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JUNE 1998

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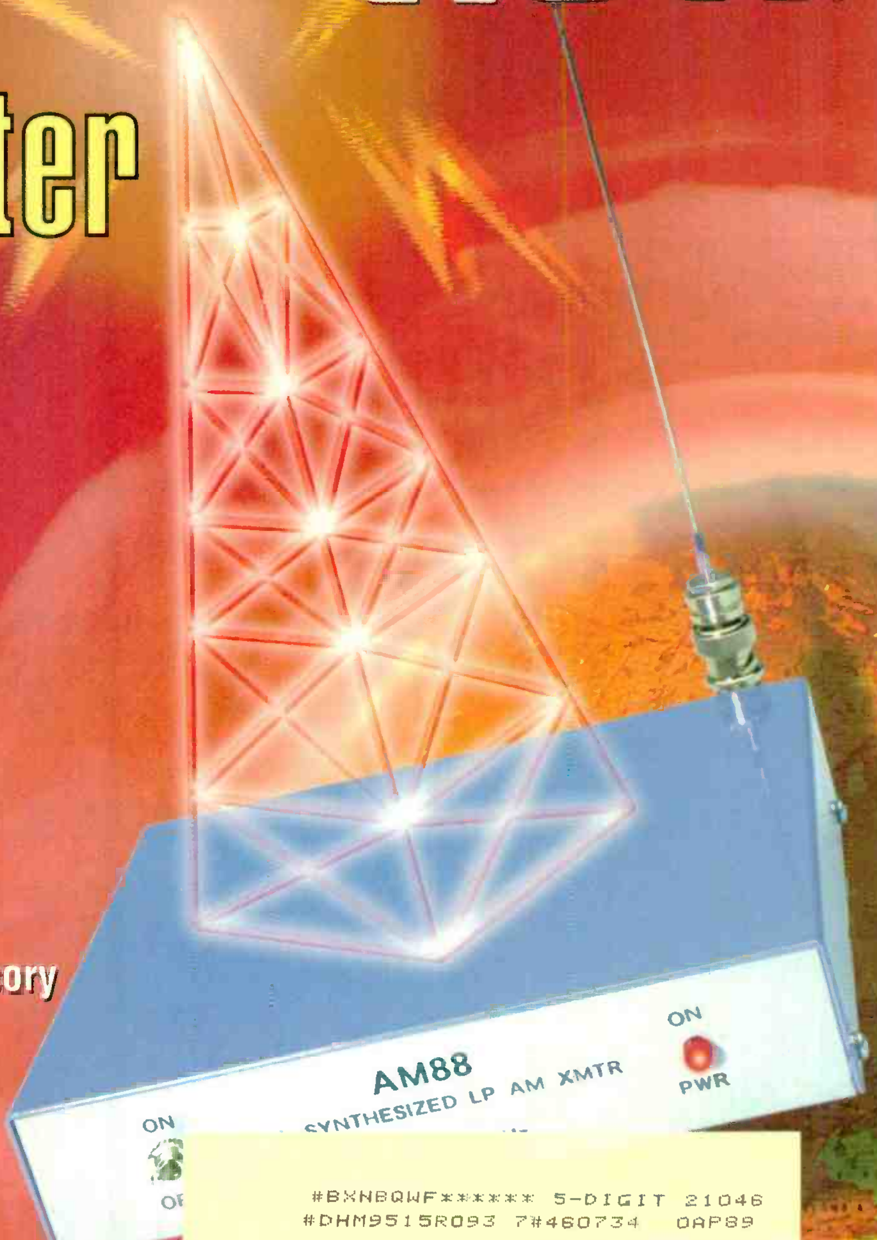


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JUNE 1998

## ON THE COVER




## TECHNOLOGY





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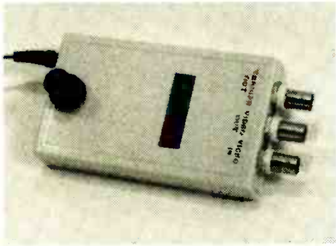
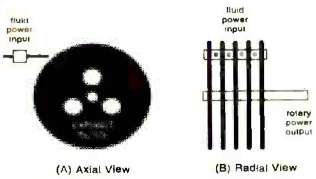
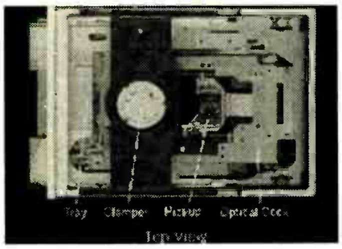


## DEPARTMENTS









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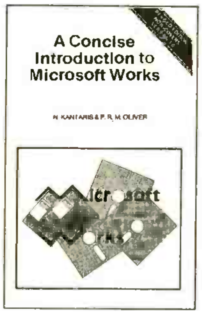


**BP349–Practical Opto-Electronic Projects $8.99.** If you shun opto-electronic projects for lack of knowledge, this is the book for you. A bit of introductory theory comes first and then a number of practical projects which utilize a range of opto devices, from a filament bulb to modern infrared sensors and emitters.

**BP350–Electronic Board Games $8.99.** Twenty novel electronic board games that you can build from the plans in this book. Whether you are interested in motor racing, searching for buried treasure on a barren island or for gold in Fort Knox, spinning the wheel of fortune, or doing a musical quiz—there is something for you to build and enjoy!

**BP378-45–Simple Electronic Terminal Block Projects $8.99.** Contains 45 easy-to-build electronic projects trhat can be built by an absolute beginner. Projects are assembled on terminal blocks using only a screwdriver and other simple hand tools. No soldering is required.

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**BP428–MS-Word 97 Explained $12.75.** Without any previous knowledge of MS-Word, you can be up and running this evening using this basic text as a guide! Nothing is assumed! The hardware specification you need to run the package, and how to install it onto your system, are covered. You discover how to enter, edit and enhance text and how to become comfortable working with document pate layouts, paragraph styles, document templates, textboxes and frames.

**BP367–Electronic Projects for the Garden $8.99.** Electronics enters the Garden! New exciting book points out how gardeners can build simple gadgets to promote success where the elements work against you. Some of the projects are: over/under temperature monitoring, dusk/dawn switching, automatic plant watering, warming cables, etc.

**BP368–Practical Electronics Musical Effect Units $8.99.** There is a constant hullabaloo for musical effects projects by the hobbyist community. This book provides practical circuits for several projects that range in complexity and are sure to work. All the circuits are easy to build and use readily-available parts.

**BP429–MS-Excel 97 Explained $8.99.** 3D Excel 97 spreadsheet is here! Get a quick start with this exciting program in the shortest and most effective way. The book was written with both the newcomer to spreadsheets and the existing spreadsheet user in mind. After a brief period of reading the beginner will be able to build up simple spreadsheet examples, edit entries, format cells and ranges, and save and open worksheets. From there, you can generate and use 3-dimensional worksheets and to link them together.

**BP385–Easy PC Interfacing $8.99.** The built-in ports in your PC provide an easy and hassle-free way of interfacing your circuits. This book provides useful PC add-on circuits including the following: Digital input/output ports; analog-to-digital and digital-to-analog converters; voltage and current measurement circuits; resistance and capacitance meters, temperature measurement interface, biofeedback monitor, and many other useful interfaces.

**BP393–Practical Concise Introduction to UNIX $8.99.** If you are using or intend to use the UNIX multi-user operating system and want to get the most out of your computer system in terms of efficiency and productivity, then you must learn its operating system. The book explains how the UNIX operating system is structured so that you understand what happens when you first approach your computer.

**BP396–Electronic Hobbyists Data Book $10.99.** This book provides a wide range of data. If, for example, you require details of a modern five-band resistor code or an old color code for a ceramic capacitor, the formula for parallel resistance, or basic data on an NE5534AN operational amplifier, it is contained within these pages. The subjects covered are numerous and widespread to cover all hobbyist interests.

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**BP282–Understanding PC Specifications $8.95.** This book explains PC specifications in detail, and the subjects covered include the following: Differences between types of PC (XT, AT, 80386, 80486, Pentium etc.); math co-processors; input devices (keyboards, mice, and digitizers); memory, including both expanded (EMS) and extended RAM; RAM disks and disk caches; floppy disk drive formats and compatibility; hard disk drives; and display adapters (CGA, Hercules, super VGA, etc.).

**BP298–Concise Intro to the Macintosh System and Finder $7.50.** Although the Mac's WIMP user interface is designed to be easy to use, much of it only becomes clear when it is explained in simple terms. The book explains: The System and Finder, what they are and what they do; how to use the System and Finder to manipulate disks, files and folders; configuring and printing files from the Finder; getting the most from the system utility programs; and running MultiFinder.

**BP88–How To Use OP Amps $7.50.** The Operational Amplifier is the most adaptable circuit module available to the circuit designer. It is possible to purchase a low-cost integrated circuit with several hundred components, very-high gain and predictable performance. This book has been written as a designer's guide for most Operational Amplifiers, serving both as a source book of circuits and a reference book for design calculations.

**BP316–Practical Electric Design Data $10.95.** A builder's bargain book–a comprehensive ready-reference manual for electronic enthusiasts with over 150 practical circuits. It covers the main kinds of components (from pig-tail leads to surface mount), pinouts, specs and type selection. Basic units are defined and most used formulae explained. Five additional sections are devoted to circuit design, covering analog, digital, display, radio and power supply circuits.

**BP346–Programming in Visual Basic for Windows $10.99.** This book is a guide to programming. The reader is not expected to have any familiarity with the language as both the environment and statements are introduced and explained with the help of simple programs. The user is encouraged to build these, save them, and keep improving them as more complex language statements and commands are encountered.

**BP341–MS-DOS 6 Explained $12.25.** The book covers: How the DOS operating system of your computer is structured so that you can understand what happens when you first switch on your computer; How directories and subdirectories can be employed to structure your hard disk for maximum efficiency; how to use the DOS Shell program, and much, much more.

**BP345–Getting Started In Practical Electronics $8.99.** If you are looking into launching an exciting hobby activity, this text provides basic essentials for the builder and 30 easy-to-build fun projects with which every experimenter should toy. Printed-circuit designs are included to give your project the professional touch.

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# EDITORIAL

## THE OBJECT OF DISAFFECTION

Recently, we've received several letters, telephone calls, and e-mails regarding our microcontroller-based projects. Specifically, we've been asked why the source code is not always available. To explain, let's step back for a moment.

Source code is the program that the project developer created to make a project function and provides the underlying principles behind how a project works. By changing the source code you can add or delete features, change operating parameters, etc.

However, you can not program a microcontroller using the source code. Instead, you need to feed it to a compiler to create object code. It is the object code that you burn into the microcontroller. The problem is that object code can not be changed. There is no practical way to reverse compile it and get the source code.

While our policy is to insist that any software required to make a project operate as described be made available, which in the case of microcontrollers means the object code as a minimum, obviously it is much more desirable to have the source code available. That's especially true if you are an experimenter or you are interested in the basics of a project but need it to operate in a different manner for your intended application. Because of that, we strongly encourage our authors to provide the source code, and many do, but others choose not to.

Their reasons vary. In some cases, the projects are kit versions of commercial products and releasing the source code could render the product commercially worthless. If we were to insist that the source code be released, authors of these articles would not permit their projects to be published. Period.

In other cases, authors have taken the position that their project would only work correctly and safely with the software as provided. Releasing the source code would allow a builder to change how the project functions, possibly rendering it unsafe to other gear or the user. Those authors do not want to deal with the liability issues that could arise if that happens.

In life there are always decisions to be made. Often, the result of a decision will make some people happy, while displeasing others. That's the case here. However, if our choice is between publishing an interesting and worthwhile project with only the object code, or depriving all of our readers of that same project in any form, then there is really not much of a choice to be made.

Carl Laron

Carl Laron
Editor

# Q & A

READERS' QUESTIONS, EDITORS' ANSWERS

## Two Questions

**Q** *I am using an LM3914 to illuminate a small sign on a building on my model-train layout, but I can only get 8 of the 10 LEDs to light. Is there some secret to getting all 10 of the outputs to operate?*

*Also, I have a very old 12-volt battery charger with selenium rectifiers and, apparently, no regulation of any kind. Do you have a schematic of a more up-to-date 12-volt charger? I have on hand a 20-amp bridge rectifier, a transformer with a 20-volt secondary at 5 amps, and all the other parts that might be necessary. — B. P., Oakland, CA*

**A** Judging from our mail, the LM3914, LM3915, and LM3916 bargraph-display chips are very popular with our readers. They have, respectively, a linear, logarithmic, and VU-meter scale. You've chosen the right one for your purpose.

Since you didn't send a circuit, we presume you are controlling the LM3914 with some kind of input signal that doesn't rise high enough to turn all the LEDs on.

What you need to do is lower the voltage on pin 6 (REF HIGH). Figure 1 shows what to do—you can adjust the potentiometer until you get the results you want, then leave it in place or replace it with fixed resistors. Although we've drawn the LEDs as an array, you can equally well use separate LEDs. The total resistance of R1 (from pin 7 to ground) affects the LED brightness. For more information, see the LM3914 data sheet, available on the Web at www.nsc.com.

As for your other question, see "A Lead-Acid Battery Charger," by Ben Spencer, in *QST* Magazine, March 1994, pp. 25-27, for a sophisticated circuit with solid-state voltage and current regulation. Mr. Spencer used an 18-volt, 5-amp transformer; your 20-volt transformer should work fine in the same circuit. That isn't our magazine, so we can't supply reprints, but your public library probably has it, and if they don't, you can get a reprint for $5 from the ARRL, Newington, CT 06111. The article tells you where to get ready-made printed circuit boards for the project.

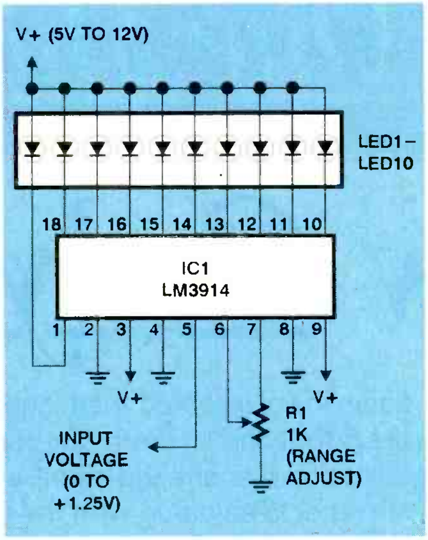


FIG. 1—THE LM3914 LED DRIVER IC can light up to 10 LEDs depending on the input voltage and the setting of R1.

## Modifying a Car EPROM

**Q** *I am interested in programming my own EPROMs for controlling the Electronic Command Module (computer) in my car (a 1989 Chevrolet Beretta). I have access to an EPROM programmers, but I need to know how to write the code for the chip. Is such a program available? — T. S., via e-mail*

**A** Most automobile engines today are controlled by microcomputers. That's why they run so smoothly under different conditions, even when cold or when given improper fuel.

As far as we know, automakers do not normally release details of the software inside their microcontrollers, so in general, nobody can tell you what to put in the EPROM if you want to modify it. A few people have reverse-engineered some EPROMs in order to market high-performance versions of them. If your car were a Nissan, we'd refer you to Jim Wolf Technology, 212 Millar Ave., El Cajon, CA 92020, Tel: 619-442-0680, Web: www.jimwolftechnology.com. As it is, we don't know what's available for your Chevy—you might write to an automotive magazine, or a reader may be able to help us.

If you *really* want to dig deep and invest a lot of your own time and guesswork into the project, look at the work of Italian consultant Marco Cortecchia, available on the Web at www.3wad.com/ew/. His "EPROM Wizard" software may be just what you need. He explains that automotive EPROMs usually consist of tables of numbers, and with a lot of experimentation, you can figure out what parameters of the engine these numbers control. EPROM Wizard displays these numbers as graphs on the screen so you can begin to understand their significance.

## A Wyse Decision?

**Q** *I have an old Wyse 2112 computer (PC AT clone). I also have newer machines, but I really like the Wyse keyboard, which has a flat RJ-11-type connector. Wyse makes an adapter cord so I can use other keyboards on the Wyse computer, but what I want to do is the reverse—use my Wyse keyboard on my new Pentium. What test equipment do I need and what procedure should I follow to figure out how to hook it up? — D. S., via e-mail*

**A** Does Wyse's flat connector match the one used on some IBM keyboards, by any chance? If so, all you have to do is swipe a cable from an IBM keyboard and your problem is solved.

Failing that, the next step would be to trace the connections in Wyse's keyboard adapter and make an adapter that does the exact opposite, so that if you connected the two adapters together, each input

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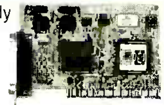
## JAMECO 75MHz Barebones Pentium® System

*Monitor, video card and hard drive not included*

- 16MB of RAM upgradeable to 128MB
- 256KB cache RAM, upgradeable to 512K
- Hard disk and floppy I/O controller card
- Four exposed bays (two 5.25", two 3.5"); one internal 3.5" bay • 3.5" floppy drive
- Includes keyboard, mouse and cables
- Four PCI slots and three ISA slots

| Part No. | Description | Price |
|---|---|---|
| 146499 | 75MHz Pentium® Sys. Special | $299.95 |

## DOLPHIN PCI I/O Cards

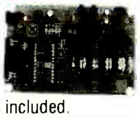


- PCI bus • PnP ready
- Software support for DOS, Windows® 95, NT 4.0
- One-year warranty

146675

| Part No. | Description | Price |
|---|---|---|
| 146675 | 1 parallel, 2 serial ports | $119.95 |
| 146659 | 1 serial port | 99.95 |
| 146667 | 2 serial ports | 109.95 |
| 146691 | 1 parallel port | 99.95 |
| 146683 | 2 parallel ports | 109.95 |

## PARALLAX Stamp Activity Board



The basic stamp activity board is a demonstration board for Parallax BASIC Stamp computers. Sample source code is included.

- 32Ω speaker outputs freq.: 500 to 8kHz
- Supports BS1-IC and BS2-IC
- PCB size: 4.0"L x 2.8"W • Weight: 0.7 lbs.
- One-year warranty

| Part No. | Description | Price |
|---|---|---|
| 149032 | BASIC stamp activity board | $79.95 |

## Jameco 110VAC Bi-directional Serial/Parallel Converter

- Serial interface: hardware handshake RTS/CTS, software handshake XON/XOFF; DCE/DTE selectable; parity: odd, even, or no parity; data bits: 7, 8
- Connectors: one DB25 female (serial) and one Centronics 36-pin male (parallel)
- Weight: 0.8 lbs. • One-year warranty

| Part No. | Description | 1-4 | 5-9 |
|---|---|---|---|
| 116935 | Bi-dir. non-buffered | $49.95 | $44.95 |

## Component Cabinet Kits

Kits include the most popular components with extra space for your customized expansion. Each kit includes a 20 drawer component cabinet.

*More kits available – call for details!*

| Part No. | Description | Price |
|---|---|---|
| 84953 | 330 pc. 7400 series IC kit | $129.95 |
| 84961 | 420 pc. 74LS series IC kit | 119.95 |
| 84970 | 300 pc. CD4000 series IC kit | 84.95 |
| 84988 | 385 pc. Linear series IC kit | 159.95 |
| 108329 | 540 pc. 1/8 watt Resistor kit | 29.95 |
| 81832 | 540 pc. 1/4 watt Resistor kit | 28.95 |
| 107879 | 540 pc. 1/2 watt Resistor kit | 32.95 |
| 108433 | 2200 pc. Electr. Hardware kit | 39.95 |
| 81867 | 110 pc. Radial Capacitor kit | 34.95 |
| 81859 | 320 pc. Ceramic Capacitor kit | 29.95 |
| 81883 | 160 pc. Mylar Capacitor kit | 34.95 |
| 81841 | 129 pc. Tantalum Capac. kit | 49.95 |
| 82587 | 270 pc. Diode kit | 39.95 |
| 82595 | 180 pc. Transistor kit | 49.95 |

## METEX® 3½-Digit Digital Multimeter

- 3½-digit LCD (.5" high digits)
- AC voltage: 200mV, 2V, 20V, 200V, 700V
- DC voltage: 200mV, 2V, 20V, 200V,1000V
- AC & DC current: 20μA, 200μA, 2mA, 20mA, 200mA, 2A, 20A
- Resistance: 200Ω, 2KΩ, 20KΩ, 200KΩ, 2MΩ, 20MΩ • Input impedance: 10MΩ
- Auto zeroing • One-year warranty

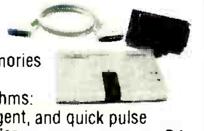
| Part No. | Product No. | 1-4 | 5-9 |
|---|---|---|---|
| 27115 | M3800 | $39.95 | $35.95 |

## DATAMAN Hand-held EPROM Programmer / Emulator

- 512Kbits of RAM
- Supports EPROMs, EEPROMs and Flash memories up to 8Mbits
- Self-powered and completely portable – ideal for field service work
- Maximum pins: 32

| Part No. | Description | Price |
|---|---|---|
| 124003 | EPROM programmer | $749.95 |

## 1 Socket 16KB-8MB E(E)PROM Programmer



- Programs EPROMs, EEPROMs, and Flash memories
- Programming speeds/algorithms: normal, intelligent, and quick pulse

| Part No. | Description | Price |
|---|---|---|
| 132468 | 16Kb-8Mb E(E)PROM prog. | $199.95 |

## Standard Adjustable Magnifying Lamp

- Maneuverable 30" arm extension • 4"dia. lens
- Uses 60W incandescent bulb (not included)
- 3X magnification • Weight: 2.9 lbs.
- Power requirement: 110VAC/60Hz

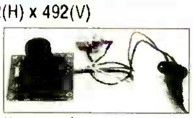
| Part No. | Description | 1-4 | 5-9 |
|---|---|---|---|
| 22718 | Magnifying lamp | $29.95 | $26.95 |

## EDWin NC (CAD/CAE) Software

The first truly seamlessly integrated suite of software running in all Windows® formats...simulation, schematics, and PCB design. Large start-up libraries.

| Part No. | Description | 1-4 | 5-9 |
|---|---|---|---|
| 141680 | EDWin NC | $149.95 | $134.95 |

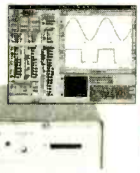
## SHARP Camera Board



- EIA system 512(H) x 492(V)
- Black & white
- Composite output – 380 lines resolution
- 1/50 to 1/1000 sec. shutter speed
- 2.1mm female center positive

| Part No. | Description | Price |
|---|---|---|
| 127263 | Camera board Closeout | $99.95 |

## mission technology PC-Multiscope 2



- 20MHz sampling rate; 10MHz analog bandwidth; built in external trigger
- 1mV/div to 10V/div; built in adjustable DC power supply output
- Frequency analyzer (FFT) and transient signal modes

| Part No. | Description | Price |
|---|---|---|
| 142834 | PC-Multiscope 2 | $399.95 |

## Digital Hand-held 5MHz Sampling Rate Oscilloscope

- Maximum sampling frequency: 5MHz for repetitive signals
- Maximum sampling frequency: 0.5MHz for single shot events
- Input impedance: 1MΩ/20pF
- Max. input voltage: 100V peak (AC + DC)
- True RMS or peak-to-peak readout
- Weight: 2.4 lbs. • One-year warranty

| Part No. | Description | Price |
|---|---|---|
| 135941 | 5MHz Oscilloscope | $249.95 |

## LG Precision Digital DC Power Supply

- Output volt.: 0-30V
- Output current: 0-3A
- Power requirements: 100-240VAC @ 50/60Hz
- Can be used for positive or negative source
- One-year warranty
- Size: 5.2"W x 5.6"H x 10"D • Wt.: 10.7 lbs.

| Part No. | Product No. | Description | Price |
|---|---|---|---|
| 121152 | GP4303D | Digital DC | $199.95 |

## Muscle Wires Project Kit

Get the facts behind the unusual properties of Muscle Wires. Study their uses in heat engines, industrial, medical and aerospace applications, electronic and mechanical devices, prosthetic limbs, robotics, virtual reality systems, and more!

- Includes Flexinol, crimps and instructions

| Part No. | Description | 1-4 | 5-9 |
|---|---|---|---|
| 141348 | Muscle Wires kit | $59.95 | $53.95 |

## PARALLAX Basic Stamps

127693 130892

Basic Stamps are small computers using a variation of Basic, called PBASIC to control execution of many applications. The BS1-IC has 8 I/O lines, while the BS2-IC has 16 I/O lines which can be connected directly to buttons, LEDs, registers, and many other TTL level devices. • One-year warranty

| Part No. | Description | Price |
|---|---|---|
| 127693 | Basic stamp BS1-IC | $34.95 |
| 130892 | Basic stamp BS2-IC | 49.95 |

## Hyper Peppy Robot Kit

- Changes course when it comes in contact with an object or hears a loud sound

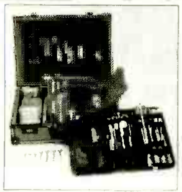
| Part No. | Description | Price |
|---|---|---|
| 140863 | Robot kit Special | $19.95 |

## Weller® 40-Watt Electronic Soldering Station

- 40 watts, 120V @ 60Hz
- Lighted on/off switch
- Adjustable power from 5 watts - 40 watts
- Temperature is electronically controlled from 350°F to 850°F • UL listed
- Includes ST3 1/8" screwdriver tip, soldering station, soldering handle and manual

| Part No. | Description | Price |
|---|---|---|
| 146595 | 40 watt soldering station | $44.95 |

## 69 Piece Professional Jumbo Tool Kit

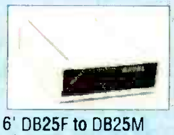


*Comprehensive Kit for Field Technicians and Engineers!*

- Size: 18.5"L x 13.8"W x 6.7"H • Wt.: 22.8 lbs.

| Part No. | Description | 1-4 | 5-9 |
|---|---|---|---|
| 149024 | Prof. tool kit | $229.95 | $209.95 |

## RACAL V.34 28.8 External Fax/Modem with QuickLink



- MNP 10-EC protocol for cellular environments
- DTE interface speeds up to 115.2 kbps
- Includes manuals, 6' DB25F to DB25M cable, phone cable, Quicklink II software (3.5" disk), modular line splitter and power adapter • Weight: 3.9 lbs.

| Part No. | Description | Price |
|---|---|---|
| 141292 | Ext. fax/modem Special | $39.95 |

## 8031 Embedded Applications Proto PC Board

- 32KB of SRAM
- 32KB of monitor EPROM
- 8031 CPU
- 14 screw-type terminal blocks connected to general purpose digital input/output ports
- 40-pin header for all system signals
- Two 23-pin headers for demultiplexed data, address, control, and I/O signals
- Size: 7.0"L x 4.0"W • One-year warranty

| Part No. | Description | Price |
|---|---|---|
| 119546 | Prototype PC board | $99.95 |

## Jameco Solderless Breadboards

20773

- Low static plastic body – CMOS safe
- Nickel plated clips designed to withstand up to 5,000 insertion cycles

| Part Number | Contact Points | Size L x W | 1-9 | 10-49 |
|---|---|---|---|---|
| 94457 | 100 | 6.5 x 0.4 | $2.49 | $2.25 |
| 20600 | 400 | 3.3 x 2.1 | 4.95 | 4.49 |
| 136901 | 1,600 | 5.5 x 2.3 | SALE | 19.95 |
| 20669 | 630 | 6.5 x 1.4 | 5.49 | 4.95 |
| 20722 | 830 | 6.5 x 2.1 | 7.95 | 6.95 |
| 20757 | 1,360 | 6.5 x 3.1 | 11.95 | 10.95 |
| 20773 | 1,660 | 6.5 x 4.3 | 17.95 | 15.95 |
| 20790 | 2,390 | 6.9 x 5.8 | 22.95 | 20.49 |
| 20811 | 3,220 | 7.3 x 7.5 | 30.95 | 27.95 |

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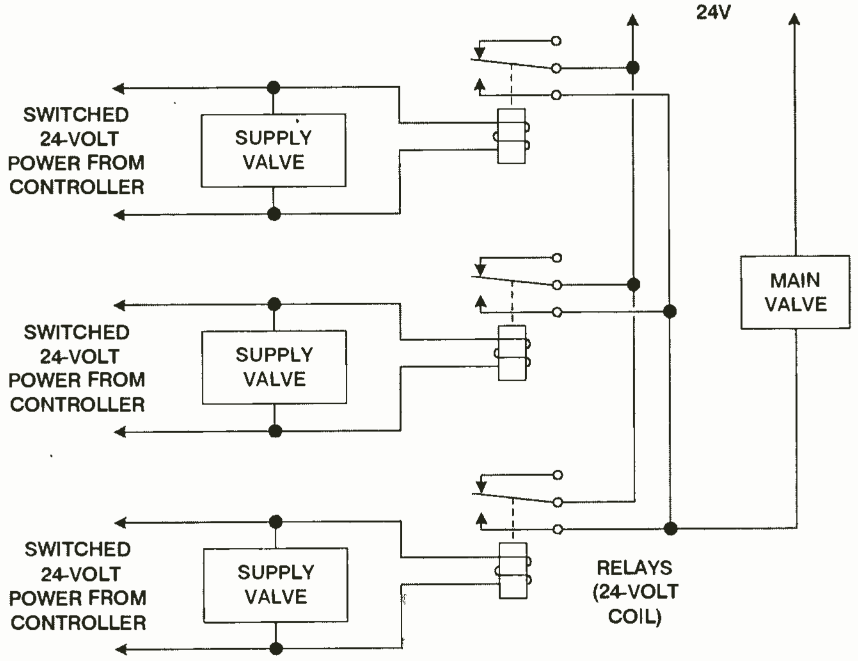


**FIG. 2**—USING RELAYS AND SIMPLE OR LOGIC, the main valve will switch on when any supply valve is energized.

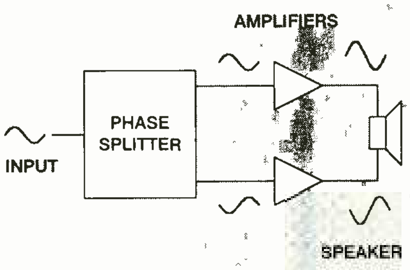


**FIG. 3**—BRIDGED AMPLIFIERS DRIVE opposite sides of a speaker with opposite-polarity signals, giving double voltage and quadruple power.

pin would be routed to the same pin at the output. Then use the new adapter to attach the keyboard to the computer.

If even that won't suffice, you can trace the circuit. Open up either the keyboard or the computer and find the +5V power and ground lines. The remaining signals are Reset In (from the computer; low when the computer is rebooting and +5V the rest of the time) and Clock Out and Data Out from the keyboard (to find out which is which, you'll need to do some experimenting). With that information, you should be able to connect a standard PC keyboard cable to your Wyse keyboard.

Keyboards haven't changed substantially since the PC AT came out, so what you are trying to do should be practical. If you were using a PC XT keyboard, it would be a different story!

## "OR" Gate For Sprinkler Valve

**Q** *Admittedly a novice at electronics, I have decided to tackle a small electrical job (gulp!). My sprinkler system uses 24-volt electrically-operated valves. I would like to add a main water valve that would be activated whenever any of the three sprinkler supply valves was turned on by the main control unit. What would be the best method to accomplish this? — I. L., Marysville, MI*

**A** We don't know the particulars of your sprinkler system, but we can tell you how to achieve a logical OR relation between several control signals. Use relays with their normally-open contacts connected in parallel as shown in Fig. 2. To avoid drawing excessive current, use small 24-volt relays; those with 650-ohm coils are a good choice, and choose AC or DC relays as appropriate.

This kind of circuit, with relays performing a simple logical function, was one of the inventions that led to the development of computers. We leave it to you to figure out how to achieve other logical relations between control signals, such as AND and NOT.

Be aware that when electricity and water meet, the results can be dangerous. Never connect any part of your sprinkler system directly to the power line (without going through a transformer), and if you have any doubts about how to wire something, get expert advice.

## Bridged Amplifiers

**Q** *At our social club, we use a 300-watt-per-channel stereo amplifier. This is loud enough for most of us, but not the younger folks. I have heard that bridging the two channels would increase the power. I understand that the output would become mono, not stereo, once the amps are bridged. How can I do this? — O. S., North York, Ontario, Canada*

**A** Figure 3 shows the principle of bridging. It's a way of getting louder sound when only a limited supply voltage is available; for example, computer sound cards and car-stereo systems often use bridged amplifiers. The amplifiers must have transformerless outputs, and you can recognize the bridge circuit because neither side of the speaker is grounded.

By doubling the voltage, you quadruple the power, assuming the speakers are of the same impedance. However, the minimum speaker impedance you can use is twice what it was before, since the other terminal of each speaker is being driven with reverse polarity, making it draw more current. Because of this, if you have to double the impedance of your speakers, you end up with only double power, not quadruple power.

In your case, we're not at all sure that one 600-watt or even 1200-watt channel would sound appreciably louder than two 300-watt channels (totaling 600 watts). Nor do we have a proven circuit for the phase splitter, which is critical for good sound reproduction. Instead of bridging the amplifiers, we suggest you look into getting more efficient speakers or improving the acoustics of the room. Also, make sure dangerously high volumes are not achieved; amplified rock music can damage people's hearing.

## Frequency Counter Frustration

**Q** *I'm a beginner in electronics. For about a year now I've been trying to build a frequency counter that can digitally count up to 460 MHz. So far I've destroyed numerous LCD displays, transistors, and ICs. Since I'm determined to build it myself, can someone who knows what they're doing assist me with a circuit, please? — R. A., Toronto, Ontario, Canada*

**A** We published plans for a 1-GHz (1000-MHz) frequency counter in our December 1990 issue; you might be able to get a copy of the article from your public library. The project uses standard parts that should still be available. If you can't locate the article, several editions of the *ARRL Handbook for Radio Amateurs* and many issues of the ARRL's magazine, *QST*, have contained plans for frequency counters. Log onto www.arrl.org and use the online index to look for articles and find out how to purchase reprints.

## Audio Compandor

**Q** *In your February 1993 issue, pages 41-44, you have plans for an audio level controller using the NE577. Can you show me a schematic using the NE570 or NE571 to accomplish the same results? — J. W., Lawton, OK*

**A** Redesigning an author's project is not something we can do on the fly, but you can find suitable circuits in the NE571 data sheet, available online at www.philips.com or by writing to Philips Semiconductors, P.O. Box 3409, Sunnyvale, CA 94088-3409, Tel: 800-234-7381. Also ask for Application Note AN176, "Compandor Cookbook."

## Automotive Code Reader

**Q** *I need a program to read the code present at the serial port on my 86 Buick Century to make it possible for me to troubleshoot the engine. Can you tell me where I can get one? — A. P. L., Nutley, NJ*

**A** You can probably get the on-board computer to give you the code by flashing the "Check Engine" light a certain number of times; no special equipment is needed. For details, see "Reading Automobile Computer-Service Codes" in our December 1997 issue, pp. 59-62. Back issues are available from our Reprint Bookstore, and possibly from your public library.

## Pocket Computer IR Signaling?

**Q** *I am an owner of many IR remote controls. My wish is to eliminate all of these devices by replacing them with a Hewlett-Packard palmtop computer that has both an IR port and a hard-wired serial port. Is there a program that my palmtop can use to learn and emit IR remote control commands? — J. F., Sugar Grove, OH*

**A** Probably not, since the IR communication protocols are quite different, and your computer probably will not let you control the IR port at a low enough level. (IR remote-control signals aren't just pulses; they're modulated at a frequency around 40 kHz which is not the same for all remotes.) But if a reader has figured out how to do it, please let us know!

## TV Problem Solved

*Thank you for your suggestions in the November 1997 "Q&A" regarding the intermittent brightness problem I was having with my Zenith TV set. I first tried removing the plug at the base of the CRT and soldering all its wires to the tube's pins, but that didn't help. Still suspecting bad contacts, I tried plugging and unplugging the luminance module several times. Luckily, that did the trick. — William A. Easson, Toronto, Ontario, Canada*

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## HOW TO GET INFORMATION ABOUT ELECTRONICS

**On the Internet:** See our Web site at http://www.gernsback.com for information and files relating to our magazines (**Electronics Now** and **Popular Electronics**) and links to other useful sites.

To discuss electronics with your fellow enthusiasts, visit the newsgroups sci.electronics.repair, sci.electronics.components, sci.electronics.design, and rec.radio.amateur.homebrew. "For sale" messages are permitted only in rec.radio.swap and misc.industry.electronics.marketplace.

Many electronic component manufacturers have Web pages; see the directory at http://www.hitex.com/chipdir/, or try addresses such as http://www.ti.com and http://www.motorola.com (substituting any company's name or abbreviation as appropriate). Many IC data sheets can be viewed online. Extensive information about how to repair consumer electronic devices and computers can be found at www.repairfaq.org.

**Books:** Several good introductory electronics books are available at RadioShack, including one on building power supplies.

An excellent general electronics textbook is *The Art of Electronics*, by Paul Horowitz and Winfield Hill, available from the publisher (Cambridge University Press, 1-800-872-7423) or on special order through any bookstore. Its 1125 pages are full of information on how to build working circuits, with a minimum of mathematics.

Also indispensable is *The ARRL Handbook for Radio Amateurs*, comprising 1000 pages of theory, radio circuits, and ready-to-build projects, available from the American Radio Relay League, Newington, CT 06111, and from ham-radio equipment dealers.

**Copies of past articles:** Copies of past articles in **Electronics Now** and **Popular Electronics** (post 1993 only) are available from our Claggk, Inc., Reprint Department, P.O Box 4099, Farmingdale, NY 11735; Tel: 516-293-3751.

