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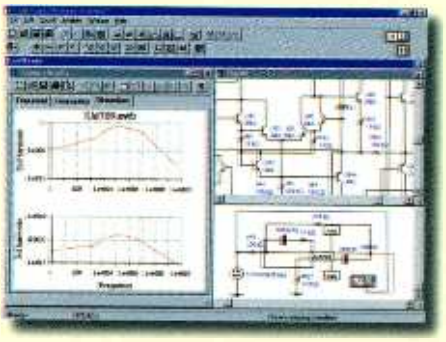

## High-End Features

| | |
|---|---|
| TRUE MIXED ANALOG/DIGITAL | YES |
| FULLY INTERACTIVE SIMULATION | YES |
| ANALOG ENGINE | SPICE 3F5, 32-BIT |
| DIGITAL ENGINE | NATIVE, 32-BIT |
| GMIN STEPPING | YES |
| TEMPERATURE CONTROL | EACH DEVICE |
| PRO SCHEMATIC EDITOR | YES |
| HIERARCHICAL CIRCUITS | YES |
| VIRTUAL INSTRUMENTS | YES |
| ON-SCREEN GRAPHS | YES |
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## Powerful Analyses

| | |
|---|---|
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| AC FREQUENCY | YES |
| TRANSIENT | YES |
| FOURIER | YES |
| NOISE | YES |
| DISTORTION | 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 six 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 [illegible], automatic reference designation [illegible] schematic size.

[illegible] instruments for quick and simple [illegible] analysis. Six analyses for on-screen graphs and more [illegible] described below).

[illegible] Management: All design information including [illegible] simulation SPICE parameters, setup and [illegible] of all models stored in a design file to [illegible] and reuse.

[illegible] Import/Export: Import/export standard SPICE [illegible] with other simulators or to reuse existing design elements. Imports manufacturers 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 [illegible]s AC [illegible]el loss. [illegible] Hz to 4MHz. Adjustable duty cycle, amplitude and DC offset.

[illegible] the 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, VCO, 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-IC's: 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, 4173, 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, 74466.

4xxx ICs: [illegible] 4008, 4011, 4012, [illegible] 4028, 4030, 4040, [illegible] 4069, 4070, 4071, 4073, 4081, 4085, 4086, 4107, 4019, 4024, 4027, [illegible] 4050, 4069, 4072, 4075, 4077, 4078, [illegible] 4503, 4512, 4516, 40163.

### MODELS

Digital: Models for IC's: 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, JFETs, 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.

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**APRIL 1997**
Vol. 14, No. 4

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## COVER STORY


### 31 Build a Lie Detector

Find out who's telling the truth with this Galvanic Skin Resistance monitor. Just press two fingers on the Detector's "electrodes" and you're all set. It's great for parties or even classrooms. The Lie Detector can also be used as a biofeedback device by providing you with a visual and audible indication of how your skin's resistance is changing—*Skip Campisi*


## CONSTRUCTION


### 42 Build a High-Efficiency Lighting System

Tired of high lighting bills? Quit wasting electricity on lights that don't work as efficiently as they could; here's a better option. With this system you'll save 90 percent on your monthly lighting bill—these are substantial savings you'll notice right away. Build these units for both home and office lights and save at both locations—*Stephen R. Rosenberg*

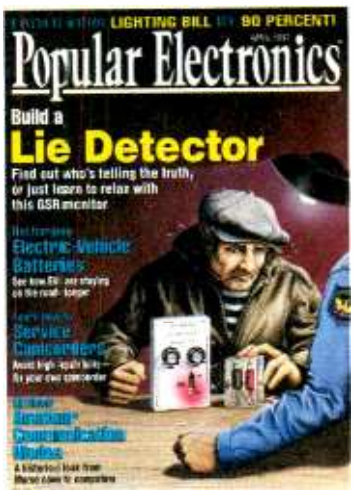

## FEATURES


### 39 Recharging Electric-Vehicle Batteries

Electric vehicles have finally hit the streets, but just how far can you travel in them before they run out of battery power? Join us for a look at the methods and systems being put in place to ensure EVs get you to and from your destinations—*Bill Siuru*

### 45 All About Amateur Communications Modes

The technology used by radio amateurs has certainly improved over the years; we've really come a long way. Here's a historical exploration of the many communications methods used by hams, past and present. From Morse code to computers, it's all right here—*Karl T. Thurber, Jr.*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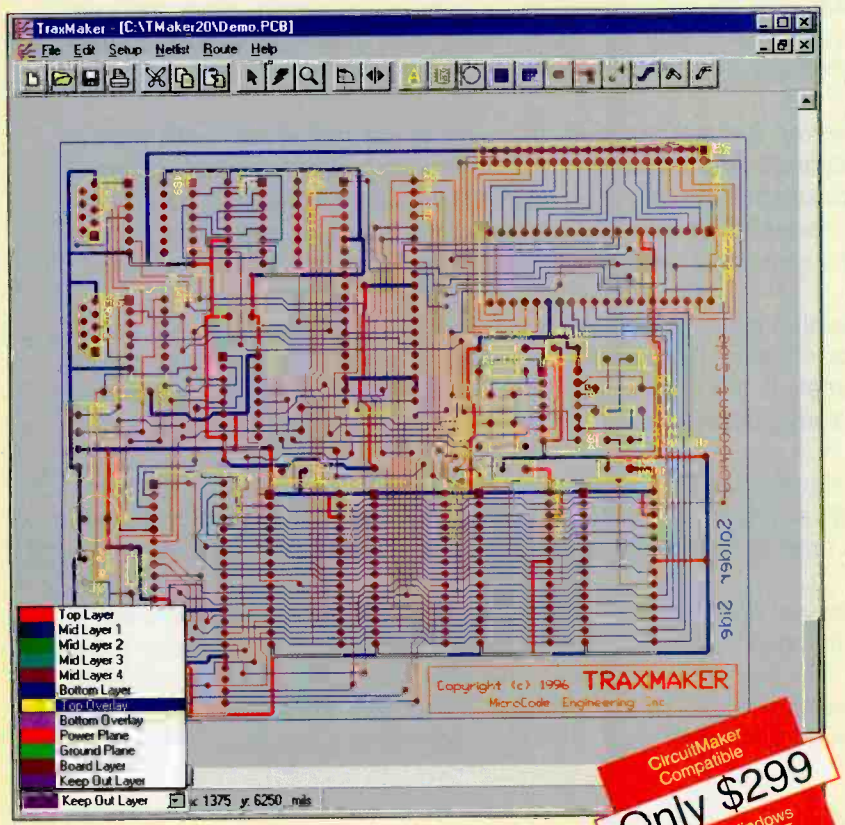


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# Editorial

## Truthfully Speaking

They have been around for years and used in thousands of police investigations. But even in this decade of high-profile criminal cases, lie detectors, or polygraphs, are still not admissible as evidence in most courts.

Why is that?

The answer lies (no pun intended) in how professional lie detectors work. They are called "polygraphs" because they measure various biological factors—such as heart and respiratory rate, and Galvanic Skin Resistance (GSR)—to determine when someone's "fibbing." The idea behind taking those measurements is that people supposedly get nervous when they lie; as a result their readings should change accordingly.

However, it might not work that way in the real world. Let's face it, everyone's different. Even if you begin with a solid baseline reading of a relaxed subject to use as a reference point for changing conditions, it's impossible to tell whether that person is lying or just going through some kind of biological fluctuations peculiar to him or her.

Does that mean polygraphs don't work? Or that they only work sometimes on some people? Well, we decided to let you try to figure out for yourselves the answers to these questions this month by presenting our own Lie Detector.

Of course, building a complete polygraph is impractical for most. That's why our Lie Detector works by monitoring just one of the factors I mentioned earlier: a subject's changing skin resistance.

Once you build the unit, you can gather your friends and have some fun trying to figure out who's telling the truth or not. Or, perhaps you'd just like to practice varying your skin resistance by using the Lie Detector as a biofeedback device. Either way, we're sure you'll enjoy experimenting with GSR. The story begins on page 31.

Dan Karagiannis

Dan Karagiannis
Editor



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# LETTERS

# A Call To Our Readers

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*If you'd like to be a part of the magazine that's brought you the best in electronics for years, we want to hear from you.*
*—Editor*

## WHERE ARE ALL THE CORRECTIONS?

I've been reading **Popular Electronics** for about five years now, and have built several of the projects that you published. However, I have a question: I haven't noticed any corrections in your *Letters* column for a while; have you stopped publishing them?

Also, are you planning on posting corrections to your Web site so we can access them quicker? The reason I'm asking is I've built things in the past, had them not work, and then found a correction a couple of months later that explains whatever problems I encountered.

Thanks in advance for any answer you can give me.

And keep up the good work.

L.B.
*Los Angeles, CA*

*Thank you for writing. The reason you haven't been seeing corrections recently is there haven't been any. Because this is a technical magazine we make every effort possible to ensure the projects published will work as published.*

*However, sometimes errors in artwork or text are missed, and in the past we have had to wait to bring them to the attention of our readers due to editorial lead time. For example, if an error is caught when a magazine hits the stands, we've already completed the following issue by that time.*

*But we have been planning and preparing to implement one of the suggestions you made. In addition to discussion forums that we will be adding to our Web site, you'll also be able to read online corrections before they are printed in this column of the magazine. That could save a month or more of aggravation if a particular circuit isn't working properly.*

*Hope this answers your questions.*
*—Editor*

## HAVES & NEEDS

I have subscribed to **Popular Electronics** for two years. I would like to find out where I might be able to get the tuning and band-spread knobs for a Hallicrafter S53 receiver. (The tuning and band-spread knobs are both identical.)

I am willing to pay for these items, and I will also cover any shipping costs.

Thank you.
ALBERT C. ANDERSON
*5258 Cordelia Ave.*
*Baltimore, MD 21215-5023*

Several years ago, I got involved in electric-flight, radio-controlled, model aircraft. The first plane I built was involved in a don't-bother-to-fix-it-type of crash.

Now, the only salvageable items from the wreck were the plane's two servos, although I have been trying to fix the electronic speed control, which is an integrated receiver/speed control that cost me about $200.

Crashes are not uncommon, and I can't afford to keep replacing the integrated unit. What I'm looking for are plans for building a separate speed control.

I could buy stand-alone receivers for a relatively cheap $70 per crash. I'm also pretty sure that I could build the simple speed controls for pennies each.

Does anyone out there have any ideas?

Any assistance from the readers of **Popular Electronics** would be greatly appreciated!
MIKE CRISWELL
*2810 Florence Street*
*Hopkinsville, KY 42240*

I am trying to locate an operator's manual for an Eico VOM that I have. The only information I have is its model number, which is 565.

Thanks in advance for any help that you or the readers of your fine magazine can give me.
LARRY COOK
*362 East South Street*
*Richland Center, WI 53581-2721* ■

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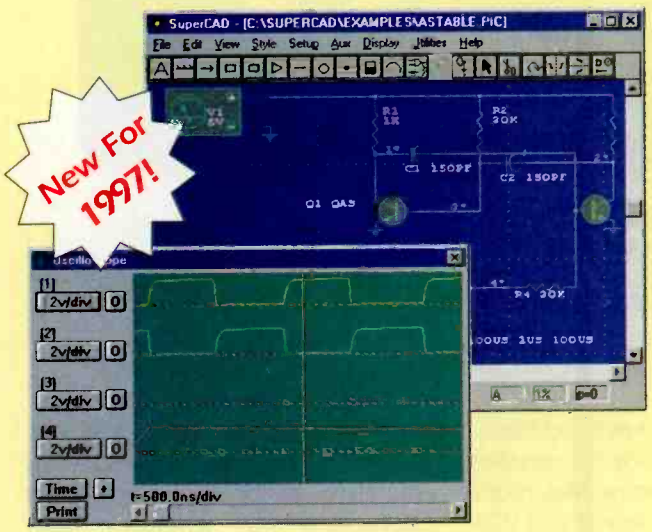


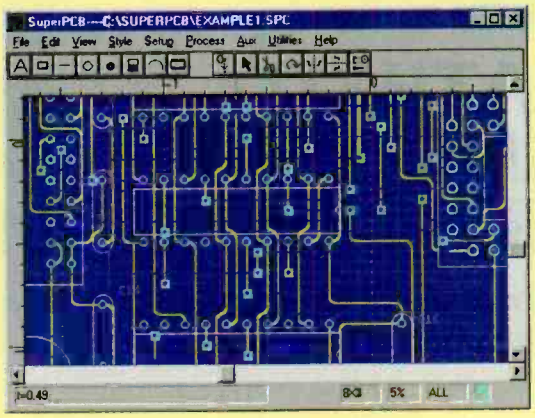


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Because of our association with McGraw-Hill in producing the **Encyclopedia of Electronic Circuits** CD ROM (available separately for $99), the SuperCAD schematic editor is fast becoming a standard for schematic entry. The Encyclopedia includes 1000 SuperCAD schematics in 142 different categories (audio, radio, etc) that can be used as a starting point for designs.

### *Mixed Mode SPICE Simulator*

For simulating purely analog circuits or circuits with some digital components, mentaMAX includes mentalSPICE. This simulator is based on the Berkeley SPICE 3F5 simulator and allows you to do timing analysis, frequency analysis, DC curve analysis and others. It comes with over 350 semiconductor and 250 IC models. Signals can be introduced into a circuit using a virtual function generator, and the resulting waveforms can be viewed in the Oscilloscope window.

### *Digital Simulator*

For heavy-duty analysis of computer interfaces, timers, state machines, controllers, and others, mentalMAX provides the digital simulator SuperSIM. This comes with 150 common TTL and CMOS models. You can stimulate circuits with a built-in virtual pattern generator and view results in a logic analyzer window. You can also single-step a circuit and monitor its progress using virtual LEDs and displays.

### *Circuit Board Layout Software*

mentalMAX comes with the popular SuperPCB program for doing layouts on printed circuit boards up to 32" x 32". SuperPCB features 1 mil (.001") resolution, 2 signal layers, silk-screen, paste and solder mask layers. It includes industry-standard Gerber and Excellon outputs, and you can also print your artwork on laser and other printers. SuperPCB comes with 150 package parts for both through-hole and surface-mount devices; you can add your own parts.

In many cases SuperPCB can automatically build a circuit board from just a SuperCAD schematic input, using the built-in autorouter and auto-placement tools. You can also layout or edit circuit board artwork using SuperPCB's intuitive, easy to learn editing features.

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A Hands-on Electronics® REPORT

# HEATHKIT CAMCORDER SERVICING COURSE

*If you're interested in learning how to service camcorders, this servicing course is the way to go.*

Camcorders are everywhere these days. Anybody can now buy what is essentially a hand-held TV studio, and instantly become an amateur movie producer/director.

Camcorders come in many flavors. With features such as autofocus and automatic light compensation, camcorders make it easy to point and shoot—anybody can do it, and the results can be impressive.

Yes, camcorders are very easy to use, but the technology that makes them so easy to use also makes them quite fragile. And when you have lots of people carrying around these fragile devices, many of them are bound to fall from high places, get soaked in a thunderstorm, and otherwise succumb to an unexpected demise. In other words, lots of camcorders end up needing servicing of some kind, whether it be to repair a smashed lens, or just clean the heads after many hours of use.

All these camcorders in need of servicing are a veritable gold mine for anyone who can repair them. The problem is that while anybody can use a camcorder only highly trained individuals should attempt servicing them. When untrained people try to service camcorders, they run the risk of causing more problems than they could fix.

Even somebody who's familiar with VCRs should not mislead themselves into thinking that camcorders and VCRs are the same. Yes, many of the components found in a VCR are also found in a camcorder. The belts, gears, motors, pulleys, springs, and circuit boards are all there. But many familiar parts, such as the tuner section of a VCR, are missing from a camcorder. That doesn't present a problem to those familiar with VCRs, but the presence of things like an autofocus lens and CCD (charge coupled device) can present problems.

A camcorder is essentially a VCR minus the tuner, but with an autofocus camera added. Advanced camcorders also have additional features thrown in such as image-stabilization circuitry and color viewfinders, so a camcorder really is a whole different animal than a VCR.

With all of the potential problems that can arise with camcorders, and all of the general maintenance they require, it makes good sense for those involved in electronics repair to familiarize themselves with camcorders. Then they can tap into the "well" of broken and in-need-of-service camcorders and start making some good money. Camcorder servicing is also a good career opportunity. It is a career that is sure to have years and years of job security.

There are many ways you can learn about camcorder servicing. You can take a formal course at an electronics school, get a job as an apprentice with someone who already services them, or you can wing it by gathering together a camcorder in need of servicing, the necessary replacement parts and tools, and all of the required documentation. Or you could take the easy way out with Heathkit's Camcorder Servicing Course, which teaches you all about basic camcorder maintenance, and how to perform various repairs. All materials in this course are of the highest quality. Documentation is clearly written and error-free—that goes a long way to understanding how anything works.

**The Camcorder Course.** The Heathkit Camcorder Servicing Course comes with everything you need to perform basic camcorder maintenance. But the heart of the course is the camcorder included with it. The camcorder is a full-size RCA VHS-HQ unit. While this unit is admittedly bulkier and heavier than most on the market, and is certainly not the one you would want to take on vacation with you, the full-size unit is easier to service than compact units. That makes it the perfect choice for a course in which you are required to open up the unit and service and replace various parts.



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TECHNOLOGY UPDATE

# World's quietest and most effective air purification system finally available to the public!

*Breakthrough air purification system uses negative ions to actively remove contaminants better than any other filter and operate in total silence.*

*by Vicky S. Hindelang*

Do you have a problem with the air in your home? Is it musty and stale? Do you sneeze the second you walk in the door? Are you bothered by tobacco smoke, dust, dander or odors? Trust me...you are not alone.

But, because you don't want a bulky, noisy air filter, you just live with the problem. A remarkable new product is now available that ends this compromise: Clearveil 250's compact design rids your home of airborne contaminants *and* operates in total silence.

**Proven technology.** Clearveil 250, a fanless electronic air purifier, uses patented microprocessor-controlled ionization and collection technology for contaminate removal. This method has been proven superior to other air filters, including High Efficiency Particulate Arresting (HEPA) filters. Clearveil is Japan's market leader in air purification devices, selling over 350,000 units since 1988.

**The best method.** In the past, the HEPA filter was considered to be the most effective air purification method. But the technology behind Clearveil is significantly more advanced. Scientific studies have shown Clearveil to be more effective in capturing a higher percentage of even the smallest contaminants.

HEPA filters have a certain level of permeability because they must allow air to pass through them. This means that small dust particles including bacteria, viruses, smog and tobacco smoke are also free to pass. But Clearveil's non-permeable sheet doesn't allow those particles to escape. This makes a big difference to anyone concerned with pure, pollutant-free air.

**Energy efficient.** Because Clearveil is so unobtrusive you will want to run it all day long. And since it only uses about four watts of electricity, you can! One Clearveil unit, running 24 hours a day, will only cost about $4 a year! Just one Clearveil unit will purify a 250-square-foot area. Additional units can be purchased to purify the air in larger homes or office buildings.

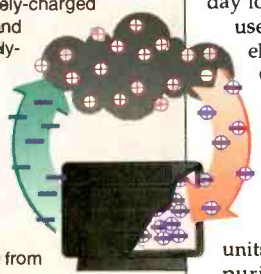
*After 168 hours of use, the Clearveil filter (B) has collected much more dust than the HEPA filter (A).*

## THE CLEARVEIL ADVANTAGE

- **No noise.** Because it doesn't rely on a fan, Clearveil operates in perfect silence 24 hours a day.
- **No misses.** Because it doesn't draw air through a filter, Clearveil catches minute particles of dust that even HEPA filters miss.
- **No mess.** Clearveil uses a positively-charged collection sheet to draw the negative ions back into the unit once they have collected dust.

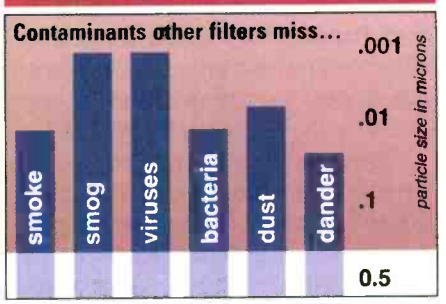
## How it works

1. Clearveil releases negative ions.
2. The negative ions combine with positively-charged dust particles and form a negatively-charged unit.
3. Then a collection plate with a positive charge attracts those negatively-charged units, removing them from your air and home.



*"The success of Clearveil...is directly attributed to the design of a sleek, silent unit that removes smoke, microbacteria, dust and viruses while replenishing negative ions to levels found in clean, mountain air."*

*–Gary Jones, Marketing Director, Clearveil Corp.*




**You'll feel healthier.** Negative ions do more than just remove the harmful contaminants from the air that you breathe. They can actually improve your environment, making it healthier and more envigorating. Studies have shown these ions can help increase alertness and ease tension.

HEPA filters are rated to remove contaminants as small as .3 micron. But many contaminants, including dander, smoke and viruses, consist of smaller particles. Clearveil's superior collection system will remove particles as small as .001 micron.

**Risk-free.** Clearveil is backed by Comtrad's exclusive risk-free home trial. Try it, and if you're not totally satisfied, return it within 90 days for a full refund, "No Questions Asked." It also comes with a one-year manufacturer's limited warranty.

**Three easy payments.** We're so sure you'll love what Clearveil does for your environment that for a limited time we're offering it at the special introductory price of $199. And for credit card customers you can get the Clearveil for three monthly payments of $67. We guarantee that you'll notice a difference in the air you breathe and that Clearveil will operate in total silence. If you don't agree, return it for a full refund, "No Questions Asked."

*Clearveil is so compact you can put it anywhere!*

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You also have the added convenience of being able to use standard VHS tapes that are—figuratively—a dime a dozen these days. (Note, however, that Heathkit, RCA, and **Popular Electronics** magazine all recommend that you *don't ever* use cheap no-name tapes in any deck, or you're asking for trouble.)

While the RCA camcorder uses full-size VHS cassettes, and is considered large by today's standards, it is by no means as large or as heavy as the first full-size units were. And even though the full-size VHS format is now considered somewhat outdated for a camcorder, this unit is loaded with features that didn't exist when camcorders first came out. This results in beautiful video recordings, whether they are made indoors or out, or in brightly or dimly lit locations. While the camcorder records audio in mono-only, this is more than sufficient for the bulk of home video recording and sufficient for the servicing course.

The RCA camcorder also includes many frills that you might not expect to see in a full-size unit. Among them are 1-lux low-light recording, which means that you will rarely need auxiliary lighting to record a scene. Even with the lights dimmed to a cozy level for chatting with company, the 1-lux camcorder can produce good results. A 12× power zoom quickly brings you closer to or farther from the action. The unit also includes a built-in 2-line/2-page titler so you can add captions to your home videos.

The camcorder comes with an AC charger, one battery pack good for about an hour's use, a lens cover, a shoulder strap, and a cable for connecting the unit to a TV. However, a full line of optional accessories for the camcorder, such as extra-capacity battery packs, AC/DC chargers, hard and soft cases, an automobile power cord, and add-on lighting is available from RCA. An accessory hot shoe is located on the top of the camcorder for connecting things such as auxiliary lights.

The camcorder has quick-response infrared autofocus. This is much more effective and faster to react than sonar-type autofocus systems. Simply put, whatever you're recording stays in focus. For times when the autofocus might not work, such as when shooting through glass, the autofocus can be turned off and you can focus manually.

A feature called PROedit makes for smooth transitions between starts and stops and at points of dubbing. This feature is made possible by the flying erase head contained within the camcorder. The flying erase head is a nice thing to have because home videos are usually the result of many starts, stops, and dubs. An unedited home video is often more boring than the worst B-movie, and an edited video with lots of "junk" visible between edits isn't much better.

The camcorder includes many features that help you make great video. But the point behind the course is servicing, so let's see how the course teaches that.

**Servicing the Camcorder.** Plenty of documentation is included with the Camcorder Servicing Course. Besides the manual for the course supplied by Heathkit, which covers all of the experiments and activities pertaining to the course, a camcorder textbook is also thrown in that describes the general maintenance and repair of camcorders. In addition, the RCA service manual for the particular camcorder is also included. This is the same service manual that an authorized RCA repair shop would use. The manual covers all mechanical and electrical operation of the camcorder, and offers tips on troubleshooting, as well. We know that factory service manuals often cost hundreds of dollars by themselves—ridiculous but true.

Two prerecorded tapes and one blank one come with the course. One of the prerecorded tapes, the Heathkit test-pattern tape, provides you with all the test patterns you need for testing and adjusting any VHS equipment. The other prerecorded tape teaches you how to do surface-mount soldering repairs, which is absolutely necessary inside the cramped housing of a camcorder. The blank tape, of course, is for recording things on with the camcorder.

Also included with the course is a clear plastic VCR tape simulator that lets you observe how a VCR is operating without having an actual tape installed. This lets you see mechanisms that would normally be blocked by an actual tape, and also prevents a good tape from being ruined by a malfunctioning camcorder. Of course the VHS cassette simulator can be used to troubleshoot any VHS player/recorder.

The course includes all of the common hand tools you need to service a camcorder. These are screwdrivers, pliers, cutters, and soldering tools including a soldering iron. The only things you'll have to supply to get the most out of the course are a multimeter and an oscilloscope. You do, of course, need a TV set in order to view the recordings you make. You can play back tapes in the camcorder and watch them in its black-and-white viewfinder, but you can't see enough detail, color or otherwise, to know whether servicing is required. So you have to supply a TV set, as well, but most people should have no trouble locating a color TV—they are quite common these days!

All of the basic maintenance supplies, such as cleaners and lubricants, are supplied with the course. These include video-head cleaner, lintless swabs, chamois wands, grease, and rubber revitalizer. Surprisingly, these supplies are all you need to service most of the camcorders you'll see. That's because, more often than not, all a camcorder needs to get it working again is a good cleaning and lubrication of its moving parts. And sometimes all a slipping belt or tire needs is a quick application of rubber revitalizer, which both cleans the rubber and makes it "grippy" again.

Material is included in the course to familiarize oneself with VHS tapes and how they operate.

*(Continued on page 16)*



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# Reaction Tune

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*AOR AR2700 scanner not sold by Optoelectronics*

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# PRODUCT TEST REPORT

## Canon ES6000 Camcorder

BY STEPHEN A. BOOTH

By any standard, Canon's ES6000 is a handful. The new camcorder combines all the advanced features introduced in earlier models into a single high-end, Hi8-format bundle.

Those advanced features include Canon's unique Eye Control technology for focusing and camcorder operation, and the recently introduced Auto Editing Function for in-camera assembly editing and VCR dubbing. Besides these, there's Canon's Optical Image Stabilization—by which the gyroscopic lens itself corrects for operator movement, rather than depend on electronic signal processing.

Consequently, there's a lot to learn about the ES6000, and the comprehensive instruction manual is must-reading. As you'd expect, there's an Easy Recording mode for point-and-shoot-type movie-making. But for all its automation, this camcorder also offers the manual controls that advanced videographers demand.

### FEATURES

The most unusual function in the ES-6000 is Eye Control, a system unique to Canon for either focusing the lens, or for hands-free operation of the camcorder's controls. It actually focuses your subject or activates camcorder functions by tracking the movement of your eye in the color viewfinder.

*Fig. 1. As this vectorscope photo shows, the ES6000's phase is right on target while its chroma—at the rim of the scope, above the cross-hairs—is slightly oversaturated.*

How so? In the Eye Control Focus mode, two beams of infrared light detect the position of your pupil, and transmit the data regarding direction and speed to the lens-focusing motor. Operation is similar in the Eye Control Switch mode: You eyeball a function on the Menu displayed at the edges of the viewfinder, and it's activated.

Canon says the IR beams are harmless. The system works with eyes of virtually any color or shape, through prescription glasses or contact lenses—anything but opaque or reflective lenses. A simple set-up process calibrates the system to your eyes. There are memories for two settings—either for different individuals, or, for an individual who might sometimes wear eyeglasses. After this, it's set—but a "Guest" mode enables the Eye Control to be recalibrated for other users.

Eye-controlled switching is an alternative to the focus mode. In this mode, the ES6000 reverts to conventional, centered autofocusing. In either case, the main benefit of eye-control is steady videos because generally, there's less need to move the camcorder.

For example, with eye-controlled effects your hands don't have to fumble for tiny buttons. With eye-control focus you won't have to move the camcorder much to keep moving subjects sharp—and operator-shake does become magnified at extreme telephoto lens settings. That operator-shake is further minimized by the image-stabilization technology built into the ES6000, a particularly useful feature given this Hi8 camcorder's extreme 20× and 40× telephoto magnifications.

The other useful technology built into the ES6000 is its Auto Editing Function. Like similar systems, such as the Random Assembly Edit in JVC's camcorders, an on-board memory lets you edit your camcorder tapes for dubbing to a VCR.

With the ES6000, you can select and, if you wish, rearrange up to eight segments of any length, and the camcorder remembers the sequence. When you're ready to dub, the ES6000 has an infrared transmitter that controls the recording and transport function of any VCR you connect for copying. Because the camcorder includes RC Time Code, your editing can be accurate to the frame.

*Thanks to Canon's Eye Control system, using the ES6000 camcorder couldn't be simpler. Combine that with its other great features, like built-in optical image stabilizing, and you have a superior camcorder.*

### TEST RESULTS

The ES6000 underwent the usual battery of electrical exams at the Advanced Product Evaluation Laboratory



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# New breakthrough clones TV signals and sends them to any other TV in your home

*Recoton's new development duplicates cable, TV, VCR and satellite signals and transmits them...without any wires!*

*by Charles Anton*

Today, television choices are virtually unlimited. Between cable, satellite TV, videos and network programming, it's almost a full-time job trying to keep up with all the alternatives. And it promises to get more complicated in the future. Breakthroughs in fiber optic technology will bring over 500 channels into your home.

**Home broadcasting breakthrough.** The problem with all this technology is the expense required to maintain your system and keep it up-to-date. Now, a wireless video broadcasting system from Recoton gives you the power to utilize this technology without the hassle and expense of re-wiring your entire home.

Today, Recoton introduces the next generation in wireless broadcasting. The wireless video broadcaster transmits (re-broadcasts) cable, TV, VCR or satellite programs to any other TV in your home...wirelessly!

**Wave of the future.** Never drag your VCR from room to room again: Recoton's wireless video broadcasting system transmits video or TV signals to any other TV in your home.

Because the system is totally wireless, you won't have to worry about running miles of wires. Besides, who wants to install cable in every room of their home? With Recoton's wireless video broadcasting system, you won't have to. You can even watch one program on your main TV while someone else watches something different on another TV. It's just like having a personal broadcasting system in your home—and it's legal in every state.

**Hi-tech home broadcast.** Recently, the *Federal Communications Commission* allocated a band of radio frequencies specifically for wireless, in-home product applications. Recoton took advantage of the FCC ruling by creating and introducing wireless equipment that can transmit within the prescribed frequency over distances of up to 150 feet.

**Wireless Video Breakthrough...**

**Cable** *Broadcast cable channels, even premium channels, to other TVs in your home that are not wired for cable.*

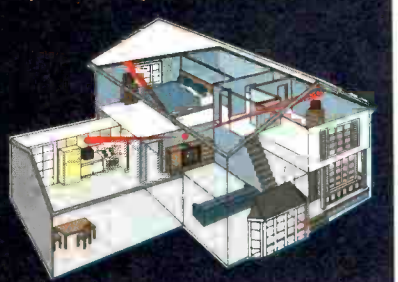
**Videos** *Transmit signals from one VCR to any room, even if someone is watching TV in the room that the VCR is in.*

**Satellite programs** *Watch satellite programs throughout your home without stringing miles of cable everywhere.*

**Live video** *View home videos as you film them or turn your camcorder into a security camera.*

**Network programs** *If the main TV is hooked up to an antenna, you can broadcast its clear signal to all the others.*

Recoton's video broadcasting system clones the accessories (cable, satellite, VCR, etc.) of one TV and broadcasts it to any other TV in your home...without wires!



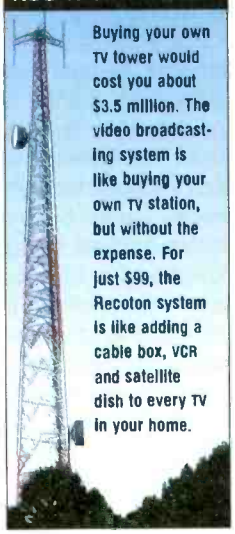
**One transmitter, unlimited receivers.** One transmitter will operate an unlimited number of receivers. This means that a transmitter in the den can send signals to a TV in the living room, kitchen, bedroom and anywhere else you may have a TV. Recoton puts your favorite programs where you want them most.

**Unlimited choices.** Since the broadcasting system uses the latest in 900 MHz frequency signals, there is no time-consuming or complicated wiring. The receiver can be easily moved from one television to another.

The transmitter will also broadcast to multiple receivers, so you can watch the same program on multiple TVs simultaneously. The transmitter connects to the source TV; the receivers simply connect to the others.

**Exclusive factory-direct offer.** With this breakthrough in home video broadcasting technology, you can have the convenience of your own personal wireless broadcasting system for a fraction of the cost of owning your own TV station. For a limited time only, we are offering Recoton's wireless video broadcasting system (one transmitter and one receiver) for the low price of $99. You can order additional receivers for other TVs for just $59 each.

**ADD A TV TOWER?**



Buying your own TV tower would cost you about $3.5 million. The video broadcasting system is like buying your own TV station, but without the expense. For just $99, the Recoton system is like adding a cable box, VCR and satellite dish to every TV in your home.

**Risk-free offer.** The wireless video broadcasting system by Recoton is backed by Comtrad's exclusive risk-free home trial. Try it, and if you are not completely satisfied, simply return it within 30 days for a full "No Questions Asked" refund. It also comes with a 90-day manufacturer's limited warranty. Most orders are processed within 72 hours and shipped UPS.

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(APEL), an independent testing facility located in Bethel, Connecticut. For the first time, though, you're seeing the results of a new—and overdue—method for measuring illumination.

You might think "They don't make 'em like they used to" if you compare the 10-lux rating of the ES6000 to the low-light sensitivity of last year's camcorders. It's an honest assumption. Henceforth the low-light ratings will be two- to five lux higher than the one- to five-lux scores obtained in recent years.

With lux, the lower the number, the better the camcorder's ability to record in low-light conditions. But camcorders haven't gotten worse. Instead, manufacturers have finally agreed on a single standard for measuring light sensitivity. This measurement, developed under the auspices of the Electronic Industries Assn., will be used on all advertising and packaging, and by all labs that conduct independent tests, such as for magazines.

