

# NUTS & VOLTS

## M A G A Z I N E

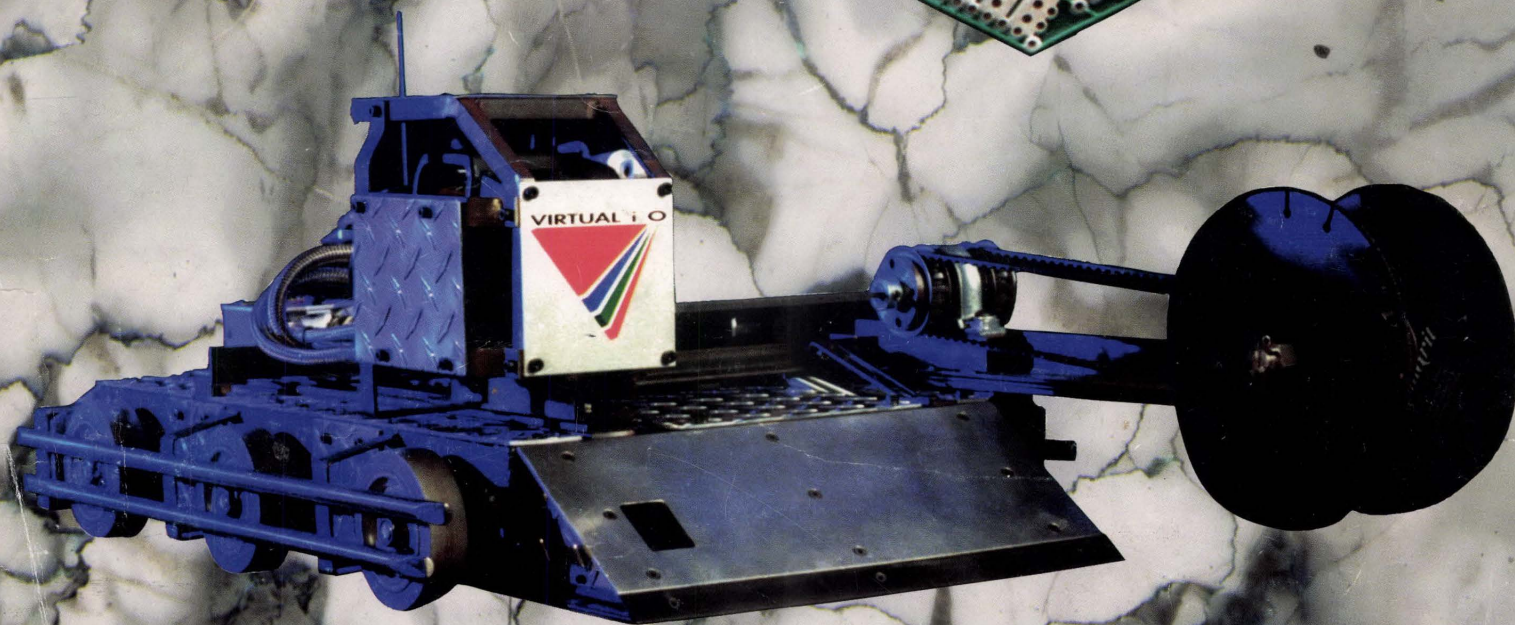
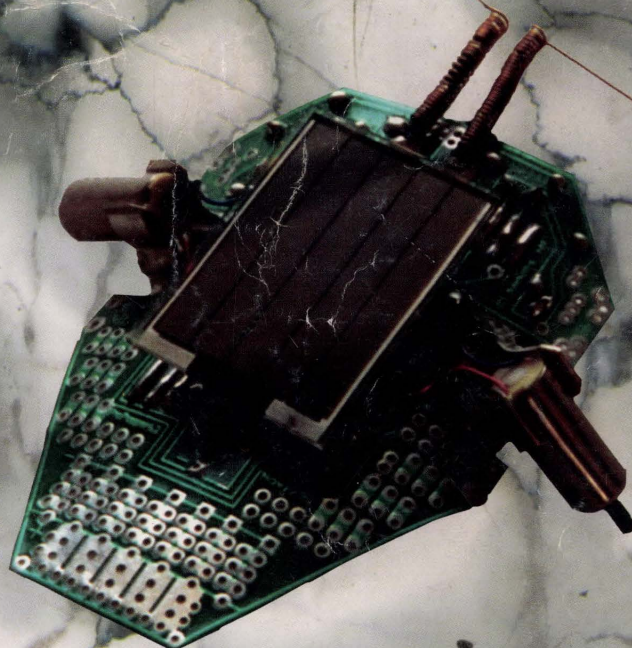


\$3.50  
VOL. 18 NO. 7  
JULY 1997

*Exploring Electronics And Technology For The Hobbyist And Professional*

# The Extremes Of Hobby Robotics

This month, check out both ends of the amateur robotics spectrum, from a tiny solar-powered robot to the big beasts of the San Francisco Robot Wars.





# If You Need It...



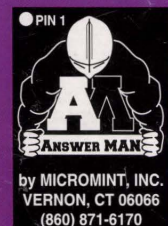
# We've Got It!

## PicStic™

PicStic (PS1-PS3) is a low-cost 0.85-in.<sup>2</sup> controller that is pin compatible with the BASIC Stamp I. Versions include enhancements like 2-channel 12-bit ADC, hardware real-time clock, more instruction space, interrupts, and 2 additional I/O lines. It runs the same PBASIC program 15 times faster. PS1-PS3: \$29 and \$39 each. PS1-PS4 development system: \$179.

## PicStic<sup>4</sup>

PicStic4 is an enclosed 32-pin DIP that combines the speed and economy of PicStic1 with a powerful I/O coprocessor in one package. Programmable in PicBasic, aPicStic4 gives you 19 I/O bits, 4-channel 8-bit ADC, 2-channels each of 12-bit ADC and DAC, 2-KB EEPROM data memory, hardware real-time clock, and a powerful set of firmware functions which include measuring frequency, generating PWM, controlling an LCD and keypad, and more. PS4: \$59 to \$89 each. PS1-PS4 development system: \$179.



Answer MAN incorporates digital I/O, 8- and 12-bit analog I/O, power regulation, and serial line drivers along with powerful firmware for keypad scanning, LCD control, analog limit monitoring, data averaging, frequency and event counting, PWM output, and reading Dallas iButton™ serial numbers in a tiny 28-pin DIP package. ANSWER MAN Junior only: \$49.

## NEW!!!

Domino2 is an enclosed 40-pin DIP that combines a full floating-point BASIC interpreter with an I/O coprocessor. Domino2 contains 32-KB SRAM, 32-KB EEPROM, 28 bits of parallel I/O, a 2-channel 12-bit ADC, RTClock/calendar, hardware PWM, and many built-in firmware functions like frequency measurement and I<sup>2</sup>C expansion. Domino2: \$109 to \$139 each. Development system: \$99.



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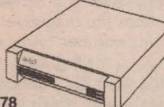
## Diamond Stealth VLB

- ◆ Diamond Multimedia "Stealth-64 Video" Accelerator
- ◆ VESA-Local Bus with 64-bit S-3 graphics accelerator chip
- ◆ Onboard 1MB DRAM, can be upgraded to 2MB
- ◆ Displays up to 800 x 600 pixel, 24-bit true color, or 1152 x 864 pixel, 65K color
- ◆ Installation sheet, drivers for Win95, Win 3.XX included
- ◆ New in OEM pack bag, 90-day HSC warranty

HSC#16754 **DIAMOND** \$19.95


## Tiny 486 Powerhouse!

- ◆ Little box with lots of features...Unisys 486 workstation
- ◆ Intel 486DX-33 installed, two SIO, one PIO on board
- ◆ Motherboard will accept up to DX2-50 for 100MHz
- ◆ On-board VGA (1MB, can add to 2MB), 10-BaseT LAN
- ◆ On-board IDE controller, Award BIOS, 256K Cache
- ◆ Two 72-pin SIMM sockets, 4MB RAM installed (1 SIMM)
- ◆ One short (7") ISA card slot
- ◆ 1.44MB Floppy installed
- ◆ New, tested, 90 day warranty
- ◆ Measures only 11.5" x 8.75" x 2" - Tiny!
- ◆ Install your choice of IDE hard disk drive and go!
- ◆ Uses standard PS2-style keyboard & mouse (not incl.)
- ◆ Note, we do not have documentation for these units, but a chart on the bottom of the motherboard and the silkscreen legend on the top give most jumper settings.

HSC#16778  \$299.00

## Small Mono-VGA Monitor

- ◆ 9" diagonal measure paper-white phosphor VGA monitor
- ◆ Used briefly then removed from service - Like new!
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- ◆ 30-day HSC warranty

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## Absolute Last of the Red Hot Reno!

- ◆ Now at clearance price -- Media Vision **Reno**:
- ◆ Consists of new external Reno CD-ROM drive, docking bay with SCSI2 port, AC Adapter, cable kit, travel pouch, headphones
- ◆ Late Model version Uses AC adaptor (included) or AA alkaline batteries (not included)
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- ◆ Mac software included
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- ◆ Brand new, 90-day warranty

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Available Separately:  
A. Macintosh Powerbook SCSI Adapter (HDI-30 to 25-pin D connector) HSC# 15704 \$12.50 if purchased alone, or with Reno of Reno Kit, \$5.00

## Ultimate Video Hack!

- ◆ Only the brave need apply, but what a great gizmo!
- ◆ Tiny, postage-stamp sized LCD screens -- in color!
- ◆ Fluorescent backlight runs on 5VDC
- ◆ Color LCD active area is 14.6mm x 11.2mm
- ◆ Overall size of board is 15/16" square!
- ◆ Backlight board is 1" square, including tube, inverter
- ◆ Resolution is 505 x 230 pixels, RGB delta pattern
- ◆ Originally made by Matsushita for virtual reality goggles
- ◆ One LCD and one backlight board is \$9.95/set
- ◆ Buy two sets for only \$17.50!
- ◆ Includes data sheet with pinouts, specs
- ◆ Plastic optics assemblies from Virtual Reality headsets allow viewing images up close
- ◆ Surface mount connector available for LCD ribbon cable

HSC# 16536 Tiny LCD/Backlight set \$9.95 ea.  
HSC# 16537 Left & Right Optics units \$7.95 pr.

## Sound Card with SCSI

- ◆ Mediavision ProSonic 16 sound card / SCSI controller
- ◆ 16-bit audio, 44.1KHz stereo sound
- ◆ MPU 401 MIDI emulation, Soundblaster compatible
- ◆ Internal SCSI CD-ROM port, microphone jack (mike not included), line-in, speaker jack, joystick port
- ◆ Includes driver disk, installation information
- ◆ OEM package, 90-day warranty

HSC#16683 \$29.95

## Super Sounding Speakers!

Tired of the cheesy sound coming from those give-away speakers in your multimedia kit? Try upgrading to these sonic wonders...you'll have to hear them to appreciate the difference these will make without blowing your budget!

- GNT2500 2-way Bass-Reflex speakers**
- ◆ 3.5" woofer, 1" piezo tweeter
  - ◆ 15W built-in amplifiers, 80W peak, 5.4W RMS
  - ◆ 40 - 20,000 Hz, built-in SRS 3-D stereo
  - ◆ Measure approx. 3.75" x 6.125" x 9.25" tall
  - ◆ AC adaptor, audio cables included
  - ◆ On-off switch, 3-D switch, tone & volume controls
  - ◆ Attractive off-white finish with grey grille-cloth

HSC#16670 \$29.95

- GNT3500 3-way Bass-Reflex speakers**
- ◆ 4" woofer, 2" midrange, 1" piezo tweeter
  - ◆ 23W built-in amplifiers, 120W peak, 20W RMS
  - ◆ 20 - 20,000 Hz, built-in SRS 3-D stereo
  - ◆ Measure approx. 6.25" x 6.5" x 9.75" tall
  - ◆ AC adaptor, audio cables included
  - ◆ On-off switch, 3-D switch, bass, treble & volume controls
  - ◆ Attractive off-white finish with grey grille-cloth

HSC#16671 \$39.95

## PCI Video Accelerator Cards from Media Vision!

Just in...blazing fast and screaming fast "ProAxe" VGA accelerators from Media Vision! Both support MPEG, AVI, and other full-motion video formats. Check out the review on the Web at <http://goinside.com/974/pro.html> -- Both cards are new in box and have a 90-day HSC Warranty

- PROAxe**
- ◆ Blazing fast 64-bit graphic & video card
  - ◆ PCI Bus card with 1MB RAM, expandable to 2MB
  - ◆ Uses proprietary chipset (Alliance Semi ProMotion 6410)
  - ◆ Resolutions up to 800 x 600, 64K colors with 1MB
  - ◆ Up to 1600 x 1200, 256 colors, 800 x 600, 16M colors (requires 2MB) -- Upgrade chipset available, \$7.50
  - ◆ 30fps full-screen video playback possible (90MHz Pentium)
  - ◆ Win95, NT & 3.1 drivers and full manual on CD-ROM
  - ◆ If you can not read CD's, diskettes are available, \$2 extra

HSC#16807 \$29.95

## PROAxe 128

- ◆ Screaming fast 128-bit graphic & video card!
- ◆ PCI Bus card with 2MB RAM, expandable to 4MB
- ◆ Uses Tseng Labs ET6000 chipset, MDRAM technology for incredible 128-bit data path at 75 Hz refresh
- ◆ Resolutions up to 1024 x 768, 64K colors with 2MB
- ◆ Resolutions up to 1280 x 1024, 16M colors (with 4MB)
- ◆ Integrated 135MHz VGA compatible 24-bit DAC
- ◆ 30fps full-screen video playback possible (90MHz Pentium)
- ◆ Win95, NT & 3.1 drivers on CD-ROM, printed manual

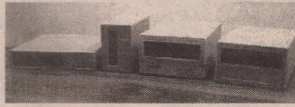
HSC#16808 \$49.95

## PCMCIA Sound Card

- ◆ Turtle Beach Systems "Audio Advantage" Card
- ◆ Add multimedia capability to your PCMCIA notebook
- ◆ Windows drivers, sound program etc. in "Zip" file
- ◆ Adapter plug allows connection of speakers, microphone
- ◆ New, OEM packaged, ninety day HSC warranty
- ◆ Mfr. offers fax-back or e-mail support for this product

HSC#16521 \$79.95

## SCSI Device Cases

- 
- ◆ Horizontal style case, 9.5" x 2.5" x 10.5", 30 watt power supply, fan cooled, room for 5.25" drive, front access
  - ◆ Upright Case, 3.5" x 5.5" x 8.125", has front opening for 3.5" drive, 20 watt power supply, no fan
  - ◆ Deluxe quality case, 7" x 4.5" x 10.75", made for Olympus Optical, has 5.25" open front bay, SCSI diagnostic indicator on rear panel, 30 watt fan-cooled power supply, IEC power cord included. Assembled in USA.
  - ◆ Case, similar to above, 7" x 4.5" x 10.5", for 5.25" or 3.5" drives, beefy 65 watt fan-cooled power supply

HSC#16820 \$29.95

All cases are new, and feature 50-pin Centronics-style Daisy-chain connectors, internal 50-pin cable and SCSI ID switch.

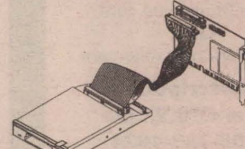
## Peltier Cooler at a Price!

- ◆ Made for cooling ceramic Pentium Processors (not metal)
- ◆ Heatsink is 2" x 2.875", .5" thick
- ◆ Mounted 12VDC fan
- ◆ Peltier device is 1.125" square, has copper plate for thermal mounting on CPU
- ◆ Unit is new, and much cheaper than the separate parts!
- ◆ Perfect for Peltier experiments!

HSC# 16106 \$24.95

## Son of SwapBox!

- ◆ Just in time...we ran out of the regular SwapBoxes!
- ◆ IBM Compatible Reader/Writer for PCMCIA Cards with built-in 1.44 MB floppy drive...fits in standard floppy bay!
- ◆ SwapBox Combo by SCM Microsystems for ISA Bus
- ◆ Convenient front access for slots (not in rear of system)
- ◆ Dual slot, Type I, II or III, hot swappable
- ◆ Perfect for transferring data or hardware from laptops, notebooks or other PCMCIA peripherals to desktop PC's
- ◆ Directly supported by Windows 95 - no drivers needed!
- ◆ Includes DOS driver disk, manuals, cable, internal card
- ◆ New in OEM package (white box), 90-day warranty

HSC#16819  \$99.95

## HSC is Hobby Parts Heaven!

- ◆ Antistatic wrist-strap -- ground yourself & preserve parts! HSC#16817 \$1.95
- ◆ Small Flashlight - swivel head, stands on end - AA's incl HSC#16815 \$.99
- ◆ 5VDC CPU fan - smallest ever! 1.75" sq. only .25" thick! HSC#16711 \$.35
- ◆ Electroluminescent panel - 2.25" x 11" runs on 110VAC, consumes miniscule power, provides eerie green glow! HSC#16804 \$.85
- ◆ Handy 110VAC motor by Hurst Mfg. -- 2.5" dia., 1.5" long, square mounting plate, 3/16" dia. shaft, 300 RPM HSC#16669 \$14.95
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- ◆ 22 ga. clear speaker wire, 500 ft. roll HSC#16290 \$10.95
- ◆ 6 rolls colored elect. tape, red, grn, yel, wht, blu, blk HSC#80352 \$1.95
- ◆ LED Grab-bag -- approx 500 pieces, all types, red, green, yellow, IR, T1 3/4, T1, rectangular, super-bright, mini, etc. HSC#16564 \$19.95
- ◆ AT&T phone dialer, stores four numbers, needs 9V batt. HSC#16594 \$7.95

## Ethernet Card Closeout

- ◆ 10-Base-T style Network card for ISA Bus computers
- ◆ NE-2000 compatible, for twisted pair networks
- ◆ AE2T by Artisoft -- Name brand quality!
- ◆ New in sealed box, ninety-day HSC warranty
- ◆ Driver software is on 5.25" disks -- be forewarned: if you only have a 3.5" drive, you will have to get a friend to copy!
- ◆ Note: not for "dumb" nodes, does not have boot ROM

HSC#16539 \$19.95

## Infrared Connections!

- ◆ IBM "Options" series ISA-Bus and PCMCIA card adaptors will add industry standard infrared communications capability to your desktop PC (with ISA slots) or notebook computer! (May not be Win95 compatible)
- ◆ Allows wireless connection to compatible notebooks, workstations, printers, and other peripherals supporting the Infrared Data Association (IrDA) standard.
- ◆ Also will emulate a COM port for cable-less hook-ups
- ◆ Communicates up to 115Kbps, or up to 1.152Mbps with the included TranXit Software.
- ◆ Operates over distances up to 3 meters (10 ft.)
- ◆ Includes Card, transceiver module, driver disk & book
- ◆ Both styles new in box, 90-day warranty

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HSC#16813 ISA-Bus Version \$19.95  
Or a package deal...get both for \$29.95

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- ◆ Pay us a virtual visit on the World Wide Web!
- ◆ Simply point your browser to <http://www.halted.com>
- ◆ Site is constantly being revised, please visit often!
- ◆ Check out the amazing "Gizmo of the Week" feature!

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- ◆ Seventy-six pages of electronics, from ordinary to exotic!
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Larry Lemieux  
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Robin Nelson  
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Nuts & Volts Magazine encourages article submissions and queries. Send a SASE for a copy of our writer's guidelines.

All submissions should be on 5-1/4 or 3-1/2 inch diskettes and include hard copy as well. If return of materials is requested, include a SASE with your submission.

Deadlines should be discussed in advance with the editor, but generally all material should be submitted by the 1st of the month for the next month's issue.

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When you send in your new address, include a current mailing label from the magazine with your account number on it. If you do not have a mailing label, be sure to include your old address and the name(s) under which the subscription was submitted.

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# reader FeedBack

Dear Mr. Byers:

I enjoy reading your articles about solar energy, etc. However, I think I have a correction to the 50W inverter described in the May '97 issue. The frequency should be 60 Hz, not 120 Hz. There should be two pulses/cycle, one to each transistor. The inverter IC1d provides the (inverted) second pulse/cycle on the "negative" half, so the clock cycle is 60 Hz for both. The R2C2, R3C3 delay works only when Q1 goes low, providing a delay for Q2 to turn on. When Q1 turns on the delay R3C3 keeps Q2 ON causing a small overlap of Q1, Q2 both on.

**Dave  
via Internet**

Response:

You're quite right, the frequency is 60 Hz. I don't know what I was thinking. Actually, I do remember. The original design used a flip-flop, which I later replaced with the IC1d inverter. Unfortunately, I forgot to change the text, too. As for the delay you mention, R2C2 and R3C3 are not delay lines, but simply spike filters used to remove switching transients. At no time are Q1 and Q2 on at the same time.

**TJ Byers  
N&V Solar Workshop**

Dear Nuts & Volts:

I enjoyed the article "Beat the Heat" by Blechman & Mallon in the Jun. '97 issue. I have had to do that several times myself in the past.

They missed a great source for "muffin" fans. Good quality, reasonably quiet fans can be pulled from bad IBM PC-type power supplies. These can be had free or for about \$1.00 each at many computer repair shops, junk yards, or yard sales.

This is usually even cheaper than buying from a surplus store.

**Robert Thompson  
via Internet**

Dear Mr. Byers:

I've enjoyed your Solar Workshop series. However, I noticed a couple of things that don't seem quite right in the Jun. '97 article.

There seems to be a misplaced decimal point in the "price per watt" entries of Tables 3 through 6. For example, I think that Table 3 should read \$9.74 per watt instead of \$97.00 per watt. Here are the correct figures.

Table 3. \$9.74 per watt  
Table 4. \$7.37 per watt  
Table 5. \$9.74 per watt  
Table 6. \$10.00 per watt

**Chuck Wright  
via Internet**

Dear Nuts & Volts:

The Tech Forum Jun. '97 answer to #5976 responded to the

question about double line feeds when using some older Radio Shack printers. The suggestions require the use of BASIC each time the printer is powered on. The following would be of interest to those who only wish to use BASIC one time to produce a short DOS program called LFSTRIP.COM that can be used whenever desired.

Early Radio Shack computers did NOT automatically send a line feed command (ASCII 10, LF) after a carriage return (ASCII 13, CR), so early Radio Shack printers automatically ADDED an LF feed after every CR. However, IBM (and many other computers) when sending text automatically send an LF after each CR, resulting in double line spacing with old Radio Shack printers. Later Radio Shack printers provided a DIP switch (a tiny switch with several toggles) to defeat the printer automatic line feed. This was usually among a bank of four or eight such switches, and generally unmarked, requiring the use of the printer manual. If there is no such switch (or no printer manual to identify the CR/LF switch), the following simple BASIC (or GWBASIC or QBASIC) program when RUN will create LFSTRIP.COM. When LFSTRIP.COM is used, it will strip the line feed after every carriage return.

Note that this is valid only for text printing, and fine for daisy-wheel printers like the DWP-210, which don't have a graphic mode. For dot-matrix printers, when printing graphics, you would not want to eliminate ANY character coming from the computer. I do not take credit for this program; I found it years ago, probably in a magazine. Since I still use both a TRS-80 Model III and an IBM PC for word processing, with both routed through a switch to the same dot-matrix printer, LFSTRIP.COM has been a great convenience!

Type the following program in BASIC, then RUN it. This creates the file LFSTRIP.COM. Whenever you wish to disable the printer "extra" LF, just type LFSTRIP in DOS and hit the Enter key. If you ALWAYS want to use LFSTRIP.COM, put it in the AUTOEXEC.BAT file. Once called, LFSTRIP.COM stays resident in memory, so you can turn your printer on and off without having to run LFSTRIP again. To disable LFSTRIP.COM once invoked, you'll need to reboot the computer.

10 REM \* DISABLES LF AFTER CR \*  
20 OPEN "LFSTRIP.COM" FOR OUTPUT AS 1  
30 FOR A=1 TO 87:READ BYTE  
40 PRINT #1,CHR\$(BYTE);NEXT A:CLOSE 1  
100 DATA 235,23,144,0,0,0,25,128,252  
110 DATA 0,117,6,60,10,117,2,180,2,250  
120 DATA 46,255,46,3,1,176,23,180,53,205  
130 DATA 33,137,30,3,1,140,192,163,5,1  
140 DATA 186,7,1,176,23,180,37,205,33,180  
150 DATA 9,186,64,1,205,33,186,18,0,184  
160 DATA 0,49,205,33,13,10,76,70,83,84  
170 DATA 82,73,80,32,105,110,115,116,97,108  
180 DATA 108,101,100,46,13,10,36

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[59C11] 13, 22 [8572] 82, 92 [9306] 16, 46, 56, 66, 86 [95010] 020, 040, 080 [35C102] 104, 108 (14 PIN) ER1400, MS8657

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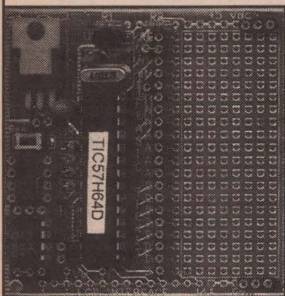
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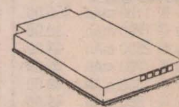


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**Ray Marston looks at two remote-controlled audio tone/volume ICs and at the MF10C filter IC in this final installment.**

**T**he first episode of this series looked at the basic theory and practical working details of the MC3340P electronic attenuator IC, the NE570/571 dual compander IC, and the LM1894 dynamic noise reduction IC.

The second episode looked at a variety of analog switching ICs that are suitable for use in multi-way hi-fi channel selection applications.

This month's concluding episode continues the special audio processing ICs theme by taking detailed looks at two special remote-controlled tone/volume ICs, and at the ever-popular MF10C dual-switched capacitor filter IC.

## VARIABLE TONE/VOLUME IC BASICS

### VOLTAGE-CONTROLLED ICs

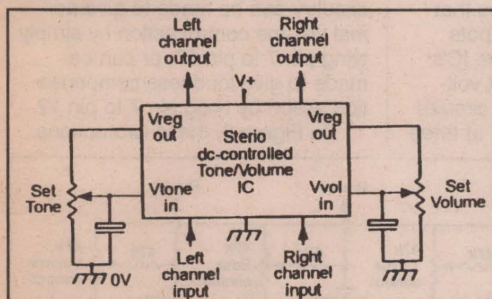
Prior to the advent of modern signal-processing IC technology, all audio tone and volume control circuits were designed around simple, but inherently noisy, electromechanical pots, which were usually mounted on the audio unit's front panel and were thus prone to pick up unwanted signals via their signal-

carrying interconnecting leads.

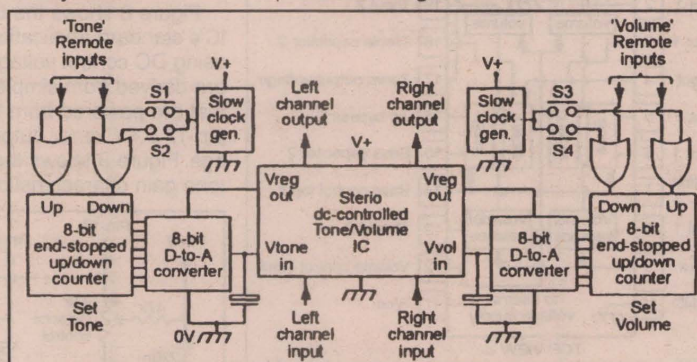
During the late 1970s, however, the ever-increasing demands for improved audio quality and remote controllability of tone and volume in hi-fi and TV sets resulted in the development of new types of ICs that housed all-electronic tone and volume-control circuits that were variable via interference-immune input signals applied to the appropriate control pins of the IC.

Throughout the 1980s and the early 1990s, most of these variable tone/volume ICs were designed around OTA (operational transconductance amplifier) types of analog circuit elements and used remotely-variable DC input voltages as their primary control medium. One of the best known of these ICs is National Semiconductor's LM1036 dual (stereo) DC-controlled tone/volume/balance IC, which is very easy to use and typically generates a THD figure of only 0.05%. This IC is described in greater detail later in this article.

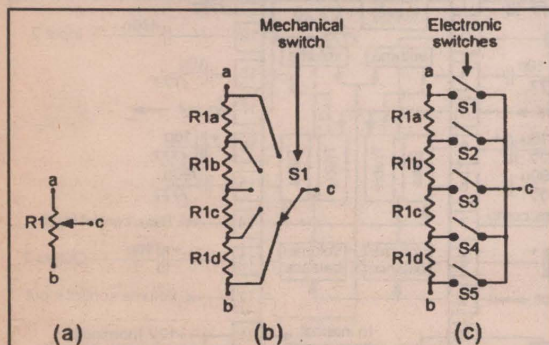
Figure 1 shows a typical basic usage circuit for a DC-controlled stereo variable tone/volume IC, using pot-generated DC tone and volume control voltages. Figure 2 shows a remote-controlled version of the circuit, in which the DC control voltages are derived from digital voltage generator circuitry that can be activated via panel-mounted push buttons or via a conventional remote control system.



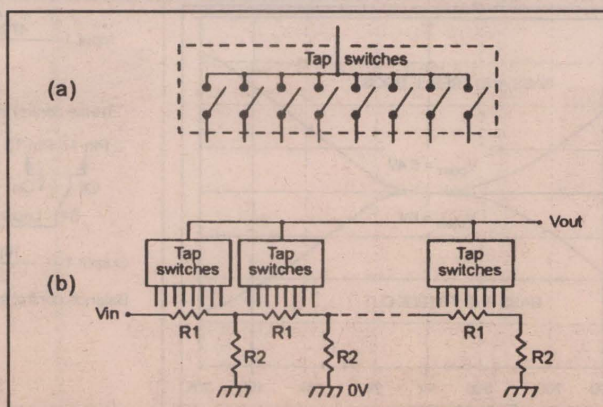
**Figure 1. DC-controlled Tone/Volume IC basic usage circuit, using pot-generated control voltages.**



**Figure 2. DC-controlled Tone/Volume IC basic usage circuit, using digitally-generated control voltages.**



**Figure 3. A simple electromechanical pot (a) can be simulated by a multi-stage potential divider and an electromechanical switch, as in (b), or by a multi-stage potential divider and a set of electronic switches, as in (c).**



**Figure 4. Groups of multi-section electronic tap switches (a) used to make a variable ladder attenuator (b).**

**(Part 3)**

# USER'S GUIDE TO SPECIAL AUDIO PROCESSING ICs

*by Ray Marston*

In the digital circuit, each DC control voltage is derived from the

output of an eight-bit digital-to-analog converter that is driven via a locally or remote-controlled eight-bit end-stopped up/down counter, thus enabling the DC control voltage to be varied from zero to maximum in 256 discrete steps.

### DIGITALLY-CONTROLLED ICs

During the early 1990s, the continuing demand for ever-better audio quality and ever-greater circuit sophistication resulted in the development of a new generation of variable tone/volume ICs that relied heavily on a mixture of analog and digital — rather than purely analog — circuit techniques, and which were specifically designed to be digitally controlled via simple microprocessor or microcontroller systems.

Currently, the best known of these ICs is National Semiconductor's LMC1983, a 28-pin device that can select any one of three stereo inputs, can control the selected channel's bass and treble response and its volume, and typically generates a THD figure of only 0.008%. This IC — which, requires the use of a specially designed microprocessor interface — is described in greater detail later in this article.

Figures 3 and 4 illustrate some of the basic techniques that are used in the circuitry of digitally-controlled tone/volume ICs. Figure 3(c) shows how a simple electro-



# USER'S GUIDE TO SPECIAL AUDIO PROCESSING ICs

mechanical pot can be simulated by a multi-stage potential divider and a set of digitally-controlled electronic switches similar to those used in the 74HC4066 IC described in Part 2 of this series.

The diagram shows a unit using only five divider and switch sections, but in practice, the unit can be given any desired number of sections. If, for example, the digitally-controlled pot is to be used as a bass or treble tone control element, a total of only 12 sections are normally considered adequate and allow the tone response to be varied from +12 dB to -12 dB in 2 dB steps.

If the pot is to be used as a volume control, however, at least 40 sections are needed to allow the volume to be varied over an 80 dB range in 2 dB steps.

In practice, a digital volume control may take the form of a ladder attenuator rather than a pot, as shown in Figure 4. Here, groups of eight-way electronic tap switches are used to tap into the R1 parts of the R1/R2 ladder sections, and only one switch is ever closed at any given moment to select the desired attenuation value. This type of attenuator presents a constant input impedance at all attenuation settings.

Figure 5 shows (in slightly simplified form) the typical basic circuitry of one complete channel of a stereo digitally-controlled, three-input variable tone/volume IC.

Here, the desired input can be selected digitally and passed on to the main tone control circuitry via C1, and the treble, bass, and volume levels can be varied digitally via the RV1 to

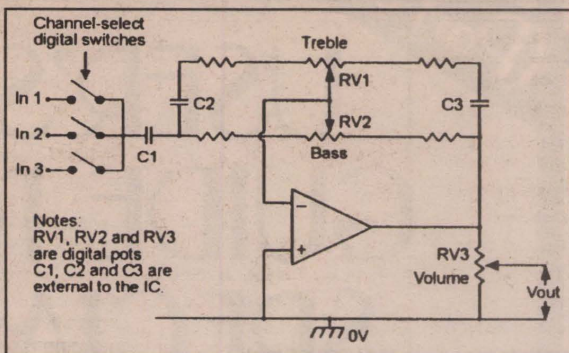


Figure 5. Typical basic circuitry of one complete channel of a stereo digitally controlled three-input variable tone/volume IC.

RV3 digital pots. Note that C1, C2, and C3 are the only components that are external to the IC and that all other components are high-precision very low-distortion elements.

## PRACTICAL VARIABLE TONE/VOLUME ICs

### THE LM1036 DC-CONTROLLED IC

National Semiconductor's LM1036 is an easy-to-use, 20-pin dual (stereo) DC-controlled tone/volume/balance IC that can

Parameter	Value
Supply voltage range	9V - 16V
Supply current (typ)	35mA
Zener output	5.4V at 5mA max
Vin max	1.6Vrms at 12V
Vout max	1.0Vrms at 12V
Vgain max	0dB at 1kHz
THD (typ)	0.05%
Channel separation	75dB
Volume control range	75dB
Bass control range	±15dB at 40Hz
Treble control range	±15dB at 16kHz
Balance control range	+1dB to -26dB

Figure 6. Basic specification of the LM1036 dual (stereo) DC-controlled tone/volume/balance IC.

use any supply in the 9V to 16V range, and that typically generates a THD of only 0.05%.

Figure 6 lists the IC's basic specification, and Figure 7 shows the IC's outline (not to scale), pin notations, and basic functional diagram. Note in each channel that the input signal is applied to pin 2 or 19 and then flows through the volume control network before being processed by the bass/treble tone control network; the signal is then passed to the pin 8 or 13 output terminal via the IC's volume balance network.

Figure 8 shows the LM1036 IC's standard application circuit, using DC control voltages that are derived from simple pots that are powered from the IC's pin-17 5.4V zener output voltage. Figure 9 shows the circuit's tone gain characteristics at three

Consequently, conventional volume control circuits (which have a perfectly flat frequency response at all signal levels) produce low-level outputs that sound distinctly bass and treble cut to the sensitive human ear.

To overcome this particular problem, most good-quality hi-fi units are fitted with an optional loudness control that modifies the response curve of the normal volume control so that the unit produces an acoustic output that is tailored to match the characteristics of the human ear. The LM1036 is fitted with just such a facility.

The LM1036's volume control circuitry can be made to give normal volume control action by simply tying pin 7 to pin 17, or can be made to give loudness compensation action by tying pin 7 to pin 12.

In Figure 8, these two options

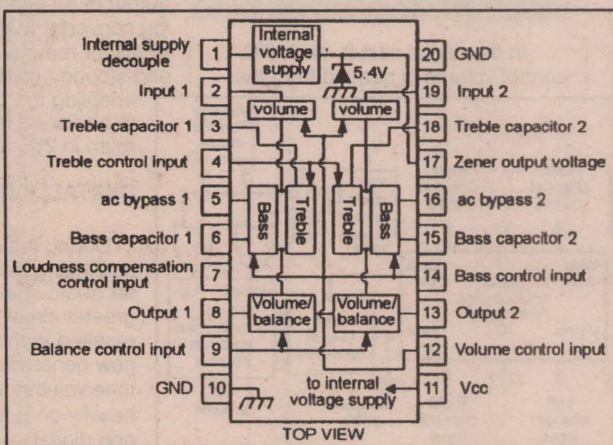


Figure 7. Outline (not to scale), pin notations and functional diagram of the LM1036.

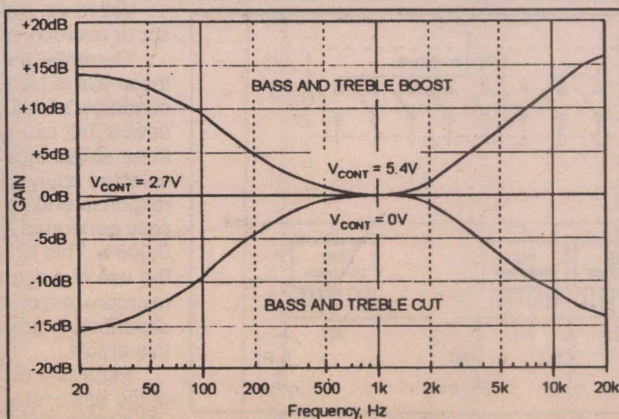


Figure 9. Tone gain characteristics of the standard LM1036 application circuit.

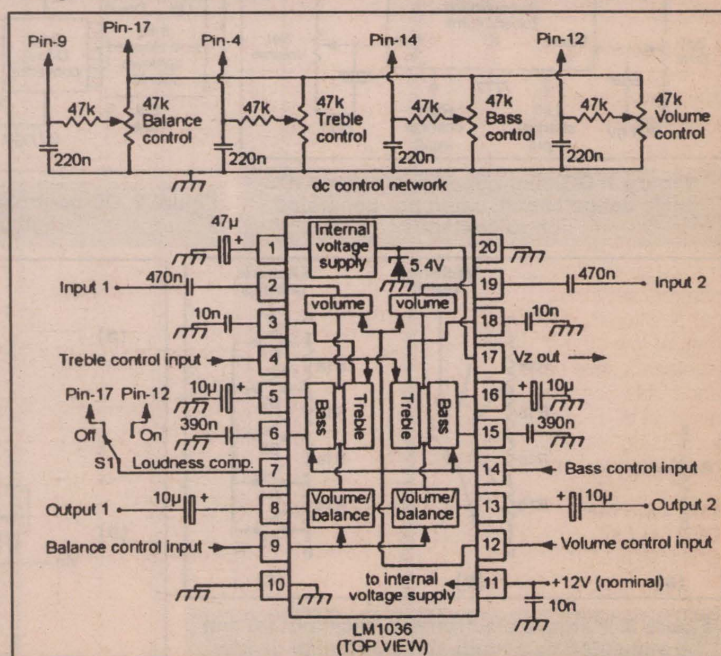


Figure 8. Standard LM1036 application circuit, using pot-generated DC control voltages.



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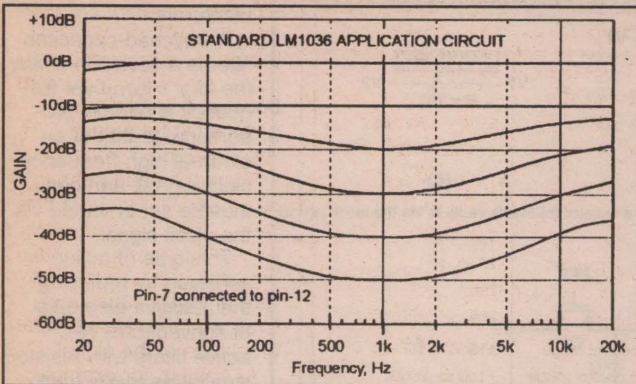


Figure 10. Loudness compensated volume characteristics of the standard LM1036 application circuit.

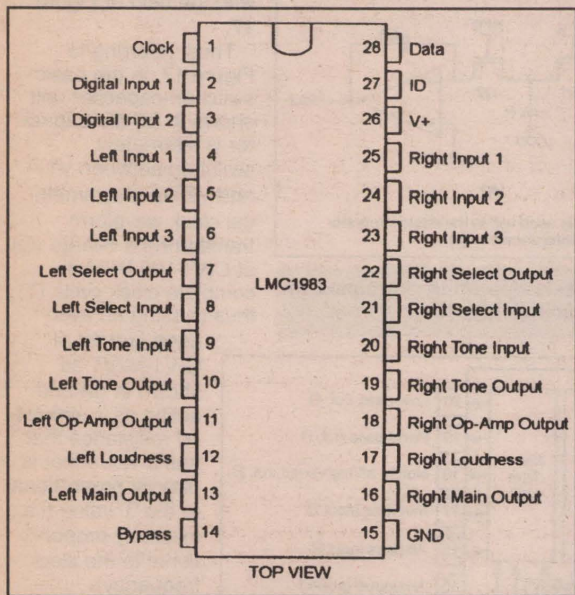


Figure 12. Outline and pin notations of the LMC1983 IC.

Parameter	Value
Supply voltage range	6V - 12V
Supply current (typ)	15mA
Vin max	2.0Vrms at 12V
THD (typ)	0.008% at Vin = 0.3Vrms
Channel separation	80dB
Mute attenuation	105dB
Volume control range	80dB, in 2dB steps
Bass control range	±12dB, in 2dB steps, at 100Hz
Treble control range	±12dB, in 2dB steps, at 10kHz
Channel balance (typ)	0.2dB
Signal-to-noise ratio	95dB (0dB = 1Vrms)
Maximum clock frequency	5MHz

Figure 11. Basic specification of the LMC1983 digitally-controlled three-channel stereo selector and tone/volume control IC.

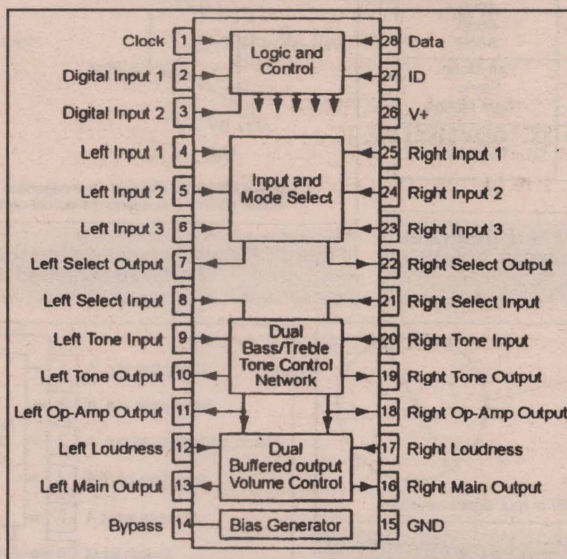


Figure 13. Functional diagram and pin notations of the LMC1983 IC.

are made available via switch S1. Figure 10 shows the actual loudness compensated volume control frequency response curve of the standard LM1036 application circuit with the normal bass and treble controls set to the flat position. Note that, at low output levels, effective bass and treble boost is attained by simply increasing the mid-band attenuation.

## THE LMC1983 DIGITALLY-CONTROLLED IC

National Semiconductor's LMC1983 is a 28-pin, digitally-controlled, three-channel stereo selector and tone/volume control

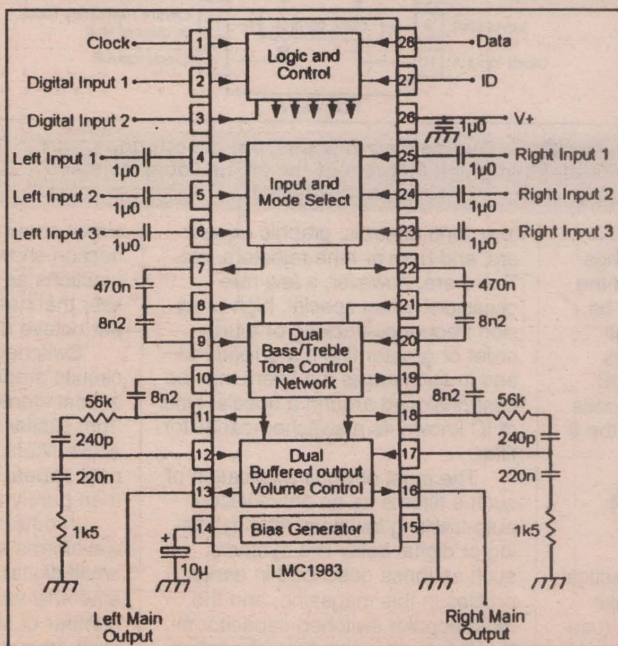


Figure 14. Functional diagram and basic application circuit of the LMC1983 IC.

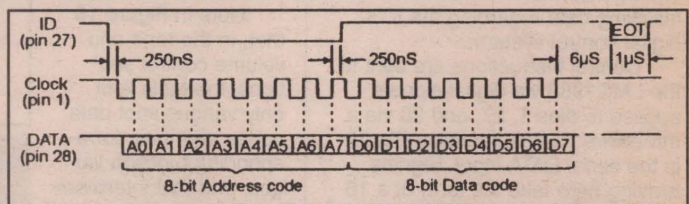


Figure 15. Basic timing details of the LMC1983 INTERMETAL (IM) bus system.

IC that can use any supply in the 6V to 12V range and that typically generates a THD of only 0.008%.

Figure 11 lists the IC's basic specification, Figure 12 shows the IC's outline and pin notations, and Figure 13 shows the IC's basic functional diagram together with (for clarity) its pin notations. Referring to the functional diagram, the IC operates as follows ...

The LMC1983's internal Input and Mode Select section acts like a two-pole

four-way selector switch that can select any one of three stereo inputs or a mute (zero signal) input, and makes the selected input available (in buffered form) at pins 7 and 22 via a selector that enables the signals to be presented in Left Mono, Stereo, or Right Mono form.

From pins 7 and 22, the signals may be externally processed (via a separate dynamic noise reduction system, etc.) or can be simply capacitively coupled directly back into pins 8 and 21 of the IC.

Signals fed into pins 8 and 21 are passed through the IC's tandem controlled tone and individually controlled left and right volume control networks, which are similar to the basic circuit shown in Figure 5 except that the volume control network can be subjected to loudness compensation and the outputs are buffered and are then passed out of the IC via pins 13 and 16.

Figure 14 shows the LMC1983's basic application circuit together with (for clarity) the IC's functional diagram. The 8n2 capacitors wired between pins 8-9 (or 20-21) and between pins 10-11 (or 18-19) control the IC's tone response, and the four components (56k, 240p, 220n, and 1k5) wired between pins 11-12 (or 17-18) and ground control the loudness response of the volume control.

The settings of the selector and mute switches and the tone and volume units are all controlled via digital input signals applied to pins 1, 27, and 28 via a three-wire INTERMETAL (IM) bus interface.

When the supply voltage is initially applied to the IC, however, the volume is automatically set to mini-

mum and the tone controls are set to flat. Digital input pins 2 and 3 do not form a direct part of the control system, but allow peripheral devices to send single-bit data to the unit's external microprocessor control system via the DATA pin (pin 28).

Note at this point that — since it uses a microprocessor-based digital control system — the LMC1983 is not really suitable for use in one-off or short production-run audio systems, but is highly suitable for use in long production-run audio systems, where (since it uses no external pots or switches and uses very



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Address (A7-A0)	Function	Data (D7-D0)	Function Selected
01000000	Input Select + Mute	XXXXXX00 XXXXXX01 XXXXXX10 XXXXXX11	INPUT 1 INPUT 2 INPUT 3 MUTE
01000001	Loudness	XXXXXX00 XXXXXX01	Loudness OFF Loudness ON
01000010	Bass	XXXX0000 XXXX0011 XXXX0110 XXXX1001 XXXX11XX	-12dB -6dB FLAT +6dB +12dB
01000011	Treble	XXXX0000 XXXX0011 XXXX0110 XXXX1001 XXXX11XX	-12dB -6dB FLAT +6dB +12dB
01000100	Left Volume	XX000000 XX010100 XX101XXX XX11XXXX	0dB -40dB -80dB -80dB
01000101	Right Volume	XX000000 XX010100 XX101XXX XX11XXXX	0dB -40dB -80dB -80dB
01000110	Mode Select	XXXXXX100 XXXXXX101 XXXXXX11X	Left Mono Stereo Right Mono
01000111	Read Digital Input 1 or 2 on IM Bus	XXXXXXD1D0	D0 = Digital Input 1 D1 = Digital Input 2

Note: X = don't care

**Figure 16.** List of the main 16-bit IM Bus programming codes that are used by the LM1983, together with their functions.

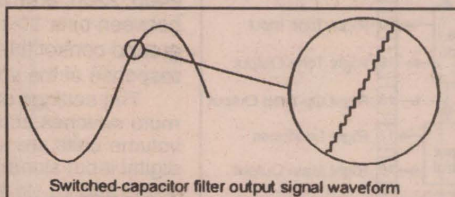
few other external components) it offers great economies in system manufacturing costs.

Design engineers considering serious use of the LMC1983 should note the following data regarding the IC's digital control system.

Control instructions are sent to the LMC1983 via digital signals applied to pins 1, 27, and 28 via a three-wire IM bus interface. Pin 28 is the serial DATA input. Signals arriving here take the form of a 16-bit word in which the first eight bits represent an address, which specifically selects the LM1983 IC and one of its eight basic functions, and the remaining eight bits represent a data word that sets the selected function to the desired value.

Each one of the 16 bits is clocked into the IC on the rising edge of a clock signal applied to pin 1, and various signals on the pin 27 ID (IDENTITY) terminal allow the IC to identify the address and data part of the 16-bit, pin 28 word and to identify an EOT (end of transmission) condition.

Figure 15 shows the basic timing details of the LM1983 INTER-METAL bus system, and Figure 16 lists the 16-bit programming codes that are used by the LM1983.



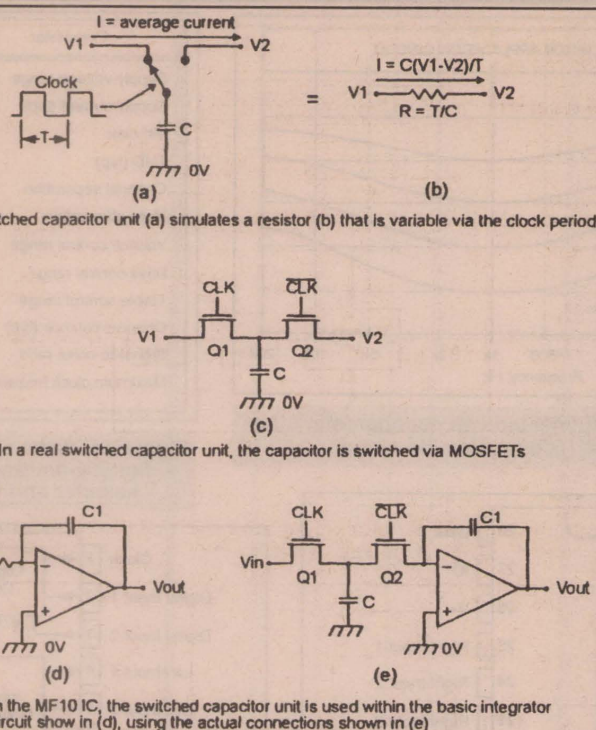
**Figure 18.** The signal output waveform of a switched-capacitor filter is quantized, and takes the form of a large number of discrete digital steps.

Note in Figure 16 that, in the tone and volume control sections, the table lists only various spot data codes and their corresponding function values, and that intermediate values can be worked out by interpolation.

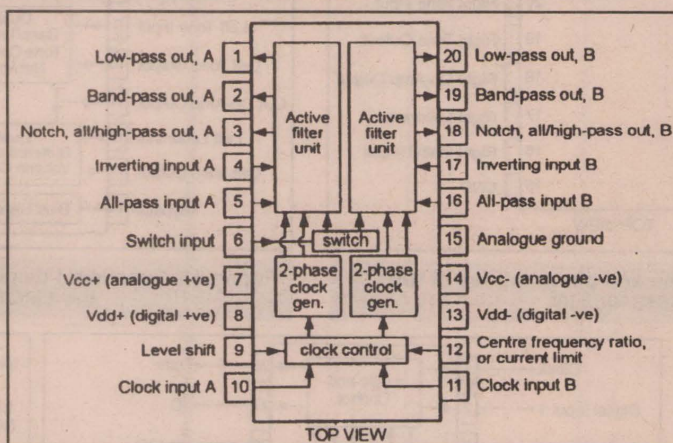
The tone and volume settings are variable in 2 dB steps, and the volume can, for example, thus be set at -20 dB by a data code of XX001010 (i.e., 10 binary steps greater than the XX000000 '0dB' value), or at -60 dB by a data code of XX011110 (30 steps up on the 0 dB code), and so on.

## SWITCHED-CAPACITOR FILTER IC BASICS

In the great majority of practical audio systems, filter circuits take the form of fairly simple active (usually op-amp based) first- or second-order low-pass, band-pass, or notch types such as speech-band selec-



**Figure 17.** Diagram illustrating the basic operating principles of the MF10 switched capacitor filter IC.



**Figure 19.** Outline (not to scale), pin descriptions, and simplified block diagram of the MF10C dual switched capacitor filter IC.

tors, tone controls, graphic equalizers, and hum or tone rejectors, etc. There are, however, a few rare occasions when special, high-precision frequency-tracking or fourth-order or greater filters are required, and in such cases the filters may be best designed around a special type of IC known as a switched-capacitor filter.

The most obvious application of such a filter is as an anti-aliasing, auto-tracking low-pass filter in analog or digital delay line systems, such as those described in earlier articles in this magazine, and the most popular switched-capacitor filter IC for use in this type of application is a device known as the MF10 which is available from several man-

ufacturers.

A switched-capacitor filter is a device in which the filter's turn-over frequency is directly proportional to that of an external high-frequency clock signal, and can thus be set or varied via the clock signal.

This type of action is achieved by replacing the resistive elements of conventional R-C active filters with resistor simulators made from switched-capacitor units. The basic operating principle can be understood with the help of Figure 17.

Thus, referring to Figure 17, in the basic switched-capacitor unit shown in (a) the capacitor is alternately switched between V1 and V2 via a symmetrical clock waveform, transferring a charge (Q) of C(V1-V2) in each complete clock cycle (T), thus passing an averaged current of C(V1-V2)/T as shown in (b) and acting as a simulated resistance that has a value that is directly proportional to the 'T' value (i.e., inversely proportional to the clock frequency).

The circuit's switch actually takes the form of two MOSFET switches that are clocked in antiphase, as shown in (c). In the MF10 IC, the switched capacitor units are used in the basic integrator

circuit shown in (d), using the connection shown in (e). The integrator functions as a first-order low-pass filter that has a fall-off slope of 6 dB per octave (20 dB per decade).

Switched-capacitor active filter circuits produce outputs that are almost identical to those obtained from similar types of conventional active filters, except that their outputs appear in quantized — rather than purely analog — form.

In other words, the filter output waveforms appear as a number of small digital steps rather than as a smoothly varying waveform. The number of steps (S) equals the clock frequency (fc) divided by the signal frequency (fs). In ICs such as the MF10, these steps are — as



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illustrated in Figure 18 — usually too small to be seen on an oscilloscope, and their basic frequency is too high to create problems in most audio applications.

If, for example, the MF10 is used as a 12 KHz low-pass filter, it will use a clock frequency of 600 KHz, thus producing 600 steps on a 1 KHz filter signal or 100 steps on a 6 KHz filter signal.

## THE MF10C SWITCHED-CAPACITOR FILTER IC

The MF10C is the most popular commercial version of the MF10 IC, and is supplied in a standard 20-pin dual-in-line plastic package. Like all MF10 ICs, it is a dual switched-capacitor filter IC that is configured as two identical general-purpose, second-order active filter blocks that can each be used in a variety of modes (high-pass, low-pass, band-pass, notch, or all-pass) at frequencies up to 20 KHz.

The two blocks can be used independently or can be cascaded to give third-order or fourth-order filter action from a single IC, or can give

an even greater number of orders from two or more cascaded MF10 ICs.

any one of several types of response, including Butterworth,

Chebyshev, and Bessel.

The IC can use single-ended or split ( $\pm 5V$ ) 10V supplies, and the clock network thus includes 'level shift' circuitry for use with 5V clock inputs. The pin 12 CFR terminal gives the filter a clock frequency ( $f_c$ ) to filter turn-over frequency ( $f_{to}$ ) ratio of 50:1 when tied to  $V_{dd+}$ , or 100:1 when tied to ground with dual supplies or to mid-supply level with single-ended supplies.

The IC can accept a maximum  $f_c$  input of 1 MHz, and can thus give a maximum  $f_{to}$  value of 10 KHz with a 100:1  $f_c/f_{to}$  value, or 20 KHz with a 50:1 value. The IC is thus very versatile.

Note in Figure 20 that functions that are associated with pin numbers that are shown singly (such as 9 and 12) are common to both halves of the IC, and that where pin numbers are shown as a pair (such as 10 and 11), the plain number applies to the IC's L/H filter, and the number in brackets applies to the R/H filter.

Figure 21 shows the basic way of connecting an MF10C filter network in its most popular mode, as a combined second-order notch, band-pass, and low-pass filter. In this mode, the notch center frequency ( $f_0$ ) equals the clock input frequency divided by the 100:1 or 50:1 CFR value set by pin 12, and the notch Q equals  $R_3/R_2$ . In the low-pass mode, the filter's gain equals  $R_2/R_1$  and the fall-off slope equals 12 dB/octave (40 dB/decade).

In hi-fi audio systems, the most important application of the MF10C is as a fourth-order Butterworth low-pass filter, which gives a fall-off slope of 24 dB/octave (80 dB/decade).

To conclude this series, Figures 22 and 23 show practical examples with the MF10C connected in this mode, as a 1 KHz (nominal) filter using a 100 KHz clock frequency, using alternative supply connections.

In both circuits, the clock input signals are derived from normal +5V TTL or CMOS sources.

In Figure 22, the circuit is shown for use with a split ( $\pm 5V$ ) power supply, with the analog ground (pin 15) terminal, etc., tied to zero volts. In Figure 23, the circuit is shown for use with a single-ended 10V supply and, in this case, a simple potential divider is used to generate a +5V half-supply voltage, which serves as the IC's analog ground reference.

Note in both filter circuits that the turn-over frequency (1 KHz nominal with a 100 KHz clock signal) can be varied from less than 100 Hz up to at least 10 KHz by simply changing the clock signal frequency. NV

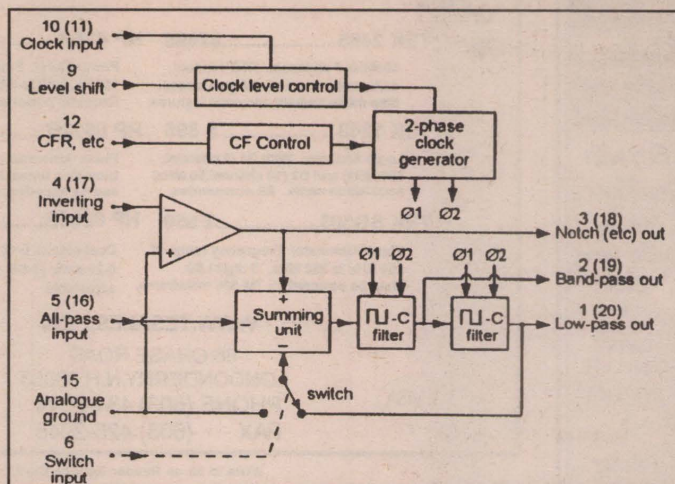


Figure 20. Functional block diagram of one of the two identical halves of the MF10 IC.

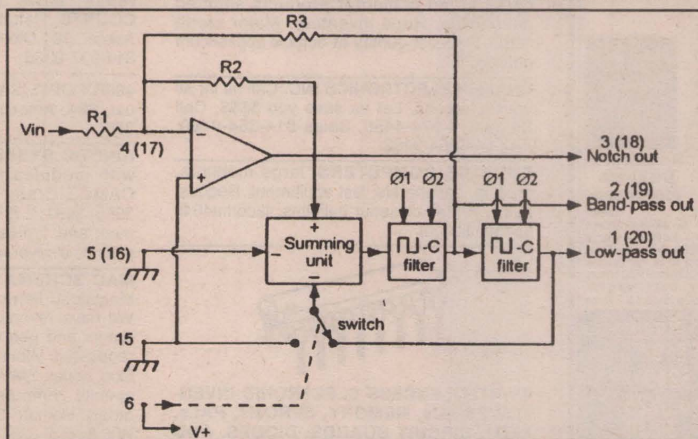


Figure 21. Basic way of connecting an MF10C filter network as a combined second-order notch, band-pass and low-pass filter.

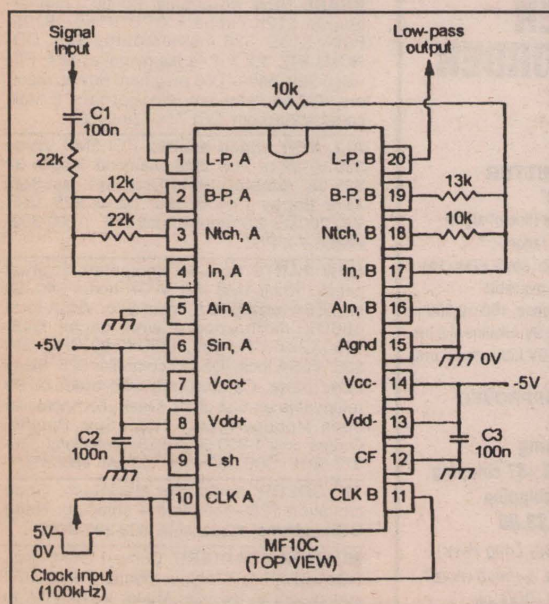


Figure 22. Connections for using the MF10C as a Butterworth 1 KHz fourth-order low-pass filter, using split ( $\pm 5V$ ) power supplies.

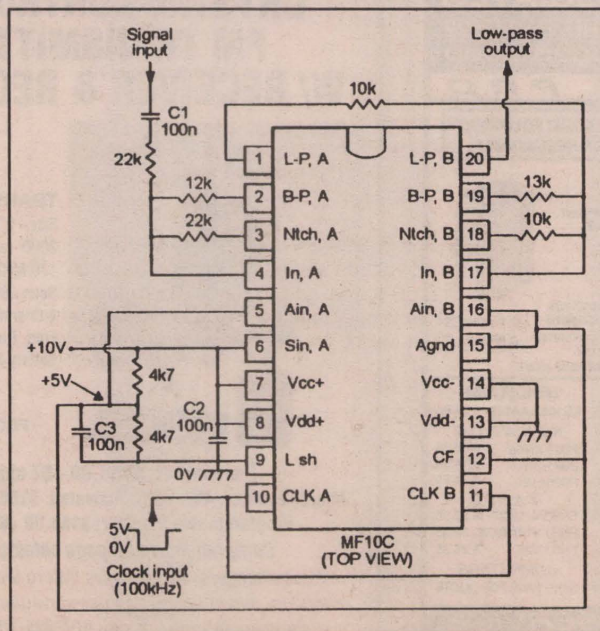


Figure 23. Connections for using the MF10C as a Butterworth 1 KHz fourth-order low-pass filter, using a single-ended 10V power supply.



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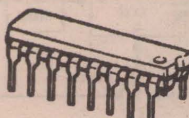
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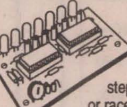


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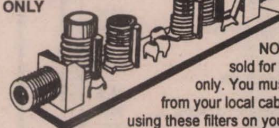
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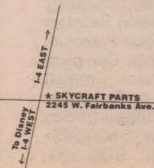
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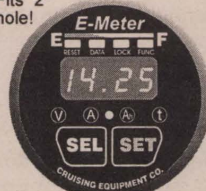
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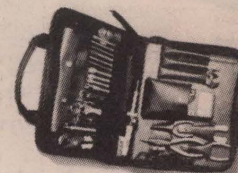
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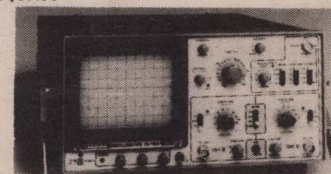


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# Stamp Applications:

Putting  
the Spotlight on  
BASIC Stamp Projects,  
Hints, and Tips

by Scott Edwards

Two previous applications showed how to measure temperature with a lowly thermistor and a clever thermometer-on-a-chip. In both cases, I touted the applications as alternatives to traditional techniques using an analog-to-digital converter and a discrete temperature sensor.

## IC Temperature Sensors are Accurate and Flexible

### Old-tech sensors are handy where newer devices don't fit

Sometimes the traditional ways are best, however. For instance, neither the thermistor trick featured in the Stamp/Counterfeit application notes (no. 7), nor the DS1620 thermometer chip (Stamp Applications no. 2) is suitable for remote use. In both cases, the sensors should be, at most, a foot from the controller.