**Electronics Now** and many other magazines are indexed in the *Reader's Guide to Periodical Literature,* available at your public library. Copies of articles in other magazines can be obtained through your public library's interlibrary loan service; expect to pay about 30 cents a page.

**Service manuals:** Manuals for radios, TVs, VCRs, audio equipment, and some computers are available from Howard W. Sams & Co., Indianapolis, IN 46214 (1-800-428-7267). The free Sams catalog also lists addresses of manufacturers and parts dealers. Even if an item isn't listed in the catalog, it pays to call Sams; they may have a schematic on file which they can copy for you.

Manuals for older test equipment and ham radio gear are available from Hi Manuals, PO Box 802, Council Bluffs, IA 51502, and Manuals Plus, PO Box 549 Tooele, UT 84074.

**Replacement semiconductors:** Replacement transistors, ICs, and other semiconductors, marketed by Philips ECG, NTE, and Thomson (SK), are available through most parts dealers (including RadioShack on special order). The ECG, NTE, and SK lines contain a few hundred parts that substitute for many thousands of others; a directory (supplied as a large book and on diskette) tells you which one to use. NTE numbers usually match ECG; SK numbers are different.

Remember that the "2S" in a Japanese type number is usually omitted; a transistor marked D945 is actually a 2SD945.

**Hamfests (swap meets) and local organizations:** These can be located by writing to the American Radio Relay League (Newington, CT 06111; http://www.arrl.org). A hamfest is an excellent place to pick up used test equipment, older parts, and other items at bargain prices, as well as to meet your fellow electronics enthusiasts—both amateur and professional.

equipment are usually the connectors, and a good first move, when anything has an intermittent problem, is to unplug all the connectors and plug them back in.

# Writing to Q&A

As always, we welcome your questions. The most interesting ones are answered in print. Please be sure to include plenty of background information (we'll shorten your letter as needed for publication) and give your full name and address (we'll only print your initials unless you've requested that readers respond directly to you). *If you are asking about a circuit, please include a complete diagram.* Send your questions to "Q&A," **Electronics Now** Magazine, 500 Bi-County Blvd., Farmingdale, NY 11735. Due to the volume of mail, we regret that we cannot give personal replies. EN

# LETTERS

SEND YOUR COMMENTS TO THE EDITORS OF ELECTRONICS NOW MAGAZINE

## Let's Raise Our Voices

I'm a retired Electrical Engineer and would like to comment on the question from E.C. about the artificial voice box that appeared in the February 1998 installment of "Q&A."

Devices of the type E.C. needs are tightly regulated by our government's FDA which, in turn, has stifled all innovation. Hearing aids also fall into this category. I can think of several easy ways to improve speech fidelity, and therefore quality of life for E.C. However, anyone attempting to manufacture or sell such an item without FDA approval faces severe penalties, such as ten years in jail. That's why you will never see schematics or advertisements in your classified section for such devices.

Because of regulation, hearing aids with less than $50 worth of components sell for the cost of a new computer ($2000 to $3000). I hate to think what E.C.'s low-quality audio device cost him.

Not too many years ago, you could not legally buy or attach any item to the telephone line. Government regulations prohibited all such devices, except when designed and sold by "MA BELL." It took the farsighted wisdom of a Federal Judge to deregulate this industry. Where would faxes, modems, the Internet, etc. be today if the status quo had been left in place?

It is indeed a tragedy that people like E.C. cannot buy a decent device. The public is held hostage to overpriced, crude electrical devices (*i.e.* hearing aids) that border on being unusable because of government regulation. Deregulation is needed for non-invasive electrical devices.

JAMES B. HALBERT
Kimberling City, MO

## "Hot" Logic Analyzer

I have just fired up the Logic Analyzer described in "Build a High-Performance Logic Analyzer" (**Electronics Now**, March 1998). It is a habit of mine to test circuits for problems at each phase of construction. I noticed that the last component that I installed, the lattice IC, had the greatest effect on



CIRCLE 122 ON FREE INFORMATION CARD

the regulator's (7805) temperature. It got pretty hot to the touch, so I pulled out the temperature probe and clip-on heat sink and did some testing. I found that the temperature was not out of spec and that the packaging design (clamping the heat sink against the metal cover) is a great idea for dissipating the heat. I understand that PLDs draw a nice chunk of current and using a dozen or so TTL ICs would have been more or less the same thing. I have a 1-inch diameter, 100 mA, 10VDC cooling fan (with filter) that I may mount in the bottom of the case if the temperature becomes a problem anyway.

JOE M. BEARD
via e-mail

## Alternate Energy Issues

I think Blake Reed's "Build a Solar Charge Controller" (**Electronics Now**, October 1997) gives a terrific overview of alternate energy technologies such as solar, fuel cell, etc. The article presents an interesting method for charging batteries from solar panels, and nicely covers all the control requirements.

However, I did notice two issues with respect to the LM339 quad comparator. The fourth unused section of IC1 must be terminated in accordance with the National Semiconductor application notes: "All pins of any unused comparators should be grounded." The inputs of the LM339 are high-impedance antennas, and, if unterminated, the unused section of the IC could go into oscillation, causing current flow to the IC substrate. This current flow would, of course, adversely affect the other three comparators in the package.

The other item is that with a battery connected, no voltage output from the solar panel, and S1 in the run position, pins 4 and 6 of IC1 are still connected to $^1/_3$ battery voltage through R4. Since the inputs should never have any voltage applied unless the power supply voltage is also present, be sure to put S1 in the OFF position when no solar power voltage is being generated.

As added insurance, you can connect a IN4148 input-clamp diode from IC1 pin 2 (anode) to pin 3 (cathode). This ensures the input will never exceed the supply pin by more than 0.6VDC, which is permitted by the LM339 application notes.

CHARLES HANSEN
Tinton Falls, NJ

EN

# Prototype

## Virtual Reality For More Than Fun and Games

Anyone who has played virtual reality games knows that the experience can be so realistic you become "immersed" in the action. Because of this realism, virtual reality could be ideal for training military or law enforcement personnel for risky tasks such as counter-terrorist teams rescuing hostages or combat medics who have to treat the wounded on the battlefield.

One system under development by researchers at the Sandia National Laboratories in Albuquerque, NM, and discussed in the October, 1997 installment of "What's News," is VRaptor, which, among other things, could be used for realistic training of counter-terrorism and "special mission" teams. VRaptor would also be valuable in planning and rehearsing before the real mission.

But Sandia, working with university researchers and sponsored by the Defense Advanced Research Projects Agency (DARPA), is also developing another virtual-reality trainer. Called VR-MediSim, it uses virtual reality for training combat medics for the stress-filled, live-or-die, battlefield environment.

### VR-MediSim

Like VRaptor, VR-MediSim use special high-fidelity avatars to put the participants right into the scenario. The avatars allow all participants to be immersed in a virtual world in which they are confronted with real-life problems and situations with immediate feedback on the results of their actions. Wearers are shown in the virtual environment as full graphical figures. They are able to see the other figures in the scene who move realistically in response to the actions of the other participants. Besides realistic motion, participants are able to grasp objects and perform functions like using medical equipment.

TO PROVIDE MAXIMUM REALISM, if the medic trainee who is put into the VR-MediSim scene makes the wrong decision, the wounded soldier could die.

VR-MediSim medics are immersed in a virtual world where they are confronted with real-life, battlefield-casualty problems. Casualty models being developed by the University of Pennsylvania are virtual downed soldiers whose "modeled" wounds change—for example, are no longer life-threatening or become fatal—as the result of actions of the medic. VR-MediSim can provide feedback to the trainee on the condition of the casualty and on the status of the procedures being performed. Medic trainees can interact with virtual casualties through spoken commands, requests for information, and manipulation of the virtual medical instruments. The distributed simulation scenarios used in VR-MediSim are being developed by the University of Central Florida's Institute for Simulation and Training. Besides training, VR-MediSim can be used to test and evaluate new battlefield-medicine techniques and technologies.

Recently, the researchers demonstrated virtual-reality technology with a scenario involving a four-man fire team and a medic. Their mission—clear a building. As the team approaches the building, a sniper fires and one soldier is hit. The team takes out the sniper, while the medic assists the wounded soldier. In the demonstration, the soldiers and the medic are all computer-generated characters controlled by the actions of the human participants.

Upon reaching the fallen soldier, the virtual medic finds a tension pneumothorax and must perform a quick assessment, reach a diagnosis, and perform the intervention quickly. If he does not, the casualty will die. Once the intervention is performed, the wounded man is stabilized, then medivaced out, and the squad is now free to continue the mission. VR-MediSim creates an environment for training combat medics in the midst of action under battlefield conditions. The technology also simulates the actual

VIRTUAL-REALITY GOGLES LIKE THESE may be more associated with fun and games, but since they allow their wearers to be "immersed" in a scenario, they are also ideal for training medics and others to deal with life-and-death situations.

**FOR MORE INFORMATION**

**Sandia National Laboratories**
Media Relations Department
MS 0167
Albuquerque, NM 87185-0167
Tel: 505-844-8066
Fax: 505-844-6367
Web: www.sandia.gov/vris

impact on the entire infantry squad of the wounded comrade by requiring them to carry stretchers, help the medic give first aid, or use the medical supplies that they all carry.

VR-MediSim, VRaptor, and other virtual-reality training systems are still in prototype form. However, researchers believe that VR training will eventually succeed, as it is offers many advantages over traditional classroom instruction and even live training.—BILL SIURU PT

## Solar-Powered Aircraft

Pathfinder, NASA's solar-powered, remotely-piloted aircraft, has successfully completed a series of science missions designed to highlight the craft's science capabilities. Pathfinder is a flying wing with a span of 99 feet. Small pods extending below the wing's center section can carry a variety of scientific sensors. Solar arrays on the upper wing surface can provide as much as 7200 watts of power at high noon on a summer day to power the electric motors and other electronic systems. A backup battery can provide power to fly the aircraft for up to five hours after sundown.

During the missions, the craft collected imagery of forest and coastal zone ecosystems on Kauai, Hawaii. Kauai was chosen as an optimum location for testing the solar-powered Pathfinder due to high levels of solar energy, available airspace and radio frequency, and diversity of terrestrial and coastal ecosystems. Flights were conducted at altitudes between 22,000 to 49,000 feet.

Major scientific activities included detection of forest-nutrient status, forest regrowth from Hurricane Iniki, sediment/algal concentrations in coastal waters, and coral-reef health. The flights tested two new scientific instruments, a high spectral-resolution Digital Array Scanned Interferometer (DASI) and a high spatial-resolution Airborne Real-Time Imaging System (ARTIS).

Designed to support NASA's Mission to Planet Earth science programs, the DASI, which mounts beneath the Pathfinder's wings, is a remote-sensing instrument that looks at reflected spectral intensities from the earth. The ARTIS payload is built around a digital camera with a six-million pixel array. Both sensors are small, lightweight, and interactive.

THE PATHFINDER SOLAR-POWERED AIRCRAFT is photographed here during one of its science missions in Hawaii.

Pathfinder is one of several remotely piloted aircraft being evaluated as part of NASA's Environmental Research Aircraft and Sensor Technology (ERAST) program, which focuses on developing technologies required to operate subsonic unpiloted aircraft at high altitudes for long-duration flights. In an earlier test, Pathfinder set an altitude record—over 71,500 feet—for propeller-driven flight. Aircraft similar to Pathfinder could spend long periods of time over the ocean to monitor storm systems, or over remote areas of land to provide early warning of crop damage or fires. PT

## LENS: Laser Engineered Net Shaping

In the manufacturing world, the faster new products get to market and the quicker changing market conditions can be incorporated into the production process, the more competitive a company will be. In the defense industry, the challenge is low-volume production of highly specialized weapons components.

The needs of both worlds may be met with a Sandia-developed technology called LENS for Laser Engineered Net Shaping. The purpose of LENS is to make small lots of high-density parts or molds, a difficult operation because high temperatures make it hard to form accurate, smooth objects from molten metals. The technology produces shapes close enough to the final product to eliminate the need for rough machining.

Nozzles each direct a stream of metal powder to a central point beneath them. Simultaneously, that point is heated by a high-powered laser beam. The laser and jets remain stationary, while the model and its substrate are moved to continually provide new areas on which to deposit metal. Layers are deposited sequentially until the desired cross-sectional geometry is completed.

According to Sandia Direct Fabrication Manager Duane Dimos, "The process produces materials with outstanding mechanical properties—very high strength and high ductility." Another plus is the ability to mix powder streams of different materials, Dimos added.

When perfected, this technology should give companies more lead time in bringing their products to market as well as the capability to quickly alter the shapes and materials of products as needed. A Sandia/industry cooperative research program has been initiated to produce an industrial tool that works automatically, robustly, and without the constant supervision of a lab attendant. PT

## World Record in Disk-Drive Storage

Scientists at IBM have doubled their own world record in hard-disk data-storage density, 11.6 billion bits-(gigabits) per-square-inch. The new density surpasses the 10-million-bit-per-square-inch data-density milestone they set just one year ago. At this storage density, every square inch of disk space could hold 1450 average-sized novels or more than 725,000 pages of double-spaced typewritten pages—a stack taller than an 18-story building.

Research teams of scientists and engineers at IBM's Almaden Research

RESEARCHER LANE HARWELL MAKES AN 11-inch high mini skyscraper using Sandia's laser-engineered net-shaping technique.

Center achieved this breakthrough. As in IBM's previous storage-density record, manufacturable component technologies were used at realistic data rates, and product-level reading and writing accuracy was achieved. The 11.6 gigabits/square-inch density was reached at data rates of 14-million bytes-per-second. The on-track density was read essentially flawlessly, with an uncorrected rate of less than one error in a billion bits.

Scientists used an advanced version of the giant magneto-resistive (GMR) head, the most sensitive sensor for reading data from disks. In addition to the GMR read head, a narrow-track thin-film inductive write head, ultra-low-noise cobalt-alloy magnetic media, and extended PMRL (Partial Response, Maximum Likelihood) channel electronics were used. Bits were packed at 315,000-per-inch along the concentric tracks on the disk. Tracks were written at a density of 36,800-bits-per-radial-inch.

Since 1991, when IBM introduced the industry's first magneto-resistive (MR) sensor for reading data on hard disks, data density had increased at 60 percent a year. Since then, the average data-storage capacity of disk drives sold worldwide has increased 18-fold, while the price per megabyte of such capacity has dropped 52-fold.

"With this laboratory demonstration, we're on track to providing products with 10-gigabit density by the year 2001," said Robert Scranton, IBM Storage Systems Division vice president for technology. Increasing data density can also lead to disk drives that are lighter and consume less energy—important factors in laptop and portable computers. In addition, these products tend to be more reliable, because fewer disks are needed to achieve a given data-storage capacity. PT

## Dinosaurs Roar, Or Do They Rumble?

Scientists at Sandia and the New Mexico Museum of Natural History and Science have recreated the sound a dinosaur made 75 million years ago. Using computed tomography (CT scans) and powerful computers, computer scientists and paleontologists successfully produced the low-frequency sound.

Since the 1995 discovery of a rare Parasaurolophus skull fossil measuring about four and half feet long, dinosaur vocalization has been studied. The dinosaur had a bony tubular crest that extended back from the top of its head. Shaped something like a trombone, the crest contained a labyrinth of air cavities. Many scientists believe that the crest might have been used to produce distinctive sounds.

As expected, based on the structure of the crest, the dinosaur apparently emitted a resonating low-frequency rumbling sound that can change in pitch. It seems that not only did each Parasaurolophus have a voice that was different enough to distinguish it from other kinds of dinosaurs, but distinctive enough to distinguish it from other Parasaurolophuses.

You can hear the Parasaurolophus speak by visiting Sandia's Web site: www.sandia.gov/media/dinosaur.htm. PT

## Protective Plastic Packaging

Dr. Joel Barlow, a University of Texas at Austin chemical engineer has developed a new plastic-packaging process that will allow small electronic parts, including microchips, to be coated in protective plastic at a much faster rate and less expensively than before—which should mean cheaper and more reliable electronic products for the consumer. JemPac International has obtained exclusive rights to the new technology through the efforts of UT Austin's Office of Technology Licensing.

Using a new inexpensive chemical material called JemStone, Dr. Barlow and JemPac have created a process allowing for high-speed encapsulation (protective coating) of microelectronics using substantially lower pressure and lower temperatures than in current conventional molding methods. The process called FlowMolding can reduce costs, improve packaging yields, and extend the life of commercial electronics, according to the developer.

Besides being as much as 30-times faster and four-times less expensive, FlowMolding is done at very low heat and with low pressure. Electronics that have never been molded before due to their inability to stand up to the necessary heat and pressure can now be encapsulated.

"Radios, phones, and cars using lower-tech computer chips could be impacted the most," said Barlow. "Currently, the packaging in these is more expensive than the chip themselves. Since our materials are cheaper and our machine increases production dramatically, you can see that cost could fall substantially."

PT

# Nanotubes: Molecular-Sized Pipes

Carbon-based electronic components that are at least a hundred times smaller than those used in silicon chips could be made in the future with tiny carbon wires, according to Dr. Madhu Menon of the University of Kentucky, Lexington, and Dr. Deepak Srivastava of NASA's Ames Research Center at Moffett Field, CA, both physicists.

Their recently published paper (*Physical Review Letters*, December 1) explains how carbon "nanotube" wires can be connected by pentagons and heptagons at wire junctions. Nanotubes are molecular-sized pipes made of carbon atoms. The junctions where nanotubes with different properties meet in an atomically precise way could be the prototypes of molecular electronic switching, transistor, and amplifying components that are used in computer chips.

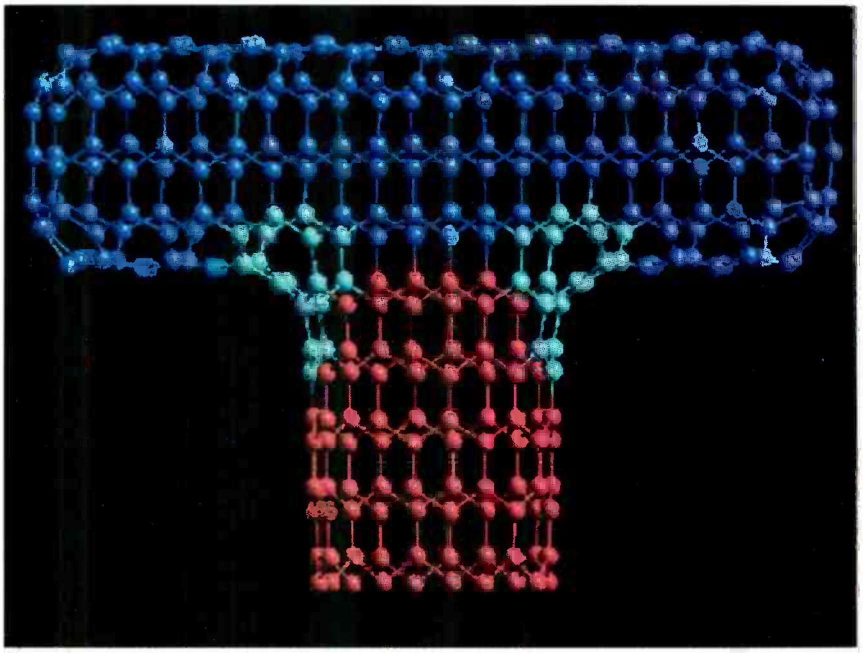
"We used supercomputers at Ames to simulate these carbon-wire components, and based on the simulations, we think this kind of electronics may be possible. The computer simulations were done with the quantum molecular dynamics method, which has predicted stable molecular structures in the past. They were later found to be real," explained Srivastava, who works in molecular nanotechnology at Ames.

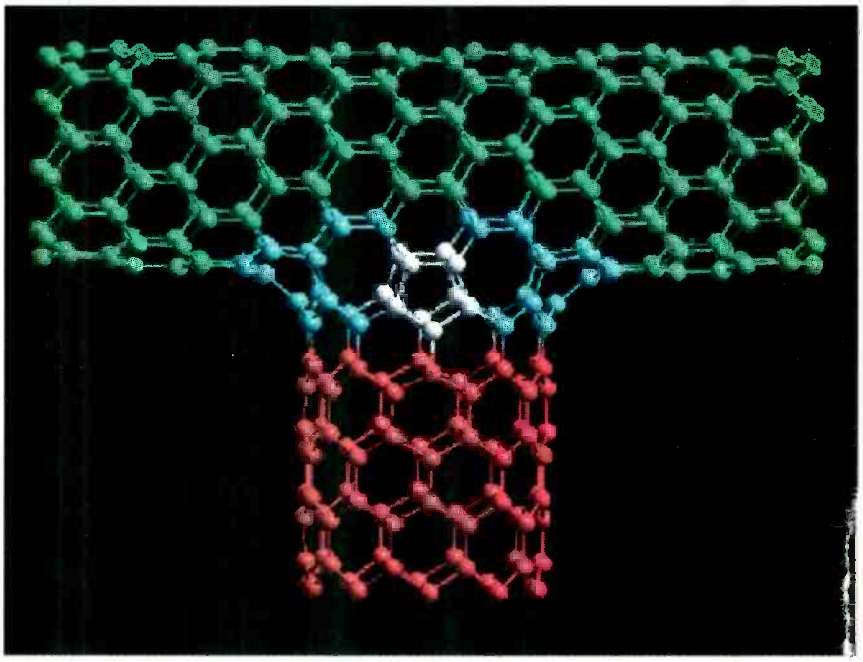
This field involves the study of how to create atomically precise and extremely small objects with dimensions measured in nanometers (a billionth of a meter). "Not only will carbon-based electronics be much smaller, but they will be substantially faster and probably less expensive," he added.

Scientists report that nanotubes will soon be available commercially in small quantities. Some scientists predict that short nanotubes could be the most rigid beams possible to make, and they could be unbreakable even when bent in half. Grown in long ropes, they are likely to be the strongest fiber ever made and will be about a sixth the weight of steel.

According to Srivastava, "Some of the electronic properties of carbon nanotubes have been measured, but it could be many years before nano-sized carbon-based electronic devices can be produced." A long-range goal of researchers is to make materials that have radically superior strength-to-weight ratios. Diamonds, for example, have 69 times the strength-to-weight ratio of titanium. More information on these materials can be found on the Internet at http://science.nas.nasa.gov/Groups/Nanotechnology.

PT





WHEN CARBON-BASED NANOTUBE WIRES of different electronic properties connect in atomically precise ways, those junctions could be prototypes of molecular switches and amplifiers that are vastly smaller than any microelectronic components that are currently available.

BY DON LANCASTER

# Some "ExtraOrdinary" Science Papers and Videos, and More

WHILE REGULAR READERS NO DOUBT KNOW MY STRONG BIAS AGAINST PSEUDOSCIENCE, I ALSO STRONGLY FEEL THAT VIABLE FORUMS MOST ASSUREDLY SHOULD EXIST FOR UNPOPULAR OR NON-MAINSTREAM THOUGHT. ABOVE all, independent thought and hands-on personal experiments definitely must be encouraged. One place where that happens is at The International Tesla Society's ExtraOrdinary Science Conferences in Colorado Springs, where bunches of highly controversial alternate-energy and non-traditional medical papers and workshops are encouraged. Some of the more technical papers are listed in Fig. 1.

Anyway, I've belatedly sat down and gone through their entire last year's video set, and thought I would share several of my impressions with you. To be honest, after blearily wading through lots of tape, I didn't find all that much here to get excited about. There was nothing even remotely in the same league as the real science carbon nanotubes (Rodriguez in the *Hydrogen & Fuel Cell Letter*, Feb, 97) or the photosynthesis metalloradicals (Hoganson in *Science*, Sept 26, 1997) that were coming down at nearly the same time. Nor was there anything compelling enough to change the scope or directions of my own personal in-house research on magic sinewaves, wireless current isopods, or PIC PostScript robotics.

I strongly feel that an hour in the library is worth a month in the lab. Had a lot more time and effort been spent on learning more math, finding out what real science believes, and in correctly making basic lab tests, the incredible energy I saw in the videos might have been better spent.

Anyway, here are some highlights and specific comments:

**Cosmic Conversion**—This video from Paul Brown is a curious mix of a real science tutorial about current nuclear-battery technologies mixed in with speculation on a bizarre T.H. Moray "free energy" device from the 1920s. He concludes that Moray definitely had a radium battery, possibly had a cosmic-ray receiver, and probably just missed inventing the field-effect transistor.

**Super Steam Technology**—This one appeared to be a fresh look at flash-steam generators. Well, there sure was bunches of white "smoke" and lots of noise in their videos, along with "Boy, look at all of that steam!" But I saw precious little in the way of actual efficiency tests, or on addressing the crucial corrosion, scale, and closed-loop-recycling issues. Compare that to Power Engineering where electric utilities are now nearing a staggering 60% efficiency through use of both multi-cycling and close coupling.

**Tesla Turbines**—As Fig. 2 shows, a Tesla turbine is a bunch of smooth and closely spaced disks that use the viscosity of laminar flow to directly convert an input fluid's energy into rotary energy, or *vice versa*. These turbines are bladeless, and can in theory even pump water full of live fish. While detailed instructions were given for creating museum quality see-through models, any efficiency tests seemed conspicuously absent.

**Cold Fusion**—I'll encourage you to form your own opinions on this one, which provided fresh updates on such happenings as the Patterson Cell and other anomalous heat measurements. Sorry, but I came away from this video with even stronger feelings that (a) cold fusion lacks credibility, and (b) the cold fusion proponents are their own worst enemies.

**Tesla's Lab**—This one is an attempt to duplicate a quarter scale model of Tesla's "free energy" lab and recreate early "earth-resonance" experiments. There sure was a lot of attention to detail here in getting just the right width of slats over the correct brand of tarpaper on the sides of the shed. Using a two-kilowatt generator, production of 12,000 foot long sparks are expected by the proponents. Sure.

**Element Five**—The atomic weight of any isotope nearly equals its number of protons and neutrons. Curiously, the only low value atomic weight that is not yet known is number five. Yes, there are a few possible candidates, but the beastie known as the curve of binding energy makes their existence unlikely. Ron Kovak believes his lab has created an isotope five, done by applying special electromagnetic fields that transmute ener-

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Phone or write all your US Tech Musings questions to:

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Box 809-EN
Thatcher AZ, 85552
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US email: don@tinaja.com
Web page: http://www.tinaja.com

gy from a hypothetical ether source.

**Shape Power**—This idea is basically repackaged "pyramid power," which tries to extract the free energy from a hypothetical (and largely discredited) ether. Sort of a "unified theory" that ties everything from clairvoyance to cold fusion to self-sharpening razor blades to Orgonne energy to dowsing all together. "Supraluminal" activities at 5× light speed and antigravity effects are claimed.

**GEET Technology**—This deals with Paul Pantone's ongoing experiments in the "miracle carburetor" arena. A self-induced "plasma" vacuum recycles its exhaust heat to further refine input fuels for a claimed big efficiency improvement and substantial pollution reduction. Transmutation of carbon down into hydrogen is apparently also implied, as is the ability to run on toxic waste instead of gasoline. There seems to be a lot of true believers on this one. More information can be found on the Web at www.friendly.net/GEET

Well, these sort of give you the flavor of the conference. Rounding out the tech presentations were some solid and real-science papers about magnetic thin films, black holes, and optical communications on one end. At the other extreme, there was lots of really far off stuff that I felt clearly went way beyond the "few chips shy of a full board" category.

The full set of videos is available from the International Tesla Society, who also stock the books, videos, lab-time rentals, and even T-shirts of the individual proponents. Their web site is www.tesla.org.

## A New Cave Lamp

As you might imagine, cavers tend to be more than a little fussy over their light sources. A few of us still doggedly stick with good old carbide lights, which certainly remain cheap, warm, repairable, and reliable—though they are pretty much useless in any waterfalls or high-wind conditions. These days, some trips underground can last several days. Operating cost, weight, useful life, and reliability are paramount. Obvious solutions such as Mag Lites usually have filaments that are unacceptably fragile.

Henry Schneiker of HDS Systems has come up with a new cave-lamp scheme that uses paralleled white LEDs. Some of the details are shown in Fig. 3. The key secret is the new white LED family from Nichia. These are really bright blue LEDs that have special phosphors added to them to boost their red and yellow spectral output. The result is an output color that is a "moonlight" white with a CRI color rendition index of 0.85. That's not half bad, but not as warm or "carbide-like" as cavers are used to.

There are a total of 25 parallel connected LEDs. Twenty of those are narrow beam and five are wider beam. That gives a pattern similar to the reflector on a carbide lamp. The pattern is further adjusted by precise orientation of the diodes.

Surprisingly, there appears to be

***Advanced GEET System*****, Paul Pantone**
***Atomic-5*****, Ron Kovack**
***Cold Fusion and the New Energy Age*****, Eugene Mallove**
***Conversion of Cosmic Rays to Electricity*****, Paul Brown**
***Drawing Energy from Black Holes*****, Rastko Marlic**
***Duplicating Tesla's Colorado Springs Lab*****, Jerry Labine**
***Implosive Technology Automotive Drive*****, Sonne Ward**
***Kirlian Photography*****, Linda White**
***Magnetic Ultrathin Films*****, Zbigniev Celinski**
***New Innovations in Brown's Gas*****, George Wiseman**
***The Neurophone*****, Mason Rumney**
***Optical Communications Technology*****, Mark Wickert**
***Rife Beam Ray Device*****, James Bare**
***Shape Power: A Key to Antigravity*****, Dan Davidson**
***Super Steam Technology*****, Leonard Dorsett**

**FIG. 1**—A FEW PAPERS from the 1997 ExtraOrdinary Science Conference.

## NAMES AND NUMBERS

**Burr-Brown**
6730 S Tucson Blvd.
Tucson, AZ 85706
(520) 746-1111

**HDS Systems**
PO Box 42767
Tucson, AZ 85733
(520) 881-2632

**Hewlett-Packard**
PO Box 10301
Palo Alto, CA 94303
(415) 857-1501

**Hydrogen & Fuel Cell Letter**
Grinnell St. PO Box 14
Rhinecliff, NY 12574
(914) 876-5988

**International Tesla Society**
PO Box 5636
Colorado Springs, CO 80931
(800) 379-0137

**Lindsay Publications**
PO Box 538
Bradley, IL 60915
(815) 935-5353

**Maxim**
120 San Gabriel Dr.
Sunnyvale, CA 94086
(800) 998-8800

**Microchip Technology**
2355 W Chandler Blvd.
Chandler, AZ 85224
(602) 786-7200

**Nichia**
181 Metro Dr. Suite 350
San Jose, CA 95110
(408) 573-0933

**Power Engineering**
1421 S Sheridan Rd.
Tulsa, OK 74112
(918) 835-3161

**Science/AAAS**
1333 H St. NW
Washington, DC 20005
(202) 326-6400

**SmartTool Technologies**
2030 B Fortune Dr.
San Jose, CA 95131
(408) 434-7000

**Snaptron**
2468 E 9th St.
Loveland, CO 80537
(970) 663-2820

**Stanford Microdevices**
522 Almanor Ave.
Sunnyvale, CA 94086
(800) 764-6642

**Synergetics**
Box 809
Thatcher, AZ 85552
(520) 428-4073

**System ID Warehouse**
1401 Capital Ave.
Plano, TX 75074
(800) 397-9783

**USMikroChips**
15 Sutton Rd.
Webster, MA 01470
(508) 943-9430

**WEB Trends**
621 SW Morrison #1025
Portland, OR 97205
(502) 294-7025

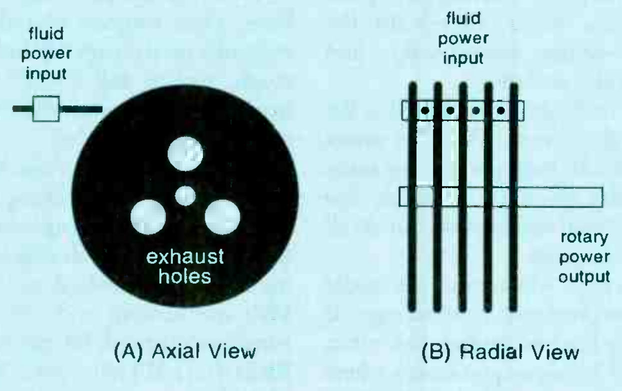



FIG.2—A TESLA TURBINE consists of closely spaced bladeless disks. The energy transfer is by way of laminar flow viscous drag. Presence of exit turbulence can severely limit the system efficiency.

enough device-to-device uniformity in any selected LED lot that current hogging or brightness variations are not all that much of a problem. At its normal brightness, each LED is biased to the five-milliamp point, which gives you the best compromise between efficiency and brightness. At normal brightness, the 125 mils total current is comparable to an incandescent flashlight bulb after it has run for a while.

Unlike some earlier LED devices, the Nichia-device efficiency is best at lower currents. The current is carefully sensed and converted to a switch-mode voltage using either a Maxim regulator chip or a baby PIC. Output voltage is typically 3.6 volts. The usual power source is a 8-amp-hour, 2.8-volt lithium "D" cell. Thus, the switching regulator steps up the voltage a little initially, and progressively more as the cell discharges. A three-position switch gives you a choice of "moonlight" with thousands of hours of run time, "normal" at forty hours or so, and "extra bright".

The efficiency of the new LEDs themselves are around 7.5 lumens per watt, which is comparable to a fresh incandescent flashlight lamp. But unlike an incandescent lamp, the efficiency holds up as your batteries age. Note that the light output is constant as the battery gives up its charge; neither your color nor your efficiency change. The light is also more useful because of the lack of a hot center spot. Also, it is reasonable to expect double or triple efficiency within a year or two as white-LED technology further improves. Orange LEDs, especially those from Hewlett-Packard, already approach three times incandescent efficiency.

HDS can be reached via e-mail at hds@rtd.com, while the Nichia Web site is www.la.meshnet.or.jp/nichia.

### Referral Log Files

Back in October 1997, we looked at using older Web log files. Playing with your ISP's log files can be extremely valuable when you have your own Web site. It turns out that newer Web servers use an Extended Log File Format, which I've shown in Fig. 4. Several very useful new features are provided. The format is different enough that you'll probably need new code to read it.

The log information and the error information is combined into a single file. Each line consists of ordinary printable ASCII characters and holds one site

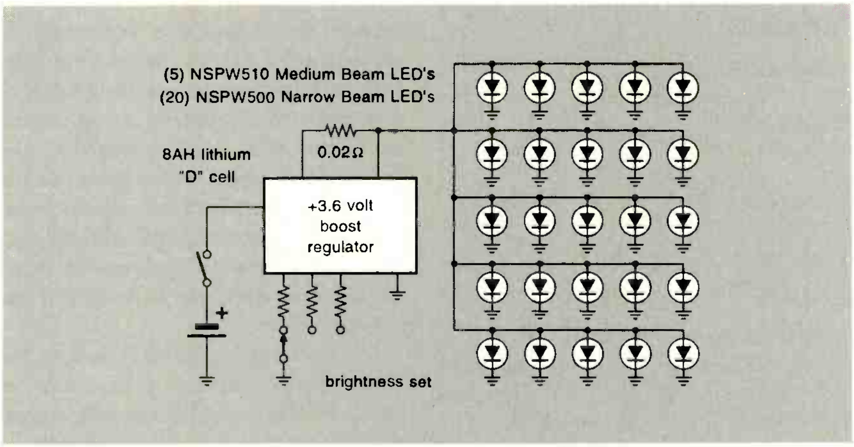



**FIG. 3**—A NEW CAVING LAMP from HDS systems uses 25 white LEDs in parallel. The performance and reliability are both exceptional.

| FIELD | EXAMPLE | PURPOSE |
|---|---|---|
| 00 | mirrorli-fxp0-ptp.alaska.net, | client ip address |
| 01 | -, | client username |
| 02 | 2/2/98, | date |
| 03 | 0:04:17, | time |
| 04 | W3SVC, | service |
| 05 | TOWER4, | computer name |
| 06 | www.Pepperoni.com, | IP address of server |
| 07 | 311, | Processing time in Msec |
| 08 | 225, | Bytes received |
| 09 | 2494, | Bytes sent |
| 10 | 200, | Service status code |
| 11 | 0, | Windows NT status code |
| 12 | GET, | target of operation |
| 13 | /Default.htm, | requested file |
| 14 | Mozilla/3.0.... (Win95; U), | client system |
| 15 | http://www.r.....htm, | client referral |
| 16 | -, | often unused |
| 17 | -, | often unused |

Each field ends with a "comma-space" delimiter.

**FIG.4**—WEB SERVER EXTENDED LOG FORMAT provides more client data. The new "referral" field #15 can be exceptionally useful.

hit. There are now eighteen fields per line. Each field is delimited by a unique ending comma and space.

Some of these new fields tell you such things as Mac users being less than five percent of all Web activity, AOL having a three-percent share on weekdays up to a four percent on weekends, and Netscape currently sitting at 57% popularity but rapidly falling. By looking at file downloads and sizes, the logs also reveal that most of you now have the new Acrobat 3.01 PDF file readers. That's becoming important because Acrobat is now the standard way of delivering all electronic technical information across the Web.

The processing times tell you how fast your server is serving and how choked up the web is. There's also the usual time-of-day, day-of-week, and total bandwidth statistics.

But the really major new field is the referral in slot fifteen. That one shows you the previous page your visitor came from. Besides being an incredible ego trip, that referral information can do all sorts of magic tricks.

For instance, your own site could often be the previously referred page. If there is any internal broken link error, your referral log shows you exactly where the problem lies. Just search for "404" in your log-file field #10, then check the referral field #15 for that line. If you are buying banner advertising or using exchange links, you can measure how effective the links are by their total hits.

