

## MAGAZINE

**\$3.50**

MARCH 1996

# Exploring Electronics And Technology For The Hobbyist And Professional



# Real-World Power For The BS21

# *Data Collection Proto Board For The Stamp II Computer Adds Analog Input, 32K Storage, And Real-Time Clock*





# Tucker Electronics

## Your Full Service Dealer Is Now An Authorized **Tektronix** Distributor

### The New TDS 300 Series Digital Real Time Oscilloscopes offer more scope for your money!

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Capture real-time signals on each and every sweep with the new TDS 300 Series Digital Real Time Oscilloscopes — with twice the bandwidth and twice the sample rate of previous TDS 300 models. All models come with Fast Fourier Transform (FFT) to display harmonic content of waveforms. In addition, the TDS 360 and 380 come with a built-in floppy disk drive for simplified PC compatibility. These digital scopes will meet your needs in all areas: education, product design, manufacturing, service and troubleshooting.

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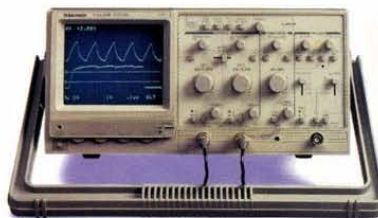
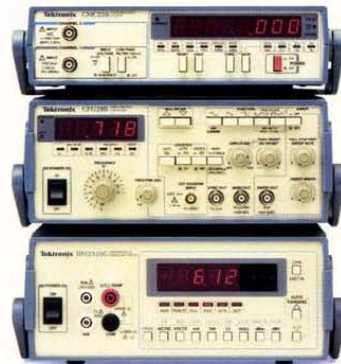
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Our **frequency counters** fit every application with a variety of price and performance levels.

Choose from among several **digital multimeters** to suit your needs, whether you'll benefit most from an inexpensive classroom model or from one of a series of programmable instruments that operate independently under computer control.

Our **function generators** are ideal for producing sine, square and triangle waves and TTL signals for testing amplifiers, filters and circuits. These instruments allow you to control duty cycle, DC offset, sweep rate, width and amplitude.



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# HSC Electronic Supply

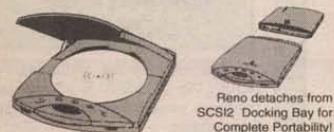
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## Multimedia Kit to Go!

- Media Vision **Reno** External CD ROM/Audio CD Drive:
  - Consists of new external Reno CD-ROM drive, docking bay with SCSI2 port, AC Adapter
  - Double-speed 180ms drive is lightning fast!
  - Drive detaches from docking bay, use with headphones as a portable personal audio CD player
  - Great for Mac or IBM (adapter bracket included)
  - Brand new in box, 90-day warranty

Media Vision Reno Kit HSC#15586 **\$89.95**



Reno detaches from SCSI2 Docking Bay for Complete Portability!

### Media Vision Reno Kit HSC#15586 includes:

- A. Rechargeable Battery Pack
- B. Reno Cable Kit (SCSI2 - DB25 cable, 50p. ribbon cable, internal & external audio patch cables)
- C. Padded Travel Pouch
- D. Internal SCSI ID50 to DB25 Adapter bracket for IBM, use with Reno cable kit (above) & your SCSI card for convenient SCSI and audio connections
- E. Headphones (not shown)



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

## Plug & Play Multimedia!

- Media Vision **Memphis** Kit (Limited Quantities Available)
  - Drive unit consists of new SCSI double-speed drive, custom enclosure, and detachable Bose active speakers with 10W/Channel amplifiers.
  - Includes Pro-Audio Spectrum 16 SCSI sound card, with special interconnect cable.
  - MPC & MPC2-compliant, true 16-bit stereo sound
  - Midi ports and audio jacks on back, NEC CDR210 CD-ROM Drive has tray, does not need caddies.
  - Supports DOS, Windows 3.1, Sound Blaster and Ad-Lib, joystick and full-duplex MIDI, so it can run nearly all audio applications ever made for PC's!
  - Awesome sound from Bose speakers!
  - Comes with copies of instruction manual, power supply, installation software, 90-day warranty



Media Vision Memphis kit HSC# 15753 **\$159.95**

## Bargain SCSI Sound Card!

- Media Vision **ProAudio Spectrum 16** sound card
- 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, information sheet (no book)
- OEM package (no box), 90-day warranty

HSC#15797 **\$39.95**

## Motor Mania!

- Small (1.5" x 1.5" x 1") Stepper Motor, 13.2VDC, .45A/Φ, 200 steps per revolution. No spec. sheet available yet. HSC# 15597 **\$5.95**
- Small (1.625" x 1.625" x 1.25") Stepper Motor, 12VDC, 210A/Φ, 100 steps per revolution. Shaft is .125" dia., has .75" dia. crowned pulley for flat belt. Made by Berger Lahr, data sheet with connection diagram (in German) included. HSC# 15751 **\$6.95**
- Small (1.75" dia x 1.875" overall body dim.) Linear Actuator Stepper Motor, 12VDC @ 5 Watts, 1" overall travel, .003" per step. Has 32 oz. (8.9N) maximum force, 8 oz. (2.2N) unenergized holding force. Shaft has .125" long x .0625" tip to attach item being moved, shaft does not rotate when actuated. Neat robotics actuator! Mfg. by Airpac, no connection diagram, but spec. sheet is included. HSC# 15750 **\$12.50**
- Medium (1.5" dia. x 3") Pittman Motor, 19.1 VDC, with optical shaft encoder. Sorry, no data sheet available yet. HSC# 15654 **\$9.95**
- Large (3.25" dia. x 6.25") 20VDC @ 5.7A Sanyo Denki permanent magnet DC Reel Motor, 9/16" shaft is stepped down to 1/2", 580rpm, or use as 70W generator! Attention robotics enthusiasts...this is a heavy-duty beauty! HSC# 15327 **\$27.50**

## Lower CD-ROM Prices!

- Tested Good CD-ROM Drives removed from systems
- 90-Day Warranty
- 2x and 3x Speeds available
- First two drives are tray-type (no caddy needed)

Sanyo CDH-94 2X-Drive	HSC# 98435	<b>\$49.00</b>
NEC CDR-55J 2X-Drive	HSC# 98436	<b>\$49.00</b>
NEC CDR-84J 2X-Drive	HSC# 15648	<b>\$49.00</b>
NEC CDR-510 3X-Drive	HSC# 15327	<b>\$79.00</b>

## Bargain Game Controller!

- Quickshot QS-191 Game pad for IBM Compatibles
- Faster action, less fatigue than a joystick
- Why pay more for a game device?
- Brand new, plugs into 15-pin game port



HSC#15594 **\$3.95**

## PCMCIA Sound Card!

- Media Vision PCMCIA 16-Bit Sound Card
- Great for Portables, Laptops with PCMCIA Slot
- External Pod has Joystick Port, Mic. input, Line In & Line Out jacks, Volume control.
- Microphone included
- Installation software, instructions included
- New in OEM packaging
- 90-day warranty

Media Vision PCMCIA Sound Card HSC# 15585 **\$39.95**

## Mini-Tower Power Supply

- "Mini-tower" power supply, pulled from new computers
- Fits most Mini- and Mid-size tower cases as well as many small-footprint desk-top cases. 230W
- Measures 6" x 5.5" x 3.5"
- Has normal motherboard connectors, three large and two small drive connectors on 12" leads
- Push-type power switch on 18" lead.