The thermistor application requires calibration to compensate for component tolerances, and is accurate over a narrow range of temperatures. The DS1620 needs no calibration and has a wide temperature range, but gobbles up lots of precious program memory.

This month, we're going to look at old-fashioned temperature-measurement devices

and techniques.

### LM34 and LM35

If nothing else, you can use these guys to double-check or calibrate other thermometers. LM34 and LM35 IC temperature sensors made by National Semiconductor are simple three-terminal devices. Connect one pin to +5 to +20 volts, and another to ground. The voltage at the output terminal will be proportional to the temperature to the tune of 0.01 volt (10 millivolts) per degree. For example, if the temperature is 68°, the output will be 0.68V. In the case of the LM34, the output corresponds to degrees Fahrenheit; the LM35, degrees Celsius.

Because of the direct relationship between temperature and voltage, you must have a negative supply voltage, or some additional components, in order to measure subzero temperatures. The National Semiconductor spec sheets (Sources) provide suitable circuits. We're going to stick to the basics; you can add bells and whistles later as necessary.

National makes several variants of the LM34 and 35, allowing you to play off the accuracy you want against the price you're willing to pay. Table 1 lists your options.

### Interfacing to the Stamp

Measuring the voltage output by a temperature sensor requires an analog-to-digital converter (ADC). We've covered a couple of those in the past, including interfacing the 12-bit LTC1298 and using cheap comparators to create your own eight-bit ADC (Stamp Applications nos. 4 and 25, respectively). But for temperature measurement, it may make more sense to use the modest ADC0831, shown in BS1 and BS2 application notes (no. 2 in each case).

The ADC0831 is a particularly suitable partner for temperature sensors because you can set both ends of its input-voltage range to match the characteristics of the sensor.

The ADC's Vin- pin sets the input voltage that will produce an output of 0 ADC units. The Vref pin sets the voltage corresponding to 255 ADC units. So, if you want 1 unit of the ADC's range to correspond to 1°F, tie Vin- to ground and Vref to 2.55V. Since the temperature sensor outputs 0.01V (10 mV) per degree, an ADC reading of, say, 78 corresponds to a temperature of 78° (F or C, depending on whether the sensor is an LM34

Table 1. Characteristics of LM34/35 Sensors

Part	Range	Accuracy	Output
LM34A	-50 to +300°F	±2.0°F	10 mV per °F
LM34	-50 to +300°F	±3.0°F	
LM34CA	-40 to +230°F	±2.0°F	
LM34C	-40 to +230°F	±3.0°F	
LM34D	+32 to +212°F	±4.0°F	
LM35A	-55 to +150°C	±1.0°C	10 mV per °C
LM35	-55 to +150°C	±1.5°C	
LM35CA	-40 to +110°C	±1.0°C	
LM35C	-40 to +110°C	±1.5°C	

or 35).

If you want finer resolution, just bring the endpoints of measurement (voltages at Vin- and Vref) closer together and use the Stamp's math capabilities to scale the reading to the correct temperature.

Figure 1 shows the hook-up for the ADC0831, while Figure 2 suggests a couple of options for the reference voltage. The pot option assumes that the +5V supply is reasonably stable, since variations in the supply voltage will affect the reference voltage, and therefore the temperature readings. This is a pretty safe bet with the Stamps and Counterfeits, since they use high-quality regulators.

The voltage-reference option is likely to be more accurate and less prone to drift, but is more expensive and less flexible than the pot.

The program listing shows the minimal programming required to take temperature readings with this circuit. I used a 2.55V reference, so the result returned by the ADC was the actual temperature in degrees — no adjustment or scaling required.

In my demo set-up, I used a 2 x 16 serial LCD as a display. You can readily modify the code for some other display device if you like. I used one of my company's BS1/LCD kits (blatant plug), installing the ADC0831 right onto the prototyping area.

Figure 1. Temp sensor and ADC.

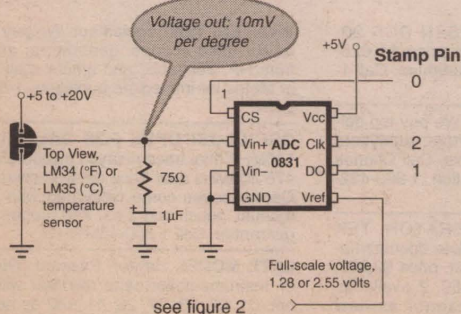
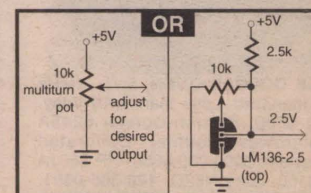


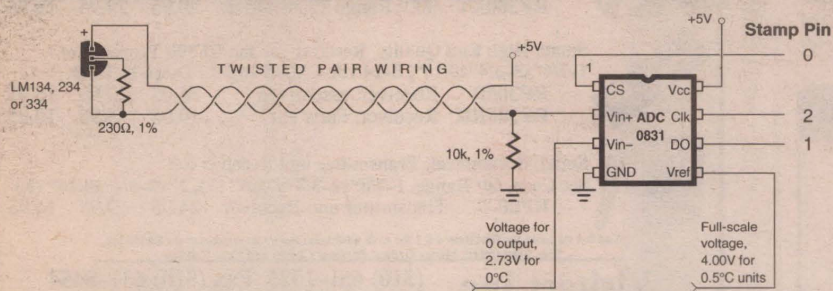
Figure 2. Voltage reference options.





# Stamp Applications:

**Figure 3. Remote Temperature Sensor.**



## Remote temperature sensor

Figure 3 introduces another temperature sensor — the LM134/234/334 series. Instead of a variable voltage output, this sensor passes a small current that varies with temperature. With the component values shown, that current is one microamp ( $\mu\text{A}$ ) per degree Kelvin. (Kelvin is an absolute scale; its 0 is absolute zero, the lowest possible temperature. To convert  $^{\circ}\text{K}$  to  $^{\circ}\text{C}$ , just subtract 273.1.)

For measurement purposes, we pass this tiny current through a 10K resistor. By Ohm's Law, the voltage across the resistor is current times resistance =  $1 \times 10^{-6} \times 10 \times 10^3 = 10 \times 10^{-3} = 10\text{mV}$  per degree, same as our other sensors. The only difference is the Kelvin scale. If we want the temperature range to start at 0, we have to set the 0 point ( $\text{Vin-}$ ) at 2.73V, since  $273^{\circ}\text{K} = 0^{\circ}\text{C}$ .

To maintain the one-to-one relationship between  $^{\circ}\text{C}$  and ADC units, we'd have to place  $\text{Vref}$  2.55 volts higher, at  $2.73 + 2.55 = 5.28\text{V}$ .

That's higher than the +5V supply, so it's not allowed. Instead, we can place  $\text{Vref}$  at 4.00V and divide the ADC result by 2 to get  $^{\circ}\text{C}$ .

Now, the big question: Why bother? Why not just put one of the voltage-mode temperature sensors at the end of a long piece of wire? The reason is noise. A current-mode sensor is far less susceptible to noise pick-up over long wire runs than a voltage-mode sensor. Those of you who have worked in industrial settings have probably heard of current-loop sensors and control systems — these are used in electrically noisy factory environments where other signaling methods wouldn't work reliably.

So, how long a wire run will our current-mode sensor support? National's excellent data book sidesteps this question, and so will I. I have seen this kind of arrangement in use with 100't wire runs with apparently satisfactory results.

## Sources

For more information on the BASIC Stamp, contact:

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## You've seen the movie, now read the book.

The book I'm referring to is the *National Semiconductor Data Acquisition Linear Devices Databook*. If you're connected with a National distributor, you should be able to get this book free for the asking. If not, you can purchase a copy from Jameco (PN 41208) or download individual data sheets from [www.national.com](http://www.national.com)

For those of us who make only occasional forays into analog electronics, data books like National's are a treasure. Browsing the application notes is an education in itself. **NV**

### ' Program: LCDTEMP.BAS (Measure and display the temperature)

' This program uses an ADC0831 to measure the output voltage from an LM34 or LM35 temperature sensor. With  $\text{Vref}$  adjusted to 2.55V, the value returned by the ADC is the temperature in degrees — no unit conversion required. The program continuously displays the temperature on a serial LCD module connected to pin 7. The prototype was constructed with a BS1/LCD kit from Scott Edwards Electronics. The kit integrates a BS1 computer, serial LCD driver, and 2x16 supertwist LCD module into a single, compact package. The product manual, catalog, and other items of interest are available from <ftp://ftp.nutsvolts.com/pub/nutsvolts/scott>. View the file index.txt for a list of available files.

SYMBOL	CS	=	0	' ADC chip-select (activates ADC0831).
SYMBOL	AD	=	pin1	' Data output of ADC.
SYMBOL	CLK	=	2	' Clock input to ADC.
SYMBOL	S_out	=	7	' Serial output to LCD.
SYMBOL	data	=	b0	' Eight-bit ADC result.
SYMBOL	clocks	=	b2	' Counter for ADC clock cycles.
SYMBOL	I	=	\$FE	' LCD instruction-prefix.
SYMBOL	LCDcls	=	1	' LCD clear-screen instruction.
SYMBOL	dg	=	223	' LCD code for degree symbol.
SYMBOL	pos	=	198	' LCD position for temp reading.

' Set-up: The program starts by setting the initial states of the pins and making all but the ADC data line outputs. It then clears the LCD and prints a label on the top line. Note that the label assumes that an LM34 (Fahrenheit) sensor is used; if you're using an LM35, change the F to C.

setup:

pins = \$7b	' Pins high, except LCD and CLK.
dirs = \$FD	' S_out, CLK, CS outputs; AD input.
serout S_out,N2400,(I,LCDcls)	' Clear the LCD screen.
serout S_out,N2400,(" Temperature ",dg,"F")	' Print fixed label.

' Main: This is where the program spends most of its time. It takes a reading via the subroutine 'convert,' prints the result to the middle of the LCD's second line, pauses a half second, then repeats.

main:	
gosub convert	' Get the data.
pause 1000	' Wait a second for LCD startup.
serout S_out,N2400,(I,pos,#b0,"")	' Write it to the LCD.
pause 500	' Wait 1/2 second.
goto main	' Loop continuously.

' Convert: This subroutine gets eight-bit analog readings from the ADC0831. With  $\text{Vin-}$  connected to ground and  $\text{Vref}$  to 2.55V, the 10mV/degree output of the LM34/35 directly translates to degrees.

convert:

low CS	' Select ADC.
pulsout CLK, 1	' 10 uS clock pulse.
let data = 0	' Clear data.
for clocks = 1 to 8	' Eight data bits.
let data = data * 2	' Perform shift left.
pulsout CLK, 1	' 10 uS clock pulse.
let data = data + AD	' Put bit in LSB of data.
next CS	' Do it again.
high CS	' Deselect ADC.
return	



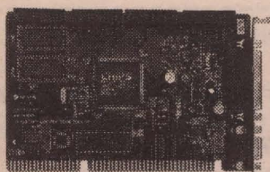
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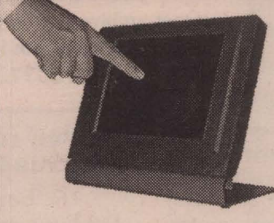
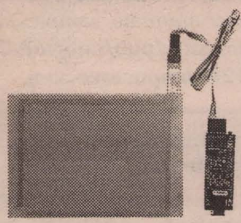
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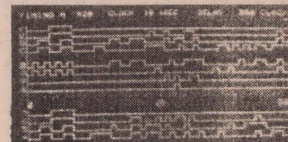
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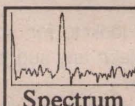
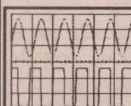
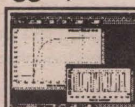
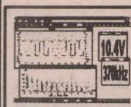
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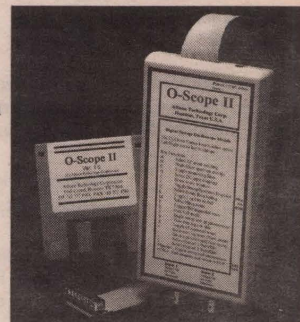
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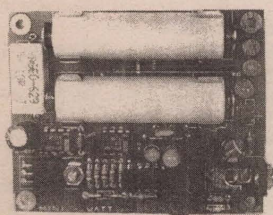
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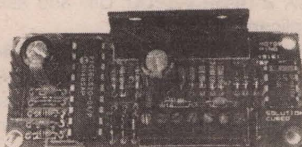
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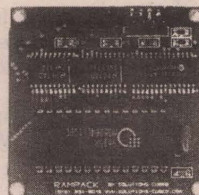
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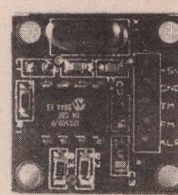
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# Questions & Answers

# TECH FORUM

This is a READER TO READER Column. All questions AND answers will be provided by *Nuts & Volts* readers and are intended to promote the exchange of ideas and provide assistance for solving problems of a technical nature. All questions submitted are subject to editing and will be published on a space available basis if deemed suitable to the publisher. All answers are submitted by readers and **NO GUARANTEES WHATSOEVER** are made by the publisher. The implementation of any answer printed in this column may require varying degrees of technical experience and should only be attempted by qualified individuals. Always use common sense and good judgement!

## QUESTIONS

I would like to locate and obtain a "how-to" on the computer interface and control of a robot. Where is there such a book on that subject?

**7971 Owen D. Aiken  
Hammett, ID**

I'm trying to figure out how to use a pager to activate a 12-volt device. For instance, I would like to be able to call the pager and have it trip a relay to ground the ignition on my car — a poor man's Lojak!

The pager is only putting out about 1-1.5 volts and I am unable to find a relay that operates below three volts.

Can anyone suggest a solution?

**7972 Dave  
Via Internet**

I recently rewired a four-sided traffic signal. The lights never change at all. I have tried everything to get them to switch like they used to. I really need help. Timer ideas would be most helpful.

**7973 Thomas W.P. Slatin  
Stamford, NY  
E-Mail: TWPS@INAME.COM**

Is there any reason, either mathematically or intuitively, why five identical toroid coils (approximately 600 mH each) connected in series from the output, pin 3, of a 555 timer (running at 470 KHz) on one end of the series to the ground (of the 555) on the other, would not all have the same AC voltage dropped upon them? My experiments have shown that the coil nearest to pin 3 will have the highest AC voltage on it and the (series) coil nearest the ground will have the lowest AC voltage on it with a continuous gradient of voltages (high to low) along the coils in-between (although harmonic ringing will increase as ground is approached, and the ringing on the inductor closest to ground surpasses the original 555 signal on the toroid that is second closest to ground).

Also, why do four identical .01  $\mu$ F capacitors, in series, gradient just the opposite way, with the highest AC voltage nearest the ground and the lowest AC voltage nearest pin 3 (when proceeded by a 1N4148 switching diode in this case)? With .1  $\mu$ F caps, the original signal dies out and the harmonics increase very fast going towards ground. Why?

It seems that in both cases, the 555's signal is dying out and the har-

monics are rising (on the oscilloscope) as ground is approached.

**7974 Greg Moran  
Riverside, CA**

I am looking for some help on a small project; any suggestions where I should go?

The project involves a wireless transmitter and receiver attached to an alarm/siren. When the transmitter and receiver are within a certain distance of each other (i.e., 10 to 50 feet), the circuit is "closed." When the distance is exceeded, the receiver causes the alarm to sound.

Any suggestions of Web sites, newsgroups, people on-line, or books?

Any help would be appreciated.

**7975 Drew  
Via Internet**

I have an application where I want to detect a vehicle pulling into a garage. I could use an infrared, microwave, or ultrasonic application, but I need to detect the vehicle from the wall or ceiling within an area of 6-8" from my mark. Can any of these applications' detection patterns be defined to a 6-8" detection area? Is there any other application I might use? (Pressure mats will not work.)

**7976 Evans  
Plano, TX**

On a schematic diagram that includes a three-phase alternator, what do the letters R, S, and T stand for when shown with R on one output lead, S on a second output lead, and T on the third lead?

**7977 Kenny  
Biloxi, MS**

## ANSWERS

### ANSWER TO #6977 - JUNE 1997

Interesting you're running 811s at 1800 volts. I checked the current Svetlana data sheets, and they show 800V as the maximum. Without really addressing why you're blowing tubes and chokes — since you didn't ask that — it could be oscillation, high current, or still bias problems.

In any event, reducing the voltage could be accomplished in a couple of ways. Consider also where heater power is derived. The same transformer, or a separate plate supply. Approaches to consider: put a hefty variac (variable autotransformer) on

the primary and crank it down; add a buck transformer (one capable of handling the primary current) to reduce the primary voltage. A transformer with a secondary of about 26 volts at whatever line current the amplifier draws should suffice; add a stack of high-power zener diodes totalling 200V in series with the DC output, but before the filter network. High power, since they'll have to dissipate 200V x plate current.

**Rick Nelson  
Newport News, VA  
nelson@jab.org**

### ANSWER TO #6979 - JUNE 1997

Here are some Hall Effect information sources as requested:

**F.W. Bell, Orlando, FL 800-775-2550.** Call and ask for applications and data.

**Micro Switch, Honeywell Division, Freeport, IL 815-235-6600.**

*Hall Effect Transducers, How to apply them as sensors*, 1982. This is a very good book and goes into some detail. It lists for \$10.00.

NASA Tech Briefs, Lewis Research Center, Cleveland, OH. *Another Nulling Hall-Effect Current-Measuring Circuit*, LEW-15069. *Magnetic Direct-Current-Measuring Circuits*, LEW-15070. These are interesting articles. I obtained them some time ago, but will be willing to copy if a SASE for 2-oz. mailing is sent to me.

**Optek Technology, Inc., Carrollton, TX 214-323-2200.** Call and ask for applications and data.

**Sprague, Concord, NH 603-224-1961.** *Hall Effect IC Applications*, CN-207. This is a good handbook and is free. Don't forget to ask for sensor information.

I hope this helps and good luck. You may contact me by E-Mail if you need further information.

**Derek Koonce  
San Jose, CA  
E-Mail: derekk@supertex.com**

### ANSWER TO #6972 - JUNE 1997

There is no convenient way to send general E-Mail to all Internet users. Even if there were, some feel it is very bad manners to send unsolicited E-Mail to people you don't know. A better approach would be to post a message to an Internet newsgroup. With an Internet connection and news reading software (readers are built into Netscape and Explorer), you send a "message" to a newsgroup "topic"

## ANSWER INFO

- Include the question number that appears directly below the question you are responding to.
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- Unanswered questions from a past issue may still be responded to.

## QUESTION INFO

### TO BE CONSIDERED FOR PUBLICATION

All questions should relate to one or more of the following:

- 1) Circuit Design
- 2) Electronic Theory
- 3) Problem Solving
- 4) Other Similar Topics

### INFORMATION/RESTRICTIONS

- No questions will be accepted that offer equipment for sale or equipment wanted to buy.
- Selected questions will be printed one time on a space available basis.
- Questions may be subject to editing.

### HELPFUL HINTS

- Be brief but include all pertinent information. If no one knows what you're asking, you won't get any response (and we probably won't print it either).
- Write legibly (or type). If we can't read it, we'll throw it away.
- Include your Name, Address and Phone Number. Only your name will be published with the question, but we may need to contact you.

rather than an individual. There are thousands of groups addressing science, computer, recreation, and various other topics. Postings are distributed worldwide via the net; people generally subscribe only to topics that they find of specific interest. Newsgroups may have charters and etiquette rules, but sharing information, asking, and answering questions are universally acceptable. Want ads are limited to specific "for sale" groups. Controversial topics are best addressed in groups chartered for such discussions.



# TECH FORUM

Newsgroups are a great way to find and share information. While spam, the newsgroup equivalent of junk mail, does exist, you can easily ignore it — don't read it or unsubscribe from the group. Unsolicited or commercial E-Mail, however, imposes on the recipient. Since I have to pay for my Internet connection, I consider it an annoyance at best, not to mention theft of services. If you want to broadcast information, use the newsgroups.

Mike Byrne  
Cupertino, CA

## ANSWER TO #69713 - JUNE 1997

Probably the best all-around piece of test equipment is a good DVM (digital voltmeter). With it, you can measure resistance, voltage, current, etc. Since all of the devices mentioned are motor driven, testing and repairing the broken elements probably would involve lack of continuity — from bad brushes, open windings, failed thermal protection elements, etc. Use the ohmmeter setting and you're on your way.

Rick Nelson  
Newport News, VA  
nelson@jlab.org

## ANSWER TO #59721 - MAY 1997

Making a PBC with plated through holes requires some extra steps compared to the single-sided boards that many of us have made at home.

You start, of course, with PCB material having a layer of copper on both sides. First, all the holes must be drilled through in the correct location. Since the circuitry isn't etched yet, it isn't possible to eyeball the hole locations as it would be with a single-sided board.

For small production runs, or for simpler shops, this requires production of a third piece of artwork (in addition to the foil layouts for both sides). This artwork, called a hole template, can be taped to the board material and drilled through; or, if the shop has a pantograph drill, the template is placed on the optical side of the pantograph, and used with a crosshair target, to guide the drill.

For larger production runs, if the artwork was produced on a computer,

the software also produces a drill file. This file, on disk, is then read into an automatic drilling machine, to produce accurate and repeatable hole locations on all the boards. I've used this process with Protel's Easy Trax, and it's a breeze to watch that drilling machine perforate the board material — much easier than trying to eyeball all those holes yourself.

After the holes are drilled, electrodes are clamped to the copper sides of the board material, the board is immersed in plating solution, and a minute copper cylinder is electroplated inside each of the holes, connecting the two copper surfaces. Because this is an electrical process, the copper surrounding each hole must be connected to the electrodes; that's why the board must be plated before the foil patterns are etched.

After the holes are plated, both copper surfaces are cleaned, and are then treated chemically with photoresist solution to make them light-sensitive. The photographic film of the foil pattern is placed in contact with the board, and carefully aligned so the donut pads are centered over the pre-drilled holes. Then the board is exposed to light (usually ultraviolet). After both sides have been exposed, the board is developed and rinsed, leaving a pattern in the photoresist that corresponds to the desired foil pattern. Next, the board is placed in a tank of etchant, which removes the copper from areas of the board that are not protected by photoresist. This produces the finished foil patterns on both sides of the board.

After etching, the board is rinsed, dried, and the copper surfaces are cleaned with a mild abrasive pad. Then (almost always), the board is plated with tin, which provides a surface less subject to corrosion than the bare copper, and, thus, easier to solder to later.

One important note is that the size of the drills used for the holes must be significantly larger than the final hole size desired. That's because the inside diameter of the holes will be reduced during production: first, because of the thickness of the copper that is plated into the holes; and second, by the thickness of the tin that is plated onto the

copper. Before specifying drill sizes to the shop, be sure to talk with them and find out what thickness of copper and what thickness of tin plating they will use when your board is made. Then make it clear whether you are specifying the finished size you want the holes to be (in which case the shop will add the appropriate amount to the drill size), or whether you are specifying the actual size of the drill bit.

Gold plated PCBs can be produced by one of two processes: electroplating or electroless plating.

Electroless plating is fairly simple, and involves either immersing the board in an electroless plating solution, or in some instances, painting the solution onto the board. I have had boards made with electroless tin plating, and some of the results were disappointing — the plating was thin and looked splotchy, the finish was not bright, and it was not easily soldered.

Electroplating normally consists of connecting the metal areas to be plated to a DC power supply, and immersing the desired area of the board into an electroplating solution. A direct current is passed between the PCB and the plating solution, and a plated layer gradually builds up on the board.

In the case of plated edge connector "fingers," it is necessary that all the fingers be connected to the power supply. Therefore, you need to extend the fingers out beyond the imaginary line where the board material will be sheared to produce the board edge. Then the extended portion of all the fingers connect to a current buss, often called a plating bar. The power supply is connected to this plating bar, with an alligator clip, etc.). This allows current to flow to all the fingers, while keeping the clip off the important area of the fingers themselves.

Gold can be plated directly onto a copper board; however, I have been warned of two potential problems. First, over time, the gold molecules can migrate into the copper of the board, so that there is no longer a clean top layer of gold. Second, if the copper is even slightly contaminated, or if the process is not optimum, the gold layer may not adhere well, and may tend to flake off. The preferred process is to first plate nickel over the copper, and then to plate gold over the nickel.

A variation of the electroplating process is the plating pen that was sold in the past. This was a small pen, similar to a felt-tipped marker, which was filled with an electroplating solution, and which had an electrical connection on its body. The pen was connected to one terminal of a DC power supply, and the copper foil was connected to the other terminal. Then by painting back and forth over the copper foil, a thin layer of electroplating was laid down. I've never tried these, but I remember seeing them advertised many years ago in electronics magazines. (A similar pen for chrome plating, for use in

Continued on page 115

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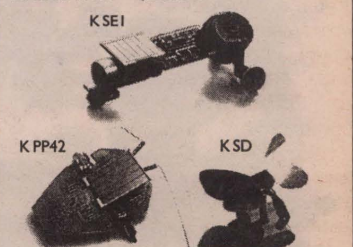
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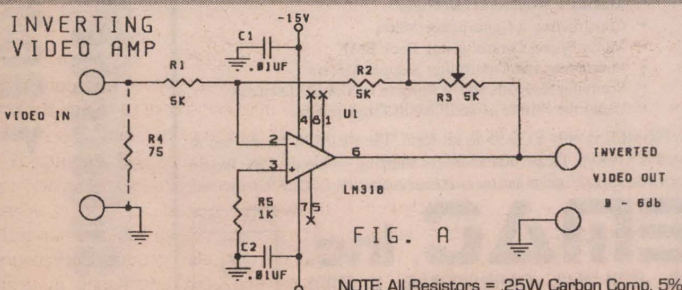
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\*No offense intended to any drum-beating pink bunny rabbits

## ANSWER TO #5974 - MAY 1997

National Semiconductor makes an op-amp with video bandwidth (>6 MHz) that will work well for your particular application. See Figure A for the inverting implementation of this device. Adjust R3 for desired gain.

Kevin Goodwin  
Oceanside, CA





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# Two Simple Electronic Sirens You Can Build

by Fred Blechman

**T**here are all kinds of alarm sounds, from bells to horns to sirens. Alarms can be used, among other things, to warn of burglars, to clear the traffic for emergency vehicles, to warn you to pull over for a traffic violation, and — in wartime — for air raid warnings.

Some alarms are extremely loud, some only for local arousal. Some alarms have a steady sound, some warble (two different high-low alternating frequencies), some duplicate the upward and downward wail of a police siren.

Here we offer two simple siren designs you can build from scratch, or from kits. One is a low-power wailing siren, the other is a more powerful siren that either warbles or produces a single tone.

## The Wailing Siren

Although this "Wailing Siren" uses very few parts, it duplicates the upward and downward wail of a police siren. It is an experimenter's delight, since you can substitute some parts for different results. For example, you can construct it with two output volume levels — roughly 150 milliwatts or 2 watts — and couple it to a PA (public address) system for even greater power.

You can build the Wailing Siren from parts you probably already have in your junk box, or you can buy a kit of most of the parts — including an etched and drilled printed circuit board — for only \$3.95.

## Theory of Operation

The schematic of the Wailing Siren is shown in Figure 1. It will operate with a voltage from 3 to 12 volts DC. The low-power version is easily powered by a standard nine-volt transistor radio battery, since it draws a peak of less than 10 milliamperes from the battery at that voltage.

To begin with, ignore resistor R3 as if it were not there; we'll discuss R3 later. With the pushbutton switch open, as shown, transistors Q1 and Q2 are not conducting at all, and capacitors C1 and C2 have no charge.

When switch S1 is pressed, electrolytic capacitor C2 starts to charge through resistor R2, but very little current is available through resistor R1 to the base of transistor Q2. As C2 charges, the voltage at R1 increases and allows current to flow through the base of the NPN switching transistor Q2, turning it on.

As soon as Q2 starts to conduct, it biases the base of PNP power transistor Q1, allowing it to conduct. This allows the voltage at terminal 2, one of the speaker terminals, to rapidly rise to almost the supply voltage. This rapid rise passes a positive pulse through disk capacitor C1 to the base of Q2, throwing it into full conduction. The positive pulse also is sent to the speaker.

When Q2 is thrown into full conduction, the amount of base current needed by Q2 is greater than the total current that can be supplied through the almost-100K series resistance of R1 and R2, and from the positive charge on C2. Although the voltage on C2 is constantly increasing, resistor R1 limits the capacitor current that is supplied to the base of Q2.

After the pulse through C1, the voltage at the base of Q2 quickly drops below the .7-volt bias needed, turning off Q2. This, in turn, shuts off Q1. C1 discharges through the speaker. Capacitor C2 has continued to charge — so long as S1 is held closed — so it is at a slightly higher voltage, allowing the conduction of Q2 and Q1 a bit sooner. Each cycle takes a little less time — as C2 continues charging, turning Q2 on sooner each cycle — so the frequency rises until it reaches a stable frequency.

The rate of charge and discharge determines the frequency of the tone

generated through the speaker. Since the voltage on C2 is constantly rising as long as switch S1 is held closed, the frequency increases until it reaches the point where the charge on C2 no longer increases. When S1 is opened, C2 discharges a little with each cycle, taking it longer and longer to trigger

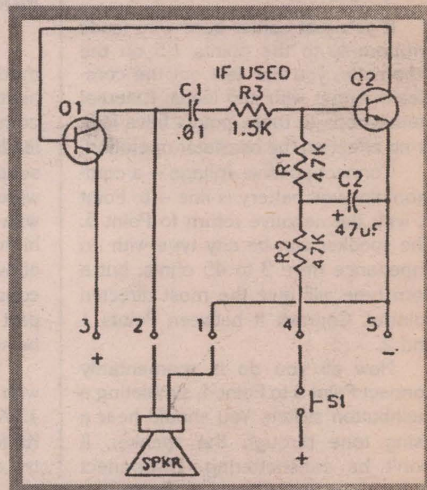


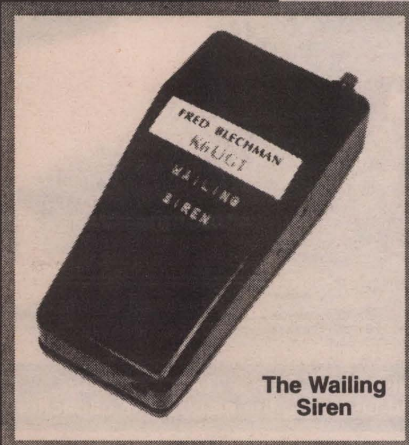
Figure 1: Wailing Siren Schematic Diagram

Q2 each time, thus the frequency drops.

## Construction

The Parts List shows all the parts needed for this project, none of which are particularly critical — although you certainly want a power transistor capable of several watts for Q1. Transistor Q2 can be a small switching NPN type. A kit with most of the parts — including an etched and drilled printed circuit board — is also listed.

This is an oscillator circuit, and therefore subject to erratic operation



The Wailing Siren



The Mad Blaster Siren



depending on lead lengths and placement between parts of the oscillator circuit. I'd recommend you build this project on the printed circuit board, such as shown in Figure 2 (and supplied with the kit). Parts placement is

Point 3 from Point 4 and the tone should be descending in frequency. When you "close the switch," the tone goes up; open it and the tone goes down. Simple enough.

But what

increases the volume, but it also increases the current drain well beyond the amount a common nine-volt battery can supply for any reasonable time.

If you want the extra volume, add

pocket radios and recorders.

The higher-powered version needs a larger speaker and battery to handle the roughly two watts output, so you have the choice of either a larger enclosure, or a smaller enclosure with a plug-in speaker.

My junk box happened to contain the empty case from a Citizen's Band walkie-talkie I bought sometime in the early '50s. The "Spacephone" was so poor in performance I junked the circuit, but saved the case thinking I might use it sometime. The photos show how perfectly the circuit board, speaker, battery, and pushbutton switch fit in this 40-year-old case!

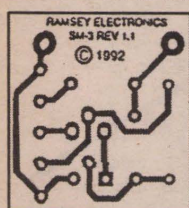


Figure 2: Wailing Siren Printed Circuit Layout Etched Side

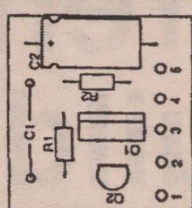


Figure 3: Wailing Siren Parts Locations

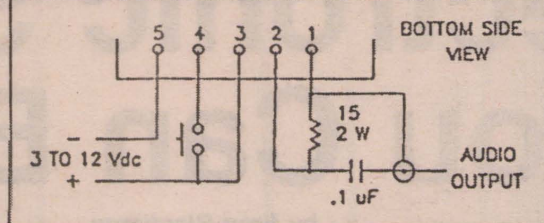


Figure 4: Coupling the Wailing Siren output to an external amplifier or PA system.

shown in Figure 3. Keep all component leads short.

Make sure the polarity of C2 is as shown, and that the emitter, base, and collector of each transistor is correctly placed. For Q1, typically in a TO-220 package with a metal tab, the tab should be closest to resistor R2. For Q2, typically in a TO-92 package with a flat side, the flat side should face Q1. Of course, if you're using some junkbox transistor, it's up to you to determine the E-B-C lead arrangement, since they vary.

## Testing

If you just solder bare wire leads temporarily to the points 1-5 on the schematic, you can test out the completed circuit with clip leads. External connections to these points have little or no effect on the oscillator operation.

Connect positive voltage — a common nine-volt battery is fine — to Point 3, with the negative return to Point 5. The speaker can be any type with an impedance from 3 to 45 ohms, but a horn type will give the most directed volume. Connect it between Points 1 and 2.

Now all you do is momentarily connect Point 3 to Point 4, simulating a pushbutton switch. You should hear a rising tone through the speaker. It won't be ear-shattering. Disconnect

if it doesn't work? First check the component orientation for the transistors and C2, then be sure all solder joints look okay. If everything seems to be right, you could still have a poorly soldered connection. Try gently bending the power transistor, Q1, for example, to see if the leads are firmly soldered. If the leads move at all, you probably don't have a good connection.

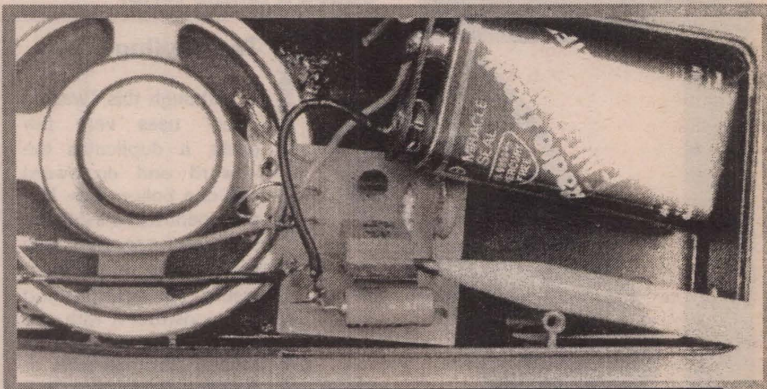
Sometimes the leads are dirty and don't solder well. This happened to me several times with Q1. Also, when testing, I had the leads at Points 1 to 5 twist loose from the PCB, despite many years of soldering experience!

## Modifications

While this circuit fairly begs for modifications, they have to be done neatly. When I tried making some component changes, I used long clip leads with resistor and capacitance substitution boxes, and the results were highly erratic! I had problems with excessive current draw (probably high-frequency parasitic oscillations above hearing range), and horribly raucous bursts of sound. I suggest each part to be substituted or added should be soldered in place on the PCB.

Resistor R3 can be added in series with C1 to produce a louder sound. A 1.5K resistor is included in the Parts Kit for this purpose. You might wish to try other values. Adding R3 definitely

R3, but use either a six-volt lantern battery or an external power supply capable of handling about 200 milliamperes. To be sure, hook an ammeter in series with the power supply you intend to use, and measure the current to see if you have what you need.



The power transistor, Q1, is in a TO-220 package. The metal tab should be facing the electrolytic capacitor.

If you want even MORE volume, couple the output of the low-power Wailing Siren to a PA system or other amplifier. Instead of connecting a speaker between Points 1 and 2, use a 15-ohm, 2-watt resistor, and a .1 uF capacitor as shown in Figure 4. Plug this audio output to the microphone or auxiliary input jack of the amplifier.

Start with a low-volume setting on the amplifier, since the output voltage of the Wailing Siren is considerably more than a typical microphone. You may even need an attenuating plug or cable, as sold by Radio Shack, to keep from overpowering the amplifier if it only has a microphone input.

The other part you may want to experiment with is electrolytic capacitor C2. Change this from a value of 47 uF to 5 uF or 10 uF, and you'll find the wailing occurring at a faster rate.

## Packaging

For the low-powered version of the Wailing Siren, any small plastic enclosure will do if you use a typical small speaker of about 2.25-inches in diameter — the kind commonly found in

door area.

All the parts are common and available from various electronic part vendors. It is also available as a kit to which you can add various options.

## Features

The Mad Blaster can be packaged in a pocket-sized unit. The circuitry consists of only one 4011 integrated circuit (IC), two transistors, and a few resistors and capacitors. It is easily powered by a car battery or other source of 9 to 12 volts DC at up to one ampere.

An inexpensive \$4.95 kit (see Parts List) provides the basic module to which you can add an optional volume control, switches, power supply, and speaker. As the photo shows, I built the unit with several options, into a small plastic case that is designed to hold 36 color slides!

## Circuit Description

The Mad Blaster circuitry with various options, is shown in Figure 5. The CMOS 4011 integrated circuit (U1) consists of four, two-input NAND gates

## The Wailing Siren PARTS LIST

- \* C1 - .01 uF ceramic disc capacitor
- \* C2 - 47 uF electrolytic capacitor, 15 WVDC
- \* R2, R2 - 47K carbon resistor, 1/4-watt
- \* R3 - 1.5K carbon resistor, 1/4-watt (optional)
- \* Q1 - PNP power transistor, TO-220 case, 5-watts or better
- \* Q2 - 2N3904 NPN switching transistor
- SPKR - Speaker - See text
- S1 - Pushbutton switch, normally open
- Battery - See text
- \* Printed circuit board optional; see text

An SM-3 Siren Kit, which includes all the parts marked with an asterisk (\*) above plus a small 12-page manual, is available from Ramsey Electronics, Inc., 793 Canning Parkway, Victor, NY 14564, phone 1-800-446-2295. Although the Kit is only \$3.95, there is a shipping charge of \$4.95 per order, and a \$3.00 charge for orders totaling under \$19.95. I suggest you call their toll-free phone number and request their 8-1/2 x 11-inch 40-page full-color catalog. It is packed with descriptions of over 70 kits and lots of other goodies. You'll probably want some of the items they offer — which will lessen the bite of the shipping charge, and could entirely eliminate the small order charge.



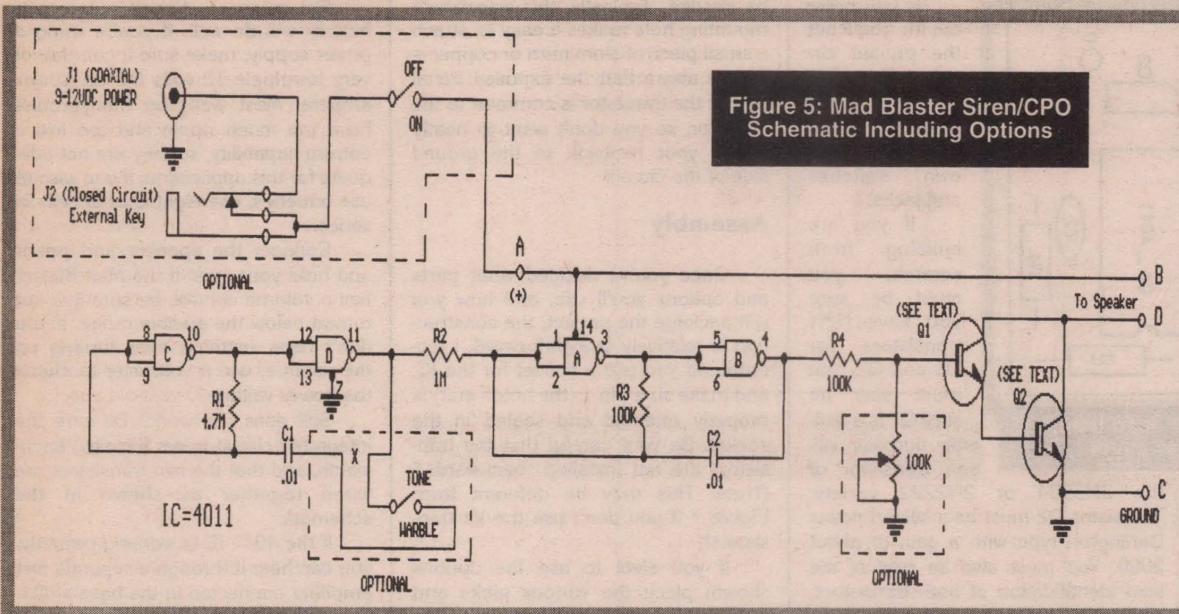


Figure 5: Mad Blaster Siren/CPO Schematic Including Options

## Options

Three options are shown in Figure 5 within dotted-line areas. Instead of just directly wiring 9-12 VDC power to Point A in the schematic, I elected to use a "Power" jack and a "Key" jack together with a power switch. When wired as shown, with no external key plugged in, power comes in through J1, flows through the closed contacts of J2, and is controlled by the ON/OFF switch.

However, if an external key, such as a typical code practice telegraph key, is plugged into J2, the upper contacts of the jack separate and current only flows when the external key is closed. The Power switch must, of course, be closed. This allows the unit to be used conveniently as a code practice oscillator in a large area.

Of course, you would not wish to use a warbling tone for code practice, which leads us to the second option — single tone operation. By simply using a switch to open the connec-

used to form two squarewave oscillators operating at different frequencies. The combined oscillator output is amplified through two transistors and fed to an external speaker.

Notice that both inputs of each IC section are wired together, so each section acts just like an inverter: whatever the voltage state at the input pins, the output is the opposite. If the input pins of a section are LO, then the output pin of that section is HI. Conversely, if the input is HI, the output is LO.

One squarewave oscillator is formed with IC sections C and D, together with resistor R1 and capacitor C1. (Normally, without an option to be discussed later, C1 is connected to output pin 11.)

To illustrate circuit action, assume that at a particular instant pins 8 and 9 of IC section C go LO. Therefore, pins 10, 12, and 13 go HI and output pin 11 of section D goes LO. At the instant pins 10, 12, and 13 go HI, capacitor C1 begins charging through resistor R1, increasing the voltage at the intersection of R1 and C1, which is also connected directly back to IC input pins 8

and 9. This voltage builds until it reaches "transfer" voltage — the voltage at which change of state to HI occurs. This snaps pins 8 and 9 HI, forcing pins 10, 12, and 13 to LO, and output pin 11 HI.

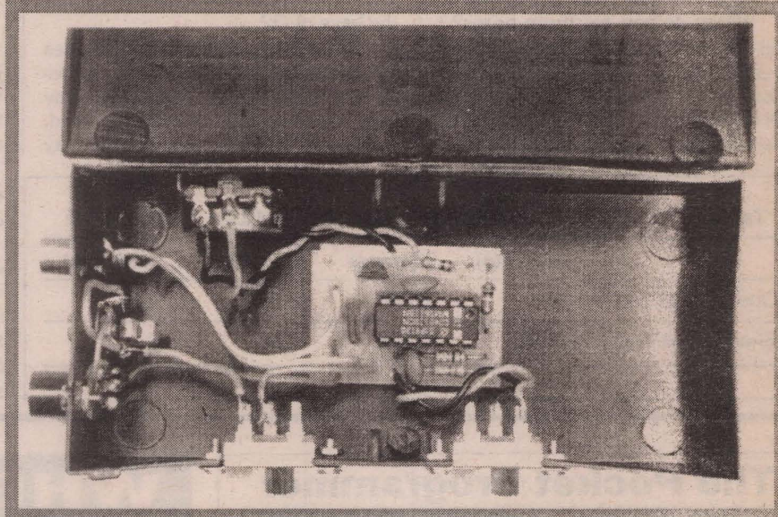
But now capacitor C1 starts discharging through R1 until the R1/C1 intersection voltage drops below threshold — the voltage at which change of state to LO occurs. This snaps pins 8 and 9 LO again, back to where we started! This keeps repeating at a rate determined by the values of R1 and C1.

Similarly, sections A and B of the IC together with R3 and C2 form a second oscillator. However, since R3 is a much smaller value than R1, this oscillator changes state more quickly, so it runs at a higher frequency.

Resistor R2 is a means of coupling the output of the section C/D oscillator to force the input section A of the A/B oscillator to follow the frequency of the slow C/D oscillator, thus producing a two-tone effect.

If C1 is disconnected (one of the options, shown at point X), the C/D

oscillator stops, and the Mad Blaster produces only a single tone.



Inside the Mad Blaster, lid open. The 35 mm slide box easily holds the printed circuit module with external parts mounted to the thin plastic sides.

Resistor R4 couples the warbling or steady tone from IC pin 4 to the base of a pair of NPN transistors wired in a Darlington amplifier circuit. Q1 can be any medium power transistor, but Q2 should be a power transistor. More on this later.

## Printed Circuit Board

You can build the basic circuitry using perforated phenolic board or make your own printed-circuit board as shown in Figure 6. If you use the PCB, Figure 7 shows the parts layout. Notice that points connecting to external circuitry are shown as A, B, C, and D.

Point A is the positive power input, Point C is ground, while Points B and D go to any 8-40 ohm speaker or horn. The kit offered in the Parts List includes a drilled and silk-screened printed circuit board.

tion of C1 to IC pin 11, this oscillator quits, and only the other (high frequency) oscillator is fed to the speaker.

The third option involves adding a 50K or 100K potentiometer from the base of Q1 to ground. This varies the amount of signal amplified by Q2, therefore acting as a volume control.

## Before Assembly

Before starting construction, make sure you have all the parts for the basic module and any options you plan. You'll need to have some idea of how you intend to package the unit, and this could determine what kind of connectors you use for the external speaker and power supply.

I recently found an ideal "cabinet" for small electronic projects. It came with some 35 mm color slides I had developed, and the local photo shop told me it was a "Fuji Slide Box." It is

## Mad Blaster PARTS LIST

- \* C1, C2 - .01 mF disk capacitor
- \* IC - 4011 CMOS quad two-input NAND gate
- \* R1 - 4.7 megohm 1/4-watt carbon resistor
- \* R2 - 1 megohm 1/4-watt carbon resistor
- \* R3, R4 - 100 Kohm 1/4-watt carbon resistor
- \* Q1 - 2N3904 NPN silicon transistor or equivalent. See text.
- \* Q2 - SK-3996 or NTE253 or ECG253 NPN Darlington power amplifier transistor or equivalent. See text.

Optional required: Battery or power supply, speaker capable of handling up to 15 watts.

Optional not required: \* Printed circuit board, 100K volume control, power switch, warble/tone switch, key jack, 14-pin IC socket, case, Q2 heatsink, external telegraph-type key, hook-up wire, and solder.

All the parts above marked with an asterisk (\*), including an etched, drilled, and silk-screened circuit board, are available as the MB-1 "Warble Alarm" from Ramsey Electronics, Inc., 793 Canning Parkway, Victor, NY 14564. Price is \$4.95, plus \$4.95 shipping per order, and \$3.00 for orders totaling less than \$19.50. Call 1-800-446-2295 to order, or for a copy of Ramsey's 8-1/2 x 11-inch 40-page color catalog full of kit projects and assembled items.



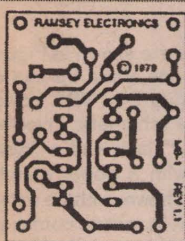


Figure 6: Mad Blaster Printed Circuit Layout Etched Side

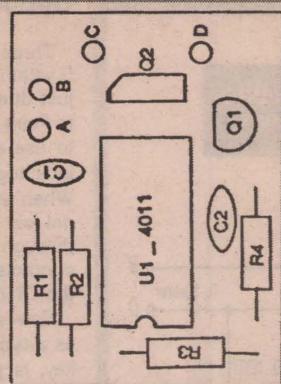


Figure 7: Mad Blaster Parts Layout

black, has a hinged snap-down cover, is made from thin plastic, and is rectangular in shape. The outside dimensions are 4.6" by 2.2" by 1.2".

Inside, with the exception of four .25" ridges that extend inside the slide box near its center, there is plenty of room for a small circuit board and one or two nine-volt transistor radio batteries. Since the plastic is so thin, it is easily cut with a sharp knife or drill to allow placement of jacks and switches.

Where do you get these boxes? I had the photo shop order some for me at 35 cents each! (Actually, Fuji only charges 25 cents each, but they won't sell to individuals, and the photo shop has the right to charge a mark-up.)

the 2N3904 or 2N2222 variety. Transistor Q2 must be a silicon power Darlington type with a gain of about 2000. You must also be sure of the lead identification of both transistors, since this circuit (as shown in Figure 5) requires the collectors of both transistors be joined together, and that the emitter of Q1 is directly connected to the base of Q2.

The power output of Q2 generates considerable heat if operation is prolonged. Unless your application only calls for very brief bursts of sound, some sort of heatsinking for Q2 may

If you order the kit, you'll get the printed circuit board and all the basic parts. You'll have to add your own switches and jacks.

If you are building from scratch, you must be sure you have NPN transistors for Q1 and Q2. You must also be sure Q1 is a general-purpose silicon transistor of

be needed. Typically, this transistor's mounting hole makes it easy to attach a small piece of aluminum or copper—but be aware that the exposed metal part of the transistor is common to the collector, so you don't want to neatly attach your heatsink to the ground side of the circuit!

## Assembly

Once you've decided what parts and options you'll use, and how you will package the project, the construction is relatively straightforward. I recommend you use a socket for the IC, and make sure pin 1 (the notch end) is properly oriented and seated in the socket. Be very careful that the transistors are not installed "backwards." (Note: This may be different from Figure 7 if you don't use the kit transistors!)

If you elect to use the options shown, place the various jacks and switches in convenient locations. The photos show where I placed mine.

## Testing and Troubleshooting

The speaker is connected between points B and D as shown in Figure 5. When you select a speaker to use with the Mad Blaster, be sure it can handle the maximum allowable power—about 15 watts. Typically, this will be a public address or paging horn-type speaker, or an automobile horn.

If you use the optional volume control you can, of course, use a smaller speaker, such as a standard four-inch or larger utility speaker. The speaker impedance should ideally be 8-ohms, although 4-ohm to 40-ohm speakers should also work.

For power, a 12-volt automobile battery will do well. If you're using a power supply, make sure it can deliver very low-ripple 12 volts DC up to one ampere. Most wall-plug transformers have too much ripple and too low a current capability, so they are not adequate for this application. If you wish to use batteries, use eight C or D cells in series.

Connect the speaker and power and hold your ears! If the Mad Blaster has a volume control, be sure it is not turned below the audible range. If you don't hear anything after turning up the volume, use a voltmeter to check the power voltage.

Still does not work? Be sure the integrated circuit is not installed backwards, and that the two transistors are wired together as shown in the schematic.

If the 4011 IC is working properly, you can hear it through a separate test amplifier connected to the base of Q1. The sound should be stronger at the base of Q2. If it isn't, Q1 is suspect. If it is stronger at the base of Q2, but the speaker is still silent, then Q2 is the problem.

## Reasonable Use

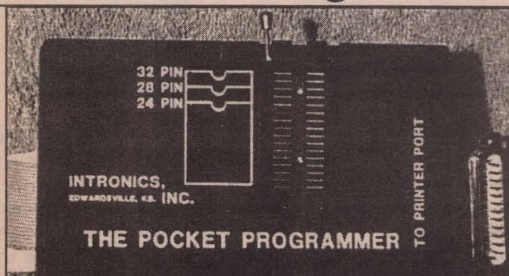
The Mad Blaster is useful as an alarm sounder, as a noise maker for parties, as an ear-catching attention-getter for science fair demonstrations, for safety warnings, and as an auditorium-level code practice oscillator.

However, common sense should be exercised with the realization that unexpected and frightening sounds can be an annoyance or a real hazard to the health of some elderly, otherwise infirmed, or sleeping people. **NV**

Table 1. Test Data on Transformer Rated 120V to 12.6V @ 1.2A, 60 Hz

	V1 (volts)	I (amps)	P (watts)	V2 (volts)
Open Circuit Test	120	0.048	2.30	14.4
Short Circuit Test	13.83	0.126	1.63	0

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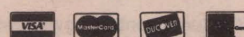


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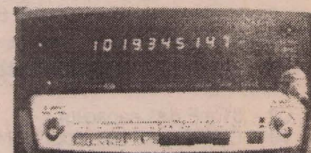
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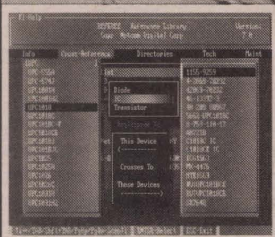
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# Optical Sensors — and Some Books

This month, we are going to look at some electro-optical sensors and a couple books that I find very interesting and suspect you will also.

## Electro-Optical Sensors

There are a number of different types of light sensors on the market: photoresistors, photovoltaic cells, and photodiodes or phototransistors are among the most common. This month, we will look at a type of sensor that builds a photodiode or transistor into a package with an operational amplifier. You may recall that I used two such sensors in the experiment I performed for my column on sensor-resolution improvement. The sensors were Burr-Brown devices, and were spaced such that the center of their fields of regard were one centimeter apart.

Figure 1 shows several different package styles for electro-optical sensors. Figures 1A and 1B are eight-pin miniDIP integrated circuit packages. The version in Figure 1A is the standard black or dark gray package, but with a clear window over the die containing the photodiode and op-amp circuitry. In Figure 1B, a different tactic is used. In this type of sensor, the entire body of the IC is made from clear plastic. The variant shown in Figure 1C is a side-mounting type. The five pins needed for connection of the amplifier come out the side of the package. The package itself is approximately the size of the eight-pin miniDIP package.

This "sideways" design solves some practical mounting problems sometimes encountered in electro-optical sensor projects. The final form of the package (Figure 1D) is a standard TO-5 transistor or TO-39 IC metal can, but with the top removed and replaced with either a clear glass window, to admit light, or a lens. The package is handled in the same manner as any other TO-

5/TO-39 package.

In some cases, electro-optical IC sensors will include a filter as part of the light window to admit some wavelengths and reject others. Forrest Mims used a special electro-optic IC sensor that has an ultraviolet filter incorporated into the window of the sensor in his famous UV detector. It was detailed in *Science Probel* magazine. Other projects using this type of sensor were published in *Scientific American* when Forrest was the editor of the *Amateur Scientist* column.

Although there are a number of different sensor circuits, Figure 2 is sufficiently representative to cover the class. This circuit is derived from the internal circuitry of the Burr-Brown OPT202 product. The OPT202 includes a photodiode and transimpedance amplifier in an IC package (Figures 1A, 1B, and 1C are available for the OPT202 device).

Like most sensors of this class, the peak response is in the near-infrared (IR) region, around wavelengths of 750 nanometers (nm). Other models also peak in the IR region, but at slightly different wavelengths. Significant output can be obtained at wavelengths as long as 1,000 nm, or as short as 350 nm (in the UV range). If the peak response output of the sensor is 500 mV/μW, then "significant output" at the ends is defined (by me) as 100 mV/μW. Some response with lower output levels is also available.

If you need an ultraviolet sensor, then the Burr-Brown OPT301 device may suit your needs. It has a double-humped spectral response. One peak is about 750 nm in the infrared region, and the other peak is at 300 nm in the ultraviolet region.

The response shown in the data sheet for the IR peak is 500 mV/μW, while for the UV it is about 180 mV/μW or so. The response between peaks, at least over about 450 nm to 650 nm (visible light), shows excellent linearity.

Figure 3 shows the basic connection for the device. The feedback terminal (pin 4) and the output terminal (pin 5) are strapped together, and the ground terminal (pin 8) is, well, grounded. The DC power supply is bipolar, with a voltage range of ±2.25 to ±18 volts DC. The output of the sensor is  $V_o = I_o R_f$ , where  $I_o$  is the current in the photodiode and  $R_f$  is the 1 megohm internal resistor.

If an external resistance is used in series with the feedback path (i.e., connected between pins 4 and

# Open Channel

by Joseph J. Carr  
K4IPV

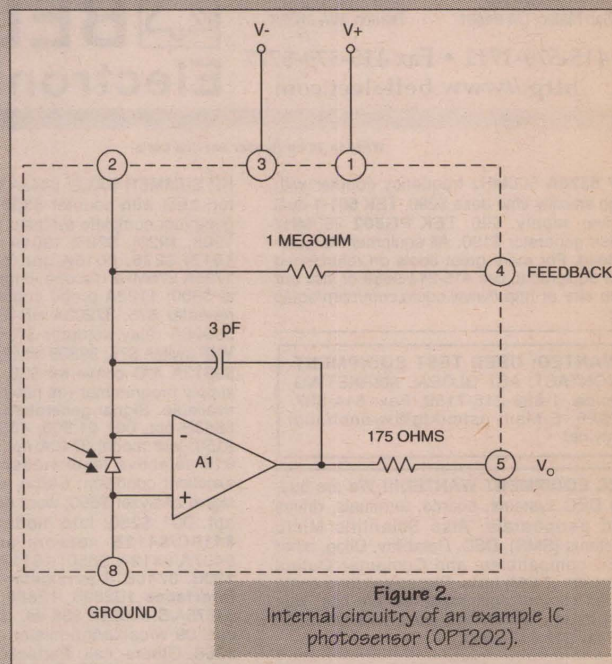


Figure 2.  
Internal circuitry of an example IC  
photosensor (OPT202).

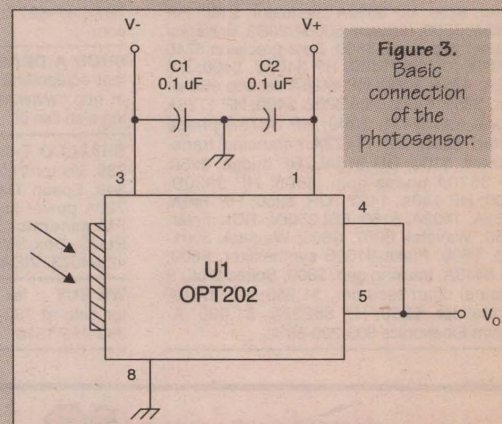


Figure 3.  
Basic  
connection  
of the  
photosensor.

5 as shown in Figure 4A), then the total value of  $R_f$  is  $R_{EXT} + 1$  megohm. Similarly, if the external resistor is connected in parallel with the internal resistor (Figure 4B), then the total value of  $R_f$  is the parallel combination:

$$R_f = \frac{R_{EXT} \times 1 \text{ megohm}}{R_{EXT} + 1 \text{ megohm}}$$

In Figure 4, the DC power supply connections are deleted for sake of simplicity. If  $R_{EXT}$  is 1 megohm or higher, or  $\leq 100K$ , then no external shunting capacitor is needed, otherwise use 2 pF.

A higher-gain circuit is shown in Figure 5. The feedback signal is provided by a voltage

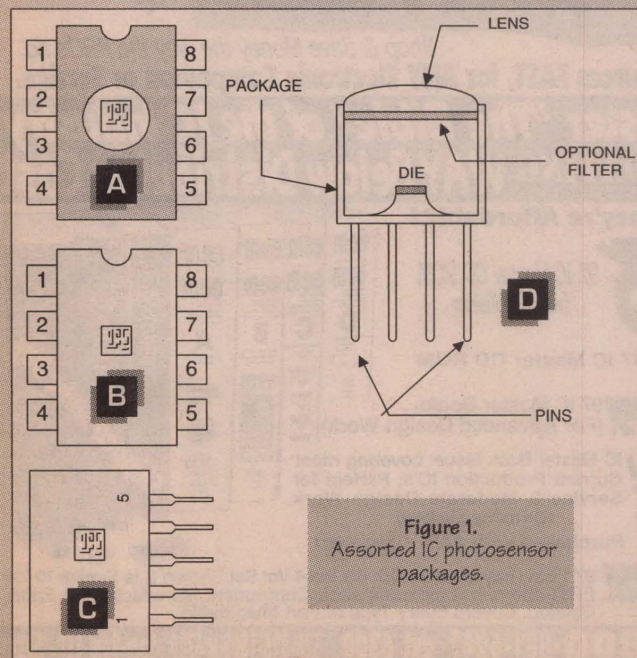


Figure 1.  
Assorted IC photosensor  
packages.



# Open Channel

frequency, so does not affect the output voltage. For other cut-off frequencies:

$$F_{-3dB} = \frac{R1}{2\pi R2 R3 C2}$$

Where: F is the frequency in hertz (Hz); R1, R2, and R3 are in ohms; C2 is in farads.

## Differential Light Measurement

A differential light measurement circuit is shown in Figure 7. In this case, the entire circuitry of U1 is used in the normal manner. The output terminal (pin 5) and the feedback terminal (pin 4) are strapped together in the manner of Figure 3. The only part of U2 that is used is the photodiode. It is connected in series with the photodiode of U1 in a manner that the overall current produced by the pair is the difference of the currents in the two diodes. Hence, the overall output voltage is proportional to the difference in light intensities applied to the two sensors.

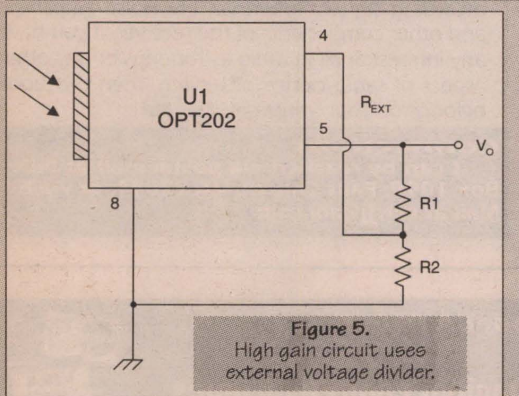
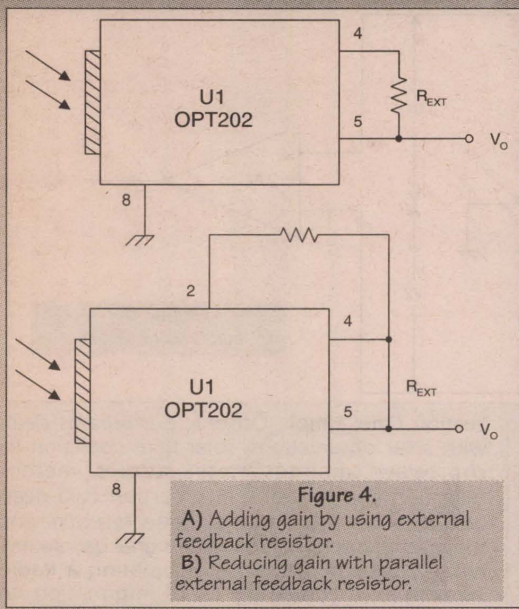
Differential light sensors can be used in circuits such as sun position finders. Another one of Forrest Mims circuits was a sun finder that one could use to position solar arrays for optimum performance over the course of the day. Another use for differential light measurement is in scientific and medical instruments called photometers or colorimeters, depending on use.

Colorimeters can be used to make comparisons between a sample being measured and either the straight light source or a specialized filter. A basic circuit is shown in Figure 8. Two photocells (PC1 and PC2) are positioned to see the same light source. Sensor PC1 is positioned so that it looks either directly into the calibrated light source, or through an optional filter. Sensor PC2 sees light that passes through a sample. The idea is to compare how much light is transmitted through the sample compared to some standard. There are several examples of basic colorimeter/photometer instruments, two being: a blood O2 analyzer and a CO2 analyzer.

Blood oxygen analyzers depend on the fact that the absorption of light and infrared is different between oxygenated and deoxygenated blood. The deoxygenated venous blood passes IR wavelengths longer than about 800 nm, while oxygenated arterial blood passes wavelength above 800 nm. The crossover point, 800 nm, is called the isobestic point.

By comparing the IR passed by blood to the IR passed by an isobestic filter, we can infer the oxygen content of the blood. In that type of instrument, a red filter is placed in front of PC1, and a sample of blood is placed in front of PC2. The differential voltage (V1-V2) is proportional to the oxygen content of blood (although the specific levels must be calibrated).