Yes, you could use the "find links to this URL" of Hotbot or the "link:" feature of Alta Vista to nail down sites having links to yours. But the referral log shows you which sites actually work and which are doing the most for you. I've found that the referral logs find more new linking sites and do so much faster.

You will find certain commercial packages such as WEB Trends that can extract all sorts of fancy log information for you. But I prefer to use PostScript instead to directly dig down into the more obscure or more specialized custom stuff. PostScript can easily read nearly any file in almost any format. A looped search can convert every log line into a new array of 18 strings. From there, the data is easily manipulated six ways from Sunday.

For instance, a "raw" referral log will mostly have blank referrals, hits from your own site, newsgroup hits, and search-engine hits. That information is not all that useful. Using PostScript, those could all get filtered out to leave you the "real" underlying referrals, which tell you what is working and what is not.

Note that typical search-engine queries have a "?" somewhere in their URL. Normally, you will want to filter those out. But a "popularity list" of what people are searching for when they find your site can tell you the direction you should be heading.

Hint: To find real linked visitors, first filter out those "no referrals" by dumping every line less than three characters. Then dump your own site referrals, along with their upper- or lower-case variations. Then get rid of the search engines by looking for "?".

Next, ignore any "file:" or "news:" lines. Then truncate everything to the right of a partial page "#" link. As a final touch, replace any "%7E" values that may rarely occur with their more common and equivalent "~".

Long term, you can also measure the ratio of your return visitors, by comparing any new referrals against those that bump the counts of already known visiting sites. I've posted a dozen examples of Web site analysis code to www.tinaja.com/acrob01.html. Be sure to check out REFLOG1.HTML and REFSUM1.HTML.

Our new PostScript routines now appear in three different ways: First as an easy-to-read linked HTML file, sec-

## SOME WIND ENERGY RESOURCES

**Alternative Energy Trends**
205 S Beverly Dr.
Beverly Hills, CA 90212
(310) 273-3486

**Alternative Power**
104 N Main St.
Viroqua, WI 54665
(608) 634-2984

**American Wind Assn.**
122 C St. NW, 4th FL
Washington, DC 20001
(202) 383-2500

**Bergey Windpower**
2001 Priestley Ave.
Norman, OK 73069

**Energy from the Wind**
SEAL/Colorado State Univ.
Ft Collins, CO 80523
(303) 491-1869

**Home Power**
PO Box 520
Ashland, OR 97520
(800) 707-6585

**Journal of Wind Energy Technology**
Box 4008
St. Johnsbury, VT 05819
(802) 748-2425

**Journal of Wind Engineering**
655 Avenue of the Americas
New York, NY 10010
(212) 633-3730

**New Topper Windmills**
2508 Bartlett
Houston, TX 77098
(713) 524-0860

**O'Brock Windmills**
9435 12th Street
North Benton, OH 44449
(330) 584-4681

**Old Mill News**
111 S Main St.
Rockford, MI 49341
(615) 577-7757

**Real Goods**
966 Mazzoni St.
Ukiah, CA 95482
(800) 762-7325

**Rocky Mountain Institute**
1739 Snowmass Creek Rd.
Snowmass, CO 81654
(970) 927-3851

**Solar/Renewable Outlook**
951 Pershing Dr.
Silver Spring, MD 20910
(800) 274-6737

**Solar/Wind Technology**
655 Avenue of the Americas
New York, NY 10010
(212) 989-5800

**Southwest Windpower**
PO Box 22178
Flagstaff, AZ 86002
(520) 526-0997

**Trace Engineering**
5916 195th St. NE
Arlington, WA 98223
(360) 435-8826

**Wind Energy Technology**
DOE/OSTI
Springfield, VA 22161
(703) 487-4630

**Windmiller's Gazette**
PO Box 507
Rio Vista, TX 76093

**WindPower Monthly**
PO Box 4258
Grand Junction, CO 81502
(970) 245-9431

ond as ready-to-run and simply edited source code, and third as actual Acrobat .PDF demo results.

### Thoughts on Wind Power

The desert Southwest certainly has its unique set of sounds, from the 3 a.m. "yip-yarfs" of coyote pups to a sidewinder's rattle. But by far the most distinct signature is the classic creaking and groaning of an ancient Aermotor windmill pumping away in some remote wash.

You can still buy real Aermotor windmills new or used, whole or in bits and pieces. They are not cheap; a new twelve footer will cost you just under $9000 with the tower. But there are other sources, including New Topper Windmills and O'Brock Windmills, who also offers windmill books, consulting, and other energy services. I've gathered together some wind-power names and numbers as this month's resource sidebar.

A magazine known as the *Windmiller's Gazette* seems like a low-cost and informal way to get started. So does *Home Power*, along with their new CD ROM II. A handful of classic windmill books are offered by Lindsay Publications, while Amazon Books has most of the rest. I've got a commented and reviewed Amazon book access link newly up for you at www.tinaja.com/amlink01.html

Useful wind energy Web sites include www.ag.ohio-state.edu/~farm/wind.html, www.nrel.gov/research/wind/wind_bib.html, and www.me3.org/issues/wind. For a history of Aermotor, check into www.4kllamas.com/history.htm. One newsletter is awea.wind.home reached via tomegray@econet.org. Typical newsgroups include alt.energy, alt.energy homepower, alt.energy.renewable, and sci.energy.

Please let me know about any wind energy resources I may have missed. Especially any other books you like. A freebie *Incredible Secret Money Machine II* for your trouble.

### New Tech Lit

From Maxim, there's the new CD holding their *Full Line Data Catalog*. From USMikroChips comes a new *Hall Effect Solutions* data book. Microchip has a new second-edition CD on their technical library. Stanford Microdevices has produced a new *Wireless Product Catalog*.

Details on a new ISU inclinometer (electronic level) are available from SmartTool Technologies. A catalog on books and products for barcode stuff is available from System ID Warehouse.

Free samples for this month: a 1NA129 instrumentation amp from Burr Brown, and tactile dome switches from the Snaptron folks.

*Radio for the Millions* is the latest new-old title from Lindsay. It is full of vacuum-tube projects from the 1940s.

Useful tools for applying critical thought to pseudoscience claims appear in my BASHPSEU.PDF. With them, you can use your water-fueled black helicopter to supraluminally dowse for Brown's Gas in Roswell.

I have just added a new "Captain Video's Secret Mountain Laboratory" library page to my www.tinaja.com web site. It is mostly video and NTSC tutorials. I've also added lots of new files to the Cubic Splines library page.

I've gathered many of my earlier books together into my Lancaster Classics Library. Check my nearby Synergetics ad for more details. Or get one of our new online catalogs at www.tinaja.com/synlib01.html. Instant solutions to any technical or research problem can be found at www.tinaja.com/info01.html.

As usual, most of the mentioned items should appear in our Names and Numbers or Wind-Energy sidebars. Let's hear from you. EN

SAM GOLDWASSER
SERVICE EDITOR

# Troubleshooting a CD Player or CD-ROM Drive

I KNOW YOU CAN'T WAIT TO GET TO THE GOOD STUFF AND START REPAIRING, BUT THERE IS JUST A LITTLE MORE PREPARATION THAT NEEDS TO BE COVERED FIRST. AS I OFTEN SAY, "SOME OF THE MOST DESIRABLE TEST EQUIPMENT THAT YOU CAN OWN sits right between your ears." In other words, do a bit of analytical thinking before breaking out the spectrum generators and such. Many problems do not require a schematic of the equipment (though one is always useful). The majority of CD-player problems are mechanical and can be dealt with using little more than a set of precision hand tools, some alcohol, degreaser, contact cleaner, light oil and grease, and your powers of observation.

That said, a good or at least decent test bench is an asset. Let's look at some of the things that you might need to repair a CD player or CD-ROM drive. Some you likely already own. Other pieces of gear might be a little scarcer, but we'll show you how you can work around that in some cases.

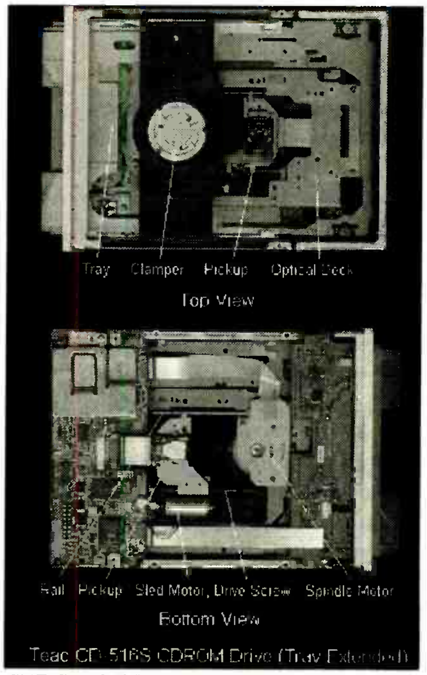
One piece of equipment that you are likely to own and need is a DMM or VOM to check power-supply voltages and sensors, LEDs, switches, and other components. Since you will be depending upon these readings, accuracy is important, yet many inexpensive meters will do the job nicely.

For other electronic problems including servo circuits, an oscilloscope is desirable. However, it too does not have to have all the bells and whistles. A 10- to 20-MHz dual-trace scope with a set of 10× probes is more than adequate for all but the most esoteric troubleshooting tasks.

To determine if the laser diode is working properly, a laser power meter is handy. Unfortunately, those instruments are expensive, but they are essential if you are to properly and safely adjust laser power. Fortunately, that's something that does not have to be done too often and for most common problems, all you need to know is if the IR laser beam is being emitted. An inexpensive IR detector card or even some camcorders can handle that job.

A stereo amplifier with loudspeakers is essential to allow your most important piece of audio test equipment—your ears—to function effectively. A lot can be determined by listening to the audio output of a drive or player. Over time, you will learn to distinguish between problems caused by dirt, lubrication or lack thereof, servo control, and other mechanical or electronic problems. By the way, when troubleshooting a CD player or CD-ROM drive, I suggest that you avoid using headphones as a sudden burst of noise could blow out your eardrums and spoil an otherwise perfectly good day.

An inexpensive test CD is also a nice thing to have. It will let you play known frequencies and volume levels. Note that a special test CD is not essential—just about any music CD will work just fine for most tests. However, to fully exercise the limits of the player, a disc with a full 74 minutes of music will be needed—Beethoven's *Ninth Symphony* is a good choice (even if you are not into classical




THE TEAC CD-516S CD-ROM drive is typical of late-model (1997), low-cost, high spin-rate units. Access to nearly everything is quite easy—just take out four screws total to remove the top and bottom covers.

music), since most recordings of it are very close (or sometimes even over) that length of time.

Hang on to old demo CDs and even obsolete CD-ROM discs (like the ones from AOL and MSN). They can be used for testing. When an optical deck develops a servo problem, the disc can end up spinning out of control. Stopping it suddenly can result in the CD scraping against the drawer or the base of the deck and getting scratched. Therefore, some "garbage" discs are always handy when testing.

To evaluate tracking and error-correction performance, any CD can be turned into a test CD with strips of black tape, a felt-tip marker, or even a hand drill! In fact, some professional test discs are made in exactly that manner.

**CAUTION:** The electronic components—especially the laser diode—in CD players, CD-ROM drives, and similar devices, are vulnerable to ESD (electrostatic discharge). There is no need to go overboard, but do take reasonable precautions like not wearing clothing made of wool (which tend to generate static). Get into the habit of touching a ground like the metal chassis before touching any circuit components. The use of an anti-static wrist strap would be further insurance, especially if the optical pickup assembly needs to be unplugged for any reason.

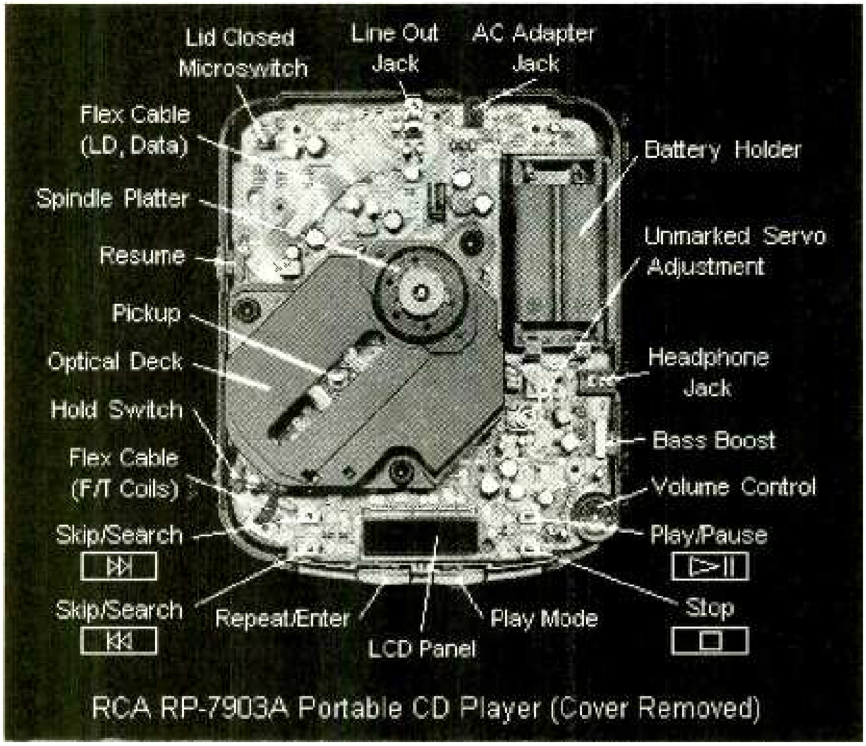
## Getting Inside the Player

OK we're almost ready to start. But first, here are some words of warning: By opening the case of the player you will void any warrantee. Obviously that means if a unit is still under warranty, it should be taken to an authorized professional for any covered repair.

Even if the unit is not under warrantee, you should be aware that by working on the unit yourself, you might make the problem worse—after all, you are not a professional service technician. If the player partially worked when you got it, it may no longer even recognize the disc directory if you make things worse. If you decide after working on it, that it should be taken to a pro, you may find that the service center will simply refuse to touch it. There is nothing worse than having to undo a "fix" introduced by a well-intentioned do-it-yourselfer. At best, you will be charged for this effort on a time and materials basis. It could well be very costly and not worth the expense. Be warned.

In other words, if the player or drive in question is one that must be returned to working order, the smart thing might be to take it to a professional from the beginning. On the other hand, if you are dealing with a unit that would be discarded anyway, why not give it a shot. Even if your repair is not successful, you will learn a lot in the process and therefore will be more likely to succeed the next time a similar problem crops up. Besides, it can be a lot of fun.

Once you've decided to try to repair your CD player, it is fairly easy to remove the top cover of most units There are usually some very obvious screws on the sides, and possibly on the back as well.




THE RCA RP-7903A PORTABLE CD PLAYER is typical of modern portables in that everything is crammed into a much-too-small space. Access to adjustments and circuitry are "conveniently" blocked when a disc is in place. The solder side of the PC board is even more fun to probe since the bottom cover also supports the optical deck assembly!

These are nearly always Philips-head types—make sure you use the proper screwdriver, especially if you expect to put the screws back again. Once all the screws are out, the top cover will lift up or slide hack and then come off easily. If it still does not want to budge, don't force it. Take another, more careful look, for an additional screw or two that you missed the first time around.

Once the top cover is removed, the optical deck and electronics board will usually be readily accessible. In most designs, the entire optical deck can be lifted out after removing the 3 or 4 screws that hold it in place. One of those screws may have a grounding contact under it. Make sure you remember where it came from and reinsert it carefully when you put the player back together after completing the repair. As you lift the deck out, watch for fragile flexible cables. Be careful and work slowly so that you do not damage them. These cables usually plug into connectors on the electronics board. Unplug them carefully.

In rare cases, removing the bottom cover will provide access to the solder side of the electronics board. However, in most CD players the bottom of the case is solid and the only way to get at the foil side of the board is to lift the board out of the case. In portable players, the bottom cover can usually be removed after taking out several very tiny screws—again use the proper-size Philips-head jewelers screwdriver. For CD-ROM drives, both top and bottom covers may be removable—it depends upon the model and manufacturer.

Make notes of screw locations and types. Immediately store the screws away in a pill bottle, film canister, or even an ice-cube tray.

When reassembling the equipment after the repair is done, make sure you route cables and other wiring carefully, so they are not pinched, snagged, or broken. Be sure you do not nick the insulation on any wires and keep the cables clear of moving mechanical parts. Replace any cable ties you cut or removed during disassembly and add additional ones of your own if needed. A little electrical tape provides handy insulation insurance as well.

## A Few Notes

Before we begin the troubleshooting part of this discussion, there are a couple of things that didn't really fit conveniently in our earlier discussions, but that you should be aware of before we proceed. Let's cover those now.

While CD players and CD-ROM drives have a common origin, and still have much in common, over time their technologies have diverged somewhat. The optical pickups remain similar, but the data processing and servo systems needed to support 24× and higher speed CD-ROM technology are much more sophisticated than those needed for 1× speed CD audio. So when you peek inside your shiny new CD-ROM drive, don't be surprised to see parts that differ rather considerably from those that you will find in a Discman.

The power supply in a component-stereo CD player is normally a linear supply that is both very reliable and easy to repair when necessary. In portables, however, you are likely to encounter a switching supply, possibly sealed in a shielded can, and difficult to repair. Usually, at least three voltages are needed: logic power ($+5V_{CC}$) and a pair of voltages for the analog circuitry ($\pm 15V$). However, some designs use a variety of voltages for the various portions of the analog circuitry.

The microcomputer controller, servos, read-back electronics, audio D/A(s) and filters are found on the unit's electronics board. Most servo adjustment potentiometers will be located there as well. In many cases, their functions are even clearly marked, but not always. Use some common sense here; do not turn anything unless you are absolutely sure of what your are doing—and then only after marking the potentiometers' original positions precisely.

## Instant Troubleshooting Chart

Now for the good stuff (and it's about time!). In this section I am going to present a variety of common problems and nearly all possible causes. You'll of course need to use diagnostic procedures to see which ones actually apply in your particular case. The possible causes are listed in approximate order of likelihood. While this chart lists many problems, it is does not cover everything that can go wrong. However, it does offer a starting point for guiding your thinking in the proper direction..

**CD player is totally dead.**
*Possible causes*:
1. Power outlet, wall adapter, or batteries are dead.
2. Damage to line or wall-adapter cord or plug.
3. Bad connections or faulty component in power supply (including blown fuse).
4. Defective microcontroller.

**CD player is operational but there is no or partial display.**
*Possible causes:*
1. Burned out backlight bulb(s).
2. Bad connections to display panel (totally dead or erratic).
3. Bad solder connections on display panel (some segments work).
4. Bad power supply.

**CD player ignores you.**
*Possible causes:*
1. Bad connections to one or more buttons or sets of buttons.
2. Microcontroller failed to reset properly.
3. Missing/incorrect voltages from power supply.
4. Defective microcontroller or other logic.

**Drawer does not open or close.**
*Possible causes:*
1. Worn, stretched, or oily belt.
2. Dirty mechanism or gummed-up lubrication.
3. Stripped gear or other mechanical damage.
4. Defective motor or bad connections to motor.
5. Bad drawer/eject button.
6. Missing/incorrect voltages from power supply.
7. Defective microcontroller or other logic.

**Drawer operation is erratic.**
*Possible causes:*
1. Dirty sense-switch contracts or bad connections.
2. Worn, stretched, oily, flabby, belt.
3. Dirty mechanism or gummed-up lubrication.
4. Defective motor or bad connections to motor.
5. Stripped gear or other mechanical damage.
6. Missing/incorrect voltages from power supply.
7. Defective microcontroller or other logic.

**Drawer does not close (or open) completely.**
*Possible causes:*
1. Worn, stretched, or oily, belt.
2. Dirty mechanism or gummed-up lubrication.
3. Foreign object such as a toy, rock, or runaway disc blocking drawer.
4. Stripped gear or other mechanical damage.
5. Gear timing is incorrect.

**Spindle table loose or sticks to clamper upon eject.**
*Possible causes:*
1. Set screw loosened or glue holding spindle to motor shaft has failed.
2. Parts of spindle table broken.

**Intermittent or erratic operation.**
*Possible causes:*
1. Dirty, scratched, or defective disc.
2. Dirty lens.
3. Extended length discs too long for player.
4. Loading (mechanical) not completed reliably.
5. Bad connections including missing/erratic optical-deck shield.
6. Cracks in ribbon cable to optical pickup.
7. Dirty drawer or limit switches.
8. Power supply or logic problems.
9. External interference.

**CD player or CD-ROM drive overheats.**
*Possible causes:*
1. Excessive ambient temperature.
2. Failing/marginal part in power supply or logic.

**Disc is not recognized (unit displays "disc," "error," etc.)**
*Possible causes:*
1. Disc loaded upside-down.
2. Transportation lock engaged.
3. Dirty, scratched, or defective disc.
4. Dirty lens.
5. Loading (mechanical) not completed reliably.
6. Dirt, gummed-up lubrication, or damage in sled-drive mechanism.
7. Dirty/defective limit switch or sensor.
8. Defective spindle motor.
9. Spindle table height incorrectly set.
10. Bad component in optical pickup.
11. Cracks in ribbon cable to optical pickup.
12. Need to adjust servo (or less likely, optical) alignment.
13. Faulty power supply, electronics or control logic.
14. Bad connections including missing/erratic optical-deck shield.
15. External interference.

**Disc spins in wrong direction or too fast and is never recognized.**
*Possible causes:*
1. Disc loaded upside-down.
2. Dirty, scratched, or defective disc.
3. Dirty lens.
4. Tracking or CLV servo out of adjustment or faulty.
5. Bad component in optical pickup.
6. Microcontroller or control logic problems.
7. Bad connections or defective ribbon cable to optical pickup.

**Pickup attempts to reset past inner track.**
*Possible causes:*
1. Dirty or defective limit switch, or faulty connections to it or its electronics.
2. Broken parts preventing limit switch from being activated.
3. Tracking servo out of adjustment or faulty.
4. Microcontroller or logic problems.

**Player won't let you go near it and/or use your favorite lamp.**
*Possible causes:*
1. Missing optical-deck shield, ground strap, or other connection.
2. Outside interference.

**Seek operations take too long or fail to complete.**
*Possible causes:*
1. Dirty, scratched, or defective disc.
2. Transportation lock engaged.
3. Dirty lens.
4. Tracking or CLV servo out of adjustment or faulty.
5. Mechanical problems with sled movement.
6. Faulty sled motor or drive IC.
7. Faulty control logic.
8. Bad flex cable to optical pickup.

**Search, seek, or play starts correctly, then loses time or position.**
*Possible causes:*
1. Dirty, scratched, or defective disc.
2. Dirty lens.
3. Tracking or PLL servo out of adjustment or faulty.
4. Stuck button.
5. Defective sled motor or drive IC.
6. Faulty control logic.

**Short-distance skipping.**
*Possible causes:*
1. Dirty, scratched, or defective disc.
2. Dirty lens.
3. Fine tracking servo out of adjustment or faulty.
4. Weak laser or other defective part in the optical pickup.

**Playback gets stuck (rapid repeat).**
*Possible causes:*
1. Dirty, scratched, or defective disc.
2. Dirty lens.
3. Dirt, gummed-up lubrication, or damage in sled-drive mechanism.
4. Transportation lock engaged.
5. Servo alignment needed.

**Occasional long-distance skipping or repeating.**
*Possible causes:*
1. Dirty, scratched, or defective disc.
2. Dirty lens.
3. Dirt, gummed-up lubrication, or damage in sled-drive mechanism.
4. Transportation lock engaged.
5. Servo alignment needed.

**Player gets stuck at approximately same time on different discs.**
*Possible causes:*
1. Dirt, gummed-up lubrication, or damage in sled-drive mechanism.
2. Sled reaching mechanical stop with extended-length (longer than 74 minutes) disc.
3. Transportation lock engaged.
4. Servo alignment needed.
5. Defective spindle motor.

**Various tracking problems on portions of discs:**
*Possible causes:*
1. Dirty, scratched, or defective disc.
2. Faulty spindle motor.
3. Misalignment of spindle table and sled track.
4. Need for CLV adjustment.

**Repetitive noise at disc rotation rate.**
*Possible causes:*
1. Dirty, scratched, or defective (possibly warped) disc.
2. Dirty lens.
3. Loose spindle or foreign material on spindle table.
4. Disc not firmly clamped.
5. Bent spindle.
6. Excessive spindle run-out due to worn bearing.
7. Servo alignment needed.
8. Weak laser or other component in optical pickup.

**Audio muting, noise, or distortion.**
*Possible causes:*
1. Dirty contacts on RCA jacks on CD player or amp.
2. Bad connections to RCA jacks.
3. Dirty/defective muting-relay contacts.
4. Defective components in the analog circuitry (final filter, muting, amp).
5. Faulty power supply (for audio circuits, if used)

## Wrap-Up

With the information we've presented thus far, in this section of CD and CD-ROM servicing, you have enough basic information to get started in your troubleshooting task. Next time we are going to look at what I call "General System Problems" and take a closer look at some of the items touched on in the troubleshooting chart.

That's all we've got room for this time. Between now and the next issue, if you have any specific problems or questions, you can reach me by e-mail at sam@stdavids.picker.com. For general information on electronics troubleshooting and repair visit my web site at www.repairfaq.org. EN

# EQUIPMENT REPORT

## SONY ELECTRONICS MVC-FD7 DIGITAL CAMERA

*A great set of features, and the fact that it stores images on standard floppy disks, make this new Sony possibly the easiest-to-use digital camera currently available.*

CIRCLE 15 ON FREE INFORMATION CARD


Digital cameras have been gaining in popularity among photographers, if not as a replacement for 35mm film, then surely as a supplement. Electronic images are a definite threat to Polaroid pictures, especially with the inexpensive, high-quality color printers on the market. And if you are only interested in placing your images on your computer or on the Internet, it costs essentially nothing to take as many digital photographs as you wish.

That's because you are not dealing with photographic film. Instead, images are stored in some type of memory. Many less-expensive cameras offer internal storage that can not be expanded. They hold no more than 50 images before they are full. You then need to download the images to your computer using, typically, a serial interface. That works fine, but it can be time consuming if you have a lot of pictures to transfer.

Better cameras offer expandable storage in the form of removable memory cards. Once the camera fills up, just slip in another card and keep on shooting. There are a couple of drawbacks here, however. Since these are the same cards that are used in laptops, they can be read by almost all laptop computers. But to transfer the images to a desktop computer, things get a little more complicated: The computer must be equipped with an accessory card reader or you need to resort to the much slower method of using a serial interface. Also, the memory cards are not cheap.

Of course, there has to be a better way to handle image storage and transfer, and it seems that Sony has found it in their *MVC-FD7 Digital Mavica* floppy-disk camera. As the name implies, this PC- and Mac-compatible digital camera uses plain old high-density floppy disks to store images. Floppy disks are the universal storage medium for personal computers—every one has a floppy drive, so it's easy to transfer images. What's more, floppy disks are fairly cheap these days, even new, and if you are the type that likes to recycle, you likely get free disks in the form of junk mail all the time. Veteran computer users also probably have a boxes full of old software on floppy disks that they would never in a million years run again.

Storing images on floppy disks eliminates the need to bring a notebook computer on trips. And because the camera has its own built-in color screen, a user can simply swap disks in and out of the camera to view or delete images. A single floppy disk can hold approximately 20 high-quality images or 40 images with greater compression applied. Images take up about 50 kilobytes each in standard mode and 100 kilobytes in fine mode. A stack of floppy disks thrown into a shoulder bag is enough "film" for any trip.

### Digital Mavica MVC-FD7

Larger than it might look in photographs but still relatively small, the MVC-FD7 measures 4¾-inches wide by 4¼-inches high by 2¾-inches front to back. It weighs 1.3 pounds. It is amazingly compact considering it contains a full CCD assembly and 10× optical zoom lens, a complete floppy-disk drive, and a color LCD monitor. It also has a built-in flash. The flash takes only a few seconds to charge, but the camera takes about 10 seconds to store a captured image on disk.

In true Sony form, the MVC-FD7 is beautifully carried out in every detail. A small back-up battery keeps time and date memory safe when the rechargeable battery loses power or is removed. The camera comes with a hand strap and battery charger. One small gripe: It would be nice if the camera had a built-in handle because, even with its molded-in, rubber finger grip, the unit is a bit awkward to hold.

The MVC-FD7 stores JPEG (.jpg) images on 3.5-inch high-density floppy disks. Image size is 640 by 480 pixels. Images are previewed or reviewed on the unit's 2.5-inch LCD, which features a brightness control. Up to six images can be viewed at a time if desired. There is also a time-stamp function for individual images. Menu settings and an on-screen display control all of the camera's functions.

The camera has a ¼-inch CCD and a 35mm-equivalent, *f*4.8 to *f*1.8, 40mm to 400mm, auto-focus optical zoom lens. Macro capability enables shots from less than an inch away from the lens. The macro mode activates automatically in wide angle, and it works with auto-focus, though focusing can be done manually as well. The Mavica also features auto-exposure and white balance with five pre-programmed exposure override modes and 1/60- to 1/4000-second shutter speeds. Special settings are available for different types of environments: Portrait, Landscape, Beach and Ski, Sports (fast motion), Sunset, and Moon (night scenes). There are also four pre-programmed special-effect modes—Monotone, Negative, Pastel, and Sepia—

*(continued on page 30)*

BY JEFF HOLTZMAN
COMPUTER EDITOR

# Turn Your PostScript Printer Into a Virtual Line Printer

I RAN ACROSS A PRETTY COOL SOURCE-CODE PRINTING UTILITY RECENTLY AND THOUGHT I'D SHARE MY EXPERIENCES WITH YOU. I FOUND THE SOURCE CODE TO THE UTILITY POSTED (SOMEWHERE) ON THE INTERNET; IT WAS ORIGINALLY DEVELOPED by Smadi Paradise at The Hebrew University of Jerusalem about ten years ago, and contains no copyright statement.

There are lots of "pretty-printing" utilities out there; what made PPS (which I think stands for PostScript Printing System) interesting was its multi-lingual capabilities—*i.e.*, its ability to print programs in a multitude of source languages intelligently. As supplied, PPS supports the following languages: awk, C, csh, lisp, list, mail, PostScript, sh, and plain text; and adding other languages is straightforward. In addition to the raw code, PPS can print line numbers, highlighted keywords, and function names in the margin rotated 90°, which is handy for flipping through self-published source-code reference guides.

As you could probably guess by the supported language list, PPS was developed on, by, and for UNIX use. What I've done is unpack the UNIX shell archive containing all the source files, decode the outer shell script handler (roughly equivalent to a DOS batch file), create build files for compiling the program with GCC (that's the GNU C Compiler, discussed here in the November 1997 issue), and build a trial version that runs on Win32 and print programs written in C. I also uncovered a few bugs and incompatibilities, and I developed a list of desirable improvements.

What makes this project interesting is its multi-lingual nature, and the way the PostScript output files are built up in chunks and concatenated together to form the final output file. The biggest technical problem I had was in fixing the line of code shown in Fig. 1. Can you guess what the problem is? The answer appears at the end of this article.

```
#define begin(S) (sput(), (BEGIN (S)), font= "S")
```

**FIG. 1**—THE BIGGEST TECHNICAL PROBLEM I had was in fixing the line of code shown here. Can you guess what the problem is? The answer appears at the end of the article.

## Getting Started

The first problem was getting the input into some kind of usable shape. All the source code and documentation files (in UNIX MAN format) were concatenated into a file called PPS, which was in turn compressed into a UNIX compressed file, PPS.Z. My Windows shell program (Explorer Plus) knows about ZIP archives, Z archives, and several others, so recovering the raw PPS file was easy. PPS is a text file, but in UNIX format, meaning a line feed but no carriage return at the end of each line. My text editor (Qedit) automatically converted the file to Wintel format.

I'm no UNIX shell archive or scripting expert, but in examining the file, I saw enough plain C and PostScript code that I felt pretty confident I could figure out what was going on and make it work on Wintel. All the component files within a shell archive are crammed together; that's the meaning of a shell archive. However, it's pretty easy to see where each file leaves off and the next file begins, so a few minutes of manual cutting and pasting allowed me to create the original set of source files. Under UNIX that could have been done automatically, by running the shell archive like a batch file.

After I figured out how the major pieces fit together, I was impressed with how clever and concise the original design was. After actually getting it to work on a Wintel system, however, I was a little disappointed with some of the author's PostScript coding conventions, which made it hard to decipher what was going on, where different components came from, and how they fit together. Also, there's a fundamental flaw that goes against the spirit of PostScript programming, and makes this tool less useful than it could have been. Still, it really is a multi-lingual tour-de-force.

The original shell-script implementation provided command-line parameters that allowed the user to specify:

- Separate fonts for comments, keywords, quoted strings, and everything else;
- Header to display on each page;
- Source language of the file to be printed;
- Line-numbering increment;
- Font size;
- Tab-stop size; and
- Line spacing.

There also seemed to be an option to use a kind of stylesheet, or collection of display characteristics stored in a disk file (as PostScript code).

## The Control Program

After studying, experimenting, more studying, and more experimenting, I came to realize that the function of pps.sh—the "batch file" controlling overall operation—is to assemble a print file in PostScript format out of the following six major chunks.

**1.** First is a standard PostScript header, complete with parameterized placeholders for printing filename, user name, and computer name. The header was contained in pps.sh, and was dynamically extracted, along with the substituted parameters for file, user, and computer name, and stored as the first chunk of the print file. I always knew the DOS batch language lacked something.

**2.** Next comes a static file (pps.pro) containing the workhorse PostScript code, essentially a set of subroutines and definitions.

**3.** The third major chunk is a style sheet. At the end of PostScript code file (item 2) I found a set of PostScript definitions specifying the print characteristics (font, line spacing, etc.) outlined above. While debugging the system, I kept getting a PostScript error. It turned out that the style definitions came after a routine that called them. By moving that section of the file from the bottom to the top of the file, those problems disappeared. Also, it appears that variations of the "Style" section could be used as the externally defined stylesheets referred to above. I didn't actually test that capability. This points out one of the dangers of picking up software off the Internet. Perhaps the author originally posted a buggy version of the pps system. Perhaps an updated version was posted. Perhaps not. At least with source code it is possible to step through the system, determine errors, and fix them.

**4.** The fourth chunk allows stylistic overrides of previously defined style values using command-line parameters (or within a batch file) at run-time. During execution, pps.sh builds up an environment variable called init. Initially, init contains only a call to the ppsinit routine defined in pps.pro. But if the user specified, say, a font change, the shell file would append a new PostScript font definition to init, which eventually would get copied to the output file. Because of processing order, and the way PostScript dictionaries work, later definitions simply override earlier ones.

**5.** Chunk five is generated by a separate compiled program; a different program is called depending on the source language. It's quite a clever arrangement, as we'll see momentarily.

**6.** The last portion of the output file is simply a PostScript trailer, which calls a routine in pps.pro called ppsdone, which in turn simply forces the last page out of the printer.

## Lex

Even if you've never had any formal language theory, you may have run across a pair of programs called lex and yacc. Together they can be used to build programming language compilers and related tools. Lex is also useful by itself. Lex and yacc are typically considered UNIX tools, but versions are available for Wintel via GNU. The Wintel versions are known as Flex and Bison, respectively; however I'll refer to these types of tools generically simply as lex and yacc.

What lex does is give you a way to specify patterns you want to recognize when scanning a text file, such as program source code. You specify the patterns using a cryptic, concise, and extremely powerful notation known as regular expressions. (File-specification "wildcards" like *.txt are a simplified kind of regular expression). You can associate a block of C code with each pattern; that code gets executed whenever lex recognizes the associated pattern.

The way it all fits together is this: You create a lex specification, which specifies the patterns and code. Then you run the lex spec through lex. It creates a C source-code file, which you then compile and link with your main program.

In our case, the main program is a generic PostScript code generator called lind.c (language independent PostScript interface). Now, say we create a lex spec, c.l, for the C language. We run c.l through lex, which creates a file called lexyy.c. Next we compile and link lexyy.c and lind.c, producing pps.exe. We then use pps.exe to process a C-language source file, producing a PostScript print file of the original source file. Using lex's pattern matching, we can do things like recognize function definitions, quoted strings, and comments, and print them in various styles, and even at various places on the page, such as in the margin.

To add languages, we only have to create a new lex spec, run it through lex, compile the new lexyy.c, link it with the same lind object file, and give the resulting executable a new name.

## Tradeoffs

The bad news is that there are some limitations and some bugs (some documented, some not). The main undocumented bug I've found is that long input lines are not broken up; they're simply replaced by an ellipsis character (which looks like three periods). It would be better to truncate the line and put the ellipsis in the right margin where the line numbers and function name "subtitles" appear. With PostScript, you get truncation automatically, so doing so cleanly would not be difficult.

Even better, of course, would be to do word wrapping. Why didn't the author implement word wrapping? The answer requires us to delve into the deep architecture of the PostScript page generation code.

Most non-PostScript printers have a notion of a cursor (the printhead in the case of a dot-matrix printer) that advances each time a character is received. If more characters are received than will fit on a line, the "cursor" typically advances to the next line.

PostScript doesn't wrap; it just keeps on going. PostScript has no concept of rows or columns. You can at any time put the cursor anywhere, to any degree of precision, and start drawing or stroking text.

More generally, PostScript provides an infinitely scaleable, infinitely sized drawing plane. You can put whatever you want wherever you want on this plane. You can then scale the plane to be exactly the size of a physical page, or half the size, or twice the size, and so forth. You can also arbitrarily change the ori-

### RESOURCES

PowerDesk Utilities, Mijenix Corp., Madison, WI; Tel: 608-277-1981; Web: www.mijenix.com.

