material) or three outer electrons (making it a "trivalent" material). When a substrate and dopant combine, they share their outer electrons. When a tetravalent substrate is doped with a pentavalent dopant, each pair of atoms has one more electron than it needs. A semiconductor with extra electrons is called an n-type ("n" for "negative") material. The dopant is called a "charge donor" because it donates the characteristic charge to the material. The substrate is called the "charge acceptor."

The extra electrons in an n-type material are more easily coaxed to roam around than they would be in the unmodified substrate. Until next time, I'll leave you with a couple of intriguing questions: What materials would comprise a "p-type" semicondutor? If it doesn't have extra electrons, what would it have a surplus of? If a current flows through a p-type material, what would actually move? Now, let's turn to the letters.

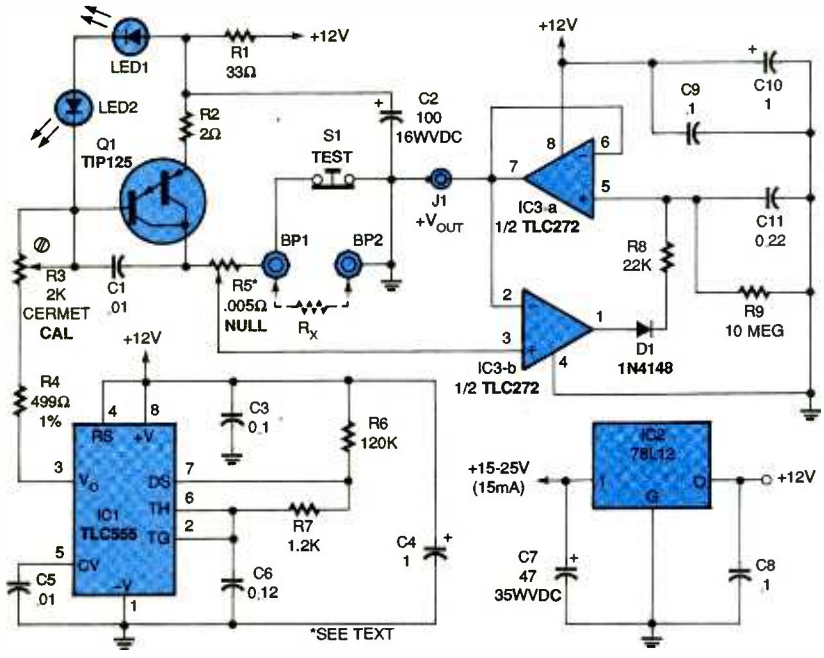


Fig. 1. Add this to your DMM to measure ultra-low resistance. But don't use it on reactive circuits.

MILLIOHM ADAPTER REVISITED

I have to comment on the "Milliohm Adapter" project shown in *Think Tank* in the March 1996 issue of **Popular Electronics**. Mr. Yacono neglected to mention a major source of error: inductance.

The 100-Hz chopper circuit shown to help measure low resistance (see Fig. 1) will yield inaccurate readings if there is any inductance in the circuit. You might even get a surprising shock if you tried to measure the primary winding resistance of an automotive ignition coil and got too close to the output wire.

The Milliohm Adapter should not be used on inductors, transformer windings, solenoids, electric motor windings, or even long pieces of wire over 15 feet. Usefulness of the circuit is restricted to measuring low-inductance items such as non-inductive resistors, heating elements (cold resistance), and contact resistance.

Chopper circuits were used for measuring resistance in some of the early digital multimeters in the '70s. They quickly gained a bad reputation because users could not trust the readings. To measure DC resistance and ignore any inductance or capacitance in a circuit, a DC current must be used and a DC voltage measured (or vice versa).

I have been reading your magazine

for 30 years and I look forward to 30 more (at least).

—*Ernie Worley, San Jose, CA*

Absolutely right. High-frequency signals cannot be used to measure resistance in circuits containing reactive components. I took it for granted when presenting the circuit, but really should have pointed it out for our beginning experimenters.

Thanks for being such an avid ***PE*** *reader.*

SURGE OF INTEREST

Regarding "Surging Ahead," on page 73 of the May 1996 issue, you say that a failure of MOV2 (shown here in Fig. 2) would compromise the grounding system of the house wiring. I presume you refer to the MOV shorting on account of a surge.

I would like to say that in the unlikely event that a sufficient surge across the ground wire and neutral wire would, perhaps, cause a short, it would merely result in an additional path to ground and in no way be dangerous. The ground circuit, completed by conduit or a grounding conductor, is connected to the neutral in the distribution panel (breaker box) and therefore would merely provide two paths for any fault current.

The purpose for the grounding wire is to prevent a short in the device that is plugged in from causing the metal enclosure of that device, such as a drill, skill saw, router or whatever, from raising its voltage level above ground. That could cause a shock to the user.

This has been largely changed in recent years by making the tools double insulated and then using a two conductor cord.

—*Dwight Eggleston, Hendersonville, NC*

I half agree. Having the MOV short is not a danger by itself, but it does compromise the grounding system. According to the National Electrical Code, ground and neutral should only be connected together at the junction box. That way there's no return current flowing through the uninsulated ground wires, which is somewhat unsafe.

Also, the return current would raise the voltage of the ground points slightly. (If you check the outlets in your home, you'll probably be surprised to find there's a potential difference between the neutral and ground circuits caused by the return current and the resistance along the neutral path.) Pulling up the ground circuit this way would also pull up grounded device cabinets, also unsafe.

Also, when a house is wired correctly, if a device shorts to ground the current must flow all the way back to the junction box before proceeding along the neutral lines through a building. That setup increases the likelihood of tripping a breaker before much damage is done.

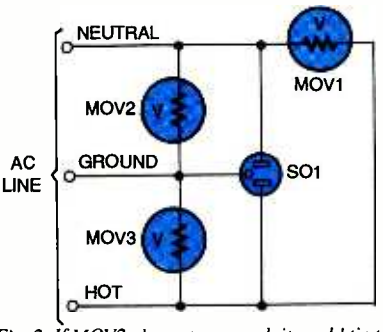


Fig. 2. If MOV2 shorts to ground, it could tie the neutral and ground lines, violating the National Electrical Code.

CORRECTED CORRECTIONS

I just read the *Think Tank* corrections (for April 1996), printed in the Letters section of the July 1996 **Popular Electronics**. While making these corrections to my copy of the April issue, I noticed another error in Fig. 2 of that month. Pin 7 of U7 (an LM384) is shown connected to ground through C5 (4.7 μF). I don't have a data sheet for the LM384 but I looked up the replacement for it in the ECG, NTE, and SK Semiconductor Replacement Guides, and all three show pin 7 as ground. As printed there is no DC current path from U7 to ground. I wonder if C5 should be connected to pin 1, which is marked in the Replacement Guides as "bypass". Also, pins 3, 4, 5, 10, 11, and 12 are shown as "ground (for heatsink)."

I also have a suggestion, which applies to both Figs. 2 and 3 from April. The parts count could reduced by using 1458 dual op-amp ICs instead of the 741 single op-amp. Perhaps even better than the 1458 would be a low-noise dual op-amp such as the 4558 or NE5532. Both have the same pin connections as the 1458. The 4558 has probably been used more than any other IC by manufacturers of guitar amplifiers.

—*Bill Stiles, Hillsboro, MO*

I don't have the original art for the circuit, but I'll bet you're right on the money. Thanks for the correction and good tips on the ICs.

MORE POWER, SCOTTIE

It was interesting to see Mr. Billy R. Pogue's circuit for powering battery-type tubes such as the 01A (see Fig. 2, page 74, March 1993). I have found that the inrush current into a cold tube filament is so high (because the cold resistance is only one-tenth of the hot resistance) that voltage regulators such as he used conveniently self-protect and shut down! You can't get there from here.

What I finally ended up doing to power the six type-01A tubes in a gift Atwater-Kent Model 35 was to use a Zener diode to set the base potential of a hefty (2N5302) series-pass transistor to deliver a regulated 5.5-volts DC at 1.5 amps (see Fig. 3). There is no overload protection for the transistor, as the 2N5302 can handle it for the short warm-up period. Make sure to heatsink Q1.

I decided to also use more filtering than Mr. Pogue. I kept improving my filter until it was just as clean as storage-battery operation, and I ended up with almost 22,000-μF ahead of the regulator and 42,500-μF behind it. The critical element in getting rid of the last bit of hum was to split the filter after the bridge rectifier in half, and use a series 0.33-ohm resistor for RC filtering. Luckily, at the low voltages involved, the capacitors are not too big to chassis-mount!

One note of warning to the neophyte: Because these old sets used a rheostat in the filament circuit to control the gain of the set, the current drawn by the filaments is not constant. If you burn out a tube while using an unregulated power source for filament voltage, you will probably burn out additional tubes as the voltage soars. Some sets had either multiple rheostats, or ran some tubes at full voltage. What you have to look out for there is that as you turn down one tube filament (decreasing the current drawn by the set) the voltage on the other tubes will go up!

—*Bill Thomas, Warner Robins, GA*

I've shorted out supplies based on the 78xx family, and while they do shut down, they come back again immediately. So Mr. Pogue's circuit will probably work just fine.

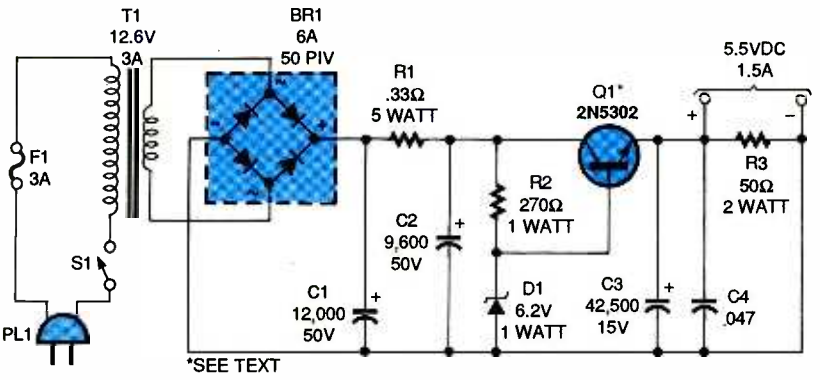


Fig. 3. This antique-radio power supply has filtering sufficent enough to make it as stable as a car battery.

That aside, your circuit is very nice and should work quite well. Thanks for the submission.

FET PROJECT

The JFET tester in the February 1993 issue (see Fig. 5, page 90 of that month) by C. Daykin will work, if you reverse diode D2 for P-channel FETs, although it appears to be designed as a go/no-go gauge for JFETs! A good tester every experimenter should have.

I enjoy experimenting with FETs, particularly power FETs, and needed a more comprehensive tester. I built one (see Fig. 4) primarily to select FETs for a motor-control circuit that must handle many amperes. The simple tester will test any FET, whether it is a JFET, CMOS, or enhanced-CMOS component. It requires only one power supply and a DPDT slide switch to test for either P-channel or N-channel. By measuring input voltages versus output voltages, graphs can be generated to check against a manufacturer's spec sheets.

The source diode in the schematic by C. Daykin will not provide enough reverse voltage to turn off most FETs. A check with spec sheets will show pinch-off voltages as high as 4 volts. I used 5.1 volt-Zeners in the source because this exceeds any pinch-off voltage, and, connected as shown, two Zeners provide bias for either N-channel or P-channel without operator selection.

In operation, either a P-channel or N-channel FET can be plugged in and tested by selecting the proper polarity with the power switch. With the control potentiometer (R2) at ground potential, the FET under test will conduct until the pinch-off voltage is reached. The LED will not turn on at this point because of the low current. This pinch-off voltage can be read at the top of resistor R4 with a high-impedance voltmeter. Increasing the potentiometer will decrease the pinch-off voltage until the FET conducts and an LED turns on. The LEDs give a rough indication of conduction. A more accurate reading is obtained by monitoring the voltage drop across the drain resistor.

For a quick go/no-go FET check, the switch (S2) across the Zeners can be closed. The associated LED should light, and go out when the switch is opened. If not, the FET is bad or connected wrong, or the selector switch is set for the wrong-polarity FET.

Enhanced FETs do not conduct until there is a positive voltage on the gate for N-channel, or negative for P-channel, and the reverse bias provided by the Zeners is not desirable. The Zeners are effectively removed from the circuit by a switch to provide proper voltages for enhancement tests. Some enhancement FETs, particularly power types, will start to turn on (reach threshold) at approximately 4 volts at the gate, but are not on completely until about 8 or 9 volts.

Power FETs of the enhancement type can conduct a lot of current and neither the Zeners or the LEDs will provide enough current-carrying capacity for power test. To determine if the FET is good or bad, a power test may not be necessary. However, to test for power ratings, a power resistor of the proper capacity must be connected between the drain and the power source where indicated, and an adequate heat sink provided for the FET. The LEDs must be switched out of the circuit. It is important to remember the FET will be in the linear mode during most of the test potentiometer's range, so a power test should be done as quickly as possible.

The 1-megohm resistor (R3) at the gate connection is protection for the potentiometer, should a unit under test short, and provides current limiting for the protection diodes in the gate of CMOS FETs. Resistor R4 (across the Zeners) provides just enough resistance to enable measuring pinch-off voltage and does not significantly affect the test. It also provides some static protection when testing CMOS transistors.

A 9-volt battery could be used to power the circuit, except in the case of power FETs. Twelve volts was chosen for the tester to compensate for the

continued on page 63

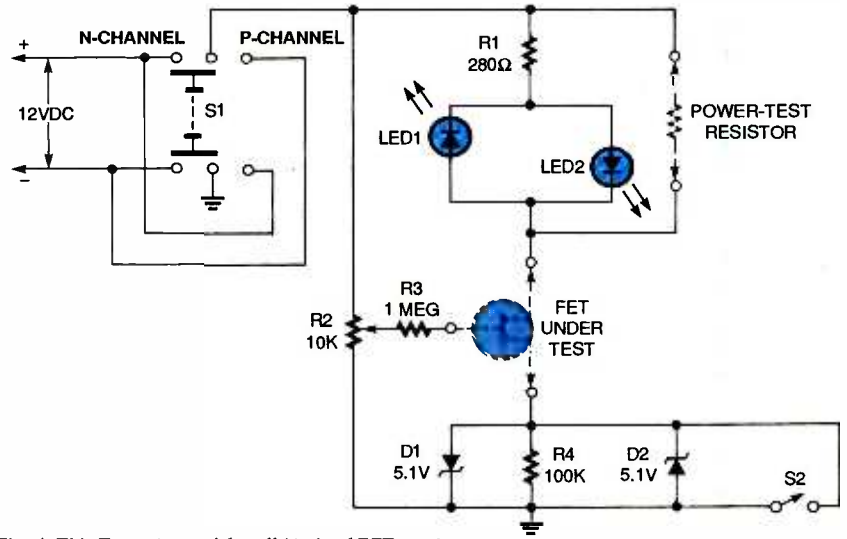


Fig. 4. This Tester is good for all kinds of FETs and even tests power output.

High-Band Antennas

BY JOSEPH J. CARR, K4IPV

The VHF/UHF ham bands are under "attack and snatch," and they will be for quite some time in the future. Various commercial and personal radio services are expanding at an exponential rate, and that imposes tremendous pressure on the limited radio-spectrum space that is currently available to hams. There are only so many frequencies. Some modern communications modes are able to make more efficient use of the spectrum, but even they have a limit. And when the bands are filled to over capacity, someone has to lose. Guess who that might be: Hams.