Carbon dioxide (CO2) levels are also measured using IR and a pair of photocells. In that case, sensor PC1 can look directly into the IR "light" source, while a gas cuvette carrying the gas sample passes in front of PC2. In most instruments, a dummy cuvette is placed in front of PC1 in order to mimic whatever IR absorption occurs in the glass of the sample cuvette. The differential voltage is proportional to the CO2 content of the sample compared to air. Calibration is usually accomplished using a calibrated gas cylinder. For medical purposes, the



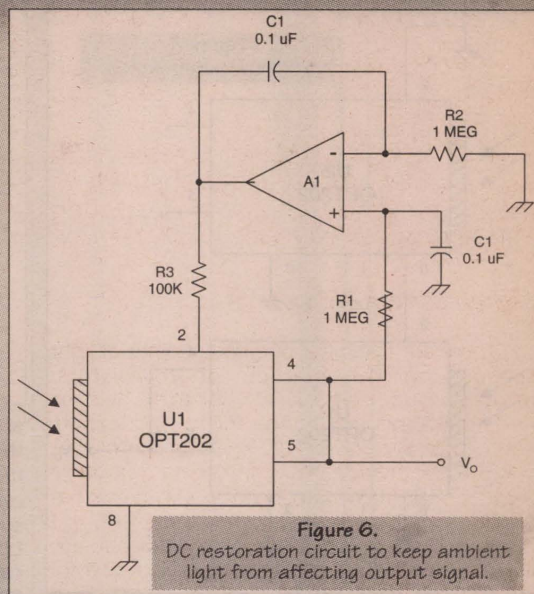
divider consisting of resistors R1 and R2. This type of circuit is sometimes called a "super-gain" circuit in operational amplifier books. The value of the output voltage,  $V_o$ , is:

$$V_o = \frac{(R1 + R2) I_D R_F}{R2}$$

On the down side, this circuit also increases the offset voltage error and the noise contribution of the sensor. These problems are largely due to the gain. However — on the plus side — in many applications, further amplification is not needed. Also, printed circuit board leakage (which can be a problem in any circuit where high value resistors are used) is minimized. It is possible to obtain the required gain with series-connected external resistors (as in Figure 4A), but this circuit uses lower value resistors to achieve the same end.

One of the problems with any light sensor circuit is that we often are looking for light changes, or small point variations in a larger ambient light field. What is needed in those cases is the ability to remove the effect of ambient light on the overall output voltage. Figure 6 shows a method for doing that job. This circuit uses the feedback principle to adapt the circuit to ambient light, and is called a DC restoration circuit.

The operational amplifier (A1) in the feedback path between pins 2 and 4 is a Miller integrator. This circuit acts like a high-pass filter with a 16 Hz cut-off frequency. As a result, slowly changing or steady state light is below the cut-off



gas is usually set to 95% nitrogen and 5% CO2.

## Digital Signal Processing Book

One of the arcana of electronics is digital signal processing. It is one of those obscure areas whose practitioners often look like a specious of sacerdotal priesthood to we lesser mortals. Basically, digital signal processing is the use of the computer to process signals. A filter, for example, can be made using inductors, capacitors, resistors, and (sometimes) op-amps. But the same job can also be done in software. Another example of digital signal processing is to find the Fourier spectrum (FFT or DFT) of a signal, or perform convolution and a number of other tasks.

Until now, digital signal processing has required at least a high-powered education in mathematics, if not an engineering degree. I've seen books on digital signal processing that you could use for weight-lifting. Fortunately, a very practical approach to the subject, which explains the math rather than ignoring it, is a remarkable 203-page book called *Digital Signal Processing Demystified* by James D. Broesch (**HighText Publications**, P.O. Box 1489, Solana Beach, CA 92075; **1-800-247-6553**; \$49.95 in USA).

The book comes with a CD-ROM that contains Windows software (DSP Calculator) which allows you to experiment with some of the concepts in the book, and is good enough for professional use. The programs available are: Complex Generator, Convolve, DFT, FFT, Filter Design, Fourier, Function Generator, Imaginary Display, and Real Display.

The language of the book is down-to-earth-easy-to-understand plain talk. Broesch does not slight his subject by this conversational tone, but he does make the subject accessible. And, speaking of accessibility, DSP requires knowledge of calculus, but not to fear — the relevant concepts are explained. Although people trained in calculus will find the book easier to understand, people with the usual high school algebra and trigonometry will find the material accessible.

If you are the type of person who likes to learn new things on your own, then you will appreciate the Interactive Exercises in the book. They allow you, the book, and the software to



# Open Channel

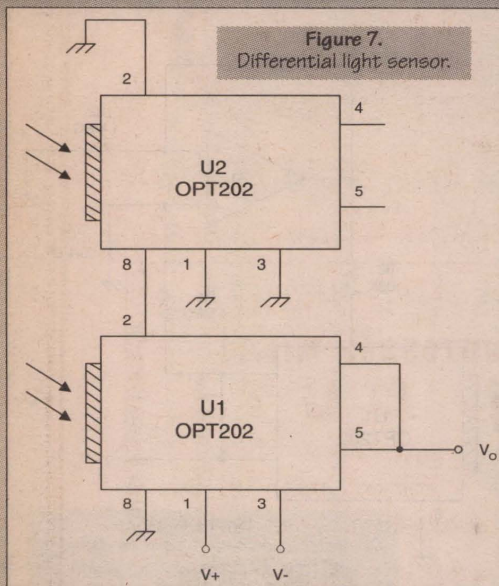


Figure 7.  
Differential light sensor.

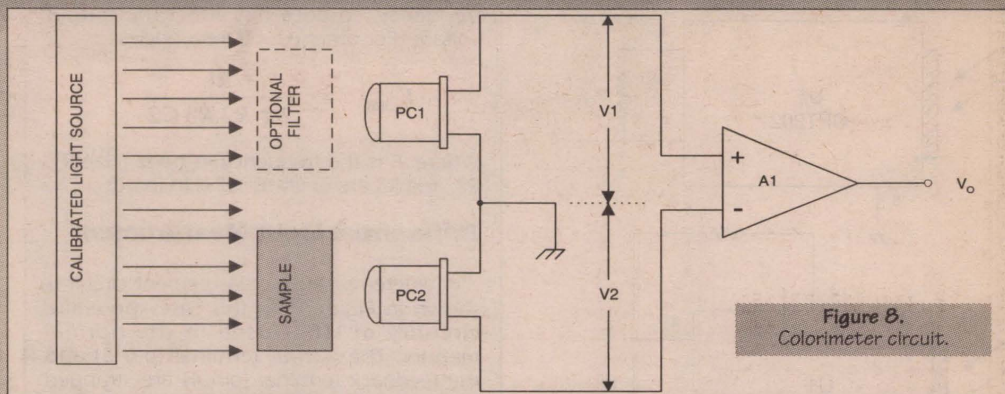


Figure 8.  
Colorimeter circuit.

explore the concepts ... almost as if James Broesch was standing over your shoulder.

## Radio Astronomy Products

If you read this column regularly, then you know that one of my passions is radio astronomy and related activities (e.g., "whistler" hunting, SID hunting, etc.). I coined the term "RadioScience Observing" to cover all of these various activities,

and am writing a book for Howard W. Sams on the subject. When I was surfing the Internet for material on my topic, I came across a rather remarkable publisher which specializes in this subject. **Radio-Sky Publishing** (P.O. Box 3552, Louisville, KY 40201-3552; E-Mail [radiosky@radiosky.win.net](mailto:radiosky@radiosky.win.net); web site <http://www.win.net/~radiosky>). In this column, and in future columns, we will take a look at several products of this company.

This month, I want to mention a book that I find misnamed: *The Radio Astronomy Teacher's Notebook*, edited by Jim Sky. Although the book lives up to its name, the material in it is of interest to a far wider audience than teachers. It contains a large number of practical projects that can be built by most readers of this column.

The book is divided into three sections.

Section One: Simple Observing Programs deals with solar observations, solar flare detection by shortwave, magnetometer studies, meteor reflection and related topics. Section Two deals with technical issues such as noise, receivers, and the mechanism of natural radio signal generation. Finally, Section Three is "Assembling a Radio Telescope." It contains a lot of information on recording signals, antennas, low-noise amplifiers, and other components of the receiver. If you have any interest at all in radio astronomy, or any other aspect of radioscience observing, then this book belongs on your "must get" list. **NW**

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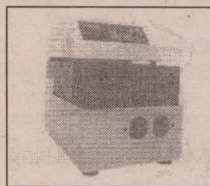
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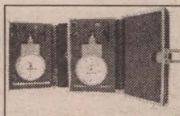
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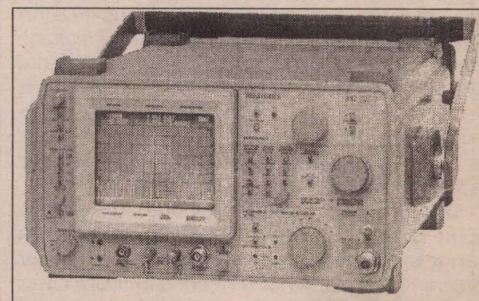
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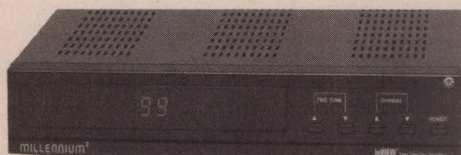
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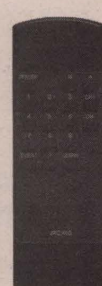
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# Electronic Stethoscope

## Find That Noise!

I built the electronic stethoscope to help find a noise in my car. It is hard to find such noises without some type of listening aid. I have also used it to find noises in moving parts of electronic and other equipment. Another use, that I did not think of when building it, is checking the operation of speaker systems.

Historically, the first listening aid (for automobiles) was an acoustic stethoscope, similar to a medical acoustic stethoscope except for the sound pickup (actually a vibration pickup). A metal probe connected to a diaphragm is used. The back of the diaphragm is enclosed, and flexible tubes connect it to metal earpieces. The probe is placed in contact with suspected sources of noise, and vibrations conducted by the probe to the diaphragm are converted into sound waves which travel through the tubes to the earpieces.

An electronic stethoscope can be a considerable improvement over an acoustic stethoscope. It is more sensitive, has better frequency response, and has a volume control to reduce the level when the noise is loud.

Several electronic units are sold by automobile parts and equipment suppliers, and several construction articles have been published in electronics publications.

In these units, the noise is picked up by a probe, then amplified and sent to headphones. Most of them use a small microphone element in the probe which picks up sounds from the air; a few use a vibration probe.

With a microphone, the probe does not have to contact the noise source. As it is brought near the source of noise, the sound in the headphones gets louder. For some noises, a microphone

probe is better. For others — for example, a noisy alternator bearing — a vibration probe is better.

When I needed to find a noise in my car, I looked at several published stethoscope circuits. Most of them used several parts or required high-impedance headphones. Some required a split power supply. I had recently built some circuits using the LM386 power amplifier IC, and I decided a simpler, better stethoscope could be built using it.

My circuit uses a single LM386 and a few other parts, operates from a single nine-volt battery, and drives standard stereo headphones with more than adequate volume. Not only are stereo headphones easier to find (most of us have some extras lying around), their wide frequency response gives better reproduction of low-frequency noises than most high-impedance headphones.

In some published stethoscope circuits, stereo headphones are used, but the headphone units are connected in series to increase their impedance for adequate volume.

A series connection drives the headphones out of phase, which may produce an odd sound. The electronic stethoscope has more than adequate power and gain with the headphones connected in parallel (producing more natural in-phase sound from the headphone units).

Several stereo headphones were tried, all of them provided higher volume than is needed. Both types of probes — a microphone probe and a vibration probe — are included, for use with different types of noises.

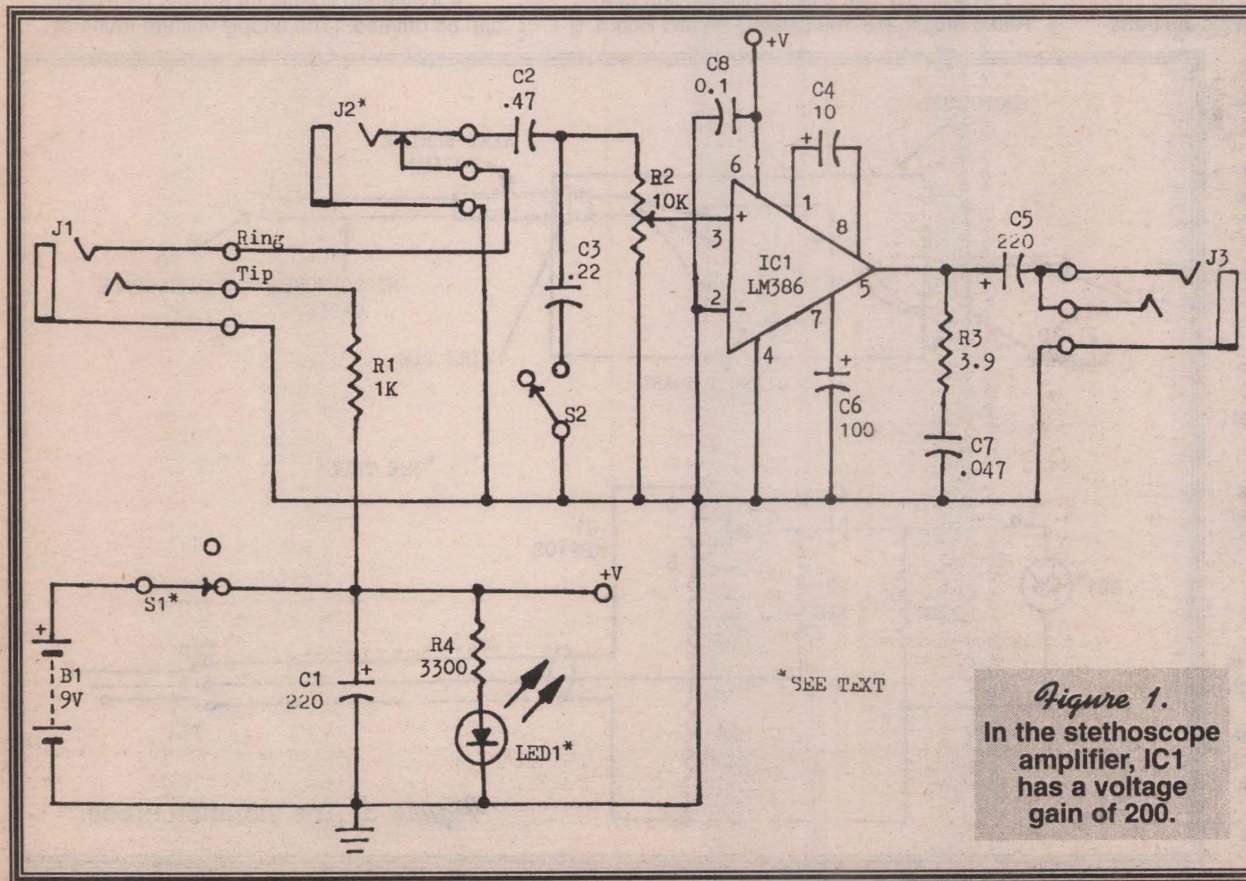
### Circuit Description

The LM386 power-amplifier IC is used in the electronic stethoscope. A number of circuits have

been published using the LM386, one of the most useful, readily available guides is the LM386 data sheet in Radio Shack's *Semiconductor Reference Guide*.

In the electronic stethoscope circuit (shown in Figure 1), the LM386 operates at its maximum voltage gain of about 200; R2 is the volume control. (In circuits using the LM386, if C4 is omitted, the gain is about 20 and bypass capacitor C6 is not needed. Intermediate gains can be obtained by connecting a resistor in series with C4; 1200 ohms gives a gain of about 50.)

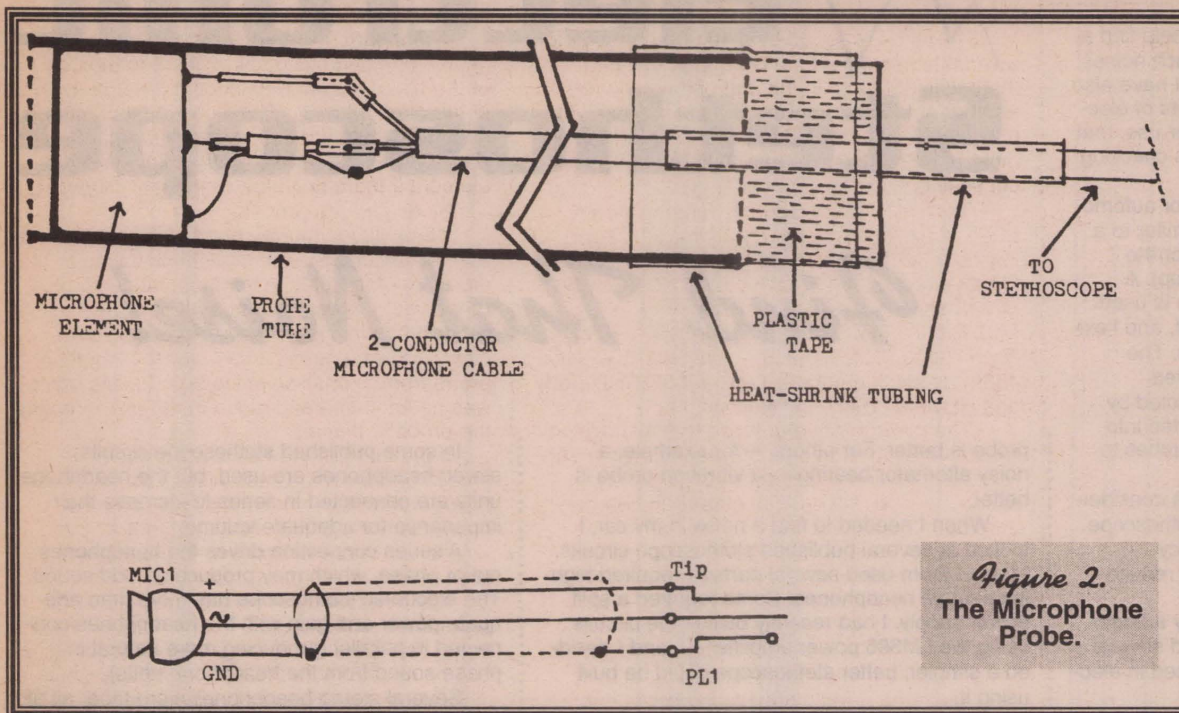
R3 and C7 improve high-frequency stability of the amplifier. In building several different circuits using the LM386, power supply bypass capacitor C8 has been very important in assuring a stable amplifier. It should be located close to IC1 (within one or two inches on the board). Some published circuits for the LM386 do not use it, but one circuit I built was very unstable until it was added.



\* SEE TEXT

**Figure 1.**  
In the stethoscope amplifier, IC1 has a voltage gain of 200.





*Figure 2.*  
**The Microphone Probe.**

Battery operation is possible because the quiescent current of IC1 is about 5 mA. For low battery drain, LED1 — the pilot light — is a low-current type, which draws only 2 to 2.5 mA. C3 and S2 form a treble-cut tone control, useful when looking for a low-frequency noise. The microphone element in the microphone probe (Figure 2) is connected directly to the input of the amplifier.

A piezo element is used as a pickup transducer in the vibration probe (Figure 3). When used as a sound source, a piezo element cannot produce low frequencies, because of the small size and stiffness of the vibrating element. However, when used as a pickup, it has a fairly good low-frequency response. (Similarly, the small diaphragm of the microphone could not produce low frequencies, but it is effective in picking up low frequencies.)

Because of its effective internal series capacitance of 0.025 uF, the piezo element (BZ1) must be connected to a circuit with a high input impedance for good low-frequency response. If it was connected directly to the amplifier input, the 10,000 ohm resistance of R2 would cause the low frequency response to roll off at 6 dB per octave below about 640 Hz.

In the circuit in Figure 3, Q1 is used as a source follower. Its high input impedance eliminates low-frequency roll off; its gain is slightly less than one. The output of the vibration probe is still higher than the output of the microphone probe; R3 and R4 form a voltage divider to reduce the output.

The impedance matching circuit of Figure 3 is located in the probe to eliminate noise pickup in the shielded cable. (High-impedance cables pick up noise unless they are very well shielded, and there is lots of noise around a car engine!)

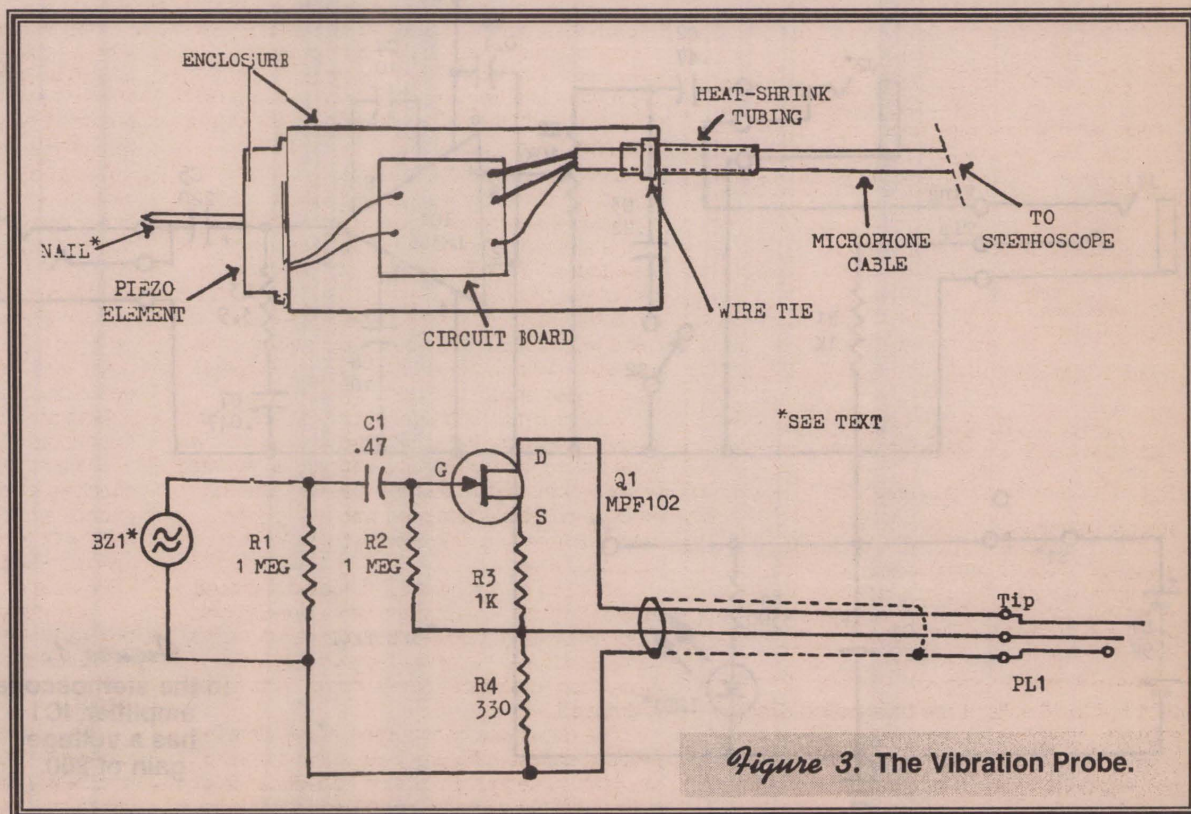
### Construction

The circuit was built on one section of a Radio Shack 276-159 Dual IC Project Board. (I

enough to fit in the end of the case.

I used a regular (1/4") jack for J3, both to make it different from J1 and to allow large headphones to be used, since most large headphones have a 1/4" plug. (An adapter is used for headphones with a 1/8" plug.) R1 was added to prevent shorting B1 if headphones are accidentally plugged into J1.

If a different connector is used for J1, R1 can be omitted. (The supply voltage rating of



*Figure 3.*  
**The Vibration Probe.**



## AMPLIFIER PARTS LIST (Figure 1)

### SEMICONDUCTORS

IC1 - LM386 audio amplifier, integrated circuit  
LED1 - Low-current LED (see text)

### RESISTORS (1/4-watt, 5% or 10%)

R1 - 1,000 ohm  
R2 - 10,000 ohm audio taper panel-mount potentiometer, with switch (Radio Shack 271-215 or similar)  
R3 - 3.9 ohm  
R4 - 3,300 ohm

### CAPACITORS

C1, C5 - 220 uF, 16 WVDC, electrolytic  
C2 - 0.47 uF, ceramic disc or Mylar  
C3 - 0.22 uF, ceramic disc or Mylar  
C4 - 10 uF, 16 WVDC, electrolytic  
C6 - 100 uF, 16 WVDC, electrolytic  
C7 - 0.047 uF, ceramic disc or Mylar  
C8 - 0.1 uF, ceramic disc or Mylar

### OTHER COMPONENTS

J1 - Miniature (1/8") stereo phone jack (see text)  
J2 - Closed circuit mono phone jack (optional, see text)  
J3 - 1/4" stereo phone jack (see text)  
S1 - Power switch (part of R2)  
S2 - SPST miniature slide or toggle switch  
B1 - Nine-volt alkaline battery

### MISCELLANEOUS

Enclosure (see text), circuit board (Radio Shack 276-159 or similar, see text), stereo headphones, nine-volt battery snap with leads, knob, wire, solder, hardware, etc.

## MICROPHONE PROBE PARTS LIST (Figure 2)

MIC1 - Electret microphone element (Radio Shack 270-092 or similar)  
PL1 - 1/8" stereo phone plug (see text)  
Small two-conductor shielded cable (Radio Shack 278-514 or similar), "faucet supply tube" or 3/8" ID tubing (metal or plastic, see text), heatshrink tubing, plastic electrical tape, wire, solder, etc.

## VIBRATION PROBE PARTS LIST (Figure 3)

### RESISTORS (1/4-watt, 5% or 10%)

R1, R2 - 1 megohm  
R3 - 1,000 ohm  
R4 - 330 ohm

### OTHER COMPONENTS

Q1 - MPF102 or similar JFET  
C1 - 0.47 uF, ceramic disc or Mylar capacitor  
BZ1 - Encased piezo element (Radio Shack 273-073 or similar)  
PL1 - 1/8" stereo phone plug (see text)

### MISCELLANEOUS

Enclosure (Radio Shack 270-220 or similar), small two-conductor shielded cable (Radio Shack 278-514 or similar), four-penny (1-1/2") nail, small perforated board, heatshrink tubing, small wire tie, wire, solder, etc.

MIC1 is 4 to 10 volts; it can be supplied directly by B1.)

J2 was added to allow the amplifier to be used separately — such as an audio signal tracer — when needed. It was mounted on the side of

the case, as there was not room on the end.

S2 can be replaced by a 10,000-ohm pot, for a variable treble-cut tone control. In my unit, there was not room in the end of the case for another pot (S2 is smaller). If a pot is used, you may want to change C3 to 0.47 uF or larger, for more high-frequency reduction at the maximum cut setting.

There are several sources for low-current LED1 (2 to 2.5 mA) used for a pilot light. A red low-current LED is sold by Radio Shack (stock number 276-044). QT Optoelectronics low-current LEDs are available from Digi-Key Corp. (701 Brooks Ave. South, P.O. Box 677, Thief River Falls, MN 56701-0677, phone 1-800-344-4539) as stock number HLMP-4700QT-ND (red) and HLMP-4719QT-ND (yellow).

(The current rating of these is not shown in recent Digi-Key catalogs, but was shown in earlier catalogs, and I used these LEDs in my stethoscope and in several other battery-powered projects.)

Hewlett Packard No. HLMP-4700 (red) is available from Hosfelt Electronics, Inc. (2700 Sunset Blvd., Steubenville, OH 43952, phone 1-800-524-6464), as stock number 25-325. Other low-current LEDs, available from various distributors, include those manufactured by Lumex Optoelectronics, Inc., Industrial Devices, Inc., Chicago Miniature Lamps, and Linrose Electronics, Inc.

I built the microphone probe in a metal "faucet supply tube" (used in plumbing). This has an outside diameter of 3/8", expanded to about 1/2" at the end which attaches to the faucet. The expanded end, which is partially closed, was drilled out to 3/8" diameter to fit MIC1. The tube is longer than needed for the probe, and can be cut to a suitable length (about 4" to 6").

A plastic faucet supply tube is also available (it probably could be used), as well as a higher-priced "flexible" metal tube, which probably would not work as a probe housing.

If you have trouble finding a faucet supply tube, a straight metal or plastic tube, 3/8" inside diameter, can be used.

Construction of the probe using a straight tube is shown in Figure 2. The shielded cable is spliced to the short cable attached to the microphone element. Then the microphone element is mounted, with a small amount of glue, near the end of the probe tube.

Strain relief must be provided where the cable leaves the probe, to prevent pulling on the microphone or on the splices. The strain relief I used is also shown in Figure 2.

First, a 2-1/2" to 3" length of heatshrink tubing is placed over the cable (this is easier if it is done before the microphone element is mounted in the probe). Then, after the element is in the probe, the cable is wrapped with 3/4" plastic electrical tape to a diameter just smaller than the probe tube.

About 2" of 1/2" heatshrink tubing is placed over the plastic tape and the probe tube to hold them together. (If desired, the heatshrink tubing can extend over the entire length of a metal probe tube to protect against shorts if the probe is dropped.)

The circuit and construction of the vibration probe is shown in Figure 3. An encased piezo element is used as a vibration transducer. It is fastened to the end of a small project box with

plastic glue or Super Glue™.

A standard four-penny (1-1/2") nail is used as the vibration pickup. It is glued to the center of the piezo element, extending through the hole in the element case. The glue would be strong enough to hold the nail to the element, but not so strong as to tear the metal coating on the element if there is a blow to the nail. Super Glue or epoxy glue are probably best.

The nail, next to the head, was built-up with 3/4" electrical tape and heatshrink tubing to the diameter of the hole in the element case, to (hopefully) protect against a blow to the nail. (After the nail in my unit was loosened by a blow, I made a carrying case for the vibration probe from a small shipping box. Plastic foam was cut to shape and glued in the box to hold the probe in place.)

If the head of the nail is not smooth, it should be smoothed with a file. If the nail head is larger than the hole in the piezo element case, the edge of the head can be filed to a smaller diameter, or the hole in the element case enlarged (very carefully).

The impedance matching circuit (Q1 and associated parts) was built on a small perforated board and mounted in the probe enclosure. Q1 can be an MPF102, 2N3819, or similar small JFET. Note that the gate is lead 3 on a MPF102, and lead 2 on a 2N3819.

On these and many other small JFETs, the source and drain are interchangeable. To provide strain relief, a length of heatshrink tubing (about 2") was placed on the probe cable where it leaves the enclosure. Then a wire tie was tightened over the heatshrink tubing inside the enclosure until the tie would not slide on the cable (see Figure 3).

## Testing and Operation

Connect the microphone probe and turn on the amplifier. At higher volume settings, sound should be heard in the headphones if the probe is near any source of sound. There may be a feedback howl if the probe is brought close to the headphones.

To use the stethoscope, bring the probe close to suspected sources of noise. The sound in the headphones will get louder as the microphone probe is brought closer to the noise source. If you have trouble locating the source, switch to the vibration probe.

For example, a noisy alternator bearing produced similar noise levels with the microphone probe when the probe was near any part of the alternator. But when touching both ends of the alternator with the vibration probe, the end with the bad bearing was noticeably louder.

The microphone probe can also be used for checking stereo speakers. Good quality headphones should be used, preferably large-size units with a cushion which reduces external sounds. Hold the probe a few inches in front of each tweeter, mid-range, and woofer unit.

Any noise, distortion, weak sound, etc., can be heard in the headphones when the probe is in front of the defective unit. If in doubt, compare with the sound from the speaker for the other channel.

You can also do a rough check of the dispersion angle of a tweeter by holding the probe at different angles and positions in front of the tweeter. **NV**



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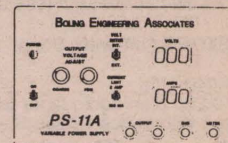
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Dozens of PCB's described - many circuits. Plus Call Forwarding, Phreak History, Conferencing, Glossary, Diverters, Extenders, Loops, REMOBS, Bridging Heads & Cans, Optocom, 3rd Party and many other non-box methods - more! \$29.

## HACKING \$29 ANSWERING MACHINES

All the known ways answering machines are hacked to listen to - even erase - messages, and to convert them into mini-VMBs. Plus countermeasures - protect yourself from hackers, thieves! \$19.

## PHREAKING \$29 CALLER ID & ANI

Details on how they work and dozens of effective ways of defeating Caller ID, ANI, \*69, \*57, Call Blocking, \*67 etc. Also describes Caller ID, Orange, Beige, Cheese & CF Boxes, ESS, SS7, E-911, various Class services, CN/A, Non Pub DA, CAMA, DNR, 800-ECR, Diverters, LD Extenders, Centrex - much more! \$19.

## BEYOND VAN ECK \$29 PHREAKING

Eavesdropping on TV and computer video signals using an ordinary TV described in detail. Includes security industry reports. Range up to 1 KM. Plans include both the Consumertronics and the original Top Secret Van Eck designs! \$29.

## THE \$29 HACKER FILES

Compilation of 100s of the best eye-popping articles written by top hackers & phreakers. ASCII text. Covers every major topic in hackerdom! Comes on 3 HD PC Disks! \$39.

## HACKING \$29 THE INTERNET

The absolute latest tricks and methods being used on the Net to pirate software (warez) and the latest, coolest hacking websites. Updated every two months, so you know its fresh. Includes examples, countermeasures, password defeats, and lots of tips! \$24.

## BY AN ORDER \$29 OF THE MAGNITUDE

The most comprehensive, hard-hitting, hi-tech survival book ever written! Topics include electronic, computer, cryptography, chemistry, weaponry, comomo, energy, concealment, revenge, alarm, disguise & ID change. Field-expedient use of technology in various threat and conflict environments. More! \$49.

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How to lie, cheat, steal, influence, and intimidate your way to success! Underpaid? Overworked? Harassed? Manipulated? Forget job performance. This exposes and outlines what it really takes to make it to the top in today's corporate BS world! \$15.

## STOPPING \$29 POWER METERS

As reported on "60 MINUTES!" How devices can slow down (even stop) watt-hour meters - while loads draw full power! Device plugs into one outlet and normal loads into other outlets. Describes meter creep, overload droop, etc. **Plans only!**

**THE I.G. MANUAL:** External magnetic ways (applied to meter) to slow down and stop power meters while drawing full loads. **Plans \$25.**

**KW-HR METERS:** How watt-hour meters work, calibration, error modes (many), ANSI Standards, etc. **Demand and Polyphase Meters.** Experimental results to slow and stop meters by others. **\$25.**

**Special! All 3 (above), Only \$59!**

## COMPUTER \$39 PHREAKING

Describes in detail how computers penetrate each other, and how VIRUSES, TROJAN HORSES, WORMS, etc are implemented. Dozens of computer crime and abuse methods and countermeasures. Includes disk filled with hacker text files and utilities, and the legendary FLUSHOT+ protection system (Ed. Choice, PC Magazine). Internet advice, password defeats, glossary - much more! **Manual + PC Disk!**

## INTERNET \$19 CONS & SCAMS

Net cons and related frauds rake in \$2+ Billion annually! Most are done with little fear of prosecution. This manual details most, and countermeasures.

## INTERNET \$29 TRACKING & TRACING

The Internet is infected with spammers, stalkers, scammers, infectors, and other wrongdoers who hide behind its anonymity. Learn how to trace them down in this comprehensive manual! **Invaluable!**

## OTHER EXCITING TITLES!

### CREDIT CARD SCAMS \$29

Describes every known means of credit card fraud and scams. Includes countermeasures. **Protect yourself!**

### RADIONICS MANUAL \$29

Exciting electronic and electromagnetic therapeutic, diagnostic devices (mostly experimental). History, descriptions, plans, availability! **Totally painless, can be used while asleep!**

### STEALTH TECHNOLOGY \$24

Every known police radar and laser error - stealth method and material used to minimize reflections - strategies to fight speeding tickets - methods to detect and jam signals!

### HIGH VOLTAGE DEVICES \$29

Many HV device plans: Stun Gun, Taser, Prod, Cane, Flasher, Blaster, Zapper, Audio/RF/Radar Jammer, Jacob's Ladder, Plasma & Van de Graaff Gens, Fence Charger, Geiger Counter, Fish Stunner, Plant Stim., Kirlian, much more!

### POLYGRAPH DEFEATS \$19

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TEST EQUIPMENT cont.

**POWER SUPPLIES, ETC.:** HP 6237B triple output: 0-18V, 1A; 0-20V, .5A dual tracking \$390. HP 6253A 0-20V, 3A dual tracking \$290. HP 6255A 0-40V, 1.5A dual tracking \$350. HP 6443B 0-120V, 2.5A \$375. Tek PS 503A triple output \$190. Xentek extreme isolation transformers for **CLEAN POWER:** 5KVA, 2.5KVA, etc., starting at \$175. Excellent condition, warranty. Pepper Systems, 214-353-0257 (FAX 214-902-9511).

**WANTED: LATE model TEST EQUIPMENT** and test equipment MANUALS, HP, Tektronix, and others. Fax your for sale list to 410-750-1192 or mail to US Surplus, PO Box 37, Ellicott City, MD 21041, Attn: Ron Baublitz. Phone # 410-750-1083, E-Mail: ussurplu@clark.net

**TEKTRONIX PLUG-INS:** AM 502, 7A22 high-sensitivity differential amplifiers \$375, \$350. AM 503 & A6302 current probe & amplifier \$850. FG 504 40MHz function generator \$725. TR 503 tracking generator \$857. 5D10 waveform digitizer with readout \$295. 7CT1N curve tracer \$350. 7D20 digital storage \$700. 7L5/L3 spectrum analyzer, 20Hz-5MHz, 10Hz RBW \$1,400; with tracking generator \$1,900. 7S12, S-6, S-52 time domain reflectometer \$1,400. 7S14 1GHz sampler \$600. Excellent condition! Mainframes available too. All with warranty. Pepper Systems, 214-353-0257.

**FLUKE 6080A/AN** signal generator 0.1MHz to 1056MHz resolution 1Hz 10 digit display output range +13dBm Am, FM and phase modulation. Sold new \$20,000. Our price \$4,500. 90 day guarantee. Call 1-800-435-1516.

**MICRODYNE 1100, 1200, 1400 series** receivers all bands, FM and PM demods, SDU, IF filters. Aydin, Schlumberger, monitor systems bit syncs. 805-934-2058.

**VIDEO EQUIPMENT SALE!** Cannon RT-191 still video transceiver \$325; HP 3781B pattern generator \$500; HP 5180A waveform recorder \$750; Shiba Soku 925R/1 NTSC color video noise meter \$225; Shiba Soku CD10A1 color decoder \$200; Shiba Soku TG-7/1 NTSC TV test signal generator \$375; Tektronix 520 NTSC vector scope \$350; Tektronix 520A \$375; Tektronix 604 \$225; Tektronix 1420/528 \$650; Tektronix 1470 color test signal generator \$250; Tektronix 1480C \$350; Tektronix 1480R \$200; Tektronix 1485R \$550. **AST GLOBAL MARKETING:** voice: 1-888-216-7159; Fax: 814-337-7920; E-Mail: astmrktg@wrench.toolcity.net

**TEK CURVE tracers:** 577 D1 \$995, 577 D2 \$750, 576 \$1,350, 575 \$250. Checked/adjusted. 30 day guarantee. Credit cards accepted. Four Designs Co. 360-887-1555, FAX 360-887-1549.

**SALE POWER SUPPLIES:** Leader LPS-152 triple output, auto tracking \$275; BK 1646 metered 15V-10A, \$150; HEWLETT PACKARD 6620B 25/50V, 5/1A \$100; 6260A 10V 100A \$250, 2 available. 6265B 40V 3A \$200; 6266A 40V 6A \$275; 6268A 40V 30A \$275; 6282A 10V 10A \$150; **Line conditioners** Sola @ 9 amp \$150; @ 16.7A \$225; @ 2A \$100; Topaz 8.3A & 6.4A \$200. All as new. **Psitech Plus** 707-745-4804. Fax 707-747-5277.

**INVENTORY REDUCTION SALE:** PRICES SLASHED UP TO 60%. LIMITED TIME OFFER. VIEW COMPLETE LIST AT WEB SITE "a-mall.com" or contact NOW: AST GLOBAL MARKETING: voice: 1-888-216-7159; Fax: 814-337-7920; E-Mail: astmrktg@wrench.toolcity.net

**SELL:** GR W5MT3A metered variac 0-140V, 0-5A, \$125; GR874-F500 low pass filter, \$60; GR 874T, \$30; HP 428B and probe current meter, \$300; HP 628A signal gen. 15-21 GHz, \$300; HP 7046B, \$400, HP plotters 7475A RS232, \$150; HP 7475A HPiB, \$250; HP 7470A, \$200. A-Comm Electronics 303-290-8012.

**WANTED TEST EQUIPMENT:** We buy all types of test and measurement equipment, call or fax us with your sale lists. phone of fax 520-432-1229. E-Mail: copp@primenet.com Coppes Electronics

**RACAL-DANA 9009N automatic AM/FM modulation meter.** Automatically tunes from 8 to 1500MHz. FM deviation is from 1.5 to 150kHz in 7 ranges. AM modulation is from 0 to 100% in 5 ranges. Sensitivity is from 0 mV to 7V. Small unit like the Marconi TF 2304. Excellent, with manual. \$365 ppd CONUS. Quantities available. Brian Kent (Tektronix), PO Box 2444, Farmingdale, NJ 07727. 908-681-3229, 908-681-3312 FAX, E-Mail: brian@kentronix.com



**HP 8640B-323 signal generator.** .5 to 550MHz. -137 to +20 dBm. AM/FM/pulse. 6-digit readout. \$900. Systron-Donner 6245A 18GHz microwave counter. Calibrated. \$1,500. FE-1000Q portable 5, 1, .1MHz frequency standard. <2x10<sup>-12</sup>/day \$500. Wavetek 3000-200 \$850. Gould 32 channel K100-D logic analyzer \$500. HP 8601A sweeper \$400. Gary N6ZD. 408-385-0301. **VISA & MASTERCARD.** HTTP://WWW.TECH-SERVICES.COM for photos & 13 page "list" plus information.

**WE PAY TOP DOLLAR** for your used test equipment. Fax us 732-280-0111 or phone us 1-800-435-1516.

**RF WATTMETER:** B&W 334-A includes 1KW dummy load \$79; Heath IG5206 video alignment gen. \$39; Shalco T-693 precision audio attenuator \$99; Vector WR-50C signal gen. \$69; Beckman Scopemate II \$129; Tek 1230 logic analyzer \$490. Synergetics Surplus, 3860 West First Street, Box 809, Thatcher, AZ 85552. 520-428-4073. synergetics@tina ja.com VISA/MC.

**HP 4328A milliohmeter** w/surface probes \$325, **Fluke 1900A** \$75. Four Designs Co. 360-887-1555, FAX 360-887-1549

**SELL:** RACAL Dana 9922 3GHz counter, \$600; HP 5340A Opt. 1, \$1,500; Tektronix 7S12, S52, S6, 7623, TDR, \$2,000; HP 8601A sweeper .4-110 MHz, \$500; HP 1411T, 8552B, 8553B, \$1,500; HP 1411T, 8552B, 8555A, \$2,000; HP 8683B sig. gen. 2.3-6.5 GHz, \$2,500; HP 8616A sig. gen. 1.8-4.5 GHz, \$650; HP 8709A synchronizer, \$200; HP 7550A plotter \$400; HP 934A harmonic mixer, \$50; Tektronix PG-508, pulse gen. \$400. A-Comm Electronics 303-290-8012.

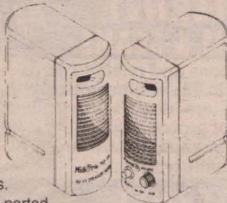
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Midipro # MD58 Amplified stereo speakers for computer/multimedia use. 3 watts RMS/ 12 watts peak full range 8 ohm speakers. Beige cabinets, ported for extra response. 7.24" x 2.95" x 4.75". Operates on 6 volts. Includes cables. Requires either 4 C cell batteries or 6 to 12 volt power adapter (not included).



CAT # SK-58 \$14.95 pair

Above speaker set including **DC POWER ADAPTER/BATTERY ELIMINATOR** CAT# SK-58A \$17.95 per set

## SMALL NEODYMIUM RARE EARTH MAGNETS

Semi-circular, irregularly-shaped magnets. Shiny finish with a polarity marking dot. 0.93" long x 0.3" x 0.07" thick. Powerful for their size.



CAT# MAG-30 \$1.00 each 160 pcs. - \$100.00

## 5 amp Solid State Relay

C.P. CLARE / Theta J # JTA2405-3 Compact, TTL compatible, optically isolated solid state relay for loads up to 5 amps @ 240 vac. 0.8" x 0.82" x 0.56" high epoxy block with a 1.4" long metal mounting flange. 1.19" mounting centers. 0.062" dia. x 0.175" high pins. Can be pc mounted or pins can be wrapped and soldered. UL and CSA listed.



Input: 4 - 8 vdc - Load: 5 amps @ 240 vac CAT# SSRly-2405 \$6.00 each 10 for \$55.00

## NOTEBOOK COMPUTER CARRYING CASE

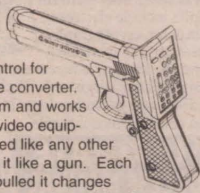
Great looking, padded carrying case, suitable for most notebook computers or similar equipment. Black leatherette exterior or with separate zippered compartment for papers or accessories. Detachable nylon web shoulder strap. Interior space is 13.5" X 9" X 2.5"



CAT # CSE-12 \$9.75 each

## Shoot That TV, VCR Etc. COLT 45 - STYLE Universal Infrared Remote

The Gunvertor™ is a full-featured, programmable infrared remote control for TV, VCR and Cable converter. It is easy to program and works with most popular video equipment. It can be used like any other IR remote. Or, fire it like a gun. Each time the trigger is pulled it changes channels. A great toy, useful and fun for the channel-surfing couch-potato in your house. Includes instructions. (4 AA batteries not included).



CAT# GNV-1 \$9.95 each

## 470 UF, 450 VOLT SNAP-IN CAPACITOR

Nichicon LGQ2W471MHSC 1.375" diameter x 2" high. 0.4" lead spacing.



CAT# EC-4745 \$4.50 each 10 for \$40.00

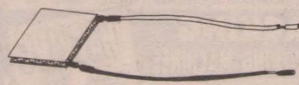
## 410 UF, 300 VOLT PHOTOFLASH CAP.



Rubycon # 1A2304A 0.7" dia. X 1.7" long. Right angle PC or solder leads on 0.25" centers.

CAT# PPC-410 \$2.00 each 10 for \$18.50 200 for \$320.00

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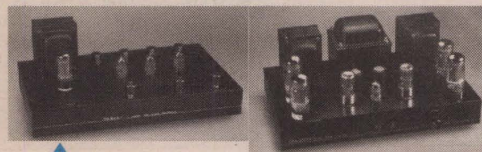
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**AR-146**  
**2 Meter Ham Transceiver**  
Features 50 watt output, CTCSS encode and

decode, DTMF paging, DTMF decode and display, 40 memories store any frequency, offset or CTCSS tones.

**Order # (ea.)**  
**111-5000 \$279.00**



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Combines time proven vacuum tube design, state of the art passive components and your own hand craftsmanship to provide the ultimate sound performance for the dollar. Assembly easily completed in two evenings. Requires advanced kit building ability.

Order #	Model	(ea.)
50-2425	VAA-100 40W/Channel Amplifier	\$299.00
50-2435	VAA-L1 Line Drive Preamp	169.00

## Miniature Replacement Speakers

Alinco magnet speakers commonly used in portable radios, tape recorders or projects. All have 8ohm coil and alinco magnets. Many other sizes and ferrite magnet versions available.

Order #	Size	(ea.)
52-085	1 1/2"	\$1.59
52-095	2"	1.59
52-105	2 1/2"	1.69
52-115	3"	1.89
52-120	3 1/2"	2.29

## 2 Amp Multi-Voltage Power Supply

Rotary switch selects 3, 4V, 6, 7V, 9 and 12 volts. Ideal for use with projects or as a battery eliminator.

**Order # (ea.)**  
**28-2200 \$16.95**



## Everything But The Box!

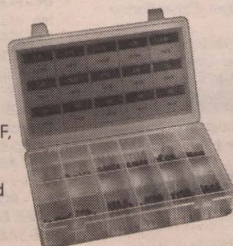
Complete kit has all you need to create an efficient low cost two-way speaker system in your own cabinet. Includes 6" long throw woofer, 1" tweeter and terminal cup with attached crossover. 60W RMS capacity.

**Order # (ea.)**  
**58-1655 \$9.44**

## 120 Piece Silicone Rectifier Diode Kit

Ideal for the professional or hobbyist. Contains ten each of the following types: 1N4002F, 1N4004F, 1N4006F, 1N4007F, 1N5401, 1N5404, 1N5407G, 1N5408, 6A10, 6A40, 6A80 and 6A100. Chart in lid also shows specifications and re-order numbers.

**Order # (kit)**  
**102-026 \$19.95**



## TENMA

### Universal Test System

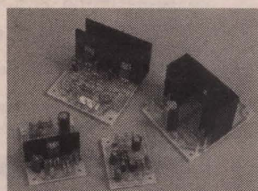
Ideal for the classroom or test bench. Combines four of the most commonly used pieces of test equipment. Triple output power supply, 3 1/2 digit DMM with bargraph, 2MHz sweep function generator and 1GHz frequency counter.

**Order # (ea.)**  
**72-5085 \$549.00**

## CCD Board Camera

1/2" format CCD camera has built-in electronic iris. Great for CCTV, surveillance or ATV use. Self contained board measures only 2" x 2" x 1/2". Requires 12VDC.

**Order # (ea.)**  
**82-1005 \$129.00**



## Audio Amplifier Modules

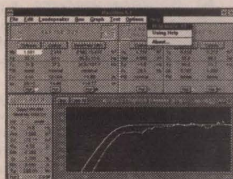
Great for any amplifying application. Pre-assembled boards require 12-24VDC and provide 1-20W RMS. They can be incorporated into existing components, speaker enclosures or a variety of other places. Frequency response 30Hz-18KHz.

Order #	Output	(ea.)
HK00028	1W	\$7.34
HK00029	5W	13.60
HK00030	15W	22.00
HK00031	20W	24.10

## Hole Cutter with Adjustable Radius Blade

Great for speaker mounting. Cuts 1 1/4"-7 1/4" holes in plywood, plaster board and acrylic sheet up to 1 1/2" thick. Also cuts aluminum, brass and metal sheets up to .04" thick. Base keeps bit perpendicular to cutting surface and cowl collects debris when ceiling cutting.

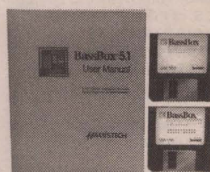
**Order # (ea.)**  
**22-1625 \$99.95**



## BassBox 5.1 Design Program

Design bandpass, vented, passive radiator and closed box speaker enclosures. Contains database of over 1,300 woofers including all MCM Audio Select models. Others can be added. Provides frequency plots from many popular measurement systems including IMP, LMS, MLSSA, and TFE-20. Requires MS Windows.

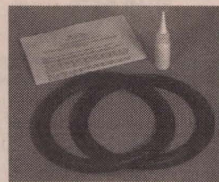
**Order # (ea.)**  
**81-2235 \$99.95**



## Security Bit Drivers

Necessary when removing tamper proof screws found in many items including Nintendo and Sega video game units and cartridges. Fits in any standard 1/4" driver.

Order #	Size	(ea.)
22-1145	3.8mm	\$3.49
22-1150	4.5mm	3.49



## Speaker Repair Kits

An ideal alternative to replacing expensive or "no longer available" speaker drivers. You can now repair your existing woofer by replacing its rotted or damaged foam surround and dust cap. Surrounds and dust caps sold in pairs. All kits include specially formulated adhesive.

Order #	Description	(kit)
50-2726	*6 1/2" kit	\$15.95
50-2731	8" kit	17.95
50-2736	10" kit	18.95
50-2741	12" kit	19.55
50-2746	15" kit	20.95
50-2751	2 1/2" dust caps	2.09
50-2756	3 1/2" dust caps	2.29
50-2761	4 1/2" dust caps	2.49



## NTSC/PAL Video System Converter

Ideal when overseas TVs or VCRs are to be connected with U.S.

models. Connects between VCR video line out and TV video line in. Requires television with vertical hold control. Includes 120/240V switchable AC adaptor.

Order #	Type	(ea.)
32-5160	NTSC to PAL	\$99.95
32-5165	PAL to NTSC	99.99



## RF Demodulator

Provides exact opposite function of standard RF modulator. Converts channel 3/4 signal to baseband audio and video. Useful in many of today's home theater applications.

**Order # (ea.)**  
**33-2060 \$49.95**

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# Events

# CALENDAR

## JULY 1997

### JULY 4

**PA - DILLSBURG** - Hamfest. Monaghan Fire Hall, 245 W. Siddonsburg Rd. Tom Hale WU3X, 717-232-6087

### JULY 4-5-6

**FL - ST. PETERSBURG** - ComputerBlast '97. The Coliseum. Computerfest Productions, 813-319-8508

### JULY 5

**CA - DALY CITY** - Computer Show. Cow Palace, Gate #5, Geneva & Santos. Robert Austin Corp. 1-800-243-7041, <http://www.robertaustin.com>  
**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052  
**MA - WEST SPRINGFIELD** - Computer Show. Eastern States Expo. Center. 9:30am-4pm. MarketPro 201-825-2229  
**NC - SALISBURY** - Firecracker Hamfest. Salisbury Civic Center. 8am-1pm. Walter Bastow N4KV 704-279-3391  
**OH - COLUMBUS** - Computer Show. Ohio Expo Center. MarketPro 301-984-0880  
**VA - NORFOLK** - Computer Show. Norfolk Scope. MarketPro 301-984-0880

### JULY 5-6

**FL - MELBOURNE** - Computer Show. Melbourne Auditorium. MarketPro 301-984-0880  
**NY - WHITE PLAINS** - Computer Fair. Westchester Co. Center. 9:30am-4pm. MarketPro 201-825-2229  
**MD - TIMONIKUM** - Computer Show. MD State Fairgrounds. MarketPro 301-984-0880

### JULY 6

**CA - LIVERMORE** - Swapmeet. Las Positas College. Noel Anklam 510-447-3857  
**OH - DAYTON** - Computer Show. Montgomery Co. Fairgrounds. MarketPro 301-984-0880  
**OH - LISBON** - Hamfest. Columbiana Co. Fairgrounds. 8am-3pm. Dick Sisley K8JKB 330-385-1245  
**MI - LANSING** - Super Computer Sales. Holiday Inn South Convention Center. 6820 S. Cedar St. 10am-4pm. Computers & You 313-283-1754  
**PA - LEHMAN** - Hamfest & Computerfest. Luzerne Co. Fairgrounds, Rte. 118. Bob WB3FAA, 717-288-3532  
**VA - HAMPTON** - Computer Show. Hampton Coliseum. MarketPro 301-984-0880

### JULY 9

**IA - IOWA CITY** - Hamfest. Jon Poulton W0CK, 319-354-1735

### JULY 11-12-13

**MI - LANSING** - Antique Radio Extravaganza '97. Holiday Inn South Convention Center. 517-349-7187  
**NV - LAS VEGAS** - DEF CON V Convention. Aladdin Hotel & Casino. 206-790-3628

### JULY 12

**CANADA - PRINCE EDWARD ISLAND - SUMMERSIDE** - Hamfest. Lloyd Cannon VY2CQ, 902-436-9078  
**CA - FONTANA** - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves  
**CA - OAKLAND** - Computer Show. Oakland Convention Center, Broadway @ 10th St. 1-800-243-7041 <http://www.robertaustin.com>  
**CO - GLENWOOD SPRINGS** - Hamfest. Chuck Kimball N0NHJ, 970-945-6778  
**MI - FLINT** - Super Computer Sales. IMA Arena, 3501 Lapeer Rd. 10am-3pm. Computers & You 313-283-1754  
**MI - PETOSKEY** - Hamfest. Jim KC8FFS, 616-537-2422  
**NC - SPRUCE PINE** - ARRL Hamfest. Byrne Tinney KT4CA, 704-688-3942, <http://www.m-y.net>  
**NY - BUFFALO** - Computer Show. Hamburg Fairgrounds. 9:30am-4pm. MarketPro 201-825-2229  
**NY - OLD WESTBURY** - Computer Show. SUNY Old Westbury. 9:30am-4pm. MarketPro 201-825-2229  
**NY - POUGHKEEPSIE** - Computer Show. Mid-Hudson Civic Center. 9:30am-4pm. MarketPro 201-825-2229  
**OH - ST. CLAIRSVILLE** - Computer Show. Ohio Valley Mall. MarketPro 301-984-0880  
**OK - ALTUS** - ARRL Hamfest. Ron Hughes KB5UCV, 405-482-7994, E-Mail: KB5UCV@intpsrv.net  
**PA - LEBANON** - Computer Show. Lebanon Valley Expo Center. MarketPro 301-984-0880  
**TX - TEXAS CITY** - Hamfest. Garth Crowe N7XKT, E-Mail: flamejumper@sat.net  
**VA - CHANTILLY** - Computer Show. Capital Expo Center. MarketPro 301-984-0880  
**WI - EAU CLAIRE** - ARRL Hamfest. Carol Ceraso N9TUA, 715-723-9205  
**WI - OAK CREEK** - Swapfest '97. American Legion Post 434. Robert Kastelic WB9TJK, 414-762-3235

The Events Calendar is a free service limited to electronic events such as computer shows, hamfests, flea markets, etc. If your organization is sponsoring an event and would like a free listing, contact us at least 60 days prior to the event. Include your flyer, estimated attendance, name of the person to contact, and phone number.

Complimentary issues are available upon request for distribution to your attendees. A street address for UPS is required.

While we strive for accuracy in our calendar, we can not be responsible for errors or cancellations. The information contained in this column is for the use of the readers of *Nuts & Volts* and may not be republished in any form without the written permission of T & L Publications, Inc.

### JULY 12-13

**FL - FORT MYERS** - Computer Show. Harborside Convention Center. MarketPro 301-984-0880  
**GA - KENNESAW** - Computer Show. I-75 Exit 116, go W. on Barrett Pkwy. to Hwy. 41, turn right, go to 2nd traffic light; you're on the right next to "Cowboys." GA Mountain Productions 706-838-4827  
**IN - INDIANAPOLIS** - Central Division Convention. Rick Ogan N9LRR, 317-257-4050  
**KY - LOUISVILLE** - Computer Show. Kentucky Fair & Expo Center. MarketPro 301-984-0880  
**MO - ST. CHARLES** - Computer Show & Sale. St. Charles Exposition Hall, St. Charles Center, I-70 & 5th St. Sat: 10am-4pm, Sun: 11am-3pm. Computer Central Shows 888-296-6066  
**NC - WINSTON-SALEM** - Computer Show. Lawrence Joel Coliseum. 9:30am-4pm. MarketPro 201-825-2229

### JULY 13

**IL - SUGAR GROVE** - Hamfest. Waubesa Community College, Rte. 47 at Harter Rd. Diana Skube 630-293-7485.  
**MA - SWANSEA** - Computer Show. Venus Demilo. Northern Computer Shows 508-744-8440  
**MD - UPPER MERLBORO** - Computer Show. The Show Place Arena. MarketPro 301-984-0880  
**MI - DEARBORN** - Super Computer Sales. Dearborn Civic Center, 15801 Michigan Ave. 10am-4pm. Computers & You 313-283-1754  
**NJ - PARSIPPANY** - Computer Show. Parsippány Hilton. 9:30am-4pm. MarketPro 201-825-2229  
**NY - ALEXANDER** - ARRL Hamfest. Don Partis WA2AIV, 716-343-4484  
**NY - ROCHESTER** - Computer Show. The Dome Center. 9:30am-4pm. MarketPro 201-825-2229  
**OH - BOWLING GREEN** - Ham-A-Rama & Computer Show. Wood Co. Fairgrounds. 8am-1pm. Larry Reitz WA8CWD, 419-372-2936  
**PA - GREENSBURG** - Computer Show. Greengate Mall Expo Center. MarketPro 301-984-0880  
**PA - KIMBERTON** - Valley Forge Hamfest. Fire Co. Fairgrounds, Rte. 113, S. of the intersection w/Rte. 23. Bob Haase W3SA, 610-293-1919  
**PA - PITTSBURGH** - Hamfest. Northland Public Library, 300 Cumberland Rd. 8am-3pm. Bob Ferrey, Jr. NJ3DOK 412-367-2393, E-Mail: bferrey@nauti.com.net  
**PA - YORK** - Computer Show. Holiday Inn Holiday & Conference Center. 9:30am-4pm. MarketPro 301-984-0880

### JULY 18-19-20

**MT - EAST GLACIER** - State Convention. Edith Van Schaick VE6EDY, 403-293-8920

### JULY 19

**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052  
**GA - MARIETTA** - Computer Show. Cobb Co. Civic Center. MarketPro 301-984-0880  
**LA - LEEVILLE** - Hamfest. Jeff Shifflet KC5GVS, 318-239-9724  
**MA - HYANNIS** - Computer Show. Tara Hyannis Hotel. Northern Computer Shows 508-744-8440  
**ME - CLINTON** - ARRL Hamfest. Tom Clay KD1KE, 207-382-6000  
**MI - LIVONIA** - Super Computer Sales. Livonia Elks Lodge Hall, 31117 Plymouth Rd. 10am-3pm. Computers & You 313-283-1754  
**NH - NASHUA** - Electronic Fleamart. Res. Ctr. Church. 617-923-2665  
**NY - FRANKFORT** - ARRL Hamfest. Bob Decker AA2CU, 315-797-6614  
**OH - TOLEDO** - Computer Show. SeaGate Convention Center. MarketPro 301-984-0880  
**OH - WELLINGTON** - ARRL Hamfest. Lorain Co. Fairgrounds. 8am-3pm. John Schaff KC8AOX,

### 216-323-0081

**OR - NORTH BEND** - ARRL Hamfest. North Bend Junior High School, near Pony Village Mall. 9am-3pm. Hugh MacDonald N7OKM, 541-347-7019  
**PA - BEACH HAVEN** - ARRL Hamfest. Charles Hooker AD3L, 717-864-2571  
**TN - CLEVELAND** - Hamfest. David Evans WD4EJC, 423-472-1421  
**TN - CROSSVILLE** - ARRL Hamfest. Nick Smith WA4GKM 615-484-8220  
**VA - ANNANDALE** - Computer Show. Northern Virginia Community College. MarketPro 301-984-0880

### JULY 19-20

**FL - WEST PALM BEACH** - Computer Show. South Florida Fairgrounds. MarketPro 301-984-0880  
**NC - CHARLOTTE** - Computer Show. The Merchandise Mart. 9:30am-4pm. MarketPro 201-825-2229  
**NY - STONY BROOK** - Computer Show. SUNY Stony Brook. 9:30am-4pm. MarketPro 201-825-2229  
**PA - HARRISBURG** - Computer Show. Farm Show Complex. MarketPro 301-984-0880  
**TN - NASHVILLE** - Computer Show. Tennessee State Fairgrounds. MarketPro 301-984-0880

### JULY 20

**GA - NORCROSS** - Computer Show. North Atlanta Trade Center. MarketPro 301-984-0880  
**IN - FORT WAYNE** - Computer Show. Memorial Coliseum. MarketPro 301-984-0880  
**MA - CAMBRIDGE** - Flea Market. Kendall Square area. 9am-2pm. MIT. Nick Altemburd 617-253-3776  
**MD - BRUNSWICK** - Sweatfest '97. MARC Train Station. 301-416-8447 Box #109, Web: <http://members.aol.com/madraclub>  
**MD - FREDERICK** - Computer Show. Frederick Fairgrounds. MarketPro 301-984-0880  
**MI - FLINT** - Computer Show. Holiday Inn, Gateway Centre, US 23 @ Hill Rd. Exit. Five Star Productions 810-890-0988  
**MI - MADISON HEIGHTS** - Super Computer Sales. UP&CW Hall, 876 Horace Brown Dr. 10am-4pm. Computers & You 313-283-1754  
**MO - WASHINGTON** - ARRL Hamfest. Dave Neal N0PNG, 314-458-3254  
**NH - NASHUA** - Computer Show. Sheraton Tara Hotel. Northern Computer Shows 508-744-8440  
**NJ - AUGUSTA** - Hamfest. Sussex Co. Fairgrounds, Plains Rd. off Rte. 206. Dan Carter N2ERH, 201-948-6999. <http://www.planet.net/scarc/fest>  
**NY - LONG ISLAND** - Electronics/Ham Radio Flea Market. Bald Hill Cultural Center. Neil Heft KC2KY, 516-737-0019. E-Mail: n2mdq@li.net  
**OH - VAN WERT** - Hamfest. Van Wert Co. Fairgrounds, US 127 South. Bob Barnes WD8LPY 419-238-1877  
**PA - HOMER CITY** - ARRL Hamfest. Elmer Sorisio KB3WG, 412-463-1314  
**PA - INDIANA** - Computer/Ham Radio Fair. Red Barn Sportsman Club near Homer City. 8am-3pm. Elmer Sorisio 412-692-8090, 412-463-1314

### JULY 24-25-26

**AR - HOT SPRINGS** - Central States VHF Conference. Clarian Resort on the Lake. Gary Gerber KBOHH, 316-842-5079

### JULY 25-26

**FL - MILTON** - ARRL Hamfest. Mark McAnally KE4QKN, 404-626-7686  
**OK - OKLAHOMA CITY** - Ham Holidays '97. Oklahoma State Fair Park, Hobbies, Arts & Crafts Bldg., Intersection I-40 & I-44. Fri: 5pm-8pm, Sat: 8am-5pm. CORA Web site: [www.geocities.com/heartland/7332](http://www.geocities.com/heartland/7332) E-Mail: n1lpm@swbell.net

### JULY 25-26-27

**AZ - FLAGSTAFF** - State Convention. John Lanza

All listing information should be sent to:

## Nuts & Volts Magazine

## Events Calendar

430 Princeland Court

Corona, CA 91719

Phone 909-371-8497

Fax 909-371-3052

E-mail [events@nutsvolts.com](mailto:events@nutsvolts.com)

### JULY 26

**CA - DALY CITY** - Computer Show. Cow Palace, Gate #5, Geneva & Santos. Robert Austin Corp. 1-800-243-7041, <http://www.robertaustin.com>  
**IL - PECATONICA** - Hamfest & Computer Fair. Winnebago Co. Fairgrounds. Marsha Plasters KB9NGN, 815-399-9233, E-Mail: wa9ffl@aol.com  
**IN - INDIANAPOLIS** - AGI Computer Fair. Indianapolis Events Center. 3655 E. Raymond St. 10am-4pm. 317-299-8827  
**MD - NEW CARROLLTON** - Computer Show. Ramada Conference & Exhibition Center. MarketPro 301-984-0880  
**MI - TAYLOR** - Super Computer Sales. Democratic Club Hall, 23400 Wick Rd. 10am-3pm. Computers & You 313-283-1754  
**NC - WAYNESVILLE** - Hamfest. Haywood County Fairgrounds, off Exit 24 on I-40. 8am-4pm. Tommy Queen K4BNP, 704-258-2639  
**NJ - PENNSAUKEN** - Computer Show. S. Jersey Expo Center. 10am-4pm. KGP Productions 1-800-631-0062  
**PA - NESCOPECK** - ARRL Hamfest. Richard Conklin WC3H, 717-387-6759, E-Mail: [tattoo@ptd.net](mailto:tattoo@ptd.net)  
**SC - GREENVILLE** - Computer Show. Palmetto Expo. Center. 9:30am-4pm. MarketPro 201-825-2229

### JULY 26-27

**FL - ORLANDO** - Computer Show. Central Florida Fairgrounds. MarketPro 301-984-0880  
**PA - ALLENTOWN** - Computer Show. Allentown Fairgrounds. MarketPro 301-984-0880  
**PA - KING OF PRUSSIA** - Computer Show. Valley Forge Convention Center. MarketPro 301-984-0880  
**PA - MONROEVILLE** - Computer Show. Pittsburgh Expo Mart. MarketPro 301-984-0880  
**TN - MEMPHIS** - Computer Show. Mid-South Fairgrounds Complex. MarketPro 301-984-0880  
**WV - CHARLESTON** - Computer Show. Charleston Civic Center. MarketPro 301-984-0880

### JULY 27

**CA - SANTA ANA** - Swapmeet. ACP parking lot. Mary Russo 714-558-8813  
**IL - GLEN ELLYN** - Computer Show & Sale. College of DuPage. Main Arena of Phys Ed Bldg. Corner of Park Blvd. & College Rd. 9:30am-3pm. Computer Central Shows 847-940-7547  
**IN - FORT WAYNE** - AGI Computer Fair. Ramada Inn, exit 105A/Jct. SR14 at I-69. 10am-3pm. 317-299-8827  
**MD - TIMONIKUM** - Hamfest & Computerfest. Timonium Fairgrounds, York Rd. off I-695, I-83. BRATS, 410-467-4634. <http://www.smart.net/~brats>  
**MI - GRAND RAPIDS** - Super Computer Sales. Crowne Plaza, 5700 28th Street SE. 10am-4pm. Computers & You 313-283-1754  
**NC - ASHEVILLE** - Computer Show. Asheville Civic Center. 9:30am-4pm. MarketPro 201-825-2229  
**NH - PORTSMOUTH** - Computer Show. Frank Jones Center. Northern Computer Shows 508-744-8440  
**NJ - SOMERSET** - Computer Show. Garden State Exhibit Center. 9:30am-4pm. MarketPro 201-825-2229  
**VA - MANASSAS** - Computer Show. Manassas Fairgrounds. MarketPro 301-984-0880  
**WI - RACINE** - ARRL Swapfest. South Hills Country Club, I-94 E. Frontage Road between Hwy. 20 & Cty.