For the first time, you'll be able to compare low-light performance among camcorders for the 1997 model-year and beyond, but not against older ones. You never could. In the past, each manufacturer measured lux differently—and by whatever method yielded the best rating. Magazines and independent labs tested differently from one another too, but APEL's method at least was consistent, so you could compare camcorders over time.

For the record, lux is a metric version of the footcandle measure. One footcandle is the illumination on a surface one foot distant from a standard candle in a dark room—and it's equal to 10 lux. In real-world conditions, the indoor lighting in a typical home ranges from 60 to 100 lux, about the same as the interior of a church, or an outdoors amusement park at night. Meanwhile, the typical business office, supermarket and department store weigh in at about 600 lux. On a clear day, nature's outdoor lighting hits 2000 lux an hour after sunrise.

APEL was one of the companies that participated in developing the new lux spec, formally called EIA Standard EIA-639. Besides the consistency it provides for rating illumination, APEL president Frank Barr points out that EIA-639 also mandates specific performance levels in other key camcorder measurements—including resolution and signal noise. Consequently, a manufacturer can't steal a better lux rating at the cost of fuzzy, grainy images. When you read APEL's test data in Table 1, keep the following in mind.

"Illumination" rates the camcorder's ability to record in low light and still capture a viewable image. At 10 lux the ES6000 is typical of the higher-resolution Hi8-format. You'll get better indoor movies though if you invest in an inexpensive accessory lamp—if only to punch-up colors.

Perhaps a more meaningful measurement for camcorders is "signal-to-noise." It's measured under optimal lighting conditions and shows the amount of usable signal, for color (Chroma AM) and brightness (Luminance, black-and-white), above the threshhold of electrical noise. On both video (the on-tape recording) and camera (straight through-the-lens operation) output, the ES6000 performs well. The S/N ratio for the camcorder's AFM stereo recording is quite good. Meanwhile, the input sensitivity for the external microphone jack isn't the most sensitive APEL has measured, but still means you can equip this camcorder with many affordable accessory mikes.

"White balance" rates a camcorder's ability to adjust to different temperatures of light, for example, sunshine or incandescent, to reproduce white purely (and thereby, correctly-balanced colors). The ES6000's automatic adjustment performs just fine here. Ditto for "color contamination," the test that would reveal the presence of unwanted color when the camcorder's trained on a black-and-white test pattern.

In "resolution" the ES6000 is typical of Hi8 camcorders—360 lines of horizontal resolution recorded to tape at the video output. This is close to the

**TABLE 1—TEST RESULTS**

The following test results were furnished by the Advanced Product Evaluation Laboratory, an independent testing facility located in Bethel, CT.

| | |
|---|---|
| **Brand:** | Canon |
| **Model:** | ES-6000 |
| **Price:** | $1,699. |
| **Weight:** | 2.25 pounds (including battery and cassette) |

**Video Measurements:**

| | |
|---|---|
| Minimum Illumination: | 10.0-lux |
| Resolution (Video Output): | 360 lines |
| (Camera): | 450 lines |
| Signal-to-Noise Ratio (Video Output): | |
| Chroma AM: | 42.0 dB |
| Luminance: | 41.9 dB |
| Signal-to-Noise Ratio (Camera): | |
| Chroma AM: | 49.3 |
| Luminance: | 41.2 |
| Color Contamination: | 5 IRE |
| White Balance: | 5 IRE |
| Streaking/Lag, Image Retention: | Excellent |
| Color Quality (see Fig. 1): | |
| Phase Accuracy: | Excellent |
| Chroma Saturation: | Slight oversaturation |
| Minimum Focus Distance: | |
| Telephoto: | 31 inches |
| Macro: | 0.25-inch |

**Audio Measurements:**

| | |
|---|---|
| Signal-to-Noise Ratio: | 59.2 dB |
| Maximum Output (built-in mic): | 0.72-volts |
| Input Sensitivity (external mic): | 4.7-millivolts |



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theoretical limit of 400 lines (compared to 240 for the conventional 8mm format). Resolution means sharpness, and it's gauged by the number of image-making lines the camcorder records, in picket-fence fashion across your TV screen. It's much higher (450 lines) in "camera" mode.

The test for streaking/lag, image retention looks for flares or tails of light and color that trail behind the highlights of a moving subject. You'll see this on TV sportscasts, usually when light reflects off shiny helmets. It's virtually nonexistent with the CCD-based image sensors used in camcorders.

The tests for color quality examine phase accuracy and chroma saturation. Each is measured using the color red—the most difficult for video to reproduce. The Phase Accuracy portion of the test looks for deviation from true red, toward magenta or yellow. Chroma Saturation gauges depth, or intensity of hue.

As the vectorscope photo (see Fig. 1) shows, phase is right on target while chroma—at the rim of the scope, above the cross-hairs—is slightly oversaturated. Saturation, over and under, does affect an image visibly. The richer red of the ES6000 can be toned down with your TV's color controls.

## OTHER FEATURES

The ES6000 comes with a feature seldom seen in camcorders anymore: Negative/Positive conversion. Although Canon touts this as a movie-making special-effect (along with solarization, mosaic, black-and-white, and sepia recording) it has a very practical function.

In conjunction the optional FP-100 Film Adapter ($199), this function lets you convert color film negatives to positive images for recording on video. The adapter also works with transparency slides, and offers another neat trick. Besides recording photos to video, you could use the camcorder, in camera mode, to input photos directly to a personal computer without the added expense of a photo scanner. Whence, the importance of the ES6000's 450-line camera resolution. ■

**FOR MORE INFORMATION**
**Canon USA, Inc.**
One Canon Plaza
Lake Success, NY 11042
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## HANDS ON REPORT

*(continued from page 10)*

After all, how can you service a recorder or player when you don't know how the cassette itself operates. After that, one can open up the camcorder and take a look inside. It is important to become visually familiar with the inside of a camcorder before attempting to take it apart. After that you can remove whole sections of the camcorder and service them.

All of the sections inside the camcorder are thoroughly discussed. The sections include the camera portion that receives and processes an image for recording and the video circuitry that the camcorder has in common with a VCR. Servos, sensors, motors, audio circuitry, power supplies, and everything else is also covered. Once a camcorder is physically back up to snuff, all of the adjustments that lead to a clean recording must be performed, and the course discusses these, as well.

As one might imagine, the workings inside a camcorder are governed by a microprocessor. The course covers all aspects of the microprocessor's operation, and how it controls camcorder functions.

While you'll probably want to start servicing the camcorder as soon as you open up the box, you should note that the unit is brand new, under factory warranty, and shouldn't require any servicing for years to come. It's just that the course makes it so tempting to open up the camcorder and start disassembling it. But that is the intent of the course, and Heathkit has obviously done its job well.

Heathkit's Camcorder Servicing Course sells for $1295. While that sounds steep at first, remember that the course includes a brand-new camcorder and everything you need to keep it working forever—well almost. ■

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**Heath Company**
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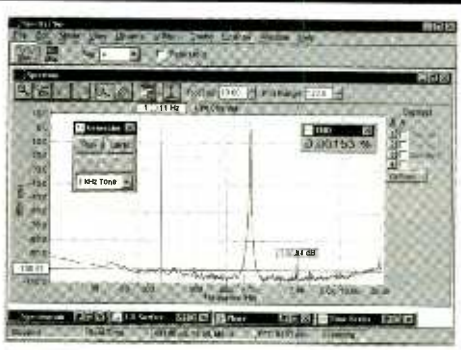

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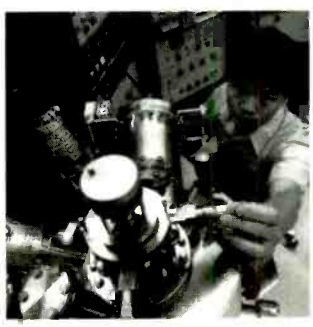

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# NET WATCH

# Become Your Own Travel Agent

BY DAN KARAGIANNIS

Ask anyone in the industry and they'll tell you that travel agencies are in trouble. Such forecasters of doom will explain how "times are tough" and people aren't going away on trips anymore. I suppose they might be right.

However, this month I'm going to add my own reason why conventional travel agents might lose some sleep. It seems that there is a brand new way to make your airline, hotel, and car-rental reservations—all without the help of another living soul. Welcome to the age of do-it-yourself trip planning, all made possible by your computer, modem, and Net connection.

*Forget about going to travel agents or calling for flight information, Travelocity lets you arrange all your getaways online.*

I found a travel site on the Web that's so comprehensive, covering any others in detail this month would only use up space. So, I decided to focus on that site, and briefly mention a few others. Let's get to our premier online marvel, shall we?

## TRAVELOCITY

Our featured site this month is one that I'm not only impressed with, but somewhat addicted to as well. Called Travelocity, it's sure to handle just about any travel concern you might have. Actually, you're presented with so many options once you log on that I'm going to have a difficult time keeping short my description of what you can accomplish here.

For starters you're presented with a ticker-tape-type banner at the top of the screen. This "news flash" banner lets you know what airlines are offering specials, and could give you some valuable hints to planning your next trip around whatever fare wars are currently being waged.

To the right of this page you'll find headline topics of interest. These change on occasion, but when I was last here they included links to special last-minute airfare deals, and information on how to earn 500 AAdvantage miles on American Airlines by using Travelocity.

On the same opening page you can choose from Travel Reservations, Destinations & Interests, Points of View, and Travel Merchandise. Let's now spend some time on each of these impressive sites, beginning of course with the heart of Travelocity.

The Travel Reservations section is definitely the area of Travelocity where you'll spend most of your time online. When you first click on it you're presented with several choices: Flights, Cars, Hotels, Retrieve Existing Reservations, and Vacation Packages.

Flights lets you either look through flight timetables and listings of fares, pick a particular flight you'd like to catch, or (this is my favorite) find the three lowest fares available to your destination.

How the lowfare finder works is simple. First you choose a login ID and password. This is because Travelocity will let you save itineraries and actually pay for them online using a credit card and a secure browser mode.

Next you enter the number of passengers, the type of class you'd like to fly (picking "low fare with restrictions," which seats you in coach, yields the best prices), and airline preferences. The form goes on to let you select what's most important to you in choosing a flight; you'll have to rank factors like price, whether it's non-stop, etc.

With all the preliminaries set, you must then choose the most obvious parameters: where you're leaving from, where you're going, and when you want to travel. The same goes for the return leg of your trip. You could enter several such segments, taking you from place to place, if you have a need to get to more than one place, that is.

Once you enter your data you submit it, wait a moment, and before you know it, the three lowest fares available will show up on your screen. Each gives you all the flight information you'll need to make up your mind.

The Cars reservation link is similar in that you're presented with a form to fill out online. Except here you are asked for the price range and type of car you're looking for, along with where and when you'll need it. You can even link to rental policies and rules of each company.

Choosing a hotel is another simple online process. What's neat about this reservation system is that you can make special requests. And I don't just mean whether or not your room is a smoking or non-smoking one. You can



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# 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!*

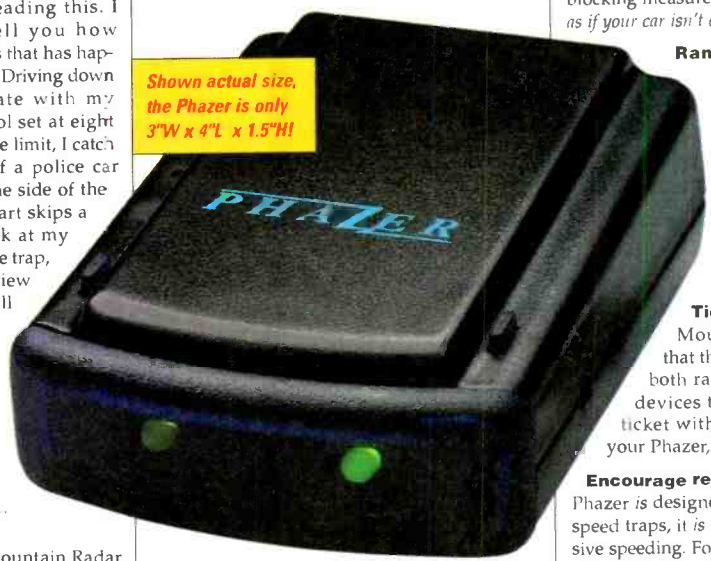
■ *The Phazer will "jam" both radar and laser guns, preventing police from measuring your speed.*

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.

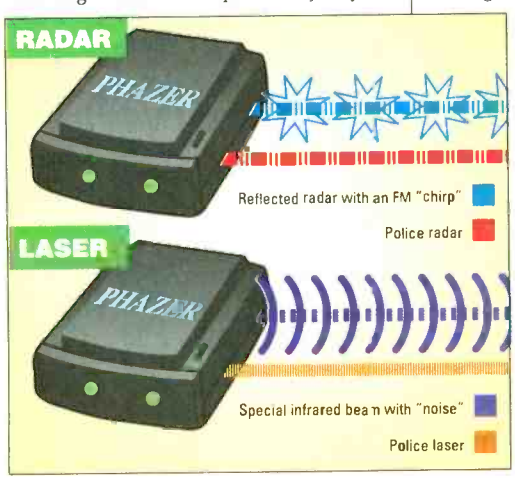
**The solution.** Today, Rocky Mountain Radar offers drivers like me a perfect solution—the Phazer. Combining a passive radar scrambler with an active laser scrambler, the Phazer makes your automobile electronically "invisible" to police speed-detecting equipment.

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.




*Shown actual size, the Phazer is only 3"W x 4"L x 1.5"H!*

**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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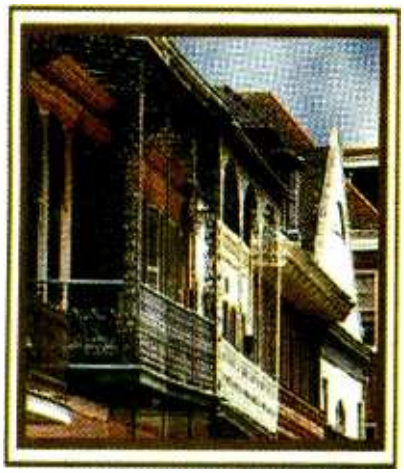

*Want a look at where you're going before you get there? Load some photos of your next destination; shown here is some New Orleans architecture courtesy of Travelocity.*

actually look for hotels that have entertainment, indoor pools, exercise facilities, etc.

Once you make travel plans, you can store them and get them later with Retrieve Existing Reservations. Need some more ideas about how to put it all together? Check out Vacation Packages for getaways that are textbook perfect.

Now that we covered that first feature of Travelocity, it's time to move on to the others I mentioned. Our next is Destinations & Interests, which is a first-rate section in itself. The page opens with a banner and a clickable map of the world; the banner lets you choose from Maps, Photos, Videos, Currency, Weather, or Features.

Selecting Maps is the same as picking a destination off the onscreen map. You'll get just what the name implies—maps, maps, and more maps to help you plan your trip.

Photos and Videos are similar in that they both let you see the places you plan on visiting before you actually buy a ticket. I personally liked the short video tours, which are provided in Quicktime format. Check out New Orleans, Paris, Cancun, and several other fun getaway spots.

Selecting Currency will provide you with a feature that's very useful to world travelers. Simply choose a unit of currency from the list provided, enter an amount in that currency, and select a unit to translate the amount into. Just about every country's currency is here, so consider yourself free of conversion tables and formulas for good.

Weather provides you with current climate information about North America, Europe, and Asia. Under each little map of these regions you can choose from: Full-Size Map, Airport Conditions, Current Outlook, and Forecasts. All of these are pretty self explanatory.

Last in this section is Features, which presents you with several travel-article titles. Just click on a story about a region you're interested in to read more.

The next section you can visit in the Travelocity site is Points of View. There you can link to World Views, Travelive, Bulletin Boards, and Trivia.

In World Views you'll find featured reviews (which are updated regularly) written by travel writers and Worldview's editorial staff. When I logged on before writing this column, there was a winter-sports feature.

Travelive lets you chat in real time with other travelers and industry insiders. The site uses the WebChat Broadcasting System (WBS), which means you only need a standard browser to participate (unlike Internet Relay Chat, for which you need special IRC software). You can talk about destinations, travel styles, and languages.

The Bulletin Boards let you participate in non-real-time online discussions about travel. These are like USENET groups and BBS forums. You'll find posted tips for traveling with kids, adventure travel, insider travel tips, and more.

Last in this section is Fun & Games. There are no prizes, but if you feel like having your travel knowledge challenged, you should enjoy this section's trivia games.

The final major section at Travelocity is Travel Merchandise. Here's where you'll find AC Adapters, Books, Games, Luggage, Maps and Guides, and links to dozens of other types of products that you wouldn't want to leave home without. There's even software you can buy to help you plan a getaway, though I can't imagine what such software does that this site doesn't already cover!

## FOR FREQUENT FLYERS

While Travelocity is a great site, some of you reading this might have a frequent-flyer plan with, or just a preference for, a specific airline. If that's the case, and you only want a way to make airline reservations, you might want to cut out the middle man and go straight to your carrier-of-choice's web site.

**HOT SITES**

**Travelocity**
http://www.travelocity.com

**American Airlines**
http://www.amrcorp.com

**Continental Airlines**
http://www.flycontinental.com

**Delta Airlines**
http://www.delta-air.com

**Northwest Airlines**
http://www.nwa.com

**Pan Am Airlines**
http://www.panam.com

**TWA**
http://www.twa.com

**United Airlines**
http://www.ual.com

**USAir**
http://www.usair.com

In this month's "Hot Sites" box you'll find URLs for American, Continental, Delta, Northwest, Pan Am, TWA, United, and USAir. I'm often logged on to Delta's site in particular, because I'm a new frequent flyer with them, but the other companies have great Web pages as well.

That's it for this month. Until next time, I hope all your travels online and through the air are pleasant ones. Want to drop me a line? Feel free to do so at peeditor@gernsback.com or *Net Watch*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. ■

*"But why do you need a mobile answering machine?"*



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### RNJ Electronics, Inc. New 1997 Catalog

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### All Phase Video Security Inc.

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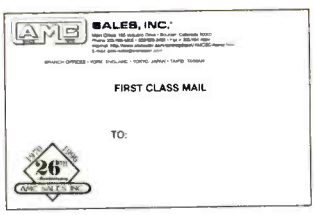


### A.M.C. Sales, Inc.

A.M.C. Sales, Inc., a 27 year old company, specializing in Electronic Surveillance offers its catalog which contains equipment of all types for the individual and/or company who are active in Electronic Surveillance. 80 to 100 items are displayed and priced, a must for the amateur and/or professional. ***$5.00***

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American Eagle Publications offers a unique catalog of educational information about computer viruses, computer hacking, security and cryptography that you just won't find anywhere else. The information offered here goes far beyond the vague descriptions offered by most publications, giving you the solid how-to information you need if you want to explore these little-discussed subjects from a technical point of view. ***$2.00***

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Antique Radio Classified is antique radio's largest-circulation monthly magazine. A typical 100-page monthly issue contains articles and hundreds of classifieds for old radios, TVs, ham equipment, hi-fi, art deco and transistor radios, telegraph, books & more. We also offer price guides and books on repair and restoration and guides for the novice collector. Antique Radio Classified is your link to the world of collecting old radios. Sample: ***$4.00***

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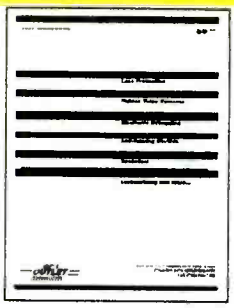

### EDE Spy Outlet

The Latest High Tech Professional Electronic Devices. Our latest catalog offers a **HUGE** selection of surveillance, counter-surveillance/privacy devices: hidden video equipment, pinhole camera w/audio $144., electronic kits, telephone recording systems: 7-Hour $125. – 16-Hour $199., touch tone decoders, scanners, bug/phone tap detectors, voice disguisers, telephone scramblers, locksmithing tools, and more. ***$5.00***

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### Information Unlimited

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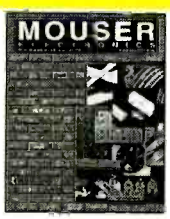


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### International Electronics Corporation

International Electronics Corporation offers a variety of quality SMT kits for students and hobbyists as well as engineers. Our 1997 catalog contains pictures, detailed descriptions, and pricing of all kits currently available, as well as manufacturing services offered. ***$2.00***

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# CATALOG SUPERMARKET

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# Multimedia Watch

## A Pair of Unusual Controllers

By Marc Spiwak
Technical Editor
Windows Magazine

I've tried to keep you all—and myself—up to date on the wide variety of controllers available for PCs. Because even if you only need a mouse for what you do with your computer today, you or someone you know might have to do something out of the ordinary some day. And sometimes tasks can be made a lot easier with a specialized controller of some kind. So this month I've got two very specialized PC controllers, one intended mostly for business presentations and the other obviously for gaming.

### REMOTEPOINT PLUS

I've reported on products manufactured by Interlink Electronics before. Interlink's ingenious force-sensitive resistor (FSR) technology uses a thin film that changes its resistance according to the pressure applied to it. The material indicates how much pressure is applied and where on the film the pressure is applied. The latest FSR device I've seen Interlink demonstrate (but will report on in a future column) is a new kind of touch pad for notebook computers.

Traditional touch pads generate a capacitive field above them that responds to moisture in your fingertip. You don't even have to touch the pad for it to respond. I find these very flaky in general, and I'm always inadvertently highlighting, cutting, and moving text. Interlink's touch pad will use much less power by not having to generate the field and should be a lot more predictable by requiring a light force on the pad to make it do anything. Interlink will OEM the device to certain notebook manufacturers and will also market a standalone touch-pad controller that I'll report on as soon as I get one.

This month I will discuss Interlink's newly designed *RemotePoint Plus*, a handheld wireless infrared (IR) mouse. It's sort of like a TV remote with a circular rubber disc that can be tilted 360 degrees. The tilting motion replaces a mouse's X-Y movement by moving the cursor in the direction that the disc is tilted. Cursor speed depends on the amount of pressure applied to the edge of the disc. You point RemotePoint Plus at a small desktop IR receiver that plugs into your computer's mouse port. The transmitter works up to 40 feet away from the receiver.

The original RemotePoint basically had just primary (left) and secondary mouse buttons. In addition to those buttons, the new RemotePoint Plus has four extra buttons that can be assigned to as many as 15 functions to access presentation tools, start games, mute sound, launch a Web browser, and so on. Software bundled with the device provides more than 50 presentation screen tools including an on-screen highlighter, laser-pointer emulator, underliner, and more. Anyone who does business presentations will definitely want to have a RemotePoint Plus. It has a suggested list price of $199.95.

*Interlink's RemotePoint Plus is a handheld wireless infrared (IR) mouse. In addition to primary (left) and secondary mouse buttons, it has four extra buttons that can be assigned to as many as 15 functions to access presentation tools, start games, mute sound, launch a Web browser, and so on.*

### THE SIDEWINDER

This month I've also got a new controller from Microsoft: the SideWinder Game Pad. This one looks and feels like the handle bars from a futuristic, miniature motorcycle. It's very comfortable to hold and all of the buttons are easy to access. The game pad has 6 action buttons, an 8-way cross-key pad, and 2 trigger buttons. It works with games running under Windows 95 or in an MS-DOS box in Windows 95. Because it's a digital controller with exotic new drivers, the game pad won't work with a lot of older software. It does provide lightning-fast response for games that do work with it, though.

Up to four users can play games simultaneously by daisy-chaining game pads together, with all the functions of each pad maintained. The Game Device Profiler software lets you create macros by programming complicated multibutton and keyboard strokes into single button presses. That gives you the edge in games that require a lot of complicated maneuvers. To use the SideWinder game pad you need a 486/66 or higher multimedia PC and Windows 95.



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*The Microsoft SideWinder Game Pad looks and feels like the handle bars from a futuristic, miniature motorcycle. It has 6 action buttons, an 8-way cross-key pad, and 2 trigger buttons.*

## NEW STUFF

I've been into photography for a long time. I actually had my own darkroom, back when I was a kid, for processing and printing black-and-white photos. While I haven't done any photographic work in a long time, aside from taking pictures that is, I'm sure the skills would come back to me in an instant. However, some day soon, my long-lost skills won't even be valuable anymore—digital cameras and computers are taking over everything. MGI Software is helping photographers get their feet wet in digital processing, without the use of a digital camera. You start with regular film.

The *MGI PC PhotoStarter Kit* ($24.99) is intended for beginners. The kit includes everything you need to place, edit, and manage photos on your PC. The kit includes a 12-exposure roll of Kodak 35mm film and free Kodak processing of film to disk—you pay for the regular developing, and they throw in electronic prints for free. You also get MGI PhotoSuite Starter Edition software and a helpful guide with step-by-step instructions.

*MGI PhotoSuite 8.0* is for those who've already played with image-editing software and know they like it. PhotoSuite 8.0 includes everything you need to customize and catalog your photos: 30 special effects, a photo lens kit, image capture, a slide show, photo albums, and more. This package sells for $74.95, and it's only $49.95 if you upgrade from the PhotoStarter kit.

There's new software this month from Microsoft. For one there's the newest release of the Encarta encyclopedia, *Encarta 97*. This is basically an update to the ever popular treasure chest of information, except that now you can buy two versions: there's the usual Encarta 97 Encyclopedia on a single CD for $54.95 and a new Deluxe Edition that comes on two discs for $79.95. The Deluxe Edition contains nearly twice as much multimedia content as the regular version, with more pictures, more video clips, extensive Internet links, and 18 months of free online updates. Also available is the new Encarta 97 World Atlas. Including 1.2 million places and over 8000 web links, this is the biggest world atlas ever, and all for only $54.95.

I've also got Microsoft's latest release of its interactive movie guide, *CineMania 97*. This one contains all you'd ever want to know and more about more than 25,000 movies—who starred in them, what they're about, the director, the producer, and so on. All information is cross referenced. For example, if you know one movie someone has been in, all the others will show up as well. There are also plenty of still images, video clips, movie reviews from respected critics, and other fascinating information. CineMania can also suggest movies for you to watch based on types and topics. If you like movies, you'll find this disc to be valuable.

Microsoft apparently wants to help you with everything under the sun, and buying a new car is one of them. Unless you know exactly what you want, there are just too many makes, models, and features to choose from. The *Microsoft CarPoint* Internet car-buying guide is a huge database of information on new cars. Find out what the features cost, where the hidden charges are, and much, much more. CarPoint can help you decide on a model based on the features that are most important to you. You can even check out the interiors of new cars with Surround Videos that let you see 360-degree views. Visit CarPoint on the Web at http://carpoint.msn.com/.

Star Wars fans are going to do cartwheels when they find out that not only is the trilogy of original movies being re-released along with special digital enhancements, but also that *The LucasArts Archives Vol. II: The Star Wars Collection* is now available. The collection includes three classic titles: Rebel Assault, Rebel Assault II: The Hidden Empire, and TIE Fighter Collector's CD-ROM. You also get the Dark Forces Super Sampler Edition. But the icing on the cake has to be the bonus CD-ROM, Making Magic: A Behind the Scenes Look at the Making of the Star Wars Trilogy Special Edition. Star Wars was released about 20 years ago, and a lot has happened to movie-making technology in the years since. Making Magic shows you how some of the movie magic is done today.

I've three new children's software titles this month from DreamWorks Interactive. The first one is *Goosebumps: Escape From HorrorLand*, where you are trapped in a scary theme park. It's based on RL Stine's series of children's books. *Someone's in the Kitchen!* is a musical multimedia title that lets kids experiment in the kitchen without making a mess. Kids can follow recipes or create their own, and they learn about food and kitchen safety along the way. The *Neverhood* is a multimedia adventure game with photo-realistic environments created from over three tons of clay. You play the hero Klaymen and must save the Neverhood from Klogg, an out-of-control clay creation. ■

### WHERE TO GET IT

**DreamWorks Interactive**
640 North Sepulveda Blvd.
Los Angeles, CA 90049
CIRCLE 60 ON FREE INFORMATION CARD

**Interlink Electronics**
546 Flynn Road
Camarillo, CA 93012
CIRCLE 61 ON FREE INFORMATION CARD

**LucasArts Entertainment Company**
PO Box 10307
San Rafael, CA 94912
CIRCLE 62 ON FREE INFORMATION CARD

**MGI Software Corp.**
40 West Wilmot Street
Richmond Hill, Ontario
Canada L4B 1H8
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**Microsoft Corporation**
One Microsoft Way
Redmond, WA 98052
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# SCANNER SCENE

# Scanning the Wild Blue Yonder

BY MARC SAXON

Aeronautical monitoring is one of the rare aspects of the hobby that offers scanner owners a taste of DXing. High-altitude aircraft can be monitored while they are several hundred miles off into the distance. To add a further touch of MHz spice, the aircraft you'll monitor might have originated at some exotic foreign locale. No matter, English is the language for all aeronautical communications.

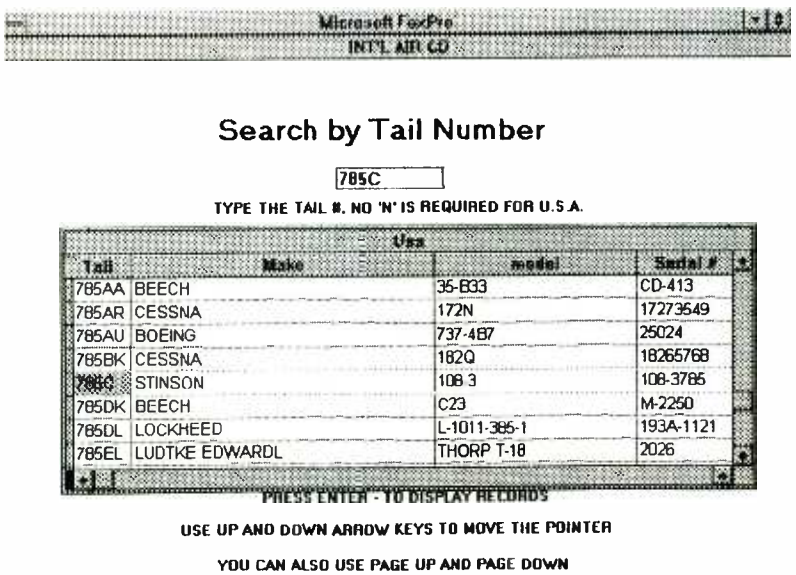
A common complaint from scanner owners, however, has been that although aircraft make for great VHF scanning, not knowing their types, owners, and other stats keeps them too anonymous. You can't look them up, like the police or fire stations a scanner can receive. That *was* true—but not any longer!

Thanks to the *International Air* CD-ROM, you can now search out the information on virtually every individual aircraft (well, except for military) registered in 84 nations of the world. The data covers 23 categories, such as airliners, private aircraft, agriculture, training, weather, balloons, gliders, research, utility, racing, acrobatic, and more.

Using the CD-ROM through a Windows program, you can look up any aircraft by its tail number or its owner's name, or by its category, its make and model, or its engine make and model. Remember that an aircraft's tail registration number constitutes its official radio call letters or identification. You can learn the year an aircraft was built, its number of engines, city of registry, number of passengers, maximum takeoff weight, average cruising details, engine horsepower, and fuel-consumption rate. There are also pilot records, as well as telephone and fax numbers for pilots and aircraft owners in the U.S. and Canada.

An enormous amount of useful data is available on this CD-ROM. Any aircraft you monitor can be identified in seconds. New editions are updated quarterly in order to keep the information current. *International Air* installs quickly and easily and is very user-friendly. It comes with a 22-page manual just in case questions arise.

The CD-ROM costs $189. It's sold by International Air CD, 2234 North Federal Highway, Boca Raton, FL 33432; Tel. 561-243-1219; Fax: 561-243-9889; Web: http://hitech.superlink.net/.




*With the* International Air *CD-ROM, finding information on a particular aircraft couldn't be easier.*

## McMONITORING

No doubt about it, fast-food drive-through windows continue to attract an inordinate amount of attention from scanner owners. Although we have run some of the frequencies in the past, we continue to get letters providing frequencies as well as asking for them.

Whatsamatta—you can't enjoy a burger and fries in your car without also eavesdropping on the counter folks? Think maybe they're talking about you behind your back? They might be!

Although frequencies vary from location to location, many McDonalds are reported to be using 30.84, 31.00, 33.14, 35.02, 151.715, 151.775, 151.895, 154.06, 154.57, 154.60, 154.70, 165.60, 169.446, 170.245, 170.305, 171.105, 171.905, 467.775, and/or 467.55 MHz.

Burger King is said to prefer 30.84, 31.00, 154.57, 170.305, 457.5625, 457.60, 467.825, 467.7875, and 461.2875/466.2875 MHz.

Try a Taco Bell on 30.84, 31.00, 33.40, 154.515, 154.54, 154.57, 457.5375, 457.55, 460.8875, 461.0375, 461.0875, 461.5375, 464.9625, 466.0375, 466.8075, 466.5375, 468.3875, and/or 469.9625 MHz.

If you're at a KFC, don't be a chicken! Try 30.84, 31.00, 33.40, 154.57, 170.305, 457.5875, 457.60, 460.8875, 461.0875, 462.75, 462.7625, 465.8875, 467.8125, and/or 467.8875 MHz.

Keep in mind that you won't hear anything if you drive much beyond the limits of the parking lots of these places because they use short-range equipment. Some places use single frequency (simplex) systems, in which case you will hear both sides of conversations. Otherwise, they are transmitting and receiving on different channels, and you'll pick up only half of what's being said, unless you use two scanners. Two scanners? You wouldn't go *that* far, would you?

Oh dear.

*continued on page 69*



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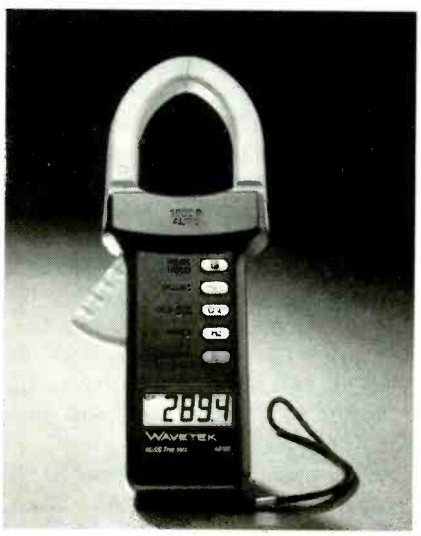
# NEW PRODUCTS

## CLAMP-ON AMMETER

*Wavetek's Model AD105* clamp-on ammeter is designed for the installation, testing, verification, servicing, and troubleshooting of today's electrical systems and equipment. Its clamp style allows for both AC and DC amp measuring and frequency test in a non-invasive manner for quicker and safer current measuring.