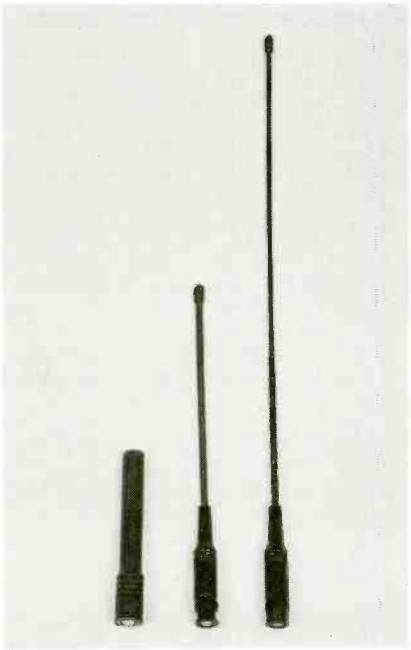


Fig. 1. These "rubber ducky" portable antennas are snappy add-ons to hand-held rigs.

The issue of spectrum-space assignment is determined by partly political and partly economic reasons. When a large company wants space, it may only have to "grease" the right political palms (make contributions to the right political campaigns), and they own a bevy of congressional representatives and senators. Some bands are protected for use by international treaty, but those are under review in 1997.

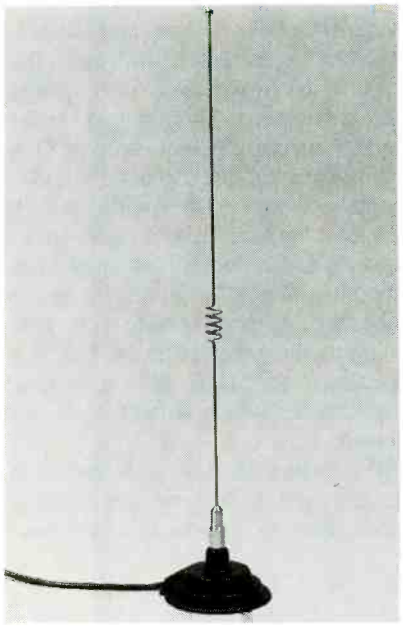


Fig. 2. Magnet-mount mobile antennas like this one grab the metal surface of your car's roof or trunk. Interconnecting coax-cable is usually long enough for most sedan models.

Several things can be done to offset the big bucks. First, monitor the situation and make sure that any political problems are answered with letters to congressional representatives (not all of them are bought), and to the Federal Communications Commission (1919 M Street NW, Washington, DC, 20036). One letter is one vote, so get all your buddies to write.

Another action you can take is to join and support the American Radio Relay League (225 Main Street, Newington, CT, 06111, or via e-mail at hq@arrl.org). You will hear a lot of grumbling about ARRL, but guess what? They are the only game in town that protects your valuable frequencies. If you don't like the way ARRL does some things, then join them and make your views known (after all, it's a membership organization and nonmembers have no standing to effect change).

The other thing you can do is to encourage the use of the VHF/UHF bands and use them yourself. After all, one of the principal arguments used in favor of reassigning spectrum space is the lack-of-use argument. If a ham band is not being used to a high percentage of its capacity, then it's a likely target of commercial interests who want to take it, or part of it, for their own use. At one time, many (if not most) executives and engineers in commercial communications organizations were amateur-radio operators themselves, but that is no longer true. Today's big-buck bigwigs are super salesmen, not engineers and scientists. Dollars, not amateur radio, come first.

Keep in mind the no-code technician license. School children and senior groups are fertile ground for new hams and they will help get some increased activity on VHF/UHF bands.

So now, in order to do my part for VHF/UHF bands, I am going to discuss antennas for those bands in this month's and future columns.

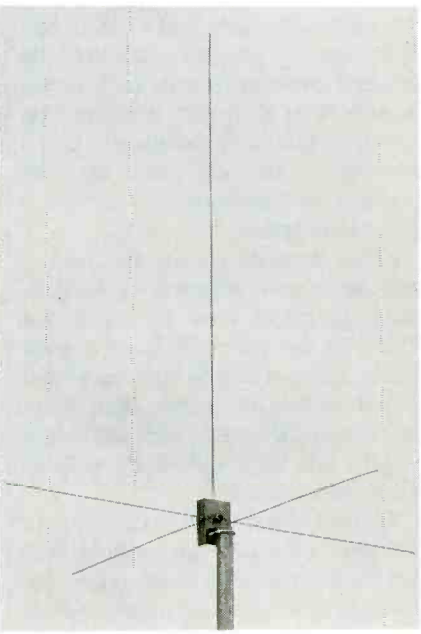


Fig. 3. A hand-made, ground-plane antenna costs only pennies to build.

6-METERS AND UP

Some antennas for VHF/UHF are special designs, but most are little more than adaptations of lower-band

TABLE 1

Frequency (MHz)	Radiator (Inches)	Radial	L (Regular Coax)	L (Foam Coax)
50	147.6	59	40	47
144	51	20.5	13.5	16
220	33.5	13.4	9	10.4

antennas. Indeed, some are the same antennas. Many years ago, a friend, now-deceased, and I went to the Red Cross Chapter House in Fairfax, VA to operate our radio club station (W4PAY). The station had several operating positions on HF and 2-meters. I accidentally connected the 80-10 meter trap dipole to the 2-meter Gonset Communicator III used for 2-meters. We received outstanding signal reports, while operating for a couple hours. VSWR was "within normal limits" (*i.e.* under 2:1) at every frequency we selected.

Okay, so how does such a thing happen? Well, it seems that an 80- to 10-meter trap dipole is on the order of 120-feet long, making each half of the dipole about 60-feet long. Half wavelength on 2-meters is around 3.4 feet. That means that 17- to 18-half-wavelength, 2-meter dipoles can be fit into the length occupied by each half of the HF dipole. Sound familiar? The 80- to 10-meter trap dipole was acting as a pair of back-to-back longwire antennas, each with a length of 17 to 18 half wavelengths! If you check some of the standard antenna references, you will discover that such an antenna has more gain than a moderate size beam antenna. A gain of 10-12 dB was deduced off-the-chart from Bill Orr's *Radio Handbook*.

If you operate on the HF bands, and use a wire antenna or vertical, then you might want to check the VSWR on the VHF/UHF band of your choice. Using a device such as a MFJ SWR Analyzer is a better check than you rig's VSWR meter and, ultimately, the MFJ unit will eliminate more QRM to the rest of us.

Figure 1 shows a small collection of VHF/UHF antennas for portable rigs. Handheld units were once quite rare and quite expensive, but today they are very common and reduced in price. The antennas shown here are variations on the "rubber ducky" theme. They are flexible, so they should be able to survive the rigors of portable operation.

The antenna shown in Fig. 2 is a magnetic-mount VHF/UHF antenna that is not dissimilar to cellular-telephone antennas. It is not permanently affixed to the car, but rather sits on the roof or trunk lid with a strong-grabbing magnet in its base. This antenna can be used for several different reasons. One is to make temporary use of the vehicle. A couple times in my life I've rented cars for a trip, and used a handheld 2-meter rig and a mag-mount antenna to temporarily make the rental car into a mobile rig. Apartment dwellers can affix a mag-mount antenna to the top of a window air conditioner for clandestine transmissions where antennas are not allowed.

The base station antenna shown in Fig. 3 is a variation on the "ground plane" antenna. It uses quarter-wavelength radials, and a longer radiator. Depending on the particular design, the radiator can be half wavelength (λ/2), five-eighths wavelength (5λ/8) or three-quarter wavelength (3λ/4). Each of these antennas has its own impedance-matching system, so they are not universally interchangeable. However, if you buy a commercial product instead of building an antenna like the one shown in Fig. 3, then the impedance matching issue is a moot point.

ANTENNA PROJECT

The $^5/_8$-wavelength, ground-plane antenna is a relatively easy way to obtain a dB or two of gain, and omnidirectional coverage at a cheap price. The antenna also has the easiest impedance-matching requirements. Figure 4 illustrates the basic design. The $^5/_8$-wavelength radiator element can be made of aluminum tubing, wire, brazing rod, or the type of cylindrical brass stock sold in hobbyist stores. If you use a small-diameter brass rod, then select one that will fit over the cen-

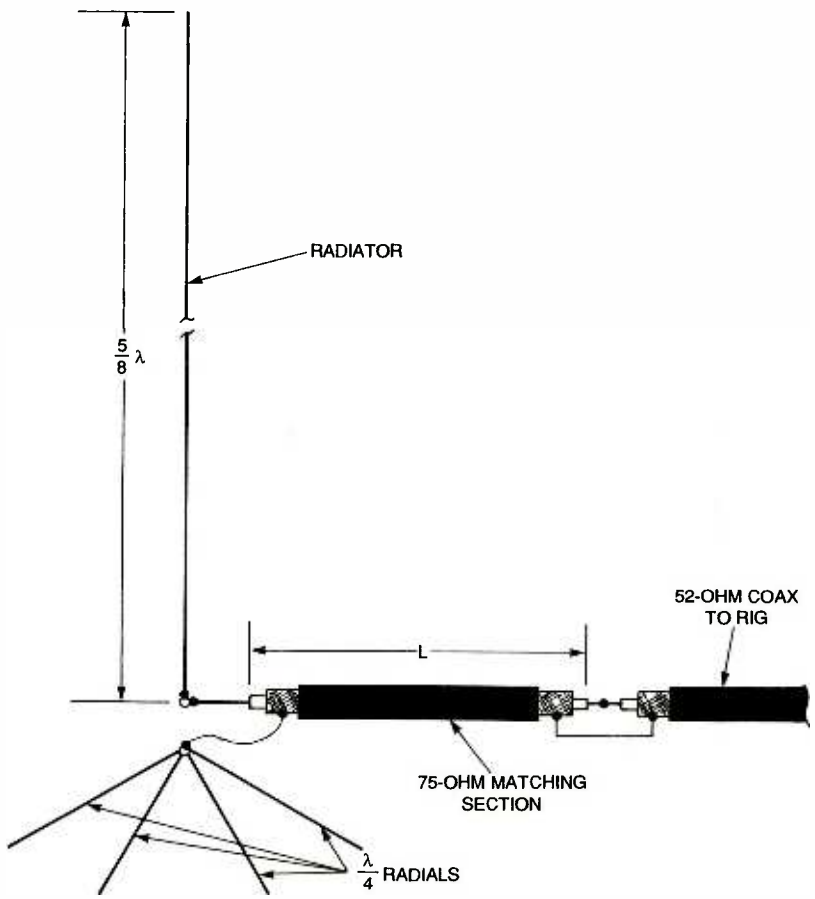


Fig. 4. You can build a $^5/_8$-wavelength vertical antenna like this one tonight. See text for all the details.

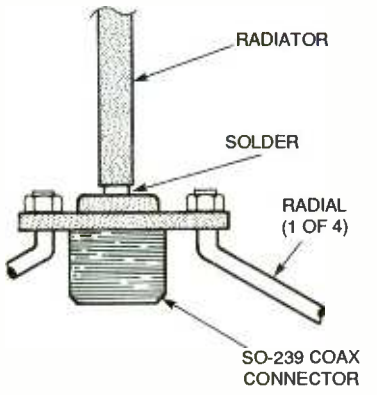


Fig. 5. Here are the base-connector details for the vertical antenna shown in Fig. 4. Only one of the four radials is detailed.

ter conductor pin on an SO-239 chassis-mount coaxial connector. It is an easy way to build that type of antenna (see Fig. 5). Make sure that the four radials are each one-quarter wavelength long.

The lengths for the radiator element, the radials, and the quarter-wavelength impedance-matching section are shown in Table 1. These antennas are relatively easy to build and adjust. Both initial adjustment and experimenting are made easier, if you have a VSWR analyzer.

That's all for now. Feel free to keep in touch. I can be reached by snail mail at P.O. Box 1099, Falls Church, VA 22041. Or, if you prefer, you can send me e-mail at carrjj@aol.com. ■

THINK TANK

(continued from page 60)

5.1-volt drop in the Zeners, and because I have a reliable 0- to 12-volt, 1-ampere supply at the bench. Above 1-ampere, the tester connects to a 12-volt car battery.

—Thornton E. Benson, Benson, AZ

That's a pretty thorough test fixture. A switch to break the circuit through the LEDs for power tests would be a good addition.

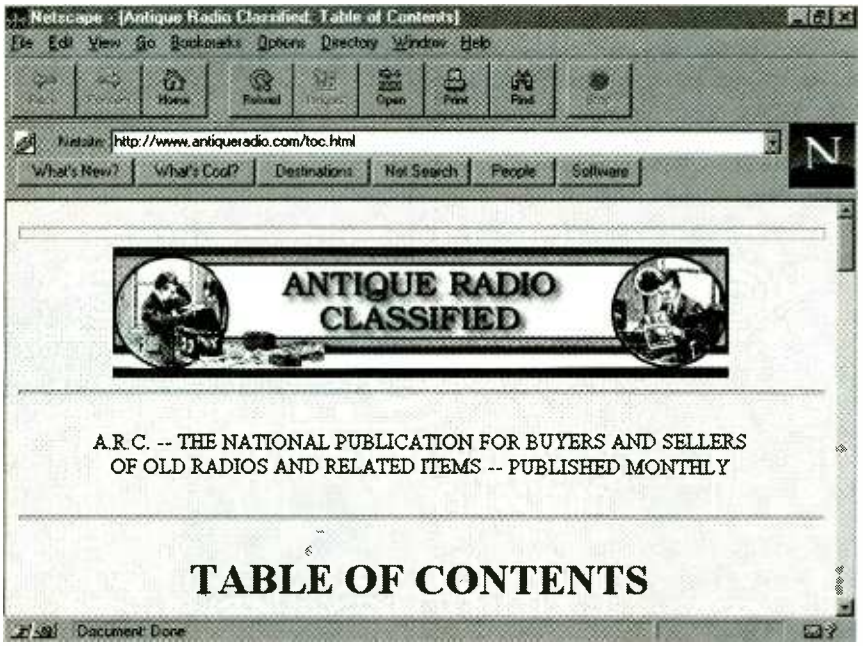
Well, this month's column has come to an end. If you'd like to participate in an upcoming issue, send your schematics and explanations to: *Think Tank*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. For each circuit that appears, you'll receive a book from our library. Send in enough circuits to fill a column, and you'll receive a kit and MCLC1010, too. ■

ANTIQUE RADIO

Antique Radio on the Web

BY MARC ELLIS

Last month we spent some time talking about antique-radio-oriented newsgroups and mailing lists on the Internet. But we ran out of space before we could even touch on the amazing array of information awaiting the antique-radio hobbyist on the World-Wide Web.



Our tour through the World-Wide Web was kicked off by the antique-radio resources listings found on Antique Radio Classified's Web page.

WWW BASICS

What is the World-Wide Web? Well, loosely speaking, it is a facility for delivering multimedia information (text, pictures, video, and sounds) to your computer. That information is handled by specialized computers, called *web servers*, which are located all over the world and linked via the Internet. It is delivered to you via documents, known as *web pages*, which are found at locations called *web sites*. The pictures, sounds, and text on those "pages" are stored as digital files that you can, if you wish, download to your computer and store on a hard or floppy disk.