Qedit, SemWare Corp., Marietta, GA; Tel: 800-467-3692; Web: www.semware.com.

### REFERENCES


*lex & yacc*, John R. Levine, Tony Mason, Doug Brown, O'Reilly & Associates, Inc, 1995, ISBN: 1-56592-000-7

*Compilers: Principles, Techniques, and Tools*, Alfred V. Aho, Ravi Sethi, Jeffrey D. Ullman, Addison-Wesley, 1988, ISBN: 0-201-10088-6

*Models of Computation and Formal Languages*, R. Gregory Taylor, Oxford University Press, 1998. ISBN: 0-19-510983-X

gin from which printing begins, thereby providing the ability to print large drawings in "tiles" on small pieces of paper, or, conversely, printing multiple logical pages on a single physical sheet.

By analogy, what the author of PPS did was implement a virtual line printer within PostScript. Actually, that's not strictly true; rows are counted, but columns are not. However, PostScript provides an operator for easily determining the width of a string, so proportional fonts may be used.

The PostScript code in pps.pro is what lays out the text on the page, not the C code in the lexer or in lind.c. The problem is that the PostScript language is not exactly optimized for easy string handling, such as implementing a word-wrap algorithm. Of course, it can be done; it's just not easy, straightforward or efficient.

The disadvantage of this approach is that page breaks cannot be predetermined. In a typical PostScript print file, you will see a number of *showpage* commands, each of which forces the current page to be printed. In the PPS approach, the PostScript routine that counts lines only executes *showpage* when it determines there is a need to.

The problem with this is that you cannot "post-process" the generated PostScript file to achieve special effects. For example, it's fairly simple to print two portrait pages side by side in landscape mode on a single sheet of paper by post-processing standard PostScript output. Basically, you just gather everything comprising the left hand page, rotate it 90°, scale it, and place it. Then you do the same to the right-hand page, but add an offset in the horizontal direction. *Voila.*

You can't do that with PPS output, because PPS essentially treats text as a stream to be interpreted by the virtual line printer. Oh, well. It's still a neat hack. I'll post the original source, as well as my Wintel-ized version on the Ingeneering Web site (www.ingenic.com); look for file PPS. ZIP.

Oh, yes; I almost forgot. The problem with the code in Fig.1 is that the macro expansion of font = "S" fails. Diagnostically, what happened was that font changes weren't occurring. The reason was that the generated code always contains an upper-case S, rather than the value of the substitution parameter. Modern compilers want to see this: font = #S. EN

## EQUIPMENT REPORT

*continued from page 27*

that can add interesting effects to images. Rounding out the unit's impressive line-up of features, there's a standard tripod mount built into its base and a self-timer so the photographer can get into the shot.

The unit uses a rechargeable lithium battery. Though it comes with only one battery, a single charge is good for up to 500 shots if the flash is not used. Extra batteries are optionally available. The lithium battery takes a normal charge after 165 minutes and a full charge (charging for an hour after the charge light goes off) after 225 minutes.

The camera is intuitive in its operation. Just like a camcorder, there are two modes: play and camera. In fact, this unit is just like a camcorder in many respects. The chief exception is that it stores still images on floppy disk instead of video on tape.

However, no matter how good the camera or photographer, sometimes we need to touch up or otherwise change an image. That's where the bundled ArcSoft PhotoStudio software comes in. That capable package lets users manipulate images, add text, change backgrounds, and so on. For many, this package is the only image-processing software that will ever be needed.

Considering all of the above, it is plain to see that the Sony Digital Mavica MVC-FD7 is just about the most user-friendly digital camera in town. It is easy to use, comes bundled with everything you need, and you don't need a serial cable or a notebook computer to transfer the images to your PC or Mac.

The Mavica's carries a suggested list price of $799, but as with all things computer or consumer-electronics related, it is likely to be discounted at major electronics outlets. And for budget-conscious buyers, there's a less-expensive model available, the MVC-FD5, that doesn't have the zoom lens and special-effects modes.

For people who want quick, no-nonsense digital images, there is no more convenient choice in digital cameras than the Sony Digital Mavica MVC-FD7. For more information on it, contact Sony (1 Sony Drive, Park Ridge, NJ 07656; Tel: 1-800-342-5721; Web: www.sony.com) directly, or circle 15 on the Free Information Card. EN

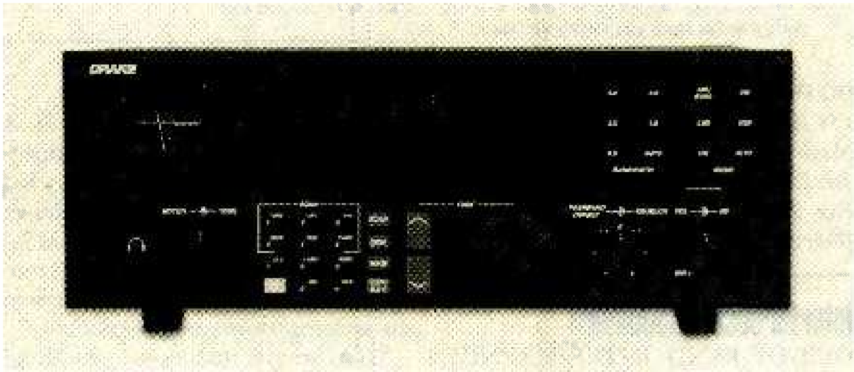
# NEW PRODUCTS

USE THE FREE INFORMATION CARD FOR FAST RESPONSE

## Communications Receiver

ALTHOUGH SIMPLE ENOUGH TO use for the beginner, the R8B world-band communications receiver is equipped with plenty of high-powered features for the hobbyist and expert. Selectable sideband synchronous detection ensures that signals are received loud and clear. In the AM mode, this feature provides enhanced reception by eliminating or reducing distortion caused by fading signals. In conjunction with multiple filters and passband offset, it gives the listener outstanding audio.

This receiver also offers standard features that increase the performance of the radio. A built-in noise blanker minimizes electrical interference. The passband-offset control minimizes or eliminates adjacent-signal interference, without compromising intelligibility. This feature is particularly useful for clarifying reception of distant signals that can be dwarfed by strong adjacent signals. To receive weak or fading signals, the radio uses a selectable AGC delay, as well as the synchronous detector. A built-in pre-amp and attenuator also improves reception.



CIRCLE 20 ON FREE INFORMATION CARD

The receiver's 1000 programmable memory positions conveniently store frequency, bandwidth, and mode data. Multiple scan functions allow users to easily scan frequencies or selected memories by carrier, time, or seek modes. The R8B also offers sequential tuning through all memory preset channels, which are stored on an electronically erasable memory chip that retains information even in a power outage.

Wide frequency range (100 kHz to 30,000 kHz) provides coverage of all world bands. Additional VHF bands (33-55 MHz and 108-174 MHz), including marine and aircraft bands, are also available with an optional VHF converter. Five built-in filter bandwidths ensure reception of most signals under virtually any conditions.

The receiver measures approximately 5- by 13- by 13-inches. Its front-panel ergonomics—keypad entry of all functions, large and legible controls, and descriptive displays—makes the R8B easy to use. Direct independent entry of mode and bandwidth via the keypad provides quick and easy selection of receiver operating parameters. Most operations can be executed with a single key press. The front panel then indicates the status of the selected parameter. Selectable kHz and MHz display modes are provided for display and entry of frequencies. There is also a seven character alphanumeric LCD display for the broadcast station name and frequency.

The R8B also includes a tone control, a mute switch for use with a transmitter, a RS232C serial interface for remote control, a built-in speaker, two clock timers, dual antenna inputs, and a headphone jack. The built-in multi-voltage power supply allows operation virtually anywhere. The R8B retails for $1199.

**R.L. DRAKE CO.**
*230 Industrial Drive*
*Franklin, OH 45005*
*Tel: 513-746-4556*
*Fax: 513-743-4510*
*Web: www.rldrake.com*

## Video-Capture Products

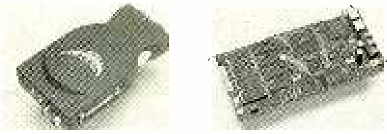
TWO NEW PRODUCTS, DAZZLE and Snazzi, are based on the MPEG-1 international standard, which allows the highest quality, full-motion video to be captured, edited, and placed into popular Windows entertainment and business applications in seconds. Snazzi and Dazzle capture video at a TV-quality 30-frames-per-second. These video files can then be played back at full-screen resolution with exceptional quality. Users can preview and see recorded images instantly.

Dazzle is an easy-to-install 5.25- by 3-inch external adapter that snaps directly onto a computer's external parallel port. Snazzi is a PCI add-in card designed to provide more extensive features including advanced editing and video "edit to tape" capabilities. Both products use a five-button on-screen software control panel that's easy to operate, and they both allow video and photos to be captured from any video source, including a camcorder, VCR, TV, laserdisc, or DVD.

Finished video and multimedia projects can be stored on hard drives or on removable media or sent to others via the Internet. Snazzi and Dazzle offer the highest video compression rate available—approximately 200 times. Recorded videos don't consume a large amount of disk space, and they can quickly and easily travel over the Internet without degrading image quality or taking a long time to download. The videos can also be recorded on CDs and played back on DVD, CD-ROM, or video CD players.

No special equipment or software is needed to view these images on a computer. Anyone using a Windows 95 PC can receive a still or video clip via CD, diskette, or e-mail, and can view the movie simply by clicking on the file.

Both Snazzi and Dazzle ship with full versions of eight popular software products, including Adobe PhotoDeluxe, Gryphon Morph, MetaCreations Kai Power Goo, InterActual VideoSaver, Astound Studio M, Cinax iFilmEdit, Stefra Video Control, and VDOnet and VDOPhone. Snazzi ships with two additional software products, Ulead Media Studio 2.5 and CeQuadrat WinOnCD 3.0. The suggested retail price is $299 for Dazzle and $399 for Snazzi.



CIRCLE 21 ON FREE INFORMATION CARD

**DAZZLE MULTIMEDIA**
*45778 Northport Loop West*
*Fremont, CA 94538*
*Tel: 888-436-4348 or 510-360-2300*
*Fax: 510-623-5894*
*Web: www.dazzlemultimedia.com*

## True RMS Meter

AMONG THE ADVANCED FEATURES available in the HC Protek Model 505 Digital Multimeter are true rms and signal injection. The 505 provides auto ranging, dual display readout of frequency, AC voltage and temperature, a 10-location memory, analog bargraph, backlit LCD display, and full annunciators, as well as a 4000 count, $3^3/_4$-digit readout.

This DMM measures decibels, inductance, and capacitance. It has a time mode (with alarm clock) and a stop watch function, in addition to min/max, average, and relative mode functions. Continuity, diode testing, auto power off, data hold, low-battery indication, a fused 20A input with warning beeper, and overload protection are some of the other features.

The Model 505 digital multimeter (8- × 3.5- × 1.5-inches) is bundled with removable rubber holsters for on-the-job protection, test leads, alligator clips, batteries, temperature probe, and instruction manual. It retails for $169.95.


CIRCLE 22 ON FREE INFORMATION CARD

**HC PROTEK**
*154 Veterans Drive*
*Northvale, NJ 07647*
*Tel: 201-767-7242*
*Fax: 201-767-7343*
*Web: www.techexpo.com/WWW/hcprotek*

## Interference Attenuators

OUT-OF-BAND INTERFERENCE can come from many sources, including paging, cellular, business, police, fire, and other VHF high-power transmitters, as well as from TV and FM stations. Such interference can produce squeals, squawks, bleeps, noises, paging tones, and unidentified voices, wreaking havoc with two-meter handheld units or mobile stations. To combat that, the MFJ 713/714 IntermodFighters can attenuate out-of-band interference up to 50 dB.

These units each offer three high-Q bandpass filters and two L-sections to provide razor-sharp selectivity. Interfering signals below and above two meters are greatly attenuated, while leaving the desired signal alone. Intermod is eliminated during receive, but the filter is automatically bypassed during transmit.

The MFJ 713 is designed for handheld devices and is equipped with BNC connectors. To eliminate intermod, remove the transceiver's rubber-duck antenna and replace it with the MFJ 713. Then attach the antenna to the MFJ 713. For mobile stations, place the MFJ 714 between the mobile rig and antenna coax, using its SO-239 connectors. The 713 is powered by an included 9-volt battery, and the 714 uses external 12 VDC.

Both units have an on/off switch, LED, and power jack. They each sell for $59.95.

CIRCLE 23 ON FREE INFORMATION CARD

**MFJ ENTERPRISES, INC.**
*300 Industrial Park Road*
*Starkville, MS 39759*
*Tel: 800-647-1800 or 601-323-5869*
*Fax: 601-323-6551*

## RAM Troubleshooting Utility

RAM STRESS TEST (R.S.T.) IS A self-booting, operating-system-independent utility program for exercising and testing RAM in AT 386 through Pentium systems. R.S.T. uses direct hardware interrogation calls to implement its test routines, which means it can operate without the assistance of an operating system.

Tests are run from easy-to-use drop-down menus in manual mode or run in auto burn-in mode. In manual mode, users can select from a group of test algorithms, including LEAK—the most thorough RAM test available. It will also test the data bus, address lines, and refresh circuit. In auto mode, the program will automatically select the most popular algorithms and run a test cycle for 48 hours, emitting an audible signal when an error is detected.

R.S.T. allows users to test RAM without the interference of memory drives, TSRs, operating-system limitations, or Windows protected-mode environment. All tests are run in protected mode, which can completely test up to four gigabytes of memory. This utility gives users the option of running complicated test patterns to detect hard-to-find memory errors or memory errors not detected by other software. The retail price for RAM Stress Test is $69.

CIRCLE 24 ON FREE INFORMATION CARD

**ULTRA-X, INC.**
*1765 Scott Blvd., Suite 101*
*Santa Clara, CA 95050*
*Tel: 800-722-3789 or 408-261-7090*
*Fax: 408-261-7077*
*E-mail: pcdiag@ultra-x.com*
*Web: www.uxd.com*

## Cable End Adapter

USING THE MODEL 232SAER interface adapter from B&B Electronics, the sophisticated on-board diagnostics systems of heavy-duty vehicles can now be accessed by means of a laptop or desktop PC. The adapter simply plugs into the RS-232 port of a PC. It converts SAEJ1708, the specification for serial communications between computer diagnostics systems in heavy-duty vehicle applications, to RS-232 specifications readable by your PC.

Once the adapter is connected, over 20 categories of vehicle condition may be addressed via the PC. The converter is self-powered from the RS-232-port handshake lines, and may be optionally powered by a 12VDC supply. The RS-232 side of the converter is DB-25 female and is configured as a DCE device.

Also available is the Model 1708CAB, a heavy-duty cable with the industry-standard 6-pin circular connector used in most J1708 systems. The cable is six feet long, and its tinned cable ends connect easily to the terminal block on the Model 232SAER.

The Model 232SAER interface adapter costs $59.95, the optional power supply is $14.95, and the Model 1708CAB heavy-duty cable is $49.95.

CIRCLE 25 ON FREE INFORMATION CARD

**B&B ELECTRONICS MANUFACTURING CO.**
*707 Dayton Road*
*Ottawa, IL 61350*
*Tel: 815-433-5100*
*Fax: 815-434-7094*
*Web: www.bb-elec.com*

## Hardware Component Kits

THIS ENGINEERING PROTOTYPE Kit from RAF provides a useful collection of electronic hardware components. The kits are filled with hardware components that can be used in new designs, repairs, and replacements. Each kit contains an assortment of component sizes, styles, materials, and finishes.

The sturdy carrying cases are filled with any one of eight component selections, or users can pick any two, four, or all eight selections. Hardware includes standoffs, swage standoffs, male/female standoffs, spacers, captive panel screws and retainers, shoulder screws and thumbscrews, flat washers, and shoulder washers. The Engineering Prototype Kits cost $99.99 plus shipping.

CIRCLE 26 ON FREE INFORMATION CARD

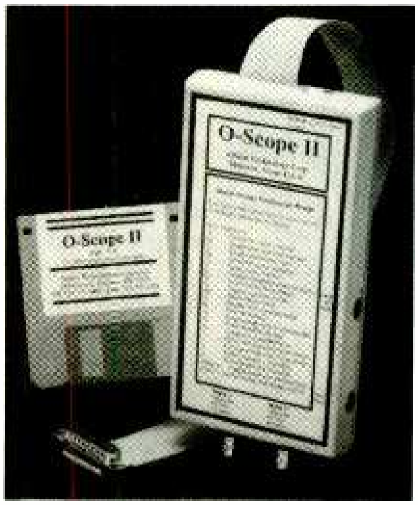
**RAF ELECTRONIC HARDWARE**
*95 Silvermine Road*
*Seymour, CT 06483*
*Tel: 203-888-2133*
*Fax: 203-888-9860*
*E-mail: info@rafhdwe.com*
*Web: www.rafhdwe.com*

## PC-Based Oscilloscope

THE O-SCOPE II MODULE CONVERTS a PC into an advanced digital storage oscilloscope and data logger. It provides oscilloscope, voltmeter, frequency-spectrum analyzer, and data-logger functions suitable for many applications.

Data may be captured to disk or transferred to other Windows programs. Display screen data may be captured graphically for printouts or may be converted to graphic images. In addition, the module features simultaneous two-channel data sampling, bandwidths up to 250 kHz, and sampling rates up to 1 Meg/sec.

The O-Scope II works with standard probes and is powered from 12VDC. A variety of probes are offered for the unit, including standard attenuating probes, high-voltage probe, differential probes, and automotive-ignition probes. The O-Scope II sells for $349 and includes the module, manuals, AC-power adapter, cable, and both Windows and DOS software packages.




CIRCLE 27 ON FREE INFORMATION CARD

**ALLISON TECHNOLOGY CORPORATION**
*8343 Carvel*
*Houston, TX 77036-6301*
*Tel: 800-980-9806 or 713-777-0401*
*Fax: 713-777-4746*
*Web: www.atcweb.com*

EN

# NEW LITERATURE

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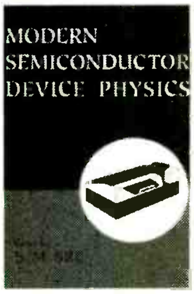
## Modern Semiconductor Device Physics

*Edited by S. M. Sze*
*John Wiley & Sons, Inc.*
*605 Third Avenue*
*New York, NY 10158-0012*
*Tel: 800-225-5945*
*Web: www.wiley.com*
**$69.95**




CIRCLE 338 ON FREE INFORMATION CARD

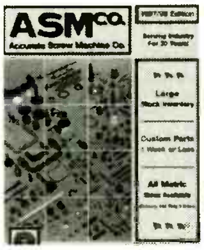
The companion volume to the Second Edition of Dr. Sze's *Physics of Semiconductor Devices*, this book covers all the significant advances in the field over the past decade. It is organized in the same format with chapters arranged in a similar sequence.

Providing the most authoritative, state-of-the-art information on the physics and operational principles of all modern semiconductor devices, this in-depth, up-to-date presentation was written by renowned experts in each area. Topics include bipolar transistors, compound semiconductor field-effect-transistors (FETs), MOSFET and related devices, power devices, quantum-effect and hot-electron devices, active microwave diodes, high-speed photonic devices, and solar cells.

With hundreds of illustrations, and references and a problem set at the end of each chapter, this book is the essential text/reference for electrical engineers, physicists, material scientists, and graduate students in micro-electronics and related fields. Useful appendixes provide lists of symbols, units, constants, and semiconductor properties.

## Electronic Hardware Catalog

*Accurate Screw Machine Company*
*10 Audrey Place*
*Fairfield, NJ 07004*
*Tel: 973-244-9200*
*Fax: 973-244-9177*
*Web: www.accuratescrew.com*
**Free**




CIRCLE 339 ON FREE INFORMATION CARD

This catalog provides illustrated information on spacers, standoffs, locking fasteners, captive screws, washers, handles, and other electronic hardware. In addition to most items in stock, custom products can be specified using the catalog.

Each item is accompanied by a drawing, complete measurements, and specifications. All products are available in metric sizes, and no minimum orders are required. The Electronic Hardware Catalog also contains engineering tables listing specifications for machine products and stamped products, as well as plating, metric, and screw specifications. Other tables cover finishes, tolerances, and compatibility selection.

There are two indexes. The pictorial index found at the front has drawings of all the different products offered and is arranged alphabetically. The index at the back is organized by part number.

Available in diskette or CD-ROM form, as well as in the 320-page printed version, all three versions of the catalog are free. The CD-ROM and diskette formats have full-scaled drawings that can be exported for use by most CAD drawing software.



## Relays and Circuit Breakers, 5th Edition

*NTE Electronics, Inc.*
*44 Farrand Street*
*Bloomfield, NJ 07003*
*Tel: 800-683-6837 or 973-748-5089*
*Fax: 800-683-3338*
*Web: www.nteinc.com*
**Free**

CIRCLE 340 ON FREE INFORMATION CARD

The fifth edition of this catalog presents NTE's complete family of relays, as well as the company's full line of circuit breakers. It is a comprehensive cross-reference containing over 534 relays and accessories, matched to over 41,000 U.S., Asian, and European part numbers from 212 different manufacturers.

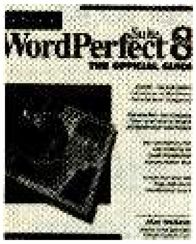
Among the products covered are five recently introduced series. The R26 and R27 series of programmable timers feature repeat cycles and 16 timing ranges. The R52 Series is a 40-amp PC-mountable open-frame relay available in SPST and SPDT configurations. The R73 Series is a 10-amp subminiature PC-mount relay designed for security and telecommunications equipment. Finally, the 1-amp DPDT low-signal relay comes in standard and surface-mount packaging.

Also featured is a relay-selector guide containing helpful information for industrial, consumer, telecommunications, HVAC, automotive, and security applications. The entire catalog can be accessed directly at the web site mentioned above.

## Corel WordPerfect Suite 8, The Official Guide

*by Alan Neibauer*
*Osborne/McGraw Hill*
*2600 Tenth Street*

*Berkeley, CA 94710*
*Tel: 800-264-4729 or 510-549-6600*
*Fax: 510-549-6603*
*Web: www.osborne.com*
**$34.99**



CIRCLE 341 ON FREE INFORMATION CARD

As the only official guide for the popular WordPerfect program, the book provides an invaluable resource for mastering all aspects of Corel's Suites 7 and 8. This 665-page guide is written in a step-by-step format to help users maximize the power and effectiveness of each of the Suite's components.

Easy-to-follow lessons help readers master such tasks as turning out elegant reports, using cutting-edge graphics, giving first-class presentations, integrating files, and launching a web site. Using Corel's complete toolkit is explained: WordPerfect, Quattro Pro, Presentations, Corel FLOW, Netscape Navigator 3.0, Envoy, and more.

Because the book is organized by Suite applications, it does not have to be read cover to cover. The first two chapters introduce you to the suite, but then readers can jump ahead to the section of most interest. To begin with, the common elements that run through the major applications are discussed, including the Corel Address Book, file management with QuickFinder, the Scrapbook for inserting clipart, and writing tools such as Spell Check.

The remaining chapters cover more advanced subjects. Chapter 3 explains how to use Netscape Navigator for e-mail and web-surfing. The next ten chapters are all about WordPerfect. Corel Quattro Pro is the focus of Chapters 14 through 21, and Corel Presentation is covered in Chapters 22 through 24. Finally, the last two chapters discuss Envoy and Photo House.

---

## Digital Panel Meters

*DATEL, Inc.*
*11 Cabot Boulevard*
*Mansfield, MA 02048*
*Tel: 800-233-2765 or 508-339-3000*
*Fax: 508-339-6356*
*Web: www.datel.com*
**Free**

This 16-page, full-color brochure describes DATEL's offerings of two-

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wire digital panel meters (DPMs). Unlike other short-form catalogs, this brochure provides enough detailed electrical and mechanical information for design engineers to make informed buying decisions. It also gives an overview of the company's broad selection of miniaturized, general-purpose DPMs.

These low-cost, two-wire DPMs are simple to install and operate. They require only two connections, which are made to the screw terminals on the back of the meter. The meters are factory-calibrated and require no external support components, as they are fully powered by the input signal. These meters are designed to measure AC volts, AC frequency, DC volts, and more. Full data sheets on all these products can be downloaded from the Web site above.

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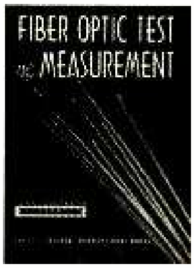
## Fiber Optic Test and Measurement

*Edited by Dennis Derickson*
*Prentice Hall*
*One Lake Street*
*Upper Saddle River, NJ 07458*
*Tel: 800-382-3419*
*Web: www.prenhall.com*
**$75**



CIRCLE 343 ON FREE INFORMATION CARD

Fiber-optic networks are evolving rapidly—and so is the technology used to design, measure, and test them. Written and edited by engineers and scientists from Hewlett-Packard, the book is the result of the collective experience of Hewlett-Packard's Lightwave test and measurement organization. It presents extensive information that has not been in general circulation until now.

This is the first, authoritative, complete guide to measuring current optical networks. Each fundamental area of fiber-optic measurement is reviewed: optical-power measurements, spectral measurements, polarization measurements, and modulation measurements. Readers will learn how to characterize all three basic components of a fiber-optic communications system: the optical transmitter, fiber medium, and optical receiver.

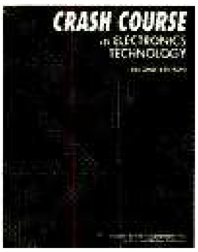
Designed to help technicians, engineers, and scientists accurately measure and test fiber-optic systems; this practical guide is equally useful for experienced professionals and those new to the field. It also provides information on future fiber-optic networks.



---

## Crash Course in Electronics Technology, 2nd Edition

*by Louis E. Frenzel, Jr.*
*Newnes, Butterworth-Heinemann*
*225 Wildwood Avenue, Unit B*
*P.O. Box 4500*
*Woburn, MA 01801-2041*
*Tel: 617-928-2500*
*Fax: 617-933-6333*
*Web: www.bh.com/bh*
**$36.95**



CIRCLE 344 ON FREE INFORMATION CARD

Combined with the two other titles in the Crash Course series, this book forms a complete course in electronics and microcomputer technology. Appropriate for technical schools, for industrial training, and for hobbyists, it teaches the basics of electronics, components, and circuits in a programmed instruction format. Each chapter includes learning objectives, clear explanations and examples, and an end-of-chapter self-quiz. A final chapter teaches the basics of troubleshooting circuits. The useful appendix contains a math review for electronics.

Subjects covered include fundamentals of electronics, electrical and magnetic principles, resistors, inductance, capacitance, diodes, transistors, op-amps, oscillators, and power supplies. The drill-and-review software included with the book allows students to test themselves on the contents of each chapter.

# The Electronics Industry is looking for a lot of good people!

Here is your chance to get in on the ground floor as an Associate CET. Is your job title "Electronics Service Technician?" Would you like to have that title? You can prove you qualify for the title with a CET Associate Certificate. It can be your career door-opener and begin your rapid advancement!

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The ISCET Computer-Aided Associate-Level Study Guide prepares you for the Associate CET Certificate by randomly selecting sample questions with appropriate diagrams, provides multiple-choice answers, grades the test and provides a summary of your strong and weak points.

Diskette requires IBM computer or compatible with VGA color monitor, 3.5-in. drive and a hard-disk drive.

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City ______________ State _____ Zip ________

New York residents add local sales taxes. Canadians add $6.00 per order. No foreign orders. Do not send cash. Checks drawn on US Bank and International Money Orders in US funds only. Credit card users may telephone or FAX orders. Telephone 516-293-3751 or FAX 516-293-3115. Price subject to change. Allow 6 to 8 weeks for delivery. CB06

## Proof Positive that you are a Certified Electronics Technician


**A New Computer Software Program — ISCET Computer-Aided Associate-Level Study Guide**

Prepare yourself for the 75-question CET Associate Examination. Model examinations provide the technician with a study program and introduction to the actual examinations. The model examinations are automatically graded in decimal numbers and bar graphs that can be outputted on your printer. The questions for each exam are selected randomly from a loaded data base—no two exams are exactly the same. When you answer a question, the correct answer is displayed and an explanation is given. From the printouts you will determine whether you need more practice and in which topic areas, or if you are ready to take the real test and continue to promote your electronics career today!

# BUILD A LOW-POWER AM TRANSMITTER

*What once was old is new again with this AM transmitter project!*


**WILLIAM SHEETS K2MQJ AND RUDOLF F. GRAF KA2CWL**


Back in the 1950s, one type of popular construction project was the "phono oscillator" that was able to transmit music from the record player (a device that played music from large plastic discs in the days before the CD) to a nearby radio in another room. Transmitting was done on the AM band—FM was still in its infancy and stereo transmission was yet to be developed. Those transmitters were also used for hobby AM broadcasting and general experimentation with low-power transmitters that were (and still are) legal to use under Part 15 of the FCC regulations for unlicensed transmissions. Although those devices worked well, they were really toys that were used mainly as wireless microphones.

While these days the FM band is much more popular for such applications and offers the additional advantage of supporting stereo audio, for some applications the AM band might be better. The higher field strengths allowed can increase the usable distance between the transmitter and the receiver. Signal bandwidths are narrower, and AM signals are easier to pick up under weak-signal conditions than FM. There are generally more usable frequencies on the AM band than the FM band, especially during daylight hours. Construction is less critical as frequencies are low, and only simple test equipment is needed to set up an AM transmitter. There are also many areas in parts of the world where FM reception is poor or limited because of a lack of "line-of-sight" between the transmitter and the receiver.

One of the more unusual examples of an application where AM works better is the "talking house" used by real-estate agents. In that instance, real-estate brokers use a small transmitter planted in a house so that the prospective buyers can hear the sales pitch on their car radio as they drive by. That arrangement works well since almost every car has an AM radio, but they might not have FM. Also, a simple AM transmitter is an excellent learning tool for beginners, who might find the very high frequencies and the added complexities of FM stereo a bit daunting as a first-time learning experience.

The low-power AM transmitter described here has features that would have been science fiction in 1950. For example, it has a crystal-controlled phase-locked loop (PLL) for frequency stability. Carrier frequencies can be selected in 1-kilohertz steps between 100 kHz and 2000 kHz. That range includes the standard AM broadcast band (from 530 kHz to 1710 kHz) and the long-wave AM broadcast band (from 150 kHz to 285 kHz) used in Europe and Asia. Both 9- and 10-kHz channel spacing is supported, meaning the unit could be used almost anywhere in the world.

While the transmitter is AM, carrier-wave (CW) under Part 15 experimental license-free operation between 160 kHz and 190 kHz is also possible. For that application, the transmitter's normal 100-milliwatt output can be increased up to 1 watt.

**Circuit Description.** The Low-Power AM Transmitter uses four ICs and nine transistors to create a complete PLL-synthesized AM transmitter. The design of the transmitter is simplified if it is divided into several sections. Those sections are the audio amplifier, the AM modulator, the phase-locked-loop frequency synthesizer, and the RF-output amplifier and filters. The schematic diagram in Fig. 1 should be followed as we describe each of the following sections.

**Audio Amplifier.** Incoming audio is input at J1 and then fed to gain control R1 and diode-controlled attenuator D1, D2, and R1. The diodes act as a variable resistance to small signals below 50 mV. That gives the audio section a form of automatic gain control.

The signal is passed to IC3-a through C31 and C1. The frequency response of the amplifier is limited to 10 kHz by C2. The need for a negative voltage source is eliminated by R5, R6, and C3. The audio gain of that stage is about 20X (26 dB) as long as D1 and D2 are not conducting.

The audio is coupled to R7, C5, S2-a, and S2-b. The switches route the audio signal to the AM modulator either for normal AM operation or to the PLL circuit for FM. It might seem odd to use frequency modulation at such low frequencies, but a use for that technique will be discussed later.

**AM Modulator.** The AM modulator is built around Q6 and Q7. The circuit is set up as a shunt-feedback pair with the bias point set by R14–R16. The audio signal with a DC offset appears at the emitter of Q7. It is used as a source of modulated DC for the RF-output stage. The voltage at the emitter of Q7 normally sits at around 5-volts DC. With audio from S2-b, the voltage swings from below 1 volt to within 1 volt of the supply voltage. Base-drive resistors R12 and R13 form a split resistance so that the modulated audio can be coupled to the junction of those resistors. Since the voltage across a capacitor does not change instantaneously, a large capacitor can also act like a battery. The effect is a constant voltage across R13, and therefore a constant drive current. That lets the base of Q6 swing above the supply voltage by about 0.7 volt, making sure that the emitter of Q7 can reach almost to the full supply voltage. That technique, widely used in audio power amplifiers, is called *bootstrapping*. Since the RF output of the RF stage is proportional to the supply voltage, full AM modulation of the RF output voltage is achieved. The bias point is set for symmetrical modulation with R16.

If the peak voltage of the audio signal were not limited, severe distortion would result from the clipping of the RF output peaks and cutoff of the RF output on the negative peaks. That type of distortion is called *overmodulation*. To prevent overmodulation, a sample of the modulator's output is taken through R17–R19. The sampled voltage is compared with IC3-a's bias voltage in IC3-b. If the sampled voltage exceeds the bias voltage, the output of IC3-b goes positive. That voltage is then applied to R8 and R9, forward biasing D3 and charging C4. Capacitor C4 is an audio-bypass capacitor that prevents audio signals from feeding back through the automatic gain-control (AGC) network, in addition to setting the time constant for the AGC network. The DC bias that is developed across C4 forward biases D1

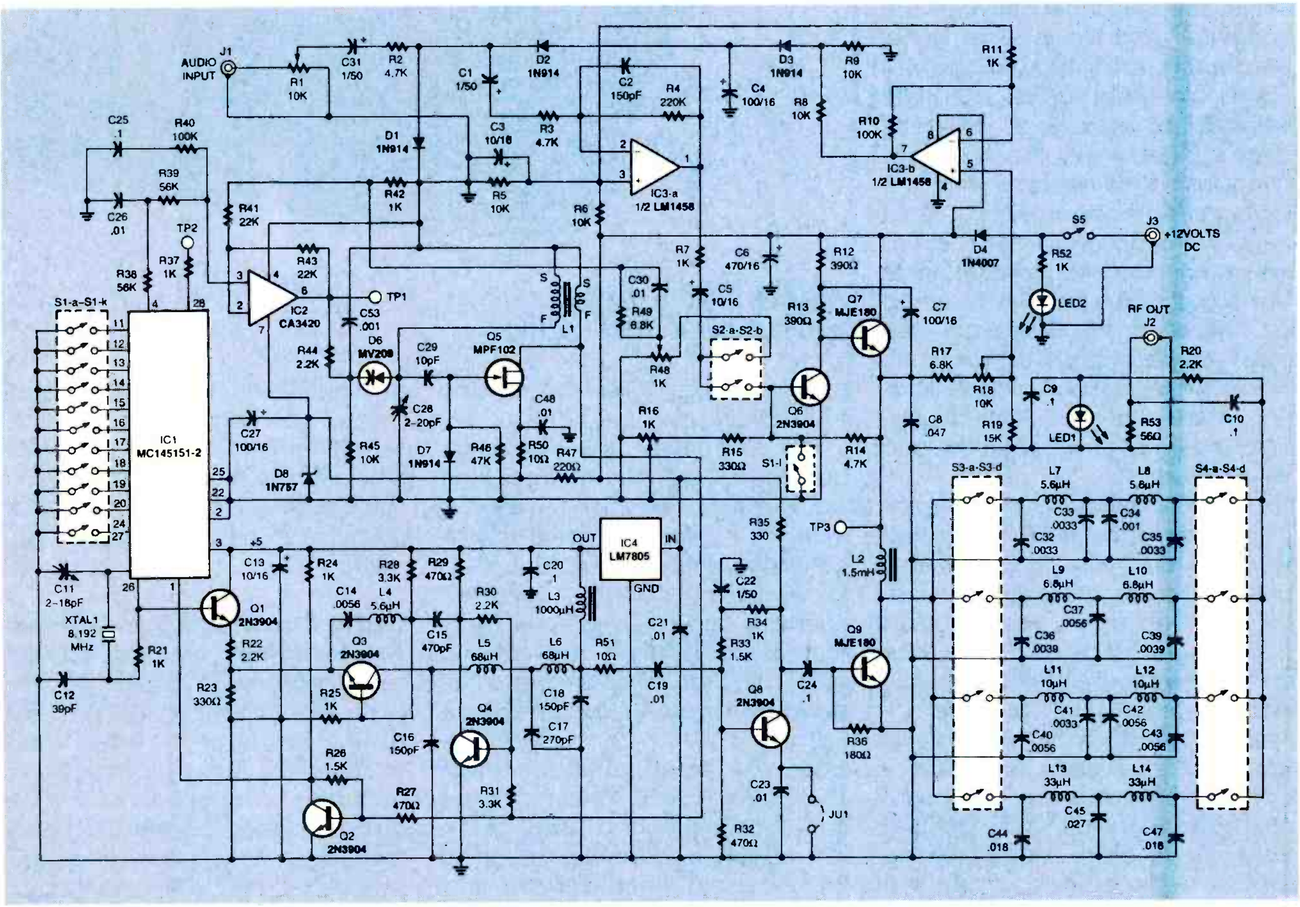



*Fig. 1. The AM transmitter is built around a phase-locked loop synthesizer for frequency control of the carrier wave.*

and D2 if it is more than about 1.2 volts. That causes the dynamic impedance of the diodes to drop from nearly infinite down to under 100 ohms. When that happens, the audio input present at the junction of R2, C1, D1, and D2 is attenuated, reducing the modulation level. In practice, R18 is adjusted so that attenuation will occur at a modulation level of 85-90%. While that method does not prevent any negative clipping or deliberate overmodulation, it works well for normal speech or music.