The Model AD105 features a large LCD readout, autoranging, true-RMS measuring, and a peak-hold button. Hall-effect technology allows for the measuring of both AC and DC current to 1000 amps and frequency to 10 kHz. The ammeter's "hand-guard" design meets international safety standards. Wavetek's No Hassle™ warranty assures that the ammeter will be replaced anywhere in the world with an instant, over-the-counter exchange, if necessary.

The Model AD105 clamp-on ammeter has a list price of $224.95. For additional information, contact Wavetek Corporation, 9045 Balboa Avenue, San Diego, CA 92123; Tel. 619-279-2200; Fax: 619-565-9558.

**CIRCLE 80 ON FREE INFORMATION CARD**

## DIGITAL VOICE RECORDER

*Sony's Voice File Model ICD-50* is a palm-sized IC chip recorder that holds up to 99 messages in each of two separate files. Measuring just 2-1/8×3-3/8×7/8 inches and weighing only 2-3/4 ounces, the digital recorder is equipped with a backlit digital LCD readout that clearly displays recording and feedback functions.

The Voice File provides crisp, distortion-free recordings, with up to 16 minutes of continuous recording time. Messages can be recorded over again and again. The ICD-50 also features a built-in alarm with personal message reminder.

Messages and notes can be recalled easily at a later time. At the touch of a button, the recorder's quick random access and flash memory capabilities help locate and play specific messages.

The scan function allows users to play back the first few seconds of each message. The insert function allows users to add additional information to an existing message.

The Voice File ICD-50, which runs on one "AAA" battery, has a suggested retail price of $189.95. For further information, contact Sony Electronics, 1 Sony Drive, Park Ridge, NJ 07656; Tel. 800-222-SONY; Web: http://www.sony.com.

## MONITOR-TOP ORGANIZER

*Kantek's Spectrum Superstor™* provides quick access and convenient storage of office and computer essentials, placing everything right at your fingertips—on top of your computer monitor. It takes up no desk space, and clears much of the clutter off your desktop.

The Superstor holds and organizes all sorts of office supplies and computer media, with compartments sized to hold CD-ROMs, 3.5- and 5.25-inch disks, ZIP disks, back-up tapes, paper, stationery, envelopes, note and full-size pads, file folders, and Post-Its. Holes in the top of the unit hold pens, pencils, markers, scissors, and rulers. The compartments are adjustable to accommodate an assortment of supplies.

The Superstor works with all popular monitor and terminal sizes (from 12 to 21 inches) and slopes. Its mounting system allows full tilt, swivel, and centering adjustability for efficient positioning. The organizer is compatible with all existing glare filters and copy holders. It can also be used as a desktop organizer.

The Superstor monitor-top organizer has a suggested retail price of $49.95. For further information, contact Kantek Inc., 15 Main Street, East Rockaway, NY 11518; Tel. 516-593-3212 or 800-536-3212; Fax: 516-593-3295; e-mail: kantek@interserv.com; Web: http://www.kantek-spectrum.com.

**CIRCLE 81 ON FREE INFORMATION CARD** ■



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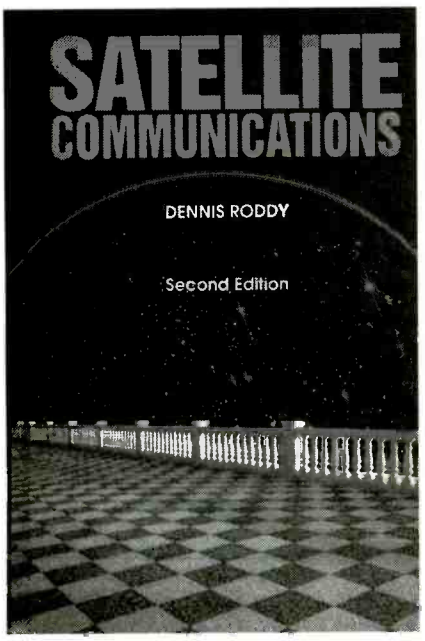
# Electronics Library

## SATELLITE COMMUNICATIONS Second Edition

*by Dennis Roddy*

This book provides students, technologists, and engineers with an introduction to the complexities of satellite communications systems that is both comprehensive and readable. It delivers clear explanations, in plain English, of all types of analog and digital systems in use today, without glossing over important technical details.




The book covers the many practical issues that are of interest to professionals and students alike. It presents the latest information on frequency-division multiple access (FDMA) and time-division multiple access (TDMA) and how those competing methods of satellite access measure up. It explains orbital mechanics, with full descriptions of hardware such as satellite structures, antennas, and earth stations. The second edition also explores cutting-edge applications including global-position-satellite and mobile-satellite systems.

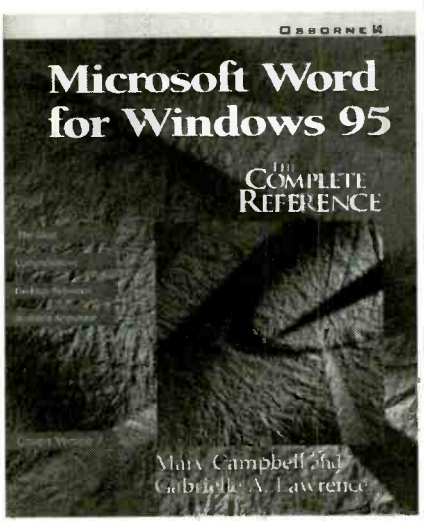
*Satellite Communications, Second Edition, costs $60 and is published by McGraw-Hill, Inc., 11 West 19th Street, New York, NY 10011; Tel. 800-822-8158.*

**CIRCLE 90 ON FREE INFORMATION CARD**

## MICROSOFT WORD FOR WINDOWS 95 The Complete Reference

*by Mary Campbell & Gabrielle A. Lawrence*

This book provides clear answers about the newest version of the best-selling word processing system, Microsoft Word. Written in an easy-to-use format, with helpful tips, shortcuts, and techniques presented along the way, the book is designed to help readers quickly and effortlessly find the information they need. Beginners will learn how to install Word for Windows 95 and find thorough instructions on creating, editing, and formatting documents. More advanced users will find information on topics including how to exchange data with other applications, use Word's desktop-publishing features, and use Word in a workgroup environment.




The book describes every Word for Windows 95 feature, menu item, command, and function, and provides examples on every topic. An alphabetic reference of all Word for Windows 95 features and a handy cross-referenced index are included.

*Microsoft Word for Windows 95: The Complete Reference costs $29.95 and is published by Osborne/McGraw-Hill, 2600 Tenth Street, Berkeley, CA 94710, Tel. 800-227-0900.*

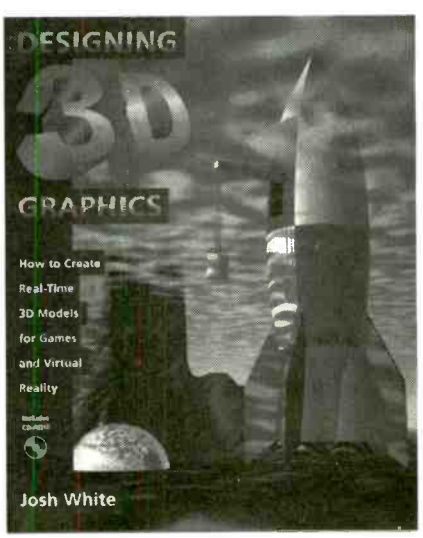
**CIRCLE 91 ON FREE INFORMATION CARD**

## DESIGNING 3D GRAPHICS: How toCreate Real-Time 3D Models for Games and Virtual Reality

*by Josh White*

This book-and-CD-ROM package gives readers everything they need to create sophisticated real-time 3D graphics for games and virtual-reality applications. The book is full of design tips, animation techniques, and step-by-step directions for the most popular drawing tools. The accompanying CD-ROM features a collection of 3D objects and textures that can be used immediately, a sample of every 3D model shown in the images in the book, and textured models.

The author, a professional computer graphics artist, reveals his in-depth knowledge of software tools and hands-on modeling techniques. Readers learn how to design 3D artwork that is optimized for real-time; create realistic 3D objects that render at a high frame rate; master industry-standard tools such as 3D Studio and Photoshop; and create graphics for different platforms, including PC, Macintosh, Sony Playstation, Nintendo, and Sega.




*Designing 3D Graphics costs $39.95 and is published by John Wiley & Sons, Inc., 605 Third Avenue, New York, NY 10158-0012; Tel. 800-225-5945; Web: http://www.wileycom/compbooks.*

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Gateway Electronics of CA
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San Diego, CA 92123

Mac's Electronics
191 South "E" Street
San Bernardino, CA 92401

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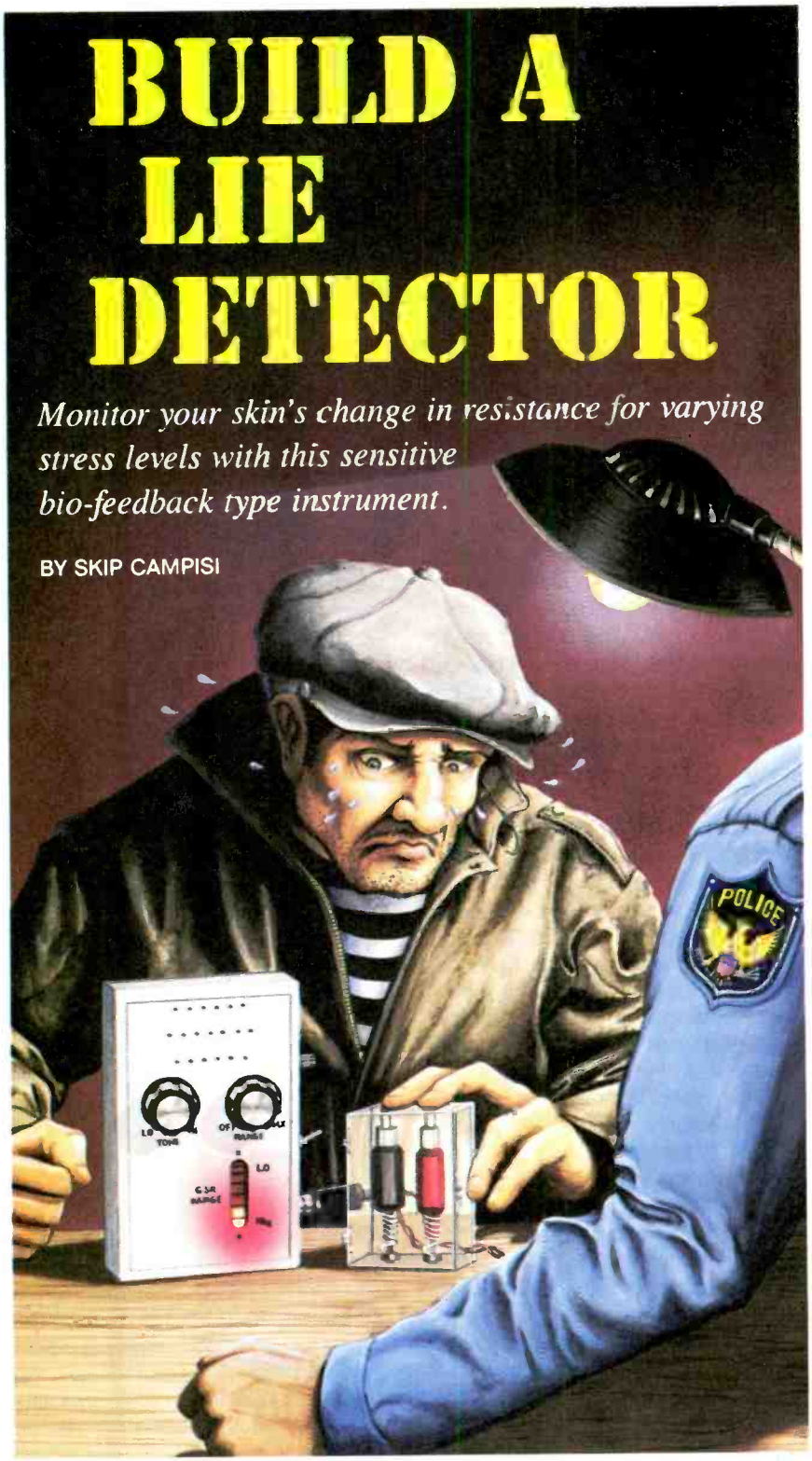
# BUILD A LIE DETECTOR

*Monitor your skin's change in resistance for varying stress levels with this sensitive bio-feedback type instrument.*

BY SKIP CAMPISI




Just about everyone is familiar with the "polygraph" instrument, or "lie detector" as it is commonly known. A typical unit will monitor respiratory rate, heart rate, and galvanic skin response (GSR) as a subject is being questioned. Some units also use an EEG to monitor brain waves. A skilled operator supposedly can determine if the subject is being truthful or not.

Of all the components of a typical polygraph, the easiest circuit for a hobbyist to reproduce is the GSR monitor, which will indicate relative changes in skin resistance. Such a device is the basis for the simple *Lie Detector* described in this article. While it only lets you perform one of the tests of a traditional polygraph, the Lie Detector could still provide you with hours of fun, and might even help you catch a "fibber."

**GSR Basics.** While most hobbyists know how to measure resistance in a circuit, few know how to measure it in skin. Let's take a brief look at how that is possible.

Skin resistance varies at the rate of about 0.01 to 0.5 Hz under normal "at rest" conditions. However, the factor most important to us is the degree of perspiration, which drastically affects skin resistance under certain conditions.

As your skin has an average of 500 to 600 sweat glands per square inch, a simple set of non-invasive electrodes is all that is required for good skin contact, assuming constant electrode pressure and contact area are maintained during testing. The resistance change is most easily observed at the fingers and palms of the hands, and the soles of the feet.

Because the degree of perspiration is related to stress levels in the body, stress directly affects skin resistance. The more stressed or excited you become, the more you perspire, and skin resistance drops accordingly. Strangely enough, not all skin areas seem to be affected equally, and tend to behave actively at one time, and then become inactive at other times!

Obviously, galvanic skin response is ripe for further experimentation as far as different types of electrode contacts and placement are concerned. The Lie Detector presented here is just the "tool" required for advanced experimentation, having all of the capabilities for expansion, with precise control of GSR measurements already incorporated in its design.

**Circuit Description.** To make an accurate resistance measurement of any type, a stable constant-current generator of some type is the basic requirement. Due to the small contact area of the electrodes used for the prototype instrument, the skin resistance to be measured is in the megohm range; thus the current required for a usable output voltage is



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quite low.

To generate stable currents of 1 microampere and lower, special constant-current circuitry is required, with the ability to go down to zero current (no leakage)—a very desirable quality. This would allow control down into the lower nanoampere range for measurements of very "dry-skin" conditions.

The schematic diagram for the Lie Detector is shown in Fig. 1. Basically, the circuit can be divided into three sections: a current generator, a visual (LED) display, and a tone generator. A standard alkaline 9-volt battery (B1) provides sufficient power for the circuit. More about this power supply later.

The current generator composed of Q1 (2N3906) and Q2 (2N3904) and their associated components is quite unusual, as it allows adjustment down to zero current. This is not normally possible with either a current "source" or a current "sink" alone. By combining a source and a sink, however, it is possible to have one cancel the other by adding equal and opposite currents.

Changing the current in either section will provide a difference current (either positive or negative) at the output. In this generator, Q1 is configured as the current source, and Q2 is configured as the current sink. Note that their collectors are directly connected to each other and the output, and that both sections are symmetrical.

An infrared light-emitting-diode, LED1, presents an input voltage of about 0.9 volts to Q1, which is in an emitter-follower configuration. As Q1's base-emitter voltage is about 0.6 volts, about 0.3 volts appears across the series combination of R1 and R2, which equals around 10,000 ohms when calibrated.

Thus a constant current of about +30 microamperes is sourced from Q1's collector. Also, LED1 provides temperature compensation for Q1's base-emitter forward voltage; thus the constant current is also relatively temperature stable.

With potentiometer R5 (the "range" setting) in its full counter-clockwise ("off") position, LED2, another infrared light-emitting-diode, generates an equal but opposite current of −30 microamperes that is sunk by Q2's collector. Thus the net difference output current is equal to zero. Potentiometer R1 allows exact matching of these two currents to compensate for component variations between the source and sink sections.

Utilizing an audio (semi-log) taper for potentiometer R5, allows very fine control of output current by "stacking-up" progressively higher currents near the end of the shaft rotation.

Turning R5 in a clockwise direction gradually reduces the negative current sunk by Q2 to a minimum of −15 microamperes. Thus a nominal +30 microamperes (sourced) added to −15 microamperes (sunk) yields a maximum sourced output of +15 microamperes, which is sufficient for most skin conditions.

When the sink and source current sections are in proper balance, you can expect the following output currents while you're turning R5 in the clockwise direction: 0 to +1 microampere over the first 33% of rotation; +1 to +5 microamperes over the next 33%; and +5 to +15 microamperes over the last 33% of rotation. This allows extremely fine adjustment over a large range (three or more decades) of current using only one control.

The output current is applied via jack J1 to the electrode cable harness made up of spring-loaded RCA phono plugs PL2 and PL3, which are connected to PL1. As you can see in the schematic, PL1 connects to J1, and the skin area to be tested is applied to PL2 and PL3. The configuration of these electrodes (more about this later) assures constant pressure and contact area for consistent readings.

The voltage drop generated by the constant current through the skin resistance is applied to IC1, an LM358 dual op-amp. Section IC1-a is configured as a non-inverting, high-impedance buffer, driving IC1-b, which is configured as a unity-gain inverting amplifier. Resistors R8 and R9 set the reference level (+4.5 volts) for IC1-b, allowing its output to swing in exactly the opposite direction from which your skin's voltage drop changes during testing.

A CD4046 CMOS phase-locked-loop, IC2, is configured as an audio-frequency, voltage-controlled oscillator. The control voltage is obtained from IC1-b, the inverting amplifier; thus the output frequency drops as your skin resistance rises. This is desirable as a drop in pitch would indicate a lowering stress level, and a rise in pitch would indicate more stress or excitement.

A high-impedance piezoelectric speaker element, BZ1, is directly driven by IC2's output to more than ample sound levels. As a result, no power amplifier is required. The output pitch is variable via potentiometer R10, to whatever range suits the user.

The visual display is provided by IC3, a LM3914 dot/bar display driver, and DISP1, a 10-segment light-emitting-diode bar-graph display (ten separate LEDs could also be used, if desired). The input of IC3 is taken from IC1-a's output; thus the display follows the magnitude of your skin's resistance.

To preserve battery life, IC3 is configured to present a "dot" display, illuminating only one LED (at about 6 mA) at a time. Diode D1 and LED3 set the LED connected to pin L10 of IC3 to have a trip point of about +7 volts, while LED4 sets the LED connected to pin L1 of IC3 to have a trip point of about +2 volts. Thus, the entire display covers about 5 volts, at 0.5 volts per step, centered around the midpoint of +4.5 volts.

Jack J2 is also connected to IC1-a's output, and provides a DC voltage output equal in magnitude to the voltage drop across your skin resistance. This output can be monitored via a DVM or a chart recorder for precise readings. If long-term measurements are desirable, a line-operated 7- to 10-volt regulated DC power supply should be substituted for B1.

**Construction.** As the Lie Detector operates in the lower frequency spectrum, actual layout and fabrication methods are not critical to performance. Use any convenient method; however, keep leads as short as possible to avoid noise pickup.

The author's prototype was built using a RadioShack number 276-170 "PC board." Using such a board can simplify assembly, but any perforated board will work just as well.

Begin by installing sockets for the ICs. Then begin wiring the circuit following the schematic in Fig. 1. Note that for long-term temperature stability, all fixed resistors should be metal-film units, and all variable resistors should be cermet or other similar low



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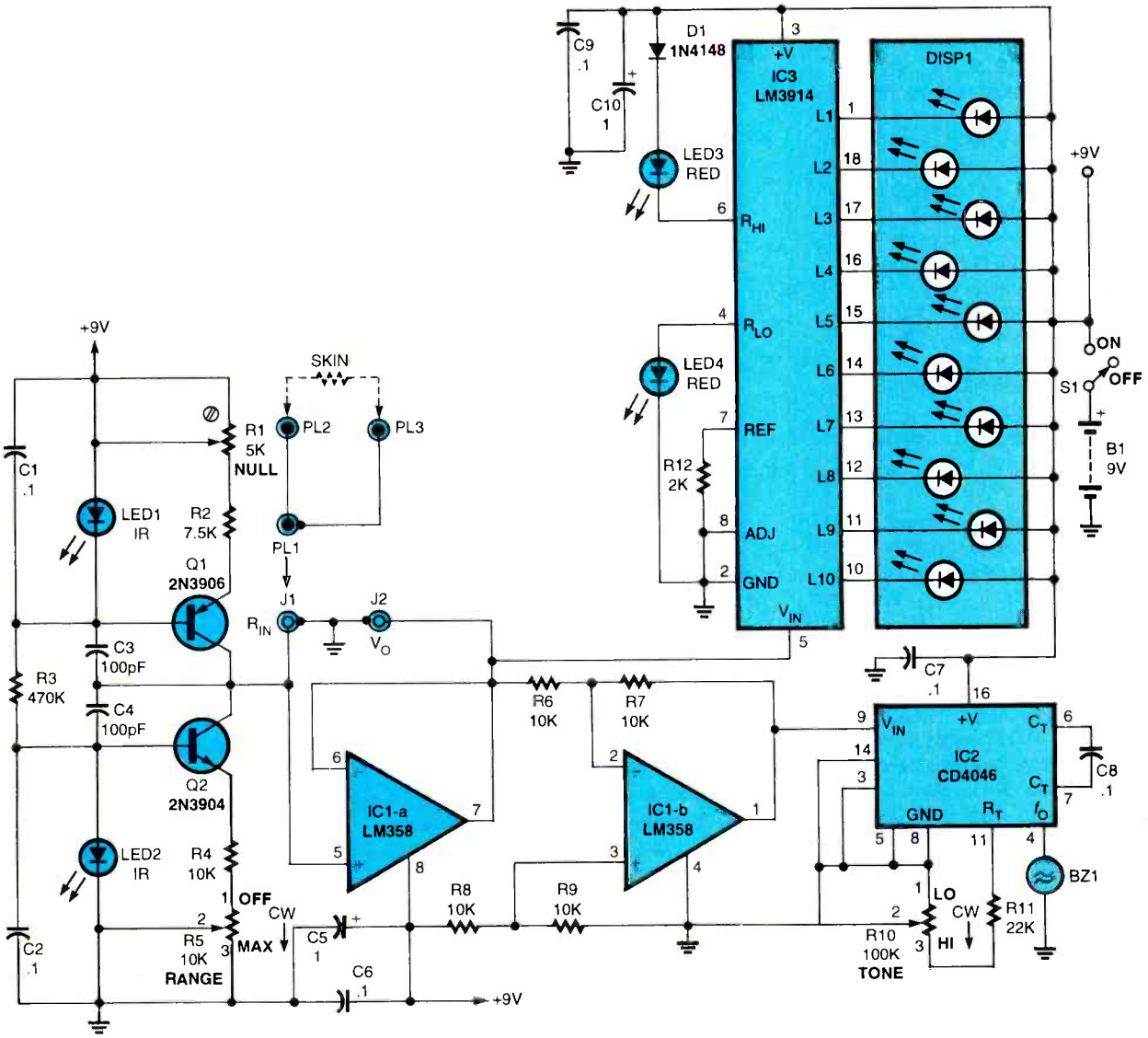


*Fig. 1. Here's the schematic for the Lie Detector. Plugs PL2 and PL3 provide skin-resistance inputs. Both visual and audible output readings are available from DISP1 and BZ1.*

tempco materials.

For proper operation, R5 and R10 must have their lugs connected correctly. With the shaft of the unit pointed directly at you, and the lugs positioned at the top, the right-hand lug is lug 1, the center one is lug 2, and the left one is lug 3. Potentiometer R5 has lugs 2 and 3 shorted together to ground, while R10 has lugs 1 and 2 shorted together to ground.

While installing the parts to the board, be careful to follow proper orientation of the polarized components. Depending on which enclosure you will use (the one used in the author's prototype is specified in the Parts List), you could mount all the parts except the Piezo speaker element on board, and then drill holes to allow access to the parts. Otherwise, the potentiometers, power switch, and possibly the jacks will have to be mounted off-board and connected with insulated leads.

When all the on-board parts are connected, it's time to prepare the enclosure. If you will be operating in an area prone to 60-Hz hum or RFI, a shielded enclosure should be considered rather than the plastic enclosure specified, as the Lie Detector is a very high-impedance circuit.

Drill a series of 1/16-inch diameter holes, evenly spaced, in a grid-type pattern in the top cabinet half, at the approximate location of where you will mount the speaker element internally. Then, drill holes for the potentiometers, display module, jacks, and power switch.

Use two thin beads of silicone rubber sealant to mount the speaker inside the cabinet. Don't press the speaker down flat, rather, let it "float" on the rubber. Set the assembly aside to cure the sealant. You could also label the controls and use a clear acrylic spray overcoat, if desired.

To complete the board assembly, install the 9-volt battery and the ICs correctly in their sockets and turn on the power. Set your DMM to read current on its 200-μA scale. Connect the common DMM lead to the junction of R8, R9, and pin 3 of IC1 and the positive lead to J1's center conductor.



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## PARTS LIST FOR THE LIE DETECTOR

**SEMICONDUCTORS**

IC1—LM358 dual op-amp, integrated circuit
IC2—CD4046 CMOS phase-locked loop, integrated circuit
IC3—LM3914 dot/bar-graph display driver, integrated circuit
Q1—2N3906 PNP transistor
Q2—2N3904 NPN transistor
D1—1N4148 silicon switching diode
DISP1—10-segment LED display (RadioShack number 276-081 or equivalent)
LED1, LED2—Infrared light-emitting diode
LED3, LED4—Light-emitting diode, red

**RESISTORS**

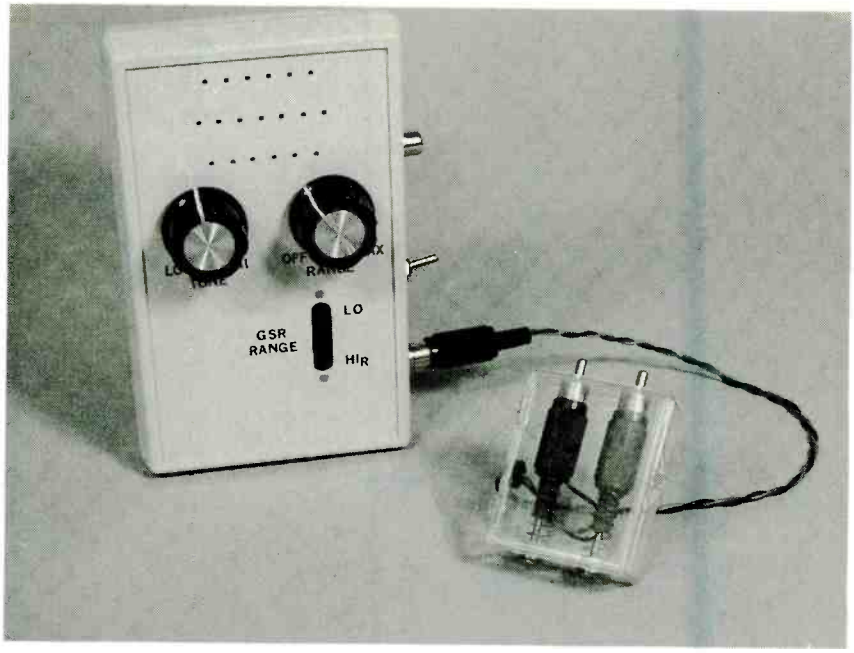
(All fixed resistors are ¼-watt, 5% carbon-film units.)
R1—5000-ohm single-turn trimmer potentiometer
R2—7500-ohm
R3—470,000-ohm
R4, R6–R9—10,000-ohm
R5—10,000-ohm audio-taper panel-mount potentiometer (RadioShack number 271-1721 or equivalent)
R10—100,000-ohm linear-taper panel-mount potentiometer (RadioShack number 271-092 or equivalent)
R11—22,000-ohm
R12—2000-ohm

**CAPACITORS**

C1, C2, C6, C7, C9—0.1-μF, monolithic ceramic
C3, C4—100-pF, monolithic ceramic
C5, C10—1-μF, solid-tantalum electrolytic
C8—0.1-μF, Mylar

**ADDITIONAL PARTS AND MATERIALS**

BZ1—Piezoelectric speaker element (RadioShack number 273-091 or equivalent)
PL1–PL3—RCA-type phono plug, strain-relief (RadioShack number 274-319 or equivalent)
J1, J2—RCA-type phono jack, panel-mount (RadioShack number 274-346 or equivalent)
S1—SPDT miniature toggle switch, 1-ampere
B1—9-volt alkaline battery
Perforated board, plastic enclosure (RadioShack number 270-213 or equivalent), control knobs, two ¼- × 1-inch coil springs (compression type), two #4-40 × 1-inch machine screws with nuts, ½-inch spacers, 2¼-inch small plastic box or vial, IC sockets, hardware, wire, solder, etc.




*As shown in this photo, the electrodes used with the Lie Detector are two spring-mounted RCA plugs.*

Set R5 to its full counter-clockwise ("off") position. Adjust R1 back and forth and you should see the current vary between about ±5 microamperes. Now set R1 for a reading of 0.0 to −0.2 microamperes. This will assure that R5 will actually reach the zero current level. Advance R5 clockwise and the current should rise to its maximum of +15 microamperes at the end of rotation.

The cabinet construction is now complete. Assemble the cabinet halves and install the knobs on their control shafts. Using large-diameter plastic knobs makes adjustments simple, and reduces noise coupling to the circuit.

**The Electrodes.** The "key" to successfully completing a functional GSR monitor or lie detector is in using quality electrodes for the measurements. As stated before, contact area and pressure must be maintained to realize consistent results.

Small-contact-area, spring-loaded electrodes were chosen for the author's prototype, due to the wide availability of the components. Details will be given here for easy duplication, but feel free to experiment! Although the prototype electrodes work extremely well, many alternate methods exist.

The first thing you need is a small plastic box or vial measuring about 2¼-inches long. It should be thick enough to clear the diameters of phono-plugs PL2 and PL3, and wide enough to have both plugs side-by-side on ¾-inch centers. The prototype measured ¾ × 1¾ × 2¼ inches.

Begin by drilling two ⅛-inch-diameter holes on one end of the box spaced ¾ inch apart and centered on the end. Drill two 9/64-inch-diameter holes exactly opposite the ⅛-inch holes on the other end of the box. Note: These two box ends are the ones separated by the 2¼-inch dimension.

Install a #4 flat washer on a #4-40, 1-inch screw, and install it in one of the ⅛-inch holes, capturing it with a #4-40 nut on the inside of the box. Repeat the process with another screw in the remaining ⅛-inch hole. Leave the nuts a little loose.

Unscrew the plastic grip from PL2, and cut off the ground lug. Solder a 12- to 18-inch length of 22-gauge stranded, Teflon insulated hookup wire to the center conductor lug. Drill a 3/32-inch diameter hole in the plastic grip end, right alongside and parallel to the strain-relief section of the grip.

Install the plastic grip back on PL2, feeding the wire through the 3/32-inch hole, rather than the strain-relief. It should screw right on without twisting the wire. Prepare PL3 in the same manner. Obtain a couple of light-gauge (0.010- to 0.015-inch wire di-



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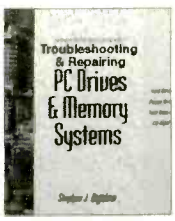


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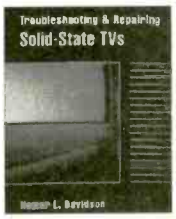


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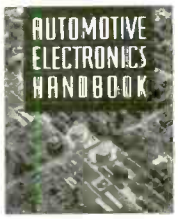


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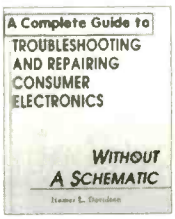


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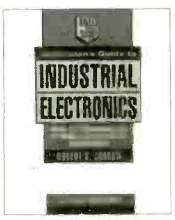


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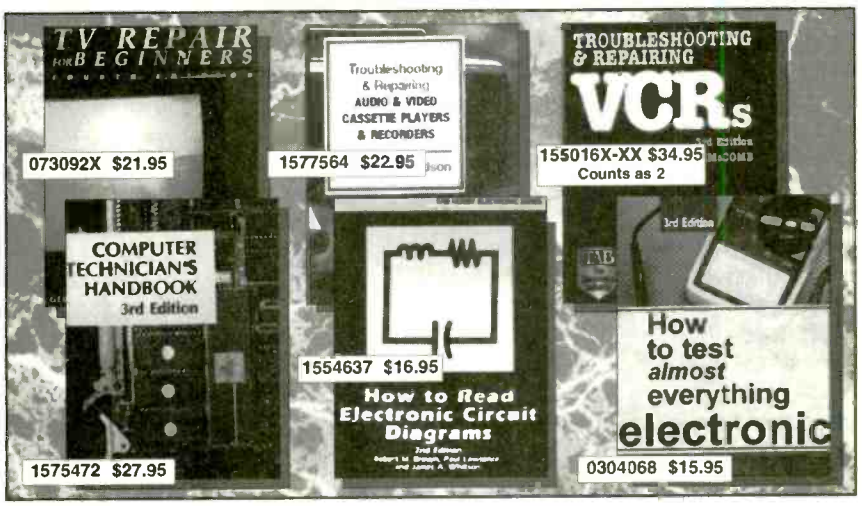


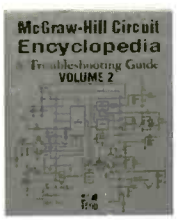


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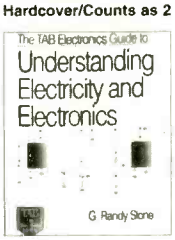


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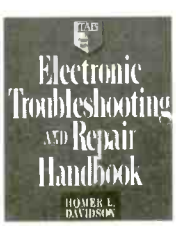


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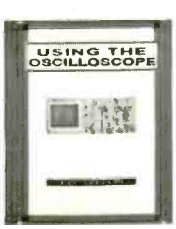


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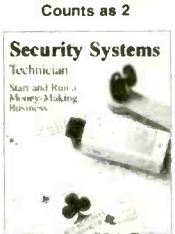


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ameter) springs about an inch long. They should slide easily onto the strain-relief section, and butt up against the ends of the grips without sliding up the grips.