Web sites are being put up by corporations and businesses of all sizes; museums, schools, and other non-profit organizations; and individuals like you and me. They are being used to communicate every conceivable kind of information. TV networks promote new shows, manufacturers promote new products, and hardware and software manufacturers provide customer service and make available updated drivers and patches. I've even come across an international "marriage bureau" with thumbnail photos and bios of women from every part of the world seeking American husbands.

And here's the interesting thing: As of now, at least, access to the Web is so inexpensive and easy that individuals are on practically the same par as large corporations. All you need are some moderate programming skills, access to a scanner to digitize photographs, and a little good taste, and you can put up a page of your own that rivals that of a major corporation like General Motors.

What kinds of things do individuals put on the Web? Well, everything and anything. But hobby interests are very big, especially the sharing of information and the posting of "brag" photos. But we'll get to that!

Another important feature of a Web document is the fact that it can incorporate *hypertext*. Words or phrases in hypertext are linked, by the author, to related parts of the document or even to other related Web sites. The hypertext word or phrase might be underlined and/or appear in a different color from the rest of the text. The reader just clicks on the hypertext with a mouse to jump to the linked material.

For example, on your Web site, you might have some text comparing two Philco receiver models. Elsewhere on your site, you have an illustrated catalog of holdings that includes pictures of both models. You link each of the Philco model numbers in your text to the appropriate picture. The person reading the text will then be able to click on either of the model numbers to see a picture of the set. If you don't have an appropriate picture on your site, you can put in a link to another site where the set is illustrated, perhaps that of another collector or a museum.

Access to the sites on the World-Wide Web is via a piece of software called a *Web browser*. One of the most well-known of those is *Netscape*, although there are others in common use, such as Microsoft's *Explorer*. A browser gives you the means to connect with a Web site of interest, which you accomplish by keying in the URL (Uniform Resource Locator) address that uniquely identifies the site.

Browsers also contain software elements that allow you to view the photographs and videos, and/or listen to sounds that might be included with the text you are reading.

You might be wondering how you can identify Web sites of interest without knowing their URLs. Most Web browsers incorporate access to one or more *search engines* that allow you to find sites by entering key words or phrases (for example: "antique radio," "radio parts," "broadcasting," etc.) The browsers will then

The Phil's old Radios Web site has a sophisticated and attractive design.

scan all Web sites in their databases to find the ones that contain your key words. The results will be presented to you as a list of sites, each with a brief description. Just click on the one you want to visit!

WEB ANTIQUE-RADIO RESOURCES

Someone once compared the World-Wide Web to a lake 1000 miles across and 1/4-inch deep. In a way, that's a pretty apt comparison. There is a truly amazing amount of information out there—and quite a lot of it could be characterized as unreliable or shallow.

It is so easy and inexpensive to "publish" something on the Web that quite a bit of information is presented without benefit of thorough research or editorial filter. Beware, especially, of private Web pages authored by people whom you don't know—especially if you are a new hobbyist. A lot of misinformation and personal bias is being published in the name of truth!

Yet, at the same time, there is so much good and useful stuff out there that one would have to say that the Web is an indispensable tool for today's active hobbyist. Browse and enjoy, but keep your guard up!

Over the past couple of days, I've "surfed" many of the antique-radio pages on the Web, trying to come up with a structure for introducing the available resource to readers of this column. Time after time, I found myself returning to the Web site of *Antique Radio Classified* (*ARC*) magazine. As most of you know, that well-known publication is a major marketplace for the buying and selling of antique-radio items. If you are new to the Web, I would recommend the site as a very good place to get started. The URL for connecting to *ARC* is http://www.antiqueradio.com/.

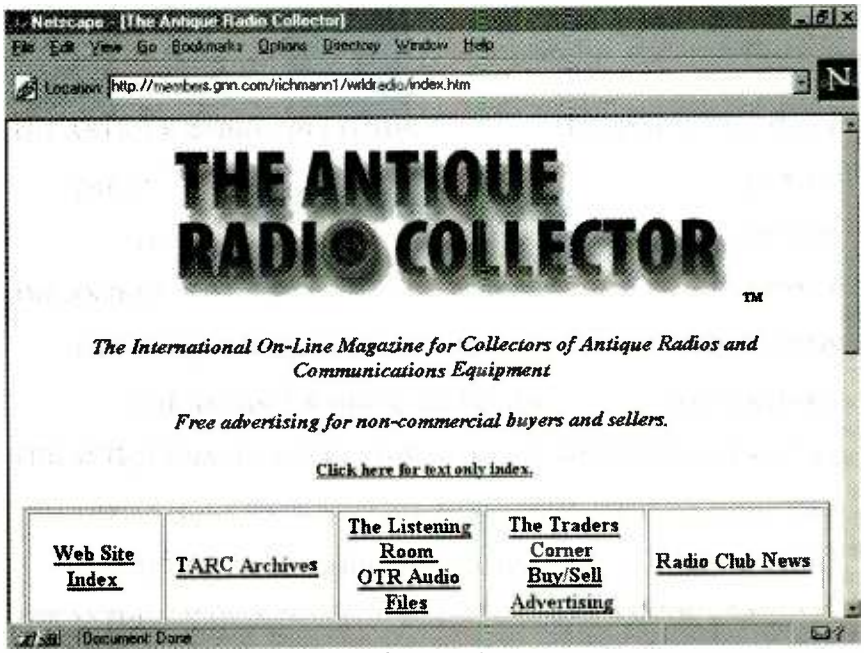
At that site, you'll find articles from current and past issues, a picture gallery of antique radios, and much material of interest. But I want to call your attention to the extensive compilation of links to other antique-radio Web sites. To see them, just click on Radio on the Web on the Table of Contents page.

As this is being written, the compilation contains almost 75 hypertext site listings; you can visit any site by clicking on its name. The sites are divided into the following categories: Clubs/Museums, Collections and Individuals, Resources, Publications, For Sale/Services/Etc., and Other Sites.

Browsing through the Clubs/Museums category, I noted that The Antique Radio Wireless Association, in addition to basic information on the club, was offering complete information on its big annual conference in Rochester, New York. The Bellingham Antique Radio Museum caught my interest with its chronologies of the development of radio and radio broadcasting. The California Historical Radio Society was presenting a very useful array of restoration tips.

Moving down to Collections and Individuals, I browsed through the Classic Radio Gallery, which showcases the extensive collection of Merrill Mabbs. Then I looked at a couple of special-interest sites: Eric Braun's Wireless Postcard Page and Mr. Transistor (of London, England). On both of those pages, the proprietors show interesting examples from their collections, share their expertise, and

continued on page 67



The Antique Radio Collector *is a unique online magazine.*

COMPUTER BITS

Coming Trends

BY JEFF HOLTZMAN

This is the first issue of the year. In honor thereof, I want to discuss some of the biggest issues confronting the computer industry, and give my totally personally biased prognostications about what's coming up. The issues fall into four categories: hardware, networking and Internetworking, applications and utilities, and business.

HARDWARE

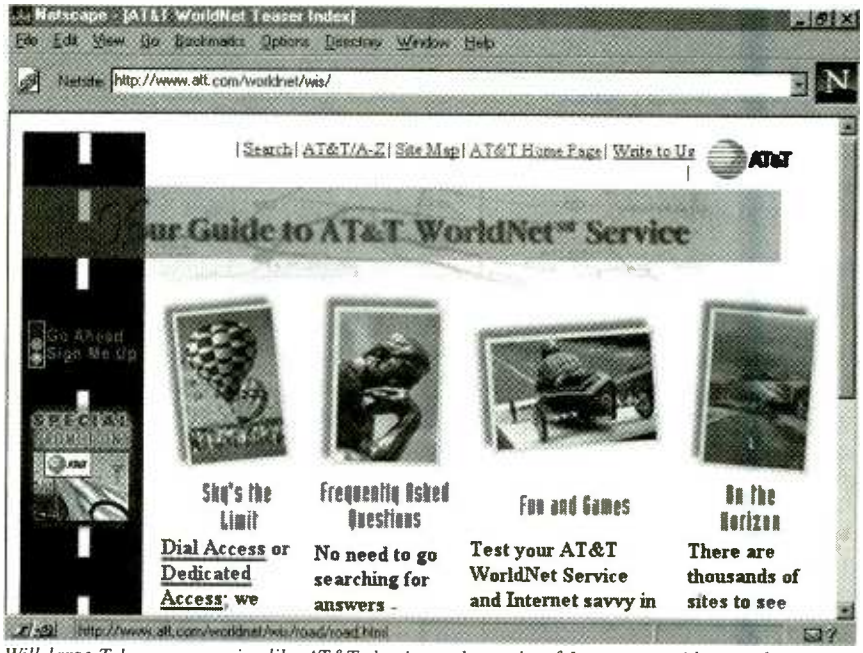
The biggest hardware *thing* to happen to the computer industry in a decade was not the advent of the Pentium, nor CD-ROM discs, nor cheap GB-size hard drives. The biggest thing was the availability in 1996 of cheap, abundant semiconductor memory. Prices are currently hovering around $120 for 16 MB. That means you can put 64 MB of RAM in a PC for about $500; and there's no reason not to. Pricing is still dropping, so when you read this column you should be able to do much better.

That in turn means there's a whole new set of rules, as far as the kinds of operating systems we can run, the applications we can use, and the data we can manipulate. If we had memory this cheap back in 1987, when IBM and Microsoft introduced OS/2, we might all be running OS/2 today. Running several huge applications on a 64-MB-equipped machine is not only possible, but painless. Doing multimedia kinds of things (audio and video) is infinitely more pleasurable.

One upcoming hardware trend to look forward to is USB (Universal Serial Bus). USB is a standard that promises to make installing computer peripherals literally as easy as snapping in a telephone extension. USB provides a high-speed bus that current peripherals (mouse, keyboard, CD) can use, as well as a newly emerging category of what we traditionally think of as consumer-electronics devices, including things like audio systems, video systems, and digital snapshot cameras.

The biggest question is digital video disc (DVD) technology—will it or won't it succeed? CD-ROM technology is basically maxed out; we're already seeing multi-CD applications and databases. The computer industry already needs something like DVD, and if the entertainment industry doesn't take its foot off the brake, the computer industry will do something on its own.

What the entertainment industry doesn't realize is that no matter what copyright and encryption schemes it comes up with, hackers will inevitably find ways to crack them. If the entertainment industry was *smart*, it would find ways to add value to the non-copyable portions of these products, such as the packaging. For example, most people I talk with who are old enough to have any sizable investment in vinyl LPs have little love for audio-CD packaging. We wouldn't want to give up the totally superior signal quality of CDs, but we nonetheless miss album-cover art and liner notes.



Will large Telcom companies like AT&T dominate the ranks of Internet providers in the coming days? It looks possible.

NETWORKING

Internet this, Internet that. What a bore. Delayed and failed log-ins are becoming more and more frequent and tiresome. Interrupted file transfers and servers that suddenly drop off-line are even more so. Home users may or may not find that acceptable, but business users absolutely will not. What will happen then is that the industry will segment into layers providing various tradeoffs among reliability of service, cost, and some kinds of value-adding features such as tech support. There is little doubt that the big telecom companies (AT&T, MCI, and Sprint) are going to eat the vast majority of the small ISPs (Internet Service Providers) for lunch. Whatever else you do, don't sign any long-term agreements for Internet services.

Then there's electronic commerce, that is, buying and selling products and services via the Internet. Already you can buy everything from music to software to stocks and bonds, and the trend is only going to increase. Perhaps we can look forward to the day when all purchases are made this way, totally eliminating the need for cost-inflating middle-men. In the process, we may create yet another dependent segment

of society. I wonder, how would we deal with that?

SOFTWARE

The major issue here is that of monolithic applications (and suites of applications) versus smaller, more modular, distributed chunks of software, downloaded and updated on an as-needed basis.

The distributed architecture makes sense technically, and is in a sense a continuation of trends most evident in the transition from mainframes to minis to PCs. But it doesn't fit the model that has been driving the PC portion of the computer industry for a decade and a half. Microsoft, for all intents and purposes having won the application suite wars, now by default owns that monolithic vision, hence it will be up to the company to defend it—or to change it. Again I think we'll see a tiered approach, ranging from everything-including-the-kitchen-sink CD-based application suites to mini-apps based on Microsoft's ActiveX (formerly OLE Controls) technology. The question is what, if anything, will occupy the middle tier.

Then there's the issue of Java *vs.* ActiveX, and Java *vs.* the monolithic suites. According to proponents, Java can be used to build everything across all tiers. However, we've seen no significant large-scale Java-based software to date. Java also has significant technical lapses, such as an incomplete range of application programming interfaces (APIs), and only moderate support from third-party tool vendors.

Java's biggest strength is not technical, but market-related: Java is not a Microsoft technology. Regardless of its technical merits or lack thereof, there may just be enough anti-Microsoft sentiment in the industry to find ways of working around, surmounting, evolving, or overcoming Java's relative immaturity, and thereby pushing development of compelling new applications.

BUSINESS

I guess the key point to be made in the context of a technical magazine like this one is that the battle is not *technical*. It is not about superior technology. It is about dollars. It is about power. It is about control. Anybody who tells you otherwise is naïve.

Another extremely important point is that computer-industry innovation used to be measured internally, according to internal standards. Now the focus is outward and based on interfacing—interfacing with Hollywood and Nashville, with AT&T and MCI, with VISA and MasterCard.

To the extent that these outside influences are helping the PC industry mature, they are good. Solutions to the problems facing the industry may not be any closer, but the change to a more global context for developing solutions will benefit everyone. ■

ANTIQUE RADIO

(continued from page 65)

extend invitations to trade. I was also charmed by Phil's old Radios, a very sophisticated and graphically beautiful site. Those interested in construction Web sites will find it to be an excellent model. In addition to displaying Phil's collection, the site contains a very complete list of antique-radio resources.

What first caught my eye in ARC's Resources category was the Broadcast Pioneers Library of the University of Maryland Library system. In addition to cataloging the museum's holdings or recordings and scripts, the site also offers soundbites of several early commercials that can be downloaded to your computer. More soundbites are available at Radio Days: A Soundbite History, James Widner's page.

Moving along to Jim Hawkins Radio Room, I was treated to a photo tour of the Voice of America Relay site at Greenville, North Carolina. Padgett's Trans-Oceanic Page contains model identification information and restoration lore invaluable to any collector of these sets. Finally, Rich Samuel's Broadcasting in Chicago, 1921—1989 featured a virtual tour of the NBC Merchandise Mart studios as they appeared in the early 1930s.

In the Publications section, I took a look at Horn Speaker, which featured excerpts from current and past issues of *Antique Radio Classified* as well as reprints of vintage articles on radio repair. Xtal Set Society also presented interesting excerpts, including complete plans on how to build a Quaker Oats canister crystal set.

Looking through For Sale/Services/Etc., I stopped first at Antique Radio Grille Cloth (John and Mary Okolowicz), where I was able to view an online catalog of reproduction grille cloth, complete with photographs of all styles. The Antique Radio Restoration and Repair site offered a nationwide radio restoration service covering every detail, down to ultrasonic cleaning of the knobs. Marty's Home Page (Marty Bunis) offered several items for sale and showcased a test version of the CD-ROM version of his *Collector's Guide to Antique Radio*.