# Events CALENDAR

Rd. K. 8am-2pm. Racine Megacycle Club,  
414-632-4941

## AUGUST 1997

### AUGUST 1-23

**TX - AUSTIN** - South Texas Section Convention. Joe Makeever W5HS, 512-345-0800

### AUGUST 2

**CANADA - ST. ROMAN** - Hamfest. Francois Berube VA2RC, 418-843-5682

**GA - WATKINSVILLE** - ARRL Hamfest. Rodney Couch KE4ANM, 706-353-2773

**IL - CARLINVILLE** - Computer Fair/Hamfest. Moose Lodge, on Alton Rd. 7am-Noon. Tim Jones 217-627-2355

**IL - QUINCY** - ARRL Hamfest. Jim Funk N9JF, 217-336-4191

**MA - MARLBOROUGH** - Computer Show. Royal Plaza Trade Center. 10am-4pm. KGP Productions 1-800-631-0062

**MD - UPPER MARLBORO** - Computer Show. The Show Place Arena. MarketPro 301-984-0880

**MI - HOUGHTON** - Hamfest. Roland Burgan KB8XI, 906-482-2403, E-Mail: rburgan@up.net

**MO - SPRINGFIELD** - State Convention. Karen Thorpe M0TWD, 417-889-6775

**NJ - HACKENSACK** - Computer Show. FDU/Rothman Center. 10am-4pm. KGP Productions 1-800-631-0062

**OH - COLUMBUS** - Hamfest. Aladdin Shrine Facility, 3850 Stelzer Rd. 8am-3pm. Jim Morton KB8KJP, 614-846-7790 eves.

**PA - LANCASTER** - Computer Show. Holiday Inn Lancaster Host. MarketPro 301-984-0880

**TN - KNOXVILLE** - Computer Show. Holiday Inn Lancaster Host. MarketPro 301-984-0880

### AUGUST 2-3

**CA - EUREKA** - Hamfest. Redwood Acres Fairgrounds. Sat: 9am-5pm, Sun: 9am-3pm. Wayne Carlson KF6AAP 707-668-4396

**CA - OAKLAND** - Computer Show. Oakland Convention Center, Broadway @ 10th St. 1-800-243-7041 http://www.robertaustin.com

**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

**FL - FORT LAUDERDALE** - Computer Show. War Memorial Auditorium. MarketPro 301-984-0880

**FL - JACKSONVILLE** - ARRL National Convention/Amateur Radio & Computer Show. Prime Osborn Convention Center. Karl Hassler 904-268-2302

**KY - LOUISVILLE** - Computer Show. KY Fair & Expo Center. MarketPro 301-984-0880

**NC - HIGH POINT** - Hamfest. National Guard Armory. 8am-3pm. 910-887-3039

**NY - ALBANY** - Hamfest. Weedsport Speedway/Fairgrounds. Rte. 31. Ken Johnson N2TRP 315-258-0169

**NY - WHITE PLAINS** - Computer Show. Westchester Co. Center. 9:30am-4pm. MarketPro 201-825-2229

**TN - KNOXVILLE** - Computer Show. Kerbella Shrine. MarketPro 301-984-0880

**WA - SPOKANE** - Eastern Washington Section Convention. University High School, 10212 E. 9th Ave. Sat: 9am-5pm, Sun: 8am-Noon. Carl Ray N7HKF, 509-487-4940

### AUGUST 3

**CA - LIVERMORE** - Swapmeet. Las Positas College. Noel Ankam 510-447-3857

**IA - AMANA** - Hamfest. Wayne Kolosik K10FE, 319-393-4224, E-Mail: k10fe@usa.net

**IL - PEOTONE** - Hamfest. Will Co. Fairgrounds.

6am-3pm. Dave Brasel NF9N 708-448-0580

**IN - ANGOLA** - Hamfest. Sharon Brown WD9DSP, 219-475-5897, E-Mail: wnbrown@dmci.net

**ME - BRUNSWICK** - Computer Show. Atrium Hotel & OTB. Northern Computer Shows 508-744-8440

**MI - PORT HURON** - ARRL Hamfest. Robert Herbert KB8WVW, 810-364-7874

**OH - RANDOLPH** - Hamfair. Portage Co. Fairgrounds. 8am-4pm. Joanne Solak KJ30, 330-274-8240

**PA - APOLLO** - ARRL Hamfest. Bob Livrone N3WAV, 412-339-9607

**PA - NORTH WASHINGTON** - Hamfest. Washington Twp. Firehall. Bob Reihms N3NOS, 412-727-2194 after 6pm EST

**PA - WILKES BARRE** - Computer Show. Genetti's Best Western. MarketPro 301-984-0880

**VA - BERRYVILLE** - Hamfest & Computer Show. Clarke Co. Ruritan Fairgrounds. Irv Barb W4DHU, 540-955-1745

**VA - CHANTILLY** - Computer Show. Capital Expo Center. MarketPro 301-984-0880

**WI - MARSHFIELD** - Hamfest. Guy Boucher KF9XX, 715-384-4323

### AUGUST 8-9-10

**MI - TAYLOR** - Computer & Technology Show. Gibraltar Trade Center, 15525 Racho Rd. 313-287-2000

### AUGUST 9

**CA - FONTANA** - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves.

**IN - VALPARAISO** - ARRL Hamfest. Rich Ard N9QLQ, 219-762-0484

**NH - SEABROOK** - Computer Show. Seabrook Greyhound Park. Northern Computer Shows 508-744-8440

**NY - DRYDEN** - ARRL Hamfest. Ross Boyer N2ISU, 607-844-4302, E-Mail: rmb3@cornell.edu

**PA - ERIE** - Computer Show. Erie Civic Center. MarketPro 301-984-0880

**PA - FORT WASHINGTON** - Computer Show. Ft. Washington Expo Center. 10am-4pm. KGP Productions 1-800-631-0062

**PA - LEWISTOWN** - Hamfest. Decatur FC grounds. 8am-2pm. 717-242-1882

**VA - NORFOLK** - Computer Show. Norfolk Scope. MarketPro 301-984-0880

**WA - TACOMA** - Electronics Fleamarket. Charles Wright Academy, 7723 Chambers Creek Rd. West. 9am-3pm. Alan Hughes KE7SVU, 206-840-4947

**WI - BARABOO** - ARRL Hamfest. Bill Hommel KA9QFJ, 608-356-8571, E-Mail: billh@baraboo.com

**WV - HUNTINGTON** - Hamfest & Computer Show. Veteran's Memorial Field House, 2590 5th Ave. 8:30am-2pm. Georgia Overby KA8QME, 304-522-1811

### AUGUST 9-10

**FL - MIAMI** - Computer Show. Dade Co. Fair & Expo. MarketPro 301-984-0880

**GA - KENNESAW** - Computer Show. I-75 Exit 116, go W. on Barrett Pkwy. to Hwy. 41, turn right, go to 2nd traffic light; we're on the right next to "Cowboys." GA Mountain Productions 706-838-4827

**MD - PIKESVILLE** - Computer Show. Pikesville Armory. MarketPro 301-984-0880

**NJ - SECAUCUS** - Computer Show. Meadowlands Expo Center. 9:30am-4pm. MarketPro 201-825-2229

**TN - CHATTANOOGA** - Computer Show. Holiday Inn Chattanooga Choo Choo. MarketPro 301-984-0880

### AUGUST 10

**IL - STICKNEY** - ARRL Hamfest. Hawthorne Race Course, 3500 S. Cicero Ave. 8am-2pm. Ed Weinstein WD9AYR, 630-985-9256

**KY - FRANKFORT** - ARRL Hamfest. Bill DeVore N4DIT, 606-273-8345

**MA - FALL RIVER** - Computer Show. White's of Westport. Northern Computer Shows 508-744-8440

**MI - JACKSON** - Hamfest & Computer Show. Jackson Community College. Terry Osborn K8SMC, 517-784-2398

**OH - NILES** - Computer Show. Eastwood Expo Center. MarketPro 301-984-0880

**OH - PAULDING** - Hamfest. Paulding Co. Fairgrounds, Fairgrounds Rd. Jerry KB8MAF, 419-399-4507 or E-Mail: jlrhod@Bright.net

**OR - REDMOND** - ARRL Hamfest. Bill Sawders K7ZM, 541-389-6258

**VA - HAMPTON** - Computer Show. Hampton Coliseum. MarketPro 301-984-0880

### AUGUST 16

**CA - DALY CITY** - Computer Show. Cow Palace, Gate #5, Geneva & Santos. Robert Austin Corp. 1-800-243-7041, http://www.robertaustin.com

**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

**IN - WARSAW** - Hamfest. New Kosciuszko Co. Amateur Radio Center. 8am-2pm. Loren Melton WB9OST, 219-858-9374 eves.

**MA - METHUEN** - Computer Show. Valley Expo Center. 10am-4pm. KGP Productions 1-800-631-0062

**NY - POUGHKEEPSIE** - Computer Show. Mid-Hudson Civic Center. 9:30am-4pm. MarketPro 201-825-2229

**VA - ANNANDALE** - Computer Show. Northern VA Community College. MarketPro 301-984-0880

**VA - RICHMOND** - Computer Show. The Showplace. MarketPro 301-984-0880

**VA - ROANOKE** - ARRL Hamfest & Computer Show. Exhibit Hall, Roanoke Civic Center. 9am-5pm. Terry AE4EW, 540-890-6782, E-Mail: ae4ew@ix.netcom.com

**WA - LONGVIEW** - Ham Radio, Computer, & Electronic Equipment Swap Meet. Cowlitz Co. Expo Center. 9am-3pm. Bob Morehouse KB7ADO, 360-425-6076

### AUGUST 16-17

**AL - HUNTSVILLE** - Hamfest. Von Braun Civic Center. Art Davis WB4KKA, 205-883-0477

**FL - TAMPA** - Computer Show. State Fairgrounds. MarketPro 301-984-0880

**OH - TOLEDO** - Computer Show. Masonic Great Hall. MarketPro 301-984-0880

**PA - HARRISBURG** - Computer Show. Farm Show Complex. MarketPro 301-984-0880

**PA - YORK** - Hamfest & Computer Show. York Interstate Fairgrounds. 8am-4pm. 717-764-8193

### AUGUST 17

**CA - GOLETA** - ARRL Hamfest. Alan Soenke WA6VNN, 805-967-1772

**CO - GOLDEN** - State Convention. Guy Reed W5GR, 303-674-5389

**DE - GEORGETOWN** - Delmarva Hamfest. Delaware Technical and Community College, Rte. 18. 8am-2pm. Thomas McDugall N3JRB, 302-856-2938

**IN - LAFAYETTE** - Hamfest/Electronic Flea Market. Tippecanoe Co. Fairgrounds. James Canarecci WA9TGO, 765-474-6570

**KS - SALINA** - ARRL Hamfest. Ron Tremblay WA0PSF, 913-827-8149

**MA - CAMBRIDGE** - Flea Market. Kendall Square area. 9am-2pm. MIT. Nick Altemburn 617-253-3776

**MD - NEW CARROLLTON** - Computer Show. Ramada Conference & Exhibition Center. MarketPro 301-984-0880

**MI - FLINT** - Computer Show. Holiday Inn, Gateway Centre, US 23 @ Hill Rd. Exit. Five Star Productions 810-890-0988

**NH - MANCHESTER** - Computer Show. Center of NH Expo Complex @ Holiday Inn. Northern Computer Shows 508-744-8440

**NJ - FAIRFIELD** - Computer Show. Fairfield Radisson. 9:30am-4pm. MarketPro 201-825-2229

**OH - BROADWAY** - ARRL Hamfest. Gene Moore N8YRF, 513-246-5943

**OH - WARREN** - ARRL Hamfest. Kent State University, Trumbull Branch. Al Van Slyke N8IKX, 330-889-3378

**VA - ROANOKE** - Computer Show. Roanoke Civic Center. MarketPro 301-984-0880

### AUGUST 22-23

**LA - NEW ORLEANS** - International DX Convention. Silvano Amenta KB5GL, 504-454-6184

### AUGUST 22-23-24

**MI - MT. CLEMENS** - Computer & Technology Show. Gibraltar Trade Center, 237 N. River Rd. 810-465-6440

**ND - BISMARCK** - Dakota Division Convention. Tim Rasset N0SDB, 701-663-6620

### AUGUST 23

**CA - OAKLAND** - Computer Show. Oakland Convention Center, Broadway @ 10th St. 1-800-243-7041 http://www.robertaustin.com

**IN - INDIANAPOLIS** - AQI Computer Fair. Indianapolis Events Center. 3655 E. Raymond St. 10am-4pm. 317-299-8827

**MA - BOXBOROUGH** - Computer Show. Holiday Inn. Northern Computer Shows 508-744-8440

**NJ - BRIDGEWATER** - Hamfest. Somerset Co. 4H Center, Milltown Rd. 8am-1pm. Pat N2CQM, 908-873-3394, E-Mail: M\_Haas@msn.com

**NY - BUFFALO** - Computer Show. The Hamburg Fairgrounds. 9:30am-4pm. MarketPro 201-825-2229

**NY - CHAFFEE** - ARRL Hamfest. Manion Park. 7am-3pm. Michael Wrona KB2TDN, 716-675-2071

**WI - SUGAR CAMP** - Hamfest. Sugar Camp Town Hall. Mary Berger NS9Q, 715-362-9296

**WV - WESTON** - State Convention. Dave Ramezan KA8ZXP, 304-462-7560

### AUGUST 23-24

**CO - WOODLAND PARK** - Hamfest. Colorado Lions campgrounds. Don AA0NW, 719-687-3692

**FL - MELBOURNE** - Computer Show. Melbourne Auditorium. MarketPro 301-984-0880

**FL - ORLANDO** - Computer Show. Central FL Fairgrounds. MarketPro 301-984-0880

**NJ - EDISON** - Computer Show. NJ Convention Center, Raritan Center. 10am-4pm. KGP Productions 1-800-631-0062

**OH - DAYTON** - Computerfest@ HARA Arena, 1001 Shiloh Springs Rd. Sat: 9am-6pm, Sun: 10am-4pm. Dayton Microcomputer Assoc., Inc. 937-22CFEST

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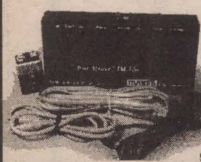
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Continued on page 108

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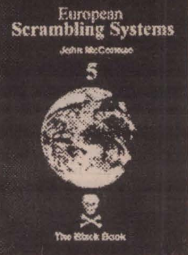
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The outstanding performance of Outbacker antennas may be attributed to basic antenna fundamentals of a quarter wavelength radiator. While there may appear to be some major mystery in how the Outbacker antenna is resonated for each amateur and/or each marine band, the whip itself is an electrical quarter wavelength long.

Tapping into the specific band points adds loading to the physical length of the whip to achieve quarter wavelength resonance on a shaft that is relatively short.

The electrical properties of a quarter wavelength antenna necessitate the antenna seeing a mirror image of itself to create a ground plane.

In conventional installations to a metal vehicle, the mirror image ground plane becomes the metal roof of the car or van. This vehicle ground plane must appear directly at the

base of the antenna, and the coax cable feeding the antenna mount must properly terminate the braid to that ground plane.

For best performance, the base of the Outbacker antenna in a mobile installation is in line with the ground plane. This is why it is important to mount the Outbacker up as high on the roof of a vehicle as possible. There are many trunk-lip and gutter-lip mounts that can adequately hold a vehicle-mounted Outbacker in place.

For installation aboard boats, or temporary installations in apartments, out at field day, or in emergency situations, all Outbacker antennas will work very well provided they are mounted over a ground plane.

Aboard boats, the required ground plane will be a stainless steel rail aft (on sailboats), or a stainless steel rail on the flying bridge (on power boats) for peak performance.

The marine Outbacker antenna may come with a stainless steel L-bracket specifically intended for horizontal rail mounting. The rail then becomes the ground plane, and it won't be necessary to do anything further (like running copper screen) to improve on the existing ground plane that is actually your stainless steel rail.

Mount the Outbacker antenna on the stern rail, or on top of any stainless steel rail. Four feet of rail in both directions should cause the antenna to resonate naturally as a quarter wavelength radiator.

If your sailboat has no metal rail, you may wish to consider the stainless steel or aluminum arch that may support other antennas on the aft end of your vessel. If your sailboat has absolutely no horizontal metal structures at all, you will need to call me on the phone so that we can discuss alternate methods of creating a suitable ground plane (Gordon West, 714-549-5000 M-F, 10:00 am to 4:00 pm).

On power boats, the stainless steel rail forward, or the stainless steel

use the aluminum channel that holds your rub rail as a counterpoise for the whip.

Your whip may have been shipped with a stainless steel rail mount. This mount will clamp onto a horizontal rail, or a vertical rail, or could mount flush on anything metal. The stainless steel hardware will resist corrosion. However, you may find that the 3/8" x 24 thread stud is not stainless. You can determine this with a magnet. If that stud is non-magnetic, the entire mount is perfectly suited for continuous marine environments.

However, if you discover that any portion of the mount is not stainless steel, feel free to call me and we can locate the necessary stainless stud and adapter that won't turn to rust after a few years hanging out on your rail.

Mount the stainless steel antenna base as indicated in these photographs. Make sure you are on the uppermost part of the stainless steel rail.

If you're installing the antenna in a non-marine installation, you will need to locate a horizontal metal surface to obtain your counterpoise. The stainless steel rail

mount will go directly into that horizontal metal counterpoise.

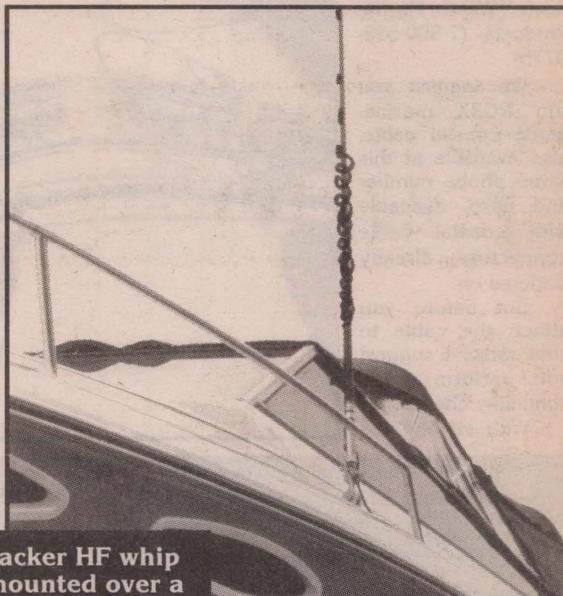
You get the idea — if the base of the antenna is

mount will go directly into that horizontal metal counterpoise.

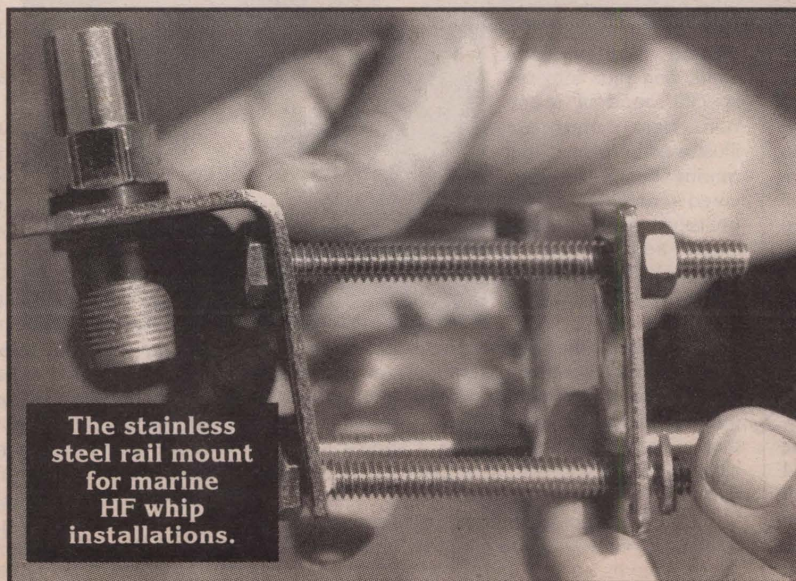
# Installing A Multi-Band HF Mobile Whip

by Gordon West

- Aluminum rain gutter on roof
- Metal balcony rail
- Long aluminum stepladder elevated off the ground (horizontal)
- Metal fence top rail (super ground!)
- Railroad tracks (only if rusty and not in use!)
- Horizontal copper water pipes
- Swimming pool ladder
- Aluminum diving board
- Aluminum awning



**The Outbacker HF whip must be mounted over a stainless steel rail aboard a boat.**



**The stainless steel rail mount for marine HF whip installations.**



## SAILBOATS

Mount the Outbacker antenna on the stern rail, or on top of any stainless steel rail. Four feet of rail in both directions should cause the antenna to resonate naturally as a quarter wavelength radiator.

If your sailboat has no metal rail, you may wish to



mounted to a substantial horizontal surface area, you will achieve a great ground plane.

The bottom of the mount will accept a common coaxial cable PL-259 connector. The coax cable and connector screw into the bottom, and the Outbacker whip into the top of the 3/8" x 24 receptor.

Run the coax cable over to your proposed ham or marine SSB installation, and leave yourself a couple of extra feet in case you need to move the equipment around a bit. Since the Outbacker requires absolutely no automatic or manual antenna tuner, the coax goes direct from the base of the antenna and ground plane over to your ham or marine SSB.

For sailboats and power boats, you may need to pass the coaxial cable through the deck or through the side of the cabin.

Deck fittings specifically made for coax cable, and made to accommodate the soldered-on PL-259, are available from many marine electronic stores, plus available through mail order from West Marine Products (1-800-538-0775).

We suggest you run RG8X marine-grade coaxial cable, also available at this same phone number and also available with coaxial cable connectors already soldered on.

But before you attach the cable to your radio, I suggest you perform some continuity checks.

With an ohmmeter

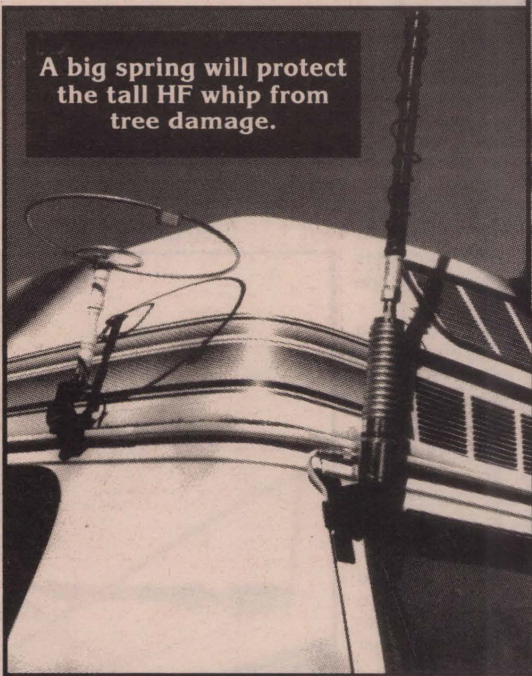
or white insulator doesn't float for a second when dropped overboard.

The best way to check VSWR (best resonance) of your antenna is with a portable VSWR bridge which contains its own built-in oscillator and frequency readout. These are manufactured by MFJ Corporation, and for the radio enthusiast are essential for checking out antenna installations (MFJ, 1-800-647-1800).

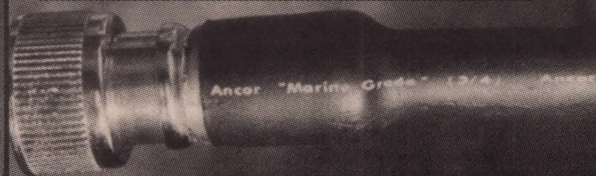
This portable test instrument lets you check VSWR without having to actually use your equipment to transmit a dead carrier over the airwaves. Everyone on the radio bands will thank you!

You wind the Outbacker lead counter-clockwise

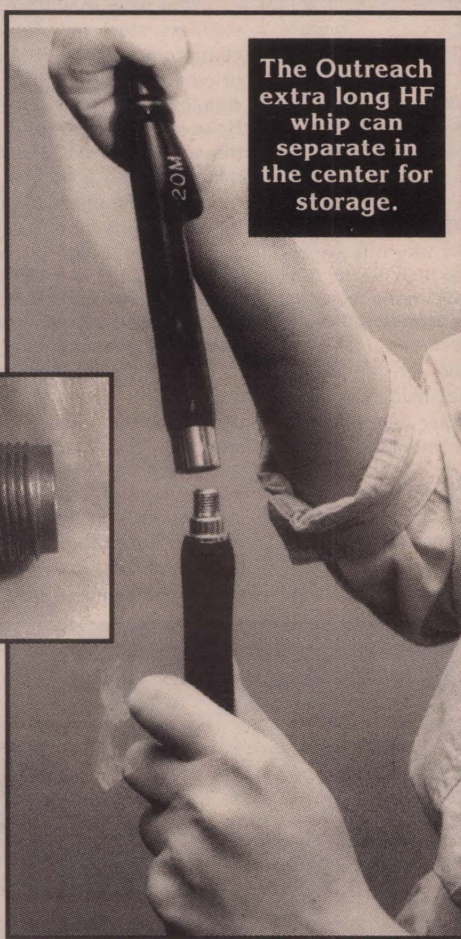
**A big spring will protect the tall HF whip from tree damage.**



**This boot will help seal out moisture from entering under the jacket at the bottom of the whip mount.**



**The Outreach extra long HF whip can separate in the center for storage.**



**Don't lose the black insulator on the marine Outbacker mount!**

the coax cable at the radio end of the circuit and the black lead to the outside sleeve. You should see no indication of continuity. While holding these connections carefully, have a friend grasp the Outbacker and antenna mount contact point with a damp hand and see whether or not you see an indication of this on your meter.

If everything is properly connected, a damp hand "shorting out" the antenna and stainless steel mount will look like some good needle action on your little ohmmeter.

If you perform the continuity test and the meter shows a dead short, I bet I can tell you what happened. Up at the antenna mount, there is a small plastic insulator that goes between the 3/8" x 24 receptor and the horizontal portion of the mount. If you loose that space overboard, or if you don't use it at all, your mount shorts out. Call me on the phone — I have spares. No, mariners, the little black

ter on its highest setting, touch the red tip to the center pin of

around the antenna shaft, and plus into the specific band of operation. Ham bands are illustrated in meters, and marine bands are indicated in megahertz. This pre-tunes the whip, and slight adjustments of lowest VSWR can be made by adjusting the tip whip.

First, see if the whip resonates on, or close to, your desired bands of operation. As the needle quickly drops to minimum VSWR, look at the frequency on your test equipment, and this indicates that everything is working like it should if you're close to where you plan to actually operate on the air.

If the best spot for antenna performance is a little higher than where you plan to operate, lengthen the tip whip by an inch and try again with your best

measurements. If the best resonance is slightly below where you would like to operate, push the tip whip in slightly and recheck.

If everything is operating properly off of a well-established counterpoise, you will see a big dip at specific resonant points on your VSWR test equipment. You will also see this same phenomena on your ham set when measuring standing wave ratio.

If your ham set does not have a VSWR bridge built in, you may need an external standing wave ratio bridge. Since most ham sets are solid-state, you can also "guesstimate" proper equipment performance to a resonance antenna by watching the

power output meter.

If power output goes all the way to the right at a certain spot while tuning, this is the frequency where your antenna is most resonant. At resonance, you should achieve maximum forward power, minimum reflected power, and best communications efficiency.

On frequencies and bands below 10 MHz, it may become necessary to write down where you have the adjustable tip whip set. On lower frequencies, adjustment of the tip whip can make for some significant improvements in antenna performance. Yet, on the higher bands, pre-setting the tip whip to the score mark felt on the tip whip will generally accommodate the entire band of frequencies without any further need of adjustments.

Aboard boats, you may find that your instrument panel indicator lamps will flicker as you speak into your microphone. This is common. It's a good sign that your antenna is putting out a lot of power. The RF power coming off of the antenna is reaching those distant stations, plus it's also

getting onto your ship's wiring, and causing the little lamps to glow at each voice syllable.

In vehicles, a properly operating whip will sometimes energize your windshield wipers, or cause your cruise control to trip off. This is not a fault of the antenna or your radio, but rather a phenomena of transmitting a lot of power in close proximity to vehicle wiring. Don't blame the antenna or radio, it's perfectly normal.

The key element in top Outbacker whip perfor-



mance is that horizontal ground plane directly below the base of the antenna mount. You will not obtain good results if you try to extend the distance to that horizontal ground plane with wire or a thin piece of copper tape.

Even though you may have mounted your antenna nice and neat on a fiberglass cabin top, and even though you have battery cable grounding the base of the antenna down to a sea water ground plate, you will not achieve resonance because the sea water ground is simply too far away from the base of the antenna. Even making a DC connection won't help. Unless your ground plane is DIRECTLY below the antenna mount, and attached physically to it, only then will you achieve great performance.

Plan your installation carefully. Make sure the antenna cannot come in contact with overhead wires. Make sure no one can touch the antenna when you are actually transmitting. Double check that your antenna installation won't pose any type of physical hazard aboard your boat or temporary installation.

Then check your installation out with a portable SWR analyzer, and prepare yourself for some terrific worldwide range!

## AND NEW FROM OUTBACKER ...

This Australian whip has been so well-received by boaters, they wanted to take it home and use it on their patio or up at the cabin. The new Outbacker tripod ground-plane system now conveniently holds the antenna in place at land, and also develops its own ground-plane system so you won't need to look around for a ground rod or a metal railing.

Initial tests of this new tripod ground-plane system are promising with communication range almost equal to that of when the antenna was originally installed aboard the boat!

Also new from Outbacker is a much longer multi-band whip called OUTREACH. This whip stands over 12' tall, but still only needs one good, strong mounting base for either marine or land operation. In recent tests with the new OUTREACH, I was able to achieve a noticeable increase in signal strength to other stations when I switched back and forth between a regular-sized 6' Outbacker and the new 12' OUTREACH.

When I ran the OUTREACH over a stainless steel rail on a sailboat, we could easily hear the difference between a regular-sized 6' Outbacker and the new 12' OUTREACH. Signal performance was definitely higher on the longer antenna.

For more information about Outbacker antennas, contact Jim Burns of Alpha Delta Communications, P.O. Box 620, Manchester, KY 40962; 606-598-2029. NV

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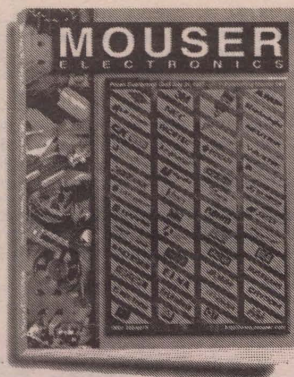
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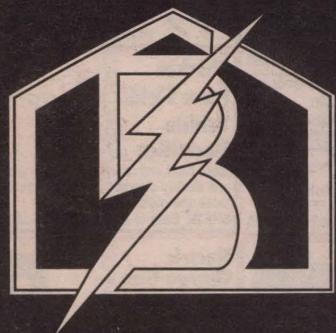
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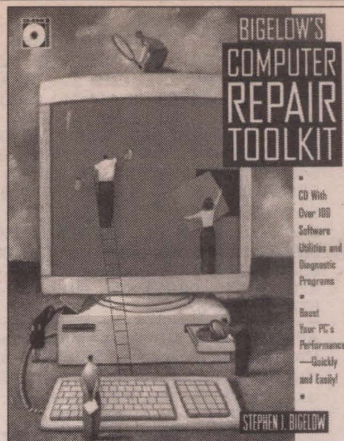
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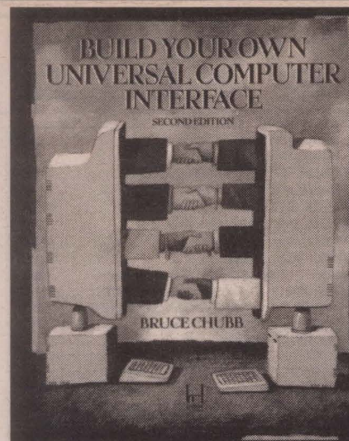


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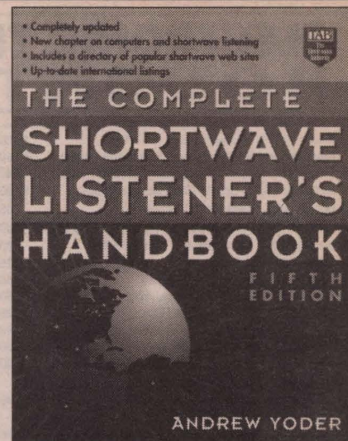
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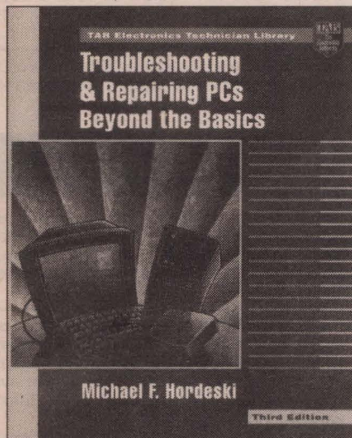
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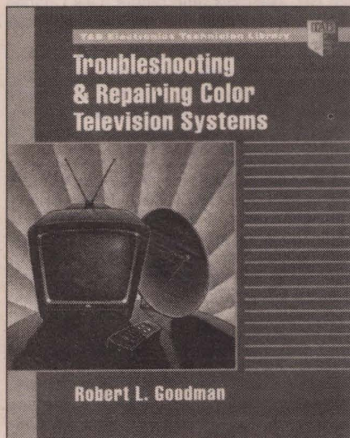
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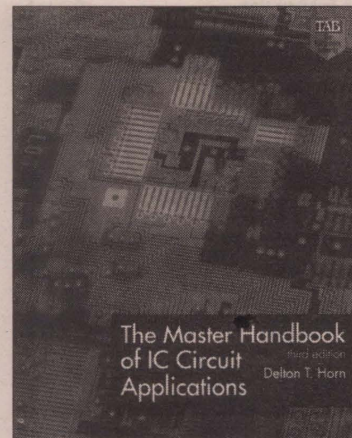
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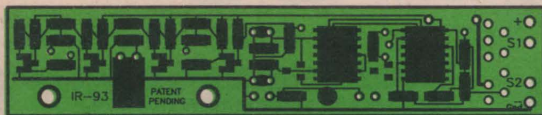
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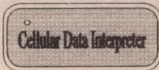
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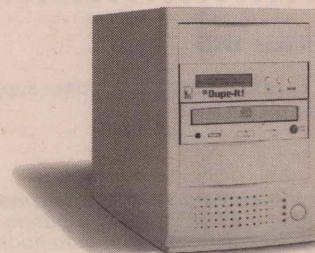
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# ELECTRONICS

## Q & A

..... With TJ Byers

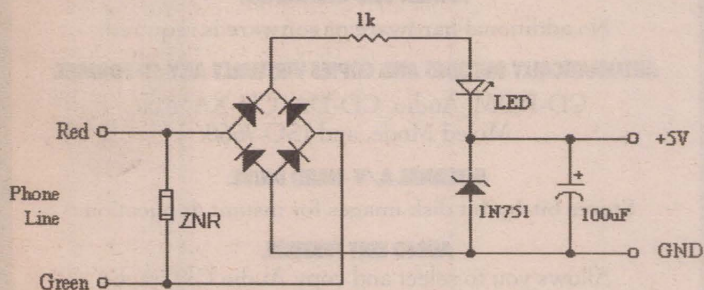
In this column, I answer questions about all aspects of electronics, including computer hardware and software. This column doesn't replace the Tech Forum that you've grown to love and support. Instead, it will supplement it, so feel free to participate as always with your questions and answers. You can reach me on America Online at TJBYSERS, on the Internet at TJBYSERS@aol.com, or by snail mail at *Nuts & Volts Magazine*, 430 Princesland Ct., Corona, CA 91719.

### Pa Bell Has To Pay This Bill

**Q.** Do you have any simple circuits for building a power supply that can supply 5 volts at 10 mA from the phone line?

**Joel Cisneros**  
via Internet

**A.** I assume that you want this circuit to power a telephone-related device, so we need to examine the two states of a phone line: a telephone on-hook and a telephone in use (off-hook). In the on-hook state, there's approximately 48 volts between the tip (red) and ring (green) phone wires. Off-hook, the voltage drops to about 10 volts. Normally this fluctuation would require a three-terminal regulator. Fortunately, phone company power is a current source, not a voltage source, of 20 mA to 40 mA. This means that you receive about the same amount of current through the line regardless of the voltage, which considerably reduces the power supply's complexity. This circuit should provide all the power you need.



As a rule, the red wire is positive and the green wire is negative – but not always. The bridge rectifier corrects for polarity reversal on the telephone company's part or on your part. The 1K resistor limits the current to 10 mA with a 10-volt input (that's 20 mA at 20 volts), and the LED is simply a power-on indicator. The zener prevents the output voltage from exceeding 5.1 volts. My concern is your current needs, because most phone circuits draw 1 mA or less. You see, the phone company triggers its on-hook/off-hook circuits on current flow. When it detects a significant increase in current through the phone line, you become connected. So, if you're using this circuit to monitor an on-hook condition, the current flow may be enough to trigger Pa Bell's relays, which would put you on-line when you don't want it. Increasing the size of the resistor will prevent this from happening, but it also limits the available current.

### Under Pressure

**Q.** I live in an area where we must use sprinklers to keep the yard looking good, which is why my neighbors have automatic sprinklers. The problem is that we don't have a lot of water, and the water pressure goes up and down as the automatic sprinklers go on and off. I would like to monitor the water pressure as a function of time using a simple monitoring circuit so that I can find my time slot. What do you suggest?

**Hilary McDonald**  
Barstow, CA

**A.** Before I answer the question, let me tell our readers that you live in the high desert of southern California (I used to live not far from there), where the days are very hot and the nights are very cold. So the lawn or ground cover is more than prestigious – it moderates the extreme temperature swings. Now the answer. I would use an oil pressure gauge – the kind used in autos and trucks – to monitor your water pressure. These sensors are resistive devices, generally in the range of 0-100 ohms, that have a range of 0 to 100 psi. Two reasons for my selection: they are cheap and easy to find, and they have standard pipe threads, so they're easily insert-

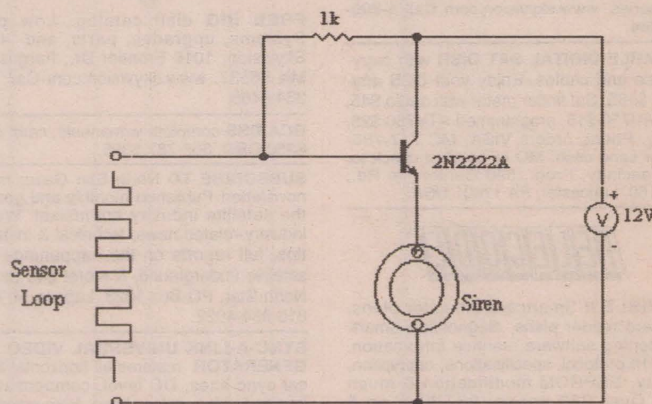
ed in your water line using off-the-shelf hardware. Just make sure you buy a pressure sender, and not a pressure switch. You can buy a pressure sender from **JC Whitney** (<http://www.jcw-catalog.com>; 312-431-6102) for \$21.95 (catalog number 12KZ8992W). There is a companion digital pressure readout (12KZ8988U) for \$35.95, but if you're just looking for relative water pressure rather than absolute, you can chart fluctuations using a DMM (ohmmeter).

### Ultra-Simple Home Security Alarm

**Q.** I made a small security system for an on-site office trailer with eight windows and one door. I ran foil tape around each window, and wired it in series with a magnetic switch on the door, to detect if it was open or closed, and hooked it to a 12 VDC wall adapter plugged into a UPS. A keyswitch mounted in the wall turns the system on and off. What I want to do is use this "chain" to sound an alarm if the door is opened or the foil is broken. The alarm is a 12-volt Radio Shack siren that draws about 400 mA. This is what I'm thinking: I should be able to monitor the security loop with a single transistor that would trigger the siren if the loop is broken. Do you think this is the cheapest way to do this, and what transistor should I use?

**Tony Farrell**  
via Internet

**A.** You're definitely on the right track. A switching transistor is the cheapest – and easiest – solution. To further simplify the design, I would take the +12 volts off the security loop, and return it to ground instead. You'll also need a biasing resistor between the collector and the base. Here's how it looks.



The transistor is a general-purpose NPN bipolar type, like a 2N2222A (Radio Shack 276-2009). The 2N2222A can handle up to 800 mA of current, yet comes in a small TO-92 plastic package. When the security loop is intact, it shorts the base to the emitter, which turns off the transistor. If the loop is broken, current flows through the base via the 1K resistor, which turns the transistor on and sounds the alarm. Repairing the break turns the alarm off.

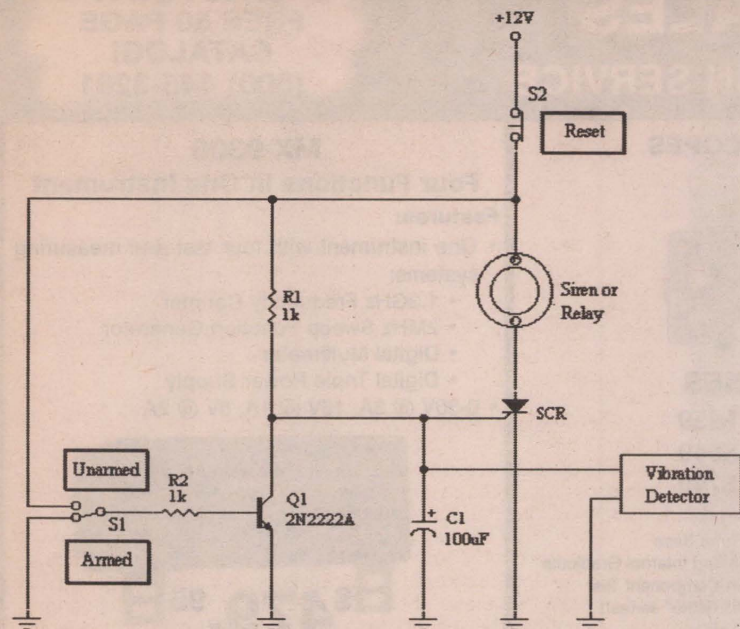
### Ultra-Simple Car Alarm

**Q.** I need a simple, sturdy circuit that will sound a siren when a piece of electronic equipment (stereo, CB, etc.) is removed from my 1982 Plymouth Horizon. At first I thought a circuit that detected when the ground lead was broken would be the easiest approach. However, I've tried two methods, both overly complicated and marginally functional, and a simpler one which SHOULD have worked, but instead went up in smoke after a few miles of driving. So I'm back to square one. Got any suggestions?

**Michael E. Keller**  
Lancaster, PA

**A.** It's been my unfortunate experience that the last thing a thief does is yank out – not gently disconnect – the wires. At this point, a screaming siren does little more than make him run all the faster with your radio in hand. The first thing he does is bash in a window, then the dash. So a better solution is to attach a vibration detector to your radio or stereo and have it trigger the siren. Here's a simple sensor circuit built around a Radio Shack vibration detector (49-521)





With S1 in the unarmed position, Q1 conducts, which shorts the gate of the SCR to ground and prevents the SCR from firing. Flipping S1 to the armed position turns off Q1. The vibration detector is of the closed loop type — that is, it's closed at rest. When a vibration is detected, as would happen when a thief smashes your dash, the detector opens. This causes C1 to charge through R1. When the voltage across C1 reaches about 1.5 volts (about one-tenth of a second), the SCR fires and activates the siren. This RC time delay prevents false triggering from passing cars and other ambient noises. Once triggered, the SCR continues to conduct — even if the vibrations quit — until S2 is pushed. For automatic reset, S2 can be replaced with a mechanical or electronic timer (such as one built around a 555 chip).

### COMMAND.COM, Where Are You?

**Q.** I recently encountered a problem with my command prompt. I started getting the following message.

Bad or missing Command interpreter.

Enter the correct name of Command Interpreter (e.g., C:\COMMAND.COM)

The only way I can get the command prompt to come up by itself is to put a SHELL command in the CONFIG.SYS file. But now I have to type AUTOEXEC.BAT at the prompt to get my system to run. It seems that the computer can't find the AUTOEXEC.BAT file anymore. I am running Windows 3.1 and DOS 6.22.

Larry Davis  
Naples, FL

**A.** Somehow, COMMAND.COM has been erased from the root directory (C:\). You'll find a copy of this file in the C:\DOS directory. Simply copy the file to the root directory and your problem will be solved. See this month's Reader's Tip for more information about COMMAND.COM.

### Removing Engine Static

**Q.** What formula can I use to determine the value to look for in buying a static or interference eliminator for a 12-volt auto radio? My friends at Radio Shack don't know what to sell me!

Don Schlaeder  
Mesa, AZ

**A.** There is no empirical formula. What you need to do is first determine the source of the interference, then go from there. Engine noise comes from three basic sources: high-voltage discharge, ignition, and alternator. Often the

noise you hear is from more than one source. The most frequent source of engine noise is the alternator. It sounds like a whine that changes frequency with engine speed: the higher the RPM, the higher the pitch. Just as popular are ignition noises, which sound like popcorn popping. Like alternator whine, the number of pops increases as the engine speed increases. Both nuisances can be removed with a choke/capacitor filter combination. Radio Shack sells three of them, ranging in size from 3 amps (270-030, \$3.99) to 10 amps (270-051) to 20 amps (270-055, \$19.99). The one you choose depends on how much current your stereo draws, and not the amount of noise or the size of the alternator. The last culprit is high-voltage discharge, which is RF radiation emitted by the spark plug wires and picked up by the radio's antenna. Most cars use carbon-filled plug wires to eliminate the RF emissions. If your car doesn't have carbon-suppressing wires, you can buy a kit of them from most auto parts stores, or you can buy a resistive noise filter from Radio Shack (270-012). It's basically a carbon resistor that plugs into the center lead of the distributor cap; while effective, carbon spark plug wires are better. The other two noise suppressors that Radio Shack (and others) sells are feed-thru filters. These devices are inserted in the 12-volt line just before it enters the stereo. All three types of filters can be used separately or in conjunction with each other.

### Shut Up!

**Q.** I'm someone who is easily irritated by the noise coming out of a PC. There is an outfit in Hayward, CA (**Decibel Instruments**; <http://www.decibel.com/quiet.html>, 800-875-8829) that modifies PCs to make them quieter and sells them for a steep price. A salesperson from the company said that they modify both the power supply and the hard disk. Can you guess what it is that they do, and tell me?

J. Lynch  
Waynesburg, PA

**A.** You and my girlfriend! She's forever complaining about noise of all kinds. I don't have to guess what Decibel Instruments is doing, they are more than happy to tell you all about it. First, they remove all the fans, including the one in the power supply. The fans account for more than 90 percent of the noise coming from the PC. To compensate for the loss of cooling air, they add extra heatsinks to the semiconductors — especially the CPU — to remove the heat build up. How hot the chip runs determines what type of heatsink they use. In some cases, it is a simple aluminum radiator, and in others it's a more expensive heat pipe. As for the hard disk noise, they purchase and install drives that are specially designed for lower noise levels. These, too, come at a premium. The bottom line: silence is golden.

### Battery Gas Gauge

**Q.** A friend of mine, Steve KE3OD, is building a 12-volt gel-cell battery pack to power his electronics when we're out in the field. What he needs, though, is a battery monitor so that we know how much power is left in the battery pack as the work progresses. What we'd like is a bar graph indicator that displays no bars when the battery is depleted and all bars when the battery is fully charged.

Charlie Heisler K3VDB  
Continued on page 113

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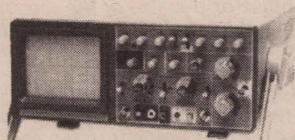
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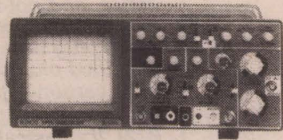
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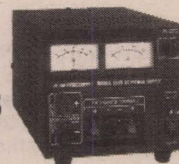
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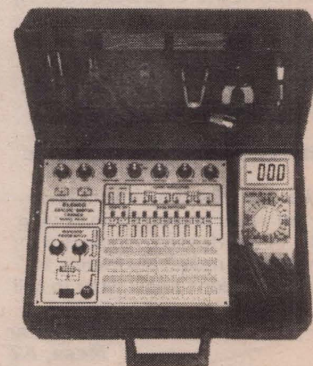
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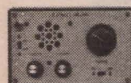


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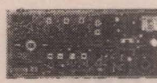
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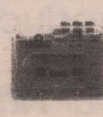


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# The most powerful computer in the universe is actually the simplest.

Programmers today are faced with an embarrassment of riches. Software tools are rich and plentiful, and hardware is powerful and cheap. One simple way to measure the ever increasing complexity and sophistication of software tools is to see what it takes to produce a "Hello, world!" program.

In the early days of C and UnixTM, it only took a few lines of source code. Now, using a Windows

by Jeff Stefan

# Turing Machines

**This article explains the concept of Turing Machines and provides a simple Turing Machine simulator you can experiment with.**

C/C++ compiler or other GUI programming tool, even producing a simple "hello world" program involves hundreds of lines of support code that the application programmer rarely sees.

The programming environments can be large because the machines available today rise in power as they fall in price. Tools are getting easier to use and debuggers are getting more sophisticated. It's a good time to be a programmer, but sometimes we're blinded by the power and elegance of our software tools and hardware platforms.

## First Principles and Some History

Sometimes it's worthwhile to

step back and look at the world in terms of first principles. Physicists (at least the good ones) view the world from first principles. In mathematics, first principles are called axioms.

It's refreshing to get away from the everyday routine of cranking out programs and to think about computers in terms of axioms. What do axioms have to do with writing computer programs? Try to answer this simple question: what is a computation? See the sidebar *What is a Computation?* for the surprising answer.

The world as we know it changed in 1936. The same year the Hoover Dam began generating electricity and Shirley Temple was the top box office draw, a 24-year-old Englishman named Alan Turing completed a paper called "On Computable Numbers" with an application to the

Entscheidungsproblem.

Entscheidungsproblem is the German expression for the question of decidability. For an explanation of decidability, see the sidebar *What is Decidability?*

In his somewhat obscure paper, Turing described an abstract universal computing machine, now called a Turing Machine.

As it turns out, there is no greater machine, theoretical or real, that equals the capability of a Turing Machine.

The Turing Machine is at the bedrock of modern computer science. Turing's abstract machine, as he insisted from the start, could actually be built.

Unfortunately, 1936 was also the year that 4,000 Nazi troops quietly slipped into the Rhineland and occupied the de-militarized zone dictated by the Treaty of Versailles, foreshadowing the beginning of World War II.

In 1940, with England at war, and with German U-boats ruthlessly destroying convoy ships, Turing (and other talented mathematicians) were conscripted by the British high command to help crack German military codes.

Luckily, a secret German cipher machine called "Enigma" was captured from a sinking U-boat. With the added bonus of the captured Enigma, Turing cracked the supposedly unbreakable Enigma code and had a significant hand in the Allies winning the war in the North Atlantic.

The unfortunate effect of the war is that it halted the

development and materialization of a Universal Turing Machine.

After World War II, a race of sorts between England and the United States to build the first digital computer was off and running. England was building the ACE (Automatic Computing Engine), and the United States was building

## A Turing Machine

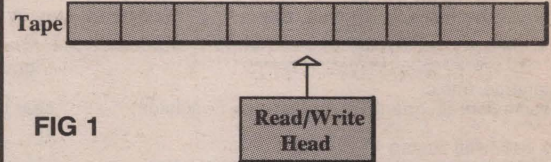


FIG 1

the ENIAC (Electronic Numerical Integrator And Calculator). Turing was on the periphery of the ACE project and not at the heart of the hardware design, so he turned his thoughts to instruction tables, or what we now call software.

## The Standard Turing Machine

A Standard Turing Machine is shown in Figure 1. It consists of a read/write head and a tape of infinite length that can move right or left one segment at a time. The read/write head reads and writes symbols on the tape.

The read/write head, (sometimes called the control head), can read, write, or erase a symbol on the tape segment it is currently under, but only one segment at a time. Believe it or not, this simplest of simple computers is capable of doing anything the most powerful supercomputer can do.

Sooner or later, if you study Turing Machines, you'll be confronted with formal notation. It's a little intimidating at first, but it's really useful and easy to understand. See Figure 2 for an explanation of the Turing Machine symbols.

## Turing Machine Symbols

The symbolic definition of a Standard Turing Machine is:

$$M = (Q, \Sigma, \Gamma, \delta, q_0, B, F)$$

FIG 2

**M** stands for the Turing Machine.

**Q** is a set of states within the Turing Machine.

**$\Sigma$**  is called the **input alphabet**. This is a set of symbols that the Turing Machine will be working with. The input alphabet includes all of the characters in the tape alphabet except B.

**$\Gamma$**  is called the **tape alphabet**. The tape alphabet is the set of symbols that appear on the tape, including B.

**$\delta$**  is the transition function.  $\delta$  is defined as  $Q \times \Gamma = Q \times \Gamma \times \{L, R\}$ . This means that when the read head encounters a symbol on the tape, it can change state, write a symbol on the tape, and move either left L, or right R. The x symbol in the formula means all of the elements from each set are used. This is called the **Cartesian Product**.

**B** is a blank symbol.

**$q_0$**  is the initial, or starting state.

**F** is a set of final states.



## What is a Computation?

The answer is: *the sequence of configurations in a Turing Machine leading to a halt state is called a computation.* This means that if your algorithm runs successfully on a Turing Machine, it's a computation. If it doesn't, then it's not a computation!

The formal definition of a Turing Machine, denoted as  $M$ , is  $M = (Q, \Sigma, \Gamma, \delta, q_0, B, F)$ .

Here's what it means:  $Q$  is a set of finite states,  $\Sigma$  (sigma) is the input alphabet,  $\Gamma$  (gamma) is the tape alphabet,  $\delta$  (delta) is the transition function,  $B$  is a blank symbol,  $q_0$  is the starting state, and  $F$  is the final state. Greek letters are used as a notation convention in theoretical computer science, just as they are used in mathematics.

Let's look at an example so you can get the feel of how a Turing Machine works. Assume we have a tape filled with the symbols  $a$  and  $b$  and framed by a blank symbol on each end, as shown in Figure 3.

We'll set the starting position under the left blank. This is the initial state  $q_0$ . What we want the Turing Machine to do is to change every  $a$  to  $b$ , and every  $b$  to  $a$ . We'll call this Turing Machine the Symbol Exchanger. In order to program the Turing Machine to do the symbol exchange, we need to develop a set of rules, or transition functions,  $\delta$ . Here are the rules in English, then

translated into Turing Machine symbols: Begin at the initial state,  $q_0$ .

If a blank is over the read head then re-copy a blank on the tape, set the state to the new state  $q_1$ , and advance the read head to the right. Symbolically, we can write this as  $(q_0, B) = \{q_1, B, R\}$ . In general, this means  $(\text{State}, \text{Symbol}) = \{\text{NewState}, \text{NewSymbol}, \text{MoveTo}\}$ . Using symbols, we can reduce the long verbal description to a short, precise symbolic declaration. That's the value in taking the time to learn and manipulate the symbols.

What's next? The Turing Machine is now in state  $q_1$ , and now we want the machine to look for an  $a$  or  $b$  and exchange them, so we need more transition functions. For state  $q_1$ , if an  $a$  is over the read head, stay in state  $q_1$ , write the symbol  $b$  on the tape, and advance the head to the right. This translates to  $(q_1, a) = \{q_1, b, R\}$ . If a  $b$  is over the read head, stay in  $q_1$ , write an  $a$  on

the tape, and advance the head to the right. This translates to  $(q_1, b) = \{q_1, a, R\}$ .

In order to get the machine to halt in a final state  $F$ , we need one more transition function. If a blank symbol  $B$  is over the read head, then halt the Turing Machine. This translates to  $(q_1, B) = \{F\}$ . This transition function is not formally defined when executing a Turing Machine.

In order to get a Turing Machine to halt, there must be a transition that is not defined, so the read head

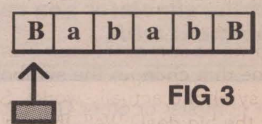


FIG 3

cannot advance to the right or left. All of the transition functions that describe the Turing Machine are listed in Figure 4. Each of our transitions is called a configuration. This is the sequence of configurations that is called out in the sidebar

```

/*****
 * Filename: tms.c
 * Description: Standard Turing Machine Simulator.
 *
 * (c) 1997 Jeff Stefan
 *****/

#include <stdio.h>
#include <string.h>
#include <conio.h>

#define MAX_TRANSITIONS 30
#define MAX_TAPE_LEN 50
#define MAX_FILENAME_LEN 13
#define MAX_FILE_LINE_LEN 80

#define SINGLE_STEP 1
#define AUTO 2

/*****
 * Function prototypes
 *****/

int ReadTape();
int DisplayTape();
int DisplayTransitions(int,int);
int ReadTuringMachine();
int ExecuteTransitions();
void PressEnterMsg();

/*****
 * Turing Machine structure
 *****/

typedef struct tm
{
    int State;
    char Symbol;
    int NewState;
    char NewSymbol;
    char MoveTo;
} TURING_MACHINE;
TURING_MACHINE TM[MAX_TRANSITIONS];
int NumTransitions = 0;

/*****
 * Single Step or Auto mode
 *****/

int Mode = 0;

```

```

* Input tape array
*****/
char InputTape[MAX_TAPE_LEN];

/*****
 * File pointers
 *****/
FILE *Tapefp;
FILE *TMfp;
char FileName[MAX_FILENAME_LEN];

void main(void)
{
    int Selection = 0;
    int ch;

    clrscr();
    printf("\n\nTMS: Turing Machine Simulator\n");
    printf("\n");
    printf(" 1: Single Step\n");
    printf(" 2: Auto\n");
    printf("\n");
    printf("Make Selection: ");
    Selection = getchar();
    Selection = abs(48 - Selection);
    switch(Selection)
    {
        case 1: /* Single Step Mode */
            Mode = SINGLE_STEP;
            ch = getchar();
            break;

        case 2: /* Auto Mode */
            Mode = AUTO;
            ch = getchar();
            break;

        default:
            Mode = AUTO;
            ch = getchar();
            break;
    }

    ReadTape();
    ReadTuringMachine();
    ExecuteTransitions();
    DisplayTape();
}

```

```

/*****
 *:: ReadTape
 *****/

int ReadTape()
{
    int i;
    char TapeFileName[MAX_FILENAME_LEN];
    char ch;

    /*****
     * init tape to all blanks B
     *****/
    for(i=0; i < MAX_TAPE_LEN; i++)
        InputTape[i] = 'B';
    i=0;

    /*****
     * Open input tape file
     *****/
    printf("Enter Input Tape Filename: ");
    gets(TapeFileName);
    printf("\n");
    Tapefp = fopen(TapeFileName, "r");

    /*****
     * exit if file doesn't exist
     *****/
    if(Tapefp == NULL)
    {
        printf("No Input Tape\n");
        exit(0);
    }

    /*****
     * read tape symbols starting from first B to last B
     * and load InputTape array.
     *****/
    while(!feof(Tapefp))
    {
        ch = fgetc(Tapefp);
        switch(ch)
        {
            case '\n': /* ignore blanks */
                break;

            case NULL: /* ignore NULLs */

```



## What is a Computation?

Now we need to run the Turing Machine to see if it works. In most classical Turing Machine literature, a move from one transition to another is indicated by ( . This symbol denotes a running Turing Machine. Figure 5 shows both a graphical and classical representation of our Turing Machine as it runs.

It becomes very cumbersome and takes a lot of space to use a graphical representation for a Turing Machine of any sophistication, so you will hardly ever see them. You will almost always see the classical representation. As you can see in Figure 5, the read head is indicated by the transition functions,  $q_0$  and  $q_1$ . The symbol to the right of the read head is considered to be the symbol under the read head. As the read head reads the tape, it travels right or left and re-writes the symbol on the tape.

So we've shown that our Turing Machine that changes the symbol a to the symbol b actually works. So what's the big deal? Well, the big deal is that the algorithm to convert

one character to another is truly a computation and, since it runs correctly on a Turing Machine, it should run on any conceivable computer in the universe! That's how deep and profound a Turing Machine really is.