Install a spring on PL2's strain-relief and slide the strain-relief and spring over one of the #4-40, 1-inch screws. Guide the wire out the side of the box through a small hole. Apply pressure to PL2 to compress the spring until you can slip PL2's center conductor through the 9/64-inch hole on the opposite end.

Allow PL2 to snap in place, and then tighten the nut to secure the screw. Assemble PL3 in the same manner, routing its wire out of the same-side hole as PL2's wire. Arrange the wires in the box so that the plugs move freely on their springs. Twist the pair of wires together, and terminate them with phono-plug PL1, using both of its lugs.

Try pressing the center conductor pins of PL2 and PL3 flush to the cabinet end simultaneously with one finger. It should take very little pressure. If it appears that the pressure might be uncomfortable, you can cut down the length of the springs, or replace them with weaker units. A comfortable grip for somewhat long periods of time is mandatory for proper and consistent measurements!

**Using the Unit.** To observe the following initial GSR measurements, you have to prepare your body first! Wash and dry your hands completely to remove any material that may hinder proper readings, such as flux, oil, etc. You should also be in a semi-relaxed mental state. If you happen to be "hyped up" at the time, you may only see little, if any, GSR change.

Plug the electrode assembly into J1 and set R5 and R10 to their mid positions. Be seated in a relaxed position and turn on the power. Grasp the electrode assembly in one hand and using either one or two fingers, press the pins of PL2 and PL3 down flush to the box surface.

Use a relaxed grip, as even the tension caused by a "death grip" on the electrodes will disturb the readings of this extremely sensitive device. As long as the pins are gently held flush to the surface, you will get perfect readings.

Now adjust R5 until DISP1 shows an indication near the center of its scale. If you can't get an indication on the scale, change your area of finger contact on the pins slightly. There are "dead spots" on some skin areas probably due to old injuries, burns, etc. If you are of the type with hands that have very high perspiration rates, you may need higher currents than provided. More about this later.

Once you are in the correct operating range, you may now adjust R10 for any pitch that pleases you. Pick a pitch at which it that is easiest for you to detect a pitch change. This varies for each individual, and may take a little experimenting.

Now just relax and listen to the tone. As you relax even more deeply, the pitch will start to slowly drop as your skin resistance increases due to less perspiration. The slightest new physical activity will send the pitch right back up! Try scratching your neck, or shaking your free hand, for example.

After a second or two, the pitch will go right up. Stop moving, and it will drop again. Try grasping the electrodes with different fingers and even the other hand, looking for a real "sweet spot." The author found that the first two fingers on his left hand would send the range display right off the scale with only mild exertion, while his wife's right hand worked better for her.

If you normally have trouble relaxing, the Lie Detector by itself may not work too well for you. You may require a "visual" aid to stimulate "alpha-wave-type" bio-feedback rhythms in your body. The author's "Multi-Chrome Projector" (see the January 1997 issue of **Popular Electronics**) is just such a device.

Once you are able to relax, you'll notice how simple anxieties, such as those caused by lies, could change your GSR readings. But what if the device isn't working for you?

**Alterations.** If it turns out that you require more current to get "on scale," there are several alterations you can make in the current generator section of the circuit to accomplish this. You can easily add another 5 microamperes just by resetting R1 with your DMM for a maximum positive calibration reading, rather than nulling at zero microamperes. With this setting you will no longer achieve "zero" output.

To gain 5 microamperes and still be able to achieve "zero" output, you may connect a 47,000-ohm resistor in parallel with R3. Replacing LED1 and LED2 (infrared LEDs) with standard "red" LEDs will just about double the available output current, and still enable the device to reach zero output current. Of course, you can always reduce the values of R1–R5 proportionally for higher current levels if you care to go that far.

Different electrode designs could also require higher current levels; especially those with large contact areas. The key word here is "experiment." A third electrode, possibly clipped lightly to an earlobe and connected to ground, may indeed show some interesting results.

If you plan on using the Lie Detector to drive an external DVM for higher resolution readouts, or a chart recorder for permanent records, it might be wise to make the modifications already described. As the LM358 is only capable of driving capacitive loads of less than 50 pF, the output cable from J2 should be short coax, or a "twisted-pair" if long runs are required.

As you can see, the Lie Detector is a very flexible GSR monitor, requiring only your imagination for applications and experiments. Try using it to help you relax. As for its name, can it really detect lies? You'll have to build one and judge for yourself! ■

*"This time I think it's definitely a hardware problem."*


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BY BILL SIURU

# RECHARGING ELECTRIC-VEHICLE BATTERIES

*Electric cars are finally making their appearance in America. Learn what techniques are being used to keep them charged up and ready to roll.*

They're finally here! Electric vehicles (EVs) have hit the streets of America. Late last year, General Motors introduced the $EV_1$ electric-powered coupe, which is currently available from Saturn dealers in Los Angeles, San Diego, Phoenix, and Tucson.

The GM $EV_1$ is essentially the same as the Impact that GM began building in 1992, but with a big difference. Instead of running on gas, it has 26 12-volt lead-acid modules that deliver energy. Under the hood there's a 137-horsepower electric motor driving the front wheels. Top speed is 80 MPH, and the $EV_1$ can accelerate from 0–60 MPH in 7.7 seonds.

Depending on terrain, temperature, use of accessories, driving style, etc., the $EV_1$ can go 70–90 miles between recharges, which take up to three hours when connected to a 220-volt source, and up to 15 hours when connected to 110 volts. However, under the worst driving conditions (cold weather and hilly roads) it might go as few as 40 miles before depleting its batteries. It has a sticker price of around $34,000, though it is only currently available for lease.

In addition, Chevrolet and Ford will soon be offering electric-powered Chevrolet S-10 and Ford Ranger pickups, mainly to commercial-fleet operators. Chrysler's entry in the EV market is the EPIC, a Dodge Caravan/Plymouth Voyager minivan converted to electric power. Many of the world's other major automakers are working on EVs and many independent companies are also developing them.

**Pressure for Electric Vehicles.** The impetus for EVs in the U.S. comes mostly from California. Originally, the California Air Resources Board (CARB) mandated that by 1998, 2% of the vehicles sold by the major automakers in California had to be zero-emission vehicles (ZEV), in other words EVs. The percentage jumps to 10% in the year 2003.

Mainly because of pressure from the automakers most affected by the mandate—Chrysler, Ford, GM, Honda, Nissan and Toyota—who are aided by oil companies and their trade associations, the mandate will



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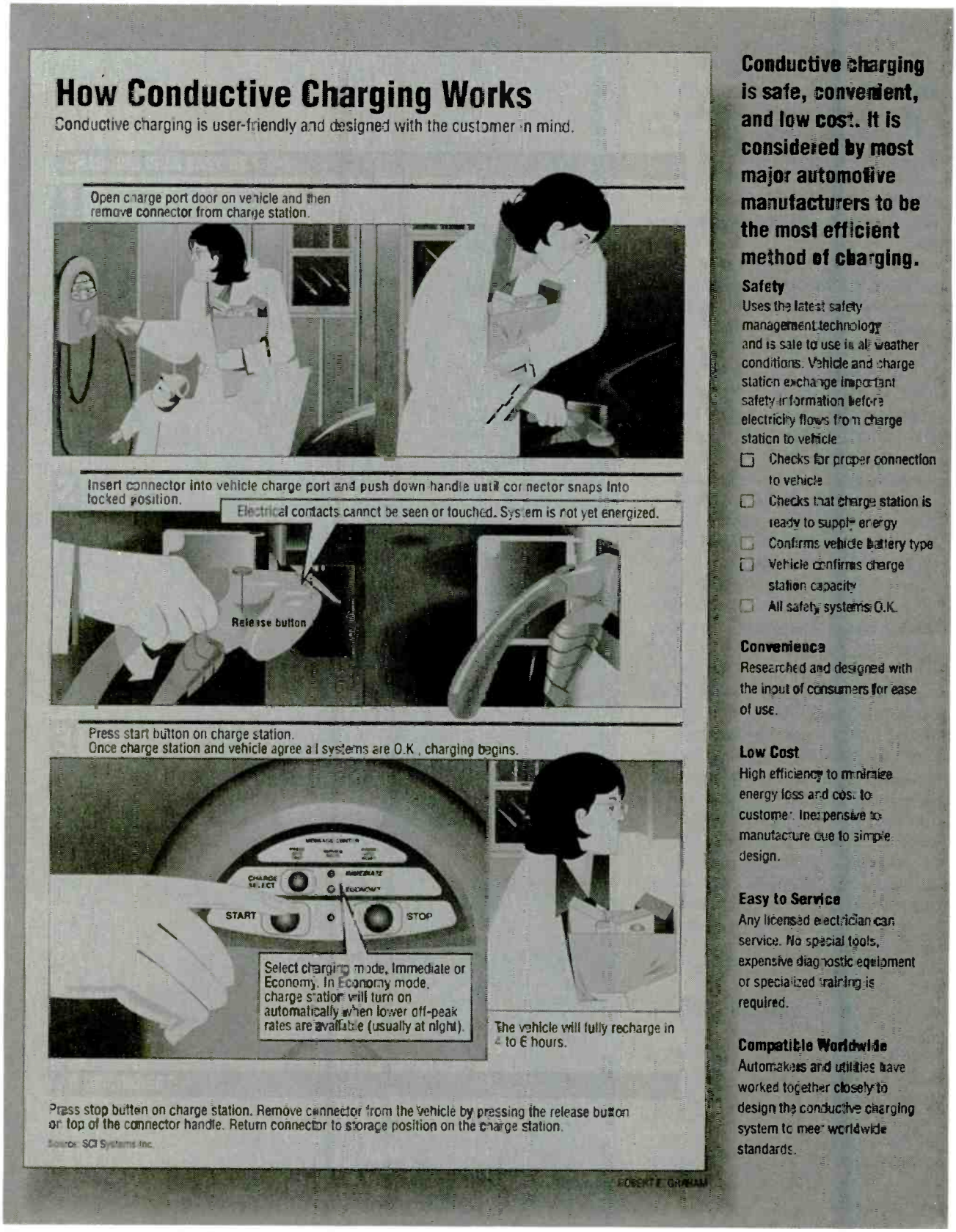


*Here's a step-by-step look at how conductive charging works.*

be scaled back a bit. Instead, of the 2% requirement equating to about 22,000 ZEVs annually, the automakers will most likely offer some 14,000 EVs in 1998, all voluntarily. This group successfully convinced the CARB that they cannot produce or, in reality, sell this many EVs to interested Californians. With the range between



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charges being less than 100 miles even under ideal climate and driving conditions, several hours required for battery recharging, and list prices as much as three times more than equivalent gasoline powered vehicles, EVs are still not ready for prime time. CARB's 10% requirement for 2003 remains in effect.

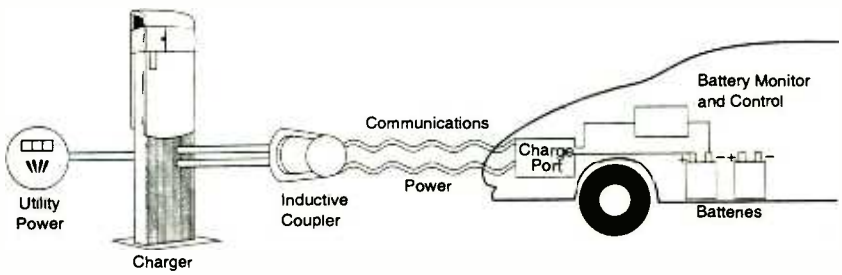
**Recharging Facilities.** Besides the EVs, the infrastructure to keep them rolling is also being developed. This includes the very important battery recharging. The design as well the location and number of recharging facilities is dictated by the EV's somewhat limited range and need for frequent recharges. Unlike a filling a tank with gasoline, which takes only a few minutes, recharging an EV battery pack can take hours, even all-day or overnight for deeply discharged ones. Therefore, recharging would be done where people stay for relatively long periods of time—homes, offices, factories, apartment complexes, etc. "Quick charge" recharging stations for "topping off" batteries could be located at shopping malls, movie theaters, health clubs, restaurants, or other places where people stay for moderate periods of time.

Besides transmitting electricity for recharging, "smart" chargers communicate with the EVs they are charging. The information exchanged in this manner includes checks for proper connection, that the vehicle is ready to accept the charge, the compatibility between the facility and the EV's recharging system, and if all the on-board safety systems are operating correctly.

Rechargers themselves would be part of the EV so that charging facilities need only provide generic electric power. Computers in the EV's recharger would continually monitor items such as battery state-of-charge, individual battery-module voltages, and temperatures and usage history.

Other requirements for recharging facilities includes the user friendliness of a gasoline pump and of course, foolproof safety. While fill-ups with gasoline always present an explosive risk, albeit a minute one, EVs represents potential electrical shock and burn hazards plus the remote possibility of an exploding battery.

*The GM $EV_1$ might look a lot like the GM Impact, but the $EV_1$ runs on batteries.*




*This diagram shows how inductive charging systems work. The Magne Charge system in particular can handle power levels from 1.5 to 25 kW.*

**Conductive Charging.** If EVs are to be used like gasoline fueled vehicles, recharging facilities have to have standardized connections. Currently, two basic means to transfer electricity from the recharging station to the EV are being developed for U.S. EVs: conductive and inductive charging. Many experts in the EV industry believe the recharging techniques must be further standardized. Otherwise, there could be a repeat of the VHS vs. Beta videotape controversy.

Of the two, conductive charging is the most familiar since it is effected by a heavy-duty cable and plug like the type used to transfer electricity to appliances. For EV recharging, conductive charging is bit more complicated, though, since information also has to be communicated via the connection and cable. Ford and Chrysler have joined forces to develop a common conductive charging system for their production EVs. SCI Systems, Inc. did the actual development to the specifications of Ford, Chrysler, five other major automakers, electric utility companies, and CARB.

According to Ford and Chrysler, conductive charging was chosen for several reasons. Besides being safe, it is the most efficient and cost-effective method of charging available. Being the traditional method of connecting electrical equipment to power sources, it is well understood by electricians. In addition, installation requires no special tools, expensive diagnostic equipment, or specialized training. Like a clothes dryer, the EV charging system would use a unique, yet standardized, plug that is easy to use and safe under all weather conditions because the electrical contacts cannot be seen or touched. Also it does not produce a high-frequency magnetic field that could result in electromagnetic and radio-frequency interference.

With the SCI conductive charging system, drivers could choose from two charging modes. Selecting the "Immediate" mode results in charging starting right away. With the "Economy" mode, charging will instead automatically start when lower off-peak

*(Continued on page 70)*



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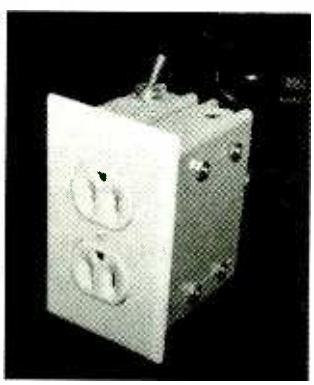
# BUILD A HIGH-EFFICIENCY LIGHTING SYSTEM

*Lower the cost of your monthly lighting bill by 90 percent!*



BY STEVEN R. ROSENBERG

Are you wasting electricity? If you're using standard light fixtures in your home or office, then you definitely are spending more for illumination than you have to. The truth of the matter is that conventional lamps are nowhere near efficient. For that reason, in this article we'd like to introduce you to a more economical source of light: *The High-Efficiency Lighting System.*

With this easy-to-build unit you'll save a bundle on electric bills in no time. That's because the Lighting System uses about 10% of the electricity that a standard lamp uses! Just think how much you'll save if you build one for every room.

**Lamp Efficiency.** When dealing with lamps, as well as many other types of electrical devices, achieving efficiency requires reducing the amount of energy used up, without weakening the output. Performing this with a transformer has been done, but it is rather ineffective. We needed to find a better way.

When solid-state components are used to simulate a step-down transformer, a secondary voltage is produced with the reliability of a transformer, but at a much more efficient rate. You see, as a generator rotates through its 360-degree cycle, sine-wave energy is produced. At any given fraction of a degree this energy can be conducted through a thyristor. That will result in an instantaneous voltage, unipolar power pulse.

A unipolar pulse is more efficient than a bipolar pulse. That's because the latter consists of two identical current pulses of opposite polarity per cycle; eliminating one pulse decreases current by fifty percent. Also, the second pulse may arrive prior to the full release of heat energy, thereby wasting the energy released by the second bipolar current pulse. With pure resistive loads, heating continues after the pulse ends (the pulse actually used by the Lighting System is from 151 to 168 degrees). By correcting for these problems found in standard lamps, the High-Efficiency Lighting System (when used with the lamp specified in the Parts List) manages to use 90% less electricity.

The bar graph shown in Fig. 1 demonstrates how much less power is used by a 30-volt, 50-watt lamp connected to the Lighting System, as opposed to that used by a standard light fixture. Keep in mind that the light output by the Lighting System lamp is equal in brightness to that of the conventional light fixture.

The efficiency of the System can translate into very tangible savings on your electric bill. For example, if you have a lamp that needs to stay on 24 hours a day, seven days a week, you should save approximately $100 a year.

**Circuit Description.** The schematic for the Lighting System is shown in Fig. 2. Plug PL1 connects to a standard 117-VAC outlet to provide power for the circuit. A capacitive/resistive filter made up of C6 and R5 eliminates SCR tracking of



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**TABLE 1**

| Conduction Angle (Degrees) | Lamp Voltage (Volts) | Lamp Current (Amperes) | Power Used (Watts) | Lumens (Foot Candles) | Lamp Simulated (Watts) |
|---|---|---|---|---|---|
| 151.10 | 12.30 | 0.60 | 7.38 | 1750 | 100 |
| 152.00 | 10.81 | 0.57 | 6.16 | 1190 | 75 |
| 158.70 | 9.28 | 0.50 | 4.64 | 870 | 60 |
| 159.70 | 8.85 | 0.48 | 4.24 | 810 | 50 |
| 162.50 | 7.69 | 0.45 | 3.46 | 505 | 40 |
| 167.60 | 5.42 | 0.36 | 1.95 | 190 | 25 |

the AC source voltage; S1 is the power switch.

Capacitors C2-C4 are used to prevent undesirable triggering of SCR1-SCR3 from transient voltage, and for this reason are connected between the gates and cathodes

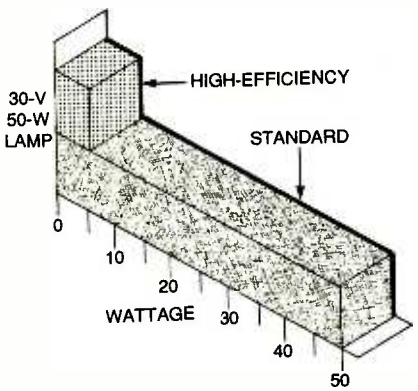


*Fig. 1. As shown in this bar graph, a 30-volt, 50-watt lamp connected to the High-Efficiency Lighting System uses only 10 percent of the power used by a conventional light fixture.*

of the thyristors. Decoupling against line-voltage transients acting on unijunction-transistor Q1 is provided by capacitor C5. As a result, positive or negative transients on the unijunction supply voltage will not trigger Q1.

Transistor Q1 is connected through resistor R3 to the voltage "low side" and directly to the gate of SCR1. The other base of Q1 connects through the serial combination of resistors R1 and R2 to the "hot side" of the supply. Resistor R1 drops the AC source voltage to the supply voltage of the timing circuit, while resistor R2 serves to compensate Q1 from thermal variations. Potentiometer R4 can be used to vary the brightness of the circuit as it determines the charging voltage on timing capacitor C1, and the range of conduction angles available (more on this later).

Thyristors SCR2 and SCR3 are connected in parallel to improve stability and to allow two lamps to be powered by the circuit. The lamps, I1 and I2, plug into AC sockets SO1 and SO2. Note that the cathodes of SCR2 and SCR3 are connected to the sockets, while the anodes connect to the hot side of the AC supply. This configuration removes the low-voltage load from the power supply of Q1 and supplies the load through the thyristors.

**Construction.** The author's prototype for the Lighting System was built on a printed-circuit board. If you'd like to do the same you can either etch your own board using the template shown in Fig. 3, or order a board from the source mentioned in the Parts List (complete kits of parts are available from the source as well). Another option is to build the circuit on a piece of perforated board.

For those using a PC board, refer to the parts-placement diagram while building the unit. To begin assembly, attach two wires to the board to allow for connections to toggle-switch S1 and AC-sockets SO1 and SO2. The wire leading to S1 should be red, signifying a direct connection to the house wiring.

Install R5, C3, C4, C6, SCR2, and SCR3 to the board, being careful to orient correctly the last two parts. The thyristors have an on-state current of 4-8 amps and a peak reverse voltage of 200-600 volts maximum. These parts are strongly recommended because the high conduction angle of the switching in the circuit could lead to component failure. Only use the highest-rated (in terms of amperage) SCR available; heatsink material is recommended for extended service.

Make the following off-board connections shown in the parts-placement diagram. Attach switch S1 to the red wire you installed, then connect the other terminal of the switch to PL1 with one lead of an AC line cord (make sure to use the lead that is *not* connected to the wide blade of PL1). Connect the other lead of the line cord (the one connected to the wide blade of

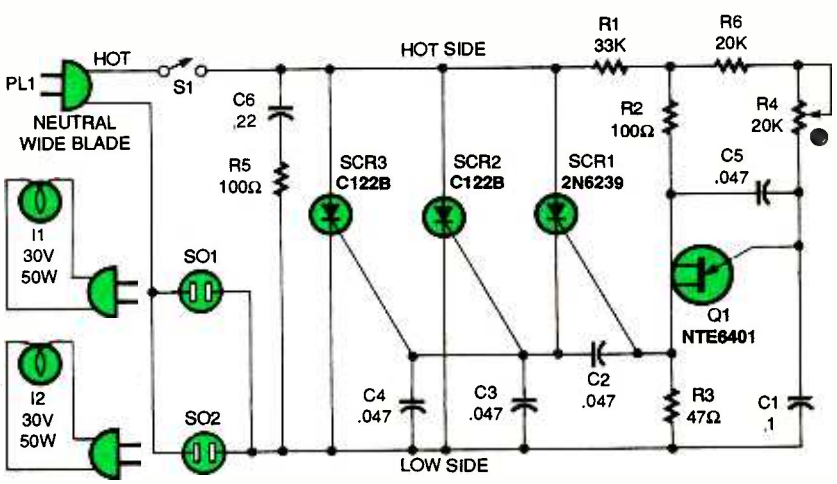


*Fig. 2. Here's the schematic for the Lighting System. Lamps I1 and I2 plug into AC sockets SO1 and SO2, providing two efficient sources of light.*



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## PARTS LIST FOR THE HIGH-EFFICIENCY LIGHTING SYSTEM

**SEMICONDUCTORS**

Q1—NTE6401 or EGC6401 N-channel unijunction transistor
SCR1—2N6239 200-volt, 4-ampere silicon-controlled rectifier
SCR2, SCR3—C122B 200-volt, 8-ampere silicon-controlled rectifier

**RESISTORS**

(All fixed resistors are ½-watt, 5% units.)
R1—33,000-ohm
R2—100-ohm
R3—47-ohm
R4—20,000-ohm, trimmer potentiometer
R5—100-ohm
R6—20,000-ohm

**CAPACITORS**

C1—0.10-µF, 50-WV, Mylar
C2-C4—0.047-µF, 200-WV, Mylar
C5—0.047-µF, 50-WV, ceramic-disc
C6—0.22-µF, 250-WV, Mylar

**ADDITIONAL PARTS AND MATERIALS**

I1, I2—30-volt, 50-watt lamp, General Electric order code 16385, description 50A21, or equivalent
SO1, SO2—Two-terminal AC socket
PL1—Two-terminal AC plug, polarized
S1—SPST toggle switch
Printed-circuit materials, plastic electrical box, AC receptacle cover plate, AC line cord, wire, solder, hardware, etc.

**Note:** The following are available from Advance Power System (1307 Maple Ave., South Plainfield, NJ 07080; Web: http://members.aol.com/Apsinfo/Apsinfo.html; e-mail: apsmail@aol.com): etched and drilled PC board—$9.50; kit of parts including everything except the lamps—$25.50; assembled and tested kit, not including lamps—$35.50; two lamps—$6. Add $2.50 for shipping and handling; NJ residents please include appropriate sales tax. Please allow 4 to 6 weeks for delivery.

PL1) to one terminal of each of the two AC sockets. Connect the other terminals to the remaining lead you soldered to the board earlier.

You now have to test the partially assembled board before you can proceed with assembly. Plug a standard 120-volt lamp into SO1 and plug PL1 into an AC outlet.

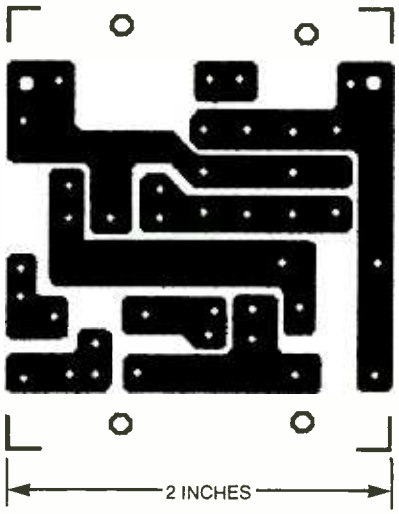


*Fig. 3. This is a full-size foil pattern for the Lighting System PC board.*

Use an alligator-clip-equipped jumper to briefly connect the gates of SCR2 and SCR3 to the AC hot side. The lamp should light. If the lamp is on all the time, or it does not light, check that the SCRs are installed correctly and not overheating, and the circuit components are of the correct voltage rating.

Unplug the circuit from the outlet and connect SCR1 and C2 to the board. Plug in PL1 again and test the circuit as just described. Once you're sure the aforementioned components are working properly, mount the remaining components to the PC board as shown in Fig. 4.

Verify that you can vary the conduction angle with R4 (although it is board-mounted in the prototype, potentiometer R4 can be replaced with an off-board component).

**Setup and Use.** As hinted at earlier, you will need to select a conduction angle using R4. To do this, connect a standard 100-watt, 120-volt AC lamp to the circuit. Adjust R4 until the standard lamp is almost extinguished.

Disconnect the 120-VAC lamp and connect the 30-volt lamp specified in the Parts List (make sure you don't use a three-way lamp, as it will drastically reduce the life of the bulb). Connect a DMM across the lamp's terminals. As you perform the next step, be certain to keep the voltage of the lamp below 15 VDC. Adjust R4 until the values measured across the lamp are 12.3-volts DC at 0.6 amperes. These values will result in a conduction angle of 151.1 degrees, which results in a 1750-foot-candle measurement. This is equivalent to a conventional 100-watt lamp's advertised initial lumens. The average power used at this setting is 12.3 volts × 0.6 amperes, or 7.38 watts.

It is possible to simulate conventional lamps that have other wattage values by setting a different

*(Continued on page 56)*

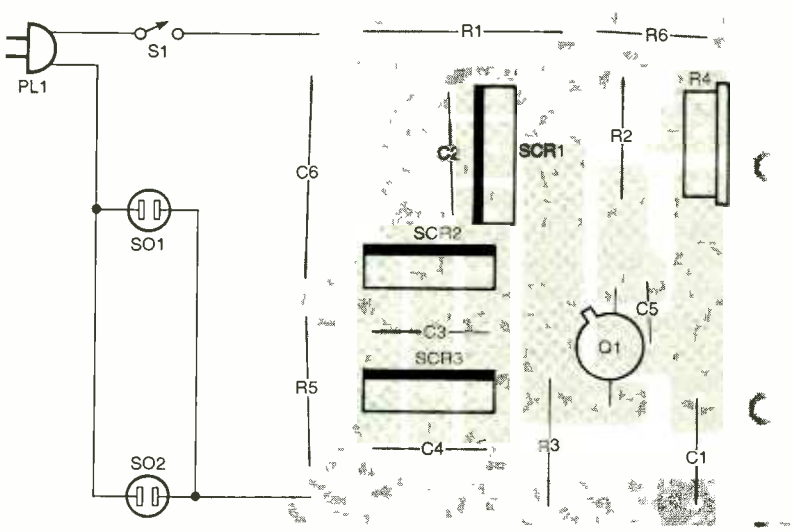


*Fig. 4. If you're building the System on a PC board, use this parts-placement diagram as a guide.*



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# ALL ABOUT AMATEUR COMMUNICATION MODES

*From Morse code to the digital age, here's a look at the past and present communication methods used by radio amateurs.*

BY KARL T. THURBER, JR.

Amateur radio is more exciting than ever, due largely to high-tech and digital operating modes and personal computers. But the vast number of communicating options available to hams today is only part of the story. Join us now for a look at the past, present, and future of amateur communications modes.

**Classic Non-Digital Modes.** One way to appreciate today's high-tech digital modes is to contrast the present with the pre-high tech days—say, the 1940s and 1950s. The radio and electronics world was different then; FM repeaters, packet radio and exotic digital modes, amateur satellite communications, and PCs didn't exist. The 1940s and 1950s were mostly an "analog world."

Amateurs could exchange messages by Morse telegraphy, voice (AM, FM, and SSB, or single-sideband); a few pioneering amateurs could even use TV. One classic digital mode, radioteletype (RTTY), was available, but it was more mechanical than digital. More sophisticated communication modes such as facsimile (fax), satellite, and packet weren't available.

The earliest radio amateur communications mode was that of spark, but it's been gone for about two-thirds of a century. Another simple mode, which is still in use today, is CW. That system consists of interrupting a "continuous wave" (CW) carrier in accordance with a code, such as International Morse (you could call it a digital mode if you wanted to).

Amplitude modulation, or AM, is an early form of voice communications. This relatively broad mode was the standard on the amateur bands until the 1950s, when a related mode became popular. That higher-tech mode was SSB (single-sideband).

SSB telephony makes use of a reduced or suppressed carrier and just one sideband, unlike AM, which transmits the full carrier and both sidebands. Either sideband can be used, but radio amateurs normally use lower sideband (LSB) below 10 MHz and the upper sideband (USB) above 10 MHz. SSB with little or no carrier isn't popular with broadcast-band and shortwave broadcasters because it can be difficult to tune.

Narrow-band frequency modulation (NBFM) is used widely on VHF and UHF, not just by amateurs but by many communications users—although AM still is standard on the VHF civilian and UHF military aircraft bands. FM is fairly immune to static.

**Packet Radio.** One form of "data by radio" in which the data is transported between PCs and radio transceivers is called packet radio. It's a high-speed, space-efficient



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*There's still room in this high-tech, digital amateur-radio world for a simpler mode: Morse Code, or CW. This MFJ electronic keyer combines built-in dot-dash memories, speaker, sidetone, and pushbutton mode selection with a classic paddle.*

mode that lets you send, receive, store, and forward messages. It's similar to RTTY, but data are sent at a higher speed, and in a "connected" (telephone-like), nearly interference-free, error-checking mode.

Packet sends data in small bundles. Each contains the sending and receiving station callsigns and optional routing. The packets are sent one at a time; each is acknowledged when received. When a packet arrives error-free, the receiving station sends an "OK" (an ACK) and the next packet is transmitted. If a packet isn't received correctly, it's retransmitted.

Most packet is at a slow rate of 1200 bits per second (bps), although 9600 bps is becoming common. Some amateurs even experiment with higher rates. Even though the data transfer rates are relatively slow for the moment, packet provides low-cost, global connectivity, and it's still clear that higher speeds are on the way.

Packet radio seems to have three main advantages over simpler digital modes, such as RTTY. These are transparency, error correction, and automatic control.

First, transparency simply refers to the fact that a packet station's operation is transparent to you. Your Terminal Node Controller (TNC) automatically "packetizes" your message, keys the transmitter, and sends the packets. While receiving packets, the TNC automatically decodes them, checks for errors, and displays received messages. A packet TNC also can be used as a packet relay station, or digipeater.

Second, packet radio offers built-in error detection and correction. When you receive a packet, it's checked for errors and displayed only if correct. If the receiving station detects an error, it discards the faulty packet and does nothing. As mentioned earlier, after a while without an ACK from the receiving station, the transmitting station resends the packet. If the data can't be delivered intact, transmission is aborted.

Finally, there's automatic control. One advantage of packet is the ability for many users to use the same frequency simultaneously. With VHF/UHF packet, you can operate in an automatic control mode and leave your station (and its "mailbox") on at all times.

Some view packet as a tool to enhance their overall enjoyment of the hobby; others go further, using packet as their main means of on-the-air communication. With these thoughts in mind, let's detail the most popular applications of VHF/UHF packet today.

You can use packet radio to communicate directly with other amateurs, even over long distances using a packet radio network. Thus, you may find yourself chatting with an amateur in the same town, in the next state, or even halfway around the earth—without using HF.

Many packet operators communicate using BBS technology, which lets you transfer mail and bulletins over the network. Like telephone-line BBSs, PBBSs promote "time-shifting": you can transfer information between users who needn't be on the air and connected to the BBS at the same time. Besides mail and bulletins, many PBBSs also have a file section, and some PBBSs offer additional services.

A recent refinement is the use of packet radio for "DX spotting" to announce the presence of "choice" DX stations they find on HF. DX spotting allows hundreds of contesters and DXers to be connected to the same system at the same time for DX reports.

Pavillion Software's DX-Cluster, formerly known as PacketCluster (R), lets multiple stations connect to the DX-Cluster station or node, or to connect to other nodes to form a network. It offers DX spotting and logging, real-time announcements, talk and mail, database access, and much more.

While packet radio isn't one of the more popular modes for awards-seekers, some packet operators do enjoy such pursuits. The ARRL, for example, issues packet-radio endorsements to the basic Worked All States (WAS) award, although it doesn't issue packet WAS as a separate award.

Two ARRL contests specifically include packet radio. One is Field Day, in which participants can earn bonus points for making packet contacts. A second is the ARRL RTTY Roundup, a "digital contest" for RTTY, AMTOR, and packet modes. The objective is to work as many digital stations as you can worldwide. So far, most HF digital contesting has focused on these modes; PacTOR, G-TOR, and CLOVER (to be discussed later) are not yet popular contest modes.