Finally, under Other Sites, I viewed an edition of *Antique Radio Collector*—a very interesting electronic magazine. I also took a look at Chuck Schwark's Home Page, showing his extensive collection of wood-cabinet table models and offering schematics and advice on Philco restoration. The Transistor Radio Page, another site with beautifully designed graphics, treats us to excellent photos of classic transistor sets and includes a "wanted/for sale" classified section.

Well, readers, that completes our brief tour through the antique-radio resources of the Web. We've hardly scratched the surface, but I hope your appetite is whetted. And one thing is for sure—once you start looking, there's no end to what you'll find! ■

CIRCUIT CIRCUS

Electronic Sensors

BY CHARLES D. RAKES

This visit we're going to explore the world of electronic sensors. In today's electronic age there are very few things that move or operate without the aid and guidance of some type of sensor. The modern automobile is a prime example. Just see how far you can travel when one of the sensors feeding the car's "brain" (microprocessor) goes off to never-never land. Unlike the model "T", duct tape and baling wire won't get you down the road. It's toe time.

Sensors don't have to be complicated or complex in nature. The simple on/off switch is probably the most often-used sensor. In a typical manufacturing operation the automated equipment uses numerous mechanically operated on/off switches to feed data to the controller. These switches tell the controller the location of various moving parts, such as starting position, end of travel, and other locations in between.

Anytime a mechanically operated sensor can be replaced with a non-moving electronic sensor the rate of failure will be greatly reduced. In fact most failures in our electronically controlled world are actually mechanical in one form or another. Basically, if it moves, it will eventually wear out and fail.

Our first group of non-moving, non-mechanical replacement sensors are light operated. That is perhaps one of the most popular types of sensor in use today.

SEE-THROUGH SENSOR

In our first circuit (see Fig. 1) an infrared emitter LED (LED1) is aimed at an infrared photo transistor (Q1). As long as the IR light path remains uninterrupted between the two, transistor Q2 will keep relay RY1 closed. Any opaque object blocking the light path will cause RY1 to open.

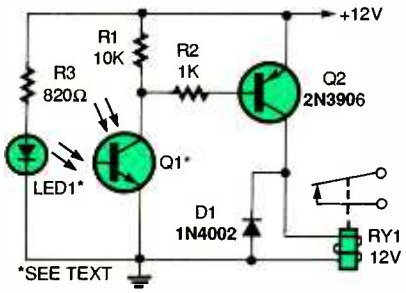


Fig. 1. Any opaque object blocking the light path between LED1 and Q1 will cause RY1 to open.

PARTS LIST FOR THE SEE-THROUGH SENSOR (Fig. 1)

SEMICONDUCTORS
Q1—NPN photo transistor (Mouser L14G2 or equivalent)
Q2—2N3906 PNP transistor
D1—1N4002 silicon diode
LED1—Infrared light-emitting diode (Mouser LED55C or equivalent)

RESISTORS
(All resistors are 1/4-watt, 5% units.)
R1—10,000-ohm
R2—1000-ohm
R3—820-ohm

ADDITIONAL PARTS AND MATERIALS
RY1—12-volt DC relay
Power source, wire, solder, etc.

This circuit is a see-through-type light sensor. Such units are often used as part-in-place detectors and parts-counter sensors.

LIGHT-BLOCK SENSOR

The IR sensor circuit shown in Fig. 2 reverses the output operation of the circuit in Fig. 1. In this new circuit, relay RY1 remains open until the light source is blocked. As long as the IR light source is uninterrupted, photo-transistor Q1's collector voltage is near zero. The voltage at Zener-diode D2's cathode is too low for conduction, keeping transistor Q2 off and the RY1 open.

These first two sensor circuits are useful as shown but each uses an electromechanical output relay that could fail long before the IR semiconductors cease to operate. One simple solution to the problem is to remove the relay and use the transistor's output as a source or sink input to an electronic controller.

An example is the PLC (Programmable Controller), which is used in manufacturing plants throughout the world. This electronic marvel started out many years ago as a replacement for large banks of relays, timers, and mechanical sequencers used to control manufacturing equipment.

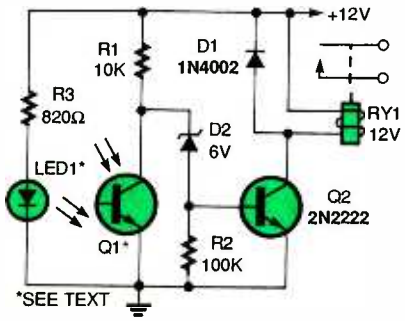


Fig. 2. In this circuit, RY1 remains open until the light path between LED1 and Q1 is blocked.

PARTS LIST FOR THE LIGHT-BLOCK SENSOR (Fig. 2)

SEMICONDUCTORS
Q1—NPN photo transistor (Mouser L14G2 or equivalent)
Q2—2N2222 NPN transistor
D1—1N4002 silicon diode
D2—6-volt Zener diode
LED1—Infrared light-emitting diode (Mouser LED55C or equivalent)

RESISTORS
(All resistors are 1/4-watt, 5% units.)
R1—10,000-ohm
R2—100,000-ohm
R3—820-ohm

ADDITIONAL PARTS AND MATERIALS
RY1—12-volt DC relay
Power source, wire, solder, etc.

PLC INTERFACE

Our next circuit, shown in Fig. 3, is an IR sensor with a timed positive output pulse that will operate with older and slower PLCs. Some of the early PLCs have scan times of 15 or more milliseconds. A part on a fast-moving manufacturing line could pass by and not be seen by the controller.

The sensor's extended output pulse may by set, by R3, to a time period longer than the controller's scan time. The sensor may also be used as a stand-alone circuit to operate a

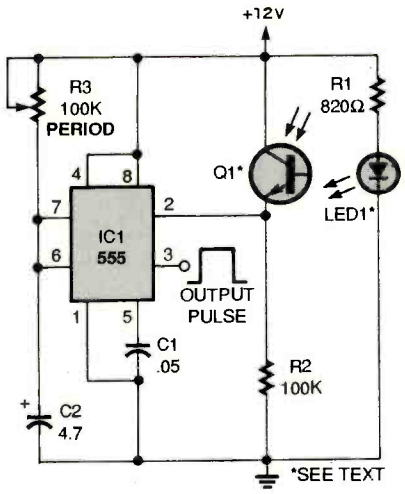


Fig. 3. This IR sensor, with a timed positive-output pulse, will operate with older and slower PLCs.

PARTS LIST FOR THE PLC INTERFACE (Fig. 3)

SEMICONDUCTORS
IC1—555 timer, integrated circuit
Q1—NPN photo transistor (Mouser L14G2 or equivalent)
LED1—Infrared light-emitting diode (Mouser LED55C or equivalent)

RESISTORS
(All fixed resistors are 1/4-watt, 5% units.)
R1—820-ohm
R2—100,000-ohm
R3—100,000-ohm potentiometer

ADDITIONAL PARTS AND MATERIALS
C1—0.05-μF, ceramic-disc capacitor
C2—4.7-μF, 25-WVDC, electrolytic capacitor
Power source, wire, solder, etc.

counter, a valve, an indicator, or any other electrically controlled device.

As long as nothing is blocking the IR light source, the emitter of photo-transistor Q1 is high and 555-timer IC1 is set in the ready state. When an object blocks the light source, Q1 turns off sending a negative pulse to the trigger input at pin 2 of IC1, producing a timed output pulse. The values of R3 and C2 determine the length of the output pulse. Larger values produce longer output pulses.

REVERSED PLC INTERFACE

Our next IR sensor circuit (see Fig. 4) operates similarly to the preceding sensor with one important difference—its function is reversed. In other words, the circuit's timed output pulse doesn't occur until photo-transistor Q1 is unblocked.

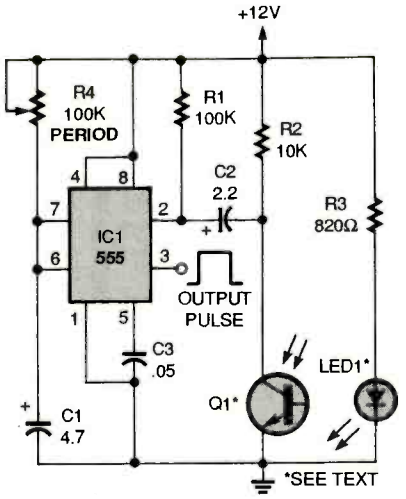


Fig. 4. The timed output pulse in this circuit will not occur until photo-transistor Q1 is unblocked.

PARTS LIST FOR THE REVERSED PLC INTERFACE (Fig. 4)

SEMICONDUCTORS
IC1—555 timer, integrated circuit
Q1—NPN photo transistor (Mouser L14G2 or equivalent)
LED1—Infrared light-emitting diode (Mouser LED55C or equivalent)

RESISTORS
(All fixed resistors are 1/4-watt, 5% units.)
R1—100,000-ohm
R2—10,000-ohm
R3—820-ohm
R4—100,000-ohm potentiometer

CAPACITORS
C1—4.7-μF, 25-WVDC, electrolytic
C2—2.2-μF, 25-WVDC, electrolytic
C3—0.05-μF, ceramic-disc

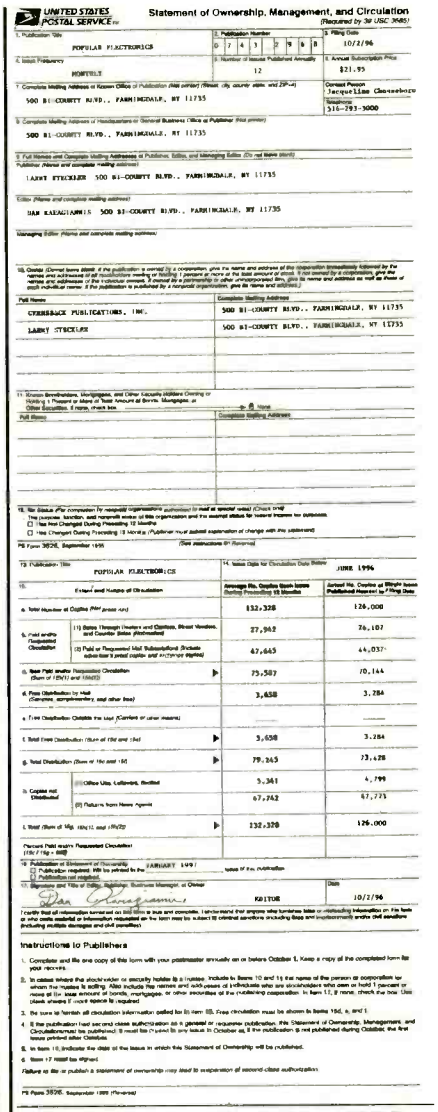
ADDITIONAL PARTS AND MATERIALS
Power source, wire, solder, etc.

As long as an object remains between LED1 and Q1, no output occurs. But as soon as the object moves out from between the LED and photo transistor, IC1 (again, a 555 timer) is triggered, producing a timed output pulse. This circuit may be used to indicate when a part has moved away from a location.

REFLECTIVE SENSOR

The IR sensor circuit shown in Fig. 5 produces an output when LED1's light is reflected from an object back to photo-transistor Q1. The LED and photo transistor should be mounted parallel to each other and aimed in the same direction.

Without a reflective object the voltage at the input of the LM339 com-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1. Publication Title: POPULAR ELECTRONICS — 2. Publication Number: 0 7 4 3 2 9 8 8 — 3. Filing Date: 10/2/96
4. Issue Frequency: MONTHLY — 5. Number of Issues Published Annually: 12 — 6. Annual Subscription Price: $21.95
7. Complete Mailing Address of Known Office of Publication (Not printer) (Street, city, county, state, and ZIP+4): 500 BI-COUNTY BLVD., FARMINGDALE, NY 11735 — Contact Person: Jacqueline Cheseboro — Telephone: 516-293-3000
8. Complete Mailing Address of Headquarters or General Business Office of Publisher (Not printer): 500 BI-COUNTY BLVD., FARMINGDALE, NY 11735
9. Full Names and Complete Mailing Addresses of Publisher, Editor, and Managing Editor (Do not leave blank)
Publisher (Name and complete mailing address): LARRY STECKLER 500 BI-COUNTY BLVD., FARMINGDALE, NY 11735
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13. Publication Title: POPULAR ELECTRONICS	14. Issue Date for Circulation Data Below: JUNE 1996
15. Extent and Nature of Circulation	Average No. Copies Each Issue During Preceding 12 Months	Actual No. Copies of Single Issue Published Nearest to Filing Date
a. Total Number of Copies (Net press run)	152,328	126,000
b. Paid and/or Requested Circulation (1) Sales Through Dealers and Carriers, Street Vendors, and Counter Sales (Not Mailed)	27,962	26,107
(2) Paid or Requested Mail Subscriptions (Include advertiser's proof copies and exchange copies)	67,645	44,037
c. Total Paid and/or Requested Circulation (Sum of 15b(1) and 15b(2))	75,587	70,144
d. Free Distribution by Mail (Samples, complimentary, and other free)	3,658	3,284
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h. Copies not Distributed (1) Office Use, Leftovers, Spoiled	5,341	4,799
(2) Returns from News Agents	67,742	47,773
i. Total (Sum of 15g, 15h(1), and 15h(2))	152,328	126,000
Percent Paid and/or Requested Circulation (15c / 15g × 100)		

16. Publication of Statement of Ownership: ☐ Publication required. Will be printed in the JANUARY 1997 issue of this publication. ☐ Publication not required.
17. Signature and Title of Editor, Publisher, Business Manager, or Owner: Hal Kakaliaris, EDITOR — Date: 10/2/96
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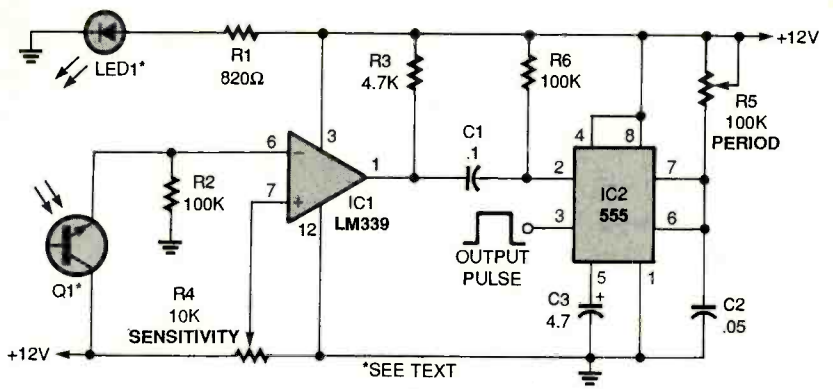

Fig. 5. Unlike the other sensors, this circuit produces an output when LED1's light is reflected from an object back to photo-transistor Q1.