### Turing Machine for BababB

$M = (Q, \Sigma, \Gamma, \delta, q_0, B, F)$

$(q_0, B) = \{q_1, B, R\}$

$(q_1, a) = \{q_1, b, R\}$

$(q_1, b) = \{q_1, a, R\}$

$(q_1, B) = \{F\}$  **FIG 4**

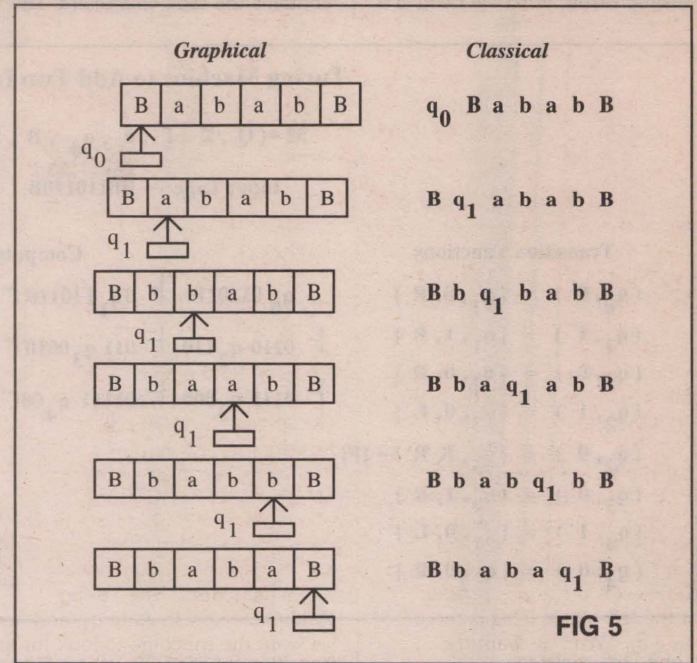
What about adding two numbers together? We know intuitively that it's indeed a computation, but how do you prove it? See if it runs on a Turing Machine!

One way to express numbers on a tape is to use unary format. In unary format, the number two is expressed as 0110. Three ones are used to represent the number three, and zeros are used to separate the numbers. The number five is unary format is 0111110. We want to see if

two plus two is a computation, so the tape will look like B0110110B (don't forget that the tape is full of blanks, so we have blank symbols

reaching into infinity on both ends of the tape).

How can we create a Turing Machine to add these two unary



**FIG 5**

```
break;

case ' ': /* ignore spaces */
break;

case EOF: /* End Of File detected */
break;

default:
InputTape[i++] = ch;
break;
}

/* init tape to all blanks B
***** */

printf("Input Tape:\n");
for(i=0; i < MAX_TAPE_LEN; i++)
printf("%c", InputTape[i]);
printf("\n");

/* close file
***** */
if(Tapefp)
fclose(Tapefp);
return(0);
}

/* ReadTuringMachine
***** */

int ReadTuringMachine()
{
int Index = 0;
char TMFileName[MAX_FILENAME_LEN];
char FileLine[MAX_FILE_LINE_LEN];
char *ptr;
char *Result;

/* Open Turing Machine file
***** */
printf("Enter Turing Machine Filename: ");
gets(TMFileName);
printf("\n");
TMfp = fopen(TMFileName, "r");

/* exit if file doesn't exist
***** */
if(TMfp == NULL)
{
printf("No Turing Machine file\n");
exit(0);
}
}
```

```
/* Read and load all of the transition functions.
***** */
while(!feof(TMfp))
{
Result =
fgets(FileLine, MAX_FILE_LINE_LEN, TMfp);
if(Result == NULL)
break;
ptr = FileLine;

/* Load transition function into TM structure.
***** */
do
{
/* ignore comments
***** */
if(*ptr == 'C')
break;
/* Start of transition function
***** */
if(*ptr == '(')
{
ptr++; /* index to State */
TM[Index].State = abs(48 - (int)*ptr);

ptr++; /* index to comma */
ptr++; /* index to symbol */
TM[Index].Symbol = *ptr;

/* Look for right half of transition function.
***** */
while(*ptr != ')')
{
ptr++;
ptr++;
TM[Index].NewState = abs(48 - (int)*ptr); // points
to new space
ptr++; ptr++;
TM[Index].NewSymbol = *ptr;
ptr++; ptr++;
TM[Index].MoveTo = *ptr;
Index++;
} while (*ptr++ != '\n');
} while (!feof(TMfp));

NumTransitions = Index;
/* close file
***** */
if(TMfp)
```

```
fclose(TMfp);
return(0);
}

/* ExecuteTransitions:
***** */

int ExecuteTransitions()
{
static int TapeCtr = 0;
static int TMCtr = 0;
static char CurrentSymbol = 'B';
static CurrentState = 0;

int Done = 0;
int Found = 0;
int i;

/* Get start state and starting symbol
***** */
CurrentState = TM[TMCtr].State;
CurrentSymbol = TM[TMCtr].Symbol;
DisplayTransition(CurrentState, TapeCtr);
printf("\n");

while(!Done)
{
/* Check for match between the transition
* function symbol and tape symbol.
***** */
if(CurrentSymbol == InputTape[TapeCtr])
{
/* Search through transition functions to
* find a match and write new symbol on tape.
***** */
for(TMCtr=0; TMCtr < NumTransitions; TMCtr++)
{
if(CurrentState == TM[TMCtr].State)
{
CurrentSymbol = TM[TMCtr].Symbol;
if(CurrentSymbol == InputTape[TapeCtr])
{
InputTape[TapeCtr] =
TM[TMCtr].NewSymbol;
CurrentState = TM[TMCtr].NewState;
break;
}
}
}

/* Move right R or left L according to transition
* rule
***** */
```



numbers? Look at the tape for a while. The result we want is four, or 011110. If we can shift the rightmost ones to the left one place, we'll have the desired result. What we need is a

consists of three parts: the input tape file, the transition functions file, and the tms.exe simulator. The input tape file is an ASCII text file that contains the tape characters. The

file is the program source code, the input tape file is the data, and the tms.exe program is the interpreter. The process of reading a source code file, breaking the source into

individual symbols or tokens, then storing the tokens in a data structure is called parsing. Our parser is in the function ReadTuringMachine( ).

To keep the code length short, ReadTuringMachine( ) contains little error checking. This means that the transition function file needs to be reasonably correct, since ReadTuringMachine( ) does not detect syntax errors.

The input tape symbols are loaded into the InputTape[MAX\_TAPE\_LEN] array. The transition functions are loaded into an array of TURING\_MACHINE structures. The TURING\_MACHINE structure and its relationship with the formal transition functions is illustrated in Figure 7.

The Turing Machine simulator can be run in Single Step mode, which executes one transition at a time, or in Auto mode, which executes all of the transition functions at full speed. The input tape, transition

### Turing Machine to Add Two Integers

$M = (Q, \Sigma, \Gamma, \delta, q_0, B, F)$

Input Tape = B0110110B

#### Transition Functions

$(q_0, 0) = \{q_1, 0, R\}$   
 $(q_1, 1) = \{q_1, 1, R\}$   
 $(q_1, 0) = \{q_2, 0, R\}$   
 $(q_2, 1) = \{q_3, 0, L\}$   
 $(q_2, 0) = \{q_5, B, R\} = \{F\}$   
 $(q_3, 0) = \{q_4, 1, R\}$   
 $(q_4, 1) = \{q_1, 0, L\}$   
 $(q_4, 0) = \{q_2, 0, R\}$

#### Computation Trace

$q_0$  0110110  $\vdash$   $0q_1$  110110  $\vdash$   $01q_1$  10110  $\vdash$   $011q_1$  0110  
 $\vdash$   $0110q_2$  110  $\vdash$   $011q_3$  0010  $\vdash$   $0111q_4$  010  $\vdash$   $01110q_2$  10  
 $\vdash$   $0111q_3$  000  $\vdash$   $01111q_4$  00  $\vdash$   $011110q_2$  0  $\vdash$   $011110Bq_5$   $\vdash$   $\{F\}$

FIG 6

form of a shift register.

It's amazing how much a Turing Machine emulates a modern computer, and it was invented in 1936! Figure 6 shows the transition functions for the adder, and the Turing Machine in action using the classical notation. Run this through the Turing Machine Simulator to verify how it works.

### The Turing Machine Simulator TMS

The Turing Machine Simulator

transition function file uses a format similar to the classical Turing Machine form. Comments are also accommodated by placing a C at the beginning of a line. With the somewhat cryptic nature of the classical Turing Machine notation, the liberal use of comments is usually necessary (if you want to remember what you did!). A rudimentary parser reads the transitions from the source file and loads the transitions into an array of structures.

What we've really built is an interpreter. The transition function

### Transition Function to Structure Map

The formal transition function:

$(\text{State}, \text{Symbol}) = \{\text{NewState}, \text{NewSymbol}, \text{MoveTo}\}$

maps directly to the structure:

```
typedef struct tm
{
    int State;
    char Symbol;
    int NewState;
    char NewSymbol;
    char MoveTo;
} TURING_MACHINE;
```

FIG 7

```
if(TM[TMCtr].MoveTo == 'R' || TM[TMCtr].MoveTo == 'r')
{
    if(TapeCtr < MAX_TAPE_LEN)
    {
        TapeCtr++;
        if(Mode == SINGLE_STEP)
            PressEnterMsg();
        DisplayTransition(CurrentState, TapeCtr);
    }
    else
    {
        printf("Ran out of tape:RIGHT END — Turing Machine FAILED\n");
        exit(0);
    }
}
else
{
    if(TM[TMCtr].MoveTo == 'L' || TM[TMCtr].MoveTo == 'l')
    {
        if(TapeCtr > 0)
        {
            TapeCtr--;
            if(Mode == SINGLE_STEP)
                PressEnterMsg();
            DisplayTransition(CurrentState, TapeCtr);
        }
        else
        {
            printf("Ran out of Tape:LEFT END — Turing Machine FAILED\n");
            exit(0);
        }
    }
    /* if */
    /* else */
    /* if */
    else
    {

```

```
/******
 * search for new transition function at
 * beginning of list.
 *****/
Found = 0;
for(TMCtr=0; TMCtr < NumTransitions; TMCtr++)
{
    if(CurrentState == TM[TMCtr].State)
    {
        CurrentSymbol = TM[TMCtr].Symbol;
        if(CurrentSymbol == InputTape[TapeCtr])
        {
            Found = 1;
            break;
        }
    }
    /* if */
    else
    {
        if(TMCtr >= NumTransitions)
        {
            printf("\nTuring Machine HALTED\n");
            Done = 1;
        }
    }
    /* for */
    if(Found == 0)
    {
        printf("\nTuring Machine HALTED\n");
        Done = 1;
    }
}
/* while */
return(0);
}

/******
 * DisplayTransitions:
 *
 *****/
int DisplayTransition(int State, int TapePos)
```

```
{
    int i;

    if(Mode == AUTO)
        printf("\n");

    for(i=0; i<TapePos; i++)
        printf("%c", InputTape[i]);
    printf("(q%d)", State);

    for(i=TapePos; i<MAX_TAPE_LEN; i++)
        printf("%c", InputTape[i]);
    return(0);
}

/******
 * DisplayTape:
 *
 *****/
int DisplayTape()
{
    int i;

    printf("\nFinal tape contents : \n");
    for(i=0; i<MAX_TAPE_LEN; i++)
        printf("%c", InputTape[i]);
    return(0);
}

/******
 * PressEnterMsg:
 *
 *****/
void PressEnterMsg()
{
    int InKey;

    printf("\nPress Enter for next transition:");
    InKey = getchar();
}
```



functions, and computation trace for the symbol exchanger are shown in Figure 8.

Hopefully, this article has turned

you on to Turing Machines. The simple Turing Machine program designed here is just a starting point. There are multi-tape Turing

Machines, Universal Turing Machines, and many other variations. Adapting the TMS program to read multiple tapes would be an

interesting project.

Thinking in terms of Turing Machines can be difficult and laborious at times, but the reward is the gained insight into the fundamental nature of computation. It's fun to write Turing Machines and watch them chug away on the simulator.

Try designing a Turing Machine to copy strings or to do other fundamental arithmetic operations such as subtraction or multiplication. Some machines may be easy to create, and some may be profoundly difficult. Try it and see. Just create an input tape file and a transition function file.

I usually put a .dat extension on the input tape files and a .tm extension on the transition function files. There is no naming constraint, so use your own system if you like.

Want to learn more? There are plenty of web sites that contain detailed, interesting information about Turing Machines, and plenty of transition functions that you can find to run through the simulator.

Remember, out of all of the sciences, computer science is still in its infancy. There are many important discoveries to make and great problems to solve.

Great discoveries are made from the framework of first principles. Using a first principle device, such as a Turing Machine, may aid in the way. NV

### Screen Output

TMS: Turing Machine Simulator

1. Single Step

2. Auto

Make Selection:2

Enter Input Tape Filename: tape1.dat

Input Tape:

BababBBBBBBBBBBBB

Enter Turing Machine Filename: tmach.tm

(q0)BababBBBBBBBBBB

B(q1)ababBBBBBBBBBB

Bb(q1)babBBBBBBBBBB

Bba(q1)abBBBBBBBBBB

Bbab(q1)bBBBBBBBBBB

Bbaba(q1)BBBBBBBBBB

Turing Machine HALTED

Final Tape Contents:

BbabaBBBBBBBBBB

### Transition Function File (tmach.tm)

C -----

C Standard Turing Machine that

C changes a to b.

C -----

(0,B) = {1,B,R}

(1,a) = {1,b,R}

(1,b) = {1,a,R}

### Input Tape File (tape1.dat)

BababBBBBBBBBBBBB

FIG 8

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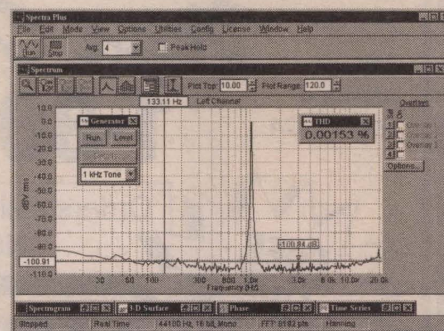
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# Electric Field Proximity Sensor

**No movement is required for this sensor to detect the presence of a human body through solid objects.**

Name a simple, non-mechanical device, that can detect the presence of either a moving or stationary human body, through solid objects, from a distance of yards.

Having a hard time? Don't feel bad, so did I until I stumbled across some research being done by a group of scientists and engineers at MIT. Their work has provided the answer to a number of unsolved

Although able to sense stationary objects, photoelectric sensors are visible, must be carefully positioned, and are subject to changes in lighting. For both aesthetic and security reasons, a sensor should not be seen.

Then there is PIR (infrared). Although less position-sensitive than photoelectric, it requires a moving, heated body to respond, and the sensors are still visible.

PIR is also particularly sensitive

1920s when Leon Theremin noticed the effect body position was having on his radio experiments (it was messing them up).

Following the advice — "If you can't fix it, feature it" — Theremin invented, you guessed it, the Theremin. It consisted of two electrodes coupled to an audio oscillator and amplifier.

Employed as a musical instrument, when the user moved his

Changes in the strength of the received signal trigger the sensor. The range can be adjusted from a few millimeters to an entire room.

Simple antennas can be completely hidden under wood, carpets, or upholstery. Antenna wires placed under the molding on either side of a door frame will detect persons entering or leaving a room. Two runs of wire under cushions or a bed pad can sense the stationary presence of a person on a bed, chair, or couch.

The circuit uses high-gain operational amplifiers and a process called synchronous detection to achieve noise immunity greater than 72 dB. The circuit board is a little over 5 1/2" x 3" and is housed in a low-profile plastic cabinet.

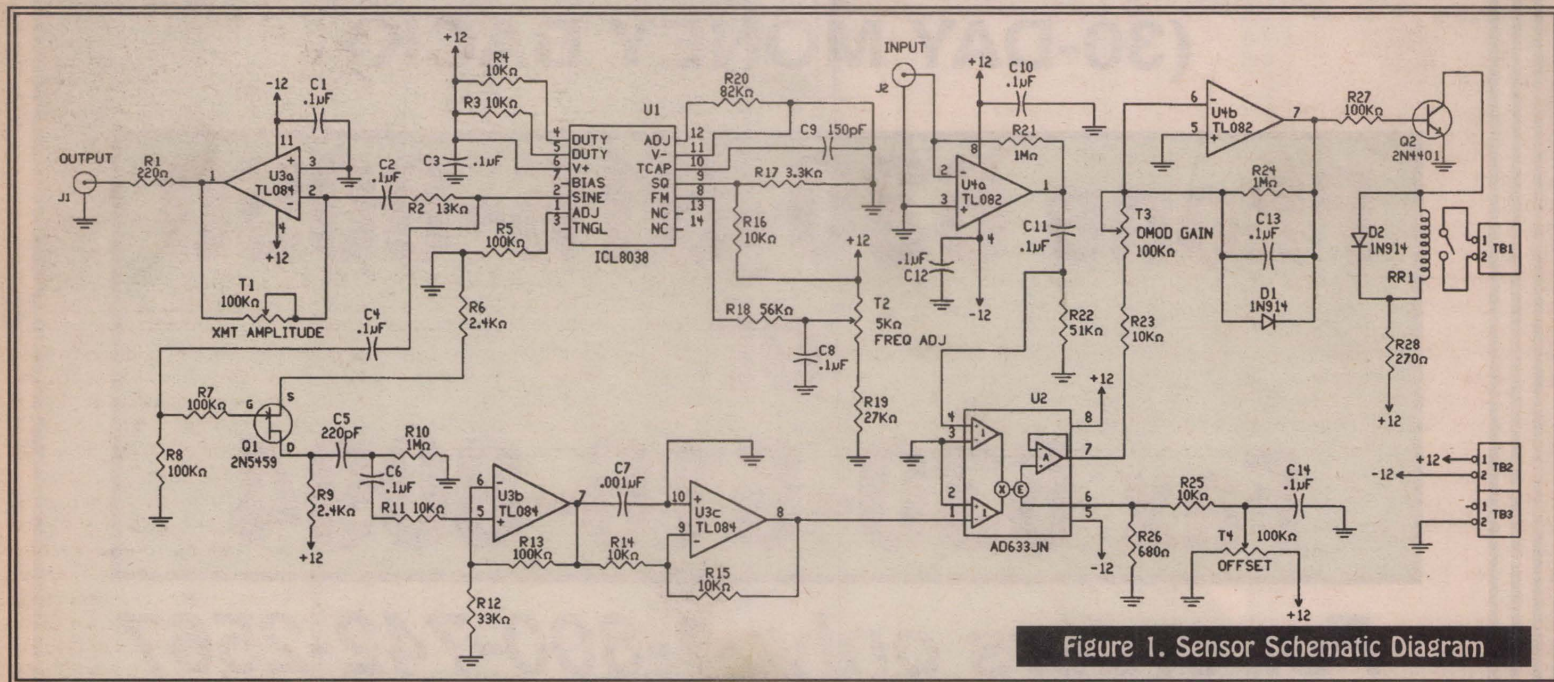


Figure 1. Sensor Schematic Diagram

problems in home automation and security.

For example, there is the need to detect the presence of a person in a room to control lighting. The challenge has been that if the person was seated quietly in a chair or lying in bed, the lights would turn on and off at inappropriate times because the sensors required movement. Problem solved.

Consider the pros and cons of some conventional technologies.

to false alarms. It often requires that areas around heating vents and strongly lighted windows be masked off.

Doppler Radar can solve the false alarm and visibility problems, but it still requires a moving object, and prolonged exposure to microwaves can present a health concern. The sensor described in this article addresses all of these issues.

The work that led to its development actually began back in the

hands toward or away from the electrodes, the frequency and volume would vary.

What is new, is the coupling of some of those principles with micro electronics. This article will show you how to apply the work being done at MIT to the construction of the EF Proximity Sensor (EF stands for Electric Field).

An electric field with a power of less than one milliwatt is transmitted from one electrode to another.

RCA phono jacks provide connection for standard shielded audio cables to connect the board to the two antenna electrodes. Power requirements are under 100 mA at  $\pm 12$  VDC. The 12 volts can be obtained from a number of commercially available supplies, or you can build your own using the schematic in this article.

One supply can run over 10 sensors and costs under \$10.00. The cost of the Sensor is under \$50.00 for



the kit and \$70.00 for the assembled and tested version.

## How the Circuit Works

Please refer to Figure 1. An 8030 Precision waveform generator IC is used to produce a sinewave in the range of 10-115 KHz. The exact frequency is determined by capacitor C9, potentiometer trimmer T2, and their associated components.

The sinewave is coupled out of pin 2 of the 8030 to operational amplifier (op amp) U3a which is one of four op amps inside IC TL084. Another IC, TL082 contains two op amps.

The term operational amplifier originated back in the 1940s when they were used in analog computers. By changing the types or arrangement of some of the feedback elements, different analog operations (i.e. multiply, divide) could be performed by the computer. The name stuck.

Although represented by a single triangle, each amplifier contains over 30 transistors and boosts the signal by over 150 times. The output of U3a is fed to transmitter antenna jack J1. A feedback loop controlled by potentiometer trimmer T1 controls the out-

put level. It is normally set for full output which results in a 17V peak-to-peak amplitude.

Also coming off of pin 2 of the 8030, the sinewave is coupled through field affect transistor Q1 to op amps U3b and U3c. In addition to amplifying the signal, phase compensation is introduced by this portion of the circuit. An additional phase shift to compensate for variable shielded cable capacitance will be made by adjusting the output frequency. That adjustment is described in the "Tune Up" portion of this article.

The signal transmitted out of J1 is received back at J2 and amplified by U4a. The amplified signal coming out of pin 1 of U4a is fed to pin 4 of the AD633 IC. Also going into the AD633 through pin 1 is the output from pin 8 of U3c. What AD633 is therefore able to do is compare a copy of the signal being transmitted to the signal being received.

It is inside of AD633 that the really clever stuff occurs. AD633 is a four quadrant analog multiplier. It is able to instantaneously multiply the sinewave voltage appearing at pin 4 times the voltage appearing at pin 1 and output the result at pin 7.

If you have a 5-volt signal at pin 4 and a 5-volt signal at pin 1, you will get 25

volts at pin 7 (actually there is some division by 10 taking place, but that can be ignored for the moment).

Remember that the signal transmitted from J1 is not the only signal being received at J2 — so is your local AM radio station and other forms of "interference." But none of these other sources has a waveform of exactly the same shape, frequency, and phase as the

one going into pin 1. As a result, only the desired signal is multiplied consistently.

The highest output voltage occurs when the two signals are perfectly synchronized (in-sync) and explains why the process is called synchronous detection. Incidentally, the term four quadrant analog multiplier refers to the circuit's ability to multiply in both positive and negative directions for both signal sources.

The AD633 isn't finished yet. Notice that potentiometer trimmer T4 is labeled "Offset." It may be difficult to see, but the output of the first

two op amps inside AD633 is fed to an X symbol signifying multiplication. From there, the signal goes to an E-like character which is the math-

ematical symbol for summation (addition). The AD633 adds the offset voltage coming from T4 to the multiplied voltage. In our prior exam-

ple, it might be used to add 5 volts to the 25 volts for a total of 30 volts.

If you hook an oscilloscope to pin 7 of AD633, you will see the multiplied inputs divided by 10 with the offset added to the result. Since any interference received is divided by 10 also, the signal-to-noise ratio remains the same.

Since the supply voltage to the IC is under 25 volts, it would be hard to actually get 25 volts at the output. Dividing by 10 is how the problem was solved. Watching the oscilloscope as you adjust T4, you will see the DC basis of the output waveform rise and fall. The offset is essentially a threshold under the changing part of the waveform and functions to control relay sensitivity. It may be helpful to think of the waveform as being offset by the amount being added to it.

A final stage of amplification is

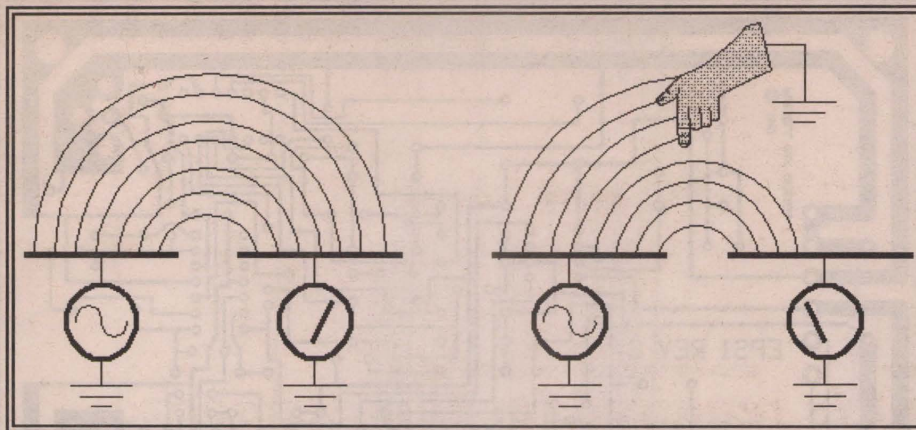


Figure 2. An electric field between an oscillating transmit electrode and a virtual ground receive electrode is intercepted by a hand. The further the hand moves into the field and/or the better grounded it is, the greater the reduction in field strength.

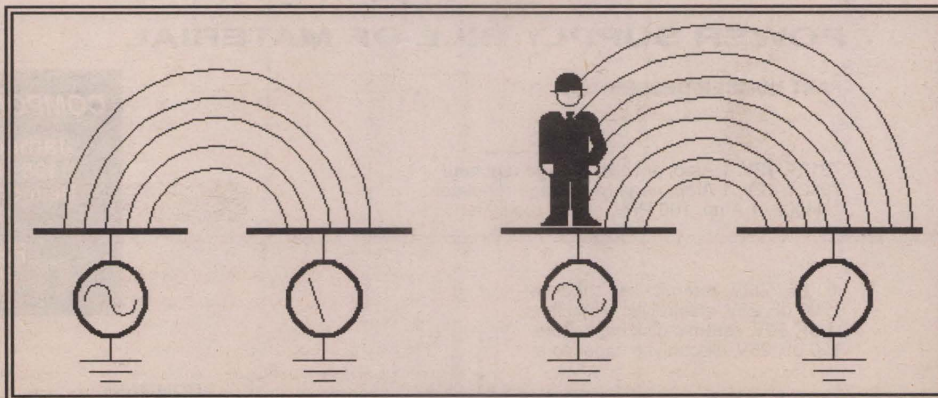
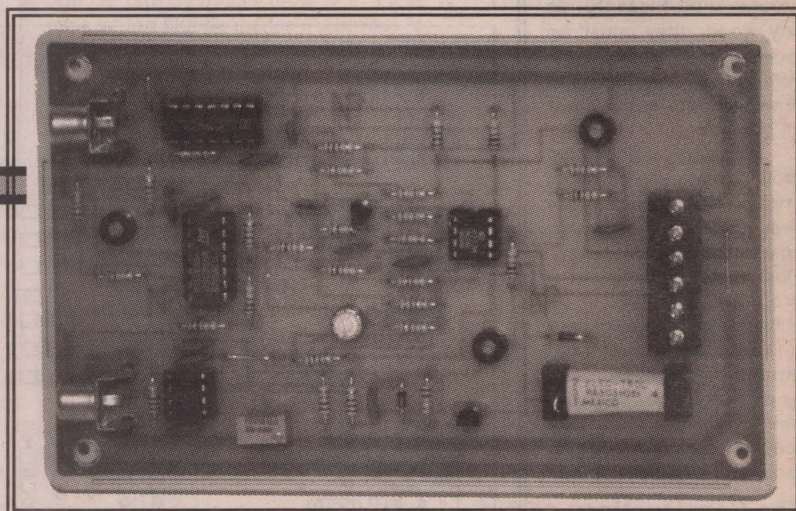


Figure 3. Energy from an oscillator is coupled into a person standing near a transmit electrode. As the person moves any body part closer to the transmit and/or receive electrodes, the field strength increases.

provided by U4b. In addition, a feedback loop comprised of R24, D1, and C13 removes the sinewave portion of the signal and turns it into a pure DC waveform of varying level thus demodulating it.

Potentiometer trimmer T3 controls the level of amplification and the overall dynamic range of the receiver system which equates to sensor range.

The final step is for Q2 to amplify the output of U4b sufficiently to control reed relay RR1. The relay is normally closed when a signal is being received.

If you would like to learn more about operational amplifiers including things like analog multipliers, a good book is the *IC Op-Amp Cookbook* by Walter G. Jung. They even use it at MIT. It is published by SAMS and strikes a reasonable balance between theory



(i.e., the math) and practical application.

## PCB Layout

One of the first objectives in laying out the PCB was to separate the portions of the circuit generating the transmitted sinewave from those receiving it. Ideally, the only signal being processed by U4a should come through the receiving antenna.

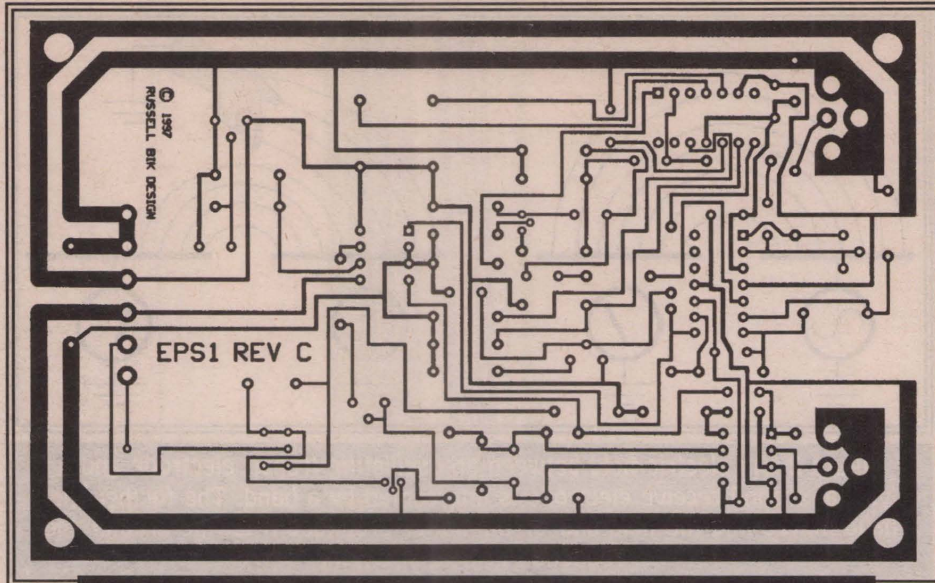
This goal dictated the location of most of the ICs and that the traces between J1, J2, and the appropriate IC pins be kept as short as possible. The location of J1 and J2 and the terminal block was dictated by the enclosure.

Like many IC designs, this circuit employs a series of .1 uF decoupling capacitors (C1, C3, C10, C12) between power and ground. For these to do any good, they must be located immediately adjacent to the IC with leads to power and ground as short as possible.

Although a dedicated ground plane is desirable, one of the goals of this design was to use a lower-cost, single-sided board. Most of the benefits of a ground plane can be achieved as they were here by keeping power and ground traces as wide and as close together as possible. This technique reduces the possibility of radiated fields developing.

## The Construction Phase

Begin by mounting J1, J2, and the terminal block. If you plan to use the





# SENSOR BILL OF MATERIAL

## SCHEMATIC REFERENCE

### SEMICONDUCTORS:

U1	ICL8038CCPD Precision Waveform Generator
U2	AD633JN Low-Cost Analog Multiplier
U3	TL084ACN JFET Input Quad Operational Amplifier
U4	TL082ACP JFET Input Dual Operational Amplifier
Q1	2N5459 N-Channel Field-Effect Transistor
Q2	2N4401 General-Purpose NPN Transistor
D1, D2	1N914 Small Signal Diode

### CAPACITORS:

C1-C4, C6, C8, C10-C14	(±20%, 50V, Ceramic Disk)
C5	.1 uF
C7	220 pF
C9	.001 uF
	150 pF

### RESISTORS:

R1	(1/4 watt, ±5%, Carbon Film)
R2	220 ohms
R3, R4, R11, R14-R16, R23, R25	13,000 ohms
R5, R7, R8, R13, R27	10,000 ohms
R6, R9	100,000 ohms
R10, R21, R24	2,400 ohms
R12	1 Meg ohms
R17	33,000 ohms
R18	3,300 ohms
R19	56,000 ohms
R20	27,000 ohms
R22	82,000 ohms
R26	51,000 ohms
R28	680 ohms
	270 ohms

### MISCELLANEOUS:

T1, T3, T4	100,000 ohm, 1/2 watt, 3/8" Square Potentiometer
T2	5,000 ohm, 1/2 watt, 3/8" Square Potentiometer
J1, J2	RCA Right Angle Phono Jacks
RR1	5V, SPST Reed Relay
TB1-TB3	PCB Terminal Blocks
Sockets	2 each 8 pin; 2 each 14 pin; low-profile IC Sockets
PCB	5.5" x 3.35" single-sided PCB w/silk-screen
Cabinet	3-5/8" x 5-3/4" x 1-1/8" Plastic Cabinet

### NOTE:

The following items are available from Russell Bik Design, P.O. Box 13910, San Luis Obispo, CA 93406-3910: Single-sided printed circuit board with parts layout silk-screened on top side, \$10.00 plus \$2.00 shipping. Complete kit of parts including silk-screened printed circuit board and pre-drilled plastic cabinet \$49.95; fully assembled and tested \$69.95; add \$4.50 for shipping. California residents add 7.25% sales tax.

## PART NUMBER/DESCRIPTION

## COMPONENT SOURCES:

**Jameco Electronics**  
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Belmont, CA 94002-4100  
800-831-4242

**Mouser Electronics**  
958 N. Main Street  
Mansfield, TX 76063-4827  
800-346-6873

**Allied Electronics**  
800-433-5700

**Newark Electronics**  
800-463-9275

## COMMENT

Beckman 72PR, Bourns 3386P, or equivalent  
Beckman 72PR, Bourns 3386P, or equivalent  
Jameco 112475 or equivalent  
Radio Shack 275-232, Mouser 431-1405, or equivalent  
Radio Shack 276-1388, Mouser 153-2102, or equivalent

Radio Shack 270-212 or equivalent

The four trimmers are mounted next. There is a wide selection of trimmers on the market, many of which will fit the board pattern. The square type listed in the parts list have a larger field of adjustment and longer rotational life than the round variety. They are a little more expensive, but worth it. These are the type supplied in the kit.

The round trimmers operate differently, also. For the same pinouts, a full counter clockwise (CCW) rotation produces maximum resistance on the round and minimum on the square. Therefore, if you use round trimmers, all of the silk-screened directional information on the board and the tune-up instructions in this article *will be backwards*.

Mount the relay next. By the way, you may notice a couple of extra holes around the relay and one at the terminal block. This was done to allow multiple sourcing.

Finally, discharge yourself to ground and straighten the IC legs so they extend at a 90-degree angle from the chip. If you don't own a straightener, just roll each side care-

fully against a flat surface. Finally, insert the ICs into their sockets matching up either a notch at one end of the IC or a small dot on top of the IC at one end, to the notched end of the socket.

## Two Modes of Operation

To be able to use the sensor, it is necessary to understand the relationship between the emitted field and objects entering it. There are two modes of operation — shunt and transmit — and the transition between the two is probably not what you would expect.

Figure 2 illustrates two antenna electrodes. The one on the left is radiating. The one on the right is receiving. The field induces a potential difference in the receive electrode as measured between the electrode and ground. The difference is measured by the op amp.

As the electrodes are moved farther apart, the field strength decreases. If the distance is doubled, the signal strength will be only one-quarter as strong (varies inversely to the dis-

tance cubed between the electrodes).

Reductions in field strength can be compensated for by using larger electrodes up to the limits of the output amplifier.

## Shunt Mode

When a hand, or other body part, is placed in the field, an electric current will be induced in it. Small, ungrounded objects will have little, if any, negative effect. If, however, as shown in Figure 2, a larger body enters the field, particularly a grounded one, the field will be shunted to ground.

In practical application, two 5' lengths of hook-up wire are stretched on either side of a door frame and connected to the sensor. The sensor is tuned so that the received signal just closes the relay. A person entering the proximity of the field will shunt the signal to ground causing the relay to open.

## Transmit Mode

Figure 3 shows how you too can become a radio antenna tower. When

a person stands, sits, or is otherwise near the transmit electrode, low-frequency energy is capacitively coupled into their body making the entire person a transmit electrode. This will occur even if the person is standing on a ground plane with the output electrode to their side rather than under-foot.

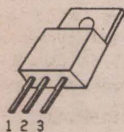
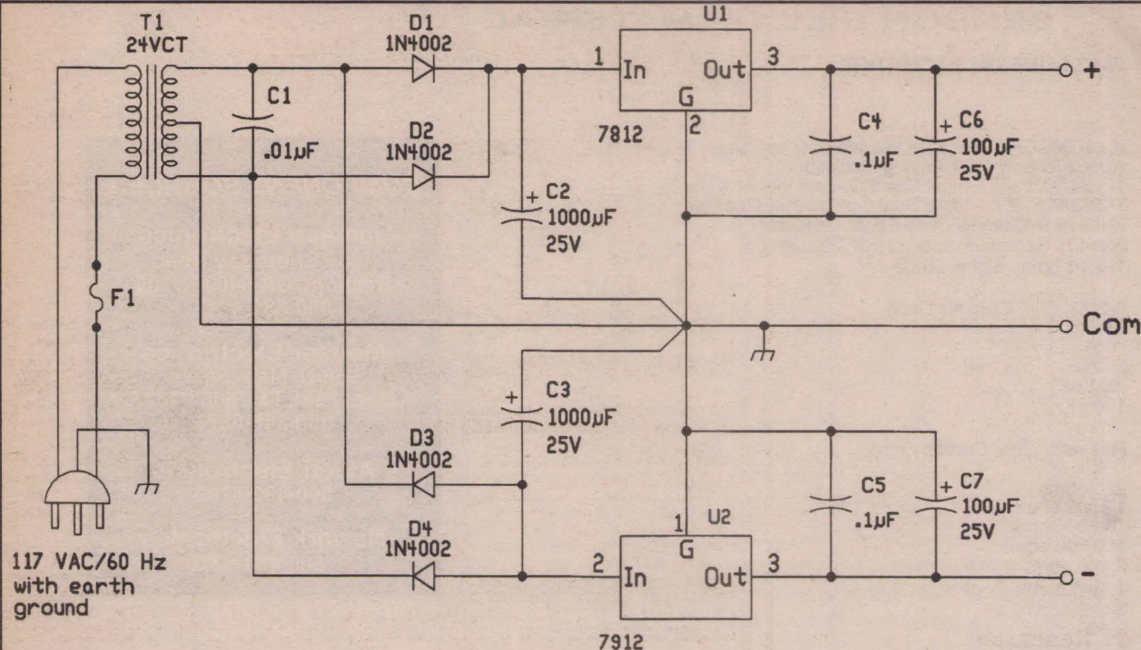
In practice, two 7' lengths of hook-up wire are stretched across a bed. They are separated by a distance of about 1'. The sensor is tuned such that the signal received is insufficient to trigger the relay. When a person lies on the bed, their body increases the strength of the radiated signal and triggers the relay.

## Mode Crossover

When a body first enters the field from a distance, it will attempt to shunt the radiated signal to ground. As the body gets closer to an electrode, the system changes from shunt mode to transmit mode.

Actually, both modes occur simultaneously. Some portion of the signal is always being coupled to the





**7812/7912 Pinouts**  
Note that functions of pins 1 and 2 are reversed between the two parts.

**Figure 6.**  
**Power Supply Schematic Diagram**

body and re-radiated to the receiver, but until the body is very close to the transmit electrode, the amount being shunted exceeds the amount being coupled and radiated.

For a given position and body size/shape, the better grounded it is, the more of the field it will couple to ground and the greater the area over which it will act as a shunt.

## Initial Tune-Up and Testing

Place the completed sensor board on your workbench and connect a continuity buzzer across the relay terminal lugs. Place a DVM or other high-impedance voltmeter between ground and test point 1. TP1 is pin 7 of IC TL082 and is most easily accessed by clipping your probe around the leg of R27 silk-screened on the PCB.

Ground is marked on the board surface as a leg of R10. Attach separate wires, each about 1' long, to the input and output terminals of the RCA phono jacks. Small test clips are good for this. Just lap the wires over each other once. Don't connect them.

Set the trimmer controls as follows:

1. Output (xmt amplitude - T1) = Full CW
2. Range (demod gain - T3) = Full CCW
3. Sensitivity (offset - T4) = Full CCW

Attach the power supply following the instructions in the Power Supply section of this article and plug it in.

4. Adjust Freq (T2) slowly back and forth until the relay closes (buzzer is on) and the voltage is maximized. This point will probably be near the Full CCW end of the trimmer range.

This completes the initial tune-up and testing.

## Building Antenna Electrodes and Cables

The antenna electrodes can be either simple lengths of hook-up wire or metal foil. If wire works for your application, it is the simplest to use. Aluminum foil from the kitchen can be used to make flat electrodes.

These are sometimes required when you want smaller electrodes (i.e., 3 x 3") because the signal strength is too strong from using lengths of wire or more precision position detection is needed.

The flat electrodes are also useful if you want to build a "ground plane" under the detection area to improve grounding and dynamic range in shunt mode.

Large electrodes are also useful to either receive or transmit from under a floor or carpet in transmit mode. To connect antenna electrodes to the sensor, use shielded audio cable. It comes with RCA jacks

already attached. Remove the unused connector from one end and strip back the wire. You won't be using the shield at the antenna end, so fully remove it to a distance of at least 1/2" from the exposed inner conductor. If it gets too close to the electrode, it may shunt the signal to ground.

Don't even allow the insulated portion of the shield to extend over an electrode. This point is also worth remembering when placing antenna electrodes along places like door frames.

You don't need the electrode to begin at ground level to work, and if you get too close to ground a portion of the signal will be shunted thereby reducing dynamic range.

When making flat electrodes, you won't be able to solder to the aluminum foil. You can clip to it, but a more permanent solution is to use a type of adhesive copper tape made by 3M. It comes in rolls of varying widths.

You simply solder a conductor to the end of a 1" length of the tape, and stick it onto the foil. Duct tape can be used over the connection as a cable strain relief. A 1' length of the copper tape is supplied with each kit or assembled unit.

An 18' roll of the 1/4" width (Stock No. 96F9287) is available from Newark Electronics for \$8.86.

## Application Tune-Up and Testing

With the sensor attached to its electrodes, peak the frequency as

described in the initial test. The peak will be determined by the receive electrode/cable combination. If you switch transmit and receive, re-tuning will be necessary.

The primary reason that there is a unique frequency for each electrode/cable set is related more to phase than wavelength. Remember from the "How it Works" section of this article that a phase shift is introduced by cable capacitance. That phase shift is a function of capacitance and frequency.

When you change the sensor frequency, you are basically causing a phase shift of the received versus transmitted signals. When they are in sync, you are at the ideal frequency. The longer you make the receive cable, the lower the frequency required to obtain synchronization.

If the frequency adjustment is done with the antennas in final position, put the range and sensitivity controls at full CW and adjust frequency until the relay closes. Then, gradually reduce the range and sensitivity settings, further refining the frequency adjustment as you go. The lower the peaking voltage, the sharper and more precise the frequency adjustment will become.

Once frequency is set, adjust the range and sensitivity settings until the relay either just closes with nothing in the field (shunt mode) or just opens with nothing in the field (transmit mode).

The two controls are interactive. It may take some experimentation to determine which mode and combination of range/sensitivity settings give the best results for your application.

Grounding and electrode size and placement will also play a role. Output power reductions should only be made as a last resort since it will reduce the signal-to-noise ratio.

## Troubleshooting

The most common problem is forgetting that the sensor operates in two modes: shunt and transmit. It can be counter-intuitive. If it isn't working in one mode, try the other.

If you find that the signal at TP1 is so strong that the relay won't open despite reducing range and sensitivity, try using smaller electrodes. What can also appear to be a very strong signal, but in fact is a loss of dynamic range, is improper grounding of the sensor board. If the board is not grounded, the reference point will float. Make sure that you have a true earth ground. Check continuity between your ground and a cold water pipe.

On raised floors with distances greater than three feet between electrodes, poor grounding of the person within the field may make use of the shunt mode more difficult. Try using transmit mode. If you want to stay



with shunt, the ground plane under the person can be improved by placing a piece of grounded aluminum foil under the carpet or under the wood floor.

Signals will be capacitively coupled through combined layers of concrete, wood, carpet, and shoes. In transmit mode, the same under-foot electrode could be used to receive or transmit the signal with the opposing electrode placed above or to the side of the person.

It should go without saying, but don't place your electrodes behind metal and expect your signal to penetrate. This only works with non-conductive materials like wood, plastic, and fabrics. You can place the antennas next to ungrounded metal (like furniture springs), but if you try to hang a long wire up the side of a wall with a pipe on the other side, you could have problems.

## Power Supply

As with many op amp circuits, this one requires both positive and negative voltage in reference to ground (common) with a 50 mA current drain at +12 VDC and 27 mA at -12 VDC. The voltage may be increased to 15 VDC.

There are at least two options available to you to obtain these outputs. You can build your own supply using the schematic in this article or you can buy a commercially available unit.

There are always a few "manufacturer's overruns" for sale in industry catalogs, and one of these supplies can usually be purchased for only a few dollars more than what you would spend for the parts alone to build your own — but beware of the following pitfalls:

Avoid supplies labeled "switching." These supplies require a minimum 10% output. Avoid the "battery eliminator" or "wall transformer" category of wall-mount supplies. They are unregulated. What you want is a "linear" supply.

Two supplies currently available that have been tested by the author are the Jameco P/N 134658 @ \$9.95 which will support two sensors, and the Jameco P/N 103173 @ \$14.95 which will support five sensors.

There is one other consideration. For the sensor to work optimally, you want an earth ground. In most cases, this means that the supply must have a grounded plug, and you will need to make sure that the case/earth ground of the power supply is connected to the common electrical ground between (+) and (-) 12 VDC.

For P/N 103173, two separate wires that lead to the DIN connector must be joined. For P/N 134658, the common lead is already joined to ground inside the supply.

For a supply with no ground plug, you can always provide the

earth ground externally to the power supply.

## Power Supply Assembly

If you would like to build your own supply, the one in the schematic is a good choice. Don't forget to read the notes in the bill of material. This unit is so simple that you can build it using point-to-point wiring on terminal strips.

The 7812/7912 will need to have their leads extended, and this can be done with hookup wire and shrink tubing. C4 and C5 are present to provide transient protection and, like all de-coupling capacitors, must be mounted immediately adjacent to the IC or they won't do any good.

Also, if for any reason the 7812/7912 are not mounted in close proximity (within a few inches) of the filter capacitors, .33 uF capacitors will be required between the input and ground legs of both ICs.

## MIT Research

The EF Proximity Sensor incorporates some of the same design technology being used at the MIT Media Lab. In some of the experiments being done at the lab, multiple receivers are used with one transmitter. The receivers are coupled to a microprocessor so that the data can be processed by a PC. The set-up is used for multidimensional sensing.

In one such installation, a single transmitter electrode covers the floor of a room coupling energy to a person walking on the floor. Four receiver electrodes, located on the walls, measure relative field strength indicating the position of the person.

The spacial resolution of this technology is better than you might suspect. A 2-D pointing mouse has been built. One finger touches a small transmitter electrode while the pointing finger moves between X and Y electrodes situated on the sides of the screen.

The pointing finger does not even need to be in contact with the screen and a third receive electrode located below the screen allows the thumb to generate click signals.

Research is underway on 3D sensing. A board designed to assist researchers in exploring EF is called "The Fish," after the abilities of weakly electric fish who have been found to navigate in three dimensions using their electric fields. They also use the fields for purposes of communication and identification. This may be another case of technology trying to catch up with natural systems.

If you would like more information on this subject, you can visit the MIT Media Lab web site at <http://physics.www.media.mit.edu/>

The author of this article would like to encourage your questions, comments, and suggestions. He can be reached at [rbik@bik.com](mailto:rbik@bik.com) NV

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COD82SS25	25 Pin Socket	.55	.52	.47
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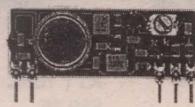
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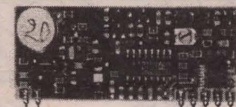
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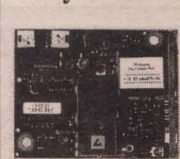
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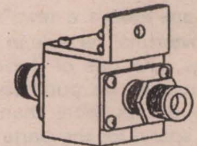


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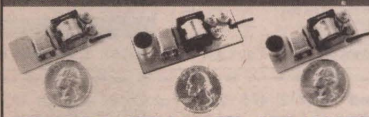
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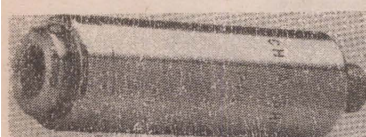
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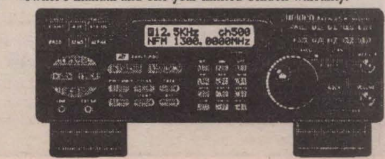
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For over 28 years, thousands of radio operators have depended on scanners, digital voice loggers, Ham/CB/GMRS transceivers, weather forecasting equipment and more from Communications Electronics. To get your free fax-on-demand catalog, call 313-663-8888 from the telephone handset on your fax machine and follow the recorded voice prompts. **Bearcat® 3000XLT-A Radio Scanner** Mfg. suggested list price \$699.95/Special \$329.95 **FREE** - Get an extra BP2500 battery pack, a \$41.95 value when you order a Bearcat 3000XLT. Hurry...offer expires 8/30/97. 400 Channels • 20 banks • Twin Turbo Search/Scan Frequency Transfer • VFO Control • Automatic Store 10 Priority Channels • Selectable Mode • Data Skip Frequency step resolution 5, 12.5 & 25 KHz. Size: 2-3/4" Wide x 1-1/2" Deep x 7-3/8" High **Frequency Coverage:** 25,000-549,995 MHz., 760,000-823,995 MHz., 849,012-868,995 MHz., 894,012-1,300,000 MHz.

The Bearcat 3000XLT is the ideal handheld radio scanner for communications professionals. This handheld scanner scans at 100 channels per second and searches at a rate up to 300 steps per second. A selectable attenuator eliminates annoying intermodulation from adjacent frequencies in highly populated areas. Selectable AM, Wide FM and Narrow FM modes allow you to change the default receiving mode of the BC3000XLT. For maximum scanning pleasure, order the following optional accessories: UA502 Cigarette lighter power cord for temporary operation from your vehicle's cigarette lighter \$14.95; LC3000 Deluxe swivel leather carrying case \$34.95; BP2500 rechargeable nickel-cadmium battery pack for up to five hours of dependable use \$29.95; ANTMBBNC Magnetic mount scanner antenna with BNC jack and 12 feet of cable \$29.95; ANTSGBNC Glass mount scanner antenna with BNC cable \$29.95. The BC3000XLT comes with AC adapter, belt clip, flexible rubber antenna, earphone, owner's manual and one year limited Uniden warranty. Order today.

**Bearcat® 9000XLT-A Radio Scanner** Mfg. suggested list price \$769.95/Special \$344.95 **500 Channels • 20 banks • Alpha numeric display** Size: 10-1/2" Wide x 7-1/2" Deep x 3-3/8" High **Frequency Coverage:** 25,000-549,995 MHz., 760,000-823,995 MHz., 849,012-868,995 MHz., 894,012-1,300,000 MHz. The Bearcat 9000XLT is superb for intercepting communications transmissions with features like TurboSearch™ to search VHF channels at 300 steps per second. This base and mobile scanner is also ideal for intelligence professionals because it has a selectable attenuator to help eliminate annoying intermodulation from adjacent frequencies in highly populated areas and selectable AM, Wide FM and Narrow FM modes that allow you to change the default receiving mode of the BC9000XLT. Other features include Auto Store - Automatically stores all active frequencies within the specified bank(s). **Auto Recording** - This feature lets you record channel activity from the scanner onto a tape recorder. Hi-Cut filter to help eliminate unwanted static noise. You can even get an optional CTCSS Tone Board (Continuous Tone Control Squelch System) which allows the squelch to be broken during scanning only when a correct CTCSS tone is received. For maximum scanning enjoyment, order the following optional accessories: P8001 Cigarette lighter power cord for temporary operation from your vehicle's cigarette lighter \$14.95; P8002 DC power cord enables permanent operation from your vehicle's fuse box \$14.95; MB001 Mobile mounting bracket \$14.95; BC005 CTCSS Tone Board \$54.95; EX711 External speaker with mounting bracket & 10 feet of cable with plug attached \$19.95. The BC9000XLT comes with AC adapter, telescopic antenna, owner's manual and one year limited Uniden warranty.



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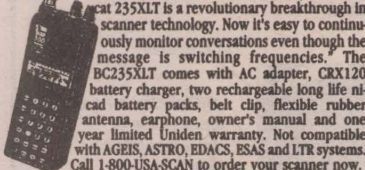
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## TrunkTracking

**Bearcat® 235XLT-A TrunkTracker** Mfg. suggested list price \$429.95/CEI price \$269.95 **300 Channels • 10 banks • Trunk Scan and Scan Lists Trunk Lockout • Trunk Delay • Extra battery & charger 10 Priority Channels • Programmed Service Search** Size: 2-1/2" Wide x 1-3/4" Deep x 6" High

**Frequency Coverage:** 29,000-54,000 MHz., 108-174 MHz., 406-512 MHz., 806-823,995 MHz., 849,012-868,995 MHz., 894,012-956,000 MHz.

The Bearcat TrunkTracker BC235XLT, is the world's first scanner capable of tracking a selected radio transmission as it moves across a trunked radio system. Now it's easy to monitor fleets and subfleets in analog trunked radio systems. The BC235XLT can also work as a conventional scanner. This 300-channel, programmable handheld scanner provides scanner users with uninterrupted monitoring capabilities of Type I, II, III and hybrid trunking systems. One of the biggest obstacles in the scanner industry has been the increasing use of trunking radio systems in business and public agencies throughout the United States and Canada. makes it nearly impossible to track a conversation as it moves within a trunk system from frequency to frequency. According to Ken Ascher, WBSLT, Chairman & CEO of Communications Electronics, "The Bearcat 235XLT is a revolutionary breakthrough in scanner technology. Now it's easy to continuously monitor conversations even though the message is switching frequencies." The BC235XLT comes with AC adapter, CRX120 battery charger, two rechargeable long life nickel cadmium battery packs, belt clip, flexible rubber antenna, earphone, owner's manual and one year limited Uniden warranty. Not compatible with AGEIS, ASTRO, EDACS, ESAS and LTR systems. Call 1-800-USA-SCAN to order your scanner now.



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Offer valid only on prepaid orders mailed to Communications Electronics Inc., P.O. Box 1045, Ann Arbor MI 48106 USA. Offer valid July 1, 1997 to August 30, 1997. Limit one coupon per item. Coupon is not redeemable with any other coupon or with any other offer. Mention offer #AN. Expires 8/30/97.

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Bearcat 235XLT-A TrunkTracking scanner	\$269.95
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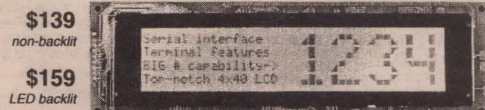


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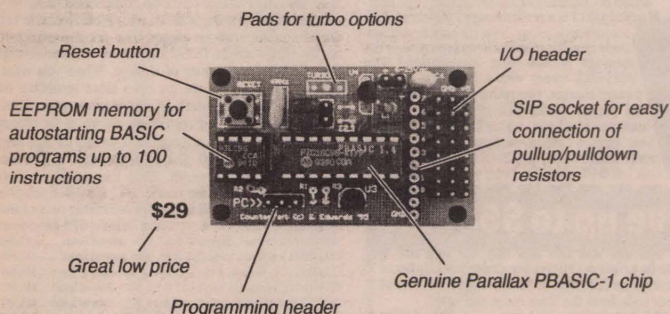
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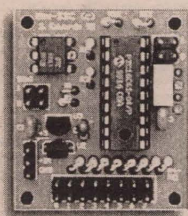


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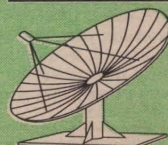
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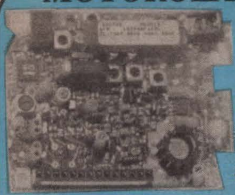
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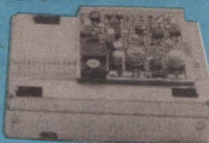


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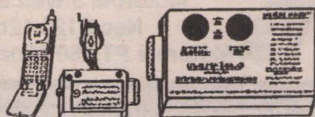
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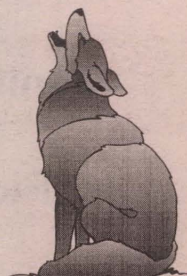
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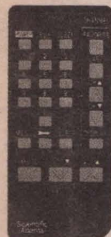


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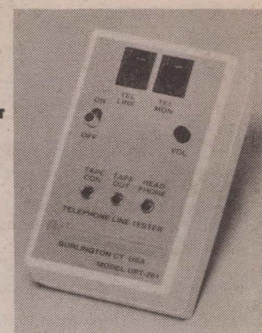
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**FM-25, Synthesized FM Stereo Transmitter Kit ..... \$129.95**



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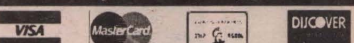
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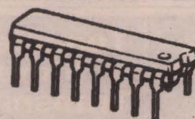


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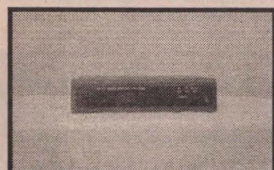
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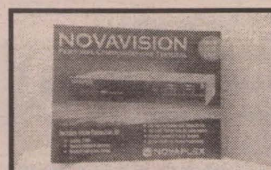
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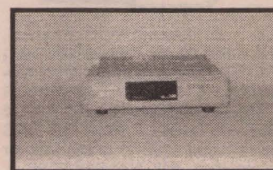
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**DALLAS 2251T-128-16**, 8051 type stix, 128K bytes RAM, RTC, timer, watchdog, 4 8-bit I/O ports, 64K memory buss, serial, 3 interrupts all battery backed, fits 72-pin socket, \$75; 2282, 8051 type 30-pin stix, \$25. Data, shipping included. See dalsemi.com on net. 352-372-8332 evenings. Bill Wagner, 1510 NW 35th Terrace, Gainesville, FL 32605-4832.

**87C520 DEVELOPMENT BOARD**. Dallas high-speed microcontroller. Application ready, fully I/O and memory mapped. Download through serial port using X-modem protocol. 16K EPROM, 8K EEPROM, and 32K RAM, 16 input and 16 output lines. 8 relay drivers. Can be remotely downloaded. \$99.95 to \$129.95. DPR Microtech 818-355-7857.

## ANTIQUE ELECTRONICS

**WANTED: FOR** historical museum, pre-1980 microcomputers, magazines, and sales literature. Floyd, VA 24091-0341 (540-231-6478/540-763-2321).

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**RADIO AND TV tubes from 1927 to 1977**. \$1 for list to: Preller TV, 208 South 2nd St., Augusta, AR 72006. Ph. 501-347-2281.

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## PUBLICATIONS

**HACKERS AND EXPERIMENTERS BOOKS**. Cable Hackers Bible Volumes 1 & 2 \$45.45 each, DSS Bible \$49.95 ppd, DSS SECRETS 3-volume set \$69.95 ppd, Scanner Hackers Bible Volume 1 & 2, \$35.45 each, Satellite Hackers Bible \$55.45, 8.6 megabytes hacker software \$29.95, Black Box Bible \$35.45, Phone Phreakers Bible \$35.45, Phone Box Bible \$45.45, Superhackers Bible Volumes 1 & 2, \$35.45 each. Add \$2 insurance per order. Many more plus videos! Ask for new 40-page 1997 catalog. Only \$1 in USA, \$3 elsewhere. TELECODE 520-726-2833. http://www.hackerscatalog.com

**START YOUR OWN TECHNICAL VENTURE!** Don Lancaster's newly updated **INCREDIBLE SECRET MONEY MACHINE II** tells how. We now have autographed copies of the Guru's underground classic for \$18.50. Synergetics Press, Box 809-K, Thatcher, AZ 85552. 520-428-4073. VISAMC.

**MILITARY COMPONENTS** wanted. Capacitors, resistors, diodes, transistors, semiconductors, ICs. Electronic Material Industries, 818-769-1002, FAX: 818-769-1084.

**HOME AUTOMATOR: "The Magazine of Home Automation Ideas."** Each issue contains technical articles, schematics, feature homes, how-tos, and product reviews. Subscription \$19.95/year. http://www.home-automator.com Home Automator Newsletter, 2258 Sandy Lane, Mebane, NC 27302. 910-578-9519 (voice), 910-578-0012 (fax).

**ELECTRONICS ENTERPRISES, home based**. Part/full time. Comprehensive guidebook, 250+ pages insider information/sources. \$24, FREE shipping USA: DCP Enterprises, 15 Mayflower, Aliso Viejo, CA 92656. 24 hr. recording/faxback 1-800-326-4560 x152.

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sp = 30mmX25mmX31mm  
pc = 58mmX45mmX11mm  
wt = 32g

Other useful specs:  
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signal format: NTSC  
lens: F2.4, f=4.7 (horiz. 45 degrees)  
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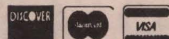
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BY KEVIN ROSS

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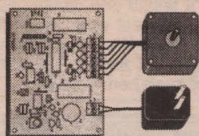
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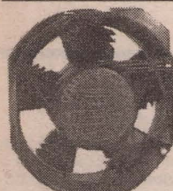


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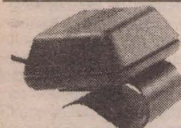
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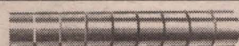
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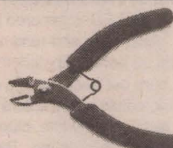
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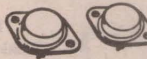
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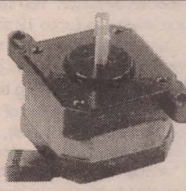
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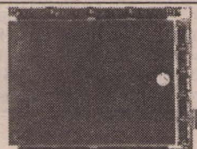
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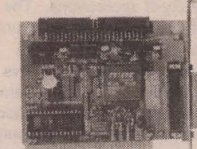
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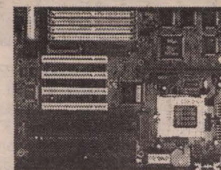
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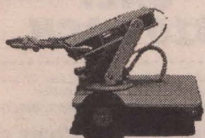
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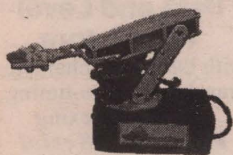
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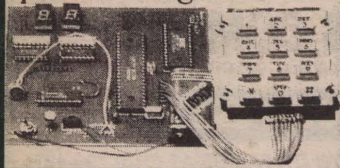
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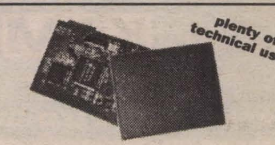
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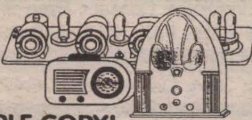
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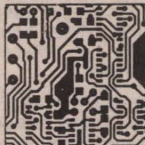
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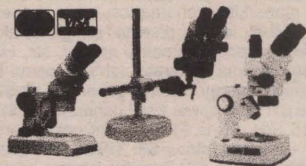
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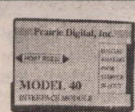
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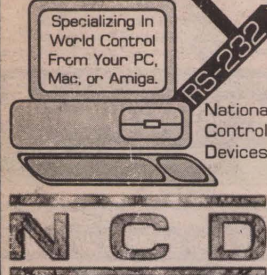
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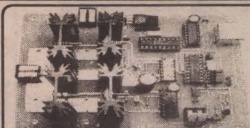


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The \$12 RSB Serial Booster May Be Required when Driving Several Devices from a Single RS-232 Port.