Packet radio lets you handle message traffic. By "traffic" we mean radiogram messages sent via the ARRL's National Traffic System (NTS). Amateur packet and other digital mode stations and PBBSs are well suited to exchanging traffic, and the NTS depends heavily on these modes to move vital messages. To find out more about traffic-handling, check into a local VHF/UHF voice network on an FM amateur repeater, or contact your ARRL Section Manger. The ARRL Operating Manual also contains information on procedures.

It's also possible to perform public service and emergency communications with packet radio. Many amateurs have their digital-mode stations ready for emergencies. The stations can become "digital lifelines," since transmissions don't depend on telephone lines. Packet, RTTY, and AMTOR can provide some security for messages while freeing voice channels for other uses. PBBSs



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also are used productively for these purposes.

Another high-tech use of packet radio is to monitor and communicate with amateur satellites. Many satellites are orbiting bulletin boards, relaying packet messages around the world. Others transmit images that you can display on your computer screen.

Finally, it's possible to transfer files between packet stations, using the TCP/IP protocol. Transfers are more satisfactory at higher bps transfer rates, but are still practical at 1200 bps (more on this later).

**Packet Equipment.** Now that we've discussed the main things you can do with packet, let's talk about how you can get in on the action. One special piece of equipment you'll need is a terminal node controller, or TNC. TNCs resemble phone modems that connect PCs and telephones to transmit computer data. But TNCs, or "radio modems," transmit data by radio rather than wire. TNCs usually contain the modem (used to interface with your radio) and a microprocessor or packet assembler and disassembler (PAD).

In transmitting, the TNC assembles packets from the data on the RS-232 serial line, computes an error check for the packet, modulates it at audio frequencies, and generates appropriate signals to transmit over the radio. On receiving, it reverses the process, translating the audio the radio receives into a data stream on the RS-232 line. Most TNCs use 1200 bps for local VHF and UHF packet, and 300 bps for HF communication. FCC regulations allow higher speeds on VHF and UHF, but not on HF.

You'll need a radio transceiver, too. For 1200 bps UHF/VHF packet, you can use commonly available FM transceivers. For HF packet, 300 bps data is transmitted using SSB. For high speed packet (greater than 1200 bps), modified radios may be required.

For packet transmissions, you can use a computer running a terminal-emulator program, a packet-specific program, or just a so-called "dumb terminal" as a user interface. Almost any modem communications program can be adapted for packet, but there are also custom packet programs.

There are three basic TNC operating modes: command, converse, and transparent. You use the command mode to configure and control the TNC; the converse and transparent modes are used to communicate with others. You use the converse mode for most communications, while the transparent mode sends special characters to another station without being interpreted as commands by your TNC.

Most VHF packet activity is on 2-meter FM. You'll also find packet on UHF, on 222 and 420 MHz. Packet is alive on 6 meters as well, with many opportunities for DX under the right ionospheric conditions.

Once you have all the basics, can you get your station up and running? Most TNCs connect to the transceiver microphone plug for push-to-talk and transmit audio connections, plus they need a connection to the audio output from the FM receiver. If you can plug an RS-232 cable into a modem, and wire the TNC to your radio, you have the technical savvy to get on packet.

The cost of setting up your station shouldn't hold you back either, especially since you might already have some of the components. TNCs are around $130 and up. MCPs cost $300 or more.

If you already own a PC, you already have the potentially most expensive part of a packet station. And, if you have an amateur FM transceiver (or HF SSB transceiver), then you're set. If not, you can purchase a used two-meter FM transceiver from $100-$250; new ones cost from about $300 up. An HF rig costs more.

*MFJ offers TNCs for HF and VHF packet radio, several of which are based on classic TAPR designs. Thousands of units similar to this rugged basic model are used as digipeaters, nodes, and BBSs, and in commercial applications.*

**Packet Operation.** A protocol is a standard stating how computer systems communicate with each other. One of the more popular protocols for amateur packet radio is known as AX.25.

The amateur AX.25 protocol standard was developed in the 1970s and accepted by the FCC and ARRL in the 1980s. It's based on the wired-network commercial protocol X.25, which was modified to suit amateur needs. One advantage of AX.25 is that every packet that's sent contains the sender's and recipient's callsign, thereby providing station identification.

The Automatic Packet Reporting System (APRS) sends and receives station location or position information from various types of stations, including fixed and mobile stations,



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nodes, digipeaters, DX clusters, packet mailboxes, and the like. APRS graphically applies packet radio to real-time events by displaying information as a symbol on a map on your PC screen.

The position information includes, as a minimum, latitude, longitude, and station type. APRS is very useful in emergencies, exercises, weather nets, and other events that are most concerned with where things are and where they're going. Several firms, including PacComm, make equipment compatible with APRS and with GPS (Global Positioning System) satellite receivers.

Loosely related to packet operation is another VHF/UHF digital mode that's just getting off the ground: digital paging. The technology is being heavily promoted by Kantronics. Digital-paging transmission and reception formats adhere to the same Radiopaging Code No. 1 (POCSAG) signal format used by paging providers. Thus, most commercial pagers can be converted to amateur use.

If you're on packet, you already have much of the equipment needed; the Kantronics KPC-9612 TNC handles this mode. Kantronics offers pager crystals and will sell refurbished and "recrystalled" pagers for 2 meters and 70 cm. Pagers promise to be useful for amateur emergency communications.

**Packet Networking and Gateways.** If you're too far away from another station to make a direct connection, you can use the nodes, or switches, of a packet network. A wide variety of available networking schemes include digipeaters, KA-Nodes, TheNet, NET/ROM, ROSE, X1J, TPRS TexNet, FlexNet, and others.

Gateways offer access to another type of network, usually nonamateur. In the radio network world, you'll also see references to wormholes, amateur links that pass through nonamateur services, like the telephone system or the Internet.

Digipeaters made up the first packet networking schemes, but they're largely obsolete today. Digipeating, short for digital repeating, allows you to extend the range of your station by retransmitting packets addressed to the digipeater. But the links between digipeaters aren't 100-percent efficient, and they're dumb: they simply look at a packet, and if the callsign is in the digipeater field, they resend the packet.

Digipeating worked well with only a few people on the channel. However, as long-distance packet became more popular, digipeaters clogged the airwaves. Also, if a packet got lost by one of the digipeaters, the originating station had to retransmit the packet, forcing every digipeater to transmit again.

Kantronics improved on the digipeater concept with KA-Nodes. As with digipeaters, KA-Nodes repeat AX.25 frames. But a KA-Node acknowledges every transmission for each link instead of over the entire route; this allows for more reliable connections than digipeaters, because acknowledgments are only carried on one link. KA-Nodes are not true networks, and they don't offer automatic routing as do other schemes, like NET/ROM.

NET/ROM was one of the first networking schemes to address the problems with digipeaters. You connect to a NET/ROM station as if connecting to any other packet station. From there, you can send commands to instruct the station to connect to another local user or to another NET/ROM station. This scheme improved reliability considerably.

Another scheme is ROSE, which is an acronym within an acronym, standing for the "Radio Amateur Telecommunications Society (RATS) Open Systems Environment." A ROSE network includes a PBBS, an online callsign directory and database server, a bulletin broadcast controller, a message management system, a packet switch, and other features.

Now let's get back to gateways, which let you access other bands and operating modes. Gateways allow connectivity between two normally "non-connectable" communication technologies. For these reasons Gateways have become an integral part of most PBBS and digital networking schemes. They include crossband gateways,

*TAPR, a nonprofit, scientific R&D corporation, is one of the cradles of amateur radio packet civilization. Various other high-tech and digital interests are supported on the TAPR home page, including spread spectrum, DSP, networks, the Internet, and other special interests. TAPR is found at http://www.tapr.org.*



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Internet/packet radio BBS gateways, and packet wormholes via the Internet.

You can participate in a variety of activities using an Internet-to-packet radio gateway. These include transferring files; "Telnetting," or accessing TCP/IP stations remotely through the gateway; and sending and receiving e-mail. Another activity is a "QSO bridge," a keyboard-to-keyboard QSO (contact) roundtable in which you enjoy real-time conversations.

**TCP/IP and Packet Radio.** Transmission Control Protocol/Internet Protocol, or TCP/IP, is a "suite" of protocols used over the Internet. Amateur TCP/IP nets, referred to collectively as AMPRNet, use an adaptation of Internet TCP/IP protocols. TCP/IP protocols provide a high level of flexible, intelligent packet networking that isn't possible with AX.25. Actually, TCP/IP software emulates many TNC functions so you aren't limited to the functions programmed into the TNC, which now can be programmed to do much more.

TCP/IP networks are mostly local and regional. But TCP/IP enthusiasts see a future when the entire country, and perhaps the world, will be linked by TCP/IP using microwave and satellites. Presently, most TCP/IP activity is on 2 meters and 70 cm.

What are some of the benefits of your using TCP/IP, in addition to its inherent ability to multitask (do several things simultaneously)? Let's take a brief look at some benefits:

With TCP/IP you can send mail reliably. You need only prepare the message and leave it in your own TCP/IP "mailbox." Your PC will attempt to make a connection and deliver the message directly—there are no PBBSs involved. The message packets travel through the net until they reach the other station. In the meantime, you can talk to, or receive mail from, the other station. If someone can't connect to you because you're not on the air, their PC holds the message and tries later.

With FTP software and TCP/IP you can pass binary files over the Internet to other stations. Under TCP/IP, you can send and receive mail or talk to others while the transfer is occurring.

Already amateurs and other hobbyists have constructed Internet Web pages and USENET newsgroups for a variety of purposes. You might want to check out some of these newsgroups:

alt.ham-radio.packet
alt.radio.digital
rec.radio.amateur.digital.misc
rec.radio.amateur.equipment
rec.radio.amateur.homebrew
rec.radio.amateur.misc
rec.radio.amateur.space
rec.radio.info
rec.radio.swap

But some amateurs also have constructed packet TCP/IP "radio Webs" with on-the-air, Internet-style Web page servers. Doing so effectively blends their several interests in amateur radio, computer communications, and networking.

As for hardware, all you really need is a computer; a 2-meter FM transceiver; and a "KISSable" TNC, one with KISS ("Keep It Simple Stupid") mode capability.

The heart of your TCP/IP setup probably will be the TCP/IP-based software written for the IBM PC by Phil Karn, KA9Q, called NOSNET, or simply "NOS." NOS, the Network Operating System, takes care of all TCP/IP functions, using your "KISSable" TNC. You'll find NOS software on CompuServe in the HamNet Forum, among other places on BBSs and the Internet.

When you place your TNC in KISS mode, you disable the AX.25 protocols and reduce it to a basic packet modem; the host PC must implement all high level protocols. Thus all of the incoming and outgoing data are processed directly by your PC and its software, not by your TNC. Most recent TNCs and MCPs have this feature.

You also need your own IP address, much like on the Internet. AMPRnet volunteer IP address coordinators issue the IP addresses; you have to contact the coordinator in your area for an address. But you don't need to memorize the addresses of TCP/IP-equipped stations; NOS keeps track of them. When you try to contact another station using TCP/IP, all network routing is performed automatically according to the TCP/IP address of the distant station. TCP/IP networks are transparent to most users.

Most amateur TCP/IP networks depend on dedicated switches to move data through the system. Like NET/ROM nodes, TCP/IP switches communicate with each other over high-speed backbone links on 222 MHz or 70 cm. Many TCP/IP users access local switches on 2 meters, at 1200 bps, while TCP/IP switches use backbone links to relay data at 9600 bps or higher.

**HF Digital Communications Modes.** Packet radio is one of amateur radio's most popular modes. But today's digital world is more than just packet, which isn't all that great a communications medium on HF. The packet goal of efficiently, rapidly, and reliably transmitting information between distant stations is still elusive: sending data via HF radio is downright tricky. Ionospheric conditions change rapidly, frequently causing distortion and errors in received data.

While you can generate each of the new and high-tech digital modes using a dedicated controller, the advent of one particular piece of hamshack equipment is largely responsible for amateurs being able to use a wide variety of digital modes. That device is called the Multimode Communications Processor, or MCP.

Today, the heart of many digitally-equipped hamshacks is an MCP that lets you use several digital modes with your transceivers. All modes may be handled by the same box, which like a TNC incorporates microprocessor design features and internal memory. With MCPs, you may be able to operate Packet, PacTOR, AMTOR, RTTY, SSTV, fax and WeatherFax (WeFax), CW, and several other high-tech modes.

Before we explore more sophisticated HF digital modes, let's discuss



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RTTY (Radio TeleTYpe), a common HF communications protocol. RTTY is a half-duplex, non-error-correcting mode. It's primarily for single keyboard-to-keyboard contacts, and operating practices closely resembling those of Morse. RTTY still is king of digital DXing and contesting.

RTTY uses Baudot encoding, a five-bit code. These five bits allow only 32 possible combinations, not enough for a full alphanumeric character set. While ASCII coding can be used in RTTY, it's uncommon. Most RTTY is at a slow 45 bps (about 60 WPM, in Morse terms), as opposed to telephone modems which typically use 9600 to 28000 bps and VHF packet at 1200 bps or higher.

So just how efficient and effective is packet when used under real world, rough-and-tumble HF conditions? The AX.25 protocol isn't an efficient protocol for HF. Even using a good radio modem, you frequently get errors—with the AX.25 protocol, one bad bit makes an entire packet unusable. This is the main reason why AX.25 isn't good to use on the error-prone channels typically encountered on HF.

Presently, no better packet HF protocol is available. However, candidates for improved HF digital communications performance include PacTOR, G-TOR, and CLOVER. You can expect to see more exotic modes develop over the next few years.

Generally, to operate HF packet you need an MCP, a HF SSB transceiver, and a PC running an appropriate terminal software program. All MCPs today have HF packet capability; so do many packet-only TNCs. You probably already have the SSB transceiver, and likely have a PC. (Actually, it's possible to operate all HF digital modes except CLOVER without using a computer, using a simple data terminal.)

Operating on HF packet is different from VHF/UHF packet: interference and noise are anathema. Whereas you can use 1200, 9600, or even higher bps data rates on VHF and UHF, and lots of high-speed packet equipment is available, FCC regs place an upper limit on the maximum data rate on HF. This is 300 bps below 28 MHz, and 1200 bps on 10 meters.

Another difference is the way in which the packet-radio signals are generated. On VHF and UHF, we usually use audio frequency shift keying (AFSK), with audio tones being applied to the FM transceiver's mike input. On HF, we normally use the SSB signal to generate an FSK (frequency shift keying) signal. Most packet activity today is on 2-meter VHF, using FM AFSK.

AMateur Teleprinting Over Radio (AMTOR) was one of the earliest methods of bringing amateur HF digital communications into the computer age. It's an error-checking mode for HF text communication that minimizes interference (QRM), fading (QSB), and static (QRN), one that's suitable for casual keyboarding and contacting HF BBSs. Importantly, you often can maintain a usable connection during poor signal-to-noise (S/N) ratio conditions when a packet connection wouldn't hold.

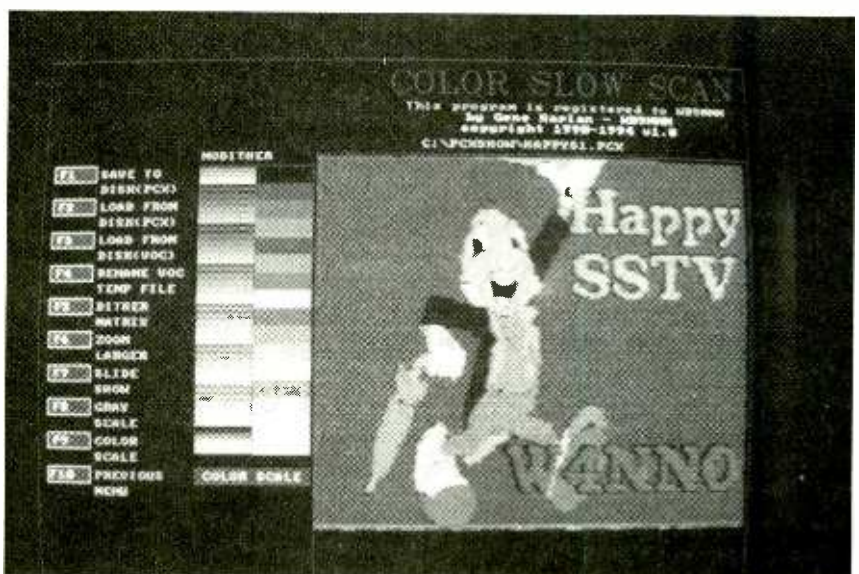
In one sense AMTOR's a throwback to an earlier era, in that it uses the same character set as Baudot, encoded differently: each character has a constant mark to space ratio. This constant ratio is how errors are detected. Errors are corrected using either of two methods: ARQ (Automatic Retransmit reQuest), and FEC (Forward Error Correction). However, the five-level code makes binary data difficult to send, error correction is weak, and effective "throughput" is low.

In ARQ mode, two stations connect. The station with data to transmit sends three characters, then waits for the other to send an acknowledgment. This activity makes for the "chirp-chirp" sound of AMTOR ARQ signals, and it means that each station transceiver must switch from sending to receiving mode quickly. Each station also has to turn the link over to the other station at the end of each exchange.

Before you operate AMTOR ARQ mode, you have to choose a selective call identifier, or SELCAL, a series of letters of your choosing that you use to establish the link. Most amateurs use some combination of letters that match part of their callsign.

Unlike in ARQ mode, in FEC mode one station can communicate with many others at once, since there's no back-and-forth acknowledging of data. FEC gets its error-correction capability from time diversity, in which it sends characters twice. In FEC mode, you can call CQ to make contacts.

Both AMTOR and packet are popular on HF, but performance




*Color Slow Scan for the Sound Blaster SSTV software from Harlan Technologies offers color SSTV send and receive using your PC and its sound card. Color and black-and-white, receive-only versions also are available. A typical received SSTV image is shown.*



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isn't optimum. Packet Teleprinting Over Radio (PacTOR), which appeared in 1990, is a robust, RTTY-like, error-correcting mode to overcome the shortcomings of packet and AMTOR on HF. PacTOR is like an enhanced AMTOR combining its best features with packet, for operation on noisy, fluctuating channels. There's about a fourfold increase in throughput over AMTOR. A new version, PacTOR II, is even more robust.

*A popular DSP receiver enhancement device is the JPS NIR-12 Dual DSP Noise/Interference Reduction Unit. The NIR-12 provides "spectral subtraction" noise reduction in addition to dynamic peaking. The spectral subtraction mode is effective in reducing impulse noise.*

This hybrid mode sends error-free data by using a handshaking system which requires that the receiving station send an ACK if data is received intact. PacTOR's most important feature is that of memory ARQ, which lets even noisy packets be restored: it tries to compensate for incomplete data by looking for missing data and filling the gaps. PacTOR also adjusts its speed automatically to changing band conditions.

PacTOR has built-in message storage and can hook up to most APLink systems; you can pass traffic interchangeably using PacTOR or AMTOR. There also are many PacTOR BBSs on the air.

CLOVER is a complex and very efficient HF digital communications waveform, system, and protocol, named after its clover-like oscilloscope wave pattern. The proprietary CLOVER properly recognizes that HF signal propagation may produce severe signal distortion, and so it takes measures to compensate for the distortion and maximize data throughput.

Developed jointly by Ray Petit, W7GHM, and HAL Communications president Bill Henry, K9GWT, it's a very popular HF mode, since CLOVER arguably offers the best overall HF digital performance. CLOVER also is very conserving of spectrum space: it requires only about 500 Hz, as compared with about 2 kHz for HF packet and 1 kHz for AMTOR.

CLOVER uses a four-tone modulation system; you can manually or automatically select any of ten modulation formats to adjust to different conditions. CLOVER incorporates ingenious adaptive modulation schemes: the more complex, high speed modulation formats are used when conditions allow them, while the slower, less error-prone modes are used otherwise.

To use CLOVER, you need a special HF digital modem, usually an IBM PC-compatible HAL Communications computer card, along with terminal software. But you won't need a separate interface since the PC card performs this function. And, while early cards were CLOVER-only, newer cards have multimode capability and offer RTTY (both Baudot and ASCII), AMTOR, and PacTOR.

First used in 1994, G-TOR is a high-throughput, narrow-bandwidth hybrid HF system developed by Kantronics Corp. G-TOR stands for Golay-coded Teleprinting Over Radio. It makes use of the error-correction system created by M.J.E. Golay used in space vehicle communications to ensure that data transmitted from the vehicle could be recovered despite serious errors caused by noise and interference. Like CLOVER, the system is very conserving of spectrum space and usually takes up 500 Hz or less.

Reliability and effective data rates generally are superior to both AMTOR and PacTOR modes; in fact, G-TOR sometimes even approaches CLOVER's efficiency. Operating using G-TOR is fairly simple and is similar to operating AMTOR or PacTOR.

**Spread Spectrum.** Spread spectrum isn't a discrete modulation scheme. Rather, it tries to get around the twin obstacles to sending greater and greater amounts of information: frequency congestion and bandwidth. It involves "slicing" a whole band of frequencies into various frequency ranges that it uses almost simultaneously. A signal is present only on one frequency at a time, but the overall effect is like being able to operate on a whole band of frequencies.

First allowed by the FCC in amateur radio in 1980, spread spectrum is still an experimental mode that's limited to certain frequencies and implementation methods. It requires sophisticated equipment that few amateurs have, and it also suffers from the objections of amateurs who don't like its basic (and arguably inefficient) premise of using whole bands of frequencies. But it has potential advantages in being able to resist interference and share frequency bands with other users.

**Image Communication Modes.** Many amateurs effectively extend the PC and home-video revolutions to amateur radio. They send and receive images by graphical modes such as fax (facsimile), FSTV



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(fast scan television), and SSTV (slow-scan television)—sometimes the latter two modes are lumped together as amateur TV, or ATV.

SSTV and fax can be handled by multimode hardware interfaces and appropriate PC software. The more advanced MCPs offer a sort of "one-stop communications center" for various on-the-air modes including CW, RTTY, PacTOR, AMTOR, fax, SSTV, and more.

Fax is the oldest amateur image mode. Offering higher image resolution than SSTV or even FSTV, fax sends a high-resolution photocopy of a two-dimensional image of a piece of paper or a still photograph.

Today, amateur faxes usually are sent using PCs equipped with special software. The images sent may be in any one of several different formats that may be displayed as received or saved to a disk file for later viewing. Color fax also is possible, though the ups-and-downs of HF transmission generally limit its successful use to VHF and UHF.

Many amateurs and SWLs also enjoy receiving government WeatherFax (WeFax) broadcasts, which often originate from weather satellites, to obtain a graphical depiction of the weather. The bulk of this activity lies below the amateur 2-meter band, in the 137-138 MHz range using AM video subcarriers, and at 1691 MHz using FM transmission formats.

You can use SSTV to transmit black-and-white or color still pictures on HF, using relatively narrow bandwidths comparable to those used by SSB stations. Conventional SSB rigs generally are used to transmit and receive SSTV signals.

Recent years have witnessed the availability of inexpensive MCPs and PC-based scan converters. You can use an MCP for SSTV, or you can use a dedicated SSTV adapter. Several firms offer dedicated SSTV hardware and or software, including Absolute Value Systems and Harlan Technologies.

Getting on FSTV isn't a great deal different from voice modes, except that you also hook up your camcorder to provide the signal input to your transmitter, and use your TV set to receive the picture. A special radio isn't required. Amateurs typically show their radio hamshacks, home videos, construction projects, and computer graphics, or they repeat SSTV video and audio. Some even transmit local radio club meetings for shut-ins.

A FSTV signal looks like a commercial TV signal; you won't find FSTV on HF. Rather, it's on UHF, mostly on the 70-cm band because of the spectrum space required, and there also are many UHF FSTV repeaters across the country. Some FSTV buffs equip themselves with professional equipment, including special-effects devices to manipulate and control video images. A full range of FSTV equipment is offered by P.C. Electronics and several others.

**Satellite and Space Communications.** Since 1961, when the first

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**NAMES AND ADDRESSES**

**Absolute Value Systems**
115 Stedman St.
Chelmsford, MA 01824-1823

**Advanced Electronic Applications (AEA)**
P.O. Box C2160
Lynnwood, WA 98036

**Amateur Radio Research and Development Corp.**
P.O. Drawer 6148
McLean, VA 22106-6148

**Amateur Television Quarterly**
3 North Court St.
Crown Point, IN 46307

**American Radio Relay League, Inc.**
225 Main St.
Newington, CT 06111-1494

**International Digital Radio Association**
P.O. Box 2550
Goldenrod, FL 32733-2550

**HAL Communications Corp.**
1201 West Kenyon Road
PO Box 365
Urbana, IL 61801-0365

**Harlan Technologies**
5931 Alma Dr.
Rockford, IL 61108

**JPS Communications, Inc.**
P.O. Box 97757
Raleigh, NC 27624-7757

**Kantronics**
1202 East 23rd St.
Lawrence, KS 66046-5099

**MFJ Enterprises, Inc.**
P.O. Box 494
Mississippi State, MS 39762

**MIS Press**
**A division of Henry Holt & Co.**
115 West 18th St.
New York, NY 10011

**P.C. Electronics**
2522 Paxson Lane
Arcadia, CA 91007-8537

**PacComm Packet Radio Systems, Inc.**
4413 N. Hesperides St.
Tampa, FL 66614-7618

**Pavillion Software**
c/o XX Towers, Inc.
814 Hurricane Road
Mason, NH 03048

**Radio Amateur Satellite Corp.**
P.O. Box 27
Washington, DC 20044

**Radio Amateur Telecommunications Society (RATS)**
P.O. Box 93
Park Ridge, NJ 07656-0093

**Tab Books**
**A division of McGraw-Hill, Inc.**
P.O. Box 5445
Blacklick, OH 43004-0545

**Texas Packet Radio Society**
P.O. Box 50238
Denton, TX 76206-0238

**Tiare Publications**
P.O. Box 493
Lake Geneva, WI 53147

**Tucson Amateur Packet Radio Corporation**
8987-309 E. Tanque Verde Rd.
#337
Tucson, AZ 85749-9399

Orbiting Satellite Carrying Amateur Radio (OSCAR) was launched, amateurs have communicated via satellite over thousands of miles using VHF and UHF frequencies that normally are used for short distance communications.

Many amateur satellites contain microcomputers that provide specialized information and communications. Some have onboard cameras that let you download images of the earth and the stars. Others provide "store-and-forward" packet mailboxes for message transfers. Some satellites use the AX.25 protocol; others use special packet protocols developed for satellite communications.

Since 1984, when OSCAR 10 was used as a repeater to connect packet stations on the two coasts, packet radio TNCs and related gear has been carried aboard amateur satellites. This has enabled packet communications either of a real-time or "store-and-forward" (PBBS-like) nature—the latter is more common. There are some amateur satellites in orbit that are dedicated to packet radio (called "PACSATs"). These are PBBS-like and help distribute packet traffic around the world.

You'll find PACSAT operation to be fairly similar to conventional, earth-bound packet, and the same AX.25 protocol is used. But the PACSATs use a variety of data rates and signal modulation schemes and formats. Special modems must be used with your TNC to communicate with the 1200-bps phase shift keying (PSK) satellites (PacComm makes dedicated "satellite modems" to support both modes). You also need a 2-meter FM transmitter to send data and a 70-cm SSB rig to receive downlink transmissions.

Several satellites are 1200 bps PACSATs; these are OSCAR 16, OSCAR 19, and OSCAR 26. OSCAR 22, OSCAR 23, and OSCAR 25 are 9600-bps PACSATs. The 9600-bps birds have become popular—their 9600-bps capability is excellent for a satellite that may be "in view" for but short periods. Unfortunately, the PACSATs can serve only so many stations at one time.

Several packet-radio based Shuttle Amateur Radio Experiments (SAREX) have been conducted by amateur astronauts. Usually special "robot software" is used that enables stations to make contact with the Shuttle. This onboard software recognizes connect requests, sends sequential contact numbers to the station, disconnects, and logs the contact. The Shuttle also carries a beacon which transmits lists of successful contacts. Most of the experiments are digital-based, but ATV operators have successfully transmitted 70-cm FSTV signals to the Shuttle.

Russian cosmonauts have conducted live packet QSOs using amateur radio aboard the Russian Mir Space Station. It uses standard, 1200-bps AFSK packet. The station includes a PBBS-style mailbox for communicating with the cosmonauts.

While Mir is fairly simple to work, and no special equipment is need-



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ed, the problem with actually working it is its erratic schedule, caused by the cosmonauts' scrambling to find the time to operate. They're sometimes forced to turn off their amateur equipment altogether to avoid interference to other systems during critical duties and tests.

The Phase 3D international satellite project is a replacement for the amateur workhorse satellite, OSCAR 13, which soon will plunge into the atmosphere and be destroyed. But it's more, being aimed squarely at reducing the cost and complexity of ground-based, satellite-capable amateur stations. It adds several new frequency and data format choices, including digital-mode capabilities.

The new satellite will have powerful transmitters, receivers, and antennas for frequencies from 21 MHz to 24 GHz. The new satellite also will be easy to find, since its orbit will place the satellite at the same position above your horizon every 48 hours.

Communications with manned spacecraft and satellites are not the only amateur digital comms in the "outer space" realm. For several years, amateurs have experimented using "natural space objects" for packet radio communication. They long have used packet radio in meteor scatter communication, bouncing packets off the ionized trails of meteors that enter the earth's atmosphere, allowing much greater than line-of-site between VHF and UHF packet stations.

Amateurs also have used earth-moon-earth (EME), or "moon-bounce" communications, to bounce their own beacon signals off the moon and listen to them on the rebound. Two-way moon-bounce is a little more difficult, however, as EME signals typically are very weak and fluttery.

**DSP: Digital Magic.** A promising technology that can dramatically enhance your hobby enjoyment is digital signal processing (DSP). DSP represents a highly flexible, entirely digital approach to decoding, encoding, modulating, demodulating, and filtering signals for various operating modes.

Unlike regular analog communications processors, DSP units use software to encode and decode signals, so they aren't dependent on specialized hardware. In DSP systems, the incoming audio is converted into digital data for very effective, thorough processing by the DSP software, which rejects noise and interference according to the specified bandwidth. The result of this processing is converted back into audio for your MCP.

Most applications have focused on receiver filtering, where DSP-based CW filters add narrow, razor-sharp selectivity to receivers that lack it. Since DSP filters are virtual, existing only in microprocessors, they also can offer "adaptive filtering" to react to changing conditions, automatically reduce noise or hiss on weak signals, and notch out interference.

DSP filters are being used to perform more and more functions. Besides receiver filtering, we're seeing DSP-based filters in transceivers, MCPs, TNCs, and radio modems to do such things as generate SSB, process speech, generate and detect FSK and FM signals, and more. Best of all, with a DSP processor it's possible to add practically any mode to your MCP by adding new software.

**PCs in the Radio Hamshack.** Do you use a PC in your radio shack? If so, great, since you have to have one for at least some of the digital modes. Microcomputers perform valuable tasks in the radio hamshack and listening post, from doing calculations to cutting down on record-keeping time to beaming in on other stations.

While computers other than the IBM PC and compatibles can be used in the hamshack, the IBM PC has pretty much become standard. But any computer for which you can obtain terminal-emulation software will work in digital communications, except for CLOVER, which requires a CLOVER board installed in an IBM PC.

Hamshack PC software used to be quite limited, and it focused on QSO and contest logging. But amateur software has come a long way since it first appeared in the late 1970s. Today, hamshack software lets you use your PC for much more, including at least a dozen-and-a-half distinct classes of hamshack software applications.

These applications include Morse Code and radio-theory practice, instruction, and testing; computer-based radio and station control; logging, contesting, and awards tracking; automated QSL card processing; directional-antenna aiming; radio propagation prediction; antenna design and modeling; satellite tracking and antenna control; CW and RTTY reception and transmission; and support for packet radio and other digital communications modes.

Other hamshack computer applications you may enjoy include support for image communications such as fax, WeFax, SSTV, and FSTV; electronic circuit design and performance calculation; CD-ROM based callsign lookup; and online communications. ■

## BUILD A LIGHTING SYSTEM

*(Continued from page 44)*

conduction angle. Use Table 1 to set your Lighting System for light levels that mimic 75-, 60-, 50-, 40-, and 25-watt lamps.

With the potentiometer set, you can complete the Lighting System by mounting it in a plastic electrical box with an AC receptacle cover. You can also modify a small project box. No matter what enclosure you use, however, *never touch any of the components while the circuit is plugged in and turned on!*

If the glow of the lamp seems to waver, check that other appliances on the circuit are in good condition. Also check that all outlets have the proper polarity (house-wiring testers are available for this purpose); appliances with reverse polarity can adversely affect the circuit. ■



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# Think Tank

## Craig's Back With a Vengeance

BY JOHN J. YACONO
TECHNICAL EDITOR
WINDOWS MAGAZINE

This month, we've got various circuits from a former contributor, Craig Kendrick Sellen. Since he's sent enough circuits to fill a column he'll get a 1967 MCL1010 chip and a kit in addition to the book we award for single submissions. If you'd like to try for a book, or the whole ball of wax, send your own complete circuit schematics and explanations to *Think Tank*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735.

Last month we talked about the characteristics of a diode and it seems like a good idea to discuss its "characteristic curve." A characteristic curve is a plot of the current through a device *vs.* the voltage applied across it. For a standard diode the plot looks like Fig. 1.

The action of applying positive potential to the anode or "forward biasing," results in the upper half of the graph. Note the diode does not conduct current until after the barrier potential is overcome by the application of voltage greater than the barrier voltage. That's around 0.7 volts for silicon-based diodes and 0.3 volts for germanium units. Even after that, though, the curve is not linear, particularly before the knee-bend. Linear behavior is really what you'd see with a resistor, but not a diode. That's important to keep in mind if you pass an audio signal through a diode: low-level signals that would fall around the knee bend or dip into the barrier-potential region would be very distorted.

Another important figure of merit in the forward-bias state is the maximum forward current, labeled $I_{FMAX}$. That's the maximum recommended current for the device. Running the diode beyond that would cause it to overheat and fail.

As you can see, when reverse biased, a tiny amount of "leakage current" flows through the diode. You can increase the current passing through the diode if you apply a voltage greater than the "reverse breakdown voltage" or "peak-inverse voltage" (PIV). When a diode is designed to be a "rectifier," a device that only permits current flow in one direction, it's not intended to work below the reverse breakdown point.