PARTS LIST FOR THE REFLECTIVE SENSOR (Fig. 5)

SEMICONDUCTORS
IC1—LM339 comparator, integrated circuit
IC2—555 timer, integrated circuit
Q1—NPN photo transistor (Mouser L14G2 or equivalent)
LED1—Infrared light-emitting diode (Mouser LED55C or equivalent)

RESISTORS
(All fixed resistors are 1/4-watt, 5% units.)
R1—820-ohm
R2, R6—100,000-ohm
R3—4700-ohm
R4—10,000-ohm potentiometer
R5—100,000-ohm potentiometer

CAPACITORS
C1—0.1-μF, ceramic-disc
C2—0.05-μF, ceramic-disc
C3—4.7-μF, 25-WVDC, electrolytic

ADDITIONAL PARTS AMD MATERIALS
Power source, opaque tubing for Q1 and LED1, wire, solder, etc.

parator (IC1) is at or near ground level, and the output at pin 1 of IC1 is high. When the photo transistor detects a reflected light signal, the voltage at Q1's emitter goes high causing the comparator's output to go low. The 555 timer (IC2) is then triggered, and produces a timed output pulse at pin 3.

The circuit's sensitivity is set by R4 and its output time period by R5. You can alter the circuit's function to operate like the sensor in Fig. 4 by reversing the connections to input pins 6 and 7 of IC1. With this simple modification an object must move in front of the sensor and then move away for an output to occur.

Note that in this circuit, as well as in the next one, all of the unused input and output pins of the LM339 must be tied to circuit ground.

TOUCH SENSOR

Our next sensor circuit (see Fig. 6) is a basic two-contact touch-switch sensor circuit. At its heart is an LM339 comparator (IC1). The negative input (pin 6) of IC1 is tied to the positive supply through R2 (which is actually two 22-megohm resistors connected in series), while the positive input (pin 7) is connected through R1 (made up of two 22-megohm and one 10-megohm resistor in series).

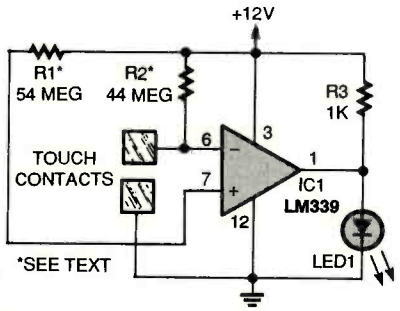

Fig. 6. The circuit shown here is a basic two-contact touch-switch sensor.

PARTS LIST FOR THE TOUCH SENSOR (Fig. 6)

RESISTORS
R1—54-megohm, 1/4- or 1/2-watt, 5% (see text)
R2—44-megohm, 1/4- or 1/2-watt, 5% (see text)
R3—1000-ohm, 1/4-watt, 5%

ADDITIONAL PARTS AND MATERIALS
IC1—LM339 comparator, integrated circuit
LED1—Light-emitting diode, any color
Power source, touch contacts, wire, solder, etc.

The comparator's output is normally low, keeping LED1 from turning on. When contact is made between the two touch contacts the condition reverses, turning IC1 off and allowing LED1 to light.

Well, it looks like we've used up our allotted time this go-round, so tune in again next issue and we'll look over some more sensor circuits. ■

NEW PRODUCTS

(continued from page 10)

For more information, contact Paradise Multimedia Products, 811 East Arques Avenue, MS 80, P.O. Box 3409, Sunnyvale, CA 94088-3409; Web: http://www.paradisemmp.com.

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MFJ Enterprises' MFJ-212 Matchmaker lets you tune up your antenna tuner quickly, easily, and safely(without transmitting a single milliwatt! Because there's no radiated power, you can't cause QRM. You can also precisely tune your antenna tuner for a 1:1 SWR, with no additional tweaking required. The MFJ-212 protects your transceiver and antenna tuner by helping to avoid overheating and arcing caused by high SWR and long tune-ups.

The device is easy to use(simply plug it between your transceiver and your antenna tuner. Tuning noise is modulated so that it will be easy to recognize. If you accidentally transmit, MFJ's RF Guard automatically bypasses your unit to prevent damage.

The MFJ-212 Matchmaker works with all transceivers from 160 to 6 meters. It is powered by a 9-volt alkaline battery or the optional MFJ-1312B 12-volt DC, 300-mA power supply.

The MFJ-212 Matchmaker costs $79.95; the optional power supply costs $12.95. For additional information, contact MFJ Enterprises, Inc., P. O. Box 494, Mississippi State, MS 39762; Tel. 800-647-1800 or 601-323-5869; Fax: 601-323-6551. ■

CIRCLE 86 ON FREE INFORMATION CARD

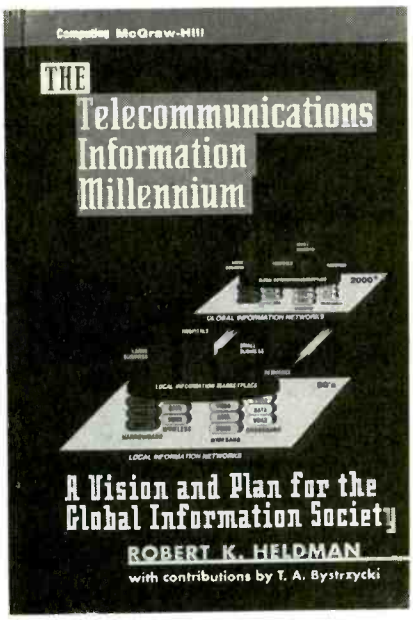
Electronics Library

THE TELECOMMUNICATIONS INFORMATION MILLENNIUM: A Vision and Plan for the Global Information Society

by Robert K. Heldman

Grounded in solid fact and informed thinking, this forward-looking book thoroughly examines and analyzes all the obstacles, as well as the many potential benefits, of creating an interactive public information network. It postulates a feasible vision for the future in telecommunications and presents a plan of action for implementing it.

The book defines tomorrow's tele-



communications opportunities in terms of today's plans and strategies, the current approaches that successfully match the right network services to the right application. It covers narrowband, wideband, broadband, and wireless information, and discusses in detail the information highway and the information marketplace. The book examines the technical possibilities and the market opportunities that will become available with a new family of networks, products, and services. In addition, it explains the regulatory, financial, and technical hurdles that must be overcome to make a public data network a reality. The book presents a realistic blueprint for the construction of a public data network that is fully interactive.

The Telecommunications Information Millennium: A Vision and Plan for the Global Information Society costs $24.95 and is published by McGraw-Hill Book Company, 11 West 19th Street, New York, NY 10011; Tel. 800-2-MCGRAW.

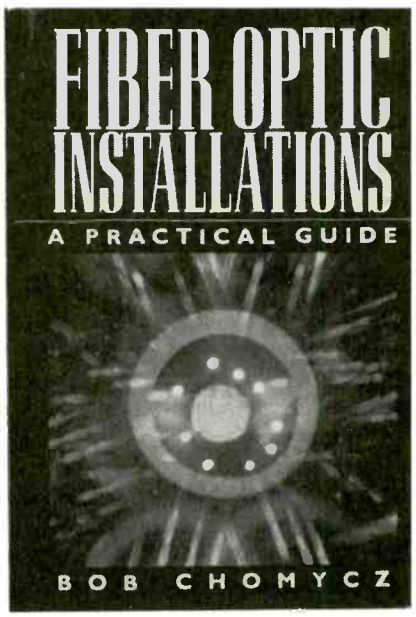
CIRCLE 90 ON FREE INFORMATION CARD

FIBER OPTIC INSTALLATIONS: A Practical Guide

by Bob Chomycz

Conventional electrical wire techniques do not apply to fiber optics. If you're one of the many engineers or technicians now required to work with fiber optics, this book can fill a gap in your training with a wealth of practical information on fiber-optic systems. Using straightforward language and a non-mathematical approach, the book provides the principles for installing and operating safe, efficient fiber-optic systems.

The book offers reliable information to speed your projects along, including safety measures specific to fiber-optic



work, handling techniques, outdoor and indoor cable installation, splicing and termination methods, using patch cords and connectors, power meter and OTDR test procedures, lightwave equipment, system integration, and maintenance procedures. It helps you understand commissioning, testing, troubleshooting, and repairing.

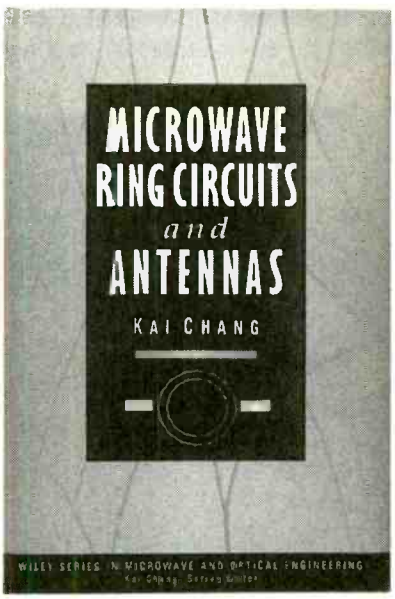
Fiber Optic Installations: A Practical Guide costs $45 and is published by McGraw-Hill Book Company, 11 West 19th Street, New York, NY 10011; Tel. 800-2-MCGRAW.

CIRCLE 91 ON FREE INFORMATION CARD

MICROWAVE RING CIRCUITS AND ANTENNAS

by Kai Chang

Dedicated specifically to ring circuits and antennas, this guide to microwave circuit design and operation includes theoretical analyses and a wealth of practical applications. It covers most ring resonators and cavities as they are used in a variety of transmission



lines, including microstrip, slotline, waveguide, and coplanar waveguide.

The book opens with a general introduction to the ring circuit, its history, and its past and present applications. It then presents a general discussion of analysis, theory, modeling, modes, coupling methods, and perturbation methods of

ring resonators. Next, the book introduces electronically tunable and switchable ring resonators. Much of the book is devoted to the application of ring circuits to microwave measurements, filters, couplers, and magic-Ts, as well as their use in mixers, active antennas, oscillators, and optoelectronics.

Microwave Ring Circuits and Antennas costs $98 and is published by John Wiley & Sons, Inc., 605 Third Avenue, New York, NY 10158-0012; Tel. 800-CALL-WILEY.

CIRCLE 92 ON FREE INFORMATION CARD

PRINTED CIRCUITS HANDBOOK: Fourth Edition

edited by Clyde F. Coombs, Jr.

For almost three decades, this definitive reference has provided comprehensive coverage of all aspects of the design, engineering, fabrication, and assembly of printed-circuit boards. The handbook will be useful to those just entering the printed-circuit field as well as experienced professionals seeking a single-volume reference that will allow them to stay competitive into the 21st century.

The fourth edition provides the same type of practical problem-solving information as its predecessors, but has been fully revised for the 1990s and beyond. Written by a team of industry experts, the book contains information on such topics as designing and engineering for performance and manufacturability, developing an effective computer-aided design process; selecting computer tools for PCB design and simulation, understanding and using SMT and MCM technologies, developing partnerships with the board and assembly suppliers, advanced materials and processes to take advantages of new components, and realistic acceptability standards for boards and assemblies. The book offers expanded sections on new component packages and design, and new chapters that provide industry-standard guidelines for inspecting boards and assemblies.

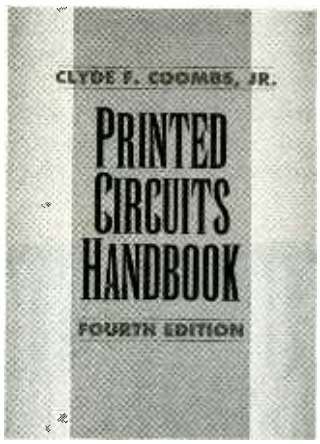
Printed Circuits Handbook: Fourth Edition costs $89.50 and is published by McGraw-Hill, Inc., 1221 Avenue of the Americas, New York, NY 10020; Tel. 800-2-MCGRAW.

CIRCLE 93 ON FREE INFORMATION CARD

SOLUTIONS '96

from American Power Conversion

This 65-page, full-color catalog is filled with information and products to protect your company's computers and networks from power spikes and surges. It features tutorials explaining how power problems can cause catastrophic damage to electronic equipment and how to match power-protection products to your needs, and provides answers to the most commonly asked power-protection questions. Aimed at home offices and small businesses as well as large corporations, the catalog offers protection devices for workstations, PCs, peripherals, modems, LANs and WANs, servers, and datacenters. Other products include power conditioners and back up power systems.



Solutions '96 is free upon request from American Power Conversion (APC), 132 Fairgrounds Road, P.O. Box 278, West Kingston, RI 02892-9920; Tel. 800-4APC or 401-7889-5735; Fax: 401-789-3180; Web: http://www.apcc.com.

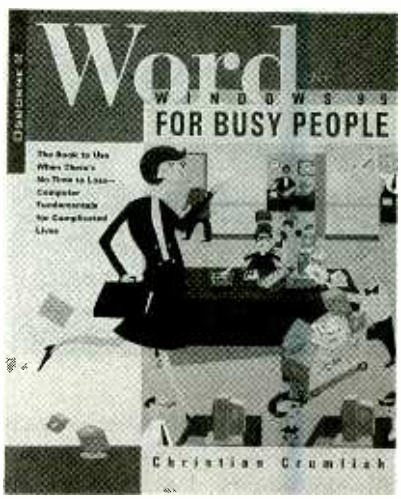
CIRCLE 94 ON FREE INFORMATION CARD

WORD FOR WINDOWS FOR BUSY PEOPLE

by Christian Crumlish

How do you learn to use a new program when your schedule is already filled to overflowing? This book makes it possible to learn how to use Word for Windows 95 even when you think you don't have a minute to spare. It is aimed at people who need to know the essentials of Word, but need to learn them over lunch or in a few brief evening sessions.

The book cuts to the chase, giving you the precise steps you need to get your word processing or desktop publishing done quickly and accurately. It offers the right blend of shortcuts and vital skills to help you learn what you need, and then move on. Its step-by-step instructions and imaginative illustrations reveal the program's new interactive features and impressive desktop-publishing capabilities.



The book uses several time-saving strategies. Quick reference sections at the beginning of each chapter demonstrate the essential tasks and features. It also presents tried-and-true shortcuts, advice on how to avoid time-consuming pitfalls, clever definitions to help you learn and remember the jargon,

continued on page 76

SCANNER SCENE

Area 51 Listening

BY MARC SAXON

Life is always getting easier, as proven by the *Optoelectronics Scout* handheld frequency counter. This amazing device excels at locating and finding active frequencies between 0 and 1400 MHz (1.4 GHz). Automatically and unattended, the Scout will store 400 discrete frequencies. All stored frequencies can be easily recalled for viewing or deletion. The Scout also records how many hits (up to 225) it records on each frequency stored in its memory.

There's a 10-digit LCD readout that's backlit for night operation. The display includes a 16-segment RF signal-strength bar graph. Distinctive audio beeps indicate frequency hits, and there's a pager-style vibrator for discrete recording.

The Scout's sensitivity is better than 1.0 μV between 30 and 900 MHz.

When connected to an AOR AR8000/2000 receiver using the optional SAC8000, the Scout will automatically tune the receiver to its operating frequency. Using an Optoelectronics interface board, the Scout can also do this for the RadioShack PRO-2005, PRO-2006, PRO-2035, and PRO-2042.

The Scout can also be used with the ICOM R7000, R7100, and R9000 receivers. The Scout captures the frequency, then automatically tunes the receiver to that frequency simultaneously. No more programming or manual tuning to root out new frequencies. You'll discover new and unusual frequencies galore!

You can also download stored data from the Scout into a PC using an Optoelectronics Optolinx serial interface.