HSC# 15736 **New Lower Price! \$17.95**

## 1200 dpi Color Scanner!

- Dextra sheet-feed full page (8.5" x 11") color scanner
- 1200 dpi, 24-bit TWAIN interface, Windows compatible
- Brand new in box with extensive software bundle
- Includes OCR Album, Fax, Copy, Image editing, Slide Show, Electronic Database
- IBM interface card & cables included
- Made by Logitech -- One Year Factory Warranty

HSC#15775 **\$249.95**

## Remote Control for your Computer!



- Infrared Remote operates your computer from 50 feet
- Perfect for sales presentations, training, demonstrations
- Serial Interface (IBM version) or ADB (Mac version)
- Handheld remote is 7" x 2.5" x .5"
- Included software provides screen pointer for emphasis
- Keystroke mapping table can be customized, saved
- Roam the room, make eye contact with your audience
- Like using a TV set remote control (easy to set-up, use)

HSC# 15240 IBM Remote Keyboard **\$29.95**

HSC# 15241 Mac Remote Keyboard **\$39.95**

## Photomultiplier Bargain!

- Just in - two styles of Phillips photomultiplier tubes!
- XP2412 has large (3") face, 9 multiplication stages.
- XP2102 has small (2") face, 9 multiplication stages
- Both tubes are 2" dia. body, 6" long over-all length.
- Note, these are light detectors, not image amplifiers
- No specs. available at press time, we're looking!
- New tubes, appear to have voltage multiplier built-in

Phillips XP2412/SQ5 (large) HSC# 15734 **\$27.50**

Phillips XP2102/SQ5 (small) HSC# 15735 **\$27.50**

## Digital Multimeter Deal!

- Low-cost Digital Multimeter with High-end Features!
- 3.5 Digit, case measures 2.75" x 5" x 1"
- DCV to 1KV, ACV to 750
- DC Current to 10A, Ohms to 2 Meg
- Diode, Transistor check with hFE
- Test Leads, 9V Battery included.
- Brand New, 90-day warranty



HSC# B0370 **\$19.95**

## Optical Drive Jukebox Project

- Optical Drive Jukebox by International Data Engineering
- Set up for Panasonic drive, which is not included
- Changer mechanism stores and changes ten disks, and can be loaded or unloaded from front access slot
- Accepts 650MB, 1GB and 1.3GB optical disks
- SCSI Interface, software included
- Can be set up for other drives, including Maxtor, but will require fabrication of mounting brackets and alignment
- Installation manual includes alignment procedure
- Measures 12" x 12" x 18"
- New in box, 90-day warranty (if unmodified)



HSC#15773 **\$295.00**

## Pentium Motherboards!

- New-in-box 66 MHz PCI Pentium Motherboard
- Four PCI Slots, Four 16-bit ISA Slots, uses 72-pin SIMM's
- ZIF Socket contains your choice of CPU, 60 or 66 MHz
- 256K Cache RAM installed, supports up to 1MB Cache
- PCI clock rates from 20 to 33 MHz supported
- User's manual included, ninety-day warranty

HSC# 15763 with 60MHz CPU **\$179.00**

HSC# 15796 with 66MHz CPU **\$189.00**

## SCSI Drive Case Deal!

- Low-profile case for 5.25" drives
- Perfect for CD-ROM, hard drives
- 9.5" x 2.5" x 10.5" overall size
- 50-pin SCSI daisy-chain connectors
- Internal 50-pin cable, SCSI ID switch
- 35-watt power supply delivers 5VDC @ 2A, 12VDC @ 2A
- Used case has 90-day warranty, may need some screws



HSC# 15744 Low-Profile 5.25" Drive Case **\$24.95**

## Bargain Video Card!

- Low-end card for bargain systems
- ATI EGA Wondercard does it all: Hercules mono-graphics, CGA, EGA, RGB, low-res VGA (9-pin 640 x 480)
- New in OEM antistatic bag
- Manual, software disks included
- Perfect for low-end systems, servers, BBS, kids, etc.
- Ninety day warranty

HSC# 15795 **\$39.95**

## Large assortment of AC Adaptors!

Fig.	Output	Plug	DIN#	Price
A	5VDC @ 500mA, ±12VDC @ 130mA	5p. DINM	12634	\$4.95
A	5VDC @ 500mA, 12VDC @ 1A	5p. DINM	15140	\$9.95
C	5VDC @ 600mA, ±12VDC @ 250mA	5p. DINM	15325	\$12.50
C	5VDC @ 700mA, 12VDC @ 500mA	5p. DINM	15532	\$4.95
A	5VDC @ 750mA, ±12VDC @ 500mA, 150mA	5p. DINM	12634	\$14.95
C	5VDC @ 3A (IEC Cord not included)	4p. DIN/F	14996	\$5.95
B	5VDC @ 3.5A	3.5mm Coax	15570	\$8.95
B	6VDC @ 2A	2.5mm Coax	15569	\$9.95
B	9VDC @ 200 mA	6p. Molex	15571	\$3.95
C	12VDC @ 500mA	6p. Molex	15668	\$4.95
A	12VDC @ 2.5A	Special Coax	15450	\$12.50
B	13.5VDC @ 1.5A	None	15643	\$9.95
B	18VDC @ 300mA	3mm Coax	14024	\$1.95
B	9VAC @ 400 mA	3mm Coax	13000	\$3.95
C	9VAC @ 1.7A	3mm Coax	12796	\$5.95
A	10VAC @ 2.2A	Screw Term.	13918	\$5.95
B	12VAC @ 9.6A	3.5mm Coax	15372	\$5.95
A	14VAC (CT) @ 1.1A	3p. Molex	14617	\$7.95
B	15VAC @ 100mA	2.5mm	11797	\$1.95
B	16VAC @ 300mA	None	12916	\$3.95
C	16VAC @ 1A (110/220VAC Input)	2.5mm Coax	15700	\$7.95
A	16.2VAC @ 1.1A	2.5mm Coax	15152	\$3.95
C	16.4VAC(CT) @ 1.4A, 25.6VAC(CT) @ 180mA	6p. DINM	15309	\$7.95
A	18VAC @ 550mA	5p. Molex	15399	\$3.95
B	20VAC @ 400 mA	3mm Coax	12601	\$4.29



## Visit HSC's Website!

- HSC has a new presence on the Internet World Wide Web!
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- Site is under construction, please be patient!
- Plans include latest specials, on-line database, more!