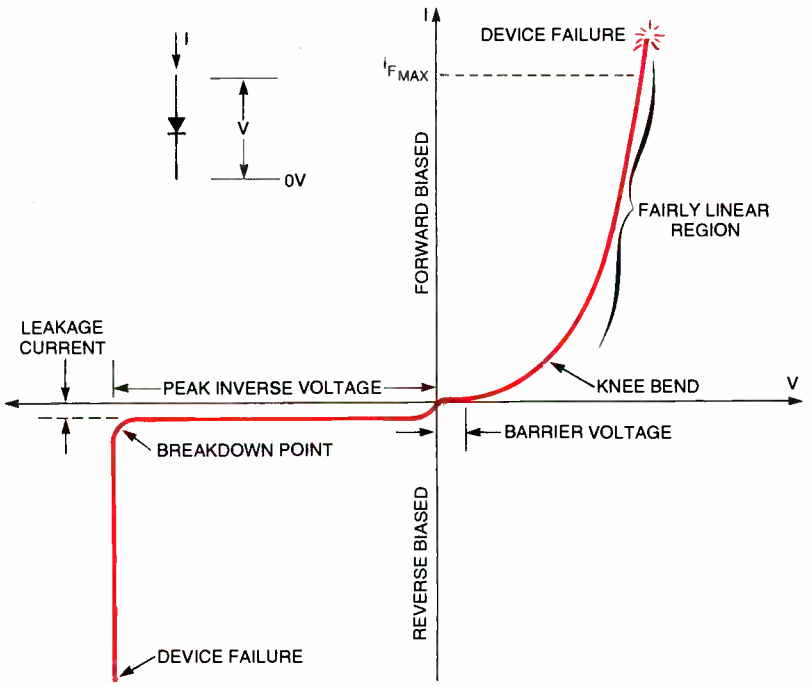


*Fig. 1. Here's the characteristic curve of the current through a standard diode* vs. *the voltage applied across it.*

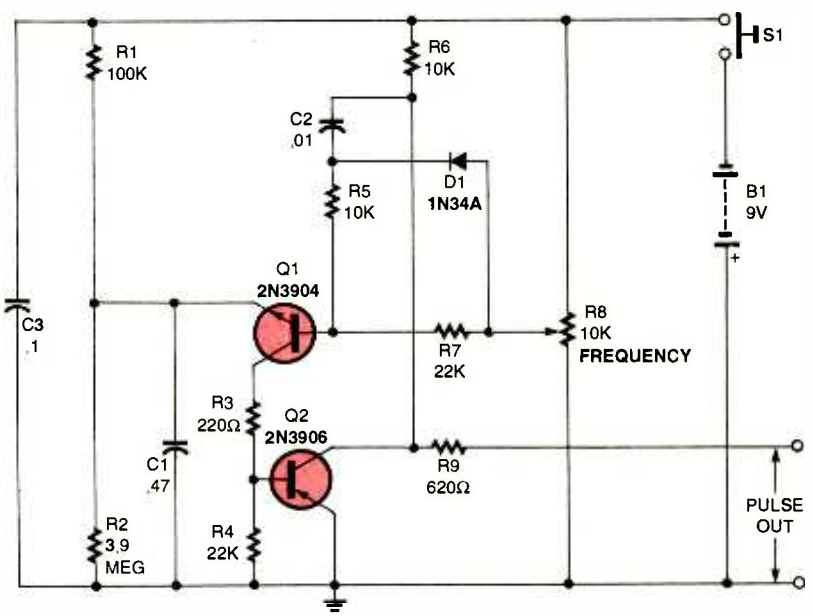


*Fig. 2. This simple pulse generator can provide several waveforms. Potentiometer R8 sets the frequency.*

There are special diodes called "Zeners" that are designed specifically to operate in that region when reverse biased. We'll talk more about them when we discuss how to use diodes as



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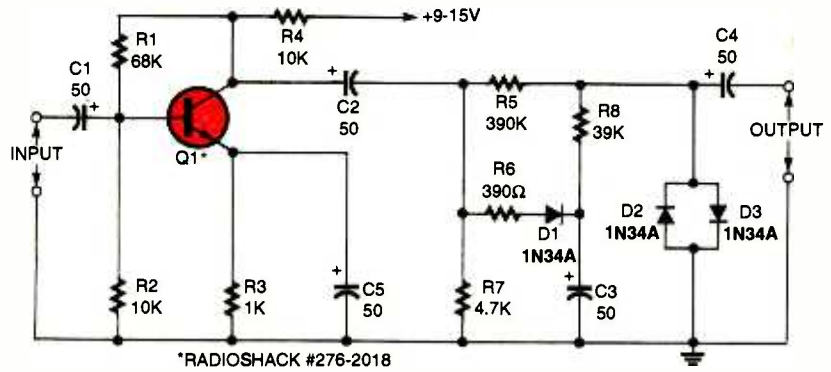


*Fig. 3. Here's a compression-type amplifier that can be used to keep the volume level of an organ constant.*

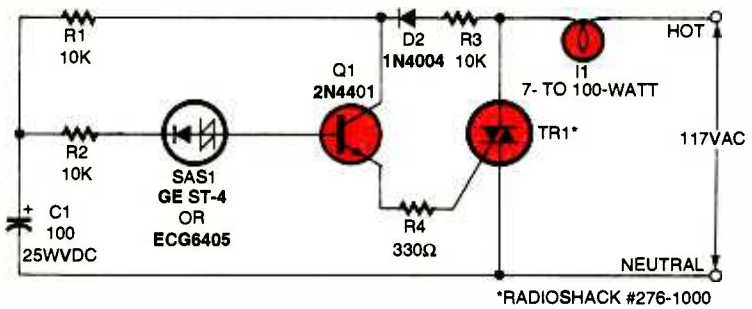


*Fig. 4. With the component values shown, this flasher circuit has a rate of approximately once per second.*

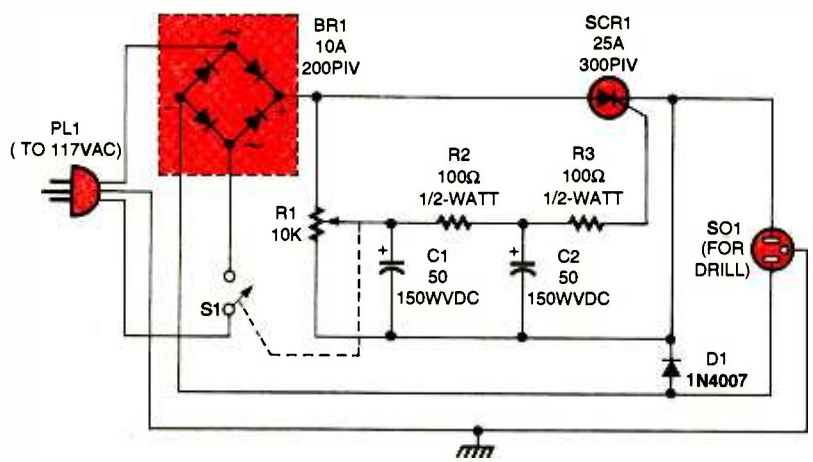


*Fig. 5. Add this circuit to a single-speed drill to make it a variable-speed one.*

voltage references and regulators. Now let's look at Craig's work.

## PULSE GENERATOR

I came up with a nifty pulse generator, shown in Fig. 2, which as you'll see can generate more than simple pulses. Timing-capacitor C1 is charged by battery B1 through R1, until Q1 is forward biased and starts conducting. When this occurs a forward base bias is applied to Q2 through Q1 and R3. As Q2 starts conducting, a pulse is made across collector-load R6, which is coupled back to Q1's base through C2 and series-resistor R5. That drives Q1 to rapidly discharge C1, and then the cycle starts over. In essence Q1 and Q2 form a high-gain amp with C2 providing positive feedback. Diode D1 reduces C2's recovery time, while R8 establishes Q1's base bias level and thus the point at which timing-capacitor C1 charges before feedback and capacitor discharge is initiated.

The lower Q1's initial base bias, the higher the circuit's repetition rate. Resistor R8 therefore serves as a frequency control providing nine octaves of coverage. The circuit will work from 5 to 25 volts, but a 9-volt source is optimum. Output impedance 600 ohms.

Although designed as a pulse generator, the circuit can provide other waveforms at various points. A sawtooth signal suitable for use as a linear scope sweep is available across C1. For frequency-divider, sweep-generator, and time-marker uses, synchonization pulses can be applied to Q1's base through a small capacitor. The frequency range can be shifted by using other values for C1 and C2. With values of 100 μF for C1 and 3 μF for C2, the circuit will work down to about 1/20 Hz. Lower values than those shown in the circuit will permit operation at ultrasonic frequencies, but it may be necessary to reduce resistor values to a tenth of those listed, except for R3, which should not be less than 100 ohms.

*—Craig Kendrick Sellen, Waymart, PA*

*Very unusual design. Interesting purposes, too! An AC powered supply, or at least regulation might make it more stable.*

## COMPRESSION AMPLIFIER

The output signal level of an organ is dependent upon the setting of the foot-pedal volume control, the number of stops or voices switched in, and the number of keys depressed at a given moment. For a fixed volume-pedal setting and a fixed number of stops on line, the volume level heard will vary considerably, depending on how many keys are depressed simultaneously. Although the organist can compensate for the changes in volume by using the volume pedal, on a fast change of stops or a quick switch from solo to rhythm the audio change is too fast for the organist to react. A choppy audio burst is the result.

It is desirable to have a means for keeping the volume level constant when such rapid changes are made. To accomplish this, a compression-type amplifier like the Organ-Leveler shown in Fig. 3 can be used. Unlike compres-



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sors used for public-address-system applications, the Organ-Leveler can respond to the entire range of frequencies generated by the organ without coloring the voices. It can handle large fluctuations in input signal without clipping. It also works well as a microphone-leveler.

*—Craig Kendrick Sellen, Waymart, PA*

*Compression amps also allow you to increase the volume of music to bring out the more subtle passages. I wonder if two of these circuits could be added to a stereo to reveal quiet intro tracks and the like.*

## LIGHT FLASHER

Shown here (see Fig. 4) is a simple flasher circuit. With the component values shown, the flash rate is approximately once per second. The incandescent-lamp load glows at half brightness for about one-third of the total flasher period and is off for the remaining two thirds. Electrolytic-capacitor C1 charges up during the positive half cycle of the AC waveform through R1, R3, and D2. When the voltage across the capacitor reaches the break-over voltage of the silicon asymmetrical switch (D1), the capacitor starts to discharge through R2, D1, Q1, R4, and the TRIAC. Emitter-follower Q1 is driven by the discharge current from C1, and in turn provides gate drive for the TRIAC. Thus the TRIAC conducts and the light glows while C1 is discharged.

The lamp goes dark when C1 is depleted of charge and remains dark until the AC power waveform goes positive again and charges the capacitor sufficiently. The TRIAC should be triggered into conduction by a gate current of no more than 5 mA. The flash rate can be varied by changing the value of capacitor C1. Using more capacitance results in a slower flash rate, and less capacitance in a faster flash rate.

*—Craig Kendrick Sellen, Waymart, PA*

*I once had a thermal flasher. It had a coil wrapped around a bimetallic strip. The strip (with a built-in contact point), the coil, and the load were all in series. When current flowed through the circuit, the coil would slowly heat the strip, which would then bend, moving its contact from its mating contact, thereby breaking the circuit. The coil/strip assembly would eventually cool, and the strip would relax and re-establish the circuit.*

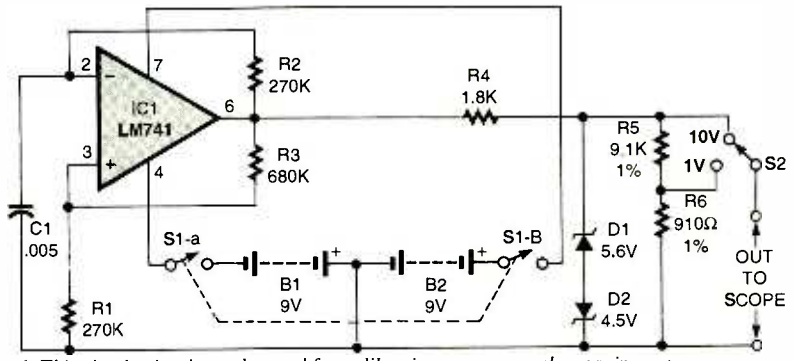


*Fig. 6. This simple circuit can be used for calibrating scopes or other equipment.*

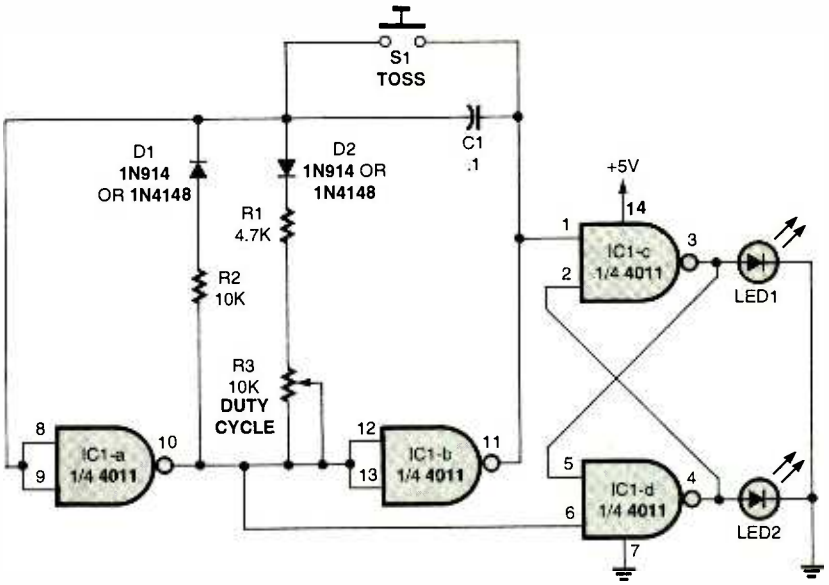


*Fig. 7. Here's a simple CMOS coin-toss circuit. Make sure to adjust R3 to a 50% duty cycle.*

## SOLID-STATE DRILL-SPEED CONTROL

Drilling holes in different types of metals, plastic, etc. is often easier with a variable-speed electric drill. If, like me, you don't own a multi-speed drill, you can add the little circuit shown in Fig. 5 to a single-speed drill to make it more useful.

The bridge rectifier (BR1) provides the full-wave pulsing direct current for the SCR switch (SCR1); BR1 should be rated at 200 PIV and have a current rating of 10A, while SCR1 should have a PIV of 300V and a current rating of 25A. Diode D1 is used to counter the back voltage developed by the drill motor; D1 can be rated at 2A. The speed of the drill is varied by R1. Also, try using the circuit with a soldering iron.

*—Craig Kendrick Sellen, Waymart, PA*

*I'd recommend using this circuit with a soldering iron rather than a drill. Coils tend to heat when driven with pulsating DC, especially when the current is suddenly turned on mid-phase repeatedly.*

## PORTABLE SCOPE CALIBRATOR

I developed a simple circuit for calibrating scopes or other equipment (see Fig. 6). Ideally, the Zener diodes should be matched with a total voltage of 10 volts. Unable to obtain a perfect match, I assembled my model using a 5.6-volt Zener for D1, and a 4.5-volt diode for D2, providing a nominal 10.1-volt output signal. The actual output voltage, of course, will depend on the Zener-diode voltage tolerances.

If a particular application requires an accurately known output voltage, a simple test will establish this value. Disconnect R4's upper lead (the one

*continued on page 61*



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# ANTIQUE RADIO

## Roaming the Stars Once More

BY MARC ELLIS

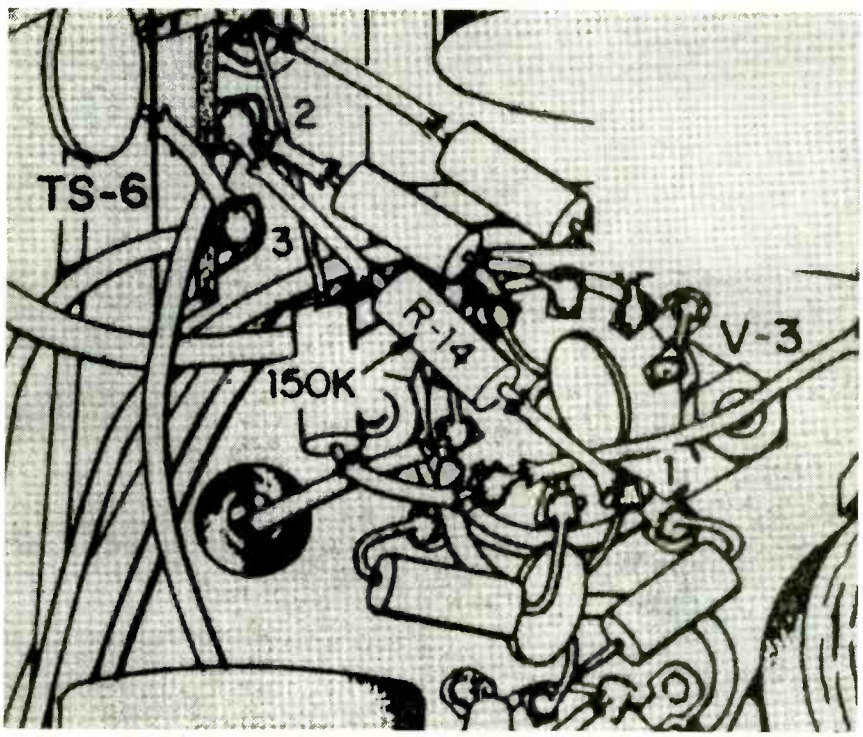
At the conclusion of last month's column, I was hoping to wrap up our work on the *Star Roamer* with a quick realignment. However, I was stymied by an intermittent connection that made the set's audio cut in and out in a random and unpredictable fashion.

For those who might just have joined us, the Star Roamer was a Knight Kit (Allied Radio's house brand) low-end communications receiver that was a popular starter set for SWLs and would-be hams in the mid-1960s. Mine was rescued (in pretty good cosmetic condition) from a trash can by a friend. After changing the filter capacitors and replacing the selenium rectifier with a modern silicon unit, I tried it out—and discovered that the set would receive only on the broadcast band. Even those signals were weak, as well as distorted at higher volume.

On top of that, there was no AVC (automatic volume control) action, as evidenced by the fact that the "S"-meter remained rock-steady even when tuning through the strongest station on the dial. Figuring that the problem could very well be a weak IF channel, I broke out the alignment equipment and began to hook it up to the set.

### ANNOYING INTERMITTENTS

That's when a new problem became obvious. It was one of those annoying hair-trigger intermittents. The static would begin whenever the chassis was tapped, even lightly, almost anywhere on its surface. That made the trouble very difficult to localize, but I finally traced it to the tangle of wiring associated with the 12AX7 dual triode used as the first and second audio amplifier. Because the wiring for those two stages had to be crammed around the base of just one tube socket, it was quite dense and hard to check.




*An annoying intermittent connection was finally discovered in the tangle of wires associated with the 12AX7 tube socket.*

However, I finally found the problem in the lower eyelet hole of one of the 12AX7 socket's solder lugs. It seems as though, even though there was a large blob of solder on the upper eyelet (blocking the view below it), no solder had found its way to the wire passing through the lower one. Gingerly sliding the tip of a small iron through the wire tangle, I was able to deposit a drop of solder on the connection that had gone naked all these many years, and the problem went away—or so I thought.

With the radio still playing, I began moving it into position to hook up the signal generator and AC VTVM that I use for alignment. That's when I found the second intermittent! Now I'd hear loud static whenever I tried to pick up the radio by the upper right-hand corner of the front panel.

The second problem was almost as hard to find as the first because it disappeared completely when I turned the chassis upside-down. That obviously made it very tough to see where the bad wiring was. But, acting on a hunch that I had probably disturbed the wiring while searching for and repairing the first problem, I looked over the connections under the 12AX7 with a careful eye.

Sure enough, I found a couple of tube socket connections that were within a hair's-breadth of touching. No doubt I had disturbed them during my earlier explorations. Moving them a safe distance apart, I turned the chassis over again and checked for the problem. It was gone at last! Now I could get back to my realignment.

### SERIOUS TROUBLE-SHOOTING BEGINS

I connected a wire to the output terminal of the vintage Navy LM frequency meter that I use as a signal generator and wrapped the other end around the Star Roamer's 6BE6 converter (oscillator-mixer) tube. Tuning the LM to the set's IF frequency (455 kHz), I could hear the LM's modulated tone weakly in the speaker. Then I connected my equally vintage Ballantine AC VTVM across the speaker terminals so I could read signal strength.

Shutting off the set's AVC, as is required for alignment, I began tweak-



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ing the adjustments of the IF transformers while watching the meter. The adjustments seemed very sloppy and broad, and no amount of tweaking did much to increase the strength of the signal coming through the IF channel. Obviously, IF realignment, by itself, was not going to correct this problem.

Lack of AVC action, broad IF tuning, and distorted audio are classic symptoms of a bad AVC filter capacitor. To check that, I looked at the table of typical tube-pin resistance readings in the Star Roamer's construction manual. It told me that the reading from pin 7 (the control grid) of the 6BE6 converter tube to ground should be 3.4 megohms, just a little more than the value of AVC load resistor, R7 (a full-page schematic of the radio was reproduced in last month's column; space doesn't permit its inclusion this month).

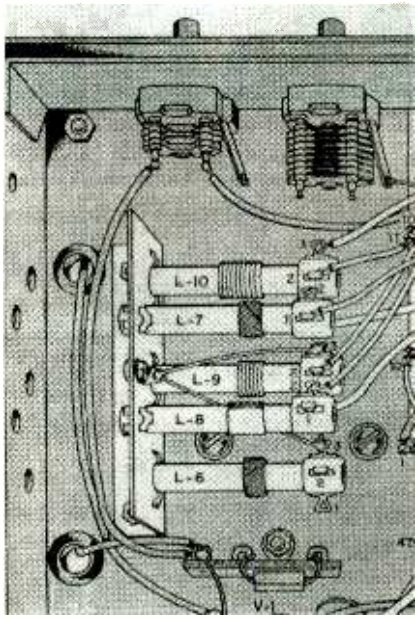
It was obvious from the schematic that if the filter capacitor (which is connected from the AVC line to ground) were leaky or shorted, that resistance value would become relatively small, or even zero. The cap is labeled C19 on the schematic shown last month. The resistance turned out to be about 200,000 ohms, so I quickly removed C19 (a 0.1-μF, 16-volt, disc) and replaced it with an equivalent unit.

## FINAL ALIGNMENT

That brought the set to life in a very satisfying way. Signals were stronger, the sound was clean, and I could hear signals on the shortwave bands even with just a few feet of antenna wire draped around the workshop. Peaking the IF transformers once more, I found that the response was much sharper and that I was able to make a significant improvement in the sensitivity of the IF channel.

With the IF channel nicely tweaked and the set operating normally, I then went ahead and realigned the tuned circuits in the Star Roamer's front end. The realignment, which was done exactly per the specifications in the construction manual, involved adjusting the slug-tuned coils in the RF and oscillator circuits of each band for maximum response at certain test frequencies. Trimmer capacitors on the oscillator and RF sections of the main tuning capacitor also required adjustment.

In general, the RF circuits tune the set to receive the radio signal of interest. The oscillator circuits determine where the signal will appear on the dial and must be adjusted accurately to obtain accurate calibration.



*The oscillator coils (L6-L10) for all five bands are mounted under the chassis, and adjusted through holes in the chassis apron.*

## TRYING OUT THE "ROAMER"

The Star Roamer covers 200 to 400 kHz and 550 kHz to 30 MHz in five bands. Listening at about 7:00 in the evening (CST), using the built-in loopstick for broadcast-band reception and a few feet of antenna wire for the longwave and shortwave bands, I was able to detect at least some signs of activity everywhere.

On the broadcast band, I was able to hear strong local stations and some DX stations over the entire tuning range. There wasn't much to be heard on the 200- to 400-kHz band, which was to be expected given that my antenna was so short as to be nonexistent at those frequencies. Even so, I thought I could make out faint Morse signals from an automated aircraft beacon, probably a local one.

In the 1.8- to 4.8-MHz band, I could hear ham CW (Morse) signals at both 160 meters (about 1.8 MHz) and 80 meters (3.5 MHz). I also heard some typical "Donald Duck" ham sideband voice signals at 80 meters. But the Roamer's BFO (beat frequency oscillator), which worked well enough for its intended purpose of making CW signals audible, was not stable enough to provide the carrier reinsertion required to make the sideband signals understandable.

Switching to the 4.8- to 12-MHz range, I found several very strong international broadcasters, some using English and some not, clustered around 6 MHz. Another group was heard clustered around 9.5 MHz. On the top band (12 to 30 MHz), I couldn't hear much of anything except some faint CW signals in the amateur 40-meter band (about 14 MHz).

I agree that this was not an outstanding performance. But, considering that the Roamer is a very minimal set and was operating from a very short antenna, the results establish that the radio is now operating pretty much as it was intended to do. ■

## THINK TANK

*(continued from page 59)*

that goes to pin 6 of IC1), reverse D2, and connect R4's free lead to the positive terminal of a 15- to 18-volt DC source that shares a ground with the rest of the circuit. Measure the voltage across the Zeners with an accurate meter, then restore the circuit to its original condition for normal operation.

*—Craig Kendrick Sellen, Waymart, PA*

*Keeping the Zeners in thermal contact is also a good idea to improve accuracy. Try sealing-bundling them together side-by-side in a piece of heat-shrink tubing packed with thermal grease.*

## COIN TOSSER

Shown in Fig. 7 is a CMOS coin-toss circuit that works well and can be built with a single 4011 or 4001 CMOS IC. (Note that IC pin numbers in the diagram apply for both the 4001 and 4011.) Two gates form a clock, and the others make up a bistable multivibrator.

With this circuit, it is necessary to adjust the 10,000-ohm potentiometer (R3) for a 50% duty cycle. If you don't have a scope to do this, simply measure the direct current flowing through each LED while adjusting R3. When the same current level flows through each LED, the clock will be adjusted for a 50% duty cycle.

*—Craig Kendrick Sellen, Waymart, PA*

*A common-cathode, three-terminal diode would be an interesting replacement for the LEDs. It would glow red or green to indicate heads or tails, glowing an eerie orange during oscillation.*

That's all we have for this month. 'Till next time, happy soldering! ■



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# DX LISTENING

## Answering Mail

BY DON JENSEN

Let's devote most of this month's column to your letters, starting off with something very basic.

Jerry D'Amato of San Francisco, CA, writes: "How can shortwave signals travel such great distances?"

It is a curious phenomenon, Jerry, particularly since radio signals travel in a straight line, while the earth's surface is curved. So before the electromagnetic energy goes too far from the transmitting antenna, it reaches the horizon and heads off into space.

How, then, is it possible to hear shortwave broadcasts thousands of miles away from the transmitter site? For the answer, consider a simple experiment you may have performed back in Mrs. Averback's grade-school science class. You placed a pencil in a glass of water; then viewed the glass from the side. The pencil seemed to have been broken just at the point where it entered the water. It seemed to bend off at a strange angle.

The reason, Mrs. Averback explained then, was that the light waves are affected by the different media through which they pass, in this case, ordinary air and the more dense water. The pencil really wasn't broken; it just looked that way because of the effect that these varying media have on the light waves. Like light, radio waves also are bent when they travel from one medium to a denser one.

As shortwave signals travel outward from the earth, they encounter the ionosphere, a region containing bands of gases circling the globe at altitudes of between about 50 and 200 miles. Here solar radiation causes changes in the makeup of the gases in the ionospheric belts. These changes, called ionization, alter the effective densities of these layers.

As radio waves encounter these layers on their outbound journey from the earth, they are bent. If the ionization is great enough, the shortwave signals are bent back toward the earth at an angle equivalent to that which they entered the ionized zone.

*A woodcut illustration showing Tahitian drummers from a QSL card issued by Tahiti's shortwave station, RFO.*

You can think of it as reflection, although the process is really called refraction. The shortwave signals bounce back to the earth's surface, thousands of miles from their starting point, like a stone skipping off the surface of a lake.

It's not surprising that DXers call it "skip," this phenomenon that bounces the radio signal once or several times between the ionosphere and the earth's surface to make distant shortwave reception possible.

### TAHITI UPDATE

"I've been a shortwave listener for more than a dozen years, now," notes Maryanne Swift, Lexington, KY. "I used to hear Tahiti on shortwave around 11,825 kHz or so with quite good signals during the late night hours. I remember the great island music and, especially, the Tahitian drumming! But I haven't heard the station for a long time. What happened to Tahiti?"

To be honest, Maryanne, it's been a long time since I heard the station too. There was some speculation that perhaps RFO Tahiti had left shortwave. But not long ago, DXer Terry Palmersheim visited Tahiti. He reported, via the Cumbre DX service, that the station is, for the present, alive and well on SW.

Terry says that RFO still broadcasts on shortwave, but only on 15,167 kHz and a local service medium-wave frequency of 738 kHz. Other former frequencies of 6,135 and 11,827 kHz are not in use.

The station plans to continue on shortwave until the transmitter gives out, and then it will not be repaired or replaced.

"Both medium wave and shortwave transmitters are on 24 hours, near as I could tell," Terry reported, "but the SW is really quite weak, even near the site. If they are using 20 kilowatts (of power) you couldn't convince me of that."

Still, according to reports, weak signals from RFO's 15.167 kHz transmitter have been heard on occasions in both Europe and North America. Keep trying, Maryanne.

### HARD TO UNDERSTAND

"One thing that bothers me about SW is the announcing, or rather, some of the announcers I hear," writes Tom Fenner of Rochester, NY. "They're supposed to be speaking English, but their accents are so bad they are really hard to understand."

Well, Tom, having once traveled across South America with little more to support me than my high school Spanish, I'm hesitant to criticize anyone struggling with *my* language.

But, on the other hand, shortwave stations that are making a conscious effort to reach English-speaking listeners really are fighting a losing battle when that very audience has trouble understanding the programming.

Peter Bowen recently wrote in the *North American SW Association's*

*continued on page 64*

(CREDITS: Brian Alexander, PA; Peter Costello, NJ; Richard D'Angelo, PA; William McGuire, NJ; Denis Pasquale, PA; Joel Whitaker, NJ; North American SW Association, 45 Wildflower Road, Levittown PA 19057)



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# Customize Your Greatest Hits Web Page

BY JEFF HOLTZMAN

This is part two of a series on putting HTML to practical use. Last time we showed how to create a basic "greatest hits" page that allows you to organize your favorite Web sites. This time we'll talk a little more about why such a page is useful, and then get into the nitty-gritty of how it works. Armed with this knowledge, you'll be able to customize your page.

But before we go on, let me address a concern that some of you might be having. Particularly, "why bother?" Internet Explorer (Microsoft) and Navigator (Netscape) both provide a means to mark and return to favorite Web sites. So why create an external solution? There are several reasons. One is that I use several browsers, and I need a solution that works with all of them. Another is that as the browser wars continue, I don't want to be locked in to any one particular tool. My solution works with any browser.

## HOW IT WORKS

Refer to Listing 1 in what follows. The HTML page breaks down into ten sections. Section one (lines 1-6) provides a title for the page. This title is not displayed; rather it is what appears in the history list. It's really more the name of the page than its title.

Section two (lines 8-20) provides a table of contents for all the site groupings listed on the page. Overall, the TOC provides eight groups of sites. The first of those eight is the Delphi Sites; lines 22-43 contain the listings for the Delphi sites (we'll discuss the details later). The remaining seven sections provide placeholders for the other seven site groupings.

Before continuing, we need to discuss Anchor Tags. Anchor tags are the most important tags in Web pages; it is anchor tags that allow the hypertext structure—the links among web pages—to be specified.

We use two kinds of anchor tags in this page. One simply labels a particular location in a document, like pinning a flag on a map. The other says to go to a new location, *i.e.*, to make the specified document the current document.

Let's look at section two, the TOC. It has a title (that does display), followed by an anchor tag and an unordered list of site groups. The page title is "My Favorite Sites." It is displayed in a style called Heading 1, or H1 for short. Squeezed in between the <H1> tag and the text of the page title

**LISTING 1—BASIC HTML FILE**

```
1. <HTML>
2. <HEAD>
3. <TITLE>
4. My Favorite Sites
5. </TITLE>
6. </HEAD>
7.
8. <BODY>
9. <H1><A Name="TOP">My Favorite Sites</H1>
10. <H2>My TOC</H2>
11. <UL>
12. <LI><A HREF="#Delphi Sites">Delphi Site</A>
13. <LI><A HREF="#ShareWare Sites">Shareware Site</A>
14. <LI><A HREF="#Other Sites 1">Other Sites 1</A>
15. <LI><A HREF="#Other Sites 2">Other Sites 2</A>
16. <LI><A HREF="#Other Sites 3">Other Sites 3</A>
17. <LI><A HREF="#Other Sites 4">Other Sites 4</A>
18. <LI><A HREF="#Other Sites 5">Other Sites 5</A>
19. <LI><A HREF="#Other Sites 6">Other Sites 6</A>
20. </UL>
21.
22. <H3><A Name="Delphi Sites">Delphi Sites</A></H3>
23.
24. <TABLE BORDER WIDTH=50%>
25.
26. <TR>
27.     <TH>Description</TH>
28.     <TH>URL</TH>
29. </TR>
30. <TR>
31.     <TD>Borland Developer's Conference</TD>
32.     <TD><A HREF="http://www.dbex.com/bdc96.htm">Borland DevCon</A></TD>
33. </TR>
34. <TR>
35.     <TD>Delphi 32</TD>
36.     <TD><A HREF="http://www.delphi32.com/">Delphi 32</A></TD>
37. </TR>
38. <TR>
39.     <TD>cell 1</TD>
40.     <TD>Cell 2</TD>
41. </TR>
42. </TABLE>
43. <A HREF = "#TOP">Back</A>
44.
45.
46. <H3><A Name ="ShareWare Sites">ShareWare Sites</A></H3>
47. <A HREF = "#TOP">Back</A>
48.
49. <H3><A Name ="Other Sites 1">Other Sites 1</A></H3>
50. <A HREF = "#TOP">Back</A>
51.
52. <H3><A Name ="Other Sites 2">Other Sites 2</A></H3>
53. <A HREF = "#TOP">Back</A>
54.
55. <H3><A Name ="Other Sites 3">Other Sites 3</A></H3>
56. <A HREF = "#TOP">Back</A>
57.
58. <H3><A Name ="Other Sites 4">Other Sites 4</A></H3>
59. <A HREF = "#TOP">Back</A>
60.
61. <H3><A Name ="Other Sites 5">Other Sites 5</A></H3>
62. <A HREF = "#TOP">Back</A>
63.
64. <H3><A Name ="Other Sites 6">Other Sites 6</A></H3>
65. <A HREF = "#TOP">Back</A>
66.
67. </BODY>
68. </HTML>
```



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is an anchor tag, which names this location in this page. In this case, the name is simply "TOP." When viewed in a browser, that anchor tag displays nothing.