This is truly next-generation advanced scanning, and you'll certainly want to be in on the leading wave of this useful new technology. For more information, contact Optoelectronics, 5821 Northeast 14th Avenue, Fort Lauderdale, FL 33334. Their phone number is 954-771-2050, or you can reach them with e-mail sent to opto@igc.net.

CAUGHT IN THE WEB

Speaking of the Net, a number of readers have asked if we know of any World-Wide Web sites of interest to scanner users. Although there might be dozens, the ones that readers have told us about are listed in the "Scanner Web Sites" box.

Move into the world of next-generation advanced scanning with the Optoelectronics Scout, a handheld frequency counter that locates active frequencies between 10 MHz and 1400 MHz.

However, when you point your Web browser to those Web sites, keep in mind that sites in general come and go. We hope all the information is good by the time you read it. But a trip down the information highway is relatively inexpensive, and while you're exploring the ones listed here you might even find some new ones.

In the meantime, readers who can add to our list are invited to send us their information for inclusion in future columns.

AREA 51

From classics like *Close Encounters of the Third Kind* and *E.T.: the Extraterrestrial* to modern blockbusters like *Independence Day*, we're all exposed to them. And the "them" refers, of course, to aliens.

It seems that all of the movies and TV programs (especially *The X-Files*) about space aliens have honed the public's interest in such matters. The recent discovery of fossilized Martian microbes has served to validate what some had previously merely suspected: that life forms do exist elsewhere.

Of course, there are those who have insisted that for decades our government has been storing, examining, testing, and attempting to duplicate captured UFOs at a secret Air Force test facility in the Nevada desert. And plenty of scanner enthusiasts out there seem to want to find out the truth.

That base, located at Groom Dry Lake, northwest of Las Vegas, lies within the extensive control zone of Nellis Air Force Base. Known as Area 51 (as well as *Dreamland* and *Skunkworks*), it's where the Stealth fighter and other high-tech secret aircraft are developed and tested.

Although Area 51 itself is heavily secured and off limits to the public, a good state highway and the tiny community of Rachel are nearby. Area 51 now attracts a huge number of inquisitive people hoping to catch sight of the strange aircraft being flown, including (perhaps) even a UFO! Most of those visitors do get to see interesting aircraft. Although many bring along scanners, not many appear to have done their homework, and they miss much of the action.

Because this is such a popular attraction, let's take a look. When I was there, half the scanner owners showed up with units that could not receive the 225- to 400-MHz military aeronautics band. That was their first mistake—it's an important band at Area 51. Some people didn't think to bring any way to power their handheld scanners from their vehicles' cigarette lighters, or at least to recharge their batteries. That's another big mistake—there are no RadioShack stores nearby and you can't buy replacement alkaline batter-

SCANNER WEB SITES

Central Massachusetts
http://www.ultranet.com/~bellvill/radio.html

Northern Pennsylvania
http://www.pitt.edu~ruhe

Long Island
http:www.li.net/~j4dice/scanli.html

NYC Fire Department EMS
http://www.gnn.com.emshighway

New York State
http://www.frontiernet.net/~dstark

The Scanning Club
http://www.enter.net/~jheller/index.html

Scanning Ref.
http://www.panix.com/clay/scanning/index/html

ies very easily once the ones in your radio go dead. "Power" is the key word at Area 51.

If you visit Area 51, bring along a clear, self-sealing, plastic food-storage bag for your scanner. Punch a hole for the antenna to poke through. Area 51 is real desert, and the plastic bag will keep grains of sand from getting into the unit and doing damage. You can still operate the scanner with the protective bag in place, reaching inside if necessary.

The roving military security patrols use (F-1) 142.20 MHz and (F-2) 141.50 MHz. The base station is on 167.70 and 409.025 MHz. These are heavy-duty dudes, so you don't want to wander into any "off limits" zones. Ground-intrusion sensors (496.25, 496.275, and 496.30 MHz) are in use, as well as video surveillance equipment.

Among the frequencies in use for various aeronautical purposes are "Dreamland Control" on 118.7, 125.15, 253.4, 255.8, 261.1, and 392.1 MHz. "Darkstar" (965th AACS) AWACS operations are on 376.2 and 391.8 MHz. The 554th Range Group is on 238.3, 259.4, 268.2, 293.5, and 389.1 MHz. The "Skunkworks" is on 264.1, 264.6, 275.2, 283.7, 289.4, 292.1, 345.4, 349.3, 379.9, 382.6, 407.40, and 407.50 MHz.

We're always looking for your input! Please pass along your frequencies, questions, ideas, and what-have-you to *Scanner Scene*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. See you next time! ■

ELECTRONICS LIBRARY

(continued from page 74)

and worthwhile Word habits to pick up.

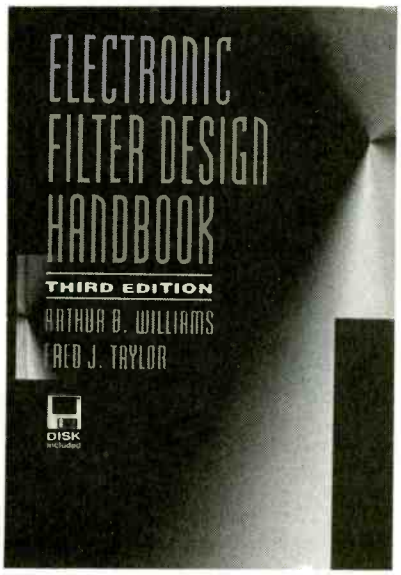
Word For Windows 95 for Busy People costs $22.95 and is published by Osborne/McGraw-Hill, 2600 Tenth Street, Berkeley, CA 94710; Tel. 800-227-0900.

CIRCLE 95 ON FREE INFORMATION CARD

ELECTRONIC FILTER DESIGN HANDBOOK: Third Edition

by Arthur B. Williams & Fred J. Taylor

This classic guide to filter design has been completely updated, and now includes software with new computer-aided design and analysis programs. The third edition provides complete coverage of the many recent advances in electronic filter design, while maintaining its emphasis on practicality.



The book offers everything you need to design an analog or digital filter. A new chapter on switched-capacitor filters presents the underlying theory behind the technology, together with design examples. Another added chapter focuses on the elimination of conducted and radiated interference, and describes the wide range of filters being used for EMI suppression. An expanded treatment of digital filters includes multi-rate filtering, quadrature mirror filters, filter banks, and other newly developed architectures. The book also provides new coverage of digital filter implementation using state-of-the-art digital signal processors from Texas Instruments, Motorola, Analog Devices, and AT&T.

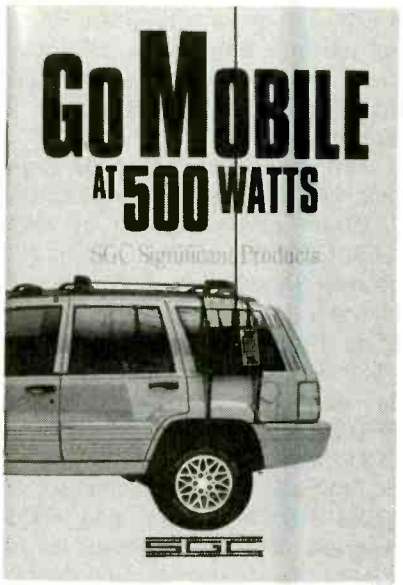
Electronic Filter Design Handbook, Third Edition, costs $79.50, including disk, and is published by McGraw-Hill, Inc., 1221 Avenue of the Americas, New York, NY 10020; Tel. 800-2-MCGRAW.

CIRCLE 96 ON FREE INFORMATION CARD

GO MOBILE AT 500 WATTS

from SGC, Inc.

This pocket-sized book shows readers how to install a 500-watt mobile station in one of several automobiles. It has chapters on the basic layout of a HF mobile system, power for a 500-watt mobile system, antennas and grounds, noise and vibrations, and installation.



The book provides in-depth details of actual installations performed by SGC technicians in four different vehicles: a Jeep Cherokee, a Cadillac, a GEO Tracker, and a GEO Metro. The special installation variables of those four vehicles appears in Chapter 7. The book makes it clear that those tips apply to any manufacturer's gear.

Go Mobile at 500 Watts costs $19.95 and is published by SGC, Inc., SGC Building, 13737 S.E. 26th Street, Bellevue, WA 98005; Tel. 800-259-7331; Fax: 206-746-6384 or 206-746-6384; e-mail: sgcmktg@aol.com; Web: http://sgcworld.com. ■

CIRCLE 97 ON FREE INFORMATION CARD

Supplement to Popular Electronics
January 1997

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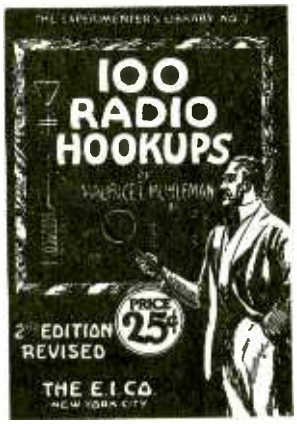
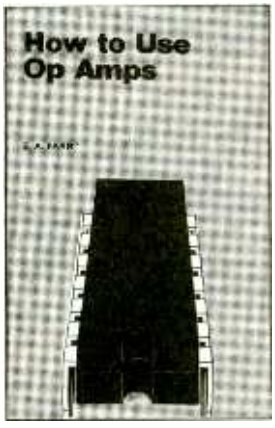
☐ 100 RADIO HOOKUPS —#7—$3.00

First published in May, 1923 this popular booklet went into reprint editions nine times. It is packed with circuits, theory, antenna installation and tips on consumer radio receivers that were popular in the early 1920's. Antique radio buffs and those inquisitive about the early days of radio will find this booklet an exciting, invaluable and excellent reference into the minds of early-day radio listeners. Sorry, we cannot honor the original 25-cent cover price.



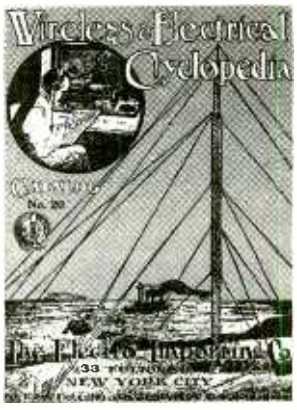
☐ INTERNATIONAL RADIO STATIONS GUIDE—BP255 —$9.95

Provides the casual listener, amateur radio DXer and the professional radio monitor with an essential reference work designed as a guide for listening tothe complex radio bands. Includes coverage on Listening to Shortwave Radio, ITU Country Codes, Worldwide Radio Stations, European Long Wave and Medium Wave Stations, Broadcasts in English and more.



☐ HOW TO USE OP AMPS —BP88—$5.95

The engineer's best friend is the op amp. This basic building block is found in many circuits, analog and digital alike. The op amp finds many useful purposes such as: oscillators, inverters, isolators, high- and low-filters, notch and band-pass filters, noise generator, power supplies, audio, MIDI, and much more. Prepared as a designer's guide, some limited math is used, however engineers and hobbyists alike find it a useful text for their design needs.



☐ WIRELESS & ELECTRICAL CYCLOPEDIA —ETT1—$5.75

A slice of history. This early electronics catalog was issued in 1918. It consists of 176 pages that document the early history of electricity, radio and electronics. It was the "bible" of the electrical experimenter of the period. Take a look at history and see how far we have come. And by the way, don't try to order any of the radio parts and receivers shown, it's very unlikely that it will be available.

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2SD-1650	SANYO	5	1.69
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STR-30130	SANKEN	1	2.66
STRS-6301	SANKEN	1	8.50
TA-7777N	TOSHIBA	1	6.96
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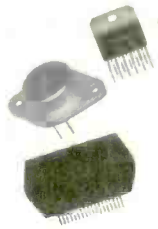

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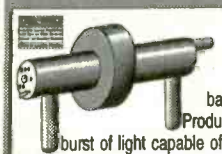

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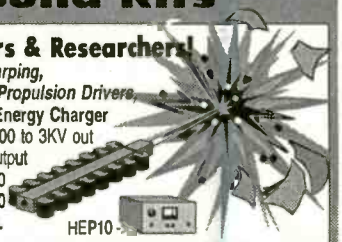

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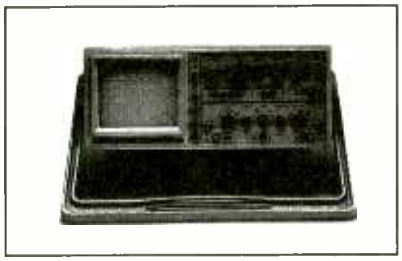

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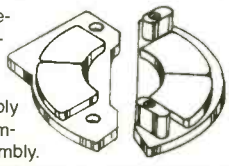

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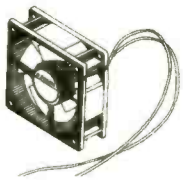

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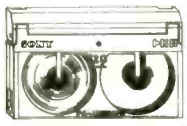

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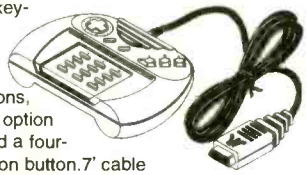

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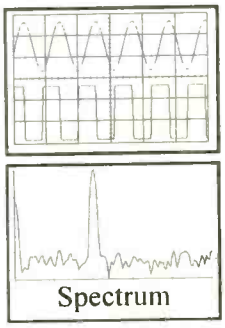

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Net Weight: 400g

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Range:	Resolution:	Accuracy:
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2000mV	1mV	
20V	10mV	±(1%rdg+2dgts)
200V	100mV	
1000V	1V	

Maximum Allowable Input: 1000V DC or Peak AC.

DC Current (DCA)

Range:	Resolution:	Accuracy:
200µA	100nA	
2000µA	1µA	
20mA	10µA	±(1.2%rdg+2dgts)
200mA	100µA	
10A	10mA	±(1.2%rdg+2dgts)

Overload Protection: mA Input, 2A/250V fuse.

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Range:	Resolution:	Accuracy:
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200Ω	100mΩ	
2000Ω	1Ω	
20KΩ	10Ω	±(1.2%rdg+2dgts)
200KΩ	100Ω	
2000KΩ	1KΩ	
20MΩ	10KΩ	±(2%rdg+10dgts)

Maximum Open Circuit Voltage: 2.8V

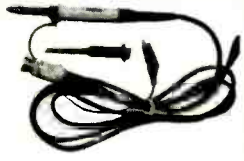
Diode Test
Measures forward voltage drop of a semiconductor junction in mV test current of 1.5mA Max.

hFE Test
Measures transistor hFE.

$19.00 any qty

CAT NO	DESCRIPTION	PRICE
9300G	Rugged High Quality DMM with Rubber Boot	$19.00

Switchable Scope Probe Sets



(Selectable X1/Ref/X10) These high quality scope probe sets are for oscilloscopes up to 60MHz (model HP 9060) or 150MHz (model HP9150). Both sets include a handy storage pouch and include an IC test-hook adapter for the probe. The BNC connector rotates to avoid cable tangle or kink. Cable length is 1.4 meters.

CAT NO	DESCRIPTION	PRICE EACH 1	10	100
HP-9060	Scope Probe Set DC~60MHz	$16.49	$14.49	$11.58
HP-9150	Scope Probe Set DC~150MHz	24.95	21.95	18.62

Positive Photo Resist Pre-Sensitized Printed Circuit Boards

These pre-sensitized printed circuit boards are ideal for small production runs. They provide high resolution and excellent line width control. High sensitive positive resist coated on 1oz. copper foil allows you to go direct from your computer plot or art work layout. No need to reverse art.