## PARTS LIST FOR THE LOW-POWER AM TRANSMITTER

### SEMICONDUCTORS

IC1—MC145151-2 Phase-locked loop synthesizer, integrated circuit
IC2—CA3420 op-amp, integrated circuit
IC3—LM1458P dual op-amp, integrated circuit
IC4—LM7805 5-volt regulator, integrated circuit
Q1–Q4, Q6, Q8—2N3904 transistor, NPN
Q5—MPF102 field-effect transistor
Q7, Q9—MJE180 transistor, NPN
D1–D3, D7—1N914 or 1N4148 silicon diode
D4—1N4007 silicon diode
D5—Not used
D6—MV209 varactor diode
D8—1N757A, Zener diode
LED1, LED2—Light-emitting diode, red

### RESISTORS

(All resistors are ¼-watt, 5% units unless otherwise noted.)
R1, R18—10,000-ohm potentiometer
R2, R3, R14—4700-ohm
R4—220,000-ohm
R5, R6, R8, R9, R45—10,000-ohm
R7, R11, R21, R24, R25, R34, R37, R42, R52—1000-ohm
R10, R40—100,000-ohm
R12, R13—390-ohm
R15, R23, R35—330-ohm
R16, R48—1000-ohm potentiometer
R17, R49—6800-ohm
R19—15,000-ohm
R20, R22, R30, R44—2200-ohm
R26, R33—1500-ohm
R27, R29, R32—470-ohm
R28, R31—3300-ohm
R36—180-ohm
R38, R39—56,000-ohm
R41, R43—22,000-ohm
R46—47,000-ohm
R47—220-ohm
R50, R51—10-ohm
R53—56-ohm

### CAPACITORS

C1, C22, C31—1-µF, 50-WVDC, electrolytic
C2, C16, C18—150-pF, ceramic-disc
C3, C5, C13—10-µF, 16-WVDC, electrolytic
C4, C7, C27—100-µF, 16-WVDC, electrolytic
C6—470-µF, 16-WVDC, electrolyt
C8—0.047-µF, Mylar
C9, C10, C20, C24, C25—0.1-µF, Mylar
C11—2-20-pF trimmer
C12—39-pF, ceramic-disc
C14, C37, C40, C42, C43—0.0056-µF, Mylar
C15—470-pF, ceramic-disc
C17—270-pF, ceramic-disc
C19, C21, C23, C48—0.01-µF, ceramic-disc
C26, C30—0.01-µF, Mylar
C28—2-20-pF trimmer
C29—10-pF, ceramic-disc
C32, C33, C35, C41—0.0033-µF, Mylar
C34, C53—0.001-µF, Mylar
C36, C39—0.0039-µF, Mylar
C38, C46—Not used
C44, C47—0.018-µF, Mylar
C45—0.027-µF, Mylar

### ADDITIONAL PARTS AND MATERIALS

J1—RCA connector, panel-mount
J2—BNC or UHF connector, panel-mount
J3—Co-axial power jack
JU1—jumper wire
L1—Toroid core, 0.375-inch outside diameter (see text)
L2—1.5-mH, 240-mA choke
L3—1000-µH choke
L4, L7, L8—5.6-µH coil
L5, L6—68-µH coil
L9, L10—6.8-µH coil
L11, L12—10-µH coil
L13, L14—33-µH coil
S1—SPST switch, 12-position, dual-inline
S2—SPST switch, 2-position, dual-inline
S3, S4—SPST switch, 4 position, dual-inline
S5—Single-pole, single-throw switch, panel-mount
XTAL1—8192-kHz crystal
24-gauge enameled wire for L1, case, wire, hardware, etc.

**Note:** The following items are available from: North Country Radio, PO Box 53, Wykagyl Station, New Rochelle, NY 10804-0053; E-mail: NCRadio200@aol.com; Web: http://www.northcountryradio.com: A complete kit of parts including drilled and etched PC board and all parts that mount on it, $78.50 plus $4.50 postage/handling ($10.00 postage/handling outside the US); Package of suitable hardware, including connectors, wires etc., $10.50 plus $1.00 postage/handling; undrilled metal case, $21.50 plus $1.00 postage/handling. NY residents must add appropriate sales tax.

**Phase-Locked Loop.** The PLL-synthesizer section is built around IC1, a complete phase-locked loop circuit. That chip has a reference oscillator, a reference divider, a charge-pump phase detector, and a variable divider that can be set for division ratios from 3 to 16383.

The AM-broadcast band between 530 kHz and 1710 kHz has channels that are spaced 10 kHz apart in the US and Canada, including the newly-expanded 1600-kHz–1710-kHz section in the US. In other parts of the world, channels with 9-kHz spacing are used. Additionally, in Europe and parts of Asia, the longwave band is used with frequencies between 150 kHz and 285 kHz and with 9-kHz channel spacing. The synthesizer will cover all of those frequencies, but in the interest of ideal synthesizer performance, cost limitations, and circuit simplicity, the tuning range has been restricted to a 2-MHz spread. The synthesizer supports all of the channels between 150 kHz and 1710 kHz in 1 kHz increments. Frequencies from as low as 50 kHz to as high as 2047 kHz can be generated, but the values chosen for the various circuit components, mainly in the filters and RF chokes, will prevent the transmitter from working at peak performance at those extreme frequencies. In order to cover those frequencies, some changes in values of those components will be necessary. That type of modification is beyond the scope of this article.

While direct generation of a frequency between 150 kHz and 1710 kHz can be done with a single-loop synthesizer, it would be difficult to control a voltage-controlled oscillator with an 11:1 frequency ratio and still get reasonable performance over such a wide range. However, there is an easier way. Synthesizer

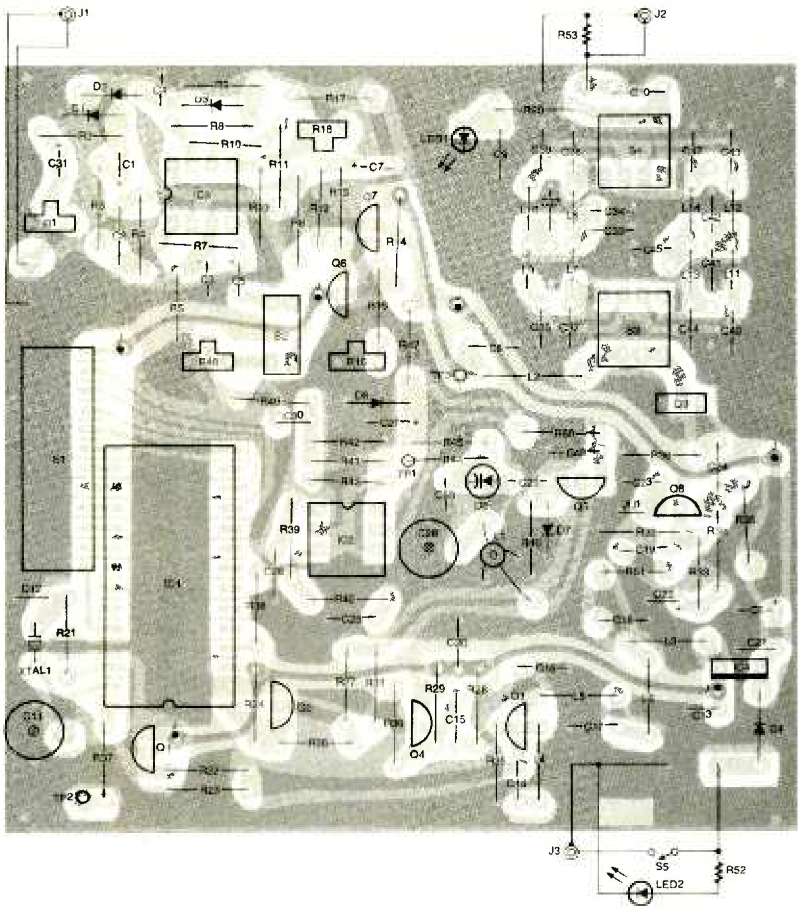


*Fig. 2. Use this parts-placement diagram when building the AM transmitter. Don't forget to solder the connections on both sides of the board.*

chip IC1, a Motorola MC145151-2, has a programmable-reference divider. The reference divider is set with digital inputs that select various fixed ratios that are mostly powers of two. For the AM Transmitter, it is set up to divide by 8192 so that a standard 8.192-MHz crystal will result in a reference frequency of 1 kHz. That reference frequency sets the resolution of the synthesizer.

Since the chip can be programmed to divide by up to 16383, the variable divider section of the chip can be set up to divide by 8192 by permanently tying its most significant digit high and grounding the next two significant bits low. By setting the remaining 11 bits with S1, a dipswitch with 12 switches, the divider can be set to divide by ratios from 8192 to 10239. That will let the synthesizer generate a frequency range between 8.192 MHz and 10.239 MHz—well within the chip's maximum rating of 12 MHz. If we take that frequency range and mix it with the 8192-kHz reference-oscillator signal using a mixer circuit and a low-pass filter on its output, we will end up with an output frequency that is (in theory) between 0 Hz (DC) and 2047 kHz. That means that S1 only has to produce a binary code that is the binary equivalent of the output frequency. That method is simple, cheap, and lets a synthesizer loop be designed with a 1.25 to 1 range—a task that is easy to do. The chip can directly handle those frequencies with no additional circuitry needed. Of course, a mixer and filter is needed, but that is simple, straightforward, and does not require any loop-design compromises. However, we are only concerned with the 150 kHz to 1710 kHz frequencies due to the need for larger coupling capacitors and RF chokes in the transmitter for lower frequencies.

In most populated areas, there are relatively few clear channels—especially at night when distant stations can be heard. Once a clear channel is found, the transmitter will normally be set and left alone. By using S1, an electrically-noisy microprocessor and complex display is eliminated from the design.

The heart of the PLL's voltage-controlled oscillator is Q5. The frequency at which the VCO oscillates is set to the 8.2-MHz-to-10.2-MHz range by L1 and the combined capacitance of D6, C28, and the input capacitance of Q5. The oscillator is DC biased by R46. A variable DC control voltage is fed to the anode of D6 by R44 and R45. Any stray RF on D6 is shunted to ground by C53. The voltage on D6 changes its capacitance, and therefore the frequency of the oscillator. The oscillator signal on the source of Q5 is passed to Q2 and Q4. A signal large enough to drive the input of the variable-divider section of IC1 (pin 11) appears at the collector of Q2. The output of the variable divider is sent to IC1's phase detector, which compares that signal with a 1-kHz reference signal. That reference signal comes from IC1's internal reference oscillator/divider, which is set by external components R21, C12, XTAL1, and C11. The output frequency accuracy depends on having an exact 1-kHz reference frequency, which in turn needs an exact 8192-kHz crystal oscillator frequency.

The phase detector generates a voltage that depends on the relative phase difference between the reference waveform and the variable divider waveform. If the divider output starts to lag the reference, the VCO frequency is too low, and the phase detector produces positive-going pulses. Those pulses go to a sample-and-hold network (R38–R40, C25, and C26). The accumulated charge on C25 is buffered by IC2 and is fed back to D6 through R44 and R45, causing the VCO frequency to increase. The opposite happens if the VCO frequency is too high, causing the divider output to lead the reference. The result is that the VCO frequency is locked to the reference frequency and will not drift. It will be exactly equal, in kilohertz, to the programmed divide ratio plus 8192.

The final output frequency is obtained by mixing the PLL output frequency with the 8192-kHz reference oscillator in a mixer circuit. The 8192-kHz frequency comes from Q1 and divider R22 and R23, while the VCO frequency is buffered by Q4. The signals are mixed together by Q3, and the signal at that transistor's collector terminal contains the sum frequency and the difference frequency. A low-pass filter consisting of C16, L56, C17, L6, and C18 passes only the difference frequency.

**RF Output.** Amplifying the output of the mixer's low-pass filter produces the RF-output signal that will be modulated with an audio signal. The amplification and mixing is done by Q8, Q9, and the associated circuitry. The emitter of Q8 is connected to ground with a jumper. If that jumper is removed and replaced with a transmitter key and capacitor, Morse-code carrier-wave (CW) transmission can be done. For low-power transmitters being used under the Part 15 regulations, the frequencies should be between 160 kHz and 190 kHz (also known as the 1750-meter band).

The final signal is then fed to a set of 5-element low-pass harmonic filters built around L7–L14 and C32–C47. Those filters attenuate the second harmonic of the signal by 20–30 dB or more. Since a filter is useful only to about 65–90 percent of its cutoff frequency, four filters are used in order to cover the AM-broadcast band and the 150- to 280-kHz range. Only one filter is used at a time; S3 and S4 select which circuit is active.

A light-emitting diode is used as an output indicator. It is also used as a crude form of VU meter—it will flicker slightly when a signal is being transmitted. Furthermore, it will not light at all if S3 and S4 are not selecting the same filter circuit.

Obviously, any transmitter needs some form of antenna. For many applications, a 56-ohm resistor shunted with a simple whip antenna will do. The whip antenna should be only as long as needed; under no circumstances should it be longer than 10 feet (3 meters). Longer lengths will violate the Part 15 regulations that limit the radiated power from the transmitter.

**Construction.** Since the AM Transmitter deals with radio frequencies, printed-circuit construction is the only recommended method of building the circuit. The circuit will fit nicely onto a double-sided layout; foil patterns are included if you want to etch your own board. A kit that contains a pre-etched PC board is available from the source given in the Parts List.

If you use the foil patterns or purchase the kit, the parts-placement diagram in Fig. 2 should be followed. Before building the board, some important points should be noted. First, the grounded leads on all of the resistors are to be soldered on both sides of board. That is essential for good grounding. Second, all of the parts are to be mounted as close to the board as possible, with the exception of the chokes. That is very important in order to reduce any audio noise pickup and for proper operation of the synthesizer and RF circuits. It also gives a professional appearance to the finished board.

Begin construction by inserting all of the resistors into the PC board.

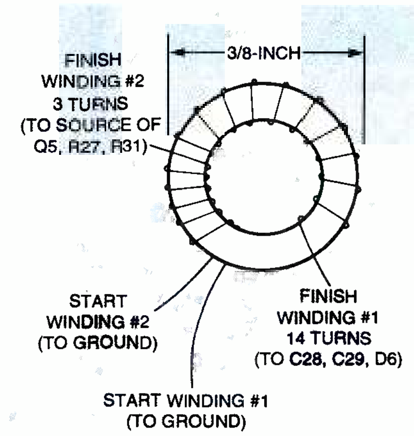



*Fig. 3. Wind L1 on a toroidal (doughnut-shaped) coil form. Use 24-gauge enameled wire.*

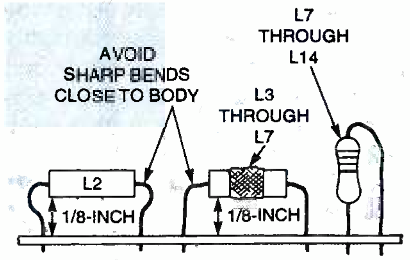



*Fig. 4. Some of the coils and chokes should be mounted off of the board. Others will need to be mounted vertically.*

Don't forget to also solder all of the ground connections on the top of the board. Install all of the diodes next, carefully observing their polarity. The capacitors are then installed. Again, make sure to observe the polarity of all of the electrolytic capacitors.

When installing the transistors, double-check the device pinouts—especially Q7 and Q9. Continue installing the remainder of the components. If you want, you can use low-profile sockets for the ICs. As always, carefully check your work as you go. Any mistakes corrected now will make testing the completed transmitter that much easier when the time comes.

Carefully fabricate coil L1 according to the illustration in Fig. 3. The doughnut-shaped core is wound with 24-gauge enameled wire. Make sure to connect the leads as shown or the VCO will not work. Leave an extra 1–2 inches of lead length on the lead of the 14 turn winding connected to C28, C29, and D6. That extra turn will be used to adjust the inductance of L1 during testing and setup.

Install L2 as shown in Fig. 4, being careful not to bend the leads sharply too close to the choke body as that might damage the choke. Install L3–L6 in the same way. The remaining inductors are mounted vertically. Again, carefully inspect all of your work as you go. Look for solder shorts, poor joints, missing parts, incorrect parts placement, etc. Once the board is completed, mount it in a suitable case and wire it as shown in Fig. 5.

One final item that will be needed for use is an antenna. The size of the antenna will depend on the frequency being used, but for general AM broadcasting the design shown in Fig. 6 will do the job.

With everything finished, the unit is ready for testing.

**Testing the Transmitter.** Before applying power to the transmitter, all of the controls and switches need to be preset. On S1–S4, set all of the switch positions to off, then turn on S2-a, S3-a, and S4-a. Potentiometers R1 and R16 should be set to ¼ full turn clockwise; R18 and R49 are set to ¾ full turn. Likewise, C11 should be

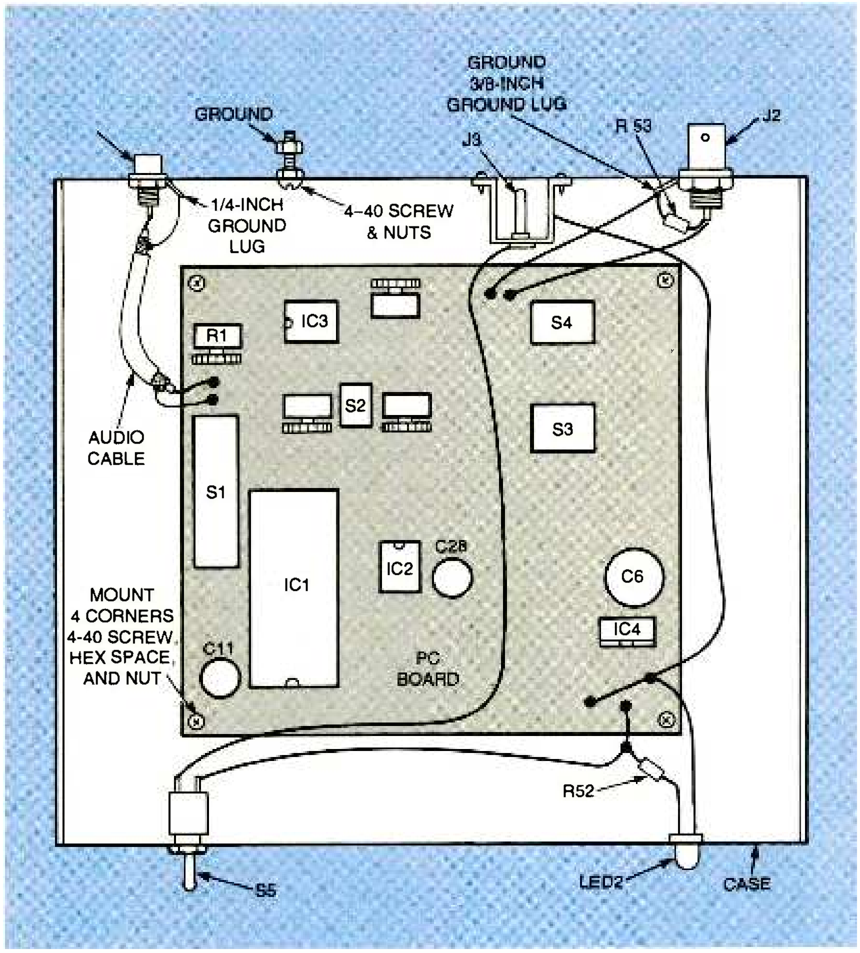



*Fig. 5. The completed board fits neatly into a project case.*

set so that its plates are 50% meshed; C28 should have its plates completely meshed.

With a 56-ohm resistor connected between the RF output and ground, connect a 12-volt power supply to the unit. The transmitter should draw between 50 and 200 mA. None of the components should get hot, although Q7 will normally run a bit warm after a few minutes of operation. A hot component or excessive current draw will indicate that something is wrong. If, on the other hand, the current draw is way too low, the unit will not be damaged—the cause of the problem should be found during testing.

With a voltmeter, the following voltages should be verified:

D4 cathode—11.4 volts
C6 positive lead—11.4 volts
IC4, pin 1—11.4 volts
IC1, pin 3—5 volts
IC2, pin 7—9 volts +/-0.6 volts
TP3—5 volts (varies when R16 rotated)
Q9 collector—5 volts (varies when R16 rotated)
Q3 collector—4-5 volts
Q4 collector—0.5-1 volt
Q5 drain—8.8 volts +/-0.6 volts
IC3, pins 1, 2, 3, 6—5.8 volts +/-0.8 volts
IC1, pin 7—2.5-7.5 volts (varies when R16 rotated)
D3 anode—1-1.5 volts (varies when R18 rotated)

A variation of 10 percent is normal. Remember to allow for meter accuracy and component and supply-voltage variations. If any major variations are noted, stop and look for the source of the trouble. Once the cause of the problem has been found and corrected, reset any potentiometers that were moved during testing back to their original preset positions, with the exception of R16; set that device so that a reading of 4.5-5 volts is observed at TP3.

Set S1 for a frequency of 1700 kHz, or within 20 kHz if 1700 kHz is being used in your area. See Table 1 for the switch settings. Remember to only set the first 11 switches; the twelfth switch is left off. Tune a nearby AM receiver to 1700 kHz, or the frequency that you set the transmitter to. A voltmeter connected to TP1 should read about 9 volts. If the reading is less than 9 volts but more than 2 volts, note the voltage. While listening to the AM receiver, rotate C28 so that its plates start to separate. At some point, the voltage at TP1 should drop. If it does not, try removing a turn from the end of the 13-turn winding on L1 that is connected to C28.

If you initially saw less than 9 volts at TP1, it should drop immediately when C28 is rotated. If the voltage is "stuck" low or will not reach as high as 7.5 volts (but will change with C28), you should add a turn to L1. Set C28 for a reading of 7.5 volts at TP1. At that point, the plates of C28 should be between 10% and 60% engaged. If C28 has to be set to more than 75%, add a turn to L1.

You should hear a dead carrier (a signal without audio) on the AM receiver. As a further test, disconnect or shut off the transmitter. The carrier should disappear. It should reappear when power is restored. If all checks out, the PLL synthesizer and mixer sections are OK.

Turn the transmitter off and set the frequency to 128 kHz with S1. Close S3-d and S4-d, opening the other switches in those banks. Turn the unit back on and measure the voltage at TP1—it should be between 2 and 4 volts. Rotating C28, the voltage at TP1 should change. Reset C28 so that the voltage on TP1 is the same as it was when the transmitter was turned on. That test verifies the synthesizer range. If the voltage at TP1 is too low and C28 has no effect, add a turn to L1, and repeat the test where the transmitter was set to 1700 kHz.

If the transmitter passes all of the tests so far, remove the extra lead length from L1 and re-solder it to the PC board. It is a good idea to coat L1 and fasten it to the PC board with clear lacquer-base cement such as Duco cement, Q dope, or

## TABLE 1—SWITCH SETTINGS FOR VARIOUS FREQUENCIES

| Frequency (kHz) | S1-a | S1-b | S1-c | S1-d | S1-e | S1-f | S1-g | S1-h | S1-i | S1-j | S1-k | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 128 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Test frequency |
| 140 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | |
| 150 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | Lowest long- wave AM frequency |
| 160 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | |
| 188 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | |
| 189 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | |
| 190 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | |
| 230 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | |
| 256 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 280 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | |
| 285 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | Highest long-wave AM frequency |
| 455 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | Common AM IF frequency |
| 512 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 530 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | Common TIS frequency |
| 570 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | Low end AM broadcast band |
| 600 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | |
| 650 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | |
| 700 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | |
| 750 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | |
| 800 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | |
| 850 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | |
| 900 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | |
| 950 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | Middle of AM band |
| 1000 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | |
| 1024 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 1053 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | |
| 1089 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | |
| 1100 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | |
| 1200 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | |
| 1250 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | |
| 1300 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | |
| 1350 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | |
| 1400 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | |
| 1440 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | |
| 1500 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | |
| 1550 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | |
| 1575 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | |
| 1585 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | |
| 1595 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | |
| 1600 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 1610 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | Common TIS frequency |
| 1620 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | |
| 1630 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | |
| 1640 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | |
| 1650 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | |
| 1660 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | |
| 1670 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | |
| 1680 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | |
| 1690 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | Used for setup |
| 1700 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | Used for setup |
| 1710 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | Used for setup. Top of AM band |

A zero (0) means that a switch is ON; a one (1) signifies a switch section is OFF.

TIS—Travel Information Service. Used for motorist information

clear fingernail polish. Hot-melt glue can also be used. Do not use anything with a pigment in it as it might damage the coil. After the coating hardens, recheck the voltage at TP1. If necessary, reset C28 so that TP1 has a voltage of 7.5 volts when the transmitter is set to 1700 kHz.

Connect an audio source to the transmitter's audio input and adjust R1 for the loudest signal in the receiver before any distortion can be heard. Adjust R16 so that TP3 is between 4.5 volts and 5 volts. Increase R1 until distortion is evident. Adjust R18 so that the distortion is just eliminated. It should be possible now to increase the setting of R1 a little without experiencing much of a change in the audio level at the receiver, although some compression might be noticed. At this point, the audio-limiter circuit is tested and adjusted. If an oscilloscope is available, R16 and R18 can be adjusted for the best modulation pattern by observing the modulated carrier across a 56-ohm resistor connected across the RF output terminals.

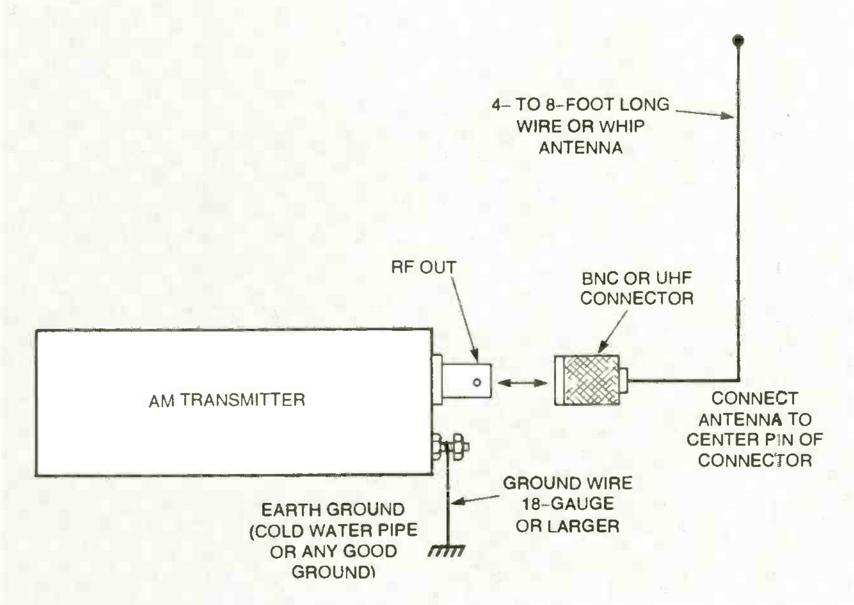
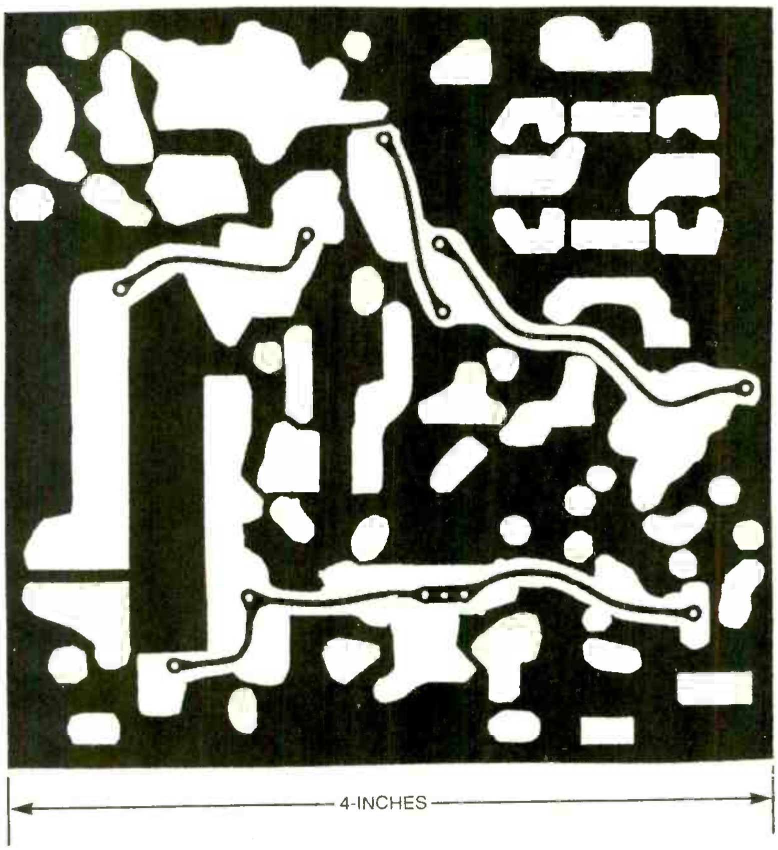



*Fig. 6. An unmatched antenna can be made from a length of wire connected to the AM transmitter.*




*Here is the foil pattern for the component side of the AM transmitter board.*

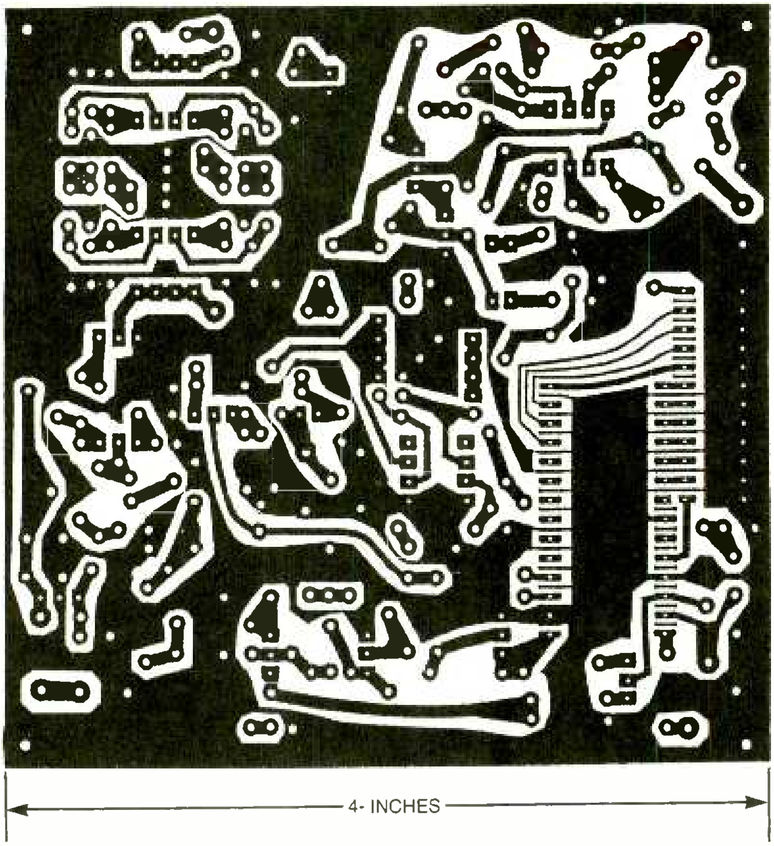
If a scope or RF voltmeter is available, check the voltage across the 56-ohm resistor that is connected across the RF output terminals to verify that the transmitter is producing RF output. About 2 volts rms across 56 ohms or 5.64 volts peak-to-peak will be present. The modulated RF signal is best seen with an oscilloscope, but a detector probe on a DVM will do as a relative indicator. If you do not have the equipment to do that final test, don't worry; just make sure that LED1 lights.

With the AM transmitter tested and calibrated, set the final transmission frequency, select the appropriate RF filter, and close up the case. The transmitter is now ready for use.

**Using the Transmitter.** The power supply for the transmitter should be 12 volts DC. The actual voltage can vary from 12 volts to 13.2 volts, but going outside those limits can cause problems. Voltages above 16 volts might damage some of the components, while dropping below 10 volts will produce poor results. Excessive noise on the supply line might be heard on the transmitted signal as interference and hum. Remember that it is normal for Q7 to get warm in operation. If you prefer, although it is not necessary, a small clip-on heat sink can be placed on Q7 to cool it.

Each time the frequency or transmitting mode is to be changed, the unit must be opened up and the dipswitches reset. Although that might seem inconvenient, in practice there are often only a few available clear channels in the AM broadcast band. Once set, the frequency will probably not be changed often. The mode settings will probably be rarely changed unless you are doing a lot of experimental work. There are over 2000 frequencies that can be programmed.

At the time that this article was written, the new AM band between 1600 kHz and 1710 kHz is lightly occupied and has generally less power-line noise than the lower frequencies. As new stations move into the expanded band, that is




*Here is the foil pattern for the solder side of the AM transmitter board.*

sure to change.

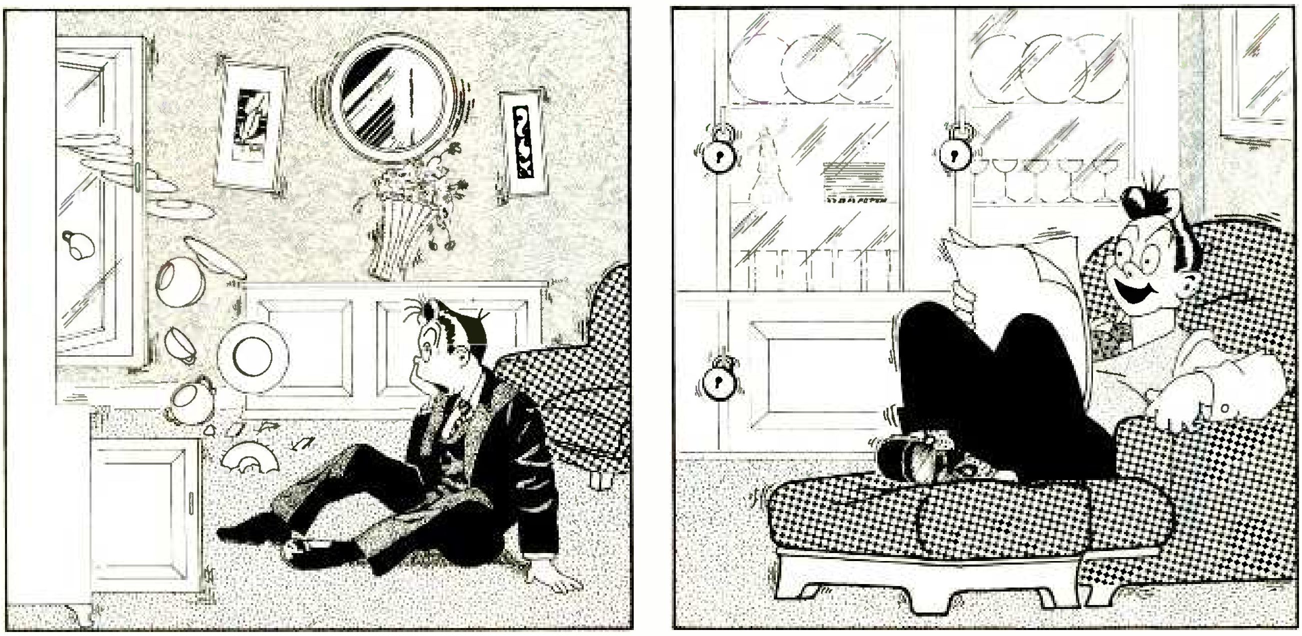
For routine Part 15 operation, try to use as high of a frequency as possible. It is a good idea to confine the signal to only the area in which it is needed. A 4-foot whip antenna will cover an average house and is easy to build from scratch or to salvage from a junked TV set. The antenna should be wired in parallel with a 56-ohm resistor connected to the RF output.

According to Part 15, the formula for the maximum field strength allowed between 510 kHz and 1600 kHz is $24000/f_{kHz}$ microvolts per meter at 30 meters. That works out to 15 microvolts per meter at 1600 kHz at a distance of 100 feet from the transmitter. Below 490 kHz, a field strength of $2400/f_{kHz}$ at 300 meters is allowed. That works out to about 12 microvolts per meter at 1000 feet.

Those levels represent a weak AM-broadcast-band station. Alternatively, 100 mW of RF into a 10-foot antenna is allowed in the AM-broadcast band, and 1-watt of RF is allowed into a 50-foot antenna between 160 kHz and 190 kHz. Those figures actually assume a power-amplifier efficiency of 100% with the power being defined as the amount of input into the final RF-amplifier stage. That method of measurement is from the vacuum-tube days when RF power was not easily measured with simple equipment. However, solid-state RF amplifiers are specified in terms of RF output. An efficiency of 60–80% is typical of transistor-based power amplifiers, although 90% or more can be reached in some instances. Therefore, in order to comply with the Part 15 rules, either make sure that the RF output is kept at 1.6 to 2 volts rms or below when connected to a 50-ohm load or use an unmatched 4-foot whip antenna. Do not use a 10-foot antenna unless you can measure and verify the RF-output power. Although you can operate anywhere in the AM band, the high end (1600 kHz) is better because of antenna efficiency.

There you have it—an AM transmitter that updates old technology with the newest circuits and designs. Ω

# BUILD AN EARTHQUAKE DETECTOR



*If you live in an earthquake zone, this vibration sensor can save your property or your life. If not, it can be used as a burglar alarm, intrusion detector, or a game of skill.*

ROBERT BULLOCK

For many of us that live in a seismically active region, an earthquake is a very real and constant threat. Even moderate earthquakes that are not strong enough to hurt anyone can cause a significant amount of damage to the contents of your house if you are not prepared. Although earthquake prediction has made great strides over the years, it is still very much an art form rather than a science. Earthquakes can strike without warning, and when they do, you do not have time to lock the kitchen cabinets or turn on any emergency lighting, much less find suitable shelter. If those steps can be done automatically at the first sign of an earthquake, property destruction and personal injury can be avoided or minimized.