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Editor  
Larry Lemieux  
KD6UWV

Managing Editor  
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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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# reader FeedBack

Dear Nuts & Volts:

Your Jan. '96 cover article, "Circuit Design Software Under \$100.00" by T. J. Byers, is really up there with some of the best articles that I've seen. As a professional consultant to manufacturers of PC board prototype-making materials for many years, I appreciate the extensive effort that Mr. Byers had to have put into this article (whew!). This is high-quality stuff, well written, and seems to be part of a pattern in *Nuts & Volts* articles. Please don't stop.

As a consultant to the people that market PCData software, I was naturally quite pleased that we did get some mention on page 20. Unfortunately, we really buried one of the program's most important features which no doubt resulted in Mr. Byers not mentioning it. And that is that PCData also permits the user to easily design a footprint for any new component and add it to the software's library. Future packaging and manuals will make this very important feature clear so that a user will see this feature "up front."

**Robert C. Reynolds**  
Corrales, NM

Dear Nuts & Volts:

I want to thank the staff and editors for publishing my question (#129524, Dec. '95), as well as the answer to this question, which you sent to me. Thanks, it helps a lot. I want to thank Ray Shetrone of Ft. Myers, FL for his answer. I was using an old schematic for a D-104 which had the resistor R-5 (emitter of second transistor misprinted as 180 K) which was one of the problems I was having. The N3904 transistors I knew would substitute, but the .01 cap I failed to include, my mistake. Not having the formula to figure the resistance of R1, and R5 being incorrect, the preamp didn't work correctly. Thanks again to all of you — staff, editors, and Mr. Ray Shetrone.

**Don L. Reynolds**  
Lexington, OK

Dear Nuts & Volts:

I am putting pen to pad extending my congratulations for your selection to print "Build a Sound Activated Christmas Tree" kit as described in the Nov. '95 issue.

My kit was ordered from Cal West Supply, Inc., and received a short time later. The instructions were very thorough and well presented. I was impressed that IC sockets were provided; most kits don't do that today. And also solder was provided, just the right amount! The PC board is very professional. About the only time-consuming item was identifying the placement of the various colors' LEDs. Once built, and making all the various double checks,

my tree performed as described.

The timing of this kit was perfect, just before Christmas. This tree was the talk of my home. Everyone enjoyed it, especially the kids! Placing the tree on top of a TV or radio was really an experience!

The only problem experienced was with the provided microphone. For some reason, the one provided seemed not to be very sensitive. I replaced it with Radio Shack's P/N 270-090 which worked very well. I don't know whether the mic provided was defective or was less sensitive than Radio Shack's.

At any rate, the tree has been saved with the other Christmas items to enjoy again next year!

**Ray L. Heller**  
Manassas, VA

Dear Nuts & Volts:

I love your magazine and have subscribed to it for several years now. I just received the February issue and much to my horror, you have seen fit to totally destroy one of my favorite sections: The Events Calendar! I hope this is a one-time thing and that you will be going back to the old format where you actually give us some information we can use, instead of one liners and a long distance telephone number for each event. For the past few years, I have been resubscribing to your magazine at the Dayton, OH hamfest. I regret to say that I will not be this year if this is what we can expect of your magazine in the future.

**Harold McCall**  
Sycamore, OH

*Editors Note:*

*Rising paper, postal, and production costs have taken their toll on us, just like other publications. It was necessary to trim down some features (like the events calendar) to save space. We have added the show locations back into the calendar this month and are considering some other space saving alternatives.*

Dear Nuts & Volts:

I just finished reading Damien Thorn's article titled "Secret Service Targets 'Extension' Cloner." I could not agree more with Mr. Thorn. I especially enjoyed the critique of Special Agent Cobb's affidavit. Sounds like a case of guilty until proven innocent. Mr. Thorn brought up some very important facts that need to be considered. I am not advocating cloning for illegal use, since I am a cellular user myself who would love to legally have two phones on the same number. I can only hope for a not guilty verdict for Mr. Yates.

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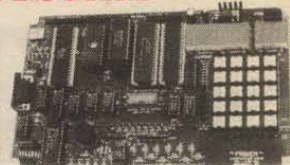
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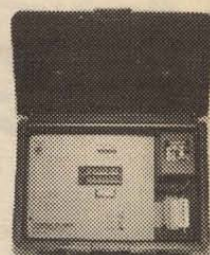
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# More On VLF Monitoring

## Open Channel

by Joseph J. Carr  
K4IPV

**W**hat radio activity I've engaged in for the past few months has been limited by a heavy work schedule, and a few health problems, and has been on the VLF bands. Those bands are a rich lode for the scientifically-oriented who want to study odd propagation phenomenon. Recently, for example, I was able to receive the powerhouse station in western Ireland on 252 KHz. As a result of my columns, I've received a fair amount of mail and a load of E-Mail (carrjj@aol.com) on the subject. A lot of the requests were for lists of VLF radio stations, and others were for a list of references (from at least three science fair students, I might add). These are provided for other readers in Tables "A" and "B," respectively.

### What You'll See (or Hear)

Many of the signals on the VLF bands are not easily interpreted by humans because they are not voice modulation and they are Morse code (although some are). In many cases, the signals will be pulses or other forms of modulation. A very common form is shown in Figures 1 and 2. Both of these illustrations are of the same set of signals (21 and 24.5 KHz), but with the oscilloscope time base set to different values. The "macro" view of the two different frequencies is shown in Figure 1. The 'scope was set for a relative long time base (1 mS or so), allowing you to see the pulse bursts as they go by. The top trace is for one of the two signals, and the bottom trace is the other.