Following that is another heading style tag, followed by a list of items. It is the <UL> tag that specifies that all <LI> items until the following </UL> tag appear as bullet list items. If we had used an ordered list tag <OL>, the site groups would have been numbered in order. Each list item <LI> begins with a tag that resembles the following:

<A HREF="#..."> ... </A>

That is the other type of Anchor tag. It is a "goto" tag that specifies where the browser should pick up the next page to display. The text string between the quotation marks could specify any legal Web address. It could be a page on a site halfway across the world, or it could be a different page on the same site as our example is (hypothetically) running. Or it could be a location in the same page, which is the way we're using it.

The pound sign (#) and the text following it together are known as a bookmark. The bookmark could be preceded by a different site and page address, or, as used here, by nothing, in which case, the goto location is the same page.

As discussed so far, an anchor tag would do nothing. However, a text string between the anchor's start and end tags (where the second ellipsis (...) appears in the figure) appears as underlined text in a browser. When the user clicks on that underlined text, the browser knows that the corresponding bookmark says what to display next and does so.

The first item in the list specifies "#Delphi Sites" as the goto location. Scan down to line 22, and you'll see the actual destination specified by the bookmark-in this case, "Delphi Sites."

That's all it takes to create a hypertext jump, whether within the same Web page, or among pages separated by thousands of miles and hosted by completely different computer systems. That's the beauty of HTML.

To recap, there are two basic kinds of Anchor tags: HREF and NAME. The NAME type names the current location. The HREF type specifies a goto location. Those are the key concepts. Understand those, and you can do quite a lot with Web pages.

## BACK LINKS

From our page TOC we have eight "outgoing" links to our eight site groups, beginning with Delphi Sites. We also have eight "incoming" links, one each from each of the eight site sections. For example, examine line 43, which displays underlined text ("Back"). When that's clicked, it causes the current page to be redisplayed literally from the top.

That's it for now. Next month we'll show how the table commands in the Delphi Sites section work. We'll also provide complete details for a page listing numerous sites of interest to **Popular Electronics** readers. ■

## DX LISTENING

*(continued from page 62)*

*Journal* about one such programming failure, Radio Prague's Economic Report.

"The host speaks with a very heavy Czech accent. In fact, his accent is so thick that it is frequently difficult to understand what he is saying. This in itself is bad enough, especially when you take into account the fact that shortwave propagation adds to the difficulties faced by listeners in comprehending what is said. But it is made even worse by the fact that his reading style is quite flat and boring.

"After a minute or so of hearing him speak, the listener's mind tends to shift elsewhere due to boredom, which in turn makes it quite difficult to concentrate on what is said....

"Of course, Radio Prague is not alone in this regard. Numerous international broadcasters use announcers with atrocious-speaking styles and accents."

To which, Richard Cuff, moderator of the *Journal* column, "Easy Listening," responded:

"Perhaps as these countries get their economies stabilized, they'll be able to enhance the speaking qualities of their on-air teams."

## VOA STILL GROWING

Al LoCicero, Jefferson City, MO, writes with word on a new Voice of America relay station under construction in the Pacific.

"The Mariana Radio Relay Station is targeted for opening in December, 1998," says Al. "A contract was awarded last August to the Sayed Hamid Behbehani and Sons construction firm to build the new shortwave facility on the island of Tinian in the Commonwealth of the Northern Mariana Islands."

Three existing 500-kilowatt SW transmitters will be moved from a deactivated Radio Free Europe/Radio Liberty broadcasting site in Portugal. The $20-million-plus facility will have four pairs of curtain antennas to transmit broadcasts to China, Southeast Asia, and Indonesia.

VOA programming in English, Standard Chinese, Cantonese, Khmer, Indonesian, Burmese, and Vietnamese will be relayed by the new station.

"The relay broadcast facility is being built on an 800-acre site made available to the U.S. Information Agency, the VOA's parent organization, by the Department of Defense."

## DOWN THE DIAL

Looking for some interesting shortwave listening? Try these:

**ALGERIA**—15,160 kHz. Radio Algers International can be heard at 1800 UTC with English news, commentary, and program preview.

**AUSTRALIA**—9580 kHz. Radio Australia has English at 1030 UTC, with identification, international and business news, followed by a musical program.

**BOLIVIA**—9,625 kHz. Radio Fides has been noted through the evening hours until sign off at 0506 UTC. Programming is all in Spanish, with a disc jockey playing Bolivian rhythms and ballads, and taking phone-in requests.

**GERMANY**—15,600 kHz. Ireland's RTE Radio One is airing special programs via a transmitter owned by Deutsche Telekom in Germany. This has been heard signing on just before 1400 UTC. It identifies as "It's RTE Radio One coming to you live."

**MEXICO**—9,705 kHz. Radio Mexico International has English language news of Latin America at 0300 UTC, followed by a cultural affairs report and light music. It switches back to Spanish at 0330 UTC.

**SAO TOME**—4,750 kHz. Voice of America is relayed from this island location off the west coast of Africa. Look for it signing on at 0258 UTC with the program, Daybreak Africa, leading off with English news and a weather report. ■



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# CIRCUIT CIRCUS

# Code-Practice Oscillators

BY CHARLES D. RAKES

Sitting here in front of the PC I glanced out at the early snow that covered the surrounding countryside and was reminded of a similar time back in the early '50s when the postman delivered a mysterious package to our door. Earlier in November that year Dad had secretly sent off an order to Burstein Applebee, our nearest electronic mail-order house, for a pair of deluxe code-practice oscillators. As I remember they were equipped with a built-in key, a tunable buzzer and a lamp for visual and secret code practice.

Dad was capable of copying 20 words a minute in his head while doing other things, and I was still struggling to reach the 5 WPM plateau. That prompted me to look elsewhere for someone to practice with that wasn't too familiar with the code but had an interest. The neighbor girl turned out to be the perfect neophyte for the visual code practice feature. Oh, I forgot to mention that each CPO had the code spelled out on a metal plaque so even if you didn't know "A" from "Z" you could search out each letter or number and decode a very slow-speed message.

Well you've probably guessed by now that we're going to look at some code-practice-oscillator (CPO) circuits this time around. Look them over and select one to build and use to increase your CW speed for a license upgrade or present one to a youngster who would enjoy becoming a Ham and going beyond the Tech level.

## TOUCH-OPERATED CPO

A touch-operated CPO is shown in Fig. 1. Here we have a single 4093 quad 2-input NAND-gate Schmitt-trigger, IC1, doing all of the CPO's chores. The gates of IC1-a are biased high through the two 22-megohm resistors (R1 and R2) keeping its output in the low state. Gates IC1-b and IC1-c are connected in an audio oscillator circuit that can only operate when pin 5 of IC1-b is high. The last gate of the 4093, IC1-d, adds isolation to the oscillator's circuit and drives the speaker (SPKR1).

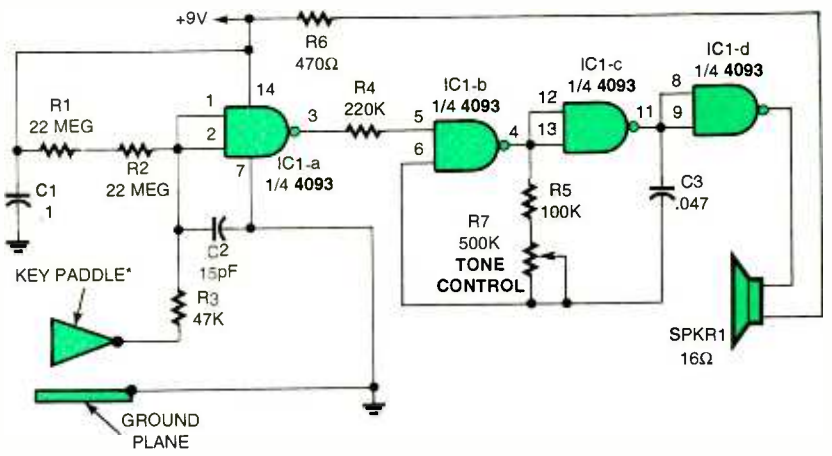


*Fig. 1. Here's a touch-operated CPO that has a quad NAND-gate doing most of the work.*

### PARTS LIST FOR THE TOUCH-OPERATED CPO (Fig. 1)

**RESISTORS**
(All fixed resistors are 1/4-watt, 5% units.)
R1, R2—22-megohm
R3—47,000-ohm
R4—220,000-ohm
R5—100,000-ohm
R6—470-ohm
R7—500,000-ohm potentiometer

**CAPACITORS**
C1—0.1-μF, ceramic-disc
C2—15-pF, ceramic-disc
C3—0.047-μF, Mylar

**ADDITIONAL PARTS AND MATERIALS**
IC1—4903 quad 2-input NAND-gate Schmitt trigger, integrated circuit
SPKR1—16-ohm speaker
Paddle and ground-plane materials (see text), power source, wire, solder, etc.

Touching the key paddle and ground plane lowers IC1-a's input gate voltage to near zero, allowing the output at pin 3 to go high. The tone generator then turns on and sends out an audio note.

The touch key paddle and ground plane can be made from a circuit board or any other conductible material. Note that the ground plane should lie flat for a hand rest and the key paddle should be positioned for ease of touch. Any configuration that works best for you is the way to go.

## PLL CPO

Our second CPO (see Fig. 2) uses a 567 phase-locked loop, IC1, as the variable tone generator. The oscillator's frequency is set by R6, and the frequency range can be changed by selecting a different-value capacitor for C5. To

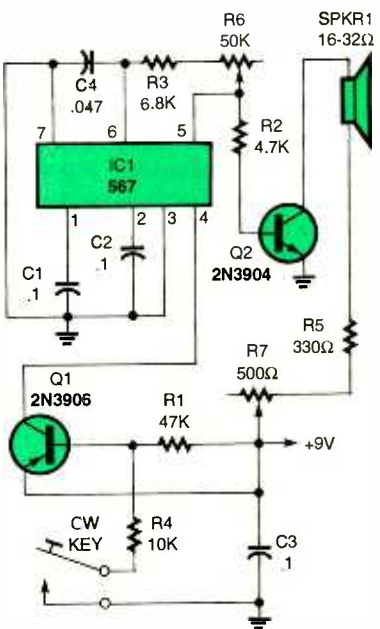


*Fig. 2. This code-practice oscillator uses a 567 phase-locked loop, IC1, as its variable tone generator.*



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## PARTS LIST FOR THE PLL CPO (Fig. 2)

**SEMICONDUCTORS**
IC1—567 phase-locked loop, integrated circuit
Q1—2N3906 PNP general-purpose transistor
Q2—2N3904 NPN general-purpose transistor

**RESISTORS**
(All fixed resistors are 1/4-watt, 5% units.)
R1—47,000-ohm
R2—4700-ohm
R3—6800-ohm
R4—10,000-ohm
R5—330-ohm
R6—50,000-ohm potentiometer
R7—500-ohm potentiometer

**ADDITIONAL PARTS AND MATERIALS**
C1-C3—1-μF, ceramic-disc capacitor
C4—0.047-μF, Mylar capacitor
SPKR1—16- to 32-ohm speaker
CW key, power source, wire, solder, etc.

lower the oscillator's frequency range make the value of C5 larger, and to increase the frequency range reduce C5's value.

A general purpose 2N3906 PNP transistor, Q1, supplies power to the 567 through pin 4 each time the CW key is closed. Meanwhile, Q2, a general-purpose 2N3904 NPN transistor, buffers the oscillator's output and drives the speaker. Potentiometer R7 sets the output volume.

## WIRELESS TRANSMITTER

The next circuit, shown in Fig. 3, is a low-power, tone-modulated FM transmitter that can be used with any FM broadcast receiver for real wireless code practice. Transistor Q1 and its associated components make up a phase-shift audio-frequency generator circuit. Potentiometer R11 sets the tone frequency.

Transistor Q2 is connected in a high-frequency RF oscillator circuit that operates in the FM broadcast band. By adjusting C8 and the size of L1, the entire FM band can be covered. The audio output tone is coupled to the base of Q2 through C4, R4, and R12. Potentiometer R12 sets the modulation level. Transistor Q3 operates as a switch turning on the FM transmitter each time the CW key is closed.

Coil L1 is a home-made air-wound coil. Take a 6-1/2-inch length of 20-gauge enamel-covered wire and close-wind it around a 1/4-inch-diameter form;

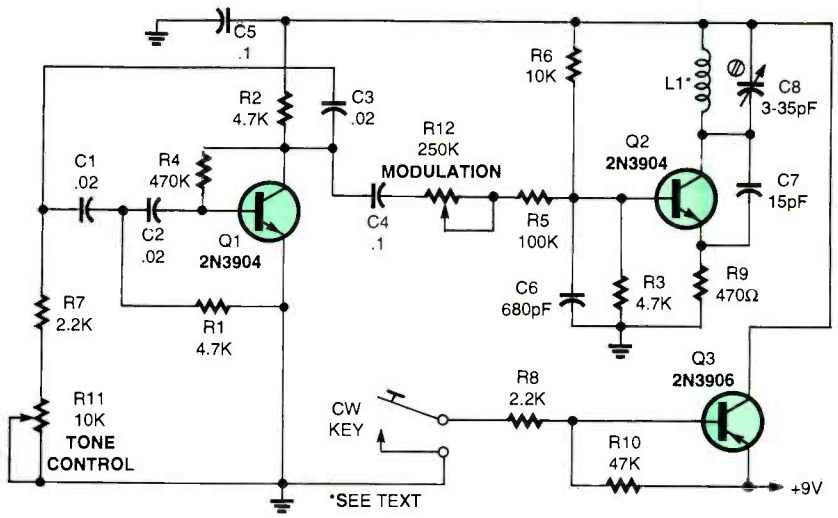


*Fig. 3. This low-power, tone-modulated FM transmitter can be used with any FM broadcast receiver for real wireless code practice.*

## PARTS LIST FOR THE WIRELESS TRANSMITTER (Fig. 3)

**RESISTORS**
(All fixed resistors are 1/4-watt, 5% units.)
R1-R3—4700-ohm
R4—470,000-ohm
R5—100,000-ohm
R6—10,000-ohm
R7, R8—2200-ohm
R9—470-ohm
R10—47,000-ohm
R11—10,000-ohm potentiometer
R12—250,000-ohm potentiometer

**CAPACITORS**
C1-C3—0.02-μF, Mylar
C4, C5—0.1-μF, ceramic-disc
C6—680-pF, ceramic-disc
C7—15-pF, ceramic-disc
C8—3- to 35-pF, trimmer

**ADDITIONAL PARTS AND MATERIALS**
Q1, Q2—2N3904 NPN general-purpose transistor
Q3—2N3906 PNP general-purpose transistor
L1—Coil made of 20-gauge enamel-covered copper wire (see text)
Power source, CW key, wire, solder, etc.

leave about 1/4-inch free at each end. Remove the insulation from the ends and slide the coil off the form. The overall length of the finished coil should be about 1/4 inch.

The circuit may be built on perforated board with all interconnecting leads kept as short as possible. Checking out the circuit is easy. Set R11 and R12 to mid position and close the CW key. Then set your FM receiver to a clear spot on the low end of the dial and slowly adjust C8. Once the tone is heard R11 may be set for the desired tone frequency and the tone level set by R12. If your oscillator won't tune to the top end of the band, carefully stretch the windings of L1 and retune. The circuit's operating range can be increased by adding a very short antenna to the emitter of Q2.

## CRYSTAL-CONTROLLED OSCILLATOR

Our next entry (see Fig. 4) takes the CPO to the ham bands via a simple

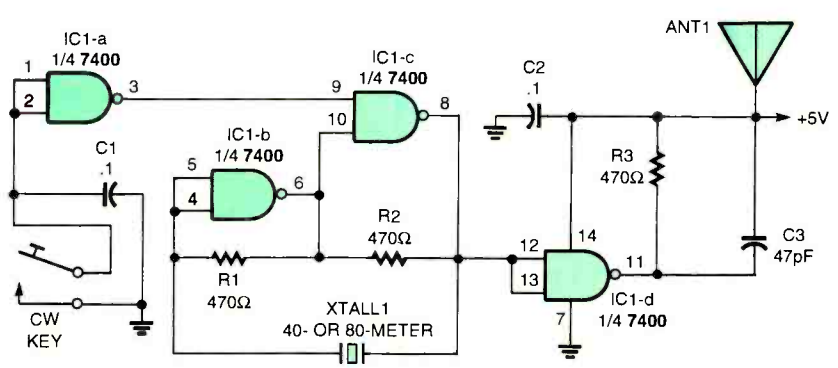


*Fig. 4. Using a simple crystal-controlled oscillator, this CPO transmits on the ham bands.*



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## PARTS LIST FOR THE CRYSTAL-CONTROLLED OSCILLATOR (Fig. 4)

IC1—7400 TTL quad NAND gate, integrated circuit
R1-R3—470-ohm, 1/4-watt, 5% resistor
C1, C2—0.1-µF, ceramic-disc capacitor
C3—47-pF, ceramic-disc capacitor
XTAL1—40- or 80-meter crystal
ANT1—Short clip lead antenna
CW key, power source, wire, solder, etc.

crystal-controlled oscillator. A single 7400 TTL (IC1) does it all. When the CW key is closed, IC1-a's output goes high allowing IC1-b and IC1-c to oscillate. The crystal supplies the feedback path setting the oscillator's operating frequency. The circuit will operate on the 40- and 80-meter bands.

Section IC1-d isolates the oscillator from the short antenna, ANT1. A clip lead should do here to get the signal out and about for operation.

Using this circuit couldn't be easier. Tune your ham-band receiver to the crystal's frequency and key down. If the receiver doesn't have a CW mode, turn on the BFO and tune for the desired CW tone.

## IR TRANSMITTER

Our last code-practice oscillator operates on IR; Fig. 5 shows the transmitter circuit. A 555 timer, IC1, is connected in an audio-oscillator circuit with its frequency set by potentiometer R6.

Transistor Q1, with the CW key up, is biased on, thereby holding pin 5 of IC1 low, and keeping it turned off. The 555 timer's output, at pin 3, ties to the gate of a power hexFET, Q2, which drives the three IR emitters, LED1-LED3.

Placing the CW key in the down position turns the 555 oscillator on. That sends out the audio tone signal via IR.

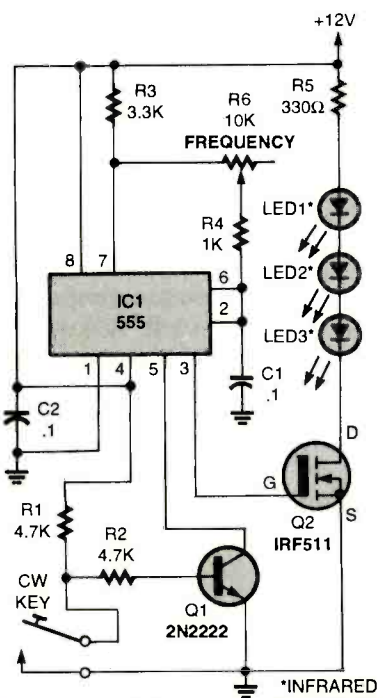


*Fig. 5. Here's a CPO that transmits on IR using LED1-LED3.*

## PARTS LIST FOR THE IR TRANSMITTER (Fig. 5)

**SEMICONDUCTORS**
IC1—555 timer, integrated circuit
Q1—2N2222 NPN transistor
Q2—IRF511 hexFET
LED1-LED3—IR light-emitting diode

**RESISTORS**
(All fixed resistors are 1/4-watt, 5% units.)
R1, R2—4700-ohm
R3—3300-ohm
R4—1000-ohm
R5—330-ohm
R6—10,000-ohm potentiometer

**ADDITIONAL PARTS AND MATERIALS**
C1, C2—0.1-µF, ceramic-disc capacitor
CW key, power source, wire, solder, etc.

## IR RECEIVER

Take a look at the IR receiver circuit shown in Fig. 6. An IR phototransistor, Q1, is direct coupled to the input of op-amp IC1-a. The output of IC1-a is fed through the gain-control potentiometer (R9) to the input of op-amp IC1-b, which has a voltage gain of 10. Section IC1-b's output drives IC1-c, which has a voltage gain of 100. The output of IC1-c supplies audio to the headphones, via J1.

The IR LEDs from the last circuit and the IR phototransistor in this one may be mounted in reflectors to increase the CPO's operating range. Layout of either IR circuit isn't critical, so just about any assembly scheme should work.

Keep in mind that a CPO in the hands of a child can produce the spark that ignites a high-tech career and the chance for a better life. So until next month, good circuitry. ■

## PARTS LIST FOR THE IR RECEIVER (Fig. 6)

**RESISTORS**
(All fixed resistors are 1/4-watt, 5% units.)
R1-R3—10,000-ohm
R4, R5—100,000-ohm
R6—2200-ohm
R7—220,000-ohm
R8—470-ohm

**CAPACITORS**
C1—0.22-µF, Mylar
C2—0.1-µF, ceramic-disc
C3, C4—47-µF, 25-WVDC, electrolytic
C5—4.7-µF, 25-WVDC, electrolytic

**ADDITIONAL PARTS AND MATERIALS**
IC1—LM324 quad op-amp, integrated circuit
Q1—IR NPN phototransistor (just about any IR unit will work)
J1—Phono jack
Reflector (see text), power source, wire, solder, etc.

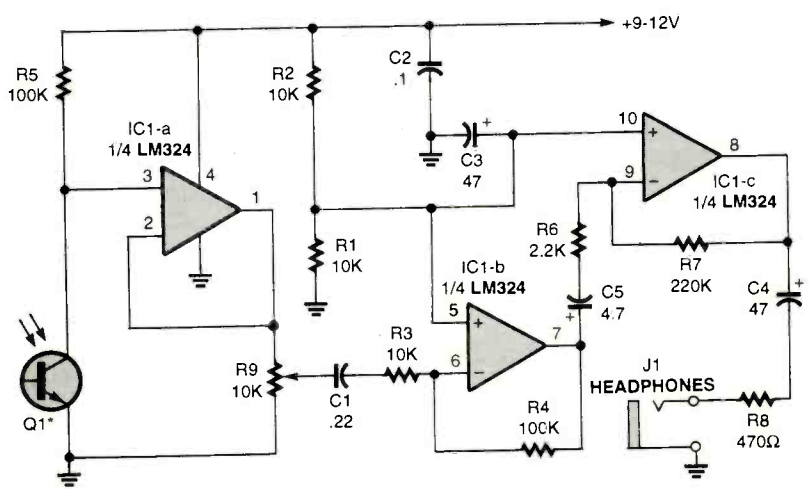


*Fig. 6. This IR receiver works with the transmitter in Fig. 5.*



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# A New Chip for RF Builders

BY JOSEPH J. CARR

For quite a long time RF circuit builders have known that Mini-Circuits (P.O. Box 350166, Brooklyn, NY 11235; Tel. 718-934-4500) has made reasonably priced RF components that work well. Perhaps the two most widely used Mini-Circuits components, at least in our circles, are the MAR-x series of monolithic microwave integrated circuits (MMIC), and the SBx/SRx series of doubly balanced mixers (DBM).

The SBx/SRx series mixers are widely available in unit quantities from dealers such as Ocean State Electronics (P.O. Box 1458, Westerly, RI 02891; Tel. 401-596-3080). One of the nice things about a DBM (as opposed to other forms of mixer) is that the DBM suppresses the local oscillator (LO) and RF signals in the output, so only the sum (LO + RF) and difference (LO - RF) signals exist (or other mixer products of higher order).

The other product is the line of MAR-x amplifiers. These MMIC devices provide gains from +8 to +20 dB, at power levels from 100 to 500 mW. Some of the MAR-x (the "x" is the specific type number for a particular member of the series) offer low noise figures (2.8 dB), while others offer higher power. Some operate from near-DC to 1,000 MHz, and others from near-DC to 2,000 MHz.

These amplifiers have a relatively constant input and output impedance over the entire frequency range. If impedance matching is necessary, use simple transformers to do the job rather than L-C matching networks. The standard input and output impedances are 50 ohms; impedance matching is not needed in most cases (50 ohms is the "standard" system impedance for RF circuits, except video where 75 ohms is used).

## THE ERA AMPLIFIERS

Mini-Circuits has continued the tradition of constant-impedance MMIC chips with the new ERA-x series devices. While the concept is similar to the MAR-x series, the specifications are quite exciting. The application circuitry is just as simple as that of the MAR-x (indeed, it looks the same!).

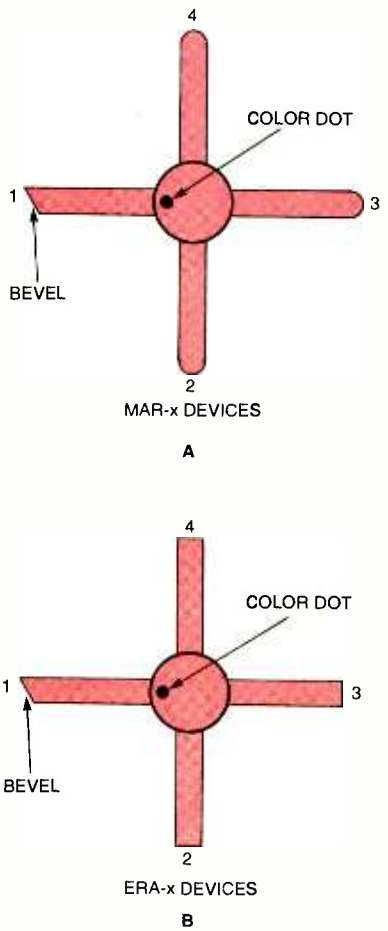


*Fig. 1. Here are the packages of the MAR-x (A) and ERA-x (B) compared.*

The ERA-x devices are Gallium-Arsenide (GaAs) technology, which accounts for their frequency range. Some of the devices operate over the range near-DC to 3,000 MHz, while others operate from near-DC to either 4,000, 6,000, or 8,000 MHz. The "near-DC" can be "DC," except for the fact that the input and output terminals are coupled to the external circuitry through capacitors. The low-end frequency limit is determined by these capacitors.

**TABLE 1**

| Type No. | Frequency Range (MHz) | Gain (dB) |
|---|---|---|
| ERA-1 | 8,000 | 11.6 |
| ERA-2 | 6,000 | 14.9 |
| ERA-3 | 3,000 | 20.2 |
| ERA-4 | 4,000 | 13.9 |
| ERA-5 | 4,000 | 19.0 |

**TABLE 2**

| Type No. | -1 dBComp (dBm) | NF (dB) | IP3 (dBm) |
|---|---|---|---|
| ERA-1 | 13 | 7 | +26 |
| ERA-2 | 14 | 6 | +27 |
| ERA-3 | 11 | 4.5 | +23 |
| ERA-4 | 19.1 | 5.2 | +36 |
| ERA-5 | 19.6 | 4 | +36 |

Table 1 shows the gain and operating frequencies for these devices. In each case, the type number shown is for the standard package. For surface-mount packaging add "SM" to the type number (*e.g.* ERA-1 is the standard drop-in packaging, while ERA-1SM is the same amplifier in surface mount packaging). Note that there are some minor gain differences between ERA-x and ERA-xSM in some cases.

Table 2 shows some of the other important parameters of the ERA series GaAs MMIC amplifiers. The noise figure gives us a measure of the amount of noise that is added to the system by the amplifier (nothing is noise-free). The lower the number the better the noise contribution. The noise figures shown in Table 2 are quite good, although for under 1,000 MHz, the 2.8-dB noise figure of the MAR-6 device by the same company is a better selection.

The power output is measured in dBm at the -1-dB compression point. A "dBm" is power decibels relative to 1 mW, or 10 LOG (PMW/1 MW).

The -1 dB compression point tells us something of the dynamic range of the device, as well as the maximum power available. It is measured in dBm also. The -1 dB compression point is the input level at which the gain drops off -1 dB from the nominal gain. If you graph power output *vs.* power input, the line is a straight line for whatever gain is achieved, up to the point where the amplifier begins to saturate. When that point is reached, the gain begins to drop a little. When the gain PO/Pin has



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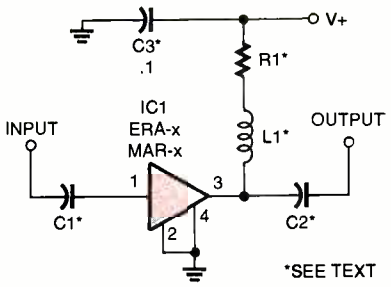


*Fig. 2. This operating circuit can be used with MAR-x and ERA-x amplifiers. See text for component values.*

dropped -1 dB from the linear region, we have the Pin value that is the -1 dB compression for that amplifier.

The other dynamic range measure is the third-order intercept point, also called TOIP or the IP3 point. If you graph PO *vs.* Pin, then you will note that the gain for harmonics generated in the amplifier increases more rapidly than the gain for the regular signal. At some point, usually above the -1-dB compression point, the gain for regular signals and the gain for harmonics generated will cross. The input signal power level (dBm) at which this occurs is the IP3 rating.

In larger quantities (*e.g.* ten each) the prices of these amplifiers are as low as $1.80 and as high as $4.15, depending on type number. Dealers will charge considerably more, but that is the price of buying small quantities. Mini-Circuits will accept credit-card orders, but may have a minimum order.

Mini-Circuits has several kits available for those who would like to experiment with all of the ERA-x devices. These kits include the K1-ERA for $49.95 (ten each of ERA-1, -2, and -3) and the K2-ERA for $69.95 (ten each of ERA-4 and -5). The surface-mount-version prices are the same; those kit numbers are K1-ERASM and K2-ERASM.

Figure 1 shows the package of the more familiar MAR-x devices, along with that of the ERA-x devices. The body of the MMIC devices is about the same size, but the leads on the ERA-x devices are shorter than the MAR-x series. Both of them have four leads: input, output, and two grounds (the use of two grounds is necessary at these frequencies. Pin no. 1 (input) is identified on both MAR-x and ERA-x by a dot and the fact that the end of the lead is beveled. In the case of the MAR-x devices the type number is indicated by the color of the color dot, but on ERA-x devices all of the dots are red.

**TABLE 3**

| FMIN (MHz) | C1,C2 |
|---|---|
| 1 | 0.1 μF |
| 10 | 0.01 μF |
| 100 | 1000 pF (0.001 μF) |
| 500 | 100 pF |
| 1,000 | 10 pF |

## TYPICAL CIRCUIT

The standard circuit for the ERA-x devices is similar to that of the MAR-x, and is shown in Fig. 2. There are two grounds (neither optional, both are required). The input and output terminals are blocked for DC by capacitors C1 and C2. The values of C1 and C2 determine the minimum operating frequency. Values to 0.1 μF are used for low-frequency work, but if higher bands are being contemplated, then use the recommended values in Table 3.

These values are not absolute. Experiment with other values, if you please, but don't stray too far from these values (*e.g.* more than a 2:1 ratio).

The ERA-x devices want to see +5-volts DC applied through a resistor and an optional RF choke between pin 3 and ground. The devices draw 80 mA (0.080 A). From these bits of information you can calculate the value of resistance for R1. For example, if you use a 78L08 regulator, it produces a regulated +8-volt DC output. R1 is:

R1 = ((V+) - V)/I = (8-5)/0.080 = 3/0.080 = 37.5 ohms

For practical reasons select a standard-value of 39 ohms for R1.

The RF choke is optional, and is used more as a peaking coil to smooth out gain variations as frequency increases. Typical values to try for starters are 100 μH from 1 to 10 MHz, 10 μH from 10 to 30 or so MHz, 1 μH to 100 MHz, and values between 0.01 and 1 μH above 100 MHz. For high VHF, UHF up to the top end of the response range, the "RF choke" is typically a ferrite bead slipped over a piece of 22-gauge solid hook-up wire.

The ERA-x and MAR-x series of chips makes designing wideband RF amplifiers a "game for all," even well into the microwaves.

I can be reached by snail mail at P.O. Box 1099, Falls Church, VA, 22041, or by e-mail at carrjj@aol.com. ■

## SCANNER SCENE

*(continued from page 27)*

### A.T.F.

Of all the vital federal agencies that always seem to be in the news, few have missions that equal the edge-of-the-seat, white-knuckle excitement of the U.S. Treasury's Bureau of Alcohol, Tobacco, and Firearms.

Based upon our compilation of information submitted by a number of readers, we have assembled a tentative listing of frequencies reported or presumed to be used by the ATF. You may have others, or see errors here. Your corrections are invited.

Bases and repeaters are found on 165.2875, 165.925, 166.5375, and 166.925 MHz. Local offices use 165.35 MHz. Car-to-car conversations can be heard on 165.9125, 166.85, 168.00, and 173.8875 MHz.

For surveillance, try 165.2875, 165.5125, 166.2875, 170.4125 MHz. The Organized Crime Task Force uses 164.55 and 168.8625 MHz. Treasury Common uses 165.4875, 166.4375, 166.4625, 414.80, and 414.90 MHz.

### TOO MUCH?

Alex Pressman, of Dallas, Texas, has a problem that is not at all uncommon. He wanted to increase the coverage of his scanner as much as possible to help with weak signals. So he added an in-line signal preamplifier that could boost incoming signals by as much as 20 dB. A good idea. But now Alex complains that his scanner keeps detecting and locking up on all sorts of "images and especially digital paging signals."

Whoa, Alex! Most scanner preamps have a variable gain control, and it sounds like you are running yours at full blast. You are obviously overloading the front end of your scanner with so many powerful local signals that it's having indigestion. Back down on that preamplifier's gain control and you'll see those unwanted images vanish, leaving just the stations you wanted to monitor in the first place.

Scanner owners in large metropolitan areas are more prone to that type of signal overload than folks who use scanners out in the boonies where local transmitters aren't quite so plentiful. Radiopaging transmitters operating in the 152-MHz band appear to be a prime culprit when it comes to interference complaints along these lines. ■



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## ELECTRIC-VEHICLE BATTERIES

*(Continued from page 41)*

electric rates are offered by utility companies.