The Earthquake Detector described here is the heart of such an automatic system. The author uses this device to automatically latch all of the kitchen cabinets when an earthquake strikes. The circuit can also be used as a burglar or impact alarm when mounted in a car. When mounted to a garbage can, it can sound a loud alarm if an animal tries to get into the container. A self-contained alarm unit can also be used as a simple game to see how far and how fast someone can carry the device before it triggers.

**How It Works.** A seismograph, which most people are aware of, is a device that measures and records the amount of seismic activity on a strip or drum of paper using vibrating pens. The sensors for that device usually consist of some type of suspended weight with a way to measure how much it moves when the sensor is shaken. The same method is used for the Earthquake Detector. A weight, in the form of a screw, is suspended on the end of a spring. The head of the screw passes through the center of a metal ring. When the sensor starts to shake, the spring and screw start to swing back and forth like a pendulum. As long as the shaking continues, the swing of the screw will keep increasing as the spring keeps absorbing mechanical energy. At some point the screw head will touch the metal ring, completing a circuit between the spring and the ring.

Since the actual contact time of the vibration sensor is very short, a retriggerable timer circuit is used to create a usable control signal. As long as the vibration sensor keeps opening and closing its contact, the timer will keep resetting itself to the beginning of its timing cycle, and the output of the timer will remain active. Once the vibrations stop and the energy in the spring is dissipated, the timer will remain active until the end of its timing cycle; only then will it turn the output off. If the sensor is damaged and is closed continuously, the timer circuit simply times out, turning the output off.

The output of the timer circuit controls a relay. That lets the unit be very versatile when controlling other devices. The switched load is limited only by the rating of the contacts in the relay itself.

When the circuit is activated, a flip-flop turns on an LED, which will remain on after the circuit times out. Only pressing a reset switch will turn the LED off. That will show if the circuit was set off at any time since the reset button was last pressed.

The earthquake sensor uses all CMOS ICs, giving the unit a very low current draw when the detector is not triggered. To be more specific, the standby current load is less than one microamp, rising to 40 mA while the relay is energized and dropping to 5 mA when just the LED is on.

**Circuit Description.** The schematic diagram for the Earthquake Detector is shown in Fig. 1. When power is first applied through J1, C1 is charged through R1. During constant shaking, S3 (the vibration sensor) closes, letting C1 dump its charge to the timer circuit. As S3 opens, C1 is quickly recharged. In case S3 is damaged during a severe shaking and remains permanently closed, C1 will not be able to charge.

The timer circuit itself is built around IC1, a CD4536 programmable timer. That particular device was chosen because of its versatility. It is especially useful for providing long time delays (up to 23 hours) with good repeatability. It uses an internal 24-stage binary ripple counter to achieve those long delays without the need for a large capacitor value, which is typically used when trying to achieve a long timing period with an RC-based circuit such as an LM555.

The timing period of IC1 is set with R4–R6 and C2. The values used let the output period be adjustable from about 30 seconds to 10 minutes. If a trigger pulse occurs during the timing cycle, the 24-stage ripple counter resets, reinitializing the timing cycle. That way, the output remains on during the entire event and extends past the last trigger by the set time. For example, if the timing period is set to 1 minute, a 3-minute earthquake will activate the output for a total of 4 minutes.

The output of IC1 is buffered by IC3-a, an inverter gate. The signal then splits between IC2-a and Q1. The transistor operates RY1, whose contacts are brought out to J2. Having both a normally-open and a normally-closed contact gives the circuit flexibility in controlling other devices. The flip-flop (IC2-a) is the trigger-memory circuit that latches on when IC1 activates. The output of IC2-a drives LED1 through IC3-b.

Test button S2 is in parallel with vibration detector S3 and provides a means to test the operation of the circuit. Reset button S1 will reset IC1 if it is active, and also resets IC2, so that LED1 will go out as well.

The circuit is designed to run at 12 volts, but can be used at any voltage between 3 and 18 volts. If the circuit will be used at a voltage level other than 12 volts, the unit specified for RY1 must be replaced with a unit with the proper voltage rating for its coil. A different value for R7 also must be calculated so that the current flowing through LED1 is limited to 5 milliamps.

**Building the Earthquake Detector.** Circuit construction is not critical; any suitable construction technique can be used. The only important point to keep in mind is the type of environment that the detector will be used in—it should be able to work while being shaken. Because of that, sockets for the ICs are not a good idea.

The circuit will fit nicely on a single-sided PC board. If you wish to make your own, a foil pattern has been supplied. Alternatively, an etched and drilled PC board can be purchased from the source given in the Parts List. If you use either of those sources for the PC board, use the parts-placement diagram in Fig. 2 for locating the various components.

In general, the easiest way to build the board is to start with the

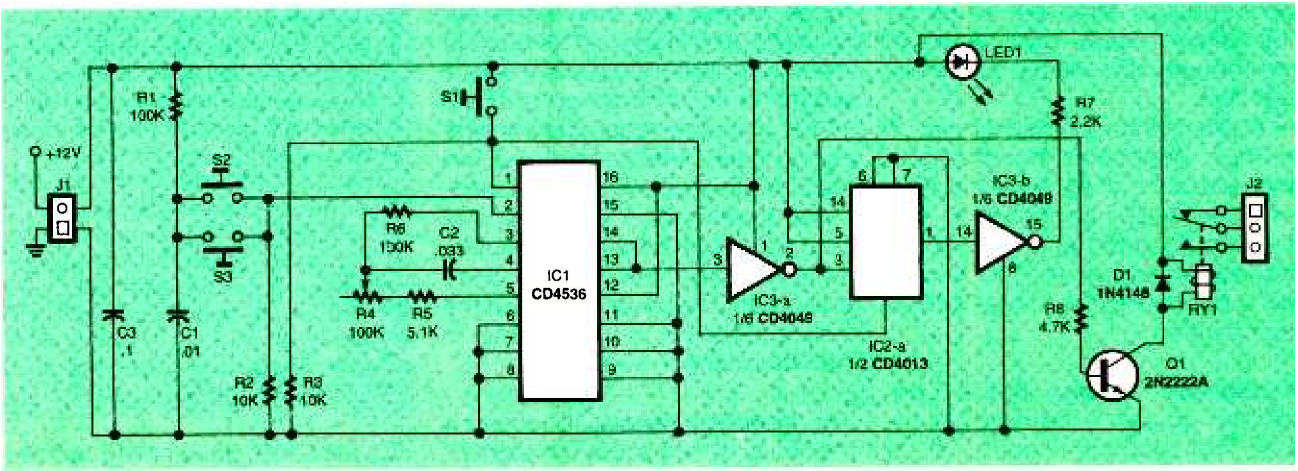



*Fig. 1. The Earthquake Detector is built around a programmable timer chip that can be reset while timing out to extend the overall timing period. A flip-flop latches an LED to indicate if the circuit has been activated. Using CMOS technology keeps the current drain incredibly low.*

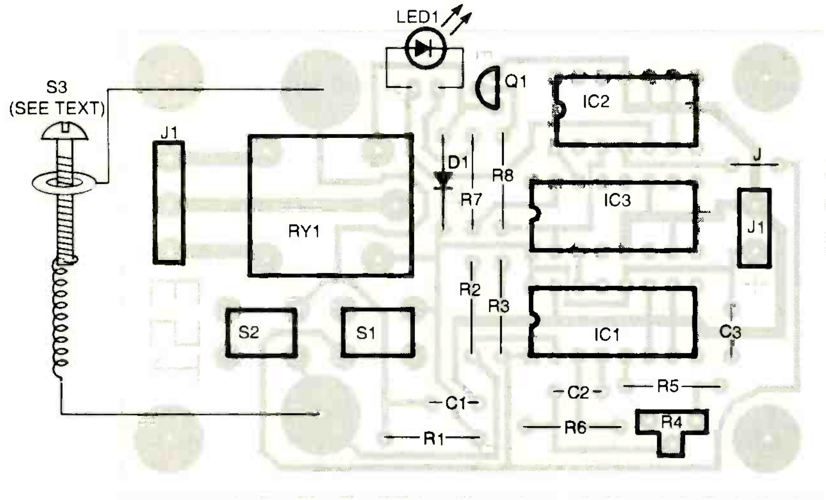



*Fig. 2. Use this parts-placement diagram when assembling the Earthquake Detector. Don't forget the small jumper next to J1.*

shortest parts first, and then work your way up to the taller ones. Note: do not install S3, which is located on the solder side of the board, until you are instructed to do so. When using that method, the diodes and resistors would be installed first, followed by the capacitors, ICs, transistors, etc. The installation of the relay and connectors would complete the job. One of the scrap resistor leads can be used for the single jumper next to J1. While you are building the board, keep in mind that CMOS ICs are very sensitive to static electricity—take the proper handling precautions.

Although screw-type connectors are indicated for J1 and J2, you might want to solder those connections for greater reliability. If you do decide to go that route, use heavy-gauge stranded wires for the power supply and whatever mechanism you will be controlling with RY1.

At this point, you should have all of the components mounted with the exception of S3. Since it is easier to test and fix any problems with the circuit before S3 is installed on the solder side of the PC board, we'll be testing the circuit before completion.

**Preliminary Testing.** Before connecting power to the circuit, measure the resistance across J1; it should measure about 3 megohms in one direction and 17 megohms in the other. If the high reading is closer to 30 megohms, Q1 might be reversed. If the readings are not significantly lower than those values, connect the power and turn the unit on. Pressing S2 should activate RY1 and light LED1. Pressing S1 should release RY1 and clear LED1. Set potentiometer R4 to its lowest resistance. Press S2 again; RY1 should stay on for about 30 seconds. With R4 set to its maximum resistance, the on time should increase to about 10 minutes. Set R4 back to the lowest resistance again. Press S2 several times over a period of about 10 seconds. Start counting the time as you press S2 for the last time. The relay should stay active for an additional 30 seconds. Finally, press and hold S2. Keep holding it until RY1 releases; the time should once again be 30 seconds. With all of the tests completed, it is now time to add the vibration sensor.

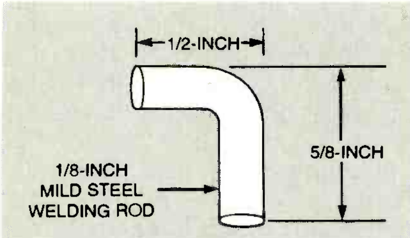



*Fig. 3. The vibration sensor is formed from pieces of welding rod. This piece supports the spring.*

**The Vibration Sensor.** The sensor is made up of two parts: a weighted spring and a contact loop. Two pieces need to be made from short lengths of mild-steel gas-welding rod. Mild-steel gas-welding rod normally has a very thin coat of copper to prevent oxidization and hence will appear copper in color.

## PARTS LIST FOR THE EARTHQUAKE DETECTOR

**SEMICONDUCTORS**

IC1—CD4536 or MC14536 programmable timer
IC2—CD4013 or MC14013 dual D Flip-Flop
IC3—CD4049 or MC14049 hex inverter
Q1—2N2222A NPN silicon transistor
D1—1N4148 silicon diode
LED1—Light-emitting diode, yellow

**RESISTORS**

(All resistors are ¼-watt, 5% units unless otherwise noted.)
R1, R6—100,000-ohm
R2, R3—10,000-ohm
R4—100,000-ohm potentiometer (BOURNS 3316W or similar)
R5—5100-ohm
R7—2200-ohm
R8—4700-ohm

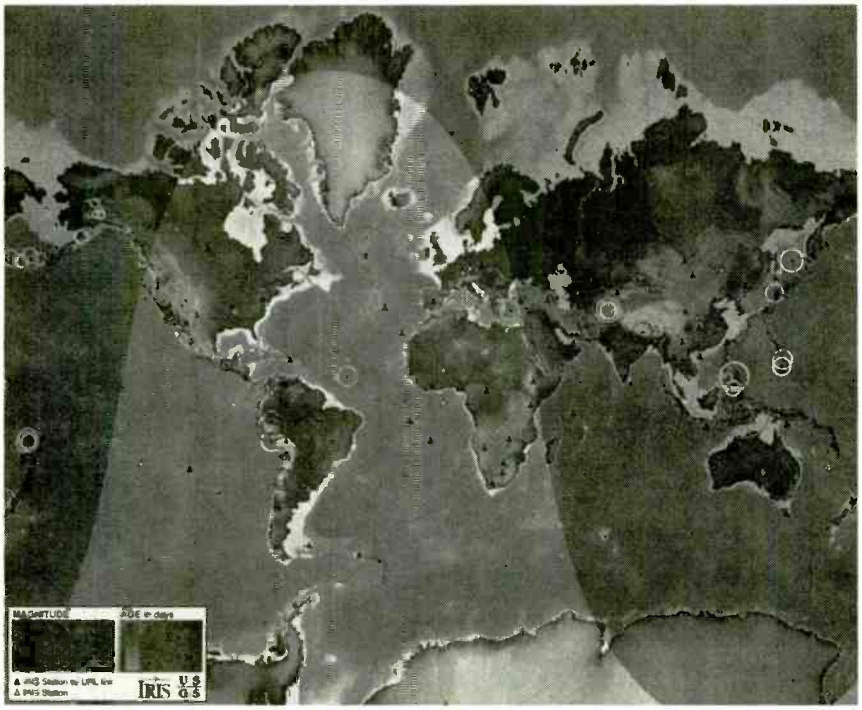
**CAPACITORS**

C1—0.01-µF, ceramic disc
C2—0.033-µF, ceramic disc
C3—0.1-µF, ceramic disc

**ADDITIONAL PARTS AND MATERIALS**

S1, S2—Momentary pushbutton switch (Digi-Key P8009S-ND or similar)
S3—Vibration sensor (see text)
RY1—12-volt single-pole, double-throw relay (OMRON G5L-114P-PS or similar)
J1—2-terminal PC-mount terminal block (optional, see text)
J2—3-terminal PC-mount terminal block (optional, see text)
8-32 ¾-inch brass screw, pen spring (see text), hardware, etc.

**Note:** The following items are available from Kool Kits, 2567 Byron Road, North Vancouver, BC, Canada V7H 1L9, E-mail: bobb@prostyle.com, Web: http://www.prostyle.com/koolkits: Complete kit of parts for the Earthquake Detector, including etched and drilled circuit board, relay, buttons, connectors, ICs and enough welding rod to form the sensor loop and spring bracket (spring is not included, see text) (ES1-KIT), $24.95; etched and drilled circuit board and enough welding rod to form the sensor loop and spring bracket (ES1-PCB), $9.95. Please add $5.00 shipping and handling. BC residents must add appropriate sales tax. All prices in US funds. International orders outside Canada and US please add $5.00.



*The Incorporated Research Institutions for Seismology (IRIS) has an interesting Web site that features a real-time map of worldwide seismic activity. The map is updated every 30 minutes. Not only are the quakes shown with their intensity and how recently they occurred, the locations of the various seismograph stations are also shown. Seismic activity for the last five years shows the definite outline of the Earth's tectonic plates. Where those plates rub against each other, earthquakes are most likely.*

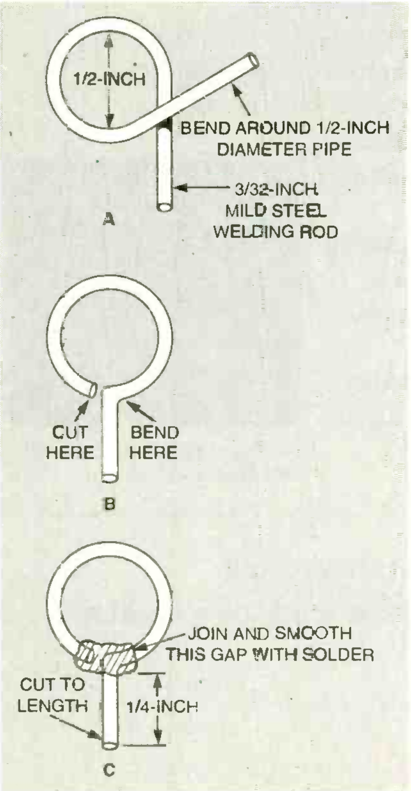



*Fig. 4. The contact loop for the vibration sensor is made from some welding rod. The rod is bent into a circle (A). One end is bent at a 45-degree angle and the other end cut off at the bend (B). The loop is closed with some solder (C).*

That copper coating will make it easy to solder the parts of the sensor together.

Start with the spring support. It is simply a length of $^1/_8$-inch welding rod that is bent to an L shape with the dimensions shown in Fig. 3. The easiest way to form the 90-degree bend is to insert one end of the rod into a vise to the desired length and gently tap on the side of the rod with a hammer. Once the rod has been bent, cut the piece to the proper length using a hacksaw and file off any burrs from of the ends of the bent rod.

The contact loop is formed using a short length of $^3/_{32}$-inch welding rod. Creating the loop is a bit more complicated, but it is easily done by following the steps shown in Fig. 4. First, form the loop by bending the rod around a ½-inch pipe. The loop of rod should look like Fig. 4A. Cut one end of the rod where it crosses the other end. Insert the formed loop into a vise and bend the uncut end 45 degrees so that the loop is centered over the tail. The piece should now look like Fig 4B. Finally, solder the end of the loop to the bend to form a closed loop as shown in Fig. 4C. That will prevent the sensor spring from getting snagged on the edge of the rod at the bottom of the loop. You will have to use a soldering gun, torch, or high-capacity soldering iron—an iron used for PC boards will not have enough heat capacity to make a good joint.

Insert the contact loop into the pad for S2 from the solder side of the board as shown in Fig. 2. That hole should be drilled to fit the rod. Align the loop so that it is parallel to the bottom of the board and facing the other pad. The photo in Fig. 5 will give you an idea of what the completed sensor will look like. Use a high-powered soldering gun or iron to solder the loop in place. Use enough solder to form a good crown, as that joint has to provide sufficient mechanical strength to hold the loop in place.

The long side of the L-shaped bracket rod is soldered to the other pad in a similar fashion. Orient the bend so that the end of the rod is pointing at the center of the contact loop.

Most people have a collection of inexpensive plastic pens, usually with some type of advertising printed on them, sitting in a drawer waiting for a refill. The spring from one of those pens is perfect for the vibration sensor. Thread one end of the spring onto a 4-40 brass screw about $^1/_8$ inch and slide the other end onto the L-shaped bracket piece so that the bolt is positioned inside the contact loop. Slide the spring up the shaft of the rod so that the bolt end of the spring is just above the contact loop. Solder the spring onto the rod. When the spring oscillates and makes contact with the detector loop, the bolt should be making contact, not the spring. Do not solder the bolt onto the spring at this time.

**Final Setup and Calibration.** The Earthquake Detector must be mounted in a vertical position so that the bolt hangs down through the approximate center of the contact loop. It should also be mounted solidly to the structure of the house, such as to a wall joist. You can mount all of the components of the detector and power supply to a

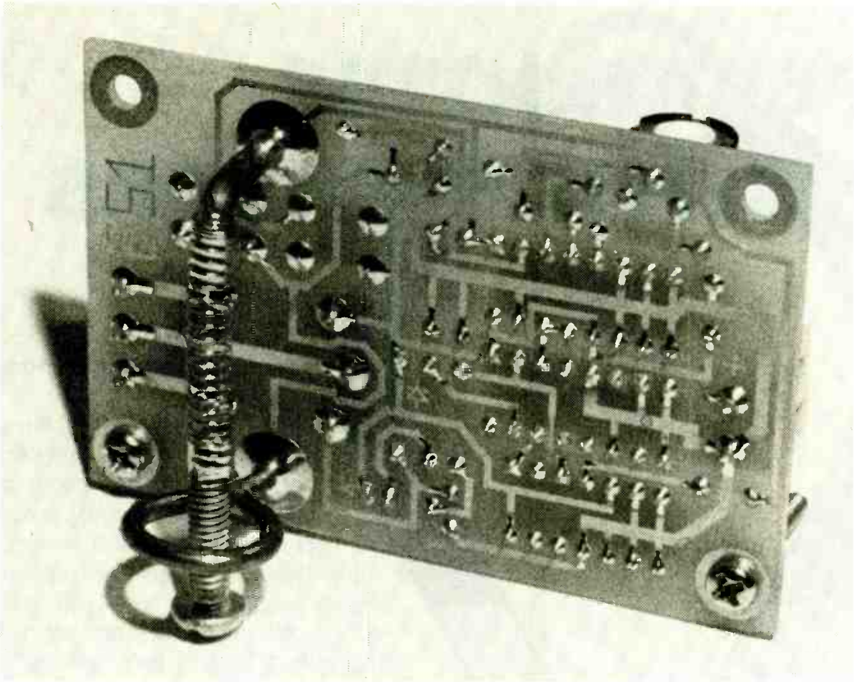
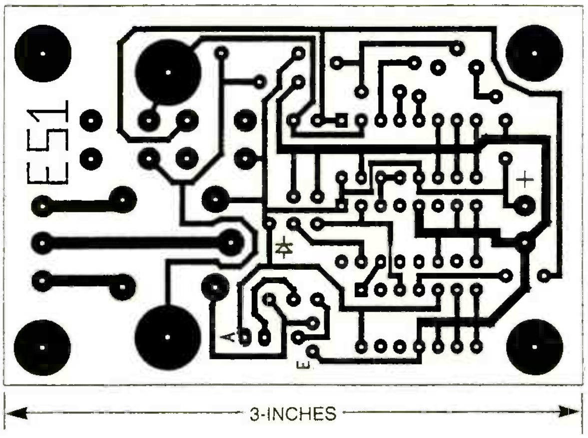


*Fig. 5. Here is how the vibration sensor looks when it is completed. Soldered to the foil side of the PC board, the screw hangs down through the center of the loop. When the spring absorbs enough energy from vibration, the screw hits the contact loop, completing the circuit.*




*Here's the foil pattern for the Earthquake Detector. The circuit is simple enough to use a single-sided board.*

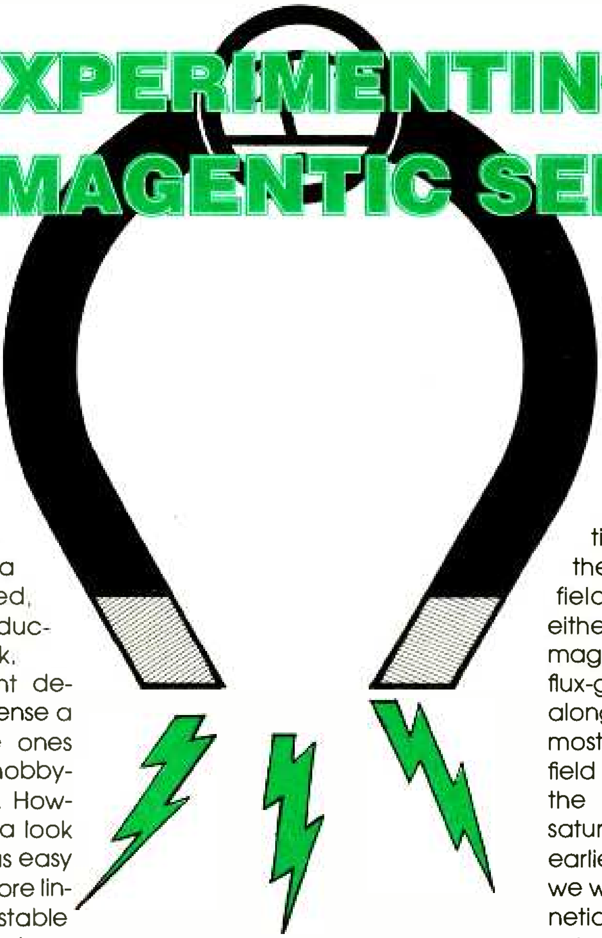
plywood base and then, using long wood screws, mount the plywood base to a wall, centering the screw holes on the joists behind the wall.

With the detector in operation, inspect it from time to time to check for false triggers, indicated by LED1. If you do get any false alarms, check to see that the sensor screw is properly adjusted in the center of the contact loop. If it is, you will have to desensitize the detector. That can be done by screwing the bolt farther into the spring. If you still have a problem with false alarms, try a shorter bolt; that will lessen the weight on the end of the spring. Once the sensor is properly adjusted, solder the bolt to the spring, being careful not to get any solder on the sensor loop.

There are many possible applications for the Earthquake Detector. For example, in the author's kitchen the detector operates solenoids that engage hooks on the cabinet doors when a tremor activates the unit. A 12-volt sealed lead-acid battery provides power so that the system does not have to rely on the 110-volt AC house current during an earthquake. The battery is constantly kept charged by using a trickle-charge circuit that was purchased with the battery. In the first two years that the circuit has been in use, it has been activated by two minor tremors, performing flawlessly each time.

There are a lot of good sites on the Internet worth checking out regarding earthquakes. One example is the Incorporated Research Institutions for Seismology, located at http://www.iris.edu. That site has an interesting seismic-monitor page that shows a world map that is updated every 30 minutes with the latest seismic activity. For practical information on preparing for an earthquake and links to other sites, try http://quake.wr.usgs.gov. Ω

# EXPERIMENTING WITH MAGENTIC SENSORS



*Flux-gate magnetic sensors can provide superior performance to other popular alternatives, and a new device makes them easier than ever to use.*

JOSEPH J. CARR

Magnetic fields are all around us. The Earth itself produces a magnetic field, which is why compasses work. Anytime an electrical current flows in a conductor, a magnetic field is generated. That is why transformers, inductors, and radio antennas work.

There are several different devices that could be used to sense a magnetic field. One of the ones most familiar to electronics hobbyists is the Hall-effect device. However, in this article we'll take a look at a magnetic sensor that is as easy to use, but is more sensitive, more linear, and more temperature stable than typical Hall-effect devices. And just like Hall-effect devices, it can be used to make a variety of instruments, including magnetometers and gradiometers.

For those unfamiliar with them, magnetometers are used in a variety of applications in science and engineering. One high-tech magnetometer is used by Navy aircraft to locate submarines. Radio scientists use magnetometers to monitor solar activity. Archeologists use magnetometers to locate buried artifacts, while marine archeologists and treasure hunters use the devices to locate sunken wrecks and sunken treasure.

Anyway, the device we will be exploring is called a "flux-gate magnetic sensor." The device, in essence, is basically an over-driven magnetic-core transformer in which the "transducible" event is the saturation of the magnetic material. These devices can be made very small and compact, yet will still provide reasonable accuracy.

The most simple form of flux-gate magnetic sensor is shown in Fig. 1A. It consists of a nickel-iron rod used as a core, wound with two coils. One coil is used as the excitation coil, while the other is used as the output or sensing coil. The excitation coil is driven with a squarewave (see Fig. 1B) with an amplitude high enough to saturate the core. The current in the output coil will increase in a linear manner so long as the core is not saturated. But when the saturation point is reached, the inductance of the coil drops and the current rises to a level limited only by the coil's other circuit resistances.

If the sensor of Fig. 1A were in a magnetically pure environment, then the magnetic field produced by the excitation coil would be the end of the story. But there are magnetic fields all around us, and these either add to or subtract from the magnetic field in the core of the flux-gate sensor. Magnetic field lines along the axis of the core have the most effect on the total magnetic field inside the core. As a result of the external magnetic fields, the saturation condition occurs either earlier or later than would occur if we were only dealing with the magnetic field of interest. Whether the saturation occurs early or later depends on whether the external field opposes or reinforces the intended field.

A better solution is shown in Fig. 2. In this version of the flux-gate sensor, there are two independent cores, each of which has its own excitation winding. A common pick-up winding serves both cores. The excitation coils are wound in a series-opposing manner so that the induction generated in the cores precisely cancels each other if the external field is zero. However, in the presence of an external field, pulses are produced in the pick-up coil that can be integrated in a low-pass filter to produce a slowly varying DC signal that is proportional to the applied external magnetic field.

**Toroidal-Core Flux-Gate Sensor.** The flux-gate sensors that use a linear or straight core suffer from two main problems. First, the desired signal is small compared with the signal on which it rides, so is difficult to discriminate properly. Second, there must be a very good match

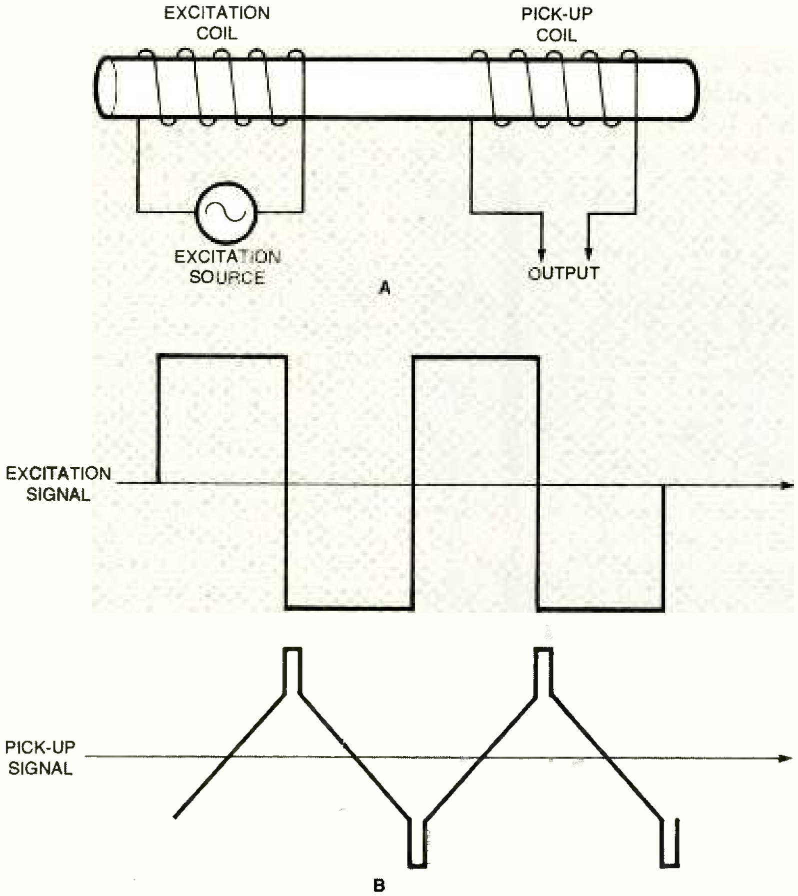



*Fig. 1. Here's the flux-gate magnetic sensor in its simplest form (A) and a sample excitation signal and the output that it produces (B).*

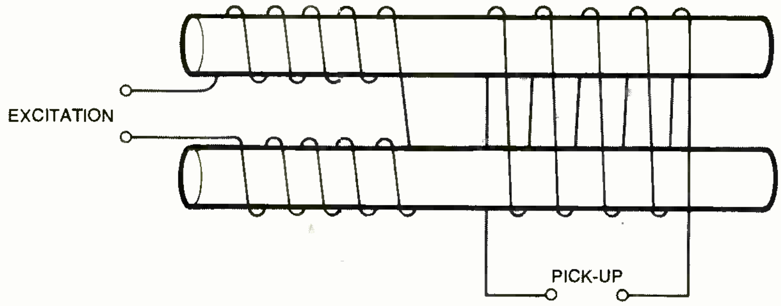



*Fig. 2. While the simple circuit of Fig. 1 would work under ideal conditions, because we are constantly surrounded by all kinds of magnetic fields, the dual-core design shows here would produce superior results.*

between the cores and the excitation winding segments on each winding. While those problems can be overcome, it becomes expensive, limiting the design's popularity.

A better solution is to use a toroidal or "doughnut"-shaped magnetic core. That type of core relieves the problem of picking off small signals in the presence of large offset components. It also reduces the drive levels required from the excitation source.

In the toroidal-core flux-gate sensor, we can get away with using a single excitation coil wound over the entire circumference of the toroidal core (see Fig. 3). The pick-up coil is wound over the outside diameter of the core.

Another advantage of the toroidal-core version of the flux-gate sensor is that a pair of orthogonal (*i.e.* right angle) pick-up cores can

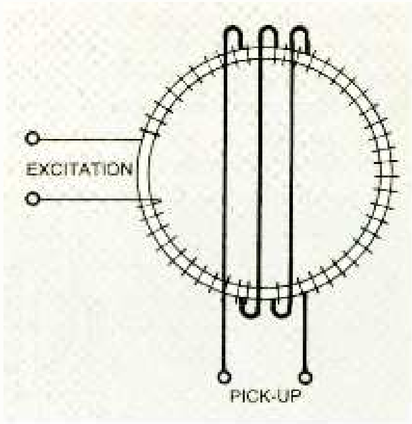



*Fig. 3. Using a toroid core overcomes some of the problems and limitations inherent in the straight-core design*

be installed that will allow null measurements to be made. Figure 4 shows the orientation of the toroid-core flux-gate sensor as a function of sensitivity. The maximum sensitivity occurs when the magnetic H-field is orthogonal to the pick-up coil, while minimum sensitivity occurs when the pick-up coil and H-field are aligned with each other. As you can see, when there are two pick-up coils at right angles to each other, one will be at maximum sensitivity when the other is at a null (minimum sensitivity).

**A Practical Flux-Gate Sensor.** A compact and reasonably low-cost line of flux-gate sensors, designated FGM-x, is made by Speake & Co. Ltd (Elvicta Estate, Crickhowell, Powys, Wales, UK), and distributed in the United States by Fat Quarters Software (24774 Shoshonee Drive, Murrieta, CA 92562; Tel: 909-698-7950, Fax: 909-698-7913; e-mail: 73162,2364@compuserve.com). The FGM-3 device is the one that I experimented with when preparing this article. It is a 62mm-long by 16mm-diameter (2.44 by 0.63 inch) device. Like all the devices in the line, it converts the magnetic field strength to a signal with a proportional frequency. One of the things I found fascinating about the FGM-3 is that a set of only three leads provides operation: Red: +5 VDC (power), Black: 0 Volts (ground), and White: output signal (a squarewave whose frequency varies with the applied field).

The magnetic detection rating of the device is ±0.5 oersted (± 50 μtesla). That range covers the earth's magnetic field, making it possible to use the sensor in Earth-field magnetometers. Using two or three sensors in conjunction with each other provides functions such as compass orientation, three-dimensional orientation measurement systems, and three-dimensional gimbaled devices such as virtual-reality helmet display devices. It can also be used in applications such as ferrous metal detectors, underwater shipwreck finders, and in factories as conveyer-belt sensors or counters. There are a host of other applications where a small change in a magnetic field needs to be detected.

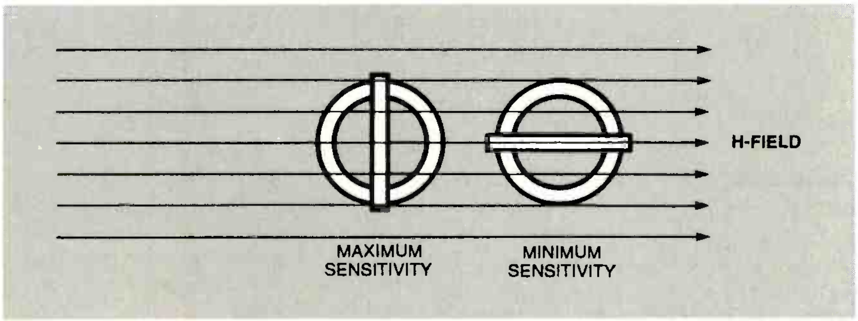



*Fig. 4. The sensitivity of the toroid-wound sensor is affected by its orientation within the magnetic field. That property can be put to good use in a variety of sensor applications.*

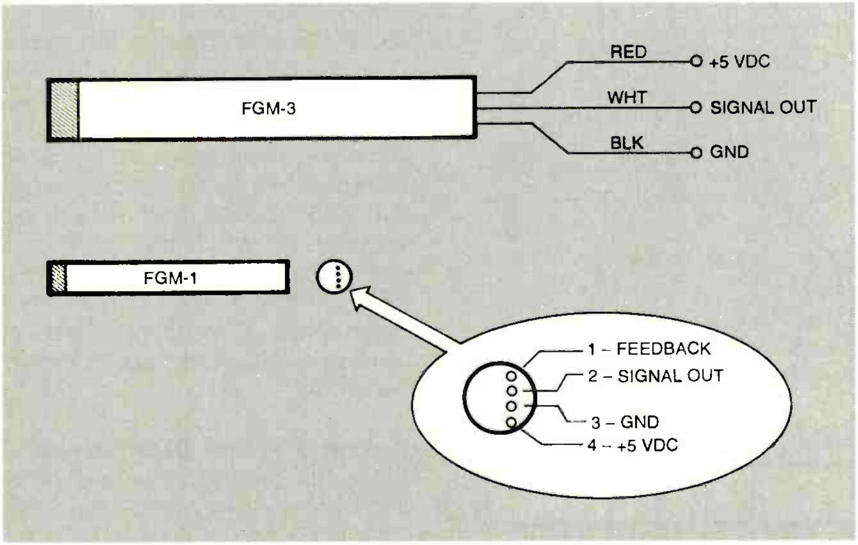



*Fig. 5. Here are the pinouts of the FGM-1 and FGM-3, two members of a family of practical flux-gate sensors made in Wales, UK by Speake & Co. Ltd.*

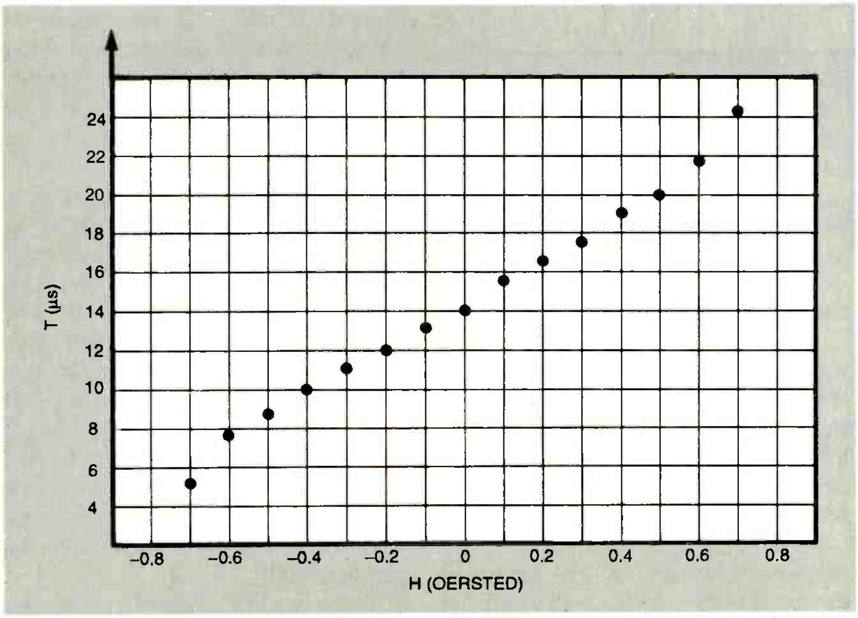



*Fig. 6. The output of the FGM devices is directly proportional to the magnetic-field strength.*

The packages for the FGM-1 and FGM-3 sensors are shown in Fig. 5. The package style of the FGM-3 has already been discussed. The FGM-1 is smaller than the FGM-3 (30mm long by 8mm diameter; 1.18 by 0.315 inches). It has a small connector on one end consisting of four pins: 1) feedback; 2) signal output; 3) ground, and 4) +5 VDC power. The signal, output, and ground terminals are essentially the same as on the FGM-3, but the feedback pin provides some extra flexibility. The feedback pin leads to an internal coil that is wound over the flux-gate sensor. It is used to alter the zero-field output frequency, or to improve linearity of the sensor over its entire range, which is ±0.7 oersted (± 70 μtesla).