An expanded view of the 24.5 KHz signal is shown in Figure 2. This view shows the amplitude shift digital modulation technique. Any form of digital modulation must use two different states to represent the two binary digits "0" and "1." On HF radioteletype (RTTY) signals, two different audio tones or two different RF frequencies (close to each other) are used for the two tones. But in the VLF band, a common form is the amplitude shift method in which one level represents "0" and the other represents "1" (a 10 dB separation between the levels makes distinguishing them easier).

Detecting these signals is relatively easy, although figuring out what they are saying is a bit harder. The method that I used was to connect an oscilloscope to the output of the receiver. The other is to use a rectifier/integrator circuit. The latter was used in the SID-hunters receivers that I covered earlier in this column. Art Stokes designed those receivers (several varieties), but I wanted to be able to look at the signal, so I added a buffered RF output amplifier to the original design. Figure 3 shows the block diagram for such a receiver.

The basic elements of the receiver are the RF tuning, the gain block, and the output circuits. The RF tuning could be inductor-capacitor (L-C) resonant tank circuits, or one of the varieties that use a gyrator circuit as a virtual inductor (Stokes' most recent design).

The gain block is a straight amplifier with a frequency response higher than the higher frequency that you want to receive, and a gain of

70 to 80 decibels (dB). I've used the three-stage transistor amplifier designed by Stokes, as well as transistor amplifiers of my own, operational amplifiers (CA-3140, CA-3240, NE-5534, and others), and the MAR-1 and MAR-6 devices. The MAR-x series are normally thought of as microwave MMIC devices, but they work down to near-DC, so they work well for VLF reception (each MAR-x provides about 18 dB of gain).

The rectifier/integrator is used to provide the DC output that drives the meter or any external recorders that you might wish to use. It consists of a 1N60 (or two 1N60's in a voltage doubler rectifier configuration). The integrator provides the time average of the input signal. You can use an operational amplifier Miller integrator if you wish, but a simple 100 to 470  $\mu$ F capacitor across the meter movement works well enough.

The RF buffer amplifier is any amplifier that will work on the frequencies of interest. I generally use a unity gain, noninverting follower operational amplifier for this function. The purpose of the amplifier is to provide an RF output without messing up the DC output (hence the term "buffered" — a buffer amplifier is any amplifier that provides isolation).

### Boosting the Performance of Existing VLF Receivers

Others and myself have published various designs for VLF receivers. But many of you already have VLF receivers, or at least communications receivers that tune down to the VLF range. Many, many receivers tune to 100 KHz, while a substantial number are equipped to tune from as low as 25 KHz.

Figure 1 - Two VLF signals on 21 and 24.5 KHz seen on a 'scope.

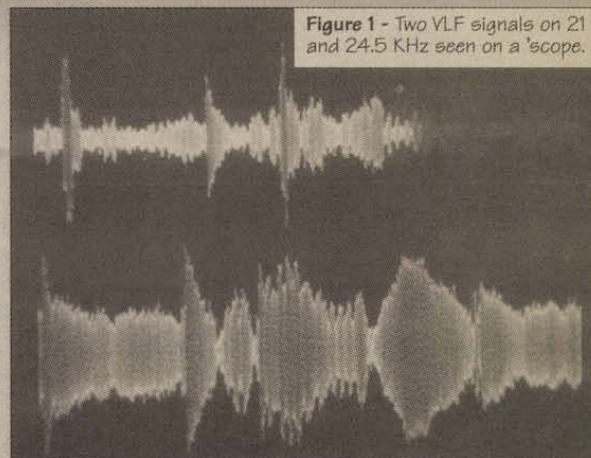


Figure - 2 Expanded view of the 24.5 KHz.

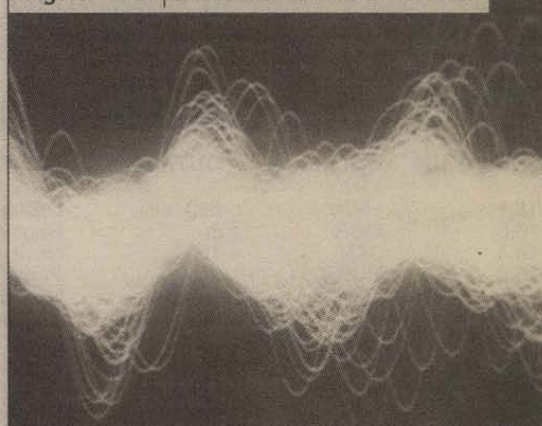
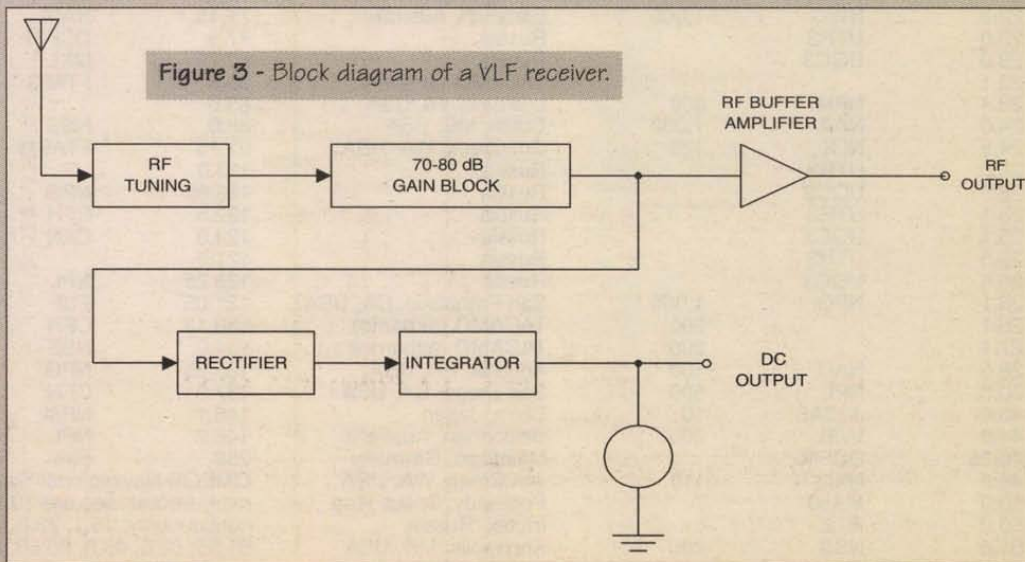
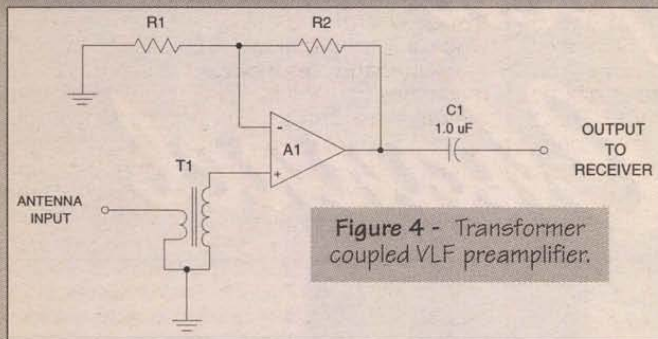


Figure 3 - Block diagram of a VLF receiver.