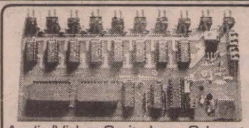
**National Control Devices**  
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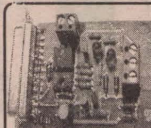
**DC Motor Controller; 9-12 Volt Operation for Motors Up to 4 Amps. Forward/Reverse 64 Speeds. With Infrared Receiver: NCD-M1 Kit \$89 Asm \$149**



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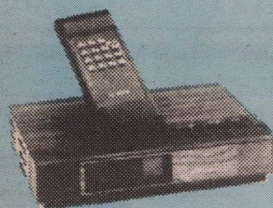


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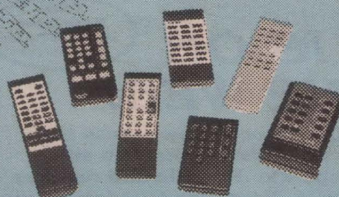
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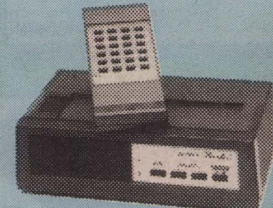
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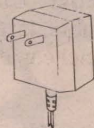
New Colorado Jumbo 120 tape backup system has up to 120MB capacity using data compression. Installs in minutes connecting to most existing floppy controllers. Includes powerful, easy-to-use Colorado backup for DOS software program. Fits into 5-1/4" or 3-1/2" half height drive bays. QIC-40 compatible. Kit includes: drive, cable, mounting screws, and all documentation. Note: Tape not included.  
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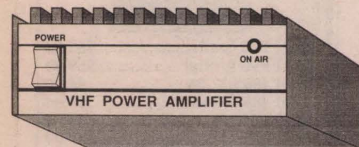
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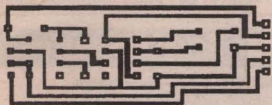
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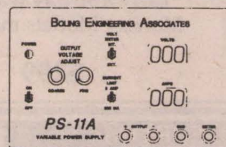
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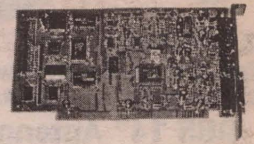
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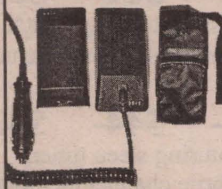
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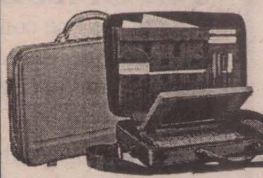
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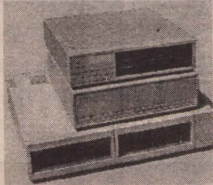


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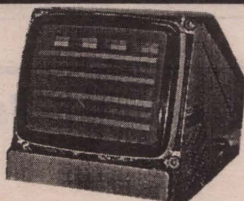


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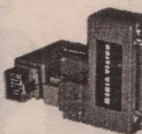
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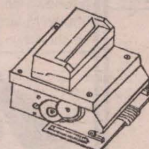
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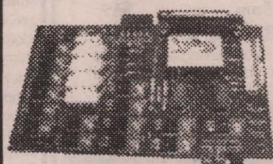
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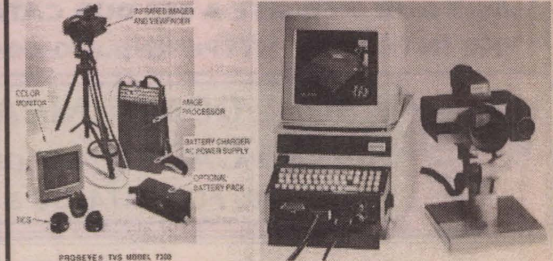
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by Karl Lunt

## The Extremes of Hobby Robotics

This month, Karl covers both ends of the amateur robotics spectrum, from a tiny solar-powered robot to the big beasts of the San Francisco Robot Wars.



My recent articles have described small, lightweight robots suitable for building by beginners. But those robopets are hardly the final answer in low-power machines. To get a real taste for a simple, low-calorie robot you can build yourself, check out the BEAM Photopopper 4.2, available for \$60.00 from Solarbotics in Canada.

I recently got to play with one of these little beasts. The Photopopper has no microcontroller, no software, no battery, and virtually no weight, yet its clever analog circuitry lets it show a limited set of behaviors. But before I get caught up in describing this robot, I need to provide a little history.

# AMATEUR ROBOTICS

Ontario, Canada. Solarbotics, which maintains a cool web page devoted to BEAM-robot products, sells the Photopopper kit based on one of Mark's designs. Drop by [www.solarbotics.com](http://www.solarbotics.com) for a look at pictures of several cool BEAM robots.

## The Photopopper

The first thing I noticed about the BEAM robots in general and the Photopopper in particular was the lack of a microcontroller. Instead, these machines use clever, but simple, electronic circuits to control power and motion. After all, an MCU and its attendant electronics would add too much weight and burn too

depends on which of the two photodiodes "sees" more light at the moment. The corresponding motor spins a few revolutions before running out of gas and stopping. The capacitor, drained down to a few millivolts, resets the trigger and the soaking action starts all over.

What you see as all this takes place is a series of arc-shaped lurches as the Photopopper pivots first one way, then the other, towards the brightest light nearby. If you set a bright light directly in front of and above the Photopopper, it will advance toward the light like a small robotic crab.

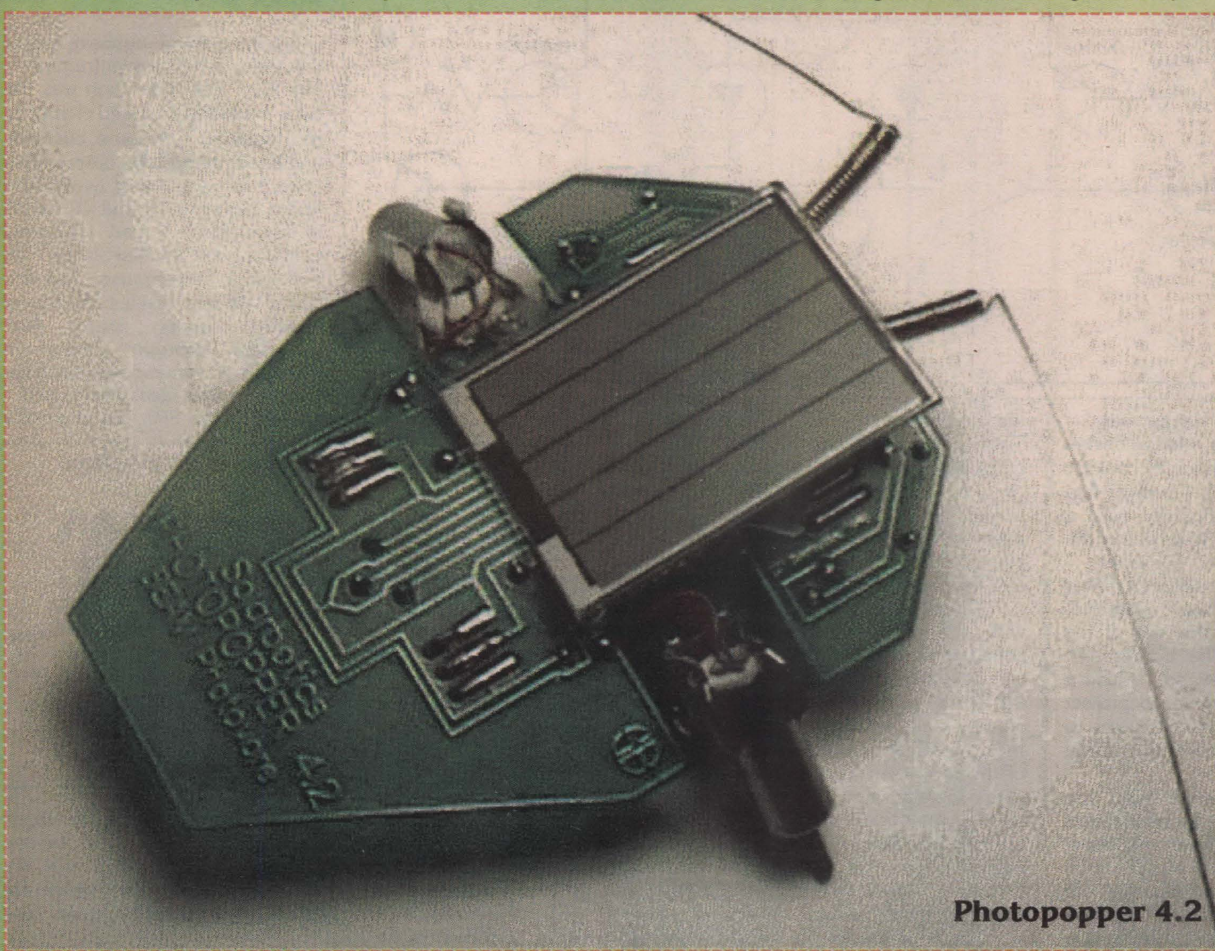
The Photopopper's motion profile depends on a great many factors, all carefully balanced in this design to use the tiny photoelectric voltage as efficiently as possible. The motors are miniature, high-efficiency devices that appear to have been pulled from pagers. Though the bodies of these motors measure just 5/8" long by 1/4" wide, they provide ample torque for moving the little 'bot.

Rather than use wheels on the motor shafts, which add extra mass, the Photopopper rests directly on the downward-pointing motor shafts, and rolls forward as the motors spin. The robot itself uses a very thin, flexible circuit board as both robot base and electronics carrier. This dual-use results in a much lighter 'bot, letting the Photopopper get as much mileage as possible from its photocell.

The robot's electronic design means that the Photopopper moves in a series of pulsed motions, as the capacitor alternately stores the photovoltaic charge, then dumps it into one of the motor drivers. Each time a motor driver fires, the robot pivots forward about 5/8", and how frequently the robot moves depends largely on the ambient light. If I set the Photopopper down on my deck outside, in the (rare) bright Seattle sunlight, I get about four "pops" a second. This results in motion not unlike a giant green beetle spastically trying to lug a solar cell into the light.

But taking the Photopopper indoors doesn't mean it stops. Diffused, overcast sunlight through a living room window will still get a pop every second or so, while reflected light from a halogen lamp yields a pop about every 10 seconds. In fact, the only way to stop the motion altogether is to put the little 'bot in a box and close the lid.

The Photopopper's design-ers added a very clever element in the form of a feeler or bumper switch. This touch sensor consists of a single wire-wrap pin, coated with a piece of heatshrink and inserted into the center of a tiny brass spring. The body of the spring is just long enough to extend the length of the pin, and the feeler end of the spring is nothing more than a five-inch length of the uncoiled brass wire. Electrically, a connection forms between



Photopopper 4.2

Mark Tilden first developed the idea of these small robots around 1990. He coined the term BEAM from the four driving elements of his philosophy regarding robotics: Biology, Electronics, Aesthetics, and Mechanics. His approach to making small, cool robots calls for reusing technoscrap to build efficient machines that mimic elements of nature's designs. Mark's machines even turn to nature for power, relying on a photocell to supply the miniscule amount of current needed to make a BEAM 'bot go.

You can visit Mark's web site at: <http://niswww.lanl.gov/robot> — the site carries lots of information about the various BEAM robots and competitions, plus a history of the annual BEAM Olympics that Mark started some years ago in

much power. Granted, we're only talking milliamps here, but for a BEAM machine, even that is too much drain.

The accompanying Photopopper schematic is typical of the many BEAM circuits I've seen, though this is the first one I can recall that controls two motors and allows for light sensing and tracking. In general, BEAM circuits use a high-efficiency photocell to soak up as much energy as possible from the ambient light, storing the accumulating charge in a large electrolytic capacitor.

When the stored voltage reaches a threshold, usually about 2.5 volts, a trigger circuit fires and dumps the entire accumulation into one of the two motor drivers; which driver receives the current



the pin and the spring if the feeler wire is pushed hard enough to bend the end of the spring into the uninsulated tip of the wire-wrap pin. Since the inside of the spring is a circle, the feeler is sensitive through 360°. This touch sensor, designed by Mark Tilden, stands as the most clever solution I've yet seen to the difficult problem of a cheap, elegant bumper switch with 360° coverage.

The two bumper switches — one for each side of the 'bot — appear in the schematic as the switches at one end of the 680K resistors. If the robot hits an obstacle and a bumper switch closes, the motor driver for the opposite side is shut down, regardless of the light's location. This effectively shuts down the light-tracking behavior, giving precedence to the obstacle-avoidance behavior. Mark was heavily influenced by Rodney Brooks' designs at MIT, and this concept of overriding behaviors is known as subsumption architecture. I usually see subsumption architecture expressed in software designs. The Photopopper's creators have carried subsumption into the

you can't mount the motors. I had to work very carefully to desolder the offending clip and remount it as required. From then on, I paid strict attention to the artwork and avoided any other problems.

I'll pass along one other comment for future Photopopper builders. The printed circuit board (PCB) that forms the Photopopper's body arrives already bent into nearly the proper shape for the finished robot. You, however, have to finish bending the board, and this takes a leap of faith. The PCB is very thin, and already looks like it's been badly warped. But to make the motors touch the floor properly, you have to bend the board some more and hold it in place with a strong copper wire stretched from one side of the robot body to the other.

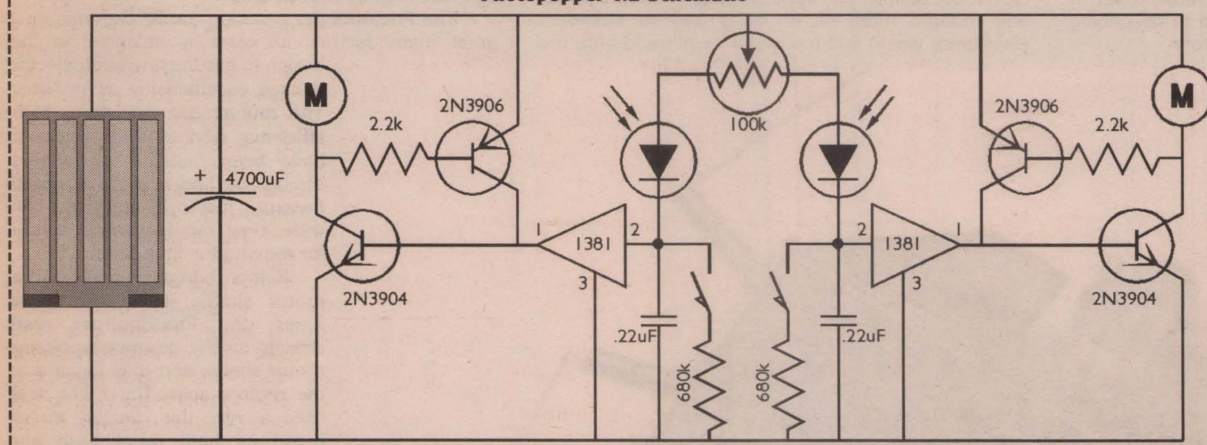
Rather than simply flex the board and try to hold it in place while I soldered both ends of a wire, I did the process in stages. As recommended, I first soldered one end of the wire to one side of the PCB. Next, I stripped slightly more insulation from the opposite end of the wire than I knew I'd need, and ran

get a better view, asked lots of questions, and left with plenty of ideas for their own solar-powered robots. I think the idea of lighter-than-battery robots struck a nerve, and the club may see other low-power robots in the near future.

Photopoppers and their ilk — a class of robot known as a photovore — offer hobbyists a chance to explore simple behavior with no software struggles. A photovore "race" towards a bright light might take a while to complete, but first place would mean your 'bot was lighter and/or more efficient than its competitors. You can build your own photovore from parts gleaned from gutted cassette tape drives or pagers, and your efforts to keep the weight down and the efficiency up will be visibly rewarded.

I can happily recommend the Photopopper kit to anyone looking to build a unique and interesting machine. I would suggest you have some experience wiring up electronics before tackling this kit, as some of the work is delicate and it is so important to get everything properly aligned. But if you work carefully, you should end up with a cute little robot that will run for years and never whine that its battery is low.

Photopopper 4.2 Schematic



## Robot Wars

At the extreme opposite end of the hobby robotics spectrum ... The May 1997 Robothon was the SRS' randomly-arranged chance to get together, run some contests, and shoot some robo-breeze. This proved to be a typical event, with about 100 humans and 40 robots in attendance, and included contests such as Mini-Sumo, Line Following, Micromouse, and the Grand Maze. Besides plenty of finished robots, many SRS members brought works in progress, so everyone could check out the various ideas being used.

Kevin Ross, president of the SRS, did yeoman's

electronics realm in a very clean and elegant way.

I will admit to tinkering with the original design somewhat. You can't really blame me; since I couldn't tweak the software (there isn't any), I had to find something to change. The robot originally used a smallish photocell. Though it appears to be one of the high-efficiency Sunceram™ types by Panasonic, I wanted to try a larger cell to see if I could get a power boost. So I wired in my own Sunceram™ cell that measures 2-1/4" by 3-1/8", nearly the size of the entire Photopopper circuit board. The Sunceram™ cells are fabbed on unprotected glass, so I added a dab of hot-glue to each of the corners, to protect them against chipping. The new solar cell seems to add a little pep, but the Photopopper works just fine with the original cell.

I'll pass along a few tips learned from my construction of this kit. First of all, the kit's manual is wonderful. It is filled with accurate artwork and lots of well-done drawings, and the instructions are well-written and clear. The manual emulates the old Heathkit docs, complete with check-boxes and resistor color bands. The authors even sprinkled in a little humor here and there; did you ever see an intentional joke in a Heathkit manual?

With such a quality manual, this kit is within the range of an experienced builder, IF you follow the kit's instructions exactly! The authors state several times, read the manual completely before attempting to build this kit. I'll echo that, and stress its importance. All elements of the Photopopper's design must work together or the kit won't work at all. Get something in backwards or misaligned, and you'll have a devil of a time getting it fixed. (Go ahead, ask me how I know!)

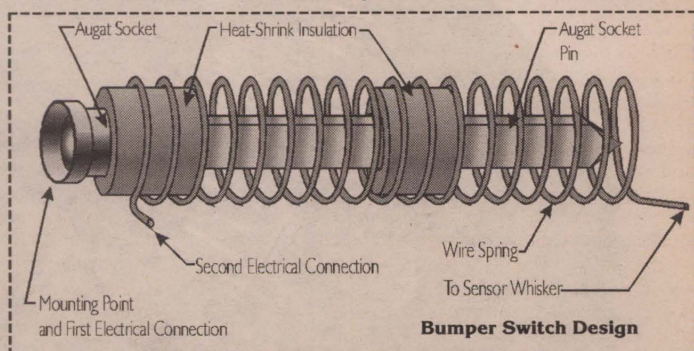
All right, I'll confess. I got in a hurry to see my Photopopper running, and rushed through one step. Next thing I knew, I'd managed to install one of the fuse clips backwards. The fuse clips hold the two tiny motors in place, and have to be installed correctly or

the wire through the hole in the other side of the PCB. Then, I carefully flexed the board, crimped the wire in place, and checked the motor's spacing. If they didn't hit the floor properly, I released the crimp, reflexed the board, crimped the wire again, and checked the motors.

When I was finally satisfied with the motor's alignment, I soldered the second end of the wire in place. If a final check at this point shows that the wire has somehow slipped, you can quickly melt the solder on the second end of the wire, then use needle-nose pliers to re-position the wire and let the solder cool back down. Verify that the motors are properly aligned, with the wire soldered in place, BEFORE you cut the second end of the wire! Otherwise, you'll have a real problem getting the motors properly set up.

I finished this kit the night before Marvin Green and I headed for a Seattle Robotics Society meeting. Marvin had driven up from Portland that day to take in a meeting, and had brought the Photopopper kit with him. We had great fun building the kit, and learned a lot about this low-power side of hobby robotics. But I was a little worried about how such a simple device would play at the SRS. After all, this crew has built some pretty sophisticated machines, and I felt that a robot without an MCU might not hold their interest.

I shouldn't have worried; the Photopopper was a huge hit. We lucked out and the meeting occurred on one of the 20 days each year that Seattle actually gets sunlight. When I set the Photopopper down on the sidewalk outside the meeting room, the little bug really started hopping. The gang crowded around to



service in pulling the event together. He has also been putting a lot of energy into the SRS' on-line newsletter, the Encoder. You can check out the newsletter, and get a more complete update on Robothon '97, by hitting [www.hhhh.org/srs](http://www.hhhh.org/srs) and following the links.

As if doing major organization for such a celebration in entropy wasn't enough, Kevin brought along one of the day's top entertainments, a video tape of the 1996 San Francisco Robot Wars competition. Talk about your extreme robotics; this 20-minute tape is chockful of fast, heavy, dangerous robots waging mayhem on each other. The last robot left moving took first place for its creators, not to mention a ton of robotic fame, and the audience had a great time watching the event.

I'm talking about a whole different scale here. One team described their robot as being in the heavyweight class. They were quite proud that their machine had been trimmed to hit the exact upper limit of the permitted weight range ... 165 pounds!

These machines are not meant for the average



living room. Many were armed with high-speed diamond-tipped circular saw blades, several hydraulic rams showed up, and gas engines were the favored motors. All machines were controlled remotely using R/C radios, but most only showed two speeds; full blast and crashed. One of the favored heavyweights rolled into the arena (evidently a hockey rink minus the flooring) with its creator standing on top, controlling the machine with the R/C unit and keeping the throttle way down.

High speed proved very important, what with Newtonian physics and all. When two of these juggernauts collided, which happened often, it was a miracle that either rolled away under its own power. But they did, then squared off and took a run at something else. The crashes were horrific, and the winning robot looked like something the Buick had dragged home. The losers were much thinner than when they started, and made mostly of dents. And then there was the walker that caught fire ...

I can enthusiastically recommend this video, available from Mondotronics ([www.robotstore.com](http://www.robotstore.com)) for about \$20.00. Think of it as an alternate-reality check. The next time you think you're hot doo-doo with your kick-butt Mini-Sumo robot, pull this tape out and watch a horde of high-tech robo-monsters do the Crash-and-Burn on each other. You'll see your lawn mower in a whole new light.

## Tidbits

Whenever Marvin shows up, we spend as much time as we can eating Chinese food and doing robots. After the SRS meeting, we headed back to my place to find something robotic to do. I dragged out a couple of surplus 12 VDC cassette drives that I had picked up, God alone knows where, and we spent some time tearing these down and bagging the parts. These cassette drives are crammed with beautifully machined bits ideal for small robots and smaller mechanisms on larger machines.

In particular, each drive contained a small, high-energy solenoid, suitable for use as part of an actuator. Though I'm pretty sure the drive was supposed to run on 12 VDC, the solenoid gave plenty of snap at 6 VDC, and should work well as part of a release mechanism or a pen carrier on an artist robot.

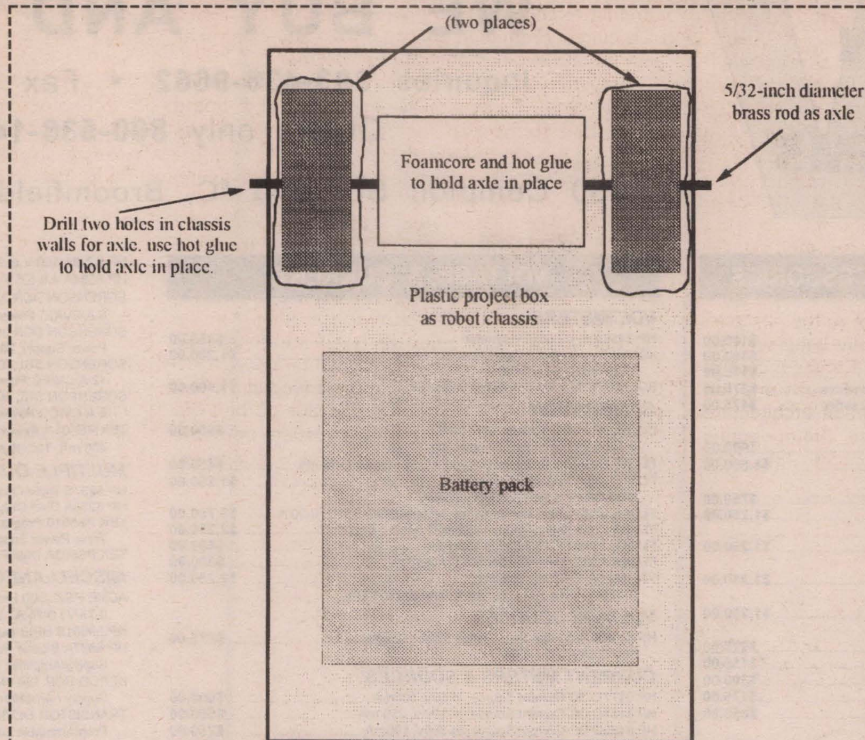
The drives also yielded a good assortment of small springs. Anyone building tiny robots will end up needing a tiny spring now and then, and I've never been able to find a reliable, walk-in-the-door store for buying them. Now I've got a couple dozen of various strengths, waiting for that next design.

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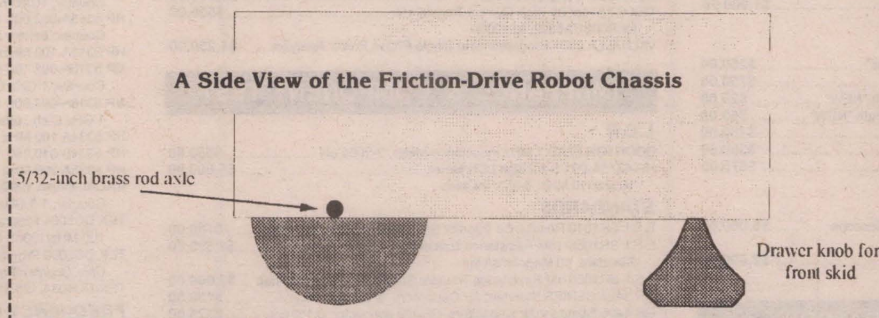
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Friction-Drive Free-Wheel Robot Chassis



A Side View of the Friction-Drive Robot Chassis

All told, the cassette drives gave me two gutted chassis and a collection of useful parts, for little more than an enjoyable afternoon of male bonding. You can usually find similar drives for sale in the mail-order surplus companies such as Marlin P. Jones and American Science & Surplus. Keep these drives in mind the next time you need that special, small mechanical part.

Blue LEDs have been out for some time now, but the last few I've seen left me very underwhelmed. I mean, how can I get excited about an expensive, one or two milli-Candela blue unit when all of the reds and greens I buy for pennies hit a Candela or more? An LED vendor recently showed up at the company where I work, lugging a suitcase full of LEDs. His sample set included some painfully bright blue LEDs, with a color so pure and intense I couldn't resist buying a couple, even at \$3.00 each. The devices are rated at 1.5 Candelas each, and will throw a large spot of blue light on a wall a foot away in strong ambient light. I can't wait to add them to a show-bot.

I purchased the LEDs directly from a distributor based in Bellevue — Power Sales & Distribution, Inc. The sales rep, Cary Aberg, told me that the LED's manufacturer, Parralight, is an Asian company that apparently holds the patents on the silicon-carbide process used in making the blue LEDs. Parralight has come up with a dazzling device in the NSPB500 LED that I bought. For those of a more technical bent, the specs for this single quantum well device are: dominant wavelength of 470 nm, typical DC

forward voltage of 3.6 VDC at a forward current of 20 mA, 5° directivity, and typical luminous intensity of 1.5 Candela. If you have trouble locating these (or similar) blue LEDs, you can always call Cary directly at 206-637-8973 in Bellevue, WA.

Marvin and I spent some time hacking a friction drive robot mechanism together. I started with a short length of 5/32" brass rod, cut to the proper length (about four inches). I slipped two model airplane wheels onto the rod; you can usually find a good selection of small wheels with the necessary 5/32-inch bore at most hobby stores. I then used a handheld Dremel tool to hog out two cutouts in the underside of a plastic project box, so each wheel fit through a cutout and rested on the tabletop. I then used hot glue and foamcore to hold the axle in place across the inside of the box. See the accompanying drawings of the friction-drive robot chassis.

The drawings don't show the motors mounted in place. Your design will vary, based on the dimensions and motor mounting scheme you use. Basically, you want to mount a motor next to each wheel, the shaft parallel to the axle, so the motor's shaft presses firmly against the wheel. As the motor's shaft turns, the friction between shaft and wheel acts as both a power transfer and as a gearing system. I suggest adding a sleeve of soft heatshrink or surgical tubing over each motor shaft, to improve the grip between the two surfaces.

I used 1-1/2" wheels in my design, and the typical small motors found in surplus cassette drives work fine for the drive motors. Given the difference in diameters between the drive motor shaft and the driven wheel, the friction-drive chassis can hit very useful speeds with a surprising amount of torque. My little test rig had no problem lugging a set of four AA-cell batteries over carpeted floors, with plenty of torque left over for the MCU and other stuff. Note that the final diameter of the motor shaft, including any sleeving you add, directly affects both the final speed and torque. The larger the final diameter, the faster the wheel speed, but the lower the torque. If necessary, dabble with various sleeveings and/or wheel diameters to get the right balance.

You don't need to limit yourself to a project box for a chassis, though they work very well. Try your hand at building a friction-drive system out of brass rod, with your motors and wheels hanging out there in mid-air. The robot drive will take on a kinetic sculpture appearance, and should net your machine even more crowd appeal. **NV**

As always, you can reach me at:

**Karl Lunt**

116 173rd St. S.W.  
Bothell, WA 98012

E-Mail: [karllunt@seanet.com](mailto:karllunt@seanet.com)

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<b>CALIBRATION</b>	
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TEK FG503 3 MHz Function Generator, TM500 series	\$250.00
TEK RG501 Ramp Generator, TM500 series	\$225.00
WAVETEK 23 12 MHz Synthesized Function Generator	\$1,100.00

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HP 214B-001 10 MHz Pulse Generator, 50 V/50 ohms, counted burst opt.	\$2,000.00
HP 8005B 20 MHz Dual Output Pulse Generator	\$450.00
HP 8007B 100 MHz Pulse Generator	\$650.00
HP 8012B 50 MHz Pulse Generator, variable transition time	\$600.00
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HP 8015A-002, 007 50 MHz Dual Output Pulse Gen., burst option	\$800.00
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HP 8080A/91A/92A/93A 1 GHz Single Channel Pulse Generator	\$950.00
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HP 8111A-001 20 MHz Pulse/Function Generator, burst mode option	\$1,650.00

TEK PG501 50 MHz Pulse Generator, TM500 series	\$250.00
TEK PG502 250 MHz Pulse Generator, Tr<1nS, TM500 series	\$600.00

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HP 8165A-002, 003 Prog. Signal Source, 1 mHz-50 MHz, log sweep, rear out	\$2,000.00
TEK AWG5102 Arb. Waveform Gen., 20 MS/s, 12 bits, 50ppm synthesis <1MHz	\$1,400.00
TEK AWG5105-opt.02 Arbitrary Waveform Generator, dual channel option	\$1,900.00
TEK FG5010 Programmable 20 MHz Function Generator, TM5000 series	\$1,200.00
WAVETEK 288 20 MHz Synthesized Function Generator, GPIB	\$1,250.00

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KEITHLEY 181 6-1/2 digit Nanovoltmeter, 10 nV sensitivity, GPIB	\$1,200.00
SOLARTRON 7081 8-1/2 digit Voltmeter	\$3,900.00

<b>CALIBRATION</b>	
FLUKE 343A DC Voltage Calibrator, 0-1100 V, 7 decades, 20 ppm acc.	\$950.00
FLUKE 510A AC Reference Standard, 10 VRMS, 0-10 mA	\$450.00
FLUKE 515A Portable Calibrator, DC/AC/Ohms, line & battery power	\$1,250.00
FLUKE 5220A Transconductance Amplifier, DC-5 kHz, 0-20 A	\$3,750.00
FLUKE 720A Kelvin-Voltage Divider, 7 decade	\$2,250.00
FLUKE 731B DC Reference Standard	\$400.00
FLUKE A55-series AC Thermal Converters	\$300.00
VALHALLA 2703 AC Volt. Std., 0-120V/10 Hz-100 kHz; 120-1200V/10 Hz-1 kHz	\$2,250.00

<b>VOLTAGE SOURCES</b>	
HP 6115A Precision Dual Range Power Supply, 50V 0.8A / 100V 0.4A	\$875.00

<b>CURRENT METERS &amp; SOURCES</b>	
HP 6177C DC Current Source, to 50V, 500mA	\$500.00
HP 6181C DC Current Source, to 100 V, 250 mA	\$500.00
HP 6186C DC Current Source, to 300V, 100mA	\$750.00
KEITHLEY 225 Current Source, 0.1 uA-100 mA, 10-100 V compliance	\$500.00
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KEITHLEY 614 Electrometer	\$1,000.00
KEITHLEY 642 Electrometer	\$2,900.00
TEK CT-5 -opt.05 High Current Transformer for P6021/A6302, to 1000A	\$500.00
VALHALLA 2301 Programmable Single Phase Power Analyzer	\$1,250.00

### IMPEANCE & COMPONENT TEST

<b>L.C.R.</b>	
BOONTON 62AD 1 MHz Inductance Meter, 2-2000 uH	\$550.00
HP 4275A-001 5-1/2 digit LCR Meter, 10 kHz-10 MHz, 0-35 V int. bias	\$6,000.00

<b>STANDARDS</b>	
E.S.I. SR1010 Resistance Transfer Standards, 1 ohm-100 K/step	\$700.00
E.S.I. SR1050-10M Resistance Transfer Standard, 10 Megohms/step	\$2,500.00
E.S.I. SR1050-1M Resistance Transfer Standard, 1 Megohm/step	\$2,000.00
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GR 1406 Standard Air Capacitors, GR900 connector, 0.1% acc.	\$375.00
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GR 1433-L 4-Decade Resistor, 0-11,110 ohms, 10 ohm resolution	\$350.00
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GR 1433-X 6-Decade Resistor, to 111,111.0 ohms, 0.1 ohm res.	\$450.00
GR 1434-G 7-Decade Resistor, 0-1,111,110 ohms, 0.1 ohm res.	\$300.00
VALHALLA 2724A Programmable Resistance Standard, 0-11 Gigohms, GPIB	\$1,675.00

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VALHALLA 4150-ATC 4-1/2 digit Ohmmeter, 20 million-2 kilohms, 4-wire	\$750.00

<b>CURVE TRACERS</b>	
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TEK 577D2/177 Curve Tracer, with standard test fixture	\$1,850.00

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HP 6261B-027 20 V at 50 A CV/CC Power Supply; 208 VAC line	\$675.00
HP 6263B 20 V at 10 A CV/CC Power Supply	\$400.00
HP 6266B 40 V at 5 A CV/CC Power Supply	\$400.00
HP 6268B-027 40 V at 30 A CV/CC Power Supply; 208 VAC line	\$850.00

HP 6299A 100 V at 750 mA CV/CC Power Supply	\$225.00
HP 6384A 4.0-5.5 V at 8 A CV/CL Power Supply	\$175.00
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SORENSEN DCR 300-8A 300 V at 8 A CV/CC Power Supply, 208/230 VAC line	\$950.00
SORENSEN SRL 20-12 20 V at 12 A CV/CC Power Supply, low noise	\$500.00
SORENSEN SRL 60-8 60 V at 8 A CV/CC Power Supply, low noise	\$750.00
TEK PS501-1 Power Supply, 0-20 V, 2 mV res., 400 mA, TM500 series	\$175.00

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HP 6253A Dual Output 20 V 3 A CV/CC Power Supply	\$500.00
TEK PS5010 Programmable Triple Power Supply, TM5000 series	\$750.00
TEK PS503A Dual Power Supply, TM500 series	\$200.00

<b>MISCELLANEOUS</b>	
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HP 59501B HP1B Isolated DAC/Power Supply Programmer	\$175.00
HP 6827A Bipolar Power Supply/Amplifier, to 100 V, 500 mA	\$800.00
KEPCO BOP 100-4M Bipolar Supply / Amplifier, 0-100 V, 0-4 A	\$1,000.00
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HP 5316A-003 100 MHz/100 nS Universal Counter, 1 GHz C-channel, HP1B	\$850.00
HP 5316A-003, 006 100 MHz/100 nS Counter, 1 GHz C-ch., offset/normalize	\$1,000.00
HP 5334A 100 MHz Universal Counter, HP1B	\$875.00
HP 5334B-010, 060 100 MHz Universal Counter, HP1B, OCXO	\$1,000.00
HP 5335A 200 MHz Universal / Statistical Counter	\$1,200.00
RACAL-DANA 1992-04 100 MHz/1 nS Univ. Counter, 1.3 GHz C-channel, OCXO	\$750.00
TEK DC5004 Programmable 100 MHz/100nS Counter/Timer, TM5000 series	\$250.00
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HP 5342A-001 18 GHz Frequency Counter, OCXO reference	\$2,500.00
HP 5342A-003, 011 18 GHz Freq. Counter, +22 dBm, -20 dBm dynamic range, HP1B	\$2,750.00
HP 5342A-01, 04, 05, 11 24 GHz Frequency Counter, OCXO, DAC, and HP1B	\$3,900.00
HP 5345A/5355A/5356B 26.5 GHz CW/Pulse Frequency Counter	\$4,000.00
HP 5382A 225 MHz Frequency Counter	\$175.00

<b>STANDARDS</b>	
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HP 8903A Audio Analyzer, 20 Hz-100 kHz	\$2,600.00
HP 8903B-001, 013, 051 Audio Analyzer, 20 Hz-100 kHz; C-message, CCITT	\$4,250.00

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FLUKE 8922A True RMS Voltmeter, 180 uV-700 V, 2 Hz-11 MHz	\$600.00

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HP 204D Oscillator, 5 Hz-1.2 MHz, 5 VRMS, 80 dB step attenuator	\$200.00
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KROHN-HITE 3202 i, Dual High-Pass/Low-Pass Filter, 20 Hz-2 MHz, 24 dB/oct	\$600.00
KROHN-HITE 3342R Dual HP/LP Filter, 0.001 Hz-99.9 kHz, 48 dB/octave	\$1,100.00
KROHN-HITE 3750 LP/HP/BP/BR Filter, 0.02 Hz-20 kHz, 6/12/18/24 dB/oct	\$700.00
ROCKLAND 852 Dual Highpass/Lowpass Filter, 0.1 Hz-111 kHz	\$1,000.00
TEK AF501 Tunable Bandpass Filter / Amplifier, 3 Hz-35 kHz	\$300.00
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## RF & MICROWAVE

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HP 11970Q WR22 Harmonic Mixer, 33-50 GHz	\$1,400.00
HP 11970V WR19 Harmonic Mixer, 40-60 GHz	\$1,400.00
HP 11970V WR15 Harmonic Mixer, 50-75 GHz	\$1,600.00
HP 11971A WR28 Harmonic Mixer, 26.5-40.0 GHz, for 8569B	\$1,100.00
HP 11971K WR42 Harmonic Mixer, 18.0-26.5 GHz, for 8569B	\$1,100.00
HP 141T/8553/8552/8443 Spectrum Analyzer & Tracking Generator, 0.1-110 MHz	\$2,500.00
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HP 8444A-059 Tracking Generator, 0.5-1500 MHz, for 855A, 856B, etc.	\$1,250.00
HP 8445B Preselector, 1.8-18.0 GHz, for HP 8555A	\$650.00
HP 8557A/182T Spectrum Analyzer, 0.01-350 kHz, 1 kHz res., w/display	\$1,650.00
HP 8565A Spectrum Analyzer, 10 MHz-22 GHz, 1 kHz min.res.bw.	\$4,500.00
HP 8565A-100 Spectrum Analyzer, 10 MHz-22 GHz, 100 Hz min.res.bw.	\$5,000.00
HP 8569B Spectrum Analyzer, 10 MHz-22 GHz, 100 Hz min.res.bw.	\$8,500.00
TEK 7L13/R7613 Spectrum Analyzer, 1 kHz-1.8 GHz, 30 Hz min.res., w/frame	\$2,250.00
TEK TR503 Tracking Generator, 0.1-1800 MHz, for 492A/5/6	\$1,375.00
TEK WM782V WR15 Harmonic Mixer, 50-75 GHz	\$2,000.00

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HP 11666A Reflectometer Bridge, 0.04-18.0 GHz, for HP 8755/6/7	\$1,100.00
HP 8410B/8411A/8743B Network Analyzer, 2-18 GHz, w/Reflection-Xms Test Set	\$2,000.00
HP 8755C(3)/11664A/182T Scalar Network An. w/3 detectors, 10 MHz-18 GHz & frame	\$1,750.00
HP 8756A(3)/11664A Scalar Network Analyzer, w/3 detectors, 0.01-18 GHz	\$3,750.00
WAVETEK 1038D/14A/H12/V13x2 Scalar Network An., w/3/15882 WR28 detectors, 26.5-40 GHz	\$2,200.00

### SIGNAL GENERATORS

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GIGATRONICS 600/10-18 Synthesized Source, 10-18 GHz, 1 MHz res., GPIB	\$2,600.00
GIGATRONICS 605/10-18 Synthesized, Source, 10-18 GHz, 1 kHz res., GPIB	\$3,000.00
GIGATRONICS 840-01 Freq. Doubler, 26.5-40 GHz (WR28) out, 13-20 GHz in	\$2,000.00
GIGATRONICS 875/50 Levelled Multiplier, x4, 50.0-75.0 GHz output, -3 dBm	\$3,500.00
GIGATRONICS 875/86 Levelled Multiplier, 26.5-40.0 & 50.0-75.0 GHz outputs	\$5,000.00
GIGATRONICS 910/12-18, opt6, 14, 16 Synthesized Source/Sweeper, 12-18 GHz, 1 Hz res., OCXO	\$3,500.00
HP 85100V Frequency Mult., 10-15 GHz in / 50-75 GHz out >0 dBm	\$4,250.00
HP 8640B-001,002,003 Signal Gen., 0.5-1024 MHz, AM, FM, var. audio osc.	\$2,500.00
HP 8654A Signal Generator, 10-520 MHz, calibrated AM & uncal. FM	\$550.00
HP 8656A Signal Generator, 0.1-990 MHz, 100 Hz res., AM, FM, HP1B	\$2,900.00
HP 8660C/86602B/86632B Synthesized Signal Gen., 1-1300 MHz, 1 Hz res., AM, FM	\$2,750.00
HP 8660C/86603A-002 Synth. Sig. Gen., 1-2600 MHz, FM / Phase mod, w/86635A	\$4,500.00
HP 8660D/86603A/86632B Synthesized Signal Generator, 1-2600 MHz	\$7,000.00
HP 8671A-005 Synthesized CW Generator, 2.0-6.2 GHz, 1 kHz res., HP1B	\$6,000.00
ROHDE & SCHWARTZ SMGU Synthesized Signal Generator, 0.1-2160 MHz, 0.1 Hz res.	\$12,000.00
WILTRON 6742A Synth. Signal/Sweep Gen., 18.0-26.5 & 26.5-40.0 GHz	\$8,750.00

### SWEEP GENERATORS

HP 11869A Plug-in Adapter	\$450.00
HP 8600A Digital Marker, for HP 8601A	\$400.00
HP 8601A Generator/Sweeper, 0.1-110 MHz, +20 dBm levelled	\$400.00

HP 8620C Sweep Oscillator Frame	\$550.00
HP 8620C-011 Sweep Oscillator Frame, HP1B programmable	\$675.00
HP 8622A-002 RF Plug-in, 10-2400 MHz, +13 dBm levelled, 70 dB atten.	\$1,600.00
HP 86230B RF Plug-in, 1.8-4.2 GHz, +10 dBm unlevelled	\$675.00
HP 86240A-002 RF Plug-in, 2.0-8.4 GHz, +14 dBm lwd, 70 dB step att.	\$1,200.00
HP 86241A-001 RF Plug-in, 3.2-6.5 GHz, +8 dBm levelled	\$500.00
HP 86242D-004,008 RF Plug-in, 5.9-9.0 GHz, +10 dBm levelled	\$500.00
HP 86245A RF Plug-in, 5.9-12.4 GHz, +16 dBm levelled	\$1,100.00
HP 86250D RF Plug-in, 8.0-12.4 GHz, +10 dBm levelled	\$675.00
HP 86260A RF Plug-in, 12.0-18.0 GHz, +10 dBm unlevelled	\$800.00
HP 86260A-H04 RF Plug-in, 10.0-15.0 GHz, +10 dBm unlevelled	\$800.00
HP 86290A RF Plug-in, 2.0-18.0 GHz, +7 dBm levelled	\$1,750.00
HP 86290C RF Plug-in, 2.0-18.6 GHz, +13 dBm levelled	\$2,500.00
WAVETEK 962 Sweep Generator, 1.0-4.0 GHz, markers, +12 dBm unlvld.	\$1,750.00

### POWER METERS

ANRITSU MP-81B/ML-83A Power Meter, 75-110 GHz (WR10), -20 to +20 dBm	\$2,500.00
ANRITSU MP-82B/ML-83A Power Meter, 90-140 GHz (WR8), -20 to +20 dBm	\$3,250.00
BOONTON 4200-01A,03/8-4A x2 Dual Channel Microwattmeter, w/(2) 1 MHz-7 GHz sensors	\$1,500.00
BOONTON 42B41-4B Analog Power Meter, with 1 MHz-12 GHz sensor	\$375.00
BOONTON 42B41-4E Analog Power Meter, with 1 MHz-18 GHz sensor	\$500.00
GENERAL MICROWAVE 476/4240A Power Meter & Sensor, 0.01-18 GHz, -35 to +10 dBm	\$375.00
HP 435A/8481A Power Meter, 10 MHz-18 GHz, -30 to +20 dBm	\$1,000.00
HP 435A/8482A Power Meter, 100 kHz-4.2 GHz, -30 to +20 dBm	\$1,000.00
HP 435A/8482B Power Meter, 0.1-4200 MHz, -15 to +34 dBm	\$1,150.00
HP 435A/8482B Thermistor Mount, 18.0-26.5 GHz, for 432 series	\$350.00
HP Q486A Power Sensor, 33.0-50.0 GHz, WR22, for 435/6/7/8	\$1,500.00
HP 486A WR28 Thermistor Mount, 26.5-40.0 GHz, for 432 series	\$350.00

### RF MILLIVOLTMETERS

BOONTON 9200A-01 RF Millivoltmeter, 10 kHz-1.2 GHz, GPIB	\$900.00
RACAL 9303 TRMS Level Meter, 10 kHz-2 GHz, -77 to +23 dBm, GPIB	\$875.00

### AMPLIFIERS, MISCELLANEOUS

HP 465A Amplifier, 20/40 dB, 5 Hz-1 MHz, 1/2 Watt/50 Ohms	\$125.00
HP 8474A-001 Dual Amplifier, 0.1-400 MHz	\$450.00
HP 8447E Amplifier, 22 dB, 0.1-1300 MHz, +13 dBm output	\$750.00
HP 8901A Modulation Analyzer, 150 kHz-1300 MHz	\$3,750.00
HP 8901B-001 Modulation Analyzer, 150 kHz-1300 MHz, rear panel input	\$6,750.00
HUGHES 1177H01F000 TWT Amplifier, 20 Watts output, 1.4-2.4 GHz	\$1,750.00
M.P.D. LAB-21020-2A Amplifier, 34 dB, 1.0-2.0 GHz, 2 Watts	\$800.00
M.P.D. LAB-21714-3A Amplifier, 34 dB, 0.7-1.4 GHz, 3 Watts	\$800.00
MICROWAVE SEMI-CORP. MC5112 Noise Source, 25.5 dB ENR, 10-12.4 GHz, N(m), +28 VDC	\$325.00

## COAXIAL & WAVEGUIDE

AMERICAN NUCLEONICS AM-432 Cavity Backed Spiral Antenna, LHC, 2-18 GHz, TNC(f) *NEW*	\$95.00
FXR/MICROLAB S3-02N Triple Stub Tuner, 200-1000 MHz, 100 Watts max., N(m/f)	\$125.00
GR 874-LTL Constant Impedance Trombone Line, 0-44 cm, DC-2 GHz	\$450.00
GR 900-Q GR900 14mm Interseries Adapters	\$125.00
HP 11589A Bias Network, 0.1-3.0 GHz, N(f/f)	\$350.00
HP 11590A-001 Bias Network, 1.0-18.0 GHz, APC7	\$450.00
HP 11691D Directional Coupler, 22 dB, 2-18 GHz	\$450.00
HP 11692D Dual Directional Coupler, 22 dB, 2-18 GHz	\$800.00
HP 11721A Freq. Doubler, 50-1300 MHz in/100-2600 MHz out	\$400.00
HP 3330B Crystal Detector, 0.01-18 GHz, neg. pol., SMA(m)/SMC(f)	\$135.00
HP 774D Dual Directional Coupler, 20 dB, 1.5-450 MHz	\$275.00
HP 777D Dual Directional Coupler, 20 dB, 1.9-4.1 GHz	\$275.00
HP 8470B-012 Crystal Detector, 10 MHz-18 GHz, neg. pol., N(m)	\$250.00
HP 8491A-030 30 dB Attenuator, DC-12.4 GHz, 2 Watts, N(m/f)	\$50.00
HP 8494G-002 Programmable Step Attenuator, 0-11 dB, DC-4 GHz, SMA	\$400.00
HP 8495G-002 Programmable Step Attenuator, 0-70 dB, DC-4 GHz, SMA	\$300.00
HP 8497K-004 Programmable Step Attenuator, 0-90 dB, DC-26.5 GHz	\$750.00
HP K422A WR42 Flat Broadband Detector, 18.0-26.5 GHz	\$350.00
HP K532A WR42 Frequency Meter, 18.0-26.5 GHz	\$500.00
HP K870A WR42 Slide Screw Tuner, 18.0-26.5 GHz	\$275.00
HP K914B WR42 Moving Load, 18.0-26.5 GHz	\$425.00
HP Q752D WR22 Directional Coupler, 20 dB, 33-50 GHz	\$650.00
HP R375A WR28 Variable Attenuator, 0-20 dB, 26.5-40 GHz	\$375.00
HP R422A WR28 Flat Broadband Detector, 26.5-40 GHz	\$400.00
HP R532A WR28 Frequency Meter, 26.5-40.0 GHz	\$500.00
HP R914B WR28 Moving Load, 26.5-40 GHz	\$300.00
HP V365A WR15 Isolator, 25 dB, 50-75 GHz	\$900.00
HP V752D WR15 Directional Coupler, 20 dB, 50-75 GHz	\$650.00
HP X870A WR90 Slide Screw Tuner	\$150.00
HUGHES 45113H-2000 WR28 Isolator, 25 dB, 26.5-40 GHz	\$450.00

HUGHES 45113H-1000 WR19 Isolator, 25 dB, 40-60 GHz	\$650.00
HUGHES 45521H-2000 WR28 Manual 4-Position Switch	\$750.00
HUGHES 45711H-2000 WR28 Frequency Meter, 26.5-40 GHz	\$600.00
HUGHES 45723H-1000 WR19 Precision Rotary Vane Atten., 0-50 dB, 40-60 GHz	\$1,000.00
HUGHES 47316H-1111 WR10 Tuneable Detector, 75-110 GHz, positive polarity	\$750.00
HUGHES 47323H-1211 WR19 Flat Broadband Detector, negative, 40-60 GHz	\$650.00
HUGHES 47974H-1000 WR15 SPST PIN Switch, 250 MHz speed, 60-62 GHz response	\$375.00
KAY 442D Step Attenuator, 0-101 dB, 75 ohms, BNC	\$100.00
KRYTAR 1818 Directional Coupler, 16 dB, 2-18 GHz, SMA(f)	\$200.00
M/A-COM 3-19-300/10 WR19 Directional Coupler, 10 dB, 40-60 GHz	\$450.00
MINI-CIRCUITS ZFDC-20-4 Directional Coupler, 19.5 dB, 1-1000 MHz, SMA(f)	\$25.00
NARDA 25171 Level Set Attenuator, 0-17 dB, 2-8 GHz, SMA(f)	\$100.00
NARDA 26298 20 dB Attenuator, 150 Watts, DC-1 GHz, N(f/f)	\$200.00
NARDA 3000-SERIES Directional Couplers	\$150.00
NARDA 3024 Bi-Directional Coupler, 20 dB, 4-8 GHz	\$300.00
NARDA 3090-SERIES Precision High Directivity Couplers	\$225.00
NARDA 368NM Coaxial High Power Load, 500 Watts, 2.0-12.4 GHz, N(m)	\$400.00
NARDA 369BNF High Power Termination, 175 Watts, 0.7-18 GHz, N(f)	\$325.00
NARDA 3753B Coaxial Phase Shifter, 0-60 deg./GHz, 3.5-12.4 GHz	\$1,250.00
NARDA 4000-SERIES SMA Miniature Directional Couplers	\$75.00
NARDA 4203-6 Directional Coupler, 6 dB, 2-18 GHz, SMA(f/f/f)	\$225.00
NARDA 4245-10 Directional Coupler, 10 dB, 4-12 GHz, SMA(f)	\$100.00
NARDA 4246B-20 Directional Coupler, 20 dB, 6-18 GHz, SMA(f)	\$100.00
NARDA 4799 Level Set Attenuator, 0-15 dB, 2-18 GHz, SMA(f)	\$135.00
NARDA 5070-SERIES Precision Reflectometer Couplers	\$300.00
NARDA 765-20 20 dB Attenuator, 50 Watts, DC-5 GHz, N(m/f)	\$135.00
NARDA 766-10 10 dB Attenuator, 20 Watts, DC-4 GHz, N(m/f)	\$100.00
NARDA 768-20 20 dB Attenuator, 20 Watts, DC-11 GHz, N(m/f)	\$125.00
NARDA 792FF Variable Attenuator, 0-20 dB, 2.0-12.4 GHz	\$375.00
OMNI-SPECTRA 2085-6010-00 Crystal Detector, 1-18 GHz, negative polarity, SMA(m/f)	\$50.00
PAMTECH KYG1014 WR42 Junction Circulator, 18.0-26.5 GHz	\$250.00
SIERRA 662A-20 20 dB Attenuator, 100 Watts, N(f/f)	\$150.00
SONOMA SCIENTIFIC 21A3 WR42 Circulator, 20 dB, 20.6-24.8 GHz	\$125.00
SPACE LABS DQ-1 WR22 Flat Broadband Detector, 33-50 GHz	\$550.00
TRG V510 WR15 Precision Rotary Vane Atten., 0-50 dB, 50-75 GHz	\$1,000.00
TRG V551 WR15 Frequency Meter, 50-75 GHz	\$600.00
TRG V559-10 WR15 Directional Coupler, 10 dB, 50-75 GHz	\$400.00
TRG V510 WR10 Precision Rotary Vane Atten., 0-50 dB, 75-110 GHz	\$1,000.00
WEINSCHEL 1515 Power Divider, 2-Way, DC-18 GHz, SMA(m/f/f)	\$125.00
WILTRON 4612K Programmable Step Attenuator, 0-70 dB, DC-40 GHz	\$800.00
WILTRON 4622K Programmable Step Attenuator, 0-110 dB, DC-40 GHz	\$1,000.00
WILTRON 60N50-opt.1 SWR Bridge, 5-2000 MHz, 46 dB directivity, N(m/f/f)	\$500.00
WILTRON 787A-50 VSWR Bridge, 2-18 GHz, 35 dB dir., APC7 test port	\$600.00

## LOGIC

FLUKE 9000A-series Microprocessor Pods: 6800; 6809; 8080; 8085; Z80	\$375.00
HP 10343B/10269C SCSI Bus Preprocessor, w/probe intfc., for 1630 series	\$300.00
HP 5005A Signature Multimeter	\$350.00
HP 8170A-002 Logic Pattern Generator, 2 MB/s, address driver option	\$1,200.00

## COMMUNICATIONS

HP 59401A HP1B Bus Analyzer	\$700.00
TEK 1410R NTSC Gen., w/SPG2 sync generator, TSG7 color bars	\$1,000.00
TEK 1411R PAL Gen., w/SPG12 sync; TSG11 color bars; TSG13 linearity	\$1,000.00
TEK 1411R PAL Test Gen., w/SPG12, TSG11, TSG13, TSG15, TSG16	\$1,400.00
TEK 1411R PAL Test Gen., w/SPG12, TSG11, TSG12, TSG13, TSG15, TSG16	\$1,600.00
TEK 1411R-opt.04 PAL Test Gen., w/SPG12, TSG11, TSG11, TSG13, TSG15, TSG16	\$1,900.00
TEK 147A NTSC Test Signal Generator, with noise test signal	\$800.00
TEK 148 PAL Insertion Test Signal Generator	\$800.00
TEK 1750 NTSC Waveform / Vector Monitor	\$2,750.00
TEK 520A NTSC Vectorscope	\$750.00
TEK 521A PAL Vectorscope	\$750.00

## MISCELLANEOUS

P.A.R. 5205-94, 95, 96, 98 Lock-In Amp, 20 Hz-20 kHz, int. osc., in/lo/g, GPIB	\$2,000.00
P.A.R. 5206 Two-Phase Lock-In Amplifier, 2 Hz-200 kHz	\$1,750.00
P.A.R. 5208-92, 94, 97, 98 Two Phase B	\$2,500.00
Lock-In Amp., 5 Hz-20 kHz or 200 kHz, GPI	
TEK TM5006 5000-series 6-slot Programmable Power Module	\$600.00
TEK TM503 500-series 3-slot Power Module	\$150.00
TEK TM504 500-series 4-slot Power Module	\$175.00
TEK TM506 500-series 6-slot Power Module	\$250.00
TEK TM515 500-series 5-slot Traveller Power Module	\$275.00



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**MISCELLANEOUS ELECTRONICS FOR SALE.** Stepper motor/encoder 3" dia. 4.5". 4 ohm 2A. HP encoders, intended for use on HP plotters \$40 ea. or will deal for all. 200 available. 760-632-9775.

**FOR SALE:** Jenmar oscilloscope cost \$200. Digital capacitance meter cost \$875. Some diodes. Write 9953 NW 9th St. Cir. #1, Miami, FL 33172.

## MISC. ELECTRONICS WANTED

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# PRINTER PORT OSCILLOSCOPE

## Part 1 of a three-part series on handy printer port devices.

**H**andheld digital oscilloscopes are quite expensive. They often sell for over \$1,000.00. By using your laptop or desktop computer, the price can be slashed *substantially*. In fact, a single-channel version can be built for under \$100.00. Any old laptop with only one floppy drive can run the software.

This is considered to be a "hobby" grade device. It is not suitable for medical purposes, or accurate enough for professional applications. Design accuracy is 10%, although with laboratory equipment, accuracy of 5% should be obtainable.

The printer port oscilloscope starts with an input buffer and voltage divider feeding an amplifier. This then drives an analog-to-digital converter which feeds a FIFO (first in first out) buffer. This is then multiplexed into two four-bit chunks to be input into a printer port. A clock is derived from clock dividers and

selected by eight-to-one multiplexers.

The printer port oscilloscope was not an easy project to design. The prototype had to be redesigned several times before it worked properly. The key component is a high-speed analog-to-digital converter. Thanks to a new chip from Analog Devices, the AD775, the problem is taken care of for \$15.00. This compares with \$35.00 for the old eight-bit 15 MC analog-to-digital converter — the CA3318. The AD775 is available from Newark Electronics. Due to high demand, it might be in short supply.

There are four problems to solve with using the AD775. The first problem is that the AD775 is .4" wide. Its socket can be made from a 24-pin socket by cutting a strip out of the center.

Second, it's rated for 20 MC guaranteed operation. For a sampling rate of 2 uS per division, 25

MC operation is needed. The Analog Devices specification sheet shows that the AD775 can work up to 35 MC, with a loss of accuracy.

Third, there is the need for a reference supply. For professional use, high-precision references are used. For our application, the five-volt power supply can suffice. It needs to be within 4.9 to 5.1 volts to be accurate enough.

The five-volt reference leads to another problem. In order to sample signals below zero volts, they must be biased so that they appear above zero volts. The AD775 has an internal reference with a low end of .6 volt and a high end of 2.7 volts. The AD775 would then need an average input voltage of 1.7 volts. This is done with a NE592 video amplifier. It naturally has a bias on its output of about 2.5 volts. A 2N3904 transistor then steps that down to 1.9 volts.

To keep the chip count to a min-

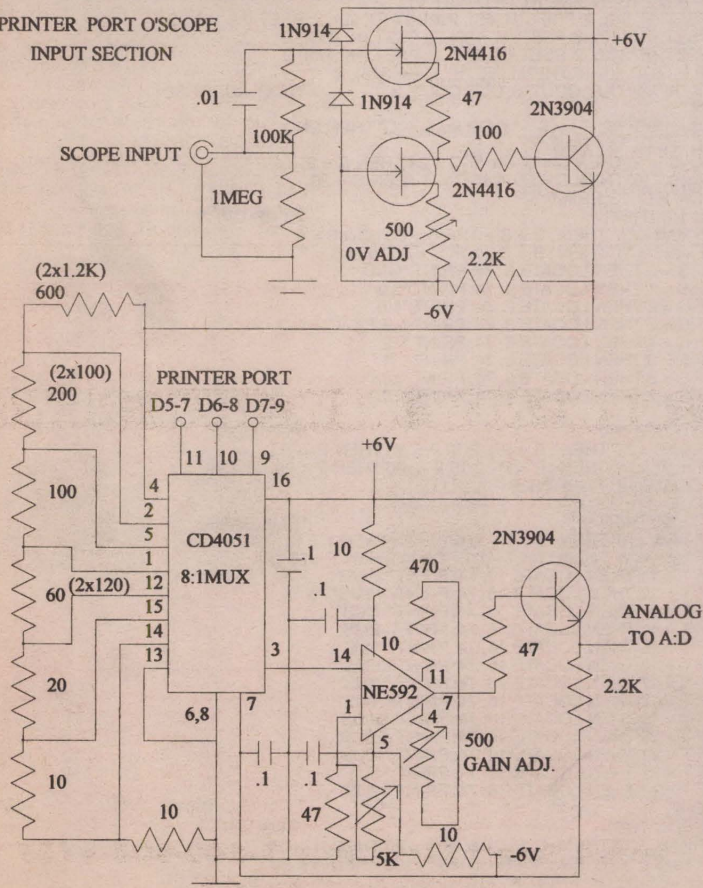
imum, a FIFO memory IC is used instead of RAM. This FIFO replaces two counters, multiplexers, and a RAM memory chip. FIFOs used to be quite expensive, but now are available for around \$10.00 to \$25.00 depending on the amount of memory and speed of the device.

FIFO stands for "First In First Out." That is to say, information is put into it, and retrieved from it, in the same order. This is much like a shift register, except that the FIFO is nine bits wide. They also feature "dual ports."

Dual ports allow information to be read from and written into the FIFO at the same time, and at two different locations in memory. The ability to read and write at the same time is not being used in this application. In order to keep digital noise to a minimum, we will not read from the FIFO while it is being written to.

FIFOs require special "hand shaking" to prevent them from going into "flow through mode" where they essentially disappear from the circuit. If a read is attempted when the FIFO is empty, or a write is attempt-

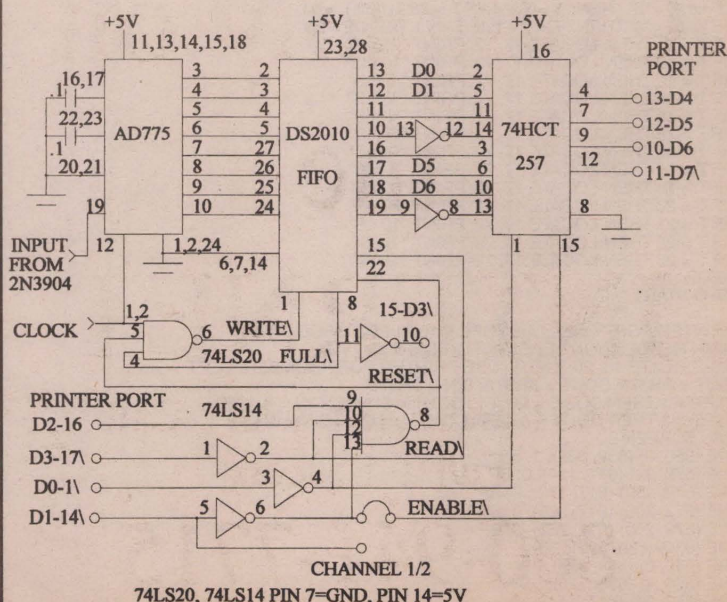
PRINTER PORT O'SCOPE  
INPUT SECTION



Mode Selection Chart

Bits	Binary	Mode
0000	0-3	Nothing
0100	4	Read Low Data
0101	5	Read High Data
0110	6	Read Low Data Channel 2
0111	7	Read High Data Channel 2
1111	15	Reset the O'scope

PRINTER PORT O'SCOPE  
MEMORY SECTION





ed when the FIFO is full, it enters this "flow through mode." After that, every read or write flows directly from input to output.

To prevent this, a four-input gate pulls the write high whenever there is a full flag or a reset.

Software prevents reading when the

FIFO is empty. But once you start reading from the FIFO, it starts writing again because it is no longer "full."

Writes at this time will be full of noise signals since the read buffers are sending data. So be careful not to read from more than 2048

addresses at a time unless the FIFO is reset. That is based on using a 2K FIFO.

When it comes to speed, the Dallas DS2010 FIFO is officially rated at 50 NS. For proper operation at 25 MC, a speed in excess of 40 NS is needed. The Am7203A-25

is twice as expensive, but rated to work at speeds in excess of 25 MC. Every Dallas chip tested has worked at 25 MC, but that is no guarantee.