The series also includes two other devices, the FGM-2 and the FGM-3h. The FGM-2 is an orthogonal sensor that has two FGM-1 devices on a circular platform at right angles to one another. That orthogonal arrangement permits easier implementation of orientation measurement, compass, and other applications. The FGM-3h is the same size and shape as the FGM-3, but is about 2.5 times more sensitive. Its output frequency changes approximately 2 to 3 Hz per gamma of field change, with a dynamic range of ±0.15 oersted (about one-third the Earth's magnetic field strength).

The output signal in all the devices in the FGM series is a +5 volt (TTL-compatible) pulse whose period is directly proportional to the applied magnetic field strength. This relationship makes the frequency of the output signal directly proportional to the magnetic field strength (Fig. 6). The period varies typically from 8.5 μs to 25 μs, or a frequency of about 120 kHz to 50 kHz. For the FGM-3 the linearity is about 5.5 percent over its ±0.5 oersted range.

The response pattern of the FGM-x series sensors is shown in Fig. 7. It is a "figure-8" pattern that has major lobes (maxima) along the axis of the

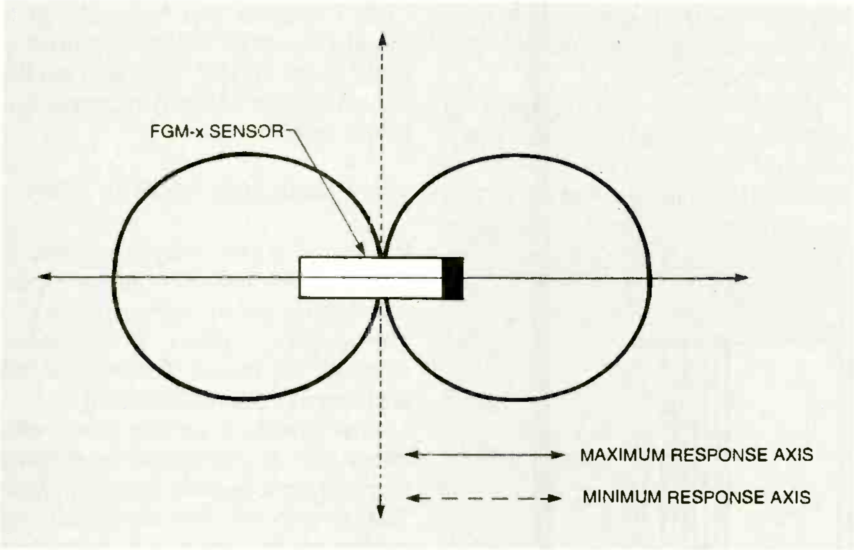


*Fig. 7. The figure-eight sensitivity pattern for the FGM-x devices makes them most sensitive along their long axis, and least sensitive at right angles to it.*

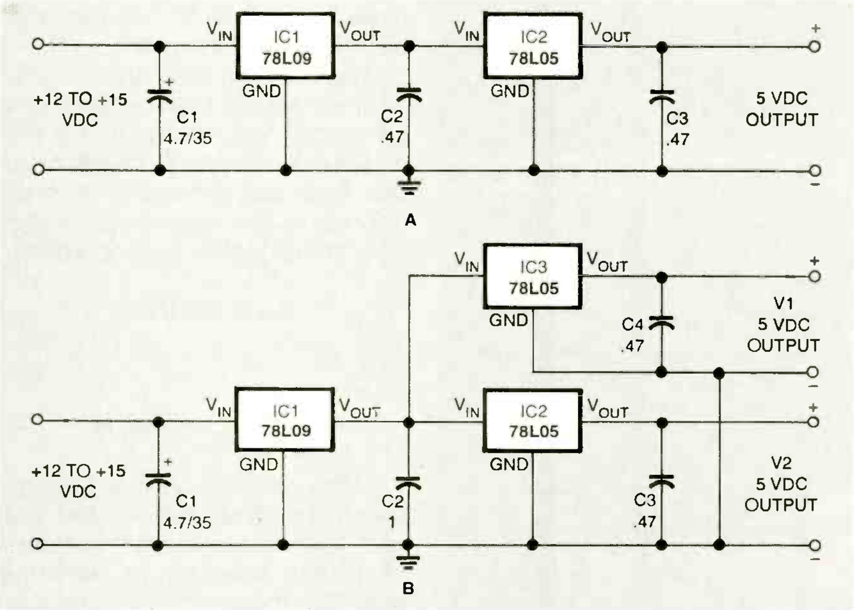


*Fig. 8. As ripple will adversely affect the operation of the device, a double-regulated DC power supply (A) should be used to power the device. If other circuits are also to be driven from the supply, use the version shown in B.*

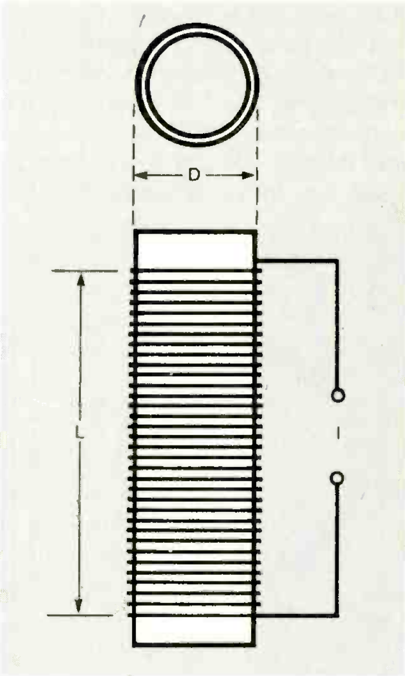


*Fig. 9. To calibrate the FGM devices, a solenoid-wound coil like this one could be used.*

sensor, and nulls (minima) at right angles to the sensor axis. This pattern suggests that for any given situation there is a preferred direction for sensor alignment. The long axis of the sensor should be pointed towards the target source. When calibrating or aligning sensor circuits, it is common practice to align the sensor along the east-west direction in order to minimize the effects of the Earth's magnetic field.

**Powering the Sensors.** The FGM-x series of flux-gate magnetic sensors operates from +5 volts DC, so it is compatible with a wide variety of analog and digital support circuitry. As is usual for any sensor, you will want to use only a regulated DC power supply for the FGM-x devices. In fact, the manufacturer recommends that double-regulation (Fig. 8A) be used. Ripple in the DC power supply can cause output frequency anomalies, and those should be avoided. In the circuit of Fig. 8A, an unregulated +12 to +15 VDC input potential is applied first to a 9 volt 78L09 or 78M09 three-terminal IC voltage regulator (IC1). That produces a +9 volt regulated potential that is then applied to the input of a 78L05 or 78M05 device (IC2). The second regulator reduces the +9 volts from IC1 to the +5 volts needed for the FGM-x sensors.

When other digital devices are being powered from the same DC power supply, it is prudent to provide a separate DC source for the FMG-x sensors. In Fig. 8B we see a circuit that would accomplish that task. There are two separate +5-volt DC outputs, labeled V1 and V2. Both are derived from 78L05 devices that are powered from a single 78L09. Care must be taken to not exceed the maximum current limits of IC1, especially if the same size IC voltage regulators are used for all three (IC1–IC3). One of the +5 VDC sources, either V1 or V2, can be used for powering the FGM-x device, while the other powers the rest of the circuitry.

**Calibrating the Sensors.** The FGM-x devices are not precision instruments straight out of the box, but can be calibrated to a very good level of accuracy. The calibration chore requires you to generate a precise magnetic field in which the sensor can be placed. One way to generate well-controlled and easily measured magnetic fields is to build a coil and pass a DC current through it. If the sensor is placed at the center of the coil (inside), then the magnetic field can be determined from the coil geometry, the number or turns of wire and the current through the coil. There are basically two forms of calibrating coil found in the various magnetic sensor manuals: solenoid-wound and the Helmholtz pair.

Figure 9 shows a solenoid-wound coil: a coil that is wound on a cylindrical form in which the length of the coil (L) is greater than or equal to its diameter. This type of coil is familiar to radio fans because it is used in many L-C tuning circuits. The magnetic field (H) in oersteds is found from:

$$H = (4\pi NIL)/(10\ SQRT\ (L^2 + D^2))$$

Where: H is the magnetic field in oersteds, N is the number turns-per-centimeter (t/cm) in the winding, I is the winding current in amperes, and D is the mean diameter of the winding in centimeters (cm)

The winding is usually made with either 24- or 26-gauge enameled or *Formvar*-covered copper wire. The length of the solenoid coil should be at least twice as long as the sensor being calibrated, and the sensor should be placed as close as possible to the center of the long axis of the coil.

The Helmholtz coil is shown in Fig. 10. It consists of two identical coils (L1 and L2) mounted on a form with a radius of R, and a diameter of 2R. The coils are spaced one radius (1R) apart. The equations for that type of calibration assembly are:

$$H = (0.8991NI)/R$$

and,

$$B = (9.1 \times 10^3 NI)/R$$

In the practical case, one usually knows the dimensions of the coil, and needs to calculate the amount of current required to create a specified magnetic field. We can get that for the Helmholtz pair by rearranging the first equation of the pair to:

$$I = (RH)/(0.8991N)$$

The coils are a little difficult to wind, especially those of large diameter (*e.g.* 4 inches). One source recommends using double-sided tape (the double-sticky stuff) wrapped around the form where the coils are to be located. As the wires are laid down on the form they will stick to the tape, and not dither around.

The above equations, plus a lot of magnetic theory and calibration suggestions are found in The *Mag-*

*(Continued on page 72)*

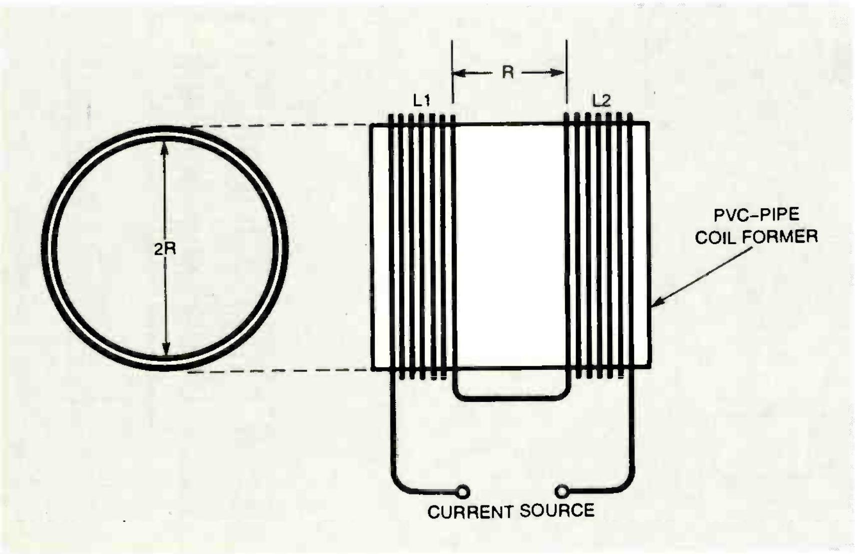



*Fig. 10. A Helmholtz-pair calibration coil could also be used, though these can be difficult to wind.*

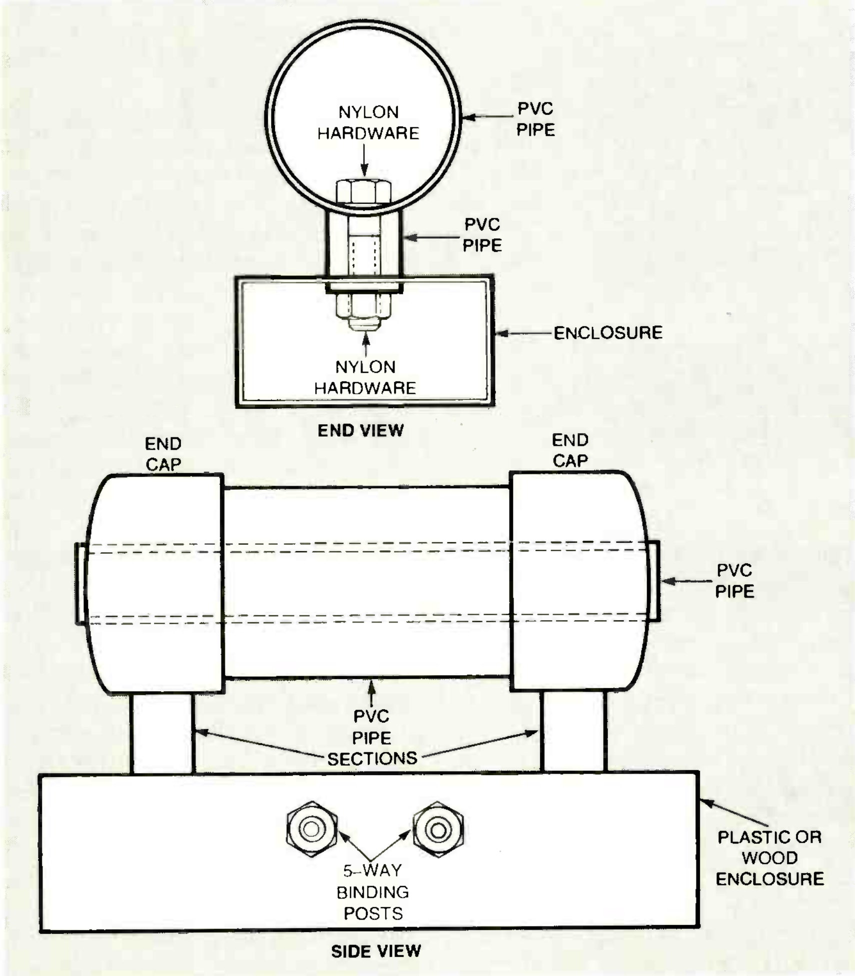
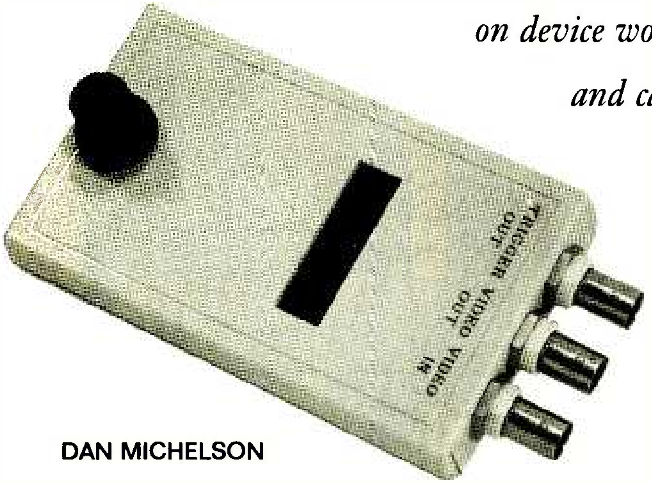



*Fig. 11. Here's a simple coil-mounting assembly that can be used in your calibration setup.*

*Even if your oscilloscope has a simple video trigger, this add-on device works with different broadcast standards, and can be set to pick out any individual line.*




DAN MICHELSON

# ADD A VIDEO TRIGGER TO YOUR OSCILLOSCOPE

One of the most aggravating tasks when working with composite video is getting the oscilloscope to trigger properly. Unless you have an oscilloscope with a video-trigger option, you have probably struggled with just such a problem repeatedly. One option, of course, is to buy a new oscilloscope. Unfortunately, that option is usually too expensive for most of us. Having a simple device that could monitor a video signal and trigger an existing oscilloscope would be a more reasonable choice.

The Video Trigger Module presented here does just that, and then some. The unit is compatible with both NTSC and the several PAL video standards. The output trigger is adjustable on not only a line-by-line basis, but also has a variable offset from the start of any particular line of video. With a single, simple control, it is easy to adjust and choose from the many options available.

**Device Description.** The Video Trigger is a small hand-held unit that accepts a video signal and generates a trigger pulse. That pulse lets a stable baseband video signal be displayed on an oscilloscope. A 4-digit, 7-segment display is used to show the unit's current setup. A special rotary encoder that has a momentary-contact switch that is activated whenever its shaft is pressed is used to make all of the adjustments and option choices that are available. Some of the options include the line number to trigger on, how much of a delay from the start of a line before triggering, and which video field to trigger on. Each time that the encoder shaft is pressed, the display shows another item whose options are then selected by rotating the encoder shaft.

To see the location of the trigger position in the video field, the Video Trigger has a video output that will contain a marker showing where in the video field the unit is triggering. That signal can be hooked up to any monitor for easy viewing. The marker can be adjusted between black and white using a potentiometer on the circuit board. The marker can be set to be either a line or a dot by selecting an option with the rotary encoder. Standard BNC connectors are used for easy hookup of the Video Trigger to a video source, a video monitor, and an oscilloscope.

**Circuit Description.** The circuit is built around two programmable devices: a single-chip microcontroller that controls all of the various functions and a programmable-logic device, or PLD. The PLD replaces almost all of the discrete circuitry that would otherwise be needed for a device such as the Video Trigger. Within it are several registers that are loaded with data from the microcontroller depending on the various settings and controls. The PLD is the main reason that the unit is so compact in comparison to its features and abilities.

Following the schematic diagram shown in Fig. 1, a video signal that is input through J1 is coupled through C8 to the input of IC1, a video-sync-separator chip. The horizontal, vertical, and odd/even field signals are separated from the video signal and sent to IC5, the PLD. One of the functions located in IC5 is a counter that is decremented on each horizontal-sync signal. The initial value of the counter, which is the video-line number on which the oscilloscope will be triggered, is reloaded at each vertical-sync signal. That value is stored in IC5, and set by microcontroller IC4 according to the options that have been selected from the controls.

When the counter reaches 0 and the selected video field matches, a trigger pulse is generated by IC5. If the offset value is zero, then that pulse becomes the actual trigger signal that is sent to the oscilloscope through J4. With an offset value of zero, triggering will take place at the beginning of the line.

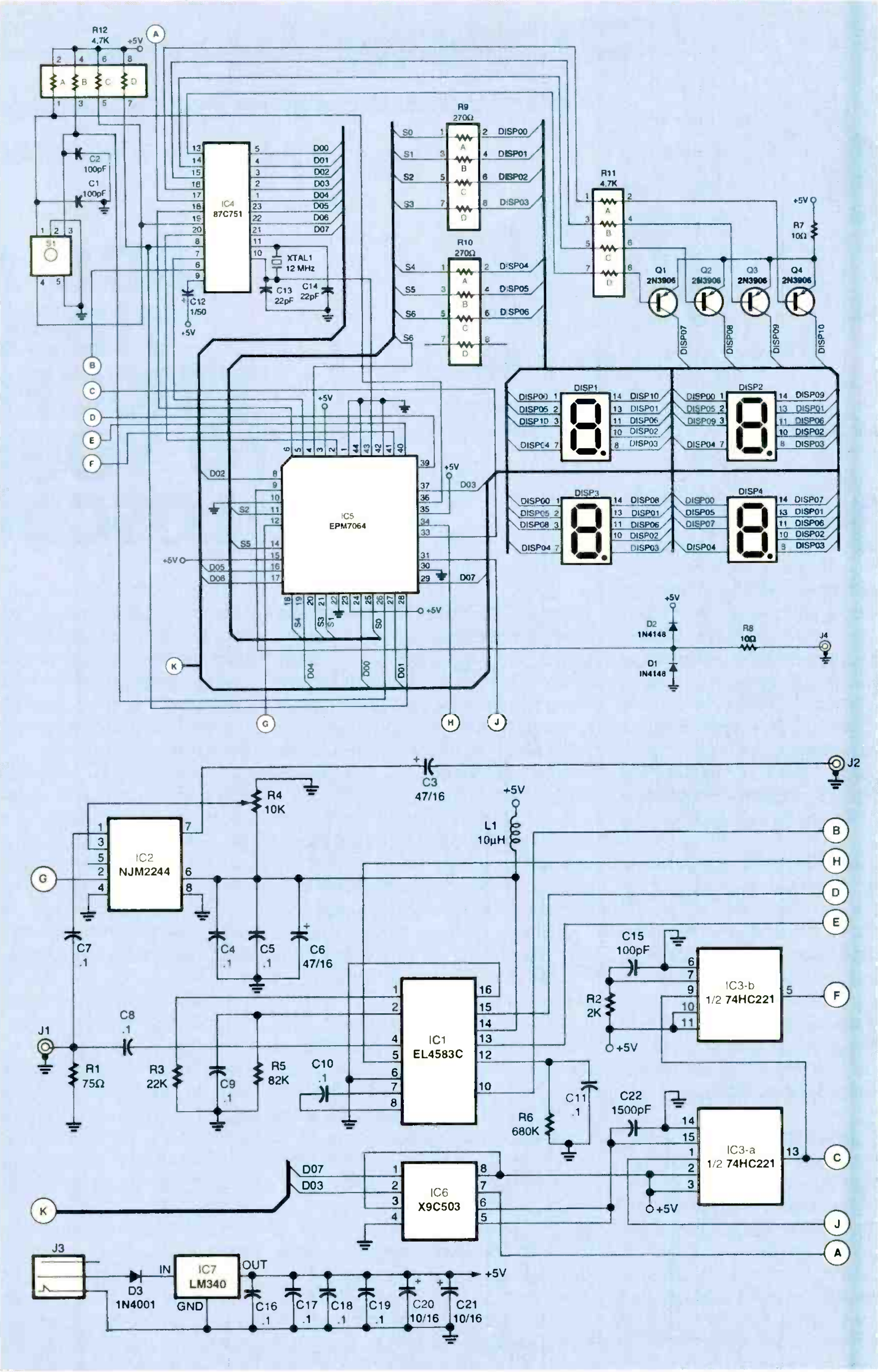



*Fig. 1. Although the Video Trigger is a complex device, a programmable-logic device simplifies the design by replacing the equivalent of almost two dozen discrete components.*

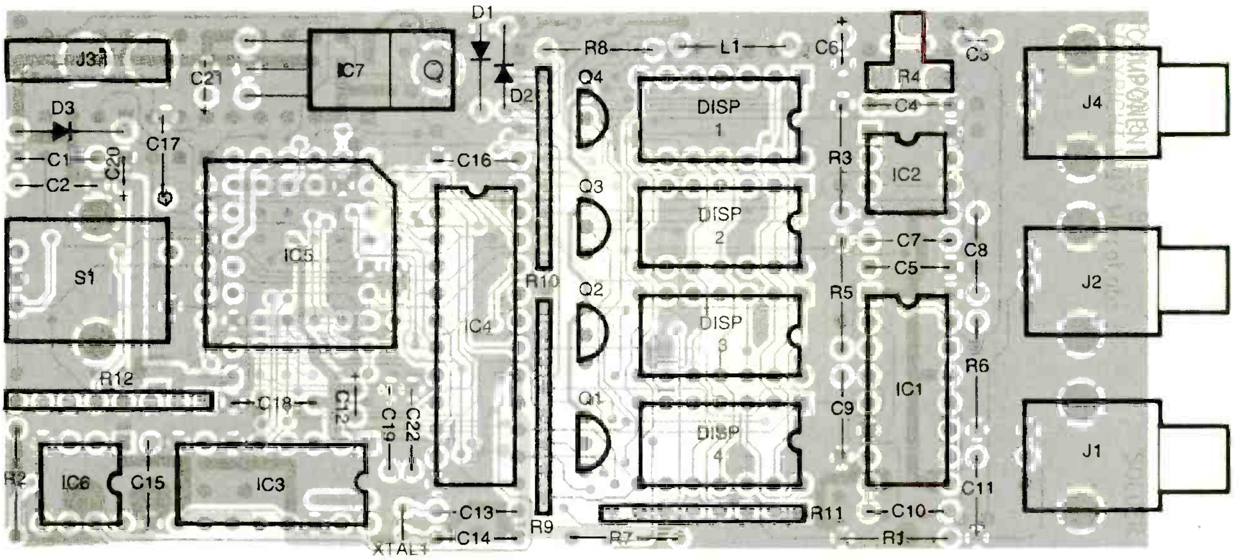



*Fig. 2. Careful layout and design of the circuit board makes the Video Trigger a compact unit.*

For any other offset, the trigger is sent to the input of IC3-a, a monostable multivibrator. That component generates a pulse whose length is set by an RC circuit. The capacitor portion of that circuit is C22, with the resistor portion coming from IC6, an electrically-settable potentiometer. A digital number from IC4 is loaded into IC6 that sets the output resistance of IC6. When the output pulse of IC3-a finishes, IC5 then sends a trigger pulse to J4.

The video signal is passed through video multiplexer IC2 to J2 so that it can be seen on a monitor. The multiplexer superimposes a line or dot on the video signal, giving a visible marker on the monitor. The DC level of the marker is set by R4, making the marker adjustable between the black and white levels.

If the marker display selected is to be a line, the marker voltage is switched in place of the video signal for the duration of that entire video line. A dot, on the other hand, needs to be switched in for only a brief instant at a particular position. The timing for the size of the marker dot itself is generated by IC3-b. The values of R2 and C15 set the output pulse to 200 nanoseconds in length. The dot pulse goes to IC5, which controls the multiplexing of IC2 by selecting whether IC2 will be controlled by the pulse from IC3-b or the horizontal sync from IC1.

Controlling the Video Trigger is done completely through S1, a combination rotary encoder and momentary-contact switch. The encoder portion of S1 outputs two signals, a position pulse and a direction indicator. Both signals are handled by IC5, which alerts IC4 when S1 has been turned. The switch portion, activated when S1's shaft is pressed, is handled by IC4 directly.

The LED display (DISP1–DISP4) is multiplexed by IC4. The program within the microcontroller updates the display at a rate of four milliseconds per digit. The current source for each digit is supplied by Q1–Q4. Those transistors are turned on one at a time by IC4. Before they are turned on, the segment pattern for the individual display is loaded into a buffer in IC5.

**Construction.** Because of the frequencies involved, the Video Trigger should be built on a printed-circuit board. If you want to make your own board, foil patterns have been included. Alternatively, a pre-etched board is available from the source given in the Parts List.

Before beginning construction, both IC1 and IC5 must be pro-

## SETTINGS AND OPTIONS

**Lxxx**—Line xxx is selected as the trigger.
**o xx**—Offset xx is selected for the trigger.

**Fevn**—The even field is selected for the trigger.
**Fodd**—The odd field is selected for the trigger.
**Fo/e**—The odd and even fields are both selected for the trigger.

**NtSc**—The unit is configured for an NTSC video input.
**PALb**—The unit is configured for a PAL B video input.
**PALd**—The unit is configured for a PAL D video input.
**PALg**—The unit is configured for a PAL G video input.
**PALi**—The unit is configured for a PAL I video input.
**PALn**—The unit is configured for a PAL N video input.
**PALm**—The unit is configured for a PAL M video input.

**VLin**—A line marker will be overlaid on the Video Output. This marker will move with the Line and Line Offset selection.
**Vdot**—A dot marker will be overlaid on the Video Output. This marker will move with the Line and Line Offset selection.
**VdiS**—No marker will be overlaid on the Video Output.

FLASHING (any of the above)—No video input detected.

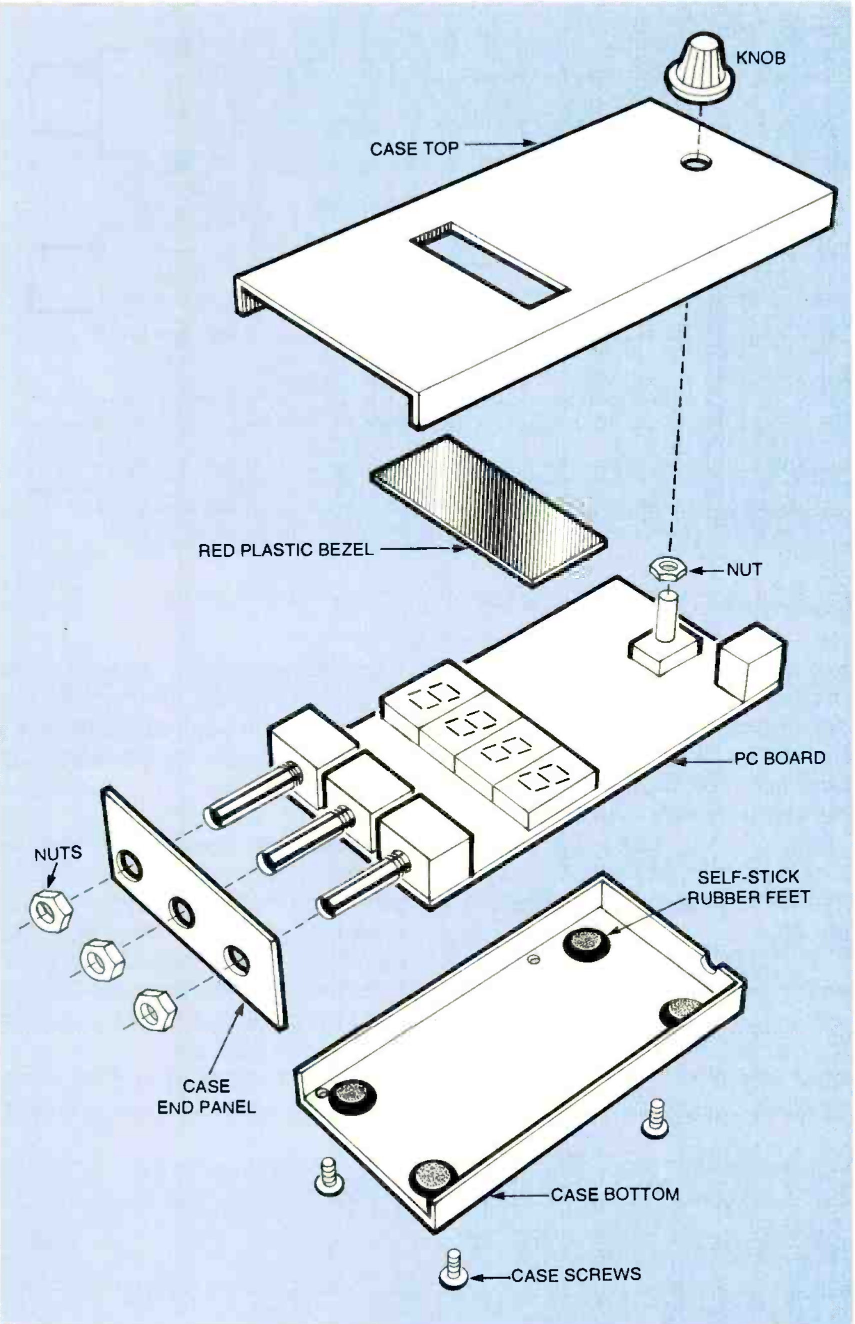
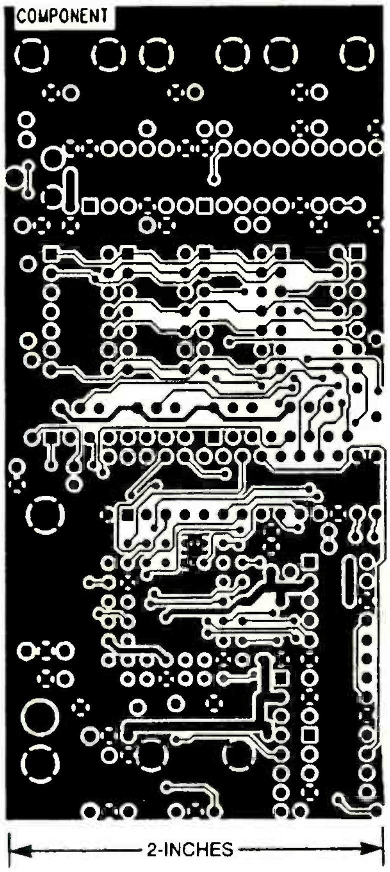



*Fig. 3. The Video Trigger fits neatly into a small hand-held case. A set of self-adhesive rubber feet applied to the inside of the case help lift the LED displays closer to the display window.*




*Here is the foil pattern for the component side of the Video Trigger.*

grammed. The data files for both parts can be downloaded from the Gernsback FTP site at ftp://ftp.gernsback.com/pub/EN/vidtrig.zip. That .zip file contains the two files needed for the programmable parts. The file with the .hex extension is the object code for IC1. That chip should be programmed according to Intel's data sheet. The other file with the .pof extension is for IC5. Programming information for that part is detailed in its data sheet from Altera. If you do not have access to the equipment needed to program those devices, pre-programmed units can be purchased from the source given in the Parts List.

If you are using a PC board from the Parts List source or the supplied foil patterns, the parts-placement diagram shown in Fig. 2 should be followed. Because of the tightness of the board layout, it is easiest to begin by installing the resistors, capacitors, and inductors first. Note that C19 is extra close to IC3, and might need to be offset a bit in order for both components to fit on the board. The parts should all be mounted as close to the circuit board as possible.

A socket is required for IC5. Using sockets for DISP1–DISP4 is a good idea—the display will be closer to the viewing window. Although sockets are optional for the other ICs, using them is highly recommended.

Finish the board by mounting the rest of the parts and inserting the ICs into the sockets. If you are using the suggested connector for J3, the pin on the side of the unit should be removed or clipped flush before installation. Voltage regulator IC7 should be mounted flat to the board by bending its leads at a right angle.

Before installing the ICs in their sockets, apply power to the board and check the voltage at the various power-supply pins at each socket. When everything checks out, the ICs can then be installed.

Drill a suitable enclosure for the various controls. Three holes will be needed for the BNC connectors,

## PARTS LIST FOR THE VIDEO TRIGGER

**SEMICONDUCTORS**

IC1—EL4583CN video-sync separator, integrated circuit
IC2—NJM2244D video multiplexer, integrated circuit
IC3—MM74HC221AN dual monostable multivibrator, integrated circuit
IC4—S87C751-1N24 microcontroller integrated circuit
IC5—EPM7064LC44-15 programmable-logic device, integrated circuit
IC6—X9C503P or DS1804-050 50,000-ohm electronic potentiometer, integrated circuit
IC7—LM340T-5 5-volt regulator, integrated circuit
Q1–Q4—2N3906 silicon transistor, PNP
D1, D2—1N4148 silicon diode
D3—1N4001 silicon diode
DISP1–DISP4—MAN71A 7-segment common-anode light-emitting diode display

**RESISTORS**

(All resistors are ¼-watt, 5% units unless otherwise noted.)
R1—75-ohm
R2—2000-ohm
R3—22,000-ohm
R4—10,000-ohm potentiometer
R5—82,000-ohm
R6—680,000-ohm
R7, R8—10-ohm
R9, R10—270-ohm 4-element resistor network
R11, R12—4700-ohm 4-element resistor network

**CAPACITORS**

C1, C2, C15—100-pF, ceramic-disc
C3, C6—47-µF, 16WVDC, electrolytic
C4, C5, C7–C11, C16–C19—0.1-µF, ceramic-disc
C12—1-µF, 50WVDC, electrolytic
C13, C14—22-pF, ceramic-disc
C20, C21—10-uF, 16WVDC, electrolytic
C22—1500-pF, ceramic-disc

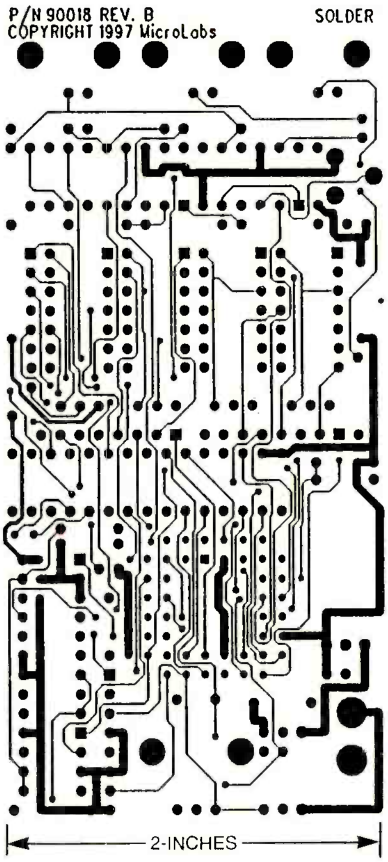
**ADDITIONAL PARTS AND MATERIALS**

L1—10 µH inductor
XTAL1—12-MHz crystal, CA-301 package (DigiKey SE3424-ND or similar)
J1, J2, J4—right-angle BNC connector, PC mount (Newark 50F979 or similar)
J3—Right-angle male power jack, PC mount (DigiKey CP-002A-ND or similar)
S1—Rotary encoder with switch (DigiKey P80675-ND or similar)
IC sockets, 9-volt 200-mA wall transformer, enclosure, red plastic filter, self-adhesive rubber feet, knob, hardware, etc.