Single-Sided, 1oz. Copper Foil on Paper Phenolic Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
PP101	100mm x 150mm/3.91" x 5.91"	$2.55	$1.90	$1.70
PP114	114mm x 185mm/4.6" x 6.6"	2.98	2.45	1.98
PP152	150mm x 250mm/5.91" x 9.84"	5.40	3.98	3.60
PP153	150mm x 300mm/5.91" x 11.81"	6.15	4.48	4.10

Single-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GS101	100mm x 150mm/3.91" x 5.91"	$ 3.90	$2.98	$2.60
GS114	114mm x 185mm/4.6" x 6.6"	4.80	3.49	3.20
GS152	150mm x 250mm/5.91" x 9.84"	8.69	5.98	5.78
GS153	150mm x 300mm/5.91" x 11.81"	10.20	7.20	6.80

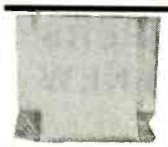
Double-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GD101	100mm x 150mm/3.91" x 5.91"	$ 5.07	$3.68	$3.38
GD114	114mm x 185mm/4.6" x 6.6"	5.95	4.29	3.99
GD152	150mm x 250mm/5.91" x 9.84"	10.47	7.39	6.98
GD153	150mm x 300mm/5.91" x 11.81"	11.95	8.69	8.30

Etching Chemicals/Ferric Chloride

A dry concentrate that mixes with water to make 1 pint of etchant, enough to etch 400 sq. inches of 1oz board.

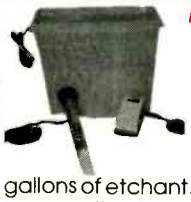
CAT NO	DESCRIPTION	PRICE EACH 1	5
ER-3	Makes 1 pint	$3.50	$2.75



Developer

This product is used as the developer on our positive photo-resist printed circuit boards. Includes instructions. 50 gram package, mixes with water,

CAT NO	DESCRIPTION	PRICE EACH 1	10	25
POSDEV	Positive Developer	$ .95	$ .80	$ .50



Etching Tank

This handy etching system will handle PC boards up to 8"x9", two at a time. Ideal for etching your PCB's! System includes an air pump for etchant agitation, a thermostatically controlled heater for keeping etchant at optimum temperature and a tank that holds 1.35 gallons of etchant. A tight fitting lid is also supplied to prevent evaporation when system is not being used. Typical etching time is reduced to 4 minutes on 1oz. copper board!

REDUCES ETCHING TIME!

CAT NO	DESCRIPTION	PRICE
12-700	Etch Tank System	$37.95

Desoldering Pumps

These powerful plastic body desoldering pumps are designed for easy one hand operation for fast, efficient desoldering. Double O-ring piston seals for maximum suction.

CAT NO	DESCRIPTION	PRICE EACH 1	5	10
08-366S	Large Desoldering Pump	$15.89	$13.49	$11.95
08-366E	Regular Desoldering Pump	10.89	8.59	7.39
08-366TIP	Replacement Tip	1.95	1.95	1.95

!!!!!! SEE OUR ON-LINE CATALOG AT http://www.cir.com !!!!!!

Electronic Soldering System

Here's the ideal solution when **Temperature Control** is required. Easy to use slide control allows user to set system from 300°F to 840°F. Voltage to iron from control unit is 24V Iron heating power is 48W. Replaceable 5.3mm tip is standard. Replacement irons and tips are available.

AS LOW AS $50.00

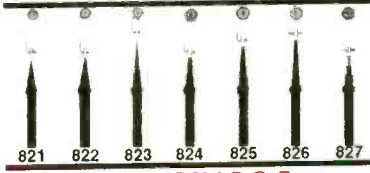
CAT NO	DESCRIPTION	PRICE EACH 1	5
SL10	Temp Controlled Soldering Iron	$56.00	$50.00
SL24V	Spare 24V Soldering Iron	10.50	7.50

Electronic Soldering System with LED Display

Deluxe temperature controlled system with LED display for maximum accuracy. Temperature is adjustable from 160°-480°C (320°-900°F). Iron heating power is 48 Watts. Runs on 24V from controller unit. Replacement irons and tips are available. Tip size is 5.3mm.

AS LOW AS $75

CAT NO	DESCRIPTION	PRICE EACH 1	5
SL30	Deluxe Soldering System w/LED	$86.00	$75.00
SL24V	Spare 24V Soldering Iron for SL10 or SL30	10.50	7.50



Replacement Tips for SL10/SL30

We now offer a variety of replacement tips for the SL10/SL30 soldering stations.

CAT NO	DESCRIPTION	PRICE EACH 1	5
821	1/32" Pencil Tip	$1.39	$1.19
822	1/32" Pencil Tip	1.39	1.19
823	1/64" Pencil Tip	1.39	1.19
824	1/16" Chisel Tip	1.49	1.29
825	1/8" Chisel Tip	1.49	1.29
826	3/64" Chisel Tip	1.49	1.29
827	3/64" Pencil Tip	1.59	1.39

Ball Bearing 12V DC Fans

These High Quality Fans feature Ball Bearings and Brushless DC Motors. All of them are designed to meet UL, CSA & VDE Standards. Design these fans into power supplies, computers or other equipment requiring additional air flows for heat removal. These fans are regular Circuit Specialists stock items — they are not surplus.

INDUSTRY BEST PRICING!

CAT NO	PRICE EACH 1	10	25	100
CSD 4010-12	$ 9.88	$ 6.38	$5.48	$4.87
CSD 6025-12	9.38	5.91	5.41	4.71
CSD 8025-12	8.88	5.85	5.19	4.49
CSD 9225-12	8.95	6.14	5.29	4.59
CSD 1225-12	11.45	8.96	7.82	6.85

Specifications

CAT NO	DIMENSIONS (MM)	RATED VOLTAGE (V)	START VOLTAGE (V)	INPUT CURRENT (A)	AIR FLOW (CFM)	STATIC PRESSURE (INCH-H_2O)	SPEED (RPM)	NOISE LEVEL (dB)	WEIGHT (g)
CSD 4010-12	40x40x10mm	12	7	0.06	5.1	0.19	5,500	26	20
CSD 6025-12	60x60x25mm	12	5	0.13	13.7	0.165	4,500	28	65
CSD 8025-12	80x80x25mm	12	5	0.16	37.8	0.177	3,000	31	80
CSD 9225-12	92x92x25mm	12	5	0.32	42	0.18	2,800	37	95
CSD 1225-12	120x120x25mm	12	5	0.35	62	0.180	2,500	42	135

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We stock high quality 60/40(Sn%/Pb%), .031" and 63/37, .031" diameter. This is prime JIS certified solder that we maintain as a regular stock item (It is not "Left-overs, Rejects or Surplus") and you can buy it from us at a fraction of the price that you are used to.

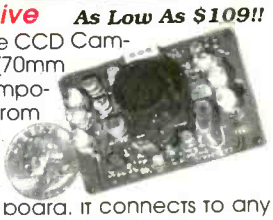
Tired of Paying Inflated Prices for Solder?

CAT NO	DESCRIPTION	PRICE EACH 1	10	25
RH60-1	1-lb. Spool, .031", 60/40	$ 6.90	$ 5.96	$ 5.30
RH63-1	1-lb. Spool, .031", 63/37	6.95	6.10	5.41
RH60-4	4.4-lb. Spool, .031", 60/40	24.00	21.90	17.92
RH60-TUBE	6-oz. Tube, .031", 60/40	.99	.89	.79

CCD Camera - IR Responsive

As Low As $109!!

This black and white monochrome CCD Camera is totally contained on a PCB (70mm x 46mm). The lens is the tallest component on the board (27mm high from the back of the PCB) and it works with light as low as 0.1 lux. It is IR Responsive for use in total darkness. It comes with six IR LED's on board. It connects to any standard monitor, AUX or video input on a VCR or through a video modulator to a TV. Works with a REGULATED 12V power supply (11V-13V). Hooks up by connectiong three wires: red to 12V, black to ground (power & video) and brown to video signal output.



CAT NO	DESCRIPTION	PRICE EACH 1	5
CA-H34A	PCB Mounted IRCCD Camera	$125.00	$109.00

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- Ultra-miniature surface mount construction.
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- Miniature battery and holder mounted directly to the circuit board.
- Transmit to any scanner type receiver

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Transmits continuous beep-beep-beep
Ideal for locating lost or stolen items
Range up to 1/2 mile

XTL3000
LONG RANGE TRANSMITTER KIT
Sensitive built in microphone
Range up to 1 mile
Custom frequencies available

XTL1000
TRANSMITTER KIT
Sensitive built in microphone
Range up to 1/2 mile
Custom frequencies available

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$149.95

- **Professional quality.**
- **Not a kit**, ready to use.
- Covers 1 to 2,000MHz.
- Uses new Microwave Integrated Circuit amplifier.
- Adjustable sensitivity.
- Audio jack for privacy ear phone.

Any intercepted signal causes an audio tone that increases from a low pitched growl to a high pitched squeal as the signal strength increases.

88-108 MHz FM RECEIVER

XMR2000
$29.95

- Worlds smallest FM radio.
- As small as a hearing aid.
- Weighs less than 1/4 oz.
- Digital touch tuning.
- Ideal for use with our 88-108MHz FM transmitters

88-108 MHz FM TRANSMITTER KITS

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XWB 1000EZ $46.95
XFM 100C $21.95
XSP 250EZ $34.95
XTR 100C $29.95
XTT 100C $19.95

XST 500 Voice transmitter. Range up to 1 mile. Supersensitive mic. Uses 9 volt battery. Uses surface mount components.

XWB 1000 Voice transmitter. Range up to 1/2 mile. Includes mic and battery on circuit board. Uses surface mount components.

XFM 100 Voice transmitter. Range up to 1 mile. 9 v battery and leaded components.

XSP 250 Super-miniature telephone transmitter. Range 1/4 mile. Powered by phone line. Uses surface mount component.

XTR 100 Tracking transmitter. Range up to 1 mile. Uses 9 volt battery. Transmits a BEEP - BEEP - BEEP tone

XTT 100 Telephone transmitter. Range up to 1 mile. Uses 9 volt battery.

XPC 400
TV CAMERA
400 LINES OF RES
- Use any TV or VCR with a video input connector.
- Includes power cube.
- About half the size of a pack of cigarettes.
- See entire room through pin sized hole.

Assembled $269.95

XVS100
TV TRANSMITTER
- Use with XPC400, VCR, Camcorder, etc.
- Power cube included.
- Uses the UHF TV band.
- Transmits video and audio.
- Up to 100 foot range.

E-Z Kit $29.95

PHONE VOICE CHANGER

16 levels of digital voice changing. Sound tougher, older or younger, female or male. Powered by 4 AA batteries. (Batteries not included).

Works with regular or multi-line phones. Connects between handset and phone. Note will not work with cordless or handset type telephones.

T-2001
Assembled
$69.95

XLB-9 $8.95
9V LITHIUM BATTERY
Worlds most powerful 9V battery! Twice the life of alkaline batteries.

XLB-3 $3.95
3V CAMERA BATTERY
Small 3V Lithium battery. For use with XTL3000, XTL1000, XTR300, and XWB1000.

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$14.95
Ideal project box to give your kits that professional look. Available custom drilled for the following kits: XFS108, XPS1000, XLC900, and XVA250.

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- Dial home from anywhere and hear inside your home.
- TouchTone coded for secure operation.
- Stop burglars and intruders.
- Reliable 24 hour protection.

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SCANNER CONVERTER KIT(800-950MHZ)
- Uninterrupted coverage of the 800 to 950 MHz band!.
- Works with any 400-550MHz scanner.
- Gain: 6 dB typical.
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XVA 250C $49.95

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- See at a glance if your being lied to!
- Subject need not be present. Works with voices from recordings, TV or radio.
- Has built-in microphone.
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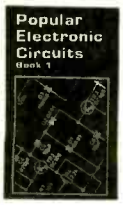

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☐ **#160—Coil Design and Construction Manual...$5.95.** A complete book for the home builder on how to make RF, IF, audio and power chokes and transformers. Practically every possible type is discussed and calculations are explained in detail.

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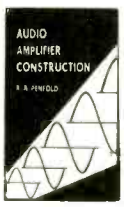

☐ **BP122—Audio Amplifier Construction...$5.75.** Practical designs are featured and include circuit diagram and description, Veroboard or printed-circuit board layout and construction notes. The text is divided into two parts. The first deals with many types of preamplifiers. The second covers power amplifiers from a simple low-power battery type to a 100-watt DC-coupled amplifier using four MOSFETs in the output stage.

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☐ **BP319—Making MS-DOS Work for You—$6.50.** What you need to know first, comes first, however the text is written in a circular style so that the reader can start anywhere in the text. This book is relevant to all versions of both MS-DOS and PC-DOS.

☐ **BP303—Understanding PC Software...$6.95.** Covers main types of PC software, giving details of typical uses, the basics of how they are used and their limitations. Each chapter covers popular software and programs of a similar type.

☐ **BP105 Aerial (Antenna) Projects...$5.50.** In this book the author has considered practical antenna designs, including active, loop and ferrite antennas which perform well and are relatively simple and inexpensive to build. The complex theory and mathematics of antenna design have been avoided. Also included are construction details of a number of antenna accessories including a pre-selector, attenuator and filters.

☐ **BP33—Electronic Calculator Users Handbook...$5.75.** The book eliminates the mysteries of the calculator and offers unique ideas for the simplest to most complex calculators. Covers the basic functions plus trigonometric, hyperbolic, logarithms, square roots and powers. Included are formulas and data for VAT, discounts, and mark up, currency conversion, interest, binary and octal numbers, and much more!

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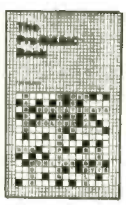
☐ **BP263—A Concise Introduction to dBASE ...$6.95.** The most popular data-base program, dBASE, is difficult to master without help. This book helps you spend your time using dBase, not setting it up. A user's guide that covers all the basics up to dBase IV.

☐ **PCP104—Electronics—Build and Learn... $9.95.** Construction details are given to build a circuit demonstrator that is used throughout the book to introduce common electronic components and how these components are built up to useful circuits.

☐ **BP302—A Concise Users Guide to Lotus 1-2-3 Release 3.1... $6.25.** Written to help existing spreadsheet users upgrade to 1-2-3 Release 3.1, which has the ability to work 3-dimensionally with both multiple worksheets and files.