Two ICs are used to determine the mode — the 74HCT20 and 74HCT14. The 74HCT14 is a

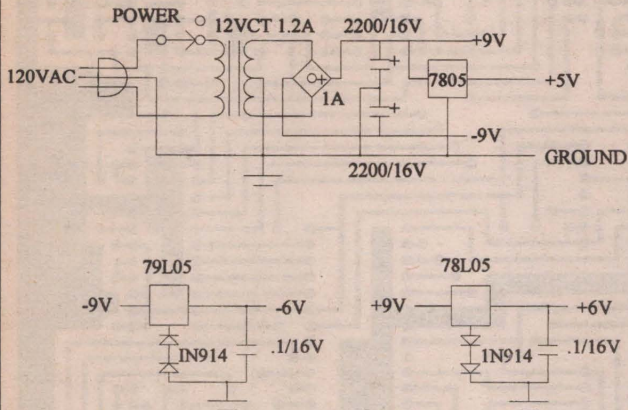
```
' PRINTER PORT OSCILLOSCOPE II 10/01/95 BY BOB DAVIS
' LOW RESOLUTION VERSION FOR 640 X 200 CGA
CLS : LOCATE 10, 20: INPUT "USE PRINTER PORT NUMBER: ", LPT
DOUT = &H378: COUT = &H37A: CIN = &H379
IF LPT = 1 THEN DOUT = &H3BC: COUT = &H3BE: CIN = &H3BD
IF LPT = 3 THEN DOUT = &H278: COUT = &H27A: CIN = &H279
CLS : SCREEN 2
LINE (0, 0)-(639, 190), , B
LINE (0, 0)-(532, 190), , B
LINE (536, 4)-(635, 186), , B
LINE (561, 62)-(610, 72), , B
LINE (561, 94)-(610, 104), , B
LINE (561, 126)-(610, 136), , B
LOCATE 2, 71: PRINT "PRINTER"
LOCATE 3, 71: PRINT "PORT"
LOCATE 4, 71: PRINT "O'SCOPE"
LOCATE 7, 69: PRINT "CH 1 V/DIV"
LOCATE 9, 72: PRINT "1"
LOCATE 11, 69: PRINT "CH 1 POSITN"
LOCATE 13, 72: PRINT "0"
LOCATE 15, 69: PRINT "HORIZ T/DIV"
LOCATE 17, 72: PRINT "5 mS"
LOCATE 21, 70: PRINT "COPYRIGHT"
LOCATE 22, 70: PRINT "BOB DAVIS"
LOCATE 25, 15
PRINT "SELECT CONTROLS WITH NUMERIC ARROW KEYS OR Q=QUIT";
T = 13: S = 2: P = 0: C = 9
START: OUT COUT, 11
OUT DOUT, (T + 32 * S)
OUT COUT, 15
FOR A = 1 TO 1000: NEXT A
FOR H = 1 TO 530
  PSET (H, 2), 0: DRAW "CO" + "M=" + VARPTR$(H) + ", 189"
  IF H > 2 THEN PSET (H - 1, V), 0 ELSE PSET (H, 95), 0
  OUT COUT, 4: V = (INP(CIN) \ 16)
  OUT COUT, 5: V = V + (INP(CIN) AND &HF0) - P - 30
  IF V > 188 THEN V = 188 ELSE IF V < 2 THEN V = 2
  IF H > 2 THEN DRAW "C1" + "M=" + VARPTR$(H) + " = " + VARPTR$(V)
  OUT COUT, 0: OUT COUT, 8
NEXT H
key$ = INKEY$: IF key$ = "q" OR key$ = "Q" THEN END
LOCATE C, 69: PRINT " "
IF key$ = "2" THEN C = C + 4: IF C = 21 THEN C = 9
IF key$ = "8" THEN C = C - 4: IF C = 5 THEN C = 17
LOCATE C, 69: PRINT ">"
IF C = 9 THEN
  'SENSITIVITY
  IF key$ = "6" THEN : S = S + 1: IF S > 7 THEN S = 0
  IF key$ = "4" THEN : S = S - 1: IF S < 0 THEN S = 7
  IF S = 0 THEN LOCATE 9, 72: PRINT "GND"
  IF S = 1 THEN LOCATE 9, 72: PRINT "2"
  IF S = 2 THEN LOCATE 9, 72: PRINT "1"
  IF S = 3 THEN LOCATE 9, 72: PRINT ".5"
  IF S = 4 THEN LOCATE 9, 72: PRINT ".2"
  IF S = 5 THEN LOCATE 9, 72: PRINT ".1"
  IF S = 6 THEN LOCATE 9, 72: PRINT ".05"
  IF S = 7 THEN LOCATE 9, 72: PRINT ".02"
END IF
IF C = 13 THEN
  'POSITION
  IF key$ = "6" THEN : P = P + 2: IF P > 30 THEN P = -30
  IF key$ = "4" THEN : P = P - 2: IF P < -30 THEN P = 30
  LOCATE 13, 73: PRINT P
END IF
IF C = 17 THEN
  'TIME BASE
  IF key$ = "6" THEN : T = T + 1: IF T > 23 THEN T = 11
  IF key$ = "4" THEN : T = T - 1: IF T < 11 THEN T = 23
  IF T = 11 THEN LOCATE 17, 72: PRINT "20 mS"
  IF T = 12 THEN LOCATE 17, 72: PRINT "10 mS"
  IF T = 13 THEN LOCATE 17, 72: PRINT "5 mS"
  IF T = 14 THEN LOCATE 17, 72: PRINT "2 mS"
  IF T = 15 THEN LOCATE 17, 72: PRINT "1 mS"
  IF T = 16 THEN LOCATE 17, 72: PRINT ".5 mS"
  IF T = 17 THEN LOCATE 17, 72: PRINT ".2 mS"
  IF T = 18 THEN LOCATE 17, 72: PRINT ".1 mS"
  IF T = 19 THEN LOCATE 17, 72: PRINT "50 uS"
  IF T = 20 THEN LOCATE 17, 72: PRINT "20 uS"
  IF T = 21 THEN LOCATE 17, 72: PRINT "10 uS"
  IF T = 22 THEN LOCATE 17, 72: PRINT "5 uS"
  IF T = 23 THEN LOCATE 17, 72: PRINT "2 uS"
END IF
GOTO START
```

```
' PRINTER PORT OSCILLOSCOPE II 10/01/95 BY BOB DAVIS
' HIGH RESOLUTION VERSION FOR 640 X 400 VGA
CLS : LOCATE 10, 20: INPUT "USE PRINTER PORT NUMBER: ", LPT
DOUT = &H378: COUT = &H37A: CIN = &H379
IF LPT = 1 THEN DOUT = &H3BC: COUT = &H3BE: CIN = &H3BD
IF LPT = 3 THEN DOUT = &H278: COUT = &H27A: CIN = &H279
CLS : SCREEN 9
LINE (550, 0)-(639, 329), 1, BF
LINE (572, 94)-(617, 114), 0, BF
LINE (572, 150)-(617, 170), 0, BF
LINE (572, 206)-(617, 226), 0, BF
LINE (572, 262)-(617, 282), 0, BF
LINE (0, 0)-(639, 329), , B
LINE (550, 0)-(639, 329), , B
LINE (554, 4)-(635, 325), , B
LINE (572, 94)-(617, 114), , B
```

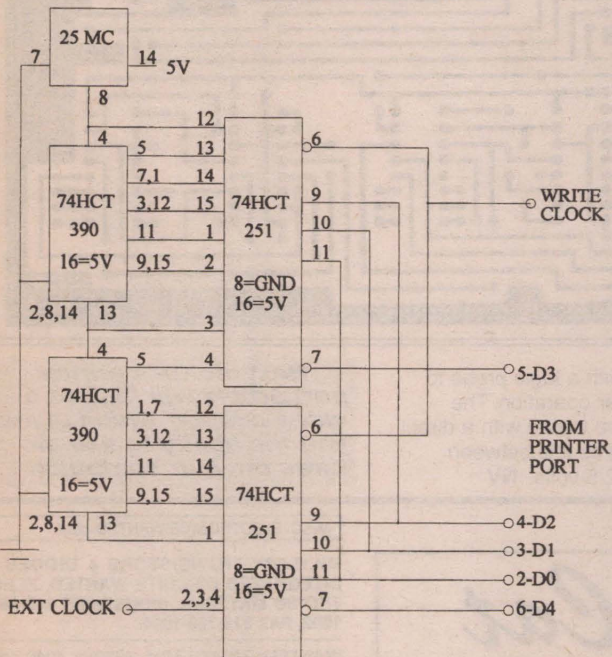
```
LINE (572, 150)-(617, 170), , B
LINE (572, 206)-(617, 226), , B
LINE (572, 262)-(617, 282), , B
LOCATE 2, 72: PRINT "PRINTER"
LOCATE 3, 72: PRINT "PORT"
LOCATE 4, 72: PRINT "O'SCOPE"
LOCATE 6, 71: PRINT "VOLTS/DIV"
LOCATE 10, 71: PRINT "POSITION"
LOCATE 14, 71: PRINT "TIME/DIV"
LOCATE 18, 71: PRINT "TRIGGER"
LOCATE 22, 71: PRINT "COPYRIGHT"
LOCATE 23, 71: PRINT "BOB DAVIS"
LOCATE 8, 73: PRINT "1.0"
LOCATE 12, 73: PRINT "0"
LOCATE 16, 73: PRINT "5MS"
LOCATE 20, 73: PRINT "5"
LOCATE 25, 15: PRINT "SELECT CONTROLS WITH NUMERIC ARROW KEYS OR Q=QUIT";
T = 13: S = 2: P = 0: C = 8: R = 5: V = 128
START: OUT COUT, 11
OUT DOUT, (T + 32 * S): OUT COUT, 15
FOR A = 1 TO 1000: NEXT A
CIRCLE (625, 272), 5, 7
PAINT (625, 272), 0, 7
MTRIG = 0: TRIGD = 0: RA = R + 128
TLOOP:
  OUT COUT, 4: V = (INP(CIN) \ 16)
  OUT COUT, 5: V = V + (INP(CIN) AND &HF0)
  OUT COUT, 0: OUT COUT, 8
  MTRIG = MTRIG + 1
  IF MTRIG < 999 THEN
    IF TRIGD = 0 THEN
      IF (V > RA AND RA < 0) OR (V < RA AND RA > 0) THEN TRIGD = 1
      GOTO TLOOP
    END IF
    IF (V < RA AND R < 0) OR (V > RA AND R > 0) THEN
      PAINT (625, 272), 4, 7
    ELSE
      GOTO TLOOP
    END IF
  END IF
FOR H = 1 TO 549
  OUT COUT, 4: V = (INP(CIN) \ 16)
  OUT COUT, 5: V = V + (INP(CIN) AND &HF0) - P + 50
  IF V > 327 THEN V = 327 ELSE IF V < 2 THEN V = 2
  IF H > 2 THEN LINE (H, 1)-(H, 328), 0
  IF H > 2 THEN LINE (H, OLDV)-(H, V)
  PSET (H, 30), 2: PSET (H, 60), 2: PSET (H, 90), 2: PSET (H, 120), 2
  PSET (H, 150), 2: PSET (H, 180), 2: PSET (H, 210), 2
  PSET (H, 240), 2: PSET (H, 270), 2: PSET (H, 300), 2
  IF H MOD 50 = 0 THEN LINE (H, 1)-(H, 328), 2
  OLDV = V: OUT COUT, 0: OUT COUT, 8
NEXT H
key$ = INKEY$: IF key$ = "q" OR key$ = "Q" THEN END
LOCATE C, 73: PRINT " "
IF key$ = "2" THEN C = C + 4: IF C = 24 THEN C = 8
IF key$ = "8" THEN C = C - 4: IF C = 4 THEN C = 20
LOCATE C, 73: PRINT ">"
IF C = 8 THEN
  'SENSITIVITY
  IF key$ = "6" THEN : S = S + 1: IF S > 7 THEN S = 0
  IF key$ = "4" THEN : S = S - 1: IF S < 0 THEN S = 7
  IF S = 0 THEN LOCATE 8, 74: PRINT "GND"
  IF S = 1 THEN LOCATE 8, 74: PRINT "2.0"
  IF S = 2 THEN LOCATE 8, 74: PRINT "1.0"
  IF S = 3 THEN LOCATE 8, 74: PRINT ".5"
  IF S = 4 THEN LOCATE 8, 74: PRINT ".2"
  IF S = 5 THEN LOCATE 8, 74: PRINT ".1"
  IF S = 6 THEN LOCATE 8, 74: PRINT ".05"
  IF S = 7 THEN LOCATE 8, 74: PRINT ".02"
END IF
IF C = 12 THEN
  'POSITION
  IF key$ = "6" THEN : P = P + 2: IF P > 90 THEN P = -90
  IF key$ = "4" THEN : P = P - 2: IF P < -90 THEN P = 90
  LOCATE 12, 74: PRINT P
END IF
IF C = 16 THEN
  'TIME BASE
  IF key$ = "6" THEN : T = T + 1: IF T > 23 THEN T = 11
  IF key$ = "4" THEN : T = T - 1: IF T < 11 THEN T = 23
  IF T = 11 THEN LOCATE 16, 74: PRINT "20MS"
  IF T = 12 THEN LOCATE 16, 74: PRINT "10MS"
  IF T = 13 THEN LOCATE 16, 74: PRINT "5MS"
  IF T = 14 THEN LOCATE 16, 74: PRINT "2MS"
  IF T = 15 THEN LOCATE 16, 74: PRINT "1MS"
  IF T = 16 THEN LOCATE 16, 74: PRINT ".5MS"
  IF T = 17 THEN LOCATE 16, 74: PRINT ".2MS"
  IF T = 18 THEN LOCATE 16, 74: PRINT ".1MS"
  IF T = 19 THEN LOCATE 16, 74: PRINT "50US"
  IF T = 20 THEN LOCATE 16, 74: PRINT "20US"
  IF T = 21 THEN LOCATE 16, 74: PRINT "10US"
  IF T = 22 THEN LOCATE 16, 74: PRINT "5US"
  IF T = 23 THEN LOCATE 16, 74: PRINT "2US"
END IF
IF C = 20 THEN
  'TRIGGER
  IF key$ = "6" THEN : R = R + 1: IF R > 30 THEN R = -30
  IF key$ = "4" THEN : R = R - 1: IF R < -30 THEN R = 30
  LOCATE 20, 74: PRINT R
END IF
GOTO START
```



## PRINTER PORT O'SCOPE POWER SUPPLY



PRINTER PORT O'SCOPE  
WRITE CLOCK SELECT



Schmidt Trigger to reduce noise and an inverter to correct for some signals being inverted from the printer port. The 74HCT20 works as a gate to generate the reset signal. The state of D1 makes it possible to select between two different channels. See the Mode Selection Chart.

The next problem is that the clock speed of 25 MC is fine for high-speed mode, but it needs to be slowed down in order to capture lower frequencies. This has to be done in an orderly method so you can know exactly what the frequency is and, hence, what the sample rate is.

Usually a 1-2-5-10 stepping sequence method is used. The 74HCT390 contains two of the dividers that are needed in each chip. Each divider divides by 2 and then by 5 for a total of dividing by 10. Then, two 74HCT251 selectors

select the desired clock frequency out of the eight possibilities that each can select.

To choose between the two selectors, data bits 3 and 4 are used. A low-data bit enables a 74HCT251 selector. The selected clock output can also be called the system clock.

Then there is the input gain and attenuation circuit. FETs on the input give it a high-impedance input to minimize loading on the circuit under test. The FETs don't provide any gain. A 2N3906 provides low-impedance drive to the resistor voltage divider network.

Next, a CD4051 analog multiplexer selects a tap on a resistor divider to feed the NE592 amplifier. This divider allows a range of .02 volts per division to two volts per division. The NE592 amplifier provides inversion, adjustable gain,

## Controls and How They Work

VOLTS/DIVISION	3 BITS GAIN (D5,D6,D7)
VERT. POSITION	SOFTWARE
TIME/DIVISION	3 BITS (D0-2), 2 SELECT BITS (D3,D4)

## Frequency to Time Conversion

Position	Frequency	Time
23	25 MC	2 uS per Division
22	10 MC	5 uS per Division
21	5 MC	10 uS per Division
20	2.5 MC	20 uS per Division
19	1 MC	50 uS per Division
18	500 KC	100 uS per Division
17	250 KC	200 uS per Division
16	100 KC	500 uS per Division
15	50 KC	1 mS per Division
14	25 KC	2 mS per Division
13	10 KC	5 mS per Division
12	5 KC	10 mS per Division
11	2.5 KC	20 mS per Division

## Printer Port O'scope Detailed Parts List

QTY	NUMBER	PINS	Source	Price	Total
2	2N3904		Newark	\$ .22	\$ .44
2	2N4416		Newark	1.00	2.00
1	NE592N	14	Newark	.75	.75
1	AD775JN	24	Newark	15.00	15.00
1	DS2010-50	28	Newark	12.02	12.02
1	570-CD74HC4051E	16	Mouser	.75	.75
1	570-CD74HCT257E	16	Mouser	.55	.55
1	570-CD74HCT14E	14	Mouser	.40	.40
1	570-CD74HCT20E	14	Mouser	.38	.38
2	570-CD73HCT390E	16	Mouser	.79	1.58
2	570-CD74HCT251E	16	Mouser	.59	1.18
1	520-TCF2500 CLOCK	14	Mouser	3.25	3.25
4	506-214-AG19DC 14-pin		Mouser	.14	.56
6	506-216-AG19DC 16-pin		Mouser	.16	.96
1	506-224-AG19DC 24-pin		Mouser	.24	.24
1	506-228-AG19DC 28-pin		Mouser	.28	.28
1	513-NJM7805FA Regulator		Mouser	.47	.47
1	513-NJM78L05A Regulator		Mouser	.27	.27
1	513-NJM79L05A Regulator		Mouser	.29	.29
6	333-1N4148 Diodes		Mouser	.12	.72
1	156-1225 25-pin Male Conn.		Mouser	.99	.99
10	581-EXWD104M .1/50V Caps		Mouser	.14	1.40
2	140-XLR16V2200 2200/16V Caps		Mouser	.75	1.50
1	583-RB151 Bridge 1A 50V		Mouser	.81	.81
1	173-53101 Power Cord		Mouser	2.80	2.80
1	10TA230 On/Off Switch		Mouser	3.55	3.55
2	323-409H-500 Ohm Trimmers		Mouser	.61	1.22
1	546-1598G-BK Cabinet 10x6x3		Mouser	23.76	23.76
2	523-311-221-RFX BNC Conn.		Mouser	1.37	2.74
~25	1/4 Watt Resistor Assortment		Radio Shack	7.99	.79
1	12.6 VCT 1A Transformer		Radio Shack	5.99	5.99

TOTAL / MACHINE ~ \$87.64

and a bias voltage of 1.7 volts. The gain should be adjusted so that a one-volt peak-to-peak signal at .1 volt per division fills the entire screen.

The input voltage divider uses some strange resistor values. The 600-ohm resistor is two 1.2K resistors in parallel. The 60-ohm resistor is two 120-ohm resistors in parallel. The 200-ohm and 10-ohm resistors are two 100-ohm and two 10-ohm resistors in series.

To reduce noise on the inputs from the wire running to the printer port, 220- to 470-ohm resistors to the five-volt supply can be used. The inputs are pins 1 to 9 and pins 14 to pin 17. Pins 20 through 25 are tied to the ground.

The circuit board is made by photocopying the design onto one of the many circuit board's transfer films. The design is then transferred

from the film to a copper-covered board with an iron. The film is removed and then the board is etched in a plastic tray with etching acid. Once etched and cleaned, the holes are drilled using a #65 bit in a drill press. Harbor Freight has drill presses that will do for only \$50.00. The drills can be bought at "ham-fests" for \$3.00. A suitable cabinet can be purchased for \$6.00 at ham-fests as well.

The circuit is built on a printed circuit board, or a pad-per-hole board. On a pad-per-hole board, power and ground are created using 20 gauge solid copper wire. After power distribution is wired up, check it out with a voltmeter for the proper voltages. Then it is safe to install the ICs.

The NE592s and 4051s should not be wire-wrapped. Instead, use point-to-point soldering with analog







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# RESOURCE BIN

number sixty six

## Useful tools for Book-on-demand publishing.

**O**ur usual reminder here that the *Resource Bin* is now a two-way column. You can get tech help, consultant referrals, and off-the-wall networking on nearly any electronic, *tinaja* questing, personal publishing, money machine, or computer topic by calling me at 520-428-4073 weekdays 8-5 Mountain Standard Time.

### Book-on-Demand Publishing

There's now a new *Book-on-demand* opportunity. With BOD, books will be produced only *when and as ordered*.

There is no inventory and nothing ever gets out of date. Author royalties can go as high as 90% and be paid *hourly*. A backlist can continue forever. There is rarely a return and never a shopworn copy. Products are easily customized for each and every buyer. The time from manuscript to product can be measured in minutes, rather than months. Corrections are trivially made at any time.

Most BOD can be done at home or as a small-scale tech start-up. For smaller quantities or unknown sales, costs are far lower than traditional publishing. At least up to 3,000 certain sales in a short time period.

BOD also circumvents most of the hassles of traditional publishing. Such as that wonderful IRS *Thor Decision* that *pays publishers to shred books* and decimates backlists. Or the notorious *publisher's committees* that sit on your manuscript for a year and then reject it because it is "not timely."

Or "reserves against returns" which blatantly rip off authors. Or the recent publisher merger mania. Which has clearly replaced normal incompetence with acute recirculation inversion.

Or chain bookstores which replace 60,000 different Mom-and-Pop titles with 10 copies each of only 6,000 "best selling" books. Most of which will get pulled and shredded after a mere 22 weeks on the shelf.

Let's see what's involved in set-

ting up your own BOD operation ...

### Adobe Acrobat

You can use most any software to create BOD files. So long as it does a good job of generating PostScript that is clean and compact. Obvious choices are *Pagemaker* or *Illustrator*.

PostScript is an outstanding general-purpose computer language which I believe is *the* standard way to publish.

PostScript's strong points include high speed, total device independence, and a stunning variety of incredibly high-quality fonts.

A new web-friendly "RISC" variant of PostScript is called *Adobe Acrobat*. Acrobat's .PDF files are by far your best way to communicate with a BOD printer. Many apps directly generate .PDF files. Otherwise, any PostScript file or any .EPS file can be converted to .PDF using either Adobe's *Acrobat Distiller* or *GhostScript* shareware.

Free Acrobat readers are available from [www.adobe.com](http://www.adobe.com). See that Acrobat Library shelf of [www.tinaja.com](http://www.tinaja.com) — Access to a free online version of Distiller is also provided for you as are GhostScript access links.

## NEXT MONTH: Don looks at useful resources for amateur astronomy.

### Which Printer?

Until recently, you absolutely had to have a PostScript printer for BOD. Between host *Acrobat* and *GhostScript*, non-PostScript printers could now at least theoretically be used for some BOD work. But they will usually be slower and may present other major problems. Thus, I strongly feel that a PostScript printer remains the most reasonable way to go. And because of speed and quality, a laser printer is often your best choice.

An ideal BOD laser printer

would speak genuine Adobe PostScript level II, version 2017 or higher. Offering an *enhanced* 600 DPI resolution. Along with improved halftones. Which most people cannot tell from unenhanced 1200 DPI or anything higher. Much of traditional ink printing will not end up remotely near this quality. Owing to press and operator variables.

A minimum speed of 15 pages per minute. With an 11 x 17 option for covers or multi-page work.

A bolt-on or slide-in *duplexer* is a must. A duplexer lets you print both sides of a sheet in one trip. Duplexing is just plain wonderful. Mess up a duplexed page in any large book, and you have to fix a single page. Without duplexing, you lose the whole job.

Duplexing nicely self-collates.

A companion *printer* hard disk is a must. To store lots of fonts, to speed up operation, for photos, for patterns and forms, and to archive your entire job. But mostly to permit unattended overnight operation.

You'll also want your toner carts to be readily rechargeable with per-page toner costs in the 0.2 cents range. The *real* service manuals should be readily available, as should all parts.

The obvious choice for heavy-duty and high-volume BOD is that superb *Hewlett-Packard 5SiMX*. This 24 PPM, duplexing 11 x 17 laser printer meets *all* of my goals for a mid-range BOD printer. Street prices are approaching \$3,400.00 or so. To put this in perspective, eight of these in parallel could easily blow away a \$240,000.00 *Docutech*.

HP's new *Mopier* software can fully automate unattended BOD printing. Carts are good for 15,000 pages. All of the high-wear parts snap in and out.

Their 5M+ printer is a lot cheaper and somewhat slower. But this meets all of my ideal printer goals *except* for that essential hard disk. When your BOD budget is really limited, check a used 4M+, which you should find for \$1,199.00 plus the duplexer.

I've recently tested an interesting niche printer.

One I'll use exclusively for covers, table tents, and business cards. Or for those few pages where photorealistic color is a must.

This is the *Alps MD2010*. Its street price is under \$390.00. *Micro-dry* ribbons get used. Special foil ribbons are also available for *Kroy Color* hot stamping effects. Heavier stocks are supported in their "cardboard" mode. The largest sheet size is 8-1/2 x 14 legal, which translates to a wrap around cover of eight inches high by 6-1/2 wide.

The machine can't speak PostScript. But it does work fine with Acrobat or GhostScript. Their printer

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Because a decent small scale binding solution is the last remaining hurdle for BOD, there are tremendous opportunities here.

A perfect binding is one that lays flat. Ideally, you'd want a low-cost lay-flat perfect binding system which can deliver a quality cover for less than 50 cents total cost. With less than \$400.00 in machinery and a one-minute processing time. You want the ability to apply any cover materials in any combination and any thickness. You want to be able to print on the spine. You'll want full color and total scuff resistance, plus foil options. And, oh yeah, you'll want the pages to never come loose or fall out.

Above all, you'll want to produce a home or small-scale product that is as good as or better than anything you see today on a bookstore's shelves. I call this the *Turing Test*, where your own product is either comparable or superior to traditional, mass-produced commercial bookbinding.

Plain old saddle bound staples are an obvious starting point. Print in four page signatures. Then fold up your sheets. Long-throw staplers are finally dropping to sane prices.

An interesting non-perfect solution is that *Personal Velobinder*. Which is great for proposals or reports. When on sale, you can get the machines for \$29.00 each and the bindings at a quarter each. One hint: Be extremely careful when punching. The small holes near the edge can trash your job with only the slightest misalignment.

Four hands are best for punching.

While plastic comb binding systems are readily available, these are always a gross and demeaning insult to your customers. You are better off stapling a used diaper to your product.

There's some interesting wire bind systems that are more user-appealing. Some even can use the plastic comb punches. Wire binding's big thing is a true lay-flat. Which is handy for user manuals, calendars, and cookbooks.

Wire-O is one source.

I currently use the *Unibind* thermal perfect binding system. Their original covers had a pre-applied glue strip of varying thicknesses. You'd jog your pages and drop the cover into a toaster-like beastie for half a minute. The books then get solidly whumped on a forming plate and then set aside to cool. Around a buck for the cover. Toasters are free if you buy enough covers and \$200.00 otherwise.

Newer Unibind products include their *Pelsaer* and *Pentabind* offerings. These are basically a positionable hot glue that you use with your unlimited choice of cover materials.

driver even does its own color separations. It sure is fascinating to watch the build-up of one color at a time.

Speed? Uh, calling it *glacial* would be a compliment. Further details are in MUSE113.PDF on [www.tinaja.com](http://www.tinaja.com)

One trick I am currently exploring: using this printer to print color blobs and boxes overnight. Then feeding the intermediate results to a 5SiMX for a final overprinting.

### Papers

Not all papers are laser or inkjet compatible, so it is super important to test what you use. It is often best to stick with "laser rated" stocks.

The older wholesale paper outfits are frustratingly impossible to deal with. But they are great sources for paper samples and swatch books.

Note that colored paper is one easy way to liven up your products. Note also that there are lots of shades of "white." Superbright premium papers have a *brightness* above 91. Use these for first quality or any time that you are doing camera-ready work.

The *basis weight* of any paper is a totally misleading number pur-

posely intended to confuse and confound. A paper's basis weight has nothing to do with how much any sheet of paper weighs. Or how thick it is.

For instance, a 20-pound paper is heavier than a 50-pound paper, but lighter than a 60-pound paper. Paper basis weight depends only upon how big your printing press is. Got it?

Fortunately, we're finally getting away from this utterly absurd system. Newer suppliers directly express their paper weight in *grams per square meter* which is a true measure of how heavy your sheet is. Thickness is something else again, depending upon a paper's *bulk*. High-bulk papers are useful to thicken up thinner books.

My favorite paper source is the 75-store, national *Paper Plus* chain. You can buy quality papers by the ream or by the case at reasonable prices. Plus bunches of related stuff. You can find your nearest store by visiting the web site at [www.paperplus.com](http://www.paperplus.com)

For plain old grunt paper, though, it is hard to beat the warehouse stores such as *Costco* or whoever. Typically, their retail case lot price is lower than paper house quantity wholesale.

There are lots of newer, direct mail paper sources. These outfits are great for specialty letterheads and matching envelopes, business card blanks, and such. But their prices are otherwise way too high for serious BOD tasks. Typical firms include *Technique*, *Great Papers*, *Paper Access*, *On Paper*, *Paper Direct*, and *Premier Papers*.

A new glossy *LaserCast* from *Darcy Paper* is offered in lots of bright colors. I use their *Champagne* for my catalog covers, with *Simpson* offset ivory for the insides. By playing games with those 4M+ trays and duplexers, I print and custom address the cover and collate it to three inside signatures.

All automated in one pass.

Humidity can totally trash a BOD operation, so a good wall mounted hygrometer is a must. The optimum humidity range is 25 to 45 percent. Cheap hygrometers come from, of all places, *Klockit*, while really good ones are available at *Abbeon Cal*.

### Bound and Determined

There is no "best" Book-on-Demand binding system. Instead, there are a few intelligent choices and potentially useful alternatives.



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For any hot-glue system, a jogger is essential. *Martin-Yale* has useful ones which list for \$300.00. Otherwise you can make up your own from a \$19.00 orbital jitter sander from *Wal Mart*.

For modest cover protection, you can use *Laser Buddy* blackening spray overlain with artist's fixative. Klutzy peel-and-stick acetate is also available at an office supply house.

Better yet, pick a true laminating system that locks in your toner. USI is one low-cost source. Note that there are gloss or matte laminates. New "lay-flat" options are also available.

Another lamination supply source is GBC. These folks also have a wide variety of binding products.

But their prices are often high.

I feel that by far your best route to home BOD is a simple peel-and-stick strip full of perforated hot glue. Which you'd place between your "anything goes" custom covers and your jogged inside pages. Then pop these into the *Unibind* toaster. There's no reason the strips could not be retailed for a nickel per binding.

It is just that nobody, but nobody, has yet picked up on how big *low-end user cost* binding options can be.

*Planax North America* has all sorts of interesting binding solutions. Besides peel-and-stick strips, they've got high-tech *cold glue* binding systems that are ultra strong and set up fast; *Otabind* lay-flat binding schemes; and bunches of other innovative systems. Sadly, I feel their prices are excessive.

Slipped a decimal point, even.

The smallest useful "real" printshop perfect binder is a *Standard Bindfast 5*. I've been meaning to pick one of these up. Sometimes these can be found at an auction for as little as \$500.00. Lots of ads for pricier alternatives appear in the printshop magazines.

Trimming makes nearly any BOD item appear more professional. Your best bet early on is to try and gain an access to someone else's shear. For a while, I set up this deal with a college where I'd keep the blade sharp on an ancient guillotine cutter.

In exchange for unlimited access.

Forget about that \$500.00 *Martin-Yale* trimmer. I have never heard anybody report anything nice about it. Instead, look at a used *Triumph 14* inch power shear or a *Challenge 18* inch manual.

There's one last binding alternative. One that can be very cheap and easily personalized. But is rather time and labor intensive. This method is to use classic hand book-

binding techniques. Check a large library for info. Both on the shelves and behind the desk.

A newer text here is *The Art of the Handmade Book* by a Flora Fenimore. *Lindsay* has a *Basic Bookbinding*. Which he feels holds all you really need for a home BOD. *Bookbinder's Warehouse*, *Gane* and *Gaylord* are all traditional suppliers here. Two useful web sites on binding are [www.redmark.co.nz](http://www.redmark.co.nz) and [holly.colostate.edu/~sheilas/](http://holly.colostate.edu/~sheilas/)

Lots more on binding solutions in **BOUNDET.PDF** on [www.tinaja.com](http://www.tinaja.com)

## Useful BOD Publications

*Recharger* is your leading magazine for toner cart refills and most printer repair parts. I now use *Static Control* as my toner source. Bargains in both new and used printers often appear in *Comp-U-Mart* and *Computer Reseller*.

Printer servicing secrets, rebuilding kits, parts, and repair videos are all available from *Don Thompson*.

*Hewlett-Packard Manuals* is the place to go for official service info. These manuals also apply to older *Apple* and *QMS* printers. But on any really dated machine, the manuals may cost more than the printer itself.

That *Desktop Publishers Journal* is probably your leading BOD resource. *Publish* is a slick offering with useful BOD content. Another good candidate is *Electronic Publishing*. Who are big on reviews of high-end printers and typesetters. Frank Romero's columns here are always interesting.

By far your finest and most bizarre typography magazine is *U&Ic*, short for *Upper and lower case*. And *Dynamic Graphics* is a useful layout pub.

Traditional printshop mags include *Quick Printing* and *Instant Printer*. The *Helene's Hotline* over in *Quick Printing* is useful to pin down oddball supply items. *Printer's Shopper* is a catalog of bits and pieces required to run a jiffy printshop operation.

Used print machinery gets sold in regional trading shoppers. Because of old-boy networks and the "multi-tier" prices, it's real easy to get very badly burned on used gear. Even if you are an industry insider.

At any rate, two useful California mags are *HorseTrader* and *California Printer*. Two national shoppers are *Print Mart* and that *Printer's Hot Line*. Useful software comes from *Printer's Shareware*. There's several net-based printing equipment services, but they charge more than they're worth.

At least for me.

There's lots of BOD opportunities just beyond the bounds of plain old books. Custom community stuff such as badges or bumperstickers, tickets, menus, tags, door hangers, catalogs, coupons, printed circuits, resumes, mugs, or political stuff.

One pub I have newly discovered here is *A & E*, and short for *Awards and Engraving*. Included are incredible sources of suppliers for all sorts of oddball emerging BOD possibilities. Another in the oddball but useful category is *POP&Sign Design*. The "pop" is short for *Point of Purchase*.

Printed circuits and direct transfer solutions are available through *Dyna-Art Designs* or *Techniks*. *Andrews* and *Labco* are two decal sources.

Old line sign magazines do include *Signcraft* and *Sign Business*. Thermal transfer and T-shirt info often appears in *Screen Printing*, *Impressions*, or in *PrintWear*. And *Inside Finishing* is big on hot stamp foil applications.

So is *Foiled Again*.

## For More Info

Much more on BOD appears on the *Book-on-demand Library Shelf* of my *Guru's Lair* website you should find at <http://www.tinaja.com> — Especially check out *REV1001.PDF* on book distribution and promotion options.

Alternate BOD approaches appear in *Midnight Engineering* magazine. I've got one example up as *PUBALTS.PDF* on my <http://www.tinaja.com>

I have also got my *Book-on-demand Resource Kit*. Which is mostly a reprint collection of all my earlier BOD stuff, along with several samples and such. Details per my nearby *Synergetics* ad, or E-Mail me at [don@tinaja.com](mailto:don@tinaja.com) NV

**M**icrocomputer pioneer and guru *Don Lancaster* is the author of 33 books and countless tech articles. *Don* maintains his no-charge US tech helpline found at **520-428-4073**, besides offering all of his own books, reprints, and consulting services. *Don* also offers a free catalog full of his unique products and resource secrets. Your best calling times are 8-5 on weekdays, Mountain Standard Time.

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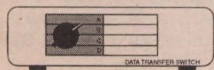
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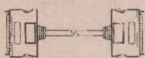
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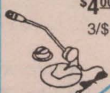
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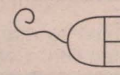


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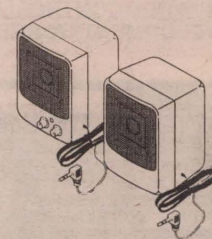


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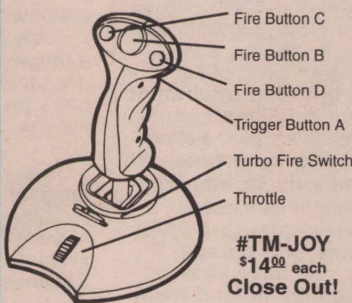
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#CC-VGA-4

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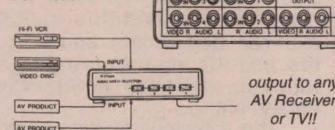
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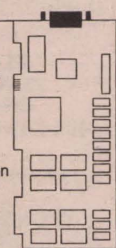
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Terminator for SCSI II



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Dynamic freq. response: 80-13,000 Hz



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12 VDC, 80 mA  
Two 6" color leads

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DB25 Female to 26 pin socket IDC



#CN-702 \$5.00 each

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**Standard PC Power  
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6 foot



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1000 feet

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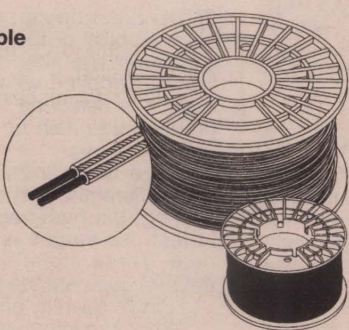
18 Gauge

1000 feet

#AC-18G

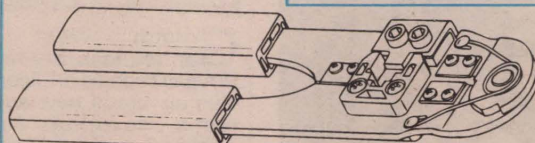
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or \$.06 per ft.



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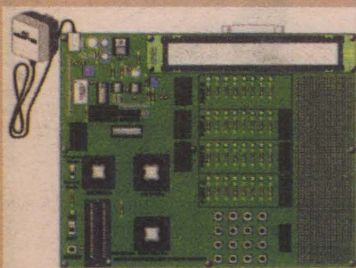
# New Product

Our readers are always looking for new and interesting electronic items. Showcase your NEW PRODUCTS here to help stimulate your product's success. Submit all news releases, product information, and/or photos to:

**NUTS & VOLTS MAGAZINE**  
NEW PRODUCT EDITOR,  
430 PRINCELAND CT., CORONA, CA 91719

# News

## MDB-1 MICROCONTROLLER DEVELOPMENT BOARD



**MDB-1**

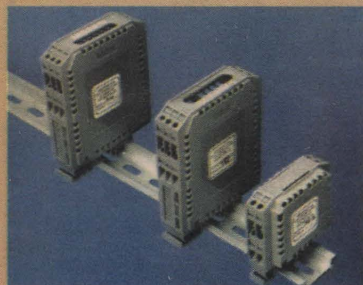
The MDB-1 was designed to facilitate the process of constructing prototype 68HC705 and 68HC11 microcontroller applications. It allows you to concentrate on the unique aspects of your application and to forget about routine prototyping problems such as power supplies, reset circuits, and common I/O devices like keypads, LEDs, and LCDs. The built device programmer, highly configurable onboard I/O devices and example programs, allows you to get started on your application software immediately without waiting for your specific hardware to be designed and constructed.

MDB-1 can be used stand-alone if a separate device programmer is available. If you wish to use the MDB-1 to program chips with the provided software, you will need a 286 class IBM PC compatible with a serial port, 640K memory and DOS 3.1 or higher.

For more information, contact:

**TECI**  
RTE. 3, BOX 8C, DEPT. NV  
BARTON, VT 05822  
802-525-3458 FAX: 802-525-3451  
E-MAIL: sales@tec-i.com

## TENSION CONTROLLER



The EZ-circuit tension controller can be custom configured from standard DIN rail mountable mod-

ules to maintain constant or taper tension. Capable of measuring tension and adjusting brakes, a basic tension controller includes a load cell amplifier, power supply, and PID module which has outputs for driving an analog or digital display.

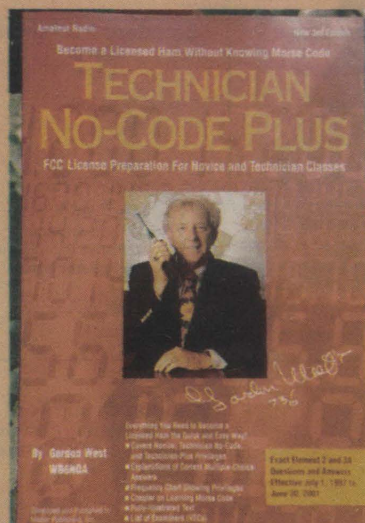
Compatible with off-the-shelf load cells, dancer position potentiometers, and Sona-Trol® ultrasonic sensors, the EZ-circuit tension controller is suitable for a wide range of applications including extruder loop control, spoolers, textile payout, metal stamping, roll forming, and other unwind/rewind equipment.

The EZ-circuit tension controller is priced from \$295.00.

For more information, contact:

**WADDINGTON ELECTRONICS, INC.**  
25 WEBB ST., DEPT. NV  
CRANSTON, RI 02920  
401-781-3904 FAX: 401-781-1650

## TECHNICIAN NO-CODE PLUS BOOK AND TAPES



Gordon West WB6NOA, announces his new updated Novice/Technician license manual, plus six brand new audio cassette tapes covering Novice and Technician class theory, plus an introduction to Morse Code.

The Novice Element 2 question pool has been increased 41 percent for a total of 483 questions, of which 35 questions will be on the test. The Technician Element 3A question pool has been expanded by 52 percent for a total of 441 questions, of which 30 will be on the examination.

The combined Novice and Technician written question pools now cover 924 questions, an average increase of 46 percent, with a total of 65 questions on the test and 48 correct to pass.

The new Gordon West Novice/Technician theory book is now expanded to 320 pages, and not only includes the entire Novice and Technician class question pool and the multiple-choice answers plus "Gordo's" description of the correct answer, but also additional chapters about license structure, vanity call signs, rules, plus a specific chapter on the importance of understanding why Morse Code may be important to ham radio.

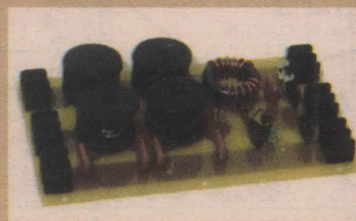
Gordon West also produces audio cassettes that parallel the question pools, and more importantly, give the sounds behind many questions and answers.

All Gordon West training materials are sold by leading amateur radio dealers, plus mail order through the W5YI Group.

For more information, contact:

**W5YI GROUP**  
1-800-669-9594

## SURGE-1



TDL Electronics announces the availability of their SURGE-1, an AC power line filter and surge protector. Supplied without an enclosure, it is designed for OEM incorporation into new or existing products.

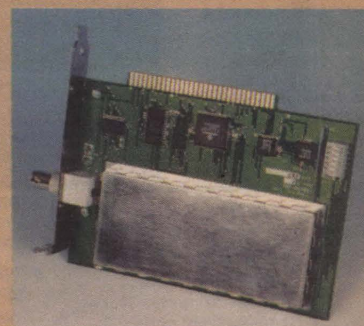
Five large inductors provide both differential and common mode filtering; the high-frequency energy in fast-rise surges is dissipated as heat. Three metal oxide varistors (MOVs) augment the passive filter.

Single quantity price is \$46.00.

For more information, contact:

**TDL ELECTRONICS**  
5260 COCHISE TR., DEPT. NV  
LAS CRUCES, NM 88012-9736  
505-382-8175 FAX: 505-382-8810  
E-MAIL: RTipton@zianet.com

## MODEL ISA-104 FUNCTION GENERATOR



J-Works, Inc. announces that it has begun shipping the Model ISA-104 function generator.

The Model ISA-104 supplies sine-, triangle-, and squarewave output covering a bandwidth of 1 Hz to 16 MHz. The instrument is a half-length ISA bus card that combines the features of a "box" function generator with the convenience of a PC.

Amplitude can be adjusted over a range of 100 mV to 20V p-p in 100 mV steps. Maximum output of 20V peak-peak into a 50-ohm load. A variable DC offset of  $\pm 10V$  is available.

Duty cycle is variable over a range of 10% to 90%.

Operating modes include a free running mode, sweep mode, and a crystal control PLL based mode. Squarewave rise times is <40 nsec.

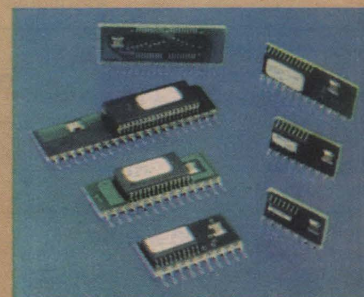
Driver and programmer's libraries included allows embedded control of the generator from user applications written in C, C++, or Visual Basic. Furthermore, stand-alone software for DOS and a Windows graphical user interface are also included.

Single unit price for the Model ISA-104 is \$395.00.

For more information, contact:

**J-WORKS, INC.**  
12328 GLADSTONE AVE. #4  
DEPARTMENT NV  
SYLMAR, CA 91342  
818-361-0787 FAX: 818-270-2413  
E-MAIL: jworksjm@gte.net

## ACCUZIP ADAPTER MODULES



AccuZIP adapter modules are a series of low-profile PC boards that accept ICs in either the narrow (0.150") or wide (0.300") SOIC packages along with a decoupling chip capacitor. Typically employed where a primary vendor no longer supplies ZIP packages, these modules adapt any 14, 16, 20, 24, 28, and 40-pin digital IC for vertical



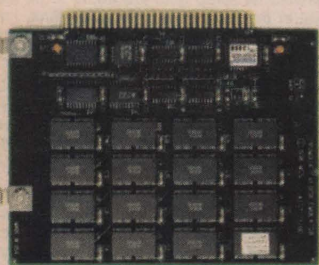
# New Products

mounting in circuit boards. Custom modules can also be provided to replace obsolete logic and memory chips to eliminate the need for PC board retooling.

For more information, contact:

**ACCUTEK MICROCIRCUIT CORP.**  
2 NEW PASTURE RD. #1  
DEPARTMENT NV  
NEWBURYPORT, MA 01950-4054  
508-465-6200 FAX: 508-462-3396  
1-800-652-7505  
E-MAIL: [accutek@seacoast.com](mailto:accutek@seacoast.com)  
<http://www.accutekmicro.com>

## PROMDISK® VI DISK EMULATOR BOARD



**M**CSCI introduces a 65 MB solid-state disk emulator board PROMDISK®VI, for ISA compatible computers. The MCSI PROMDISK VI disk emulator board is bootable as drive C and can emulate a fixed disk ranging from 8 MB to 64 MB using on-board SMT nand flash memory.

The PROMDISK VI disk emulator board comes complete with the on-board VBF flash file system, Datalight ROM-DOS ver. 6.22, a user's manual, and utility diskette. Priced at only \$250.00 for the 8 MB version.

For more information, contact:

**MCSI**  
2598 FORTUNE WAY, DEPT. NV  
VISTA, CA 92083  
619-598-2177 FAX: 619-598-2450  
E-MAIL:  
[mcsi@mcsi1.com](mailto:mcsi@mcsi1.com)

## DESOLDERING BRAID DISPENSER



**T**he Xuron Wickgun™ desoldering braid dispenser is a handheld tool that lets technicians dispense, position, and cut off braid with one hand while holding a soldering iron in the other. Eliminating the handling

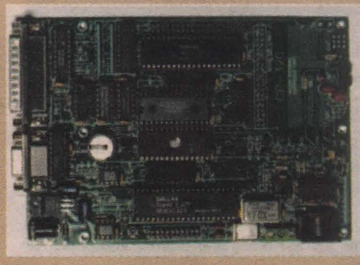
of braid, burned fingers, and manual cutting, this tool speeds desoldering operations by three to five times and cuts braid waste by up to 50%.

The Xuron Wickgun desoldering braid dispenser is priced at \$39.95 (list) and the braid cassettes cost \$5.65 each, sizes 1-3 and \$6.25 each for size 4.

For more information, contact:

**XURON CORPORATION**  
60 INDUSTRIAL PARK RD.  
DEPARTMENT NV  
SACO, ME 04072  
207-283-1401 FAX: 207-283-0594

## CP-320 SINGLE BOARD COMPUTER CARD



**T**he CP-320 is a high-speed 8051 card with an assortment of interface options. A unique feature of the board is its IR data link which operates at speeds of up to 115.2K baud. In addition, the CP-320 supports a variety of PC interfaces. These include a port for high-speed communications which connects to a PC bidirectional parallel port, an RS-232C buffered serial port, and a bidirectional PCAT compatible keyboard interface. Finally, the card has an RS-485 interface for multipoint data transmission.

For more information, contact:

**ALLEN SYSTEMS**  
2346 BRANDON RD., DEPT. NV  
COLUMBUS, OH 43221  
614-488-7122

## DIGITAL VIDEO CONVERTER



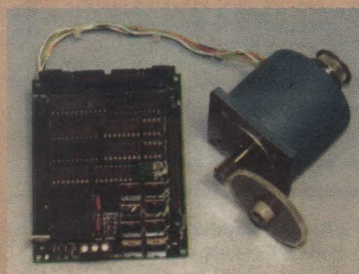
**T**enLab introduces the TR-11SVHS, the first consumer digital video converter featuring S-VHS input/output connectors (real Y/C separation), which assure better conversion quality. It also features a built-in time-base corrector (TBC), exclusive phase and video gain controls, possibility to upgrade with different input/output systems, etc. The TR-11SVHS is available for 110 or 220 volts at a suggested retail price

of \$745.00.

For more information, contact:

**TENLAB**  
2217 MALCOLM AVE., DEPT. NV  
LOS ANGELES, CA 90064-2023  
310-474-6909 FAX: 310-441-1807  
E-MAIL: [info@tenlab.com](mailto:info@tenlab.com)  
URL: <http://www.tenlab.com>

## QED DIGITAL I/O BOARD



**T**he 3.2" x 4.0" QED digital I/O board delivers 18 heavy duty isolated inputs and outputs to enable direct control of motors, solenoids, heaters, valves, lamps, and other actuators. Eight isolated inputs monitor digital signals to 50V. Eight isolated outputs sink up to 3 amps and switch signals up to 50 VDC, and two relay outputs can control heavy duty AC or DC loads. When mated to the palm-sized QED Board™ C-programmable controller, the digital I/O board can directly drive two stepper motors at up to 1,000 steps/second, delivering a low-cost indexer/controller/driver for motion control applications.

The price is \$149.00 in singles with off-the-shelf availability.

For more information, contact:

**MOSAIC INDUSTRIES, INC.**  
5437 CENTRAL AVE. STE. 1  
DEPARTMENT NV  
NEWARK, CA 94560  
510-790-8222 FAX: 510-790-0925

## PCB LAYOUT PROGRAM

**M**icroCode Engineering announces the release of TraxMaker 2.0, a professional-quality printed circuit board layout program for Windows.

The program supports multiple signal layers, and provides automatic placement of components and autorouting of tracks.

The program is easy to use and works with schematic software like CircuitMaker to complete a start-to-finish circuit design system. TraxMaker 2.0 will import any CircuitMaker, Protel, or Tango netlist, and designs can be printed, plotted, or saved as Gerber photo-plot files.

TraxMaker 2.0 sells for \$299.00. A functional demo can be downloaded from the Internet at [www.microcode.com](http://www.microcode.com)

For more information, contact:

**MICROCODE ENGINEERING**  
927 W. CENTER ST., DEPT. NV  
OREM, UT 84057  
801-226-4470 FAX: 801-226-6532  
1-800-419-4242

## MODEL HM1507 OSCILLOSCOPE



**H**ameg Instruments introduces its combination scope model HM1507 to the US market.

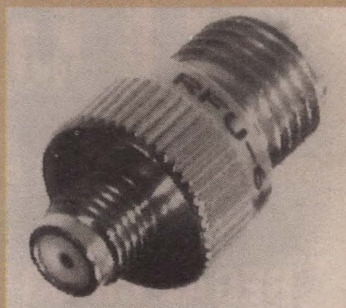
Special features are: auto-set, readout/cursor, save/recall, RS232 interface standard component tester, refresh rate 180 Hz for clear crisp display.

The price is \$1,980.00.

For more information, contact:

**HAMEG INSTRUMENTS**  
266 EAST MEADOW AVE.  
DEPARTMENT NV  
EAST MEADOW, NY 11554  
516-794-4080 FAX: 516-794-1855  
E-MAIL: [HAMEG@AOL.COM](mailto:HAMEG@AOL.COM)

## MINI-UHF CELLULAR ADAPTERS



**R**F Connectors announces the introduction of its RFU-642 between series adapter.

The connector adapts between a mini-UHF female and a (Motorola) SMA style female connector, used extensively on Motorola cellular handheld portables. Its application is for connecting an external antenna to a cellular phone or for connection to test equipment for service purposes.

For more information, contact:

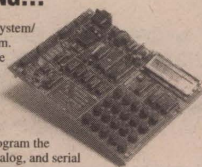
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Continued on page 114



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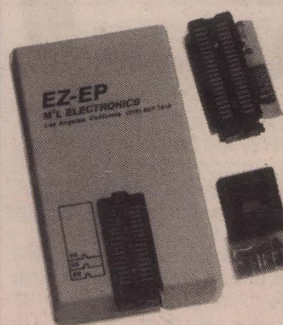
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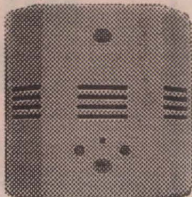
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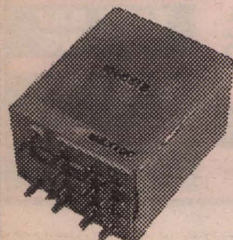
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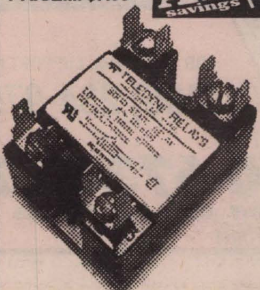
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24VDC 4PDT  
650 OHM COIL 900 mw.  
GOLD Flashed contacts RATED:  
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Nylon dust cover, no stud mount.  
SIZE: 1-3/32" x 13/16" x 1-3/8"H  
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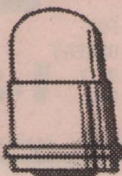
## TELEDYNE SOLID STATE RELAY PART# 615-8500

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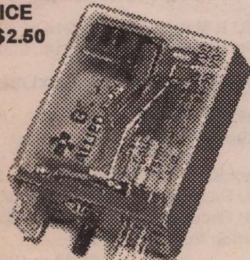
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life Hours Bulb style:  
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•RPM: 18590 MAX •Direction: Reversible  
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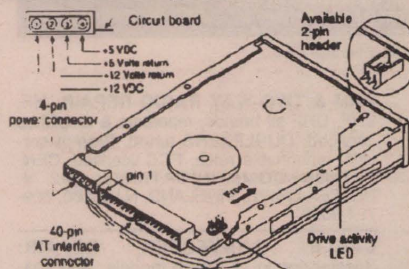
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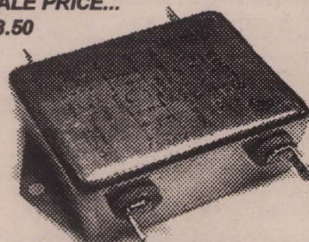
924 10 35 160  
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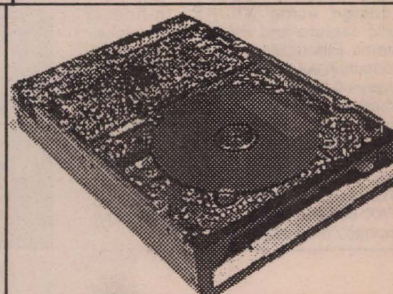
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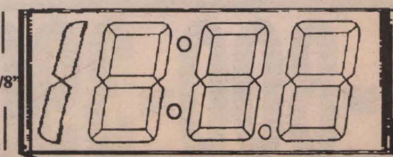
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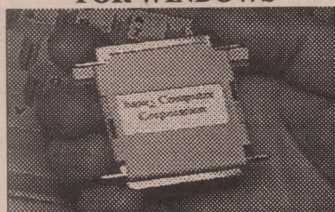
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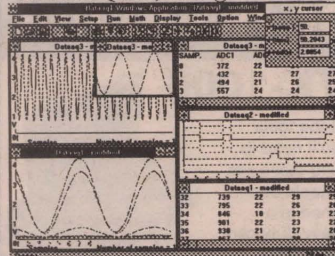
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## MICRO LIPSTICK CAMERAS

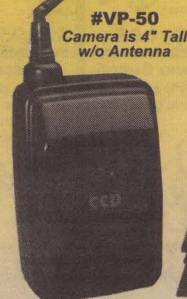
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for second channel

#VP-40  
5 x 5.5" Receiver



#VP-50

Prices, availability and specifications are subject to change without notice. Shipping and Handling are not included with price.

Nuts & Volts Magazine/July 1997 **107**



# Events CALENDAR

Continued from page 43

E-Mail: tcrgh@hotmail.com

**MA - ADAMS** - ARRL Hamfest. Joel Miller N1WCF, 413-442-2609

**MA - TAUNTON** - Computer Show. Holiday Inn. Northern Computer Shows 508-744-8440

**MI - CORUNNA** - ARRL Hamfest. Jan LaBrenz N8NSE, 517-893-3475

**MO - ST. CHARLES** - ARRL Hamfest. Blanchette Park. 6:30am-2:30pm. Scott Schultz AA0ZS, 314-928-7267

**NJ - MILLICA HILL** - ARRL Hamfest. John Lloyd KA2EZN, 609-838-1285

**NY - ROCHESTER** - Computer Show. The Dome Center. 9:30am-4pm. MarketPro 201-825-2229

**NY - YONKERS** - Hamfest/Computerfest. Yonkers Municipal Parking Garage, Main St. 9am-3pm. Jim 914-969-5182

## AUGUST 30

**KY - LOUISVILLE** - Computer Fair South. Executive West Hotel. 9:30am-3pm. Sammy L. Hastings 812-333-9300

**IN - INDIANAPOLIS** - AGI Computer Fair. Indianapolis Events Center. 3655 E. Raymond St. 10am-4pm. 317-299-8827

**MD - WEST FRIENDSHIP** - Computer Show. Howard Co. Fairgrounds. MarketPro 301-984-0880

**NM - ALAMOGORDO** - ARRL Hamfest. Bill Leehan N5SUM, 505-437-9781

**PA - YORK** - Computer Show. Holiday Inn Holidome & Conference Center. MarketPro 301-984-0880

## AUGUST 30-31

**FL - WEST PALM BEACH** - Computer Show. South FL Fairgrounds. MarketPro 301-984-0880

**IN - SOUTH BEND** - Computer Show. St. Joseph Co. 4H Fairgrounds. MarketPro 301-984-0880

**NC - SHELBY** - ARRL Hamfest. June Melvin WA4JNJ, 704-739-2583

**OH - COLUMBUS** - Computer Show. Veterans Memorial. MarketPro 301-984-0880

**SC - GREENVILLE** - Computer Show. Palmetto Expo Center. 9:30am-4pm. MarketPro 201-825-2229

**TN - MEMPHIS** - Computer Show. Agricenter

International. MarketPro 301-984-0880

## AUGUST 31

**IA - DUBUQUE** - Hamfest/Radiocast/Computer Expo. Dubuque Co. Fairgrounds, Old Highway Rd. 8am-2pm. Loren Heber NOYHZ 319-556-5755

**IN - LAFAYETTE** - AGI Computer Fair. Radisson Inn 4343 SR 26 East. 10am-3pm. 317-299-8827

**MD - UPPER MARLBORO** - Computer Show. The Show Place Arena. MarketPro 301-984-0880

**PA - READING** - Computer Show. Sheraton Berkshire. MarketPro 301-984-0880

## SEPTEMBER 1997

### SEPTEMBER 1

**NC - ASHEVILLE** - Computer Show. Asheville Civic Center. 9:30am-4pm. MarketPro 201-825-2229

**OH - CLAIRSVILLE** - Computer Show. Ohio Valley Mall. MarketPro 301-984-0880

**PA - ALLENTOWN** - Computer Show. Holiday Inn Conference Center. MarketPro 301-984-0880

**VA - MANASSAS** - Computer Show. Manassas Fairgrounds. MarketPro 301-984-0880

### SEPTEMBER 6

**CA - DALY CITY** - Computer Show. Cow Palace, Gate #5, Geneva & Santos. Robert Austin Corp. 1-800-243-7041, <http://www.robertaustin.com>

**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

**IL - ROLLING MEADOWS** - W9DXCC Convention & Banquet. Holiday Inn. Phil Camera KB9CRY, 708-343-1696 E-Mail: [iphil@megsnet.net](mailto:iphil@megsnet.net)

**LA - PRAIRIEVILLE** - Hamfest. Gourmet Catering, Inc., 13417 Hwy. 73. AARC 504-673-8396

**MA - HARWICH** - Computer Show. Cape Cod Tech. Northern Computer Shows 508-744-8440

**PA - ERIE** - Hamfest. Franklin Twp. Firehall. 8am-2pm. Chris Robson KB3A, 814-474-1211

### SEPTEMBER 6-7

**CANADA - MANITOBA - AUSTIN** - Hamfest. Manitoba Agricultural Museum. Dave Snydal VE4XN, 204-728-2463

**KY - LOUISVILLE** - Hamfest, Computer Show, & ARRL State Convention. KY Fair & Exposition Center Pavilion. Greater Louisville Hamfest Assn., POB 34444, Louisville, KY 40232

**NY - WHITE PLAINS** - Computer Show. Westchester Co. Center. 9:30am-4pm. MarketPro 201-825-2229

### SEPTEMBER 7

**CA - LIVERMORE** - Swapmeet. Las Positas College. Noel Ankam 510-447-3857

**IL - JOLIET** - Hamfest/Electronics/Computer. Inwood Recreation Center, 3000 W. Jefferson St. (Rte. 52). BARS Hotline 630-759-7005

**MD - GAITHERSBURG** - F.A.R.fest. Montgomery Co. Agricultural Center Fairgrounds. Mary Morris N4TCL, 703-971-3905, [N4TCL@erols.com](mailto:N4TCL@erols.com)

**NH - DURHAM** - Computer Show. Whittemore Arena @ UNH. Northern Computer Shows 508-744-8440

**OH - FINDLAY** - Hamfest. Hancock Co. Fairgrounds. FRC, Box 587, Findlay, OH 45839

**PA - BUTLER** - Hamfest & Computer Show. Farm Show Gnds. Cliff Frescura K3LL, 412-538-9491

### SEPTEMBER 12-13-14

**CA - RIVERSIDE** - ARRL Southwestern Division Convention. Riverside Convention Center. Joe Magaditsch, 909-685-7441

### SEPTEMBER 13

**CA - FONTANA** - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

**CA - OAKLAND** - Computer Show. Oakland Convention Center, Broadway @ 10th St.

1-800-243-7041 <http://www.robertaustin.com>

**NY - BALLSTON SPA** - Hamfest. Saratoga Co. Fairgrounds. Darlene Lake N2XQQ, 518-587-2385

### SEPTEMBER 13-14

**GA - KENNESAW** - Computer Show. I-75 Exit 116, go W. on Barrett Pkwy. to Hwy. 41, turn right, go to 2nd traffic light; we're on the right next to "Cowboys." GA Mountain Productions 706-838-4827

**NY - STONY BROOK** - Computer Show. SUNY Stony Brook. 9:30am-4pm. MarketPro 201-825-2229

### SEPTEMBER 14

**MA - SWANSEA** - Computer Show. Venus DeMilo. Northern Computer Shows 508-744-8440

**MI - FLINT** - Computer Show. Holiday Inn, Gateway Centre, US 23 @ Hill Rd. Exit. Five Star Productions 810-890-0988

**MO - MONETT** - Hamfest & Picnic. City Park. Joe KB0RVB, 417-235-8359

**NC - MONROE** - Hamfest & Computer Fair. National Guard Armory. Zachary Davies KF4FDE, 704-536-1952 E-Mail: [KF4FDE@JUNO.COM](mailto:KF4FDE@JUNO.COM)

### SEPTEMBER 19-20-21

**MI - TAYLOR** - Computer & Technology Show. Gibraltar Trade Center, 15525 Racho Rd.

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Continued on page 112

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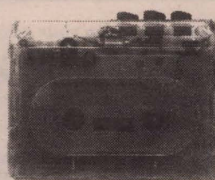
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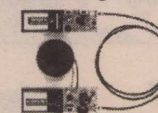
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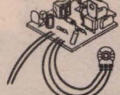


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by Carl Motsinger

# AN EXPERIMENTER'S

## CHEAP

## ANTENNA TUNER

## THE BWC TUNER

*There is no doubt someone will read a portion of this article, smile and say, "Well, they finally found a use for a damned ol' CB." Sho' 'nuff. This will probably be the cheapest, yet the most useful, project you have ever built. You even get to recycle an old CB.*

*Here is one of many projects you can make from an old CB radio. And, if you have an SSB unit you can scrap, you can use the case itself as the enclosure because SSB mobile radios tend to be larger than AM units.*

Antenna tuners come in all shapes, sizes, and configurations. You can find complete descriptions and the theory behind tuners in amateur radio handbooks such as the *ARRL Handbook*. This article will provide a means to better understand them by actually making a working model. Specifically, we are going to make a T MATCH roller inductor antenna tuner rated at 300 watts from an old CB channel

selector, some scrap printed circuit boards (PCBs), a bunch of switches, and a piece of wire.