**Inductive Charging.** General Motors is using its Delco Magne Inductive Charger System, which transfers electricity using a magnetic field rather than metal-to-metal contact. The user inserts a lightweight, weatherproof plastic paddle, called an inductive coupler, into the vehicle's charge port. The coupler consists of copper secondary windings around a ferrite core encased in thick, nonconductive plastic. The Charge port is a "take apart" transformer consisting of the ferite transformer core and the copper primary winding. After being transferred inductively at high frequencies (80–350 kHz) between the charger and charger port, the system rectifies the incoming AC power to DC power for battery recharging. High frequencies plus high voltages up to 260 volts means small physical size of components and cables for power levels from 1.5 to 25 kW.

Like conductive systems, the inductive system could be installed just about anywhere there is source of electrical energy, including homes and offices. The microcomputer-controlled Magne Charge has the flexibility to interface with virtually any battery technology or configuration, and to any EV equipped with the Magne Charge charge port.

A bi-directional communications link uses close-coupled radio frequencies (915 MHz) for system monitoring, control, and built-in diagnostics. The link can be used for other functions such as communicating with the utility company for remote monitoring, automatic billing, control of load management, and reporting power-usage patterns.

According to GM, inductive coupling is safer because there is no direct metal-to-metal contact. This eliminates the possibility of electrical shock even under very wet conditions. Also, it stays cool during charging, does not need a heavy and bulky cable, and is easier to complete the connection. The system is designed so that the inductive coupler cannot induce circulating currents in nearby objects, like jewelry, heating them to produce skin burns.

Finally, in some communities, zoning and building codes may have to be modified to allow charging facilities. New health, safety, fire, and rescue procedures and educational programs will have to be developed. Parking spaces will have to dedicated for EV recharging in public and private parking lots. Also, trained technicians and special tools will be needed to service electric vehicles and charging facilities.

But despite all the steps that have to still be taken, the EVs are out there. How long will it be before you say goodbye to gasoline too? ■


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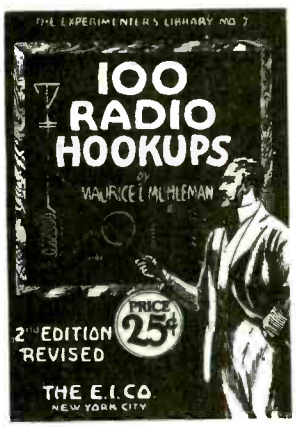


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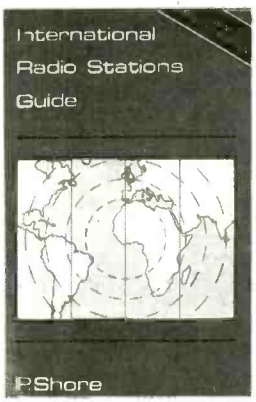


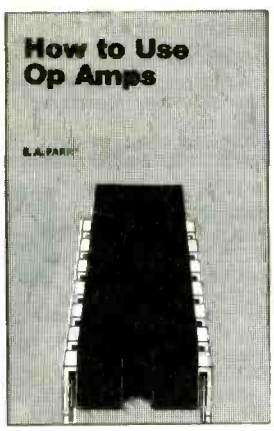


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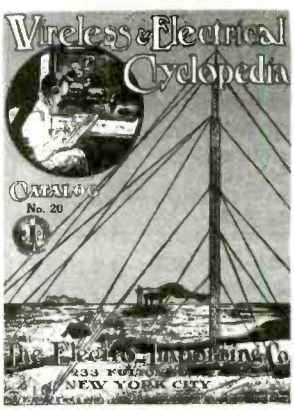


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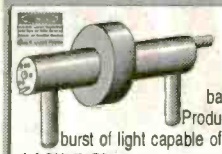

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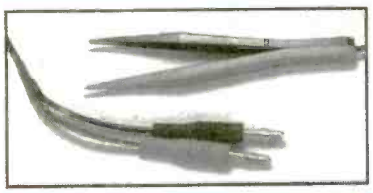

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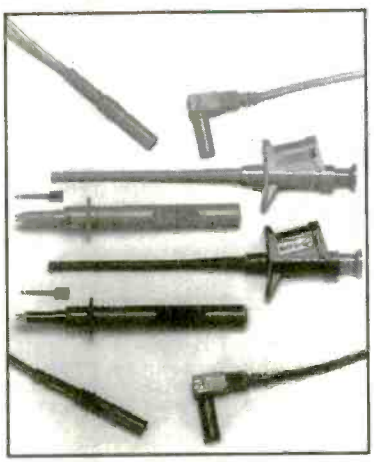

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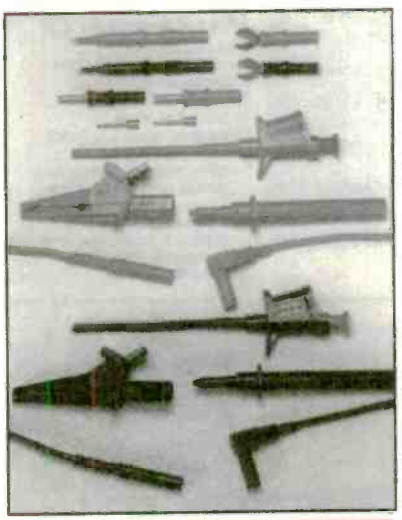

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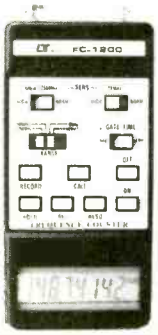

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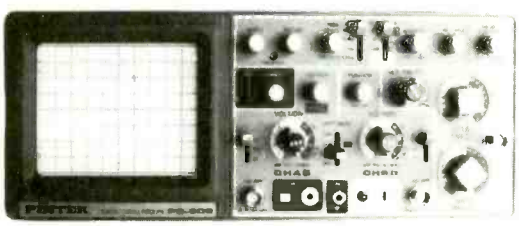

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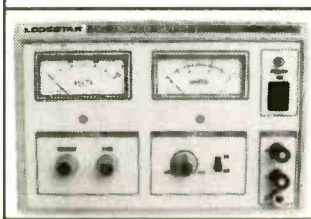

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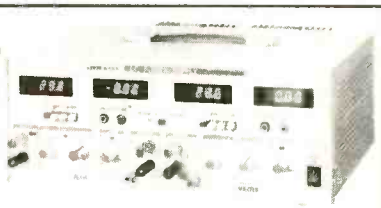

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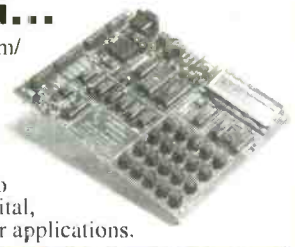

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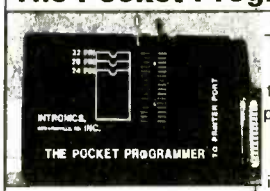


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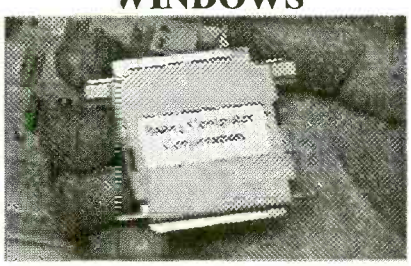

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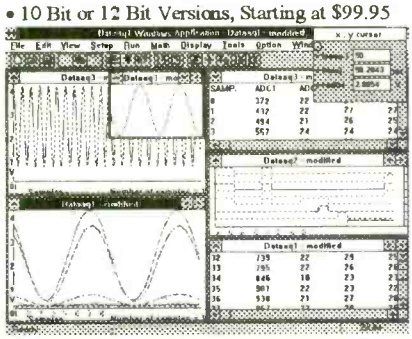

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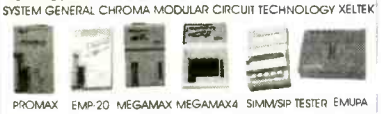

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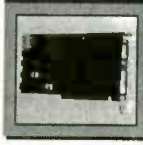

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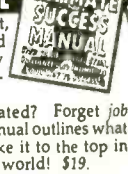

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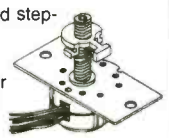

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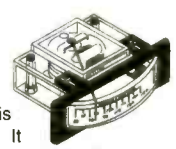

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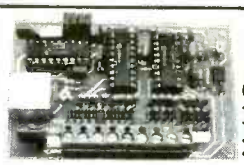

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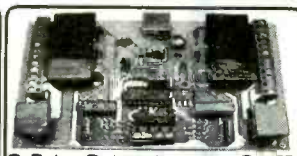

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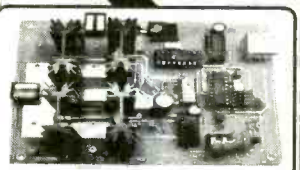

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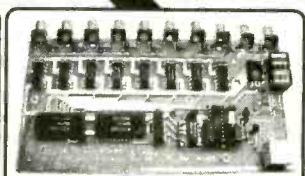

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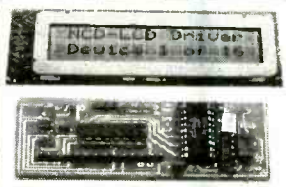

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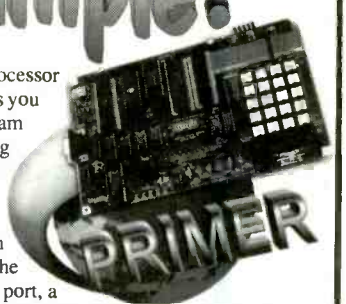


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# RAINBOW KITS

Many of our kits are available completely built!

## WIRELESS FM MICROPHONE

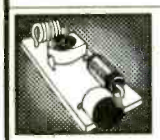
Small but mighty this little jewel will out perform most units many times its price. It really stomps out a signal. The WM-2 kit is a buffered wireless mike that operates from 80MHz to 120MHz FM, the frequency of any broadcast FM radio. Includes a mini-electret mike. 6 to 12v DC. SIZE: 1.25" x 1

WM2 KIT $14.95

## MICRO-MINIATURE PHONE TRANSMITTER

We haven't seen a smaller phone transmitter than the MMPT2 kit. Powered by the phone, it requires no battery. Transmits both sides of a phone conversation to an FM radio up to a 1/4 mile away.Tunable from 88 to 108MHz FM. Attach it to one phone or add it to the line to pick up all incoming calls. The MMPT2 is undetectable if properly installed. Unit has surface mounted parts, you install the leaded parts. Size .45 "x .6"

MMPT2 KIT $29.95



## MICRO-MINIATURE WIRELESS MIKE

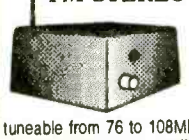
So small you could hide this one on some real bugs! It's the smallest we've ever seen. With it's super sensitive mike it transmits a whisper or a room of conversation to an FM radio, tunable from 88 to 108MHz FM. With a proper antenna it transmits about 1/2 mile. The kit is made with surface mounted parts, we have already mounted these parts. You install the leaded parts. Power requirement 6 to 12v DC. Size .35"x.9"

MMWM5 KIT $34.95

## STROBE LIGHT

Do you need an attention getter, warning light,or flashing light for model airplanes? Then this kit is for you. Use it as an emergency light for your auto, radio tower, even use it on your bicycle. Has a variable flash rate. Power requirement 6 or 12v DC .
Size 3.5"x1.9"

ST-1 KIT $11.95



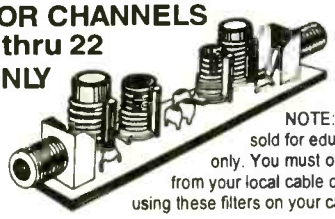
## FM STEREO TRANSMITTER

Own your own FM radio station. Any stereo signal you plug into the FMST-100 will be transmitted to any FM radio tuneable from 76 to 108MHz FM. Transmit a wireless link through an auditorium, from your car to your camper, listen to your CD's while mowing the lawn, Play music on one channel sing on the other. Clarity is excellent, aprox. 40dB stereo separation. Length of antenna determines the distance of transmission. Complete with stereo input level controls & crystal for stereo separation. 9v battery operation. SIZE: 1.5" x 2.5" x 3"

FMST-100 Cabinet $8.95 KIT $29.95

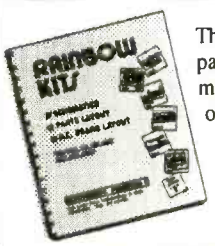
## TV NOTCH FILTERS FOR CHANNELS 2 thru 22 ONLY

Our TV filters eliminate unwanted TV channels or interference that alters both sound and video with a beep beep beep. Works on cable channels (2 thru 22) only.



NOTE: All TV Filter Kits are sold for educational purposes only. You must obtain permission from your local cable company before using these filters on your cable system.

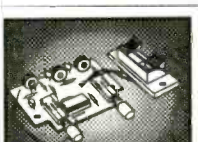
DF-222 KIT $14.95



This Manual contains schematics, parts lists & P.C. board layouts for many of the Rainbow Kits. Use your own parts to construct our kits.

**KIT BOOK $14.95**

$9.95 with the purchase of any kit.



## INDUCTANCE METER

This is the kit everyone has been asking for. Turn your digital volt ohm meter into an inductance meter. It will read inductors 3uH to 7MH. Power requirement 9v DC. SIZE: 1.75" x 2.5"

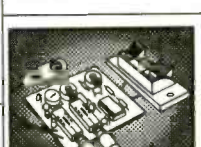
IA-1 KIT $14.95

IA-1 CABINET $8.95

## DIGITAL THERMOMETER

The DT-3 kit will turn your digital volt ohm meter into an accurate digital thermometer with .1 degree resolution. Measure temperatures from -40° to 250F° The remote sensor is .25" sq. and can be mounted many feet from the meter.Power requirement 9V DC. SIZE: 2" x 1.35"

DT-3 KIT $8.95



## CAPACITANCE METER

This kit will turn your digital volt meter into a capacitance meter. Turn that junk box of unmarked capacitors into a fortune of usable parts. Measure capacitors from <2.2pF to 2.2uF.Power requirement 9v DC. SIZE: 1.80" x 2"

CA-1 KIT $12.95

## TEMPERATURE GENIE

Ever lost frozen food because your freezer stopped? The TC-2 kit would have saved you money. An alarm activates when the temperature reaches a critical point. Turn ceiling fans on automatically when it gets too hot. This kit gives you 100mA of output. SIZE: 2" x 1.4" Power requirement 6 to 15V DC.

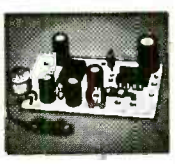
*If you want to switch more power see our Triac (TP-1) or Relay (RP-1)Power kit.*

TC-2 KIT $7.95

## PHONE TRANSMITTER

Small but mighty,it fits anywhere. Phone line powered, never needs batteries. Transmits both sides of a phone conversation loud and clear, wireless, to any FM radio at great distances. Variable tunes from 70MHz to 130MHz FM. You can also use it as a speaker phone. SIZE:1.25" x .6".

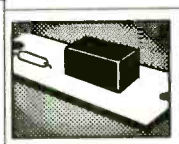
TEL-B1 KIT $12.95



## SUPER SNOOPER BIG EAR

Listen through walls, hear conversations across the room. Add a parabolic reflector and hear blocks away. The BIG EAR can be hidden about anywhere. Makes an ultra sensitive intercom. Can be used as a 1.5W AMP. We supply a mini-electret mike in the kit. Power requirement 6 to12v DC. SIZE:1.75"x 1"

AA-1 BUILT $29.95 KIT $10.95

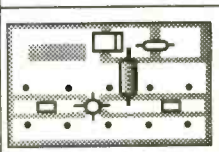


## RELAY POWER KIT

***Increase the output of any kit from 100mA to 3 Amps***

If you need to switch more power, up to 300 Watts, with the Light Genie, Temperature Genie, Timer or Vox kits, use the Relay Kit. We supply a two pole relay 1.5 Amps ea., tie both poles together and get 3 Amps. Size .75" x 2"

RP-1 KIT $9.95



## WIDE BAND PRE-AMP

Uses PCB and surface mount technology for better performance. Use for scanners, HT's, Frequency counters, Satellite Receivers. It amplifies low-level (weak) signals. If the signal is extremely low , two amplifiers can be used in a series.

- 1MHz to 2.5 GHz 2.8dB NF
- 1dB compression=OdBm
- Gain: 1MHz- 20dB to 2.5GHz-6dB
- Power requirement: 12v @ 6Ma

WBA-6 KIT $19.95

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### Home Automation

Connects between a TW523 and an RS-232 serial port. Use your PC/Mac to receive and transmit all X-10 commands. Create your own program to control your home automation system, turning on/off any device plugged into an electrical outlet with responce to time/date, other X-10 transmissions or any other computer input stimuli. **$38.50**

### Caller ID / RS-232

Connects between a telephone wall jack and an RS-232 serial port. Decodes the caller ID data sent over the phone line and sends it to your PC/Mac, in a pre-formatted ASCII character string. Create your own program to log the name, number, date, and time of all incoming calls. Block out unwanted callers to your BBS/modem. **$34.50**

### Telephone Call Restrictor

Connects to telephone wall jack. Disables all phones on the line if attempting to either: dial a number that has been stored in memory "Block" mode or, dial a number that has not been stored in memory "Allow" mode. Use touch-tone phone to enter telephone numbers into memory, and choose mode. Program from any phone on the line using your password. **$35.00**

### 50 MHz Frequency Counter

Reads frequency from 1Hz to 50MHz and displays up to 7 digits on a 16x1 character LCD display. Auto-range feature provides floating decimal point and automatic placement of suffix (Hz, KHz, or MHz). Microcontroller based provides for very small parts count, only 2" x 3" blg. **$48.50**

### Telephone Scrambler

Scrambles your voice before sending it over the telephone line. Prevent eavesdropping from an extension or tap. Connects between your telephone and wall jack. No modifications are required to your telephone. Full duplex operation. **$43.00**

### IR Remote Control Receiver

Learns and records the data patterns emitted by standard infrared remote controls used by TVs, VCRs, Stereos, etc. Lets you control all your electronic projects with your TV remote. Seven individual I/O pins can be assigned to any button on your remote, and can be configured for either "toggle" or "momentary" action. **$32.00**

### RS-232 Digital I/O

Give your home-brewed PC/Mac programs a link to the outside world! 12 I/O pins can be configured individually for input or output. Turn on/off relays, triacs, etc. Respond to button presses, switch changes, 4x4 matrix decoding with auto-debounce. Stack up to 16 units on the same serial port for a total of 192 I/O points. **$32.00**

### DTMF Decoder/Logger

Keep track of all numbers dialed or entered from any phone on your line. Connects to your telephone wall jack. Decodes all 16 touch-tones and displays them on an LCD display. Holds the last 240 digits in a non-volatile memory. Scroll through and view all telephone numbers dialed, credit card numbers entered, etc. **$54.50**

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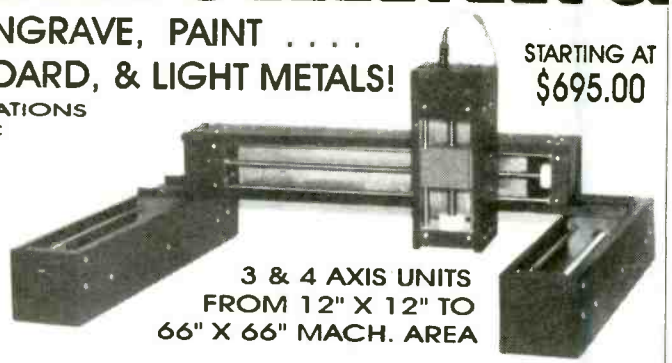

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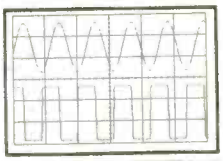

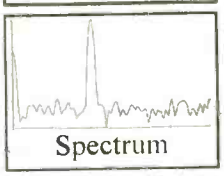


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**General**

*Display:* 3-1/2 Digit LCD, 21mm Figure Height with Automatic Polarity
*Overrange Indication:* 3 Least Significant Digits Blank
*Temperature for Guaranteed Accuracy:* 23°C±5°C RH<75%
*Temperature Ranges:*
Operating: 0°C to 40°C (32°F to 104°F)
Storage: -10°C to 50°C (14°F to 122°F)
*Power:* 9V Alkaline or Carbon-Zinc Battery(NEDA1604)
*Low Battery Indication:* BAT on Left of LCD Display
*Dimensions:* 188mm long x 87mm wide x 33mm thick
*Net Weight:* 400g

**DC Voltage (DCV)**

| Range: | Resolution: | Accuracy: |
|---|---|---|
| 200mV | 100µV | |
| 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.

**AC Voltage (ACV)**

| Range: | Resolution: | Accuracy: |
|---|---|---|
| 200V | 100mV | ±(1.2%rdg+10dgts) |
| 750V | 1V | |

*Frequency Range:* 45Hz-450Hz
*Maximum Allowable Input:* 750V rms
*Response:* Average Responding. Calibrated in rms of a Sine Wave.

**Resistance (Ω)**

| Range: | Resolution: | Accuracy: |
|---|---|---|
| 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.

**ohFE 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 SetDC~150MHz | 24.95 | 21.95 | 18.62 |

## 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 |

## 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 165mm/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 |
| PP1212 | 305mm x 305mm/12" x 12" *NEW!* | 12.78 | 10.65 | 8.52 |

***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 165mm/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 |
| GS1212 | 305mm x 305mm/12" x 12" *NEW!* | 18.88 | 15.73 | 12.59 |

***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 165mm/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 |
| GD1212 | 305mm x 305mm/12" x 12" *NEW!* | 22.09 | 18.35 | 14.68 |

## Developer

This product is used as the developer on our positive photo-resist printed circuit boards. Includes instructions. 50 gram package, mixes with water, makes 1 quart.

| 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!

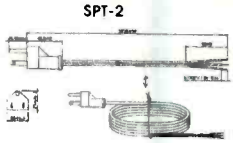
***REDUCES ETCHING TIME!***

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

## AC Power Cords

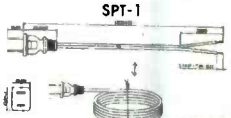
Our power supply cords are economical and practical for OEM and replacement applications. We stock 6' lengths, with the open end conveniently stripped and tinned (5mm).

SPT-2



| CAT NO | SIZE | TYPE | RATING @ 125V (A) | LENGTH (ft) | COLOR | TEMP |
|---|---|---|---|---|---|---|
| SPT-1BLACK | 18/2 | SPT-1 | 10 | 6 | Black | 60° |
| SPT-1GRAY | 18/2 | SPT-1 | 10 | 6 | Gray | 60° |
| SPT-2BLACK | 18/3 | SPT-2 | 10 | 6 | Black | 60° |

SPT-1



| CAT NO | PRICE EACH 1 | 10 | 100 | 500 |
|---|---|---|---|---|
| SPT-1BLACK | $ .88 | $ .57 | $ .51 | $ .46 |
| SPT-1GRAY | .92 | .61 | .55 | .49 |
| SPT-2BLACK | 1.97 | 1.21 | 1.07 | .97 |

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## Digital Panel Meters (LCD & LED)

Don't let the prices fool you. These digital panel meters are not surplus, so even if you design them into an ongoing manufactured product, you can be assured of continued availability. These high quality digital panel meters are decimal point selectable with guaranteed zero reading at zero volts input.

**Applications Include:**

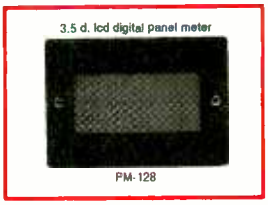
- Voltmeter
- Thermometer
- pH Meter
- dB Meter
- Watt Meter
- Current Meter
- Capacitance Meter
- LUX Meter
- LCR Meter
- Other Industrial & Domestic Uses

**PM-128: 3-1/2D LCD Digital Panel Meter**

**PM-129: 3-1/2D LED Digital Panel Meter**

**Features**

- 200mV Full Scale Input Sensitivity
- PM-128 - Single 9VDC Operation
- PM-129 - Single 9VDC Operation
- Decimal Point Selectable
- PM-128 - 13mm Figure Height
- Automatic Polarity Indication
- Guaranteed Zero Reading for 0 Volt Input
- High Input Impedance (>100Mohm)




**Specifications - PM-128/PM-129**

| | |
|---|---|
| Maximum Input | : 199.9mV DC |
| Maximum Display | : 1999 counts (3-1/2 Digits) w/Automatic Polarity Indication |
| Indication Method | : PM-128 - LCD Display<br>PM-129 - LED Display |
| Measuring Method | : Dual-Slope Integration A/D Converter System |
| Overrange Indication | : "1" Shown in the Display |
| Reading Rate Time | : 2-3 Readings per sec. |
| Input Impedance | : >100 Mohm |
| Accuracy | : +-0.5% (23+-5°C, <80% RH) |
| Power Dissipation | : PM-128 - 1mA DC<br>PM-129 - 60mA DC |
| Decimal Point | : Selectable w/Wire Jumper |
| Supply Voltage | : PM-128 - 9V DC<br>PM-129 - 9V DC |
| Size | : 67mm x 44mm |

## 3-1/2 Digit LCD 3-1/2 Digit LED 4-1/2 Digit LCD

**PM-328: 4-1/2D LCD Digital Panel Meter**

**Features**

- 200.00mV Full Scale Input Sensitivity
- Single 9V DC Operation
- Decimal Point Selectable
- 11mm LCD Figure Height
- Automatic Polarity Indication
- Low Battery Detection and Indication
- High Input Impedance (>100 Mohm)

**Specifications - PM-328**

| | |
|---|---|
| Maximum Input | : 199.99mV DC |
| Maximum Display | : 19999 counts (4-1/2 Digits) w/Automatic Polarity Indication |
| Indication Method | : LCD Display |
| Overrange Indication | : "1" Shown in the Display |
| Input Impedance | : >100 Mohm |
| Accuracy | : +-0.05% (23+-5°C, <80% RH) |
| Power Dissipation | : 1mA DC |
| Decimal Point | : Selectable w/Wire Jumper |
| Supply Voltage | : 9V DC |
| Size | : 67mm x 44mm |

**AS LOW AS $5.25 ea.**

| CAT NO | DESCRIPTION | PRICE EACH 1 | 10 | 25 | 100 | 250 |
|---|---|---|---|---|---|---|
| PM-128 | 3-1/2 Digit LCD Panel Meter | $ 9.90 | $ 7.09 | $ 6.40 | $ 5.86 | $ 5.25 |
| PM-129 | 3-1/2 Digit LED Panel Meter | 11.49 | 9.54 | 8.67 | 7.95 | 6.95 |
| PM-328 | 4-1/2 Digit LCD Panel Meter | 19.88 | 16.40 | 14.90 | 13.66 | 11.93 |

## 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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| 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

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| CAT NO | DESCRIPTION | PRICE EACH 1 | 5 |
|---|---|---|---|
| CA-H34A | PCB Mounted IRCCD Camera | $99.00 | $85.00 |
| A34 | Power Supply Regulating Kit | $6.95 | ----- |

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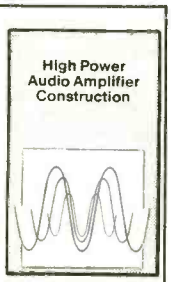


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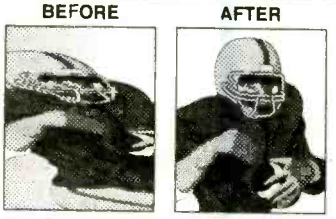


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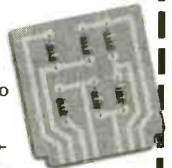

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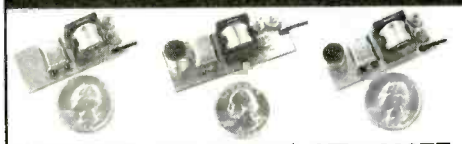

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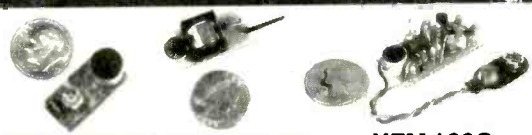

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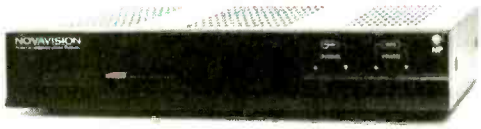

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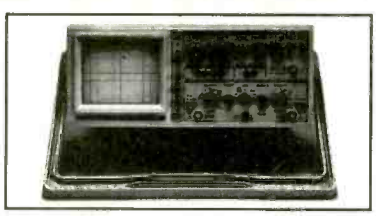

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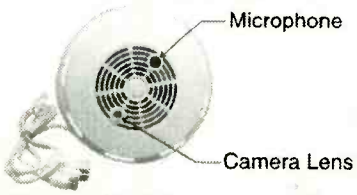

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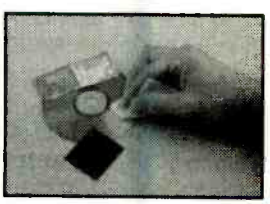

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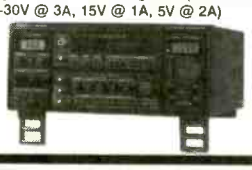

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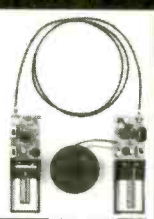

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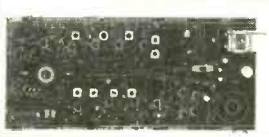

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- Delayed Sweep

**S-1325 $325**
- 25MHz Analog

**2 Year Warranty**

**OSCILLOSCOPE SELECTION CHART**

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 |
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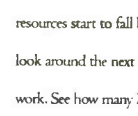
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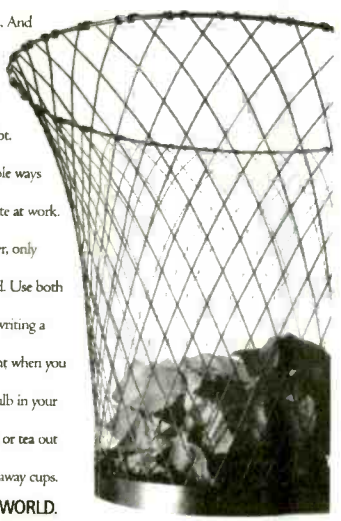

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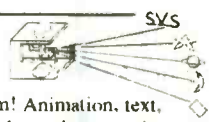


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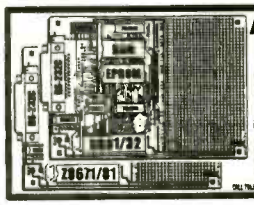

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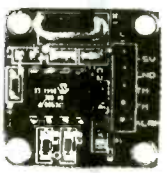

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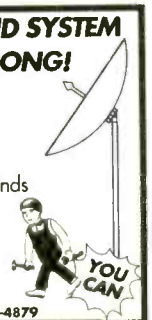


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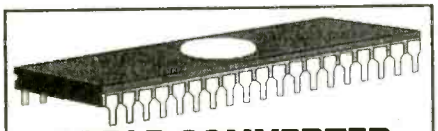

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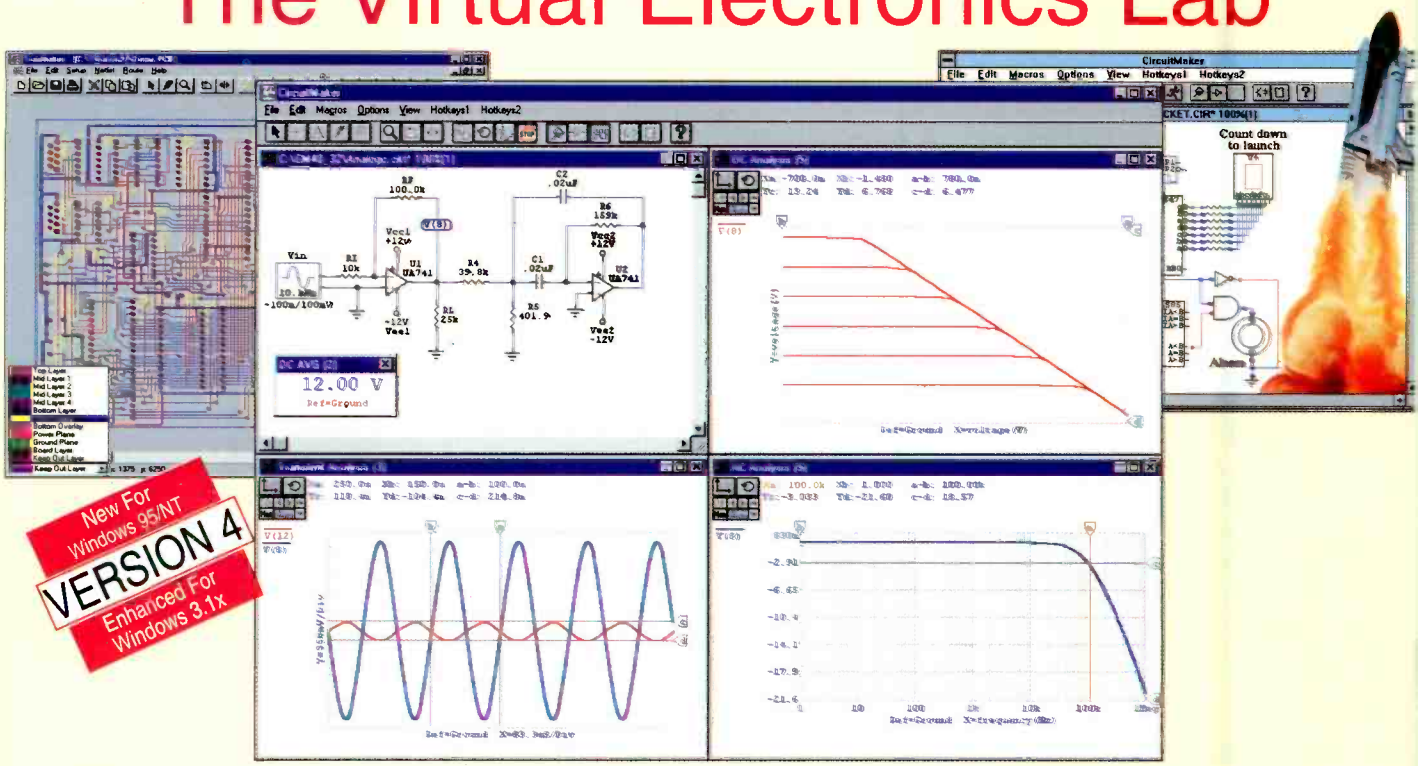


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