# Open Channel



**Figure 4 - Transformer coupled VLF preamplifier.**

One fly in the ointment, however, is that these receivers are typically very poor performers on the VLF bands. While they may have super specs on the HF bands, they tend to dry up below the AM broadcast band. Indeed, some of them are pukey on the 540-1700 KHz AM BCB.

Two things can be done to boost the performance of your receiver in these bands. One is to use a shielded loop antenna tuned to the desired frequency. A little difficult to tune and adjust sometimes, but a very good way to eliminate man-made and natural interference problems (which can be horrendous in the VLF bands!). We've discussed loops in this column before, and will do so again in the future.

The other approach is to use a preamplifier. It is relatively easy to gain an additional 5 to 20 dB of gain to beef up the front-end of the receiver. The preamplifier is placed between the antenna transmission line and the antenna input of the

receiver. In some loop antennas a preamplifier is placed inside the loop tuning box. Figures 4 and 5 show two approaches to using an operational amplifier for the preamplifier application. The amplifier in Figure 4 uses an operational amplifier to set the gain, as is usual, but also uses the turns ratio of the input transformer to provide some gain, as well. The transformer (T1 in Figure 4) depends on the desired frequency range. Up to 100 or 120 KHz, you can use an ordinary transistor radio audio output transformer. These transformers typically don't cut off immediately above the audio range, but rather go considerably higher. I tested several in Joe Carr's Basement Laboratory (where my family says I go to for "therapy") and found -3 dB bandwidths of 80 KHz for some cheap Radio Shack transformers, and up 120 KHz for commercial grade transformers. In all cases, there was a high turns ratio. The Radio Shack transformers were 1000Ω/8Ω audio output models. The 8Ω winding is normally the secondary, but, in this case, use it as the primary and connect it to the antenna. The commercial grade transformer was from Mouser and had a ratio of 600Ω/50Ω, and worked well to over 120 KHz (although the -3 dB point was 120 KHz).

An advantage of using the audio transformer is that they are inherently bandwidth limited. One of the possible consequences of using an amplifier is that signals on frequencies way out

side the band will adversely affect the receiver. By using bandwidth limitations on the front-end, however, these problems are significantly reduced.

The gain of this amplifier is set by:

$$A_v = \frac{N_s}{N_p} \times \left( \frac{R_2}{R_1} + 1 \right) \quad (1)$$

In general, it's best to use a low value (100 to 1,000 ohms) for R1, and then provide a higher value resistor for R2. For example, if you want a gain of 20 dB (voltage), then make R1 = 1,000 ohms and R2 = 10,000 ohms (or, if you need more gain, use 100,000 ohms for R2). Don't use more gain than is necessary for your application, however, or you will overload the receiver and make things worse rather than better.

An alternative method is to make your own transformer by winding the primary and secondary windings on a ferrite (not powdered iron) toroid or bazooka-BALUN core. Ads in this magazine will help you locate sources. The ferrite cores have very high core permeabilities, so can be used to provide the significant inductances needed in the VLF bands with only a few turns of wire (10 to 50, rather than 200 to 2,000 turns!).

The alternative method is shown in Figure 5. This circuit uses the same amplifier at its core, but replaces the transformer with an L-C tuned circuit. The capacitor can be a 365 pF, 400 pF, 450 pF, or 550 pF broadcast variable. Or you can use a broadcast variable with a couple hundred picofarads shunted across it, if that's what you need. The inductor should match the capacitor for the

## SIDEBAR A

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16.4	JXN	100	Noviken, Norway
16.8	FUB	250	Paris, France
17.1	UMS	1,000	Moscow, Russia
17.4	NDT	50	Vosami, Japan
18.1			Russia
18.5	DHO	35	Flensburg, Russia
19.0	GQD	500	Anthorn, England
19.6	GBZ	350	Criggon, England
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21.4	NSS	400	Annapolis, MD, USA
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50.0	MA50	7	Poderady, Czech Rep
50.0	RTZ		Irtutsk, Russia
51.6	NSS	200	Annapolis, MD, USA

51.95	GYA	60	London, England
53.5			Norway
54.05	NBA	50	Balboa, Panama
55.5	GKH	100	Thurso, Scotland
56.5	NPG		Dixon, CA, USA
60.0	MSF	50	Rugby, England
60.0	WWVB	13	Ft. Collins, CO, USA
61.55			NATO
62.6			France
65.8	FUE	15	Brest, France
66.66	RBU	80	Moscow, Russia
68.0	GBY20	80	Rugby, England
68.9	XPH	25	Thule, Scotland
71.0		2.4	Klenmond (Europe)
73.6	CFH	250	Halifax, Nova Scotia
75.0	HBG	20	Prangins, Switzerland
76.2	CKN	50	Vancouver, BC, Canada
77.15	NAM	50	Norfolk, VA, USA
77.5	DCF77	50	Mainflingen, Germany
82.75	MKL	40	Petreavie, Scotland
83.8	FTA83	45	St. Andre de Coroy, France
85.0		2.4	Toww River (Europe)
88.0	NSS	50	Annapolis, MD, USA
91.15	FTA911	50	St. Andre de Coroy, France
113.0		2.4	Piquetterur (Europe)
119.85	NPG	50	Dixon, CA, USA
122.5	CFH	15	Halifax, Nova Scotia
124.0	CKN		Vancouver, BC, Canada
127.0		2.4	(Europe)
128.25	NPL		San Diego, CA, USA
131.05	FUF	2	Martinique
133.15	CFH	15	Halifax, Nova Scotia
134.0	NSS	100	Annapolis, MD, USA
135.95	NPG	50	Dixon, CA, USA
137.0	CFH		Halifax, Nova Scotia
146.1	NPM	20	Lualualei, HI, USA
148.2	NPL	25	San Diego, CA, USA
252	Eire	1000	Ireland

OMEGA Navigational System operates in the range 10 to 14 KHz. Four primary frequencies are 10.2, 11.05, 11.33, and 13.6 KHz. Not broadcasting continuously: 15.1, 23.0, 23.1, 25.0, 25.1, 25.5, 26.1, 27.1, 50.0 (RTZ), 61.55, 62.6, 65.8, 66.66, 83.8, and 91.15 KHz.



# Open Channel

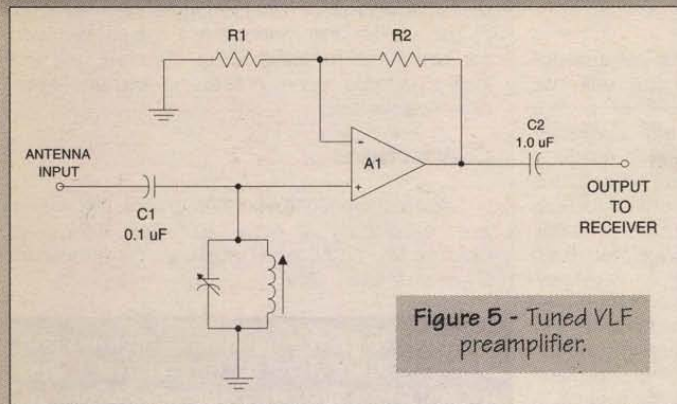


Figure 5 - Tuned VLF preamplifier.

frequency that you wish to receive; values in the range 4 to 80 mH are common.

Two capacitors are used in this circuit. The input capacitor is a 0.1 µF unit, and can be any type of capacitor that you desire. The output capacitor (C2) is also used in Figure 4 (where it is called C1), and should be one of the non-electrolytic types, even though it is 1.0 µF.

The gain for this circuit is set using a similar equation to the previous circuit, but without the transformer turns ratio:

$$A_v = \left( \frac{R_2}{R_1} + 1 \right) \quad (2)$$

In both Figures 4 and 5, the power supply connections are not shown. Most operational amplifiers will have two supplies needed: a V+

supply (typically +12 volts) and a V- supply (typically -12 volts). Other operational amplifiers only need one DC power supply connection plus a ground. It is also possible to use a dual polarity op-amp in a single polarity circuit if the right external circuitry is provided. In any case, bypass the DC power supply terminal to ground with a 0.1 µF to 1.0 µF capacitor mounted as close as possible to the body of the op-amp.

## Additional VLF Phenomena

In this column in the past, we've discussed whistlers and spherics, as well as the signal enhancement effect seen in the VLF band due to solar flares and Sudden Ionospheric Disturbances (SIDs). However, there are some additional phenomena that have been noted.

**Non-reciprocal Propagation.** Radio propagation is normally reciprocal, i.e., it is the same in both directions between any two points. The reason for this is that the atmospheric conditions between the two points is the basic issue (see my articles on propagation last two months). But occasionally an anomaly is noticed in which A→B propagation is not the same as B→A. This occurs over very long distances at ELF (under 1000 Hz). I've seen this affect the medium-wave bands as

well. It's well known that ham operators on the East Coast of the USA can hear European hams who cannot, in turn, hear them.

**Schumann Resonance.** One of the things that makes VLF and ELF reception different from the other bands is that the wavelengths of the signals approximate the distance between the surface of the earth to the bottom of the ionosphere. As I understand this phenomenon, the cavity between the surface of the earth's spherical shape and the bottom of the heavily ionized D-layer forms resonances at about 8 Hz, 14 Hz, and 20 Hz. Propagation of electromagnetic signals at these frequencies can be very efficient, according to the Schumann Resonance Theory. The source of these signals apparently is lightning strikes.

**Anomalous Signal Increases.** The nighttime propagation in any band is considerably different from the daytime performance because of the ionization of the upper reaches of the earth's atmosphere. It appears that signals in the 40 to 80 Hz, and 150 Hz region can undergo rapid changes of up to 10 dB over a period of several hours, when conditions on other frequencies are relatively calm. This sounds like a spurious report to me, but I would be interested in hearing reports from anyone who has actually observed them, or has a good scientific article on the topic (see "Connections ...").

## VLF Products Source

Recently I saw a catalog that should interest

## SIDEBAR B

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continued



# Open Channel

VLF research and listening fans. It comes from LF Engineering Company, 17 Jeffry Road, East Haven, CT, 06473; phone **203-248-6816**. I ordered a catalog from them from an ad in *Lowdown*, and found a number of interesting converters, receivers, and antennas offered for sale.

## World Wide Web VLF/RadioScience Activity

Now that I have America On-Line, I've been surfing the Internet's World Wide Web. There is a considerable amount of information of interest to VLF and other radioscience observing fans. Use keywords such as "NASA," "Very Low Frequency," "VLF," and "Radio" to locate the URL addresses for the various pages. The Whistler Hunter's "Project Inspire" have a page on the NASA WWW Home Page. Also, some of this material is also found in the "Science Education" keyword.

## In the Future ...

Although many people doing radioscience and other science hobby observing will use mechanical recorders (as covered here a few months ago), others will use a digital computer for recording and logging signals. It's relatively easy to pick up MS-DOS computers with simple monitors and 40 megabyte hard drives for less than \$100.00 today (I've seen them for \$40.00). These computers are good enough for such recording, even though they don't run Windows. An advantage of those computers is that they can be left running all the time, and don't represent a huge financial loss if a passing thunderstorm puts transient spikes on the line and thereby wipes out the computer (I turn my super 4.6-gbyte computer off during storms!).

One thing that seems lacking in much of the coverage of science activities is the analog front-end. The computer speaks binary, but the rest of

the world is analog. The analog front-end processes the signals and makes them compatible with the computer. In some future columns, we will look at analog signal processing and analog-to-digital converters.

## Connections ...

You can reach me either c/o of this magazine, or directly at either P.O. Box 1099, Falls Church, VA 22041 (snail mail), or carrj@aol.com (Internet E-Mail). **NV**

**J**oe has written a lot about antennas and propagation. Two of his related books are *Joe Carr's Receiving Antenna Handbook* (HighText, \$19.95, 1-800-247-6553), and *Practical Antenna Handbook* (TAB/McGraw-Hill, \$26.95, 1-800-233-1128).

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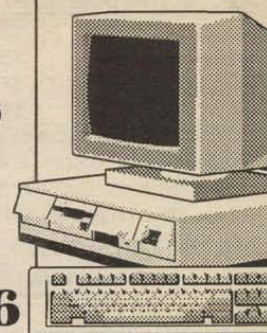
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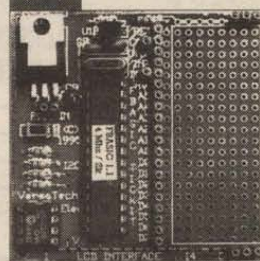
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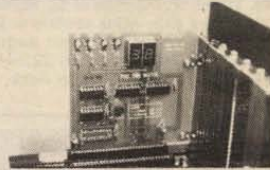
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Like many readers, I have coveted a satellite dish for years. Unlimited channels, low or no cable-like fees, exotic TV from foreign lands, and sports. Unfortunately, my budget and neighborhood prohibited my dreams. Instead, I shelled out huge fees for cable television and its limited fare. That all changed with the introduction of Digital Satellite Service.

Digital Satellite Service is really a cross between conventional satellite service and cable TV. Two hardware components make up the physical portion of the DSS system. The most unique element, and also its most appealing feature, is the 18" satellite dish which can be easily mounted to a house, apartment roof, or fence. The only limitation is that the dish must face a clear line of sight to the southwest.

Unlike a conventional antenna, the angle of signal is very narrow, so even the smallest obstruction will prevent any signal at all from being received. The dish mounts virtually anywhere on a house, and can also be chimney or pole mounted.

Note that, if you want to install the system yourself, you may not be able to tap into your existing cable wiring. Cable TV uses a cheap, low-impedance coaxial wire, which can't handle the signal needs of the satellite. Instead, you should use high-impedance coaxial cable, like the kind that comes with the installation kit, which, while physically identical, handles the higher signal load of the dish. I have successfully used my internal house cable wiring to split the satellite signal to a second television.

Two dishes are currently available: a single polarity model that is sold with the basic unit; and a dual polarity which comes with the deluxe multi-television unit. Unlike cable television which sends all of the necessary signals waiting for your television or cable box tuner to select a channel, the satellite dish box directs the dish to receive a specific channel. This type of sys-

tem is the biggest drawback to a DSS system.

If you only want to watch satellite transmissions on one television, or don't mind watching the same thing on all TVs in your house via a splitter, a single polarity system can be purchased at a cost of less than \$500.00. However, if others in your home don't share your interest in watching Batman the 37th time or every NBA basketball game, you will have to invest approximately \$1,400.00 for both the deluxe system with dual polarity signal and another television set controller box.

Beyond two televisions with separate signals currently requires another dish, but third party plans may result in a device which allows additional televisions to receive unique programming, with the purchase of an additional encoder box. RCA also sells an additional television signal kit for \$99.00, which includes 100 feet of cable, a gold plated splitter, a DSS remote control, and an infrared transmitter and receiver which allows channel changing on the transmitting box of up to 150 feet. This system upgrade still limits the programming that can be watched to the same channel on the transmitting system as the receiving system.

The satellite control box is far more complex than the average cable box. About the size of a small VCR, it offers some face controls for channel switching between the satellite signal and your local antennae. The back offers outputs for both RCA and SVHS, as well as stereo sound. There are also unused serial port connectors labeled low band and high band

# Digital Satellite Service

by Michael Posner

which may, someday, provide high-speed Internet access. There is also an RJ11 phone connector. You must keep the box connected to the phone line at all times in order to use the special ordering features of the system. The set top box also utilizes a small credit card-sized security card which contains account information about your system. The card must be kept in the machine at all times.

Programming is provided by two separate companies: DirectTV and USSB. The system currently has over 175 channels which are available for a fee in several packages. Unlike regular satellite programming, there are no discounts for programming. Expect to pay the same or more per month than your existing cable bill. What you do get for your money is more of everything.

Each month, there are 50 to 60 pay-per-view movies available at a cost of \$2.99. These generally become available at the same time as the movie in the video store. The non-premium channels include both the common channels, including three ESPNs, two Disney channels, CNN and CNN International, and about 40 more channels (see sidebar). Movie lovers are well served with 15 premium channels from HBO, Showtime, Cinemax, Starz, TMC, and Flix. There are also commercial free older films presented on Encore's theme channels: Love, Mystery, Western, and True Life.

Special-order channels include the direct sports line which provides all of the NFL, NBA, NHL, or MLB games. Additional regional sports

channels and college football packages are also available. Playboy Channel is available on a daily or monthly basis as is a separate "adult" channel. For those with a taste for the exotic, Asia TV is also available, but it mostly plays bad Indian movies.

Music lovers will also appreciate the DSS system. Currently there are 25 commercial free, CD audio quality music channels covering all music genres.

One drawback to the satellite system is the lack of support for local channels. Most users either keep their lifeline cable programming (the local channels for about \$7.00 per month) or use a separate television antennae. DSS does offer one feed each of CBS, NBC, Fox, and ABC if you haven't had cable TV in the last 90 days. This gets you national programming at a loss of local news and information for a small monthly charge.

The DSS system is easy to use once installed. An on-screen program guide controlled by the remote shows a listing of all available programs, as well as the ability to narrow your viewing list by subject, such as movies, sports, or others, so, for example, you could find all of the comedy movies on in the next 60 hours.

Overall, I am quite pleased with my DSS system. For the same monthly fee as my old cable bill, I get 100 more channels, higher-resolution viewing, easier channel surfing, and lots of movies and sports, including every Philadelphia Eagles football game.

Next time, I'll discuss the technical aspects of the DSS system. **NV**

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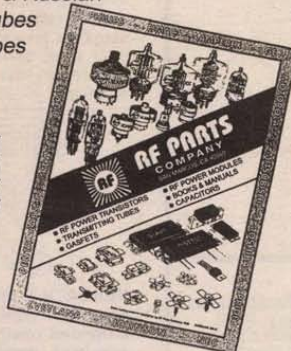
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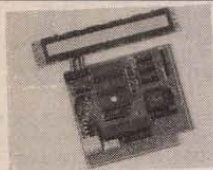
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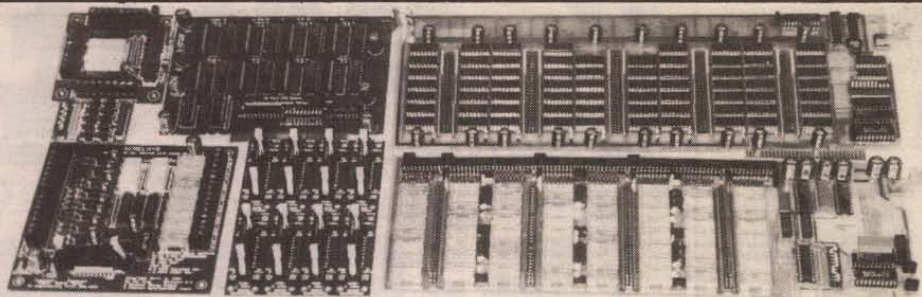
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**SCPIO16****128 Channel I/O Board**