**Note:** The following items are available from: MicroLabs, Inc., 1036 Marshall Drive, Des Plaines, IL 60016; E-mail: ulabs@ix.netcom.com: IC1 (EL4583CN), $7.05; IC2 (NJM2244D), $2.75, IC6 (X9C503P), $3.65; PC board (TRIG1), $25.00; Programmed IC4, programmed IC5, and PC board (TRIG2), $65.00; Complete kit of all parts and PC board, less case (TRIG3), $125.00. Payment is by check or money order only. Illinois residents must add sales tax. Please add $5.00 to all orders for shipping costs. All orders are shipped via US Priority Mail. Allow 2 to 6 weeks for delivery. The author can be contacted via e-mail at: ulabs@ix.netcom.com.

with additional holes for J3 and the shaft of S1. A rectangular hole is also needed for the display. As an option, drill an access hole for adjusting R4. The overall arrangement of the final assembly is shown in Fig. 3. Glue a red plastic bezel over the rectangular hole to protect the display. Depending on the height of the case used, four rubber feet can be placed in the corners of the bottom of the case in order to lift the board up. That will position the displays closer to the plastic bezel if needed for better viewing.

**Testing and Using the Video Trigger.** When power is applied to the unit, the display will show "L 1," indicating that the trigger is set for the first line of video. Additionally, the unit will trigger on the even field of an NTSC video signal with a line offset of 0 (beginning of the line) and a line video-output marker. A typical test setup is shown in Fig. 4. The oscilloscope should have a high-impedance input that will not load the video input because the Video Trigger already has a 75-ohm termination resistor as a part of the J1 input circuitry. The default line marker will look like the sample video-monitor screen shot shown in Fig. 5A. If the marker is changed to a dot, it will look like the screen shot in Fig. 5B.




*Here is the foil pattern for the solder side of the Video Trigger.*

Any video signal that is applied to J1 should be stable with an amplitude of 1 volt peak-to-peak into a 75-ohm load. Either NTSC- or PAL-standard video can be used as long as the Video Trigger is set properly. Information on the various modes and options is shown in the "Settings and Options" box. Note that if there is either too much noise or not enough amplitude in the video signal, IC1 will not properly separate out the horizontal sync, vertical sync, and odd/even-field signals. When no video input is detected, the display will flash.

The trigger output at J4 is a TTL-compatible signal. That output is connected to either the channel input or the trigger input of your oscilloscope, depending on the scope that you will be using with the Video Trigger. In either case, the trigger-input setting on the oscilloscope should be set for activating on a negative-edge signal and DC coupling. If your oscilloscope happens to have an alternate-channel

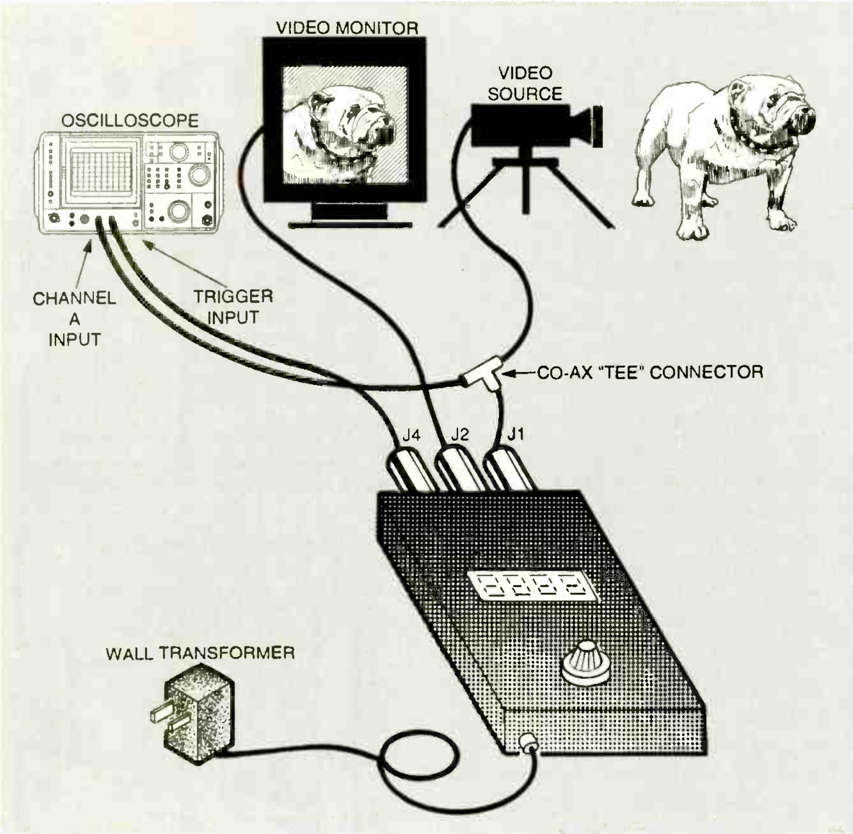



*Fig. 4. Here is a typical setup when using the Video Trigger to view a line of video on an oscilloscope. All of the settings for the Video trigger are controlled by a single knob.*

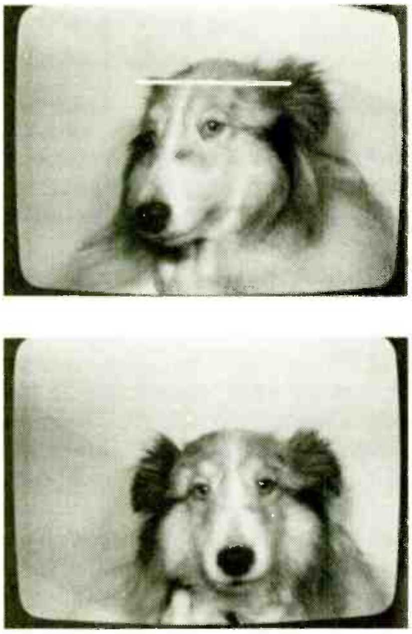


*Fig. 5. The Video Trigger also has a monitor output that marks the position of the trigger on the video signal. You can choose from either a line (A) or a dot (B).*

mode, you can view both the odd and even fields at the same time by setting the Video Trigger to output a trigger on both the odd and even fields. The video signal should then be connected to two oscilloscope channels. The oscilloscope will then alternate between the two inputs on each successive trigger.

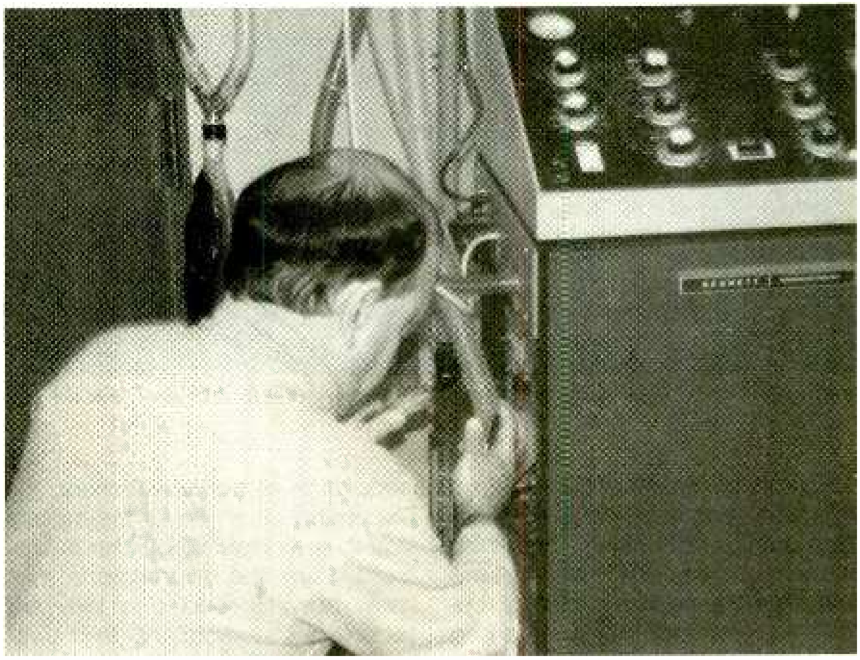
The video-output at J2 lets you see the video signal and the marker, if selected, on a monitor. As previously mentioned, the marker can range from white to black as set by R4. Being able to display the video signal with a marker is most useful as an instructional tool for students as it helps relate the actual video on a monitor with the waveform on the oscilloscope.

All of the settings and options available in the Video Trigger are selected with S1 and detailed in the "Settings and Options" box; the current choice is shown on the display. Each time the encoder shaft of S1 is pressed, the next group of options is selected. For any particular group, rotating the knob will change the setting for that option.

Whether it is used for education, troubleshooting, or examination of new circuits, the Video Trigger is a welcome addition to any test bench. Ω

# ALL ABOUT BIOMEDICAL TECHNICIANS

ALBERT LOZANO-NIETO, Ph.D.



*If you are an electronics enthusiast with a knack for understanding how things work and a desire to help others, here's how to convert your hobby into a successful career in the health-care industry.*

I am sure that most electronics hobbyists, and especially those who read **Electronics Now,** are aware that there is a constant need for highly trained technicians who can bring their expertise to the workplace. Some of the opportunities available were discussed in "Recruiting Tomorrow's Electronics Technicians" in the October 1997 issue of this magazine. However, there are other jobs out there in which those interested in electronics, interested in building and repairing equipment, and who have a desire to learn how things work, could develop excellent and successful careers. This article will explore one career path where a talented individual could make a tremendous impact on our society: Biomedical Engineering Technology.

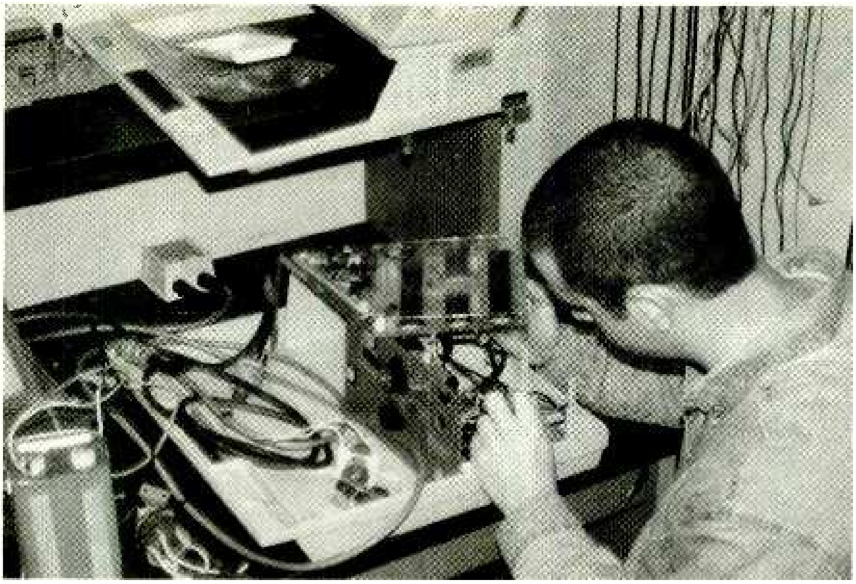
If you have recently been in a hospital or you like to watch TV shows and movies based on a clinical setting, you have surely noticed the large amount of electronic medical equipment. Today, physicians and other health-care professionals often rely on electronic instrumentation to aid in diagnosis, therapy, or surgery. The medical instruments used in hospitals range from auxiliary equipment designed to make jobs easier and more reliable (red-cell counter for blood analysis, for example), to devices that are used to sustain the life of the patient (such as pacemakers and ventilators). Because the role of electronic equipment is only going to increase in the coming years, there is a pressing need for good, qualified, expert, and well-trained technicians who are equipped to deal with the special circumstances that arise in the repair and maintenance of biomedical gear.

**What do Biomedical Technicians Do?** A chain is only as strong as its weakest link. It is the enormous responsibility of a biomedical technician to ensure that the weakest link in the clinical chain is not the electronic instrumentation. Biomedical technicians work closely with manufacturers, electronics technicians, computer technicians, electricians, mechanics, physicians, and nurses to make sure that the instruments to which the patients are connected are safe and in reliable working condition. They also need to assure that the equipment is in compliance with the manufacturer's specifications and all the regulations that apply to the particular machine.

Ensuring electrical safety is probably the most important task in the working day of a biomedical technician. They anticipate and prevent the many different types of accidents that might occur in a hospital. Those possible accidents range from mechanical hazards such as pieces of equipment falling onto a patient to fires and even electrocution.

It is important to remember that a hospital is a hazardous environment for electronic gear. For example, hospitals regularly use several types of gases, like oxygen and anesthetics, that might become flammable or even explode if exposed to a spark.

To ensure that the gear entrusted to their care can safely perform its tasks, biomedical technicians inspect the instruments at regular intervals, and after each time they have been repaired or worked on. One thing that is a particular concern is leakage current. If it is true that all electrical apparatus will leak some current, it is also true that this current can be especially harmful when the apparatus is connected to a patient. Levels of current that are imperceptible to most of us become very dangerous to patients that, for example, have catheters inserted into their heart to measure blood pressure, or pacemakers.



*Inspecting the high-voltage section of a defibrillator, which is used in the emergency room to resuscitate patients with severe cardiac problems.*

But biomedical technicians do a lot more than test equipment for electrical safety. They are also involved in the calibration of the instruments used in the clinical routine to ensure that they are working as intended. If an instrument (for example a blood-pressure meter) is useless when it is down or broken, it becomes dangerous when it works but the readings it gives are not reliable. If a blood-pressure meter displays a number that is 10% higher than the actual pressure, the medical professionals using it could take actions that could jeopardize their patient's health.

Another typical task for the biomedical technician is to maintain and repair medical equipment. For a hospital, it is crucial to have any equipment out of commission for as short a time as possible. When an important piece of equipment (for example a CT scanner) is down, the hospital loses money, and they cannot provide the diagnostic services to the patients who might need it. When an instrument that is being used in the operating room during a surgical procedure malfunctions, it is essential to have it back to work as soon as possible.

In the last few years, hospital budgets have become more restricted, and hospital staffs have become more accountable for the way they spend the money. When a hospital is contemplating the acquisition of new equipment, it is becoming common for the clinical staff to seek input about the equipment from the technicians that know how to read and interpret technical specifications. That way, hospitals can help ensure that they are getting the best value for their intended use, and that there are no details hidden in the specs that could render a piece of gear unsuitable for their needs.

Another role for a biomedical technician is that of teacher. It often is the job of a technician to train doctors, nurses, etc. in the correct way to operate a specific piece of gear.

In any case, all the technicians and clinical engineering managers whom I have spoken to have a similar answer when I asked them to describe their job: No two days are the same!

**The Job Market.** The job market for biomedical technicians is growing every day. Of course, prime employers are the many hospitals, but they are not the only ones.

A few years ago, biomedical technicians were mainly employed by hospitals and their prime job function was doing preventive maintenance and repair tasks. There was little opportunity for personal entrepreneurs and small business in this field. However, in the last few years, the number of small independent companies that provide technical services under contract has grown steadily. To reduce costs, some of the large hospitals are turning to these firms for their maintenance and repair work. Typically, they will have a number of biomedical technicians on the hospital grounds to provide the basic maintenance and repair services and will contract external assistance to work on specialized equipment or to cover peak periods.

But maybe the best customer for the independent medical-equipment service companies are small health care organizations. These could be clinics, large medical practices, assisted living facilities, and the like. Though small when compared to a hospital, these organizations also rely on electronic gear to an increasing degree. However, they do not own or use as much as a hospital, and for the most part, deal with a smaller volume of patients. As such, they rarely can afford to keep their own technicians on staff and must turn to an outside company for their repair and maintenance work.

Another source for employment are the manufacturers of medical instruments. Technicians that work for the manufacturer typically perform field work and sometimes work at a hospital under terms of a maintenance contract between the hospital and the manufacturer. This is especially true for large, complex systems (CT scanners, MRI imaging systems, X-rays, etc.) that require a high degree of specialization.

In any case, the trend for medical equipment is to depend more and more on electronics and computers. That means that there is a growing need to have technicians with good broad knowledge of medical instrumentation, but also a strong specialization in specific areas. The medical-equipment industry is in a growing stage, and this will translate into all kinds of job and advancement opportunities for biomedical technicians.

**How to Become a Biomedical Technician.** To become a successful biomedical technician, probably the most important asset that you might already possess is to

have an interest in learning how things work. You get extra credit if, as a child, you loved to take things apart. And you get even more extra credit if you were able to put things back together without missing pieces or having extra ones!

Most of the academic institutions that train biomedical engineering technicians offer a two-year college program that leads to an Associate Degree in Technology. The main emphasis of these college programs is on the electronic aspects of medical instruments: the safety issues, how physiological measurements are made on the human body, and how the medical equipment works. Also covered are related issues and technologies such as computers, telecommunications, mechanics, and fluids; education in these disciplines is important as they all converge in medical instrumentation.

If you are interested in pursuing a degree in this field, contact the colleges near where you live to obtain more detailed information. There are not a lot of universities and colleges that offer this degree, so you might need to do a little bit of research on your own. In any case, you can contact me (see the "About the Author" sidebar), and I will help you find a suitable institution near you. Ω

### ABOUT THE AUTHOR

Albert Lozano-Nieto, Ph.D. is an Assistant Professor of Engineering at the Penn State University, Wilkes-Barre Campus, where he is responsible for the Associates Degree in Biomedical Engineering Technology. Dr. Lozano-Nieto has worked in academia as well as with private and government industry, especially in the subjects of Bioengineering and Electromagnetic Compliance of electronic instruments. He has been involved in research projects with the European Space Agency, designing equipment to monitor physiological parameters for in-flight astronauts. Dr. Lozano-Nieto can be reached by email at: AXL17@psu.edu, by phone at (717) 675-9245, or by mail at P.O. Box PSU, Lehman, PA 18627.

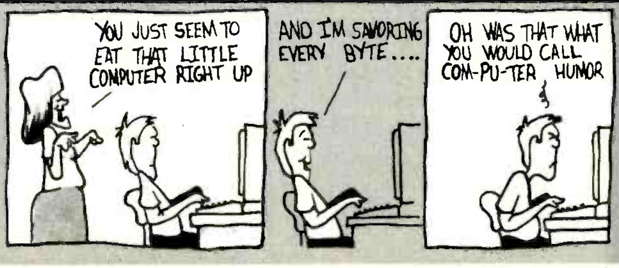
## MAGNETIC SENSORS

*(continued from page 60)*

*netic Measurements Handbook* by J.M. Janicke ($20, Magnetic Research Press, 122 Bellevue Avenue, Butler, NJ, 07405).

Figure 11 shows a type of assembly that can be used for either the solenoid or Helmholtz coil. I first saw this type of assembly in a college freshman physics laboratory about 25 years ago. It consists of a PVC pipe section used as the coil former. End caps on the coil former also serve as mountings. The mounts at either end consist of smaller segments of PVC pipe and nylon (non-magnetic) hardware fasteners. Another segment of PVC pipe, of much smaller diameter than the coil former, is passed through the former from one end-cap to the other, such that its ends protrude to the outside. This pipe forms a channel into which the sensor can be placed. The base is a plastic or wooden box (again, non-magnetic materials). One thing nice about that type of assembly is that the sensor is always in approximately the same position in the coil, and close to the center of the field.

**Conclusion.** Now that we've established a base of understanding of flux-gate sensors, it is a simple matter to put that knowledge to use to build some practical magnetometer and gradiometer projects. That will be the focus of another article, which will appear shortly. In the meantime, if you have any question or comments on what we've discussed here, you can contact me directly at PO Box 1099, Falls Church, VA 22041, or via Internet E-mail at carrjj@aol.com. Also, before we wrap up, I'd like to acknowledge the assistance of Richard Noble of Speake & Co. Ltd, and Erich Kern of Fat Quarters Software, the USA distributor of Speake sensors. Ω



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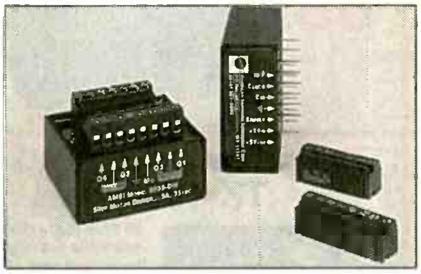

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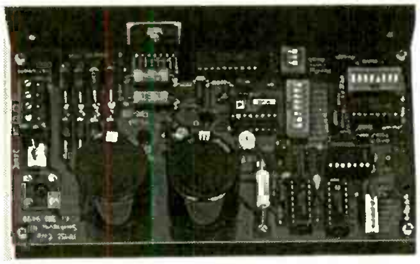

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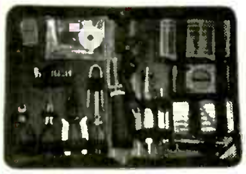

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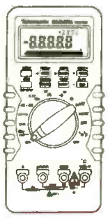

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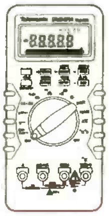

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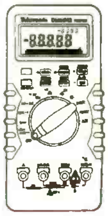

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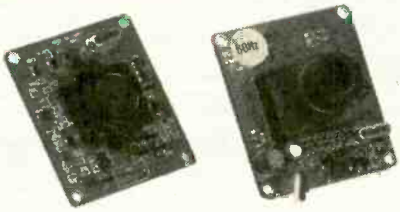

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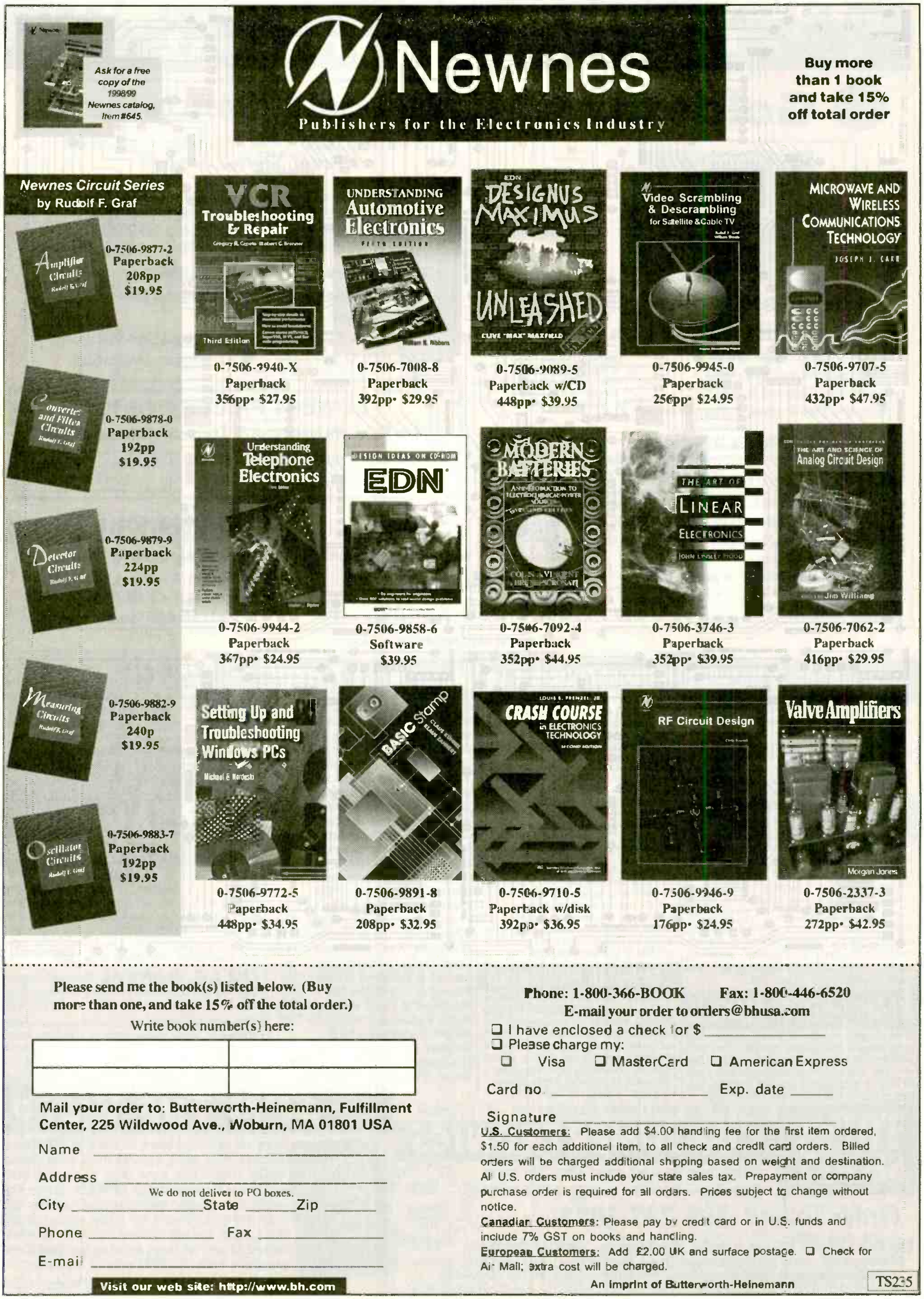


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## Synthesized FM Stereo Transmitter

Microprocessor controlled for easy frequency programming using DIP switches, no drift, your signal is rock solid all the time - just like the commercial stations. Audio quality is excellent, connect to the line output of any CD player, tape deck or mike mixer and you're on-the-air. Foreign buyers will appreciate the high power output capability of the FM-25; many Caribbean folks use a single FM-25 to cover the whole island! New, improved, clean and hum-free runs on either 12 VDC or 120 VAC. Kit comes complete with case set, whip antenna, 120 VAC power adapter - easy one evening assembly.

FM-25, Synthesized FM Stereo Transmitter Kit ........ $129.95

## Tunable FM Stereo Transmitter

A lower cost alternative to our high performance transmitters. Offers great value, tunable over the 88-108 MHz FM broadcast band, plenty of power and our manual goes into great detail outlining aspects of antennas, transmitting range and the FCC rules and regulations. Connects to any cassette deck, CD player or mixer and you're on-the-air, you'll be amazed at the exceptional audio quality! Runs on internal 9V battery or external power from 5 to 15 VDC, or optional 120 VAC adapter. Add our matching case and whip antenna set for a nice finished look.

FM-10A, Tunable FM Stereo Transmitter Kit. ........... $34.95
CFM, Matching Case and Antenna Set. ............... $14.95

## RF Power Booster Amplifier

Add some serious muscle to your signal, boost power up to 1 watt over a frequency range of 100 KHz to over 1000 MHz! Use as a lab amp for signal generators, plus many foreign users employ the LPA-1 to boost the power of their FM Stereo transmitters, providing radio service through an entire town. Power required: 12 to 15 volts DC at 250mA, gain of 38dB at 10 MHz, 10 dB at 1000 MHz. For a neat, professionally finished look, add the optional matching case set.

LPA-1, Power Booster Amplifier Kit ................. $39.95
CLPA, Matching Case Set for LPA-1 Kit.............. $14.95
LPA-1WT, Fully Wired LPA-1 with Case ............... $99.95

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World's smallest FM transmitter. Size of a sugar cube! Uses SMT (Surface Mount Technology) devices and mini electret condenser microphone, even the battery is included. We give you two complete sets of SMT parts to allow for any errors or mishaps-build it carefully and you've got extra SMT parts to build another! Audio quality and pick-up is unbelievable, transmission range up to 300 feet, tunable to anywhere in standard FM band 88 to108 MHz. 7/8"w x 3/8"h x 3/4"h.

FM-5 Micro FM Wireless Mike Kit.................. $19.95

## Crystal Controlled Wireless Mike

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FM-6, Crystal Controlled FM Wireless Mike Kit ......... $39.95
FM-6WT Fully Wired FM-6 ......................... $69.95

# RAMSEY

## Super Pro FM Stereo Radio Transmitter

A truly professional frequency synthesized FM Stereo transmitter station in one easy to use, handsome cabinet. Most radio stations require a whole equipment rack to hold all the features we've packed into the FM-100. Set frequency easily with the Up/Down freq buttons and the big LED digital display. Plus there's input low pass filtering that gives great sound no matter what the source (no more squeals or swishing sounds from cheap CD player inputs!) Peak limiters for maximum 'punch' in your audio - without over modulation, LED bargraph meters for easy setting of audio levels and a built-in mixer with mike and line level inputs. Churches, drive-ins, schools and colleges find the FM-100 to be the answer to their transmitting needs, you will too. No one offers all these features at this price! Kit includes cabinet, whip antenna and 120 VAC supply.

*We also offer a high power export version of the FM-100 that's fully assembled with one watt of RF power, for miles of program coverage. The export version can only be shipped outside the USA, or within the US if accompanied by a signed statement that the unit will be exported.*

FM-100, Professional FM Stereo Transmitter Kit ....... $299.95
FM-100WT, Fully Wired High Power FM-100........... $429.95

## AM Band Radio Transmitter

Ramsey AM radio transmitters operate in the standard AM broadcast band and are easily set to any clear channel in your area. Our AM-25, 'pro' version, fully synthesized transmitter features easy frequency setting DIP switches for stable, no-drift frequency control, while being jumper setable for higher power output where regulations allow. The entry-level AM-1 uses a tunable transmit oscillator and runs the maximum 100 milliwatts of power. No FCC license is required, expected range is up to 1/4 mile depending upon antenna and conditions. Transmitters accept standard line-level inputs from tape decks, CD players or mike mixers, and run on 12 volts DC. The Pro AM-25 comes complete with AC power adapter, matching case set and bottom loaded wire antenna. Our entry-level AM-1 has an available matching case and knob set for a finished, professional look.

AM-25 Professional AM Transmitter Kit.................$129.95
AM-1 Entry level AM Radio Transmitter Kit..............$29.95
Cam Matching Case Set for AM-1...........................$14.95

## Tone-Grabber Touch Tone Decoder / Reader

Dialed phone numbers, repeater codes, control codes, anywhere touch-tones are used, your TG-1 will decode and store any number it hears. A simple hook-up to any radio speaker or phone line is all that is required, and since the TG-1 uses a central office quality decoder and microprocessor, it will decode digits at virtually any speed! A 256 digit non-volatile memory stores numbers for 100 years - even with the power turned off, and an 8 digit LED display allows you to scroll through anywhere in memory. To make it easy to pick out numbers and codes, a dash is inserted between any group or set of numbers that were decoded more than 2 seconds apart. The TG-1 runs from any 7 to 15 volt DC power source and is both voltage regulated and crystal controlled for the ultimate in stability. For stand-alone use add our matching case set for a clean, professionally finished project. We have a TG-1 connected up here at the Ramsey factory on the FM radio. It's fun to see the phone numbers that are dialed on the morning radio show! Although the TG-1 requires less than an evening to assemble (and is fun to build, too!), we offer the TG-1 fully wired and tested in matching case for a special price.

TG-1, Tone Grabber Kit............................ $99.95
CTG, Matching Case Set for TG-1 Kit................ $14.95
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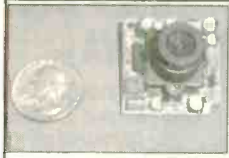
## The Cube World's Smallest TV Transmitter

Perfect video transmission from a transmitter you can hide under a quarter and only as thick as a stack of four pennies- that's a nickel in the picture! Transmits color or B&W up to 150' to any TV tuned to cable channel 59 with a solid 20 mW of power. Crystal controlled for no frequency drift with performance that equals law enforcement models that cost hundreds more! Deluxe model includes sound using a sensitive built-in mike that will hear a whisper 15 feet away! Units run on 9 volts and hook-up to most any CCD camera. Our cameras shown below have been tested to mate perfectly with The Cube and work great. Fully assembled.

C-2000 Video Transmitter Cube.......................................$89.95
C-3000 Video and Audio Transmitter Cube.......................$149.95

## CCD Video Cameras



If you're looking for a good quality CCD board camera, stop right here! Our cameras use top quality Japanese Class 'A' CCD arrays, not the off-spec arrays that are found on many other cameras. You see, the Japanese suppliers grade the CCDs at manufacture and some manufacturers end up with the off-grade chips due to either cost constraints or lack of buying 'clout'. These cameras have nice clean fields and excellent light sensitivity, you'll really see the difference, and if you want to see in the dark, these are super IR (Infra-Red) sensitive! Available with Wide-angle (80°) or super slim Pin-hole style lens. Both run on 9 VDC and produce standard 1 volt p-p video. Add one of our transmitter units for wireless transmission to any TV set, or add our Interface board (below) for Audio sound pick-up and direct wire connection to any Video monitor or TV video/audio input jacks. Fully assembled.

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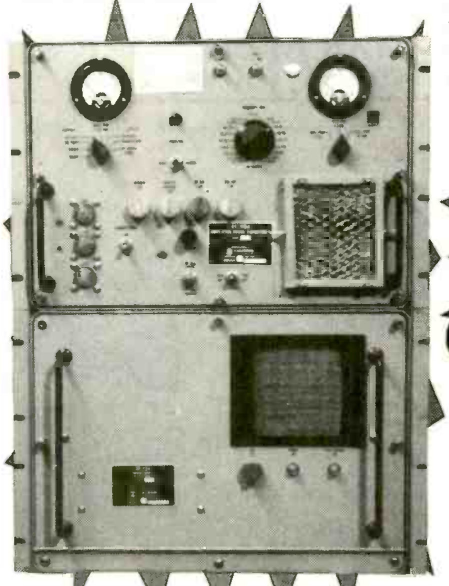

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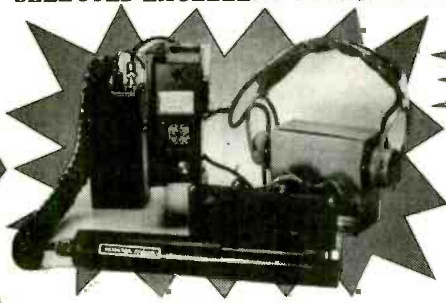
This transmitter covers 2-30MHz in 100 Hz increments. Available modes of operation are SSB or AME, compatable AM,CW, ISB. It utilizes a pair of 4CX1500B final output tubes and is supplied with the RF-124 power supply which operates on 230Vac 48-63Hz single phase. These units are in good/used condition and are available with or without tubes They are sold not tested. **Price:$1750.00** w/tubes Without tubes $895.00 (packing extra) 300lbs.



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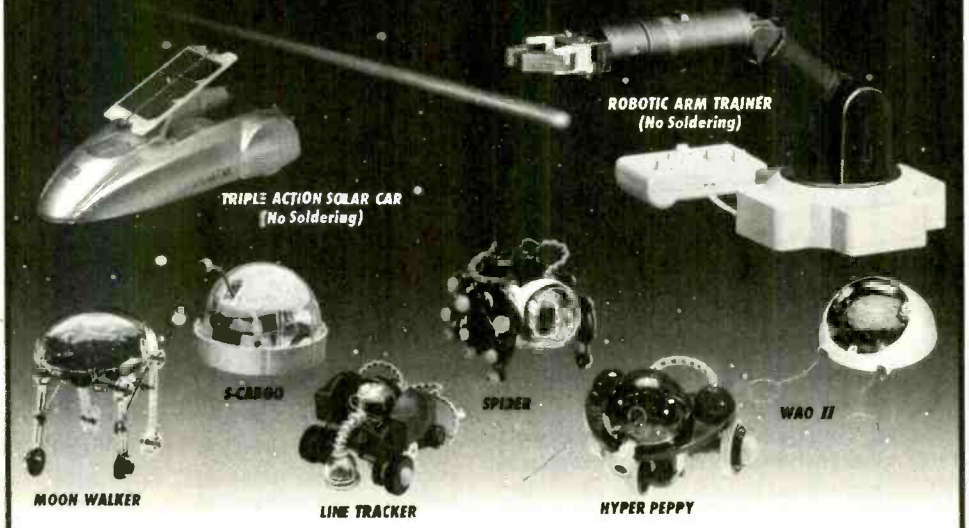


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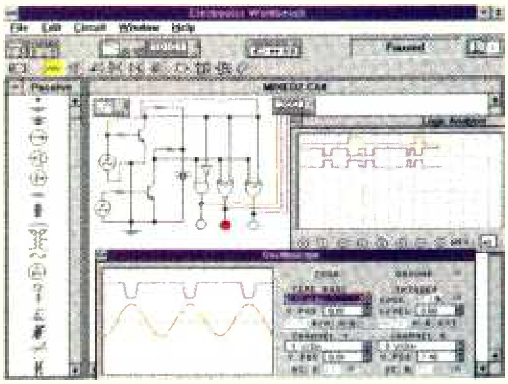

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