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DMM 20 $74.95

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LCR Meter 131D $229.95

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Resistance:10Ω-10MΩ
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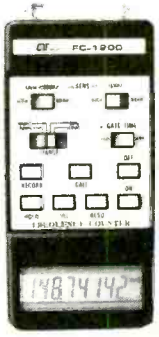
Dissipation factor & Q factor
Serial & parallel mode
Relative mode for comparison and to remove parasitics
Statistics, tolerance,
Best for design, incoming testing & production
SMD and chip component test probe $25.00

LCR Meter 814 $189.95

Best Resolution LCR

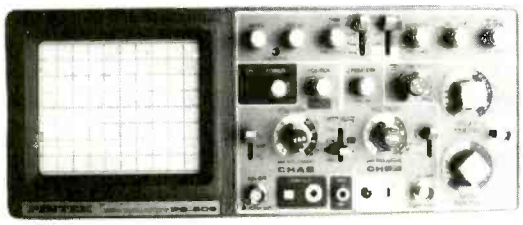
Inductance: 200uH-200H
Capacitance: 200pF-20,000uF
Resistance: 2Ω-20MΩ
Resolution of 0.1uF, 0.1pF, and 1mΩ are useful for high frequency and SMD
Dissipation factor indicates leakage in capacitor and Q factor in inductor
Zero adjustment to reduce parasitics
Best for high frequency RF
SMD and chip component test probe $25.00
Padded deluxe case $6.00



Frequency Counter FC-1200 $129.95

Frequency:10Hz-1.25GHz
Display: 8 digit LCD
Period: 0.1µs-0.1s
Records Max/Min/Average
Data hold, relative mode
Telescoping antenna $8.00
Deluxe case $5.00

Also Available:
AC/DC clamp meter, Light meter, Thermometer, pH meter, High voltage Probe, Digital Caliper, Anemometer, Electronic scale, Force Gauge, Tachometer, Stroboscope, Humidity & EMF adapter, Sound level meter, Frequency counter, SWR/field strength/power meter, Dip meter



20 MHz Oscilloscope with Delay Sweep PS-205 $429.95

Dual Trace, Component test, 6" CRT, X-Y Operation, TV Sync, Z-Modulation, CH2 Output, Graticule Illum, 2 probes each has x1,x10 switch. Best price with delay sweep.

PS-200	20 MHz DUAL TRACE	$339.95
PS-400	40 MHz DUAL TRACE	$494.95
PS-405	40 MHz DELAY SWEEP	$569.95
PS-605	60 MHz DELAY SWEEP	$769.95
PS-1000	100 MHz DUAL TRACE	$999.95

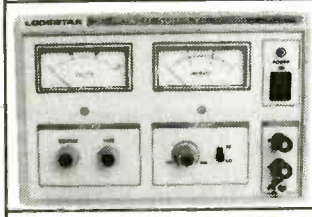
Scope Probe: 60MHz x1, x10 $15, 100MHz x1, x10 $22
250MHz x1, x10 $29, 250MHz x100 $39

Digital Storage Scope

DS-303 30MHz, 20M Sample/sec $849.95

DS-303P w/ RS-232 interface $1,049.95

Switchable between digital and analog modes
2 K word per channel storage
8 bit vertical resolution (25 Level/div)
Expanded Timebase 10ms/div - 0.5 s/div
Refresh, Roll, Save all , Save CH2, Pre-Trig
Plotter control



DC Power Supply PS-303 $159.00

0-30 VDC , 0-3A output

Constant voltage & constant current mode
0.02% + 2mV line regulation
0.02% + 3mV load regulation
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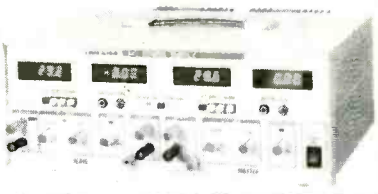
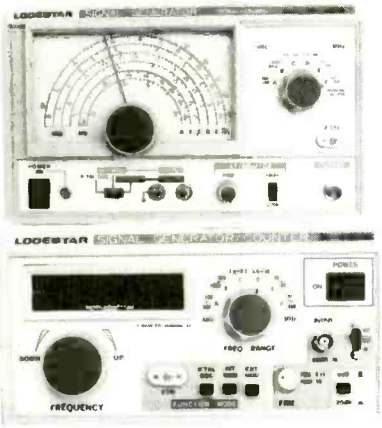
Short circuit and overload protected
PS-8200 with digital voltmeter $179.00
Also available 30V/5A, 60V/3A, 60V/5A 16V/10A, 30V/10A



DC Power Supply Triple Output PS-8202 $499.95

Two 0-30 VDC , 0-3A outputs
One fixed 5VDC, 3A output
Capable of independent or tracking operation
Constant voltage and constant current mode
Four digital meters for volt and current display
Excellent regulation and low ripple
Short circuit and overload protected
Also available: 30V/5A triple output $549.95
Dual tracking 30V/3A, 30V/5A, 60V/3A, 60V/5A



RF Signal Generator SG-4160B $124.95

100 kHz-150MHz sinewave in 6 ranges
RF Output 100mVrms to 35 MHz
Internal 1kHz, External 50Hz-20kHz
AM modulation
Audio output 1 kHz, 1 Vrms
Output Impedance: 50 Ohm
Size: 5.9"H x 9.8"W x 8.1"D

RF Signal Generator Counter SG-4162AD $229.95

Generates RF signal same as SG-4160B
6 digit frequency counter 1Hz - 150 MHz for internal and external source Sensitivity <50mV

Audio Generator AG-2601A $124.95

10Hz - 1MHz in 5 ranges
Output: 0-8Vrms sinewave
0-10Vp-p squarewave
Synchronization: ±3% of oscillation frequency per Vrms
Output distortion:
0.05% 500Hz - 50kHz
0.5 % 50Hz - 500kHz
Output impedance: 600 ohm

Audio Generator/Counter AG-2603AD $229.95

Generates audio signal same as AG- 2601A
6 digit frequency counter 10Hz-150MHz for internal and external sources Sensitivity <50mV

Function Generator FG-2100A $169.95

0.2 Hz -2 MHz in 7 ranges
Sine/square/triangle/pulse/ramp
Output: 5mV-20Vp-p
1% distortion, DC offset ± 10V
VCF: 0-10V control freq. to 1000:1

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Generates signal same as FG-2100A
Frequency counter 4 digits
Feature TTL and CMOS output

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Assembled and Tested
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XK-550K - Kit
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Tools and meter shown optional

TK-3000
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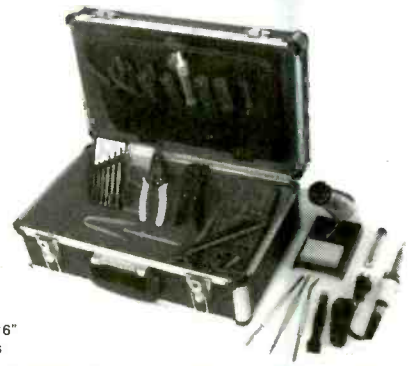

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- ST-2 - Long Nose Pliers
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- TL-8 - Precision Screw Drivers
- ST-5 - Screw Driver Slotted 3/16"
- ST-6 - Screw Driver #1 Phillips
- ET-10 - IC Puller
- SP-2 - Solder Pump
- ST-20 - Safety Goggles
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- Counter Range 1Hz to 10MHz
- 4 Digit Display

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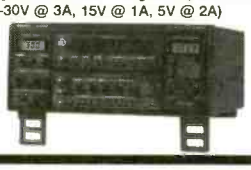

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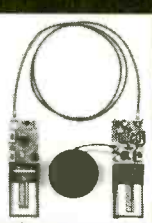

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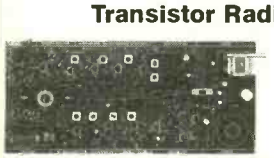

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6 Functions & Transistor Test

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- Video sync separators
- Z-axis input
- Single Sweep
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S-1330 $439
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- Delayed Sweep

S-1325 $325
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ANALOG

Model	Bandwidth MHz	Sensitivity (max)	No. of Channels	Sweep Rate Max ns/div	Delayed Sweep	Video Sync	Component Tester	Beam Find	Time Base
S-1360	60	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1345	40	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1340	40	1mV/div	2	10ns/div	No	Yes	No	No	1
S-1330	25	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1325	25	1mV/div	2	10ns/div	No	Yes	No	No	1

DIGITAL STORAGE

Model	Bandwidth MHz	Analog Sen (max)	No. of Channels	Sampling Rate	Memory Channel	Internally Backed Up	Pretrigger %	Output
DS-303	30	1mV/div	2	20MS/S	2K	Yes	0, 25, 50, 75	RS232
DS-603	60	1mV/div	2	20MS/S	2K	Yes	0, 25, 50, 75	RS232

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MULTIMEDIA SUBWOOFER

(Continued from page 40)

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First, connect the multimedia speaker with the built-in amplifier and volume control to your computer. Attach the cable (just described) to the output of that first speaker and to the input of the Subwoofer (J1). Then plug the other multimedia speaker into the throughput jack of the Subwoofer (J2).

When the input connections are made, turn the volume knob of the Subwoofer down all the way and plug the unit into an AC outlet. Play some music or other audio through the multimedia speakers, and slowly turn up the Subwoofer volume. If everything is assembled correctly, the Subwoofer should produce deep bass. You'll especially notice it on games with crashes, explosions, and rumbling noises.

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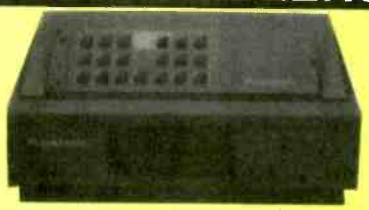

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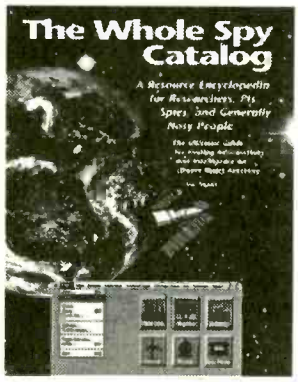

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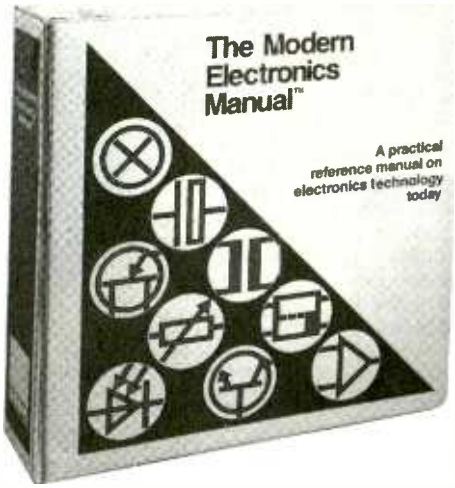

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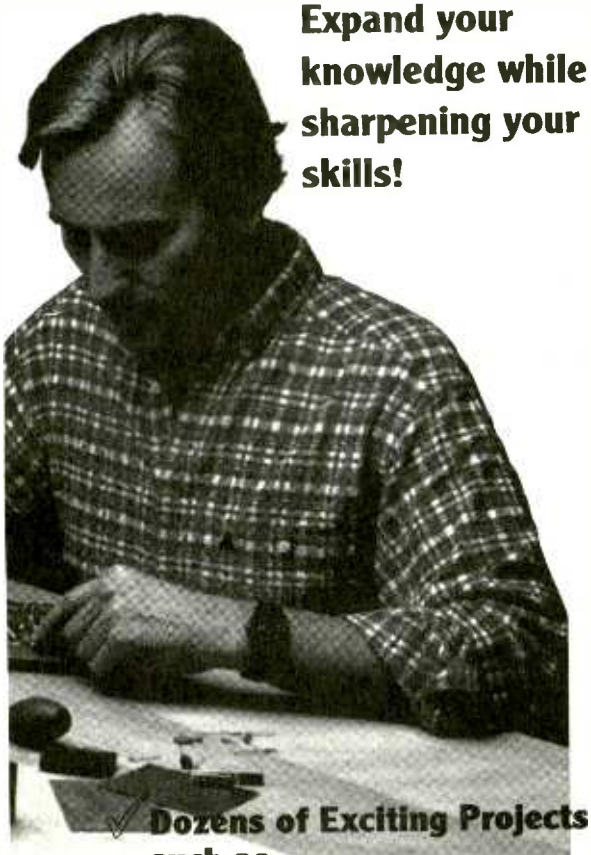

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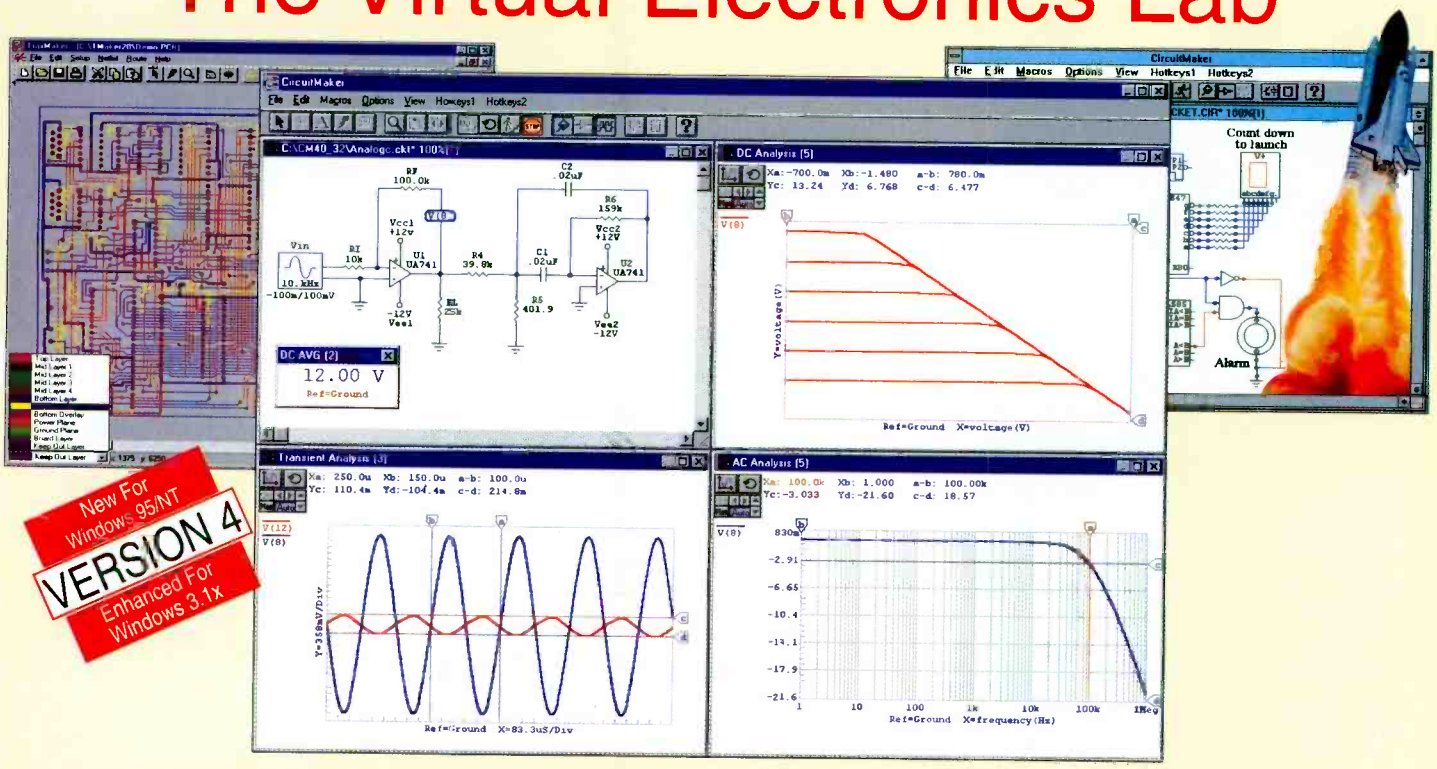

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