- FREE I/O Tester board when you buy SCPIO16
- Directly drive many popular Solid State Relays.
- Directly drive sensitive mechanical relays.
- Control many different types of devices.
- Monitor wide range of sensors & events.
- Interface to TTL, LS, HCT, ALS, AS, FCT, etc...
- Blows away performance of 8255 I/O boards.
- Outputs source & sink more current than 8255s.
- Powerful yet very inexpensive. With software.
- 16 Byte wide ports. 8 In + 8 Out. 1/2 card size.
- Sustained I/O > 500 K Bytes / Second.
- High noise immunity low load CMOS inputs.
- With power, ground, read & write strobes.
- Cards can share same space via extended I/O.
- Machine pin sockets make field repairs a snap.
- Silk screened, solder masked, & gold plated.
- See SCREWTERM, TERMRACK, SCRELAY8

**SCREWTERM****16 Channel Screw Terminal Board**

- Directly interfaces to any port on SCPIO16.
- Supports 8 Input + 8 Output channels.
- LED Bargraph Displays monitor inputs & outputs.
- Screw terminals for all I/O, control & power lines.
- Termination resistors increase noise immunity.
- Fuse protected power lines.
- Screw terminal blocks socketed for quick release.
- Minimize your setup time.
- Reduce maintenance and repair costs.
- Saves many hours of building & wire wrapping.
- Shrouded Gold plated header with ejectors.
- Boards are Solder Masked & Silk Screened.
- I/O, Pwr, Gnd, Cntrl identified with legends.
- 3"x3" board with mounting holes & hardware.

**TERMRACK****128 Channel Termination Board**

- Directly interfaces to SCPIO16
- Supports full set of 8 SCPIO16 cables.
- Supports 128 channels. 64 Input / 64 Output.
- 2 solder pads for ea. signal, control, & power line
- Provides simple interface to Solid State Relays.
- Easy interface to many other devices.
- Simple interface to wide range of sensors.
- Saves many hours of building & wire wrapping.
- Shrouded Gold plated header with ejectors.
- Boards are Solder Masked & Silk Screened.
- I/O, Pwr, Gnd, Cntrl identified with legends.
- Large solder pads with plated through holes.
- Wide dual signal traces increase reliability.
- Plenty of well spaced mounting holes.

**SCRELAY64****64 Channel Relay Board**

- 64 SPST 10VA 100 VDC 70 VAC 0.5 AMP relays.
- Use to drive solenoids, valves, relays, contactors.
- 16 Relays per 64 line gold plated header.
- 2 pins per relay line reduces resistance
- Independent A & B lines on all relays
- High density board reduces computer slots used.
- Sensitive relays minimize power consumption.
- Only 1.0 milliseconds to turn on/off relays.
- Long life relays (10,000,000 operations).
- Cards can share same space via extended I/O.
- Power on reset leaves relays open on power up.
- Uses 16 Byte wide ports. 8 Input + 8 Output.
- Full length PC AT form factor card for 8 bit slot.
- Input ports can read back state of any relay.
- Gold plated 64 line headers support 16 relays ea.
- Silk screened, solder masked, & gold plated.
- Includes manual and software.

**SCPROBE****240 Channel Stimulus/Response**

- Ideal to test cables, wire harnesses, PCBs
- Use for ATE, testing switch matrices & boxes.
- 240 Output paired with 240 Input channels.
- Use to stimulate any line
- Then monitoring all other lines for responses.
- Set port 0 to stimulate any 1 of 240 channels
- Set port 1 to monitor selected channel.
- Read port 0 to determine response.
- Then scan 1 to 240 channels for response.
- Multiple boards may be used in system.
- Open collector outputs with 5.1K pullups.
- Every output paired with an input channel
- Uses only 4 ports in PC I/O space.
- Full size fuse protected PC/AT form factor card.
- Gold plated 50 line headers. 48 signal+power/gnd.
- Machine pin sockets make field repairs a snap.
- Silk screened, solder masked, & gold plated.

**SCRELAY8****8 Optoisolators + 8 Relays**

- Drive solenoids, valves, relays, & contactors.
- Monitor external events & power sources.
- Directly interface to any port on SCPIO16 board.
- 1500 V optically isolated inputs.
- SPST 10VA 100VDC 70VAC 0.5AMP relays.
- Sensitive relays minimize power consumption.
- LED Bargraphs display input & output status.
- Opto inputs monitor A/C/DC 0..32 volt lines.
- Independent A & B lines on all relays
- Power on reset leaves relays open on power up.
- Fuse protected power lines
- Supports use of optional external power supply.
- I/O, Pwr, Gnd, Cntrl identified with legends.
- 5"x5" board with mounting holes & hardware.

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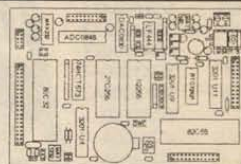
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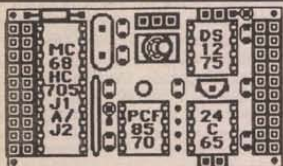
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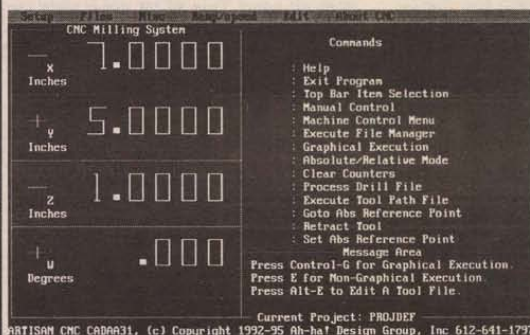
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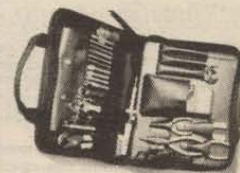
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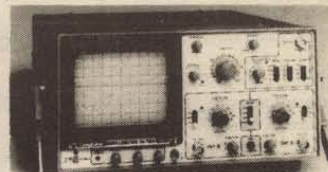


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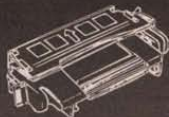
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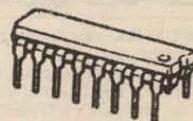
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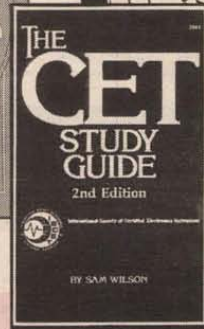