People in remote areas do not have access to equipment as most of us do. Someone in the outback or even in the jungle could make this tuner with what they have on hand. I would

think radio operators such as those would welcome the chance to construct one.

This article details the tuner I made while experimenting with antennas made from metal tape wound around PVC pipe.

Accompanying photos show the crude simplicity of its construction, yet it is still a fully functional roller inductor antenna tuner. Figure 1 is the schematic of the BWC tuner. Note that all the switches are ON and the inductor is at minimum inductance.

### BINARY WEIGHTED CAPACITORS

Tuners must be just that — tunable. Common practice is to use variable capacitors. Oh, but commonly expensive if bought new. Finding one surplus at a value you require is uncommon. I call the capacitors used in this project Binary Weighted Capacitors or BWCs.

Binary gives its number base only two values: 0 or 1. This value — either 0 or 1 — is a bit. Multiple number (bit) placement can extend its usefulness to phenomenal proportions. These two values, in a two or more bit number, can even be added! Or subtracted!

This tuner uses two BWCs, each consisting of eight stripline areas on a PCB. From the smallest through the largest, each strip of copper is twice the area of the other. These are made from double-sided PCBs and can be made simply by cutting to size. In practice though, the size is controlled by the room inside the enclosure. Later on are suggestions on how to make this tuner even better. This gives you a chance to experiment with my experiment. Note that the above is how I look at binary numbers. Look to others for a better understanding of number bases.

One BWC consists of a piece of double-sided glass or phenolic printed circuit board. I used phenolic board because it was plentiful. One side is left as is. This is called the stator in conventional terms. In Figure 2, it is the bottom of the capacitor. (I used one piece of board for both capacitors and isolated the two stators.)

On the other side of the stator, the area is divided into eight equal parts. This is called the rotor. It is the top of the PCB in Figure 2. Each division is summarily isolated from the others by scoring with a knife and removing a small part of the copperclad between each section.

A close look at Photo 1 will show that I used a single-sided board and used strips of copper tape on the plain side to make the capacitors. A look at the front of the tuner (Photo 2) will show that only seven switches were used for each capacitor. Only the seven largest areas were used.

Refer to Figure 2 as a template to make your capacitors. It is not drawn to scale. Use it as a guide to assist you in making your caps. The shaded boxes

represent the copperclad area you leave on the PCB. Once the first area (largest) is marked, the others are simple to make.

Remove one-half of the area of the copper-clad from the next section. Do this also to the remaining sections dividing the next section by half of the previous section each time. You should end up with each section equal to half of the previous one. You need two BWCs, so make another. Size is not critical, but you must leave room for the roller inductor.

From the photos, you can see how I made the tuner. There are variations that can be made to this tuner and they will be presented later. You can get an idea of the appropriate space you need for the inductor. Set the BWCs aside and let's start on the roller inductor.

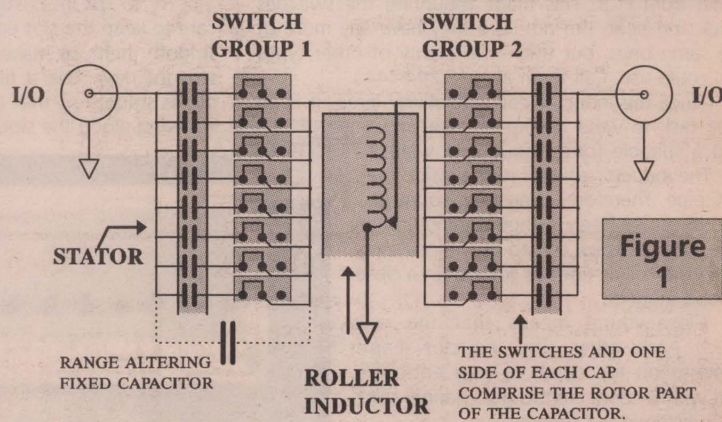
### THE ROLLER INDUCTOR

I have seen roller inductors from old amplifiers that were works of art. Really slick. Well, ours ain't gonna be so fancy, but just as functional as any you are likely to run into. Our roller inductor is simply a coil of wire that rolls around inside a piece of PVC pipe.

Start by removing the channel selector from the CB chassis. Don't tear things up too much because you might want to use the case as the enclosure for the tuner. The CB you have chosen to junk should have a large channel selector and not the small one that is in the newer units. An old CB will have the larger selector that we need. Study the selector for a little while and you will see how to dismantle it.

Although not common, there are a few old CBs that had a small shaft. You need to locate a 6 mm or 1/4" shaft. You will not need the detent system. You

## The "BWC" Antenna Tuner



know ... the spring holding a little ball bearing. There are PCB wafers on the shaft. Save the one with the most copper on it. It may be usable.

You need a length of #12 wire. It must be free of any insulation. Use ground wire from #12 household electrical wiring. Get four feet if you go out and purchase it new. You don't need that much though, unless you get the first coil wrong and have to rewind it. You will need one foot of one-inch OD PVC pipe. Get the thin type. Schedule 20, I think. Yes, you can use the thick one if its all they have.

The formula for winding an air-wound coil to any value can be found in the old faithful *ARRL Handbook*. In this project, we simply use as much of the coil as will fit inside the PVC pipe. It is my belief that you would benefit greatly by getting your own up-to-date copy of the handbook. It is a reference book I go to often for data. Using your own copy can provide you with more usable data than I can here. If you read the book, you will know a lot more about tuners and other RF-related equipment. I can only present pertinent data for the article at hand.

Should you decide to make an antenna tuner that



will include 80-meter operation, a larger PVC pipe will be necessary. Use a three-inch PVC pipe, if available. A tuner for that band needs substantially more inductance than, say, one for 10 or 15 meters. A really big enclosure will also be needed to hold it all.

You will need a small leaf switch from an old CB desk microphone. Inside old desk mics, the switching activators for receive and transmit used a couple of leaf switches. You merely pressed on a bar and the contacts were open or closed. You should have no trouble finding a junk desk mic in your junkbox, or get one from a friend. Still, one can be made easy enough if you cannot find one.

## OKAY! HERE WE GO ...

Start by precutting everything to size so it will all fit in your enclosure. A piece of PVC pipe will need to go from front to back along the depth of the enclosure. The PVC pipe is part of the roller inductor. It will be turned by the old channel selector, so include the selector's depth in determining the length of the PVC pipe.

Look in the junkbox or on another old CB for a SO-239 panel mount antenna connector. There's one on the CB you're getting the parts from, so you just need one more.

If there is a local electronic surplus store, go there and get 16 SPDT miniature panel-mounted switches. I got mine from Javanco, in downtown Nashville, and was lucky enough to get very small ones that I could solder into the front panel of my tuner. I made a front panel from PCB. This made mounting the switches quick and neat. I'm not sure they have any more of the same ones, but they have plenty of other types you could use. Call them at 615-244-4444.

Since the inductor coil is relatively large, it is an easy task to wind it yourself. You must find a suitable form, though, to wind it on. The inductor coil will rotate inside the PVC pipe. Therefore, it must be wound so that it rotates freely without binding. In my case, a broomstick served as the coil form. Wind the coil as tight as you can in a close-wound manner.

Close-wound means that the coils touch each other. The inductor length depends on the depth of your enclosure, and with it connected to the channel selector, which we will do next.

Keep the wire pressed in around the form as you wind it and it will be okay. Don't be concerned about the coils touching each other. It will be spread out later. You might just wind a turn or two to make sure the coil will rotate freely in the PVC pipe.

The length of the coil should be at least slightly longer than the PVC pipe when spread out. If you will prepare the length of the close-wound coil to about three-quarters of the length of the PVC pipe, you will be very close to having it right. That would be nine inches for a one-foot PVC pipe. Using the three-quarter rule, you will still have to shorten the coil a little for the final assembly.

## PREPARING THE PVC PIPE

With any roller inductor, there must be a means

to tap or adjust the inductance value of the inductor as it is used in the design circuit. Cutting a slot along the length of the pipe will give us access to connecting a tap to the coil as it is rotated inside the PVC housing. This is done with a simple loop of wire connected at 90° to the coil inside the pipe.

Beginning 1/4" from either end, cut a 1/8" slot along the length of the pipe. Continue to within 1/4" of the other end and stop. Don't cut through either end.

Slot the pipe like this: Mark the pipe where the slot will be. Drill a pilot hole 1/8" at each end of the

## THE COIL SLIDER

Figure 3 shows how to make this slider. It is just a short piece of #12 wire bent to form an open loop in a "U" fashion. The ends are then bent straight out about 3/8" from the round end. You need a small piece of stiff sponge now to hold the slider firmly against the outside of the coil. The loop goes through two small holes in the sponge which keeps the loop in contact with the coil inside the PVC pipe.

Connect the slider to the center of all the switches. You should use a flexible piece of wire. I used a piece of shield from RG174 coax. This is necessary because the slider moves up and down the PVC pipe. Your connecting wire will also move back and forth.

Cover the flexible wiring with a piece of plastic tubing or the covering from another piece of coax. A cable tie around the pipe at the end is how I made a stop for the slider. Did I mention crude? It works, though.

## THE CHANNEL SELECTOR

Prepare a piece of PCB to mount the coil to the selector. You can make the piece you need from some scrap PCBs. The diameter of the board is controlled by the height of your enclosure. It should be at least 1/2" larger in diameter than the pipe.

If your housing height is spacious, you can make it as large as you like. Bear in mind it will turn with the channel selector. You need to solder one end of the coil to this round piece of PCB and place it on the channel selector shaft. This is how the coil is turned.

The PCB needs a slotted hole cut in it so that it can be placed on the shaft. Prepare the mounting hole just like the hole in one of the original wafers. Prepare and solder one end of the inductor coil to the board.

You might need to file or grind the end of the coil wire to get the end flat. It must be mounted squarely, centered on the hole you made in the wafer. Coat the coil end with solder to reduce the time needed to connect it to the PCB. Soldering the board will also help. The 1/4" that the wafer extends from the pipe is the area needed to ground the coil for proper operation.

This will be done by the leaf switch mentioned earlier. It will be mounted on the bottom of the chassis and bent up to rub on the wafer as it is turned.

Proper grounding cannot be realized by relying on contact through the wafer and the selector shaft to the panel mounting. Arcing might even freeze up the shaft if problems occur when operating. And they most certainly occur now and then.

The front end of the pipe will actually touch the wafer as it rotates. This holds the wafer against the selector. Any excess solder should be removed so that the pipe rests smoothly on the PCB as it rotates. Determine the proper place for the channel selector and mount it.

Photo 1

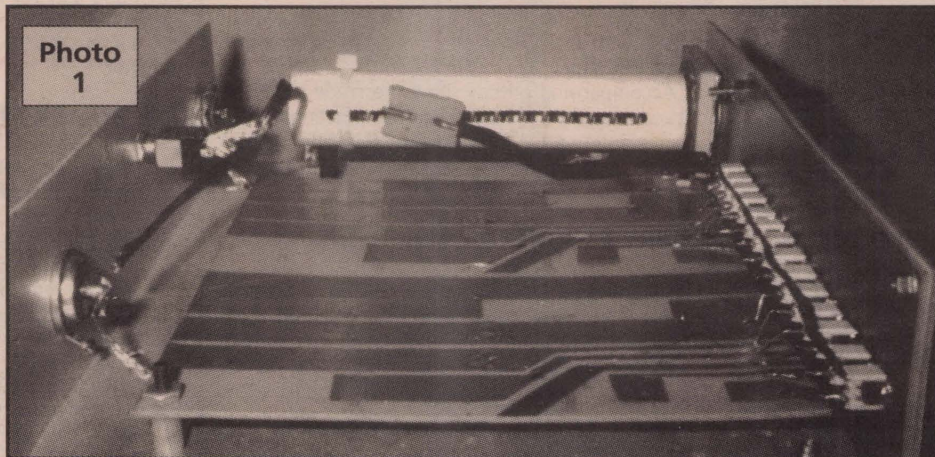


Photo 2

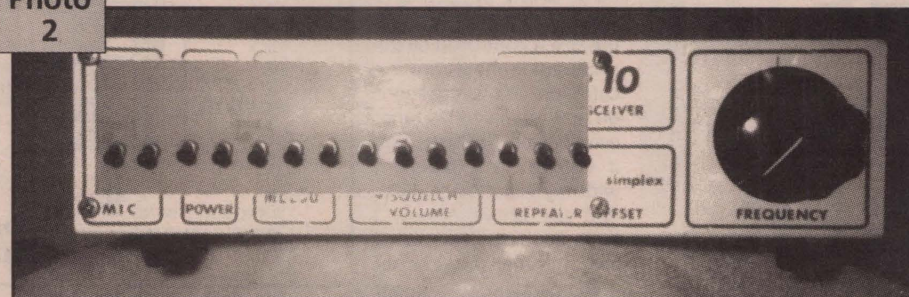
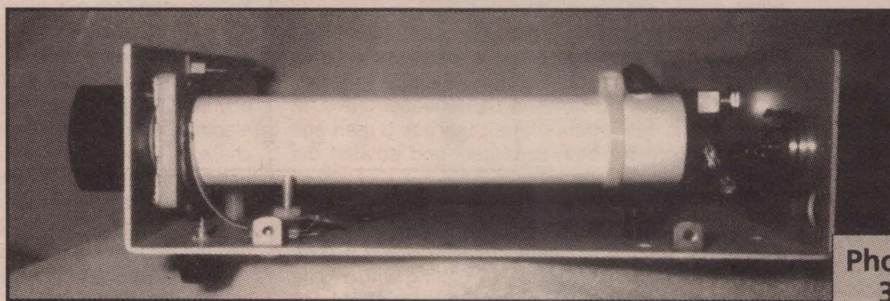


Photo 3



Drill a 1/8" hole in one end of the pipe at 90° from the slot. This is where the inductor will be supported at the rear of your enclosure. It will be held in place with a standoff. The slot will face the inside in the direction of the caps and the opposite side of the enclosure.

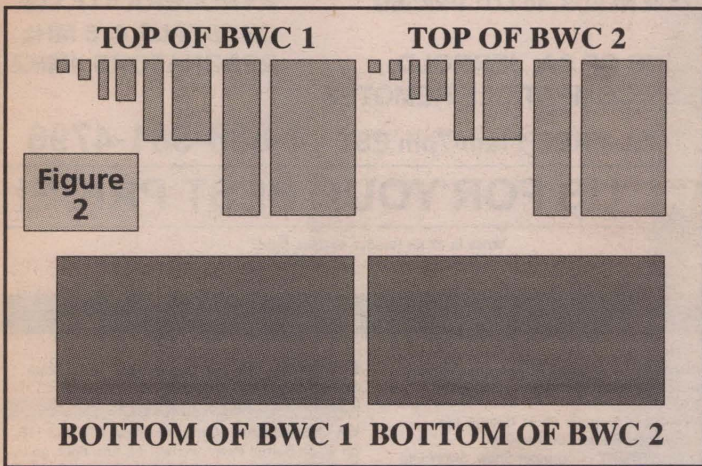
Drill the mounting hole 90° around the pipe on the bottom. The standoff height is determined by the placement of the channel selector that is mounted to the front panel.



## NO PROBLEM

A reader might think it strange that there are no critical areas in respect to the roller inductor mounting or rotation. No precise tolerances are required to make and use this tuner. Tuners are not adjusted in the same manner as a main dial on the radio.

Once set, it may not be turned again for days or even months. An experimenter might use it steady for a day or two. Once the reason or purpose for



using a tuner is fulfilled, it is stored until next time. Or maybe left in place forever.

## THE LEAF SWITCH GROUND

Refer to Photo 3 to understand how to mount the leaf switch. You can make this grounding wiper from any metal that has a little spring to it. Any metal will work because you do not have to solder to the leaf switch. Try a thick piece of brass for the leaf switch, if one is available. Simply attach it to the enclosure and make sure it is well grounded.

As you can see, it must be bent at a 90° angle to permit it to lay against the PCB soldered to the coil. Make a tip on the leaf switch, if necessary. This tip must rub and contact the PCB at all times.

Use whatever method you like to mount the leaf switch, but do not rely on the selector shaft to provide a proper ground for the inductor.

If everything has been prepared and you just read through to here, then put it all together as indicated. Separate the two groups of switches slightly when mounting. I did not label any controls on my tuner because I used it as soon as I got it working and forgot to do it later.

Connect each stator to a panel-mount SO239 connector. You should put these two connectors on the rear panel of your enclosure.

Antenna tuner's connectors are usually labeled with an input and output designator. Most tuners have some sort of metering to indicate Forward and Reflective power. Correct signal flow through those tuners is important.

In our tuner, signal flow can be either way. In the *ARRL Handbook*, there are many metering circuits you could add to this tuner.

## USING THE BWC TUNER

The value of each capacitor is unknown, but since each is one-half of the previous, we can assume some values. Start by assuming the smallest cap is 1 picofarad (pF). You could also give it a value of 10. Just give the next one a "times 2" value.

There are formulas for determining the value of these capacitors. This data can be found in the *ARRL Handbook*. The area, spacing, and number of the plates determines the capacitance value. (Try the library if you would like to browse through a copy of the handbook without buying one. I'm afraid the

only formula you will ever find in my articles is how to make a better cheeseburger.)

Okay, we have eight switches to identify and/or label. The smallest cap, we give a value of 1. The next gets the value 2. Value the next at 4. The next gets the value of 8. The next group of four starts with a times 10 value. Number five gets the value 10. Give number six the value of 20.

Forty is the value given number seven and finally number eight is given a value of 80. You have labeled switch group 1. Do the same for group 2. If your capacitor values were exact, all of them added together would equal 165 pF each.

The switches enable you to set the total capacitance between 1 and 165 pF in 1 pF increments. Your capacitors are not exact, so don't expect this kind of resolution unless you actually used a formula to compute the value of each individual capacitor. This is an experimenter's project, so feel free to experiment with any aspect of it.

Refer to the photos and mount 16 switches in a similar manner on the front panel. It will not be necessary to mount the BWC boards at the front if you solder them directly to the switches. Switch 1 of each group gets soldered to the smallest piece of copper for that group. Respectively solder in the other pads to the correct switches.

Antenna tuners usually have capacitors valued at 200 to 300 pF. Ours is close to that range. Let's do an example at setting the caps. As an example, we need a value of 110 pF to match one side of the tuner. In actual use, you never know the required value needed because you adjust until it gets right. Here is (simplified) how the binary weighting occurs:

- Value needed is 110 pF.
- We would start by setting the cap closest to that value.
- In our set-up, that is #8 equal to 80 pF.
- We need 30 more pF.
- Set #6 and #5. 20 pF and 10 pF.
- Our capacitor is set to 110 pF.
- It is that simple.

In actual use, you would connect an SWR meter between the tuner and the antenna. If you would rather not create any unnecessary interference, use a dummy load for an antenna until you get familiar with the new equipment.

The dummy load will present a sort of perfect antenna, but it will let you play around a little.

Transmit and set the switches that give you a minimum reading on an SWR meter after you adjust the roller inductor for the same condition. Use low power for your initial testing of the tuner. Your objective is to have a minimum reflective power reading on the SWR meter.

All the values needed to reach a 'match' are unknown. You must find them by turning and setting the controls. Several attempts to tune the antenna are needed before you get the hang of it.

All you do is turn the inductor and set individual switches ON or OFF until you get a match, which is indicated on the SWR meter as a minimum reflected power. In time, setting the controls becomes a snap and you can match the antenna in seconds.

You will discover that there are at least two different settings that will provide a "MATCH" for you. It is a practice to use the setting that has more capacitance than the other in that case. This helps decrease any harmonic level coming from the exciter or amplifier.

When using the tuner on low frequencies — 75 and 80 meters — you may not be able to reach a low SWR due to the fact that you do not have enough capacitance to achieve a match. The schematic shows a fixed capacitor added to the circuit.

I would start with a 100 pF cap for 80 meters. Just solder it in place at the indicated points. Use a fixed cap with a high-voltage rating in this position. You could add another switch to do this or, if you always use the tuner on lower bands, just leave it in there.

## MAKING IT BETTER

This tuner is rated at 300 watts. I rated it at that level because the capacitors started getting warm at that output level. No specs. No elusive feedpoint impedances or antenna currents. No unknown reactances. Just started getting warm at 300 watts. This is an experiment, remember? A project simple enough that even I could make one. Give it the ol' smoke test yourself. Fire it up and see if it smokes.

You are not required to use the PCB material for your capacitors. Use strips of copper or brass cut to length from the formula. The only requirement would be to keep the spacing precise if you expect a certain value. Copper or brass is recommended because they can be soldered. Use of metal plates and air spacing will greatly increase the output level rating. Remember, my caps were made of phenolic PCB. Glass PCB would be even better.

A variation here would be to make a "PI" tuner. In that configuration, the inductor is in series with the signal flow. The stator of each cap would be grounded and the leaf switch would have to be isolated from ground. I/O ports would be connected to the roller inductor at each end.

One problem with the roller inductor is knowing where the tap is at. I used my tuner with the top off and just watched its placement as I tuned. A turns-counting dial will correct this. You'll find this item at hamfests, or get one from a parts house.

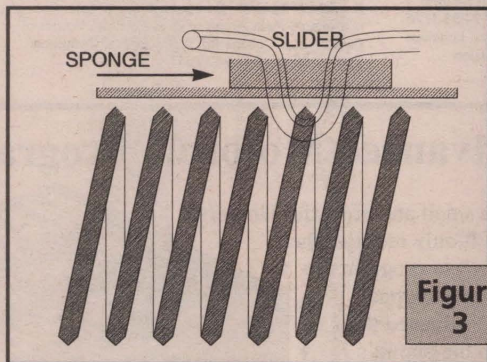
I even thought about making a custom indicator for mine, but never got around to it. Try making a turns indicator using a cable tie. Attach a long cable tie to the slider. Cut two 1/4" holes in the front of the case; one at each end of the switches but above them.

Thread the cable tie from inside out through the first hole. Feed it back through the other hole. Make a black mark on the cable tie furthest from the roller. The roller

should be at minimum.

As you turn the inductor, the cable tie will be pulled and the black mark will relatively indicate the slider's tap position. You could make a scale under the cable tie. You might have to enlarge the holes or lubricate them to get the cable tie to slide through. A little brainwork here could get you a very nice looking indicator of the tap position.

The BWC antenna tuner will provide a means to experiment with less than optimum antennas that sometimes need a little matching when connected to an exciter. Although we refer to a perfect match sometimes when using a tuner, I feel it is a false condition that is indicated. There is no substitute for a proper direct feed to your perfect antenna. **NV**





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# Events CALENDAR

Continued from page 108

## SEPTEMBER 20

**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052  
**GA - GAINESVILLE** - Hamfest. Fairgrounds. LARC 770-532-4118

**IN - INDIANAPOLIS** - AGI Computer Fair. Indianapolis Events Center. 3655 E. Raymond St. 10am-4pm. 317-299-8827

**ME - AUGUSTA** - Computer Show. Civic Center. Northern Computer Shows 508-744-8440

**NY - Poughkeepsie** - Computer Show. Mid-Hudson Civic Center. 9:30am-4pm. MarketPro 201-825-2229

## SEPTEMBER 20-21

**AK - ANCHORAGE** - Hamfest. Kincaid Park Rec Center. Lillian Marvin NL7DL 907-277-6741  
**IL - PEORIA** - Hamfest & Computer Show. Exposition Gardens, Northmoor & University Streets. 309-692-FEST

**MA - WORCESTER** - Computer Show. Worcester Centrum. 9:30am-4pm. MarketPro 201-825-2229

**VA - VIRGINIA BEACH** - Hamfest & State Convention. Virginia Beach Pavilion. Manny Steiner K4DOR, 757-HAM-FEST

## SEPTEMBER 21

**FL - NEW PORT RICHEY** - Hamfest & Computer Show. New Port Richey Recreational Center, 6630 Van Buren. Mimmie KO4FB, 813-937-7455

**IN - NOBLESVILLE** - AGI Computer Fair. Hamilton Co. Fairgrounds. 10am-3pm. 317-299-8827

**MA - CAMBRIDGE** - Flea Market. Kendall Square area. 9am-2pm. MIT. Nick Altemburnd 617-253-3776  
**MI - ADRIAN** - Hamfest & Computer Show. Lenawee Co. Fairgrounds. 8am-2pm. Brian J. Sarkisian

KG8CO, 517-265-1537 kg8co@juno.com

**NH - PORTSMOUTH** - Computer Show. Yoken's. Northern Computer Shows 508-744-8440

**NJ - PARSIPPANY** - Computer Show. Parsippa Hillon. 9:30am-4pm. MarketPro 201-825-2229

**OH - CINCINNATI** - Communications Expo '97. Kolping Center, 10235 Mill Rd. 8am-5pm. Paul N. Riedel WB8NFT, 513-733-3900

## SEPTEMBER 27

**CA - DALY CITY** - Computer Show. Cow Palace, Gate #5, Geneva & Santos. Robert Austin Corp. 1-800-243-7041, <http://www.robertaustin.com>

**FL - DAYTONA BEACH** - Hamfest & Computer Show. DBARA E-Mail: k4bv@juno.com

**IN - TERRE HAUTE** - Computer Fair. Vigo Co. Fairgrounds. 10am-4pm. David Martin 812-442-0110

**ME - PORTLAND** - Computer Show. Portland Expo Center. Northern Computer Shows 508-744-8440

**NJ - WESTFIELD** - Computer Show. Westfield Armory. 9:30am-4pm. MarketPro 201-825-2229

**NY - HORSEHEADS** - Hamfest/Computerfest. Chemung Co. Fairgrounds. 6am-3pm. Dave Lewis 607-589-7495

**SC - ANDERSON** - Hamfest & Computer Fair. Civic Center. 9am-4pm EDT. C. H. Merrell 864-225-0028

## SEPTEMBER 27-28

**IL - GRAYSLAKE** - Radio Expo '97. Lake Co. Fairgrounds. Sat: 8am-4pm, Sun: 8am-3pm. Mike Brost 708-457-0966

## SEPTEMBER 28

**CA - SANTA ANA** - Swapmeet. ACP parking lot. Mary Russo 714-558-8813

**IL - GLEN ELLYN** - Computer Show & Sale. College of DuPage. Main Arena of Phys Ed Bldg. Corner of Park Blvd. & College Rd. 9:30am-3pm. Computer Central Shows 847-940-7547

**KY - LOUISVILLE** - Computer Fair South. Executive West Hotel. 9:30am-3pm. Sammy L. Hastings 812-333-9300

**MA - TAUNTON** - Computer Show. Holiday Inn. Northern Computer Shows 508-744-8440

**NY - OLD WESTBURY** - Computer Show. SUNY Old Westbury. 9:30am-4pm. MarketPro 201-825-2229

**NY - YONKERS** - Electronic Flea Market. Lincoln High School. 9am-3pm. Otto Supliski WB2SLQ, 914-969-1053

**OH - BEREIA** - Hamfest & Computer Show. Cuyahoga Co. Fairgrounds. 8am-2pm. Hamfest Assn. of Cleveland 1-800-CLE-FEST info@hac.org

## OCTOBER 1997

### OCTOBER 3-4-5

**MI - TAYLOR** - Computer & Technology Show. Gibraltar Trade Center, 15525 Racho Rd. 313-287-2000

### OCTOBER 4

**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

### OCTOBER 5

**CA - LIVERMORE** - Swapmeet. Las Positas College. Noel Anklam 510-447-3857

**NY - QUEENS** - Hamfest. New York Hall of Science parking lot, Flushing Meadow Park, 47-01 111th St. 9am-3pm. Arnie Schiffman WB2YXB, 718-343-0172 eves.

### OCTOBER 11

**CA - FONTANA** - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

**FL - TAMPA** - Hamfest. Unit Building, 4050 Dana Shores Dr. J. F. Strom K9BSL, 813-822-9107

### OCTOBER 11-12

**GA - KENNESAW** - Computer Show. I-75 Exit 116, go W. on Barrett Pkwy. to Hwy. 41, turn right, go to 2nd traffic light; we're on the right next to "Cowboys." GA Mountain Productions 706-838-4827

### OCTOBER 12

**NJ - LINCROFT** - Hamfest. Brookdale Community College. AJ Jackson NK2O, 908-922-8121

### OCTOBER 17-18

**FL - STARKE** - Hamfest & Computer Show. Bradford Co. Fairgrounds on US 301 N. of Starke. Fri: 1pm-8pm, Sat: 8am-3pm. Dan Phillips K4RVD, 352-475-2695

### OCTOBER 18

**CA - OAKLAND** - Computer Show. Oakland Convention Center, Broadway @ 10th St. 1-800-243-7041 <http://www.robertaustin.com>

**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

**IN - INDIANAPOLIS** - AGI Computer Fair. Indianapolis Events Center. 3655 E. Raymond St. 10am-4pm. 317-299-8827

**TN - GRAY** - Hamfest. Appalachian Fairgrounds. Tri-Cities Hamfest, POB 3682 CRS, Johnson City, TN 37602

### OCTOBER 19

**IN - KOKOMO** - AGI Computer Fair. Ramada Inn. 10am-3pm. 317-299-8827

**KY - LOUISVILLE** - Computer Fair South. Executive West Hotel. 9:30am-3pm. Sammy L. Hastings 812-333-9300

**MA - CAMBRIDGE** - Flea Market. Kendall Square area. 9am-2pm. MIT. Nick Altemburnd 617-253-3776

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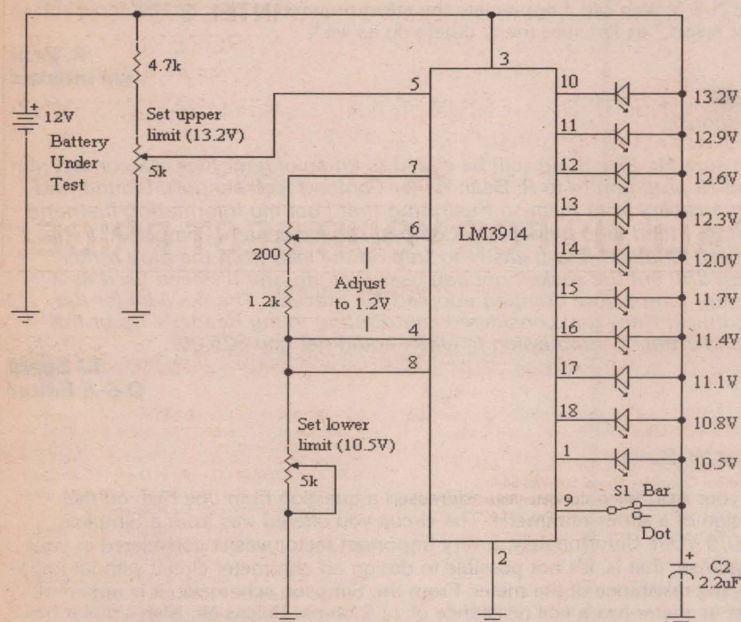
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Battery Voltage	LED Color	Description
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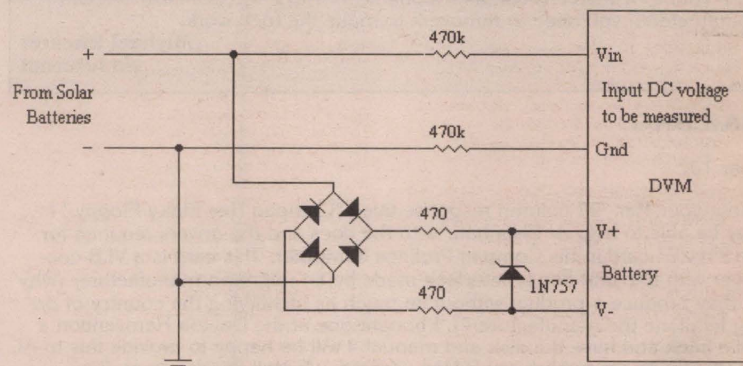
13.2	Green	About 100% of charge remains
12.9	Green	About 80% of charge remains
12.6	Green	About 70% of charge remains
12.3	Green	About 55% of charge remains
12.0	Green	About 40% of charge remains

11.7	Yellow	About 25% of charge remains
11.4	Yellow	About 10% of charge remains
11.1	Red	Caution!
10.8	Red	Danger!
10.5	Red	Dead!

Notice that I've included a switch (S1) labeled Bar/Dot. S1 lets you switch the display mode between a bar, where the LEDs light consecutively as the voltage increases, and a single LED that represents the battery's voltage (the other nine LEDs are dark). You can use this feature to save battery power in the field.

**Q.** I purchased several inexpensive (under \$10.00) 3-1/2 digit LCD panel meters from a company that advertises in *Nuts & Volts Magazine*. The intended use for the meters was to monitor my 100% solar-powered house, but was disappointed to discover that the meter cannot use the voltage being measured to power the meter. Is there a way to modify these cheap meters to have a common mode of operation without a separate isolated power source or expensive DC/DC converter?

**A.** The meter you bought uses an ICL7106 IC, which is a complete voltmeter on a chip. In a standard configuration, the INPUT Lo pin is shorted to COMMON, causing V+ to sit +2.8 volts above INPUT Lo, and V- to be -6.2 volts with respect to INPUT Lo. The solution is to isolate the two inputs. One way to do it is with resistors and diodes.

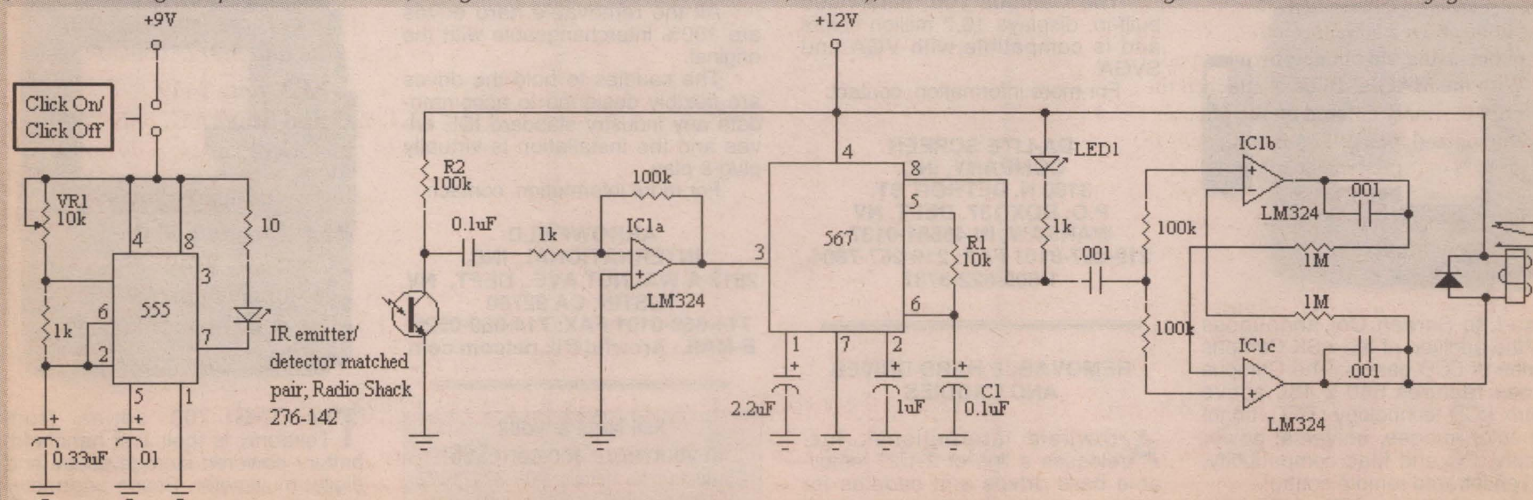


**Q.** Where can I find a schematic for a simple infrared remote control? I only want to switch a device on and off, nothing else. It should have a fairly long range of 50 to 100 feet, with quick response (as in one second or less).

**A.** This is a classic design that's become a classroom exercise. In fact, extra points are awarded for innovation. Unfortunately, hobbyists live in a practical world where innovation has to give way to mundane things like finding the needed parts from a local jobber such as Radio Shack. With that thought in mind, here's my solution.

The design is divided up into two parts: the transmitter and the receiver. The transmitter is nothing more than a 555 chip strobing an IR LED. A fresh 9V battery will power this sender for a year or more. The receiver is

built around a 567 tone decoder. Tone modulated IR can span much greater distances than an "IR flashlight" because it has greater immunity to ambient light. At the front of the receiver is a phototransistor IR detector — one that is spectrally matched to the IR LED in the transmitter. This signal is amplified by IC1a and directed to the input of the 567 tone decoder. When the input frequency of the IR signal matches that of the tone decoder's filter (R1 and C1), pin 8 goes low. To match the sender frequency with the decoder, adjust VR1 until LED1 lights. This triggers the toggle switch, made up of IC1b and IC1c. When IC1b is on, IC1c is off, and visa versa. Hence, the relay alternates between off and on each time you "click" the transmitter. Not enough distance for you? Simply up the transmitter's voltage (up to 15 volts) and replace the IR LED with Radio Shack 276-143. Of course, the range is dependent on the ambient light at the receiver, which can be partially compensated for by adjusting the value of R2. While this design probably won't net me an A+ (too straightforward), I'm sure it scores well with you and other readers. Enjoy.





The 470-ohm resistors basically isolate the meter battery from the photovoltaic batteries. As an added bonus, the power source is now held at 9.1 volts, which prevents the charging voltage from damaging the IC. The two 470K resistors provide further isolation for Vin. Because the input impedance of the ICL7106 is greater than 100 megohms, the voltage error created by the 470K resistors is a negligible 1  $\mu$ V. The bridge rectifier corrects for accidental polarity reversal of the battery, and offers a small amount of additional isolation.

### Reader's Tip

I was reading through the Jan. '97 issue and saw the question "DOS Invasion Stopped," where you said that there's no way to prevent a person from shelling to DOS. Technically, that's true. However, you can trick the computer into not shelling to DOS. Whenever a program shells to DOS, it runs COMMAND.COM, looking for it first in the directory that the program is currently operating in. You can easily exploit this fact by adding a bogus COMMAND.COM file to that directory.

I created a fake COM file which simply says "PRESS ANY KEY" (you can find this file on our Web site, <http://www.nutsvolts.com>, under the name FAKE.COM). I then moved FAKE.COM to the directory where my program is and renamed it COMMAND.COM. Now when anyone tries to shell to DOS, all they get the message "PRESS ANY KEY" — not a DOS prompt. Pressing any key sends you back to the parent application.

Two words of caution:

- 1) Make sure that you don't overwrite the actual COMMAND.COM file!
- 2) If your CONFIG.SYS contains a line with SHELL=C:\COMMAND.COM (parameters), you need to remove it to make the trick work.

Michael Shearer  
via Internet

### MAILBAG

Dear TJ:

About your Mar. '97 column response titled "Compaq Has Flaky Floppy." I may be able to help Al Eisenhaur with the docs and the drivers required for the PTI 227 card in his Compaq Prolinea computer. This card is a VLB controller with IDE and floppy interface made by an unknown manufacturer (why do they produce a product without so much as identifying the country of origin, let alone the manufacturer?). I bought one at the Dayton Hamvention a while back and have the disk and manual. I will be happy to provide this to Al, but please do not publish my E-Mail address — E-Mail floods are no fun.

Also, let me say that some Prolinea computers don't have the ability to disable the onboard controller. The ones that do usually show the jumper marked as "HDFE disen" or HD EN." Some Compaq tech support people can be very helpful, others are on the karmic merry go-round. Another interesting scenario surfaced a while back when I tried to install an off-the-shelf Colorado Jumbo

tape drive in a Compaq Pentium slimline desktop via a floppy piggyback cable (also Colorado stock). There is a pin that is blocked on the floppy cable, apparently to force folks to buy Compaq's pricey-if-available options. I simply drilled out the blocked pin (no connection necessary) and connected everything as in a normal installation. It works just fine.

If there is enough demand, I will make the above files available for posting on the N & V Web site. I appreciate the effort required to provide this "court of last resort," as I'm sure many others do as well.

R. Bear  
via Internet

Response:

I'm sure Mr. Eisenhaur will be elated to know of your files. Al, contact me and I'll plug you in to R. Bear. As for Compaq tech support, I found finding answers from them so frustrating that I got my information firsthand from a friend who works at a Compaq service center (CompUSA, to be exact). Finally, I find it easier to snip off the lead from the plug rather than drill out the socket; nobody uses that pin and it's been used as a locator long before Compaq adopted the practice. Thanks a lot for the feedback! Have you considered contributing to my Reader's Tip or the Tech Forum? A submission to either could net you \$25.00.

TJ Byers  
Q & A Editor

Dear Mr. Byers:

In your Apr. '97 column, you addressed a question from Joe Kish on the design of a series ohmmeter. The circuit you offered was from a Simpson 260/6 VOM. Unfortunately, a very important factor wasn't considered in your response; that is, it's not possible to design an ohmmeter circuit without knowing the resistance of the meter. From the Simpson schematic, it is apparent that its meter has a coil resistance of 11.2 ohms. Unless Mr. Kish's meter has the same internal resistance, he won't be able to zero the meter! If Mr. Kish wants help with his design, have him contact me.

Barry Fichter  
Dale City, VA

Response:

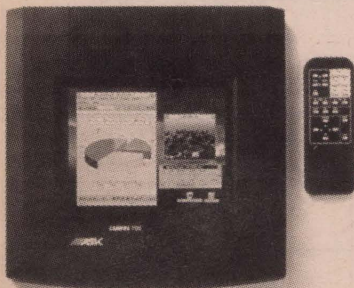
Actually, the resistance of the Simpson meter is more like 5K, not 11.2 ohms. However, what you're thinking about is a parallel ohmmeter, where the meter's resistance is a critical part of the circuit. With a series ohmmeter, it's the total resistance of the circuit that counts — not that of the meter. This amounts to 30K with a 1.5-volt battery. If the meter's resistance is 5K, then you need a 25K series resistor to limit the current to 50  $\mu$ A. This is what the Zero Ohms adjustment does — insert the needed 25K in combination with the 17.55K resistor.

TJ Byers  
Q & A Editor

Continued from page 103

## New Product News

### ASK CAMPUS SERIES LCD PANELS



Da-Lite Screen Co. announces the addition of the ASK Campus Series of LCD panels. The Campus Series features 640 x 480 active matrix LCD technology (TFT), bright full color images, universal power supply, PC and Mac compatibility, and an infrared remote control.

The Campus 300, data only

model, displays 2.1 million colors and is compatible with VGA and SVGA.

The Campus 700, data/video built-in, displays 16.7 million colors and is compatible with VGA and SVGA.

For more information, contact:

DA-LITE SCREEN  
COMPANY, INC.  
3100 N. DETROIT ST.  
P.O. BOX 137, DEPT. NV  
WARSAW, IN 46581-0137  
219-267-8101 FAX: 219-267-7804  
1-800-622-3737

### REMOVABLE HARD DRIVES AND CADDIES

Arrowfield International, Inc. releases a line of 2-1/2" removable hard drives and caddies for various notebook computers such

as Compaq LTE 5000, IBM Thinkpad series, Toshiba Tecra series, and NEC Versa series.

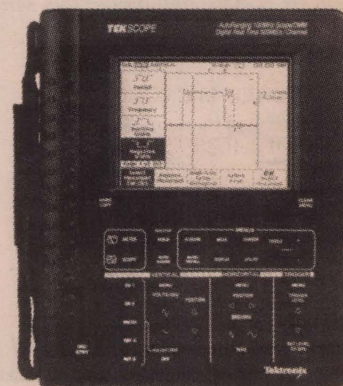
All the removable hard drives are 100% interchangeable with the original.

The caddies to hold the drives are flexibly designed to accommodate any industry standard IDE drives and the installation is virtually plug & play.

For more information, contact:

ARROWFIELD  
INTERNATIONAL, INC.  
2812-A WALNUT AVE., DEPT. NV  
TUSTIN, CA 92780  
714-669-0101 FAX: 714-669-0526  
E-MAIL: Arowfld@ix.netcom.com

### HANDHELD SCOPE/MULTIMETER



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# New Product News

and independently. The high resolution, backlit display, and pop-up menus make taking waveform readings a quick and easy operation. Instrument settings are pre-programmed for the most common and useful measurements. It is able to catch extremely fast glitches. Measures 8.5 x 6.9 x 2" and weighs 3.2 lbs.

For more information, contact:

**JENSEN TOOLS**  
7815 S. 46TH ST., DEPT. NV  
PHOENIX, AZ 85044  
602-968-6231 FAX: 602-438-1690  
1-800-426-1194

## FIBER TEST ADAPTER

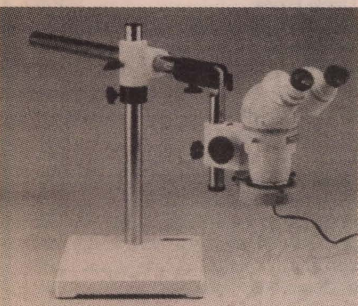


No longer is it necessary to buy a whole new set of expensive fiber test meters. The new Fluke® Fiber Optic Meter is an inexpensive alternative that turns your DMM into an optical loss meter at a fraction of the cost. It's easy to use, simply plug it into your meter, set the range to millivolts, connect the fiber, power the meter, and read the results. Small and lightweight.

For more information, contact:

**JENSEN TOOLS**  
7815 S. 46TH ST., DEPT. NV  
PHOENIX, AZ 85044  
602-968-6231 FAX: 602-438-1690  
1-800-426-1194

## STEREO MICROSCOPE



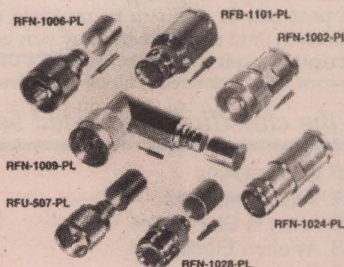
This compact general-purpose microscope is ideal for a wide variety of electronic and industrial applications. Selectable 20X or 40X

magnification. Bottom transmitted and overhead illuminators. It includes 2X and 4X objectives, rotary turret with positive click stop for easy power change. Precision rack and pinion focus. Eyetubes are inclined 45°. Working distance is 3.15" at 20X. It comes with rubber eye cups and a dust cover.

For more information, contact:

**JENSEN TOOLS**  
7815 S. 46TH ST., DEPT. NV  
PHOENIX, AZ 85044  
602-968-6231 FAX: 602-438-1690  
1-800-426-1194

## RG-8/U PLENUM



## CABLE CONNECTORS

RF Connectors releases several BNC, N, and UHF connectors designed for use with RG-8/U type plenum cable, having .108 sold-center conductors and .355 outer jacket dimensions. This cable is used in many computer, instrumentation, and broadcast installations.

For more information, contact:

**RF CONNECTORS**  
7610 MIRAMAR RD., DEPT. NV  
SAN DIEGO, CA 92126-4202  
619-549-6340 FAX: 619-549-6345  
1-800-233-1728  
E-MAIL:  
102061.2261@compuserve.com

## HIGH-SPEED COUNTER/TIMER REPLACEMENT

Announcing the immediate availability of the CTS9513 20 MHz counter/timer peripheral. Patterned after the long popular but discontinued AMD AM9513 device, the CTS9513 duplicates all original features and operating modes at three times the clock frequency of the original device.

The CTS9513Ax1-2 is currently available in plastic DIP-40 and PLCC-44 packages. Prices start at \$37.50 in single quantities and \$25.00 in 1,000 piece quantities.

For more information, contact:

**CELERITOUS TECHNICAL SERVICES, CORP.**  
5109 82ND ST. #7 STE. 1200  
DEPARTMENT NV  
LUBBOCK, TX 79424-3099  
806-783-0904 FAX: 806-783-0905

# TECH FORUM

Continued from page 23

repairing brightwork, was advertised in automotive catalogs.]

**Greg Miller**  
State College, PA  
a.v.guru@juno.com

## ANSWER TO #6975 - JUNE 1997

The fix is fairly simple if you're good with a soldering pencil. Next to the tuner on the chassis is a metal-cased box called a tuning block. Remove it and pull both covers. Inside you will find a number of tuning coils and transformers. Look over the solder connections carefully and you will find at least one that needs to be resoldered, but it's a good idea to touch up all of them. Reinstall the block and that should take care of the problem.

The cycling is the aft not being able to lock.

**Larry Campbell**  
Fairchance, PA  
wmbs590@wmbs590.com(larry)

## ANSWER TO #5975 - MAY 1997

The easy video amp is the Signetic NE592. Wiring it is a breeze. Gain is controlled by a resistor between a couple of pins and can be variable and continuous. It has a pair of inputs, plus and minus, and outputs plus and minus. A 12-volt supply (to pin 10) ground to 5. Pins 1 and 14 are the inputs and 7 and 8 are the outputs. In the event that a lower impedance output is needed, direct drive a 2N2222 emitter follower with a 560 ohm emitter resistor and collector to 12 volts.

**Travis Brackeen**  
Fayetteville, GA

## ANSWER TO 69715 - JUNE 1997

I have done business with a company in Yonkers, NY for a number of years. They are **Circuit Techniques, Inc.** They don't really cater to the hobbyist, but they will manufacture single- or double-sided circuit boards from 12 pieces to 100,000 pieces. They can be reached at 914-423-2000.

**Douglas Mooney**  
Bronx, NY

## ANSWER TO #6974 - JUNE 1997

A fuel cell experimenter's kit is made by E-Chem Technic and can be purchased from Sargent-Welch for \$29.95 [Cat # WLS-30198]. It consists of a fuel cell and a 22-page manual containing instructions and experiments. The device is fueled by air and methanol or ethanol and is safe to use. I purchased one of these and was pleased with the device and the manual. The chemicals can be purchased from a supplier such as **Fisher Scientific (1-800-766-7000)**. A company called Warsitz Enterprises makes commercial hydrogen/air fuel cells starting at \$850.00 for a 3.6V/10W device. For additional fuel cell data, see the E-Chem Technic web site and check the Fuel Cell Commercialization Group on the web at <http://www.ttcorp.com/fccg/> These

sites also contain many links to other fuel cell sites. A useful book is the *Fuel Cell Handbook* by A. J. Appleby, NY: Van Nostrand, ISBN 0442319266:82.95.

**Sargent-Welch (IL): 1-800-727-4368**, E-Mail: [sarwel@sargent.com](mailto:sarwel@sargent.com)  
<http://www.sargentwelch.com/index.html>

**E-Chem Technic (UK):** <http://www.w.iway.co.uk/~ectechnic/home.html>

**Warsitz Enterprises (CA): 408-726-3564** <http://www.slip.net/~h2man/hyperfrm.htm>

**Paul Szozdowski**  
E-Mail: [pts2@po.cwru.edu](mailto:pts2@po.cwru.edu)

## ANSWER TO #59713 - MAY 1997

You have done all the right things (in theory, at least), but you didn't mention one thing that has me curious. Could your headphones and their leads be acting as the antenna for the AM station? Unless you are using the same decoupling techniques on all the leads (including those to the headphones), there is still a way for the RF to get in and be detected. In severe cases like yours, every single wire into or out of the enclosure must be appropriately filtered at the point of entry/exit. Waiting until the wire joins the circuit board is too late; the signals will already be inside the box!

Here are a few comments that might help in the future:

Ferrite beads may not provide much filtering in the standard broadcast band, so may not really be suitable filter elements in your case. It all depends on the characteristics of the ferrite. Typically beads are too small and have too low permeability to have much insertion loss at this frequency. You may have to use inductors as RF chokes, or you could wind several turns of wire on the beads. If you want to try an inductor, try to match the specified self-resonant frequency (SRF) with the maximum frequency you are trying to reject. For example, a leaded inductor of several milliHenries has an SRF above 3 MHz and less than 10 ohms of DC series resistance. This is the equivalent of several thousand ohms at RF.

Series resistance is good (and cheaper than inductors), and the more you can insert into each lead (without losing circuit performance, of course) the more filtering you will have.

Your capacitance size, .01 uF, may be too small to do a good filtering job at standard broadcast frequencies. Also, remember that lead length is critical here. If the leads to the capacitors are too long, the capacitors will not have the desired effect.

Finally, steel is a better shield against magnetic fields than electric fields. This usually means that it is a better shield at audio frequencies than at RF. Brass or copper would probably be a better choice. However, if you are diligent in the other areas, shielding will not be required anyway.

**Harry O. Boling III**  
Garland, TX



# HOW TO PLACE A CLASSIFIED AD

TYPE or PRINT your **ELECTRONICALLY RELATED** ad copy **CLEARLY** (not all caps) on a separate piece of paper. Spell out words when submitting handwritten copy. Calculate the number of words and multiply it by the appropriate rate (see RATE PER WORD section). Include any charges for bold and/or CAPPED words, any artwork costs that would be applicable, and/or costs for boxing your ad (explained below). Choose the appropriate classification for your ad(s) to appear in (see below). If no classification is indicated, it will be placed in Misc. Electronics or wherever we deem most suitable. **Enclose your name, address, phone number, and Nuts & Volts account number from your mailing label** (if available) for identification purposes. Include full payment — **CLASSIFIEDS RUN ON A PRE-PAID BASIS ONLY** — and mail your completed order to:

**NUTS & VOLTS MAGAZINE**, 430 Princeland Ct., Corona, CA 91719.

## RATE PER WORD

The ad rate for **current PAID subscribers** is **60¢** per word. All others pay **\$1.20** per word. There is a **\$9.00 minimum** charge per ad per insertion.

## WORDS IN BOLD AND/OR ALL CAPS

Words to be set in **bold** or **CAPS** are each **10¢** extra PER WORD. **BOLD CAPS** are **20¢** extra per word. The first two words of each ad are bold capped at no charge. Indicate bold words by underlining. Words normally written in caps (e.g., IBM) and accepted abbreviations such as VAC or MHz are NOT charged as all cap words. Use a two-letter abbreviation for states.

## PHOTOS, DRAWINGS, AND BOXES

A photo or drawing may be run at the top of your classified ad for an additional **\$10.00** (1" depth max.) for camera-ready art. No wording is allowed in this area. Add a one-time charge of **\$5.00** to enlarge, reduce, or duplicate line

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## FAXING IN AD COPY

You may fax in ad copy or changes before the closing date (5:00pm on the 10th) at 909-371-3052 using MasterCard or Visa. Include credit card expiration date, the name that appears on the card, a daytime phone number, and your Nuts & Volts account number. Ads without credit card information will not be listed as received until payment is received in full. **WE DO NOT CALL OR FAX BACK VERIFICATION OR QUOTES OF FAXED-IN ADS.** For verification of faxed-in ads, please call 909-371-8497.

## DEADLINE

Prepaid ads received by 5:00pm on the closing date (10th of the month) will appear in the following month's issue. Ads postmarked through the 10th, but received after the closing date, will be placed in the next available issue. No cancellations or changes after the 10th. Cancellations and changes must be submitted in writing.

## IMPORTANT INFORMATION

All classified ads are running copy only. No special positioning, centering, dot leaders, extra space, etc. is allowed. All advertising in Nuts & Volts is limited to **electronically related items ONLY**. All ads are subject to approval by the publisher. We reserve the right to reject or edit any ad submitted. We do not take ad copy or changes over the phone. We do not bill for classified ads. Repeat ads or ads run in multiple classifications within the same issue are allowed. Paid subscribers may run ads at the 60¢ rate only through their subscription expiration date. **NO REFUNDS.** Credit only. No credit for typesetting errors will be issued unless you clearly print or type your ad copy.

*Choose a category for your ad from the classifications listed below.*

10. Ham Gear For Sale	80. Test Equipment	120. Components	155. Manuals/Schematics Wanted
20. Ham Gear Wanted	85. Security	125. Microcontrollers	160. Misc. Electronics For Sale
30. CB/Scanners	90. Satellite Equipment	130. Antique Electronics	170. Misc. Electronics Wanted
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50. Computer Hardware	100. Audio/Video/Lasers	140. Publications	180. Education
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## Fantastic DMM Offer!!!

Don't let the price fool you. This meter is a digital multimeter designed for engineers and hobbyists. Equipped with 5 functions and 19 ranges. Each test position is quickly and easily selected with a simple turn of the FUNCTION/RANGE selector rotary switch.

### Rubber Boot Included

**General**  
Display: 3-1/2 Digit LCD, 21mm Figure Height with Automatic Polarity  
Overrange Indication: 3 Least Significant Digits Blank  
Temperature for Guaranteed Accuracy: 23°C±5°C RH<75%  
Temperature Ranges:

Operating: 0°C to 40°C (32°F to 104°F)  
Storage: -10°C to 50°C (14°F to 122°F)  
Power: 9V Alkaline or Carbon-Zinc Battery (NEDA1604)  
Low Battery Indication: BAT on Left of LCD Display  
Dimensions: 188mm long x 87mm wide x 33mm thick  
Net Weight: 400g

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

Maximum Allowable Input: 1000V DC or Peak AC.

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

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

**AC Voltage (ACV)**  
Range: Resolution: Accuracy:  
200V 100mV ±(1.2%rdg+10dgts)  
750V 1V

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

Maximum Open Circuit Voltage: 2.8V

**Diode Test**  
Measures forward voltage drop of a semiconductor junction in mV test current of 1.5mA Max.  
**ohmFE Test**  
Measures transistor hFE.  
Frequency Range: 45Hz-450Hz  
Maximum Allowable Input: 750V rms  
Response: Average Responding. Calibrated in rms of a Sine Wave.



Our Best Offer Ever on a

High Quality Full Sized DMM

**\$19.00** any qty

## Switchable Scope Probe Sets

(Selectable X1/Ref/X10)

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

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

## CCD Camera - IR Responsive

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

**Power Supply Regulating Kit for CA-H34** This simple kit is designed to fit onto the back of the CA-H34 CCD camera. It resolves the problem of hooking up the camera to an UNREGULATED supply (which damages the camera) by providing safe regulated power from any 12V-14V DC supply. It also provides regulated 12V DC from a 12V AC source.

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

## PM-128: 3-1/2D LCD Digital Panel Meter; PM-129: 3-1/2D LED Digital Panel Meter

### Features

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

### Specifications - PM-128/PM-129

Maximum Input : 199.9mV DC  
Maximum Display : 1999 counts (3-1/2 Digits)  
w/Automatic Polarity Indication  
Indication Method : PM-128 - LCD Display  
PM-129 - LED Display  
Measuring Method : Dual-Slope Integration  
A/D Converter System (cont.)

### (cont.)

Overrange Indication : "1" Shown in the Display  
Reading Rate Time : 2-3 Readings per sec.  
Input Impedance : >100 Mohm  
Accuracy : ±0.5% (23±5°C, <80% RH)  
Power Dissipation : PM-128 - 1mA DC  
PM-129 - 60mA DC  
Decimal Point : Selectable w/Wire Jumper  
Supply Voltage : PM-128 - 9V DC  
PM-129 - 9V DC  
Size : 67mm x 44mm

### Applications Include:

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

## Positive Photo Resist Pre-Sensitized Printed Circuit Boards

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

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

CAT NO	DESCRIPTION	1	10	50
PP101	100mm x 150mm/3.91" x 5.91"	\$2.55	\$1.90	\$1.70
PP114	114mm x 165mm/4.6" x 6.6"	2.98	2.45	1.98
PP152	150mm x 250mm/5.91" x 9.84"	5.40	3.98	3.60
PP153	150mm x 300mm/5.91" x 11.81"	6.15	4.48	4.10
PP1212	305mm x 305mm/12" x 12"	12.78	10.65	8.52

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

CAT NO	DESCRIPTION	1	10	50
GS101	100mm x 150mm/3.91" x 5.91"	\$ 3.90	\$2.98	\$2.60
GS114	114mm x 165mm/4.6" x 6.6"	4.80	3.49	3.20
GS152	150mm x 250mm/5.91" x 9.84"	8.69	5.98	5.78
GS153	150mm x 300mm/5.91" x 11.81"	10.20	7.20	6.80
GS1212	305mm x 305mm/12" x 12"	18.88	15.73	12.59

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

CAT NO	DESCRIPTION	1	10	50
GD101	100mm x 150mm/3.91" x 5.91"	\$ 5.07	\$3.68	\$3.38
GD114	114mm x 165mm/4.6" x 6.6"	5.95	4.29	3.99
GD152	150mm x 250mm/5.91" x 9.84"	10.47	7.39	6.98
GD153	150mm x 300mm/5.91" x 11.81"	11.95	8.69	8.30
GD1212	305mm x 305mm/12" x 12"	22.09	18.35	14.68

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

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

## Etching Tank

This handy etching system will handle PC boards up to 8" x 9", two at a time. Ideal for etching your PCB's! System includes an air pump for etchant agitation, a thermostatically controlled heater for keeping etchant at optimum temperature and a tank that holds 1.35 gallons of etchant. A tight fitting lid is also supplied to prevent evaporation when system is not being used. Typical etching time is reduced to 4 minutes on 1oz. copper board!

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

**REDUCES ETCHING TIME!**

## Etching Chemicals/Ferric Chloride

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

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

## Digital Panel Meters (LCD & LED)

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

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

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

### Specifications - PM-328

Maximum Input : 199.9mV DC  
Maximum Display : 1999 counts (4-1/2 Digits)  
w/Automatic Polarity Indication  
Indication Method : LCD Display  
Overrange Indication : "1" Shown in the Display  
Input Impedance : >100 Mohm  
Accuracy : ±0.05% (23±5°C, <80% RH)  
Power Dissipation : 1mA DC  
Decimal Point : Selectable w/Wire Jumper  
Supply Voltage : 9V DC  
Size : 67mm x 44mm

### Features:

- 200.0mV Full Scale Input Sensitivity
- Single 9V DC Operation
- Decimal Point Selectable
- 11mm LCD Figure Height
- Automatic Polarity Indication
- Low Battery Detection and Indication
- High Input Impedance (>100 Mohm)

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

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# QuickCheck

The **Xplorer** Test Receiver. The professional choice when speed, performance, and reliability are an issue !

For Commercial and Mobile Radio testing, the **Optoelectronics Xplorer** stands alone. Let the Xplorer perform all your quick radio checks, instantly determining the radio's frequency, **CTCSS**, **DCS**, **DTMF**, deviation or signal strength. The Xplorer automatically locks on to any nearfield signal from **30MHz - 2GHz** in less than a second.

There is **no setup necessary**-Whether you're in the field or in the shop, the Xplorer is the portable, compact and **economical solution** for any two-way communications business.



## FEATURES

- Nearfield receiver, sweeps **30MHz-2GHz** in <1 second ( Cellular blocked on all U.S. units)
- Decodes **CTCSS**, **DCS**, and **DTMF**. Manually record tones into memory
- Lockout up to 1000 frequencies
- Store **500 frequencies** in **memory** with time & date stamp, as well as number of hits per frequency
- NMEA-0183 **GPS interface** for recording Latitude & Longitude coordinates (GPS Required)
- **VFO mode** for tuning to specific frequencies
- PC interface for **downloading** data from **memory**
- FM demodulation / **Built-in speaker**
- **Auto** or manual frequency **hold**
- **Maximum nearfield** reception / Up to **1/4 mile** away

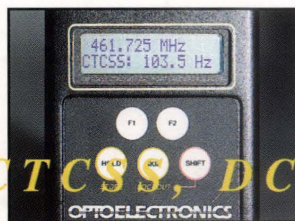
**\$899**

**Summer Special Includes:**  
**Spectrum CD & CC30 Case**

**Xplorer includes:** TA100S antenna, NiCads, Charger, PC Download cable and software

## SPECIFICATIONS

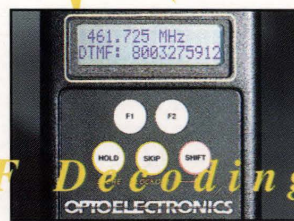
Freq. Range	30MHz - 2GHz
Modulation	FM Deviation
Freq. Response	50 - 3000Hz
Auto Sweep Time	<1 second
Input 50 Ohm	-59dBm @100MHz -25dBm @1GHz
Display	2 line LCD
Power	Internal NiCad



CTCSS Decode



DCS Decode



DTMF Decode

**CTCSS, DCS, and DTMF Decoding**

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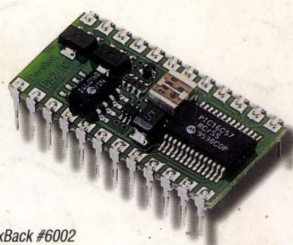
# BASIC STAMP<sup>®</sup> COMPUTERS

Tiny computers run PBASIC<sup>™</sup> programs

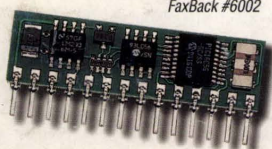


## Little Green Men from Mars

Bjarne Bergheim, Ken Christian, William Jackson, and Ben Strayer worked on "the Flying Saucer Project" at the University of California, Irvine. Their project, which used two BASIC Stamp II modules, was a literal flying saucer. Although not as dramatic as Hollywood versions, their saucer did indeed fly! And fortunately, it didn't come on Independence Day.



FaxBack #6002



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2000 instructions/sec.  
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14-pin SIP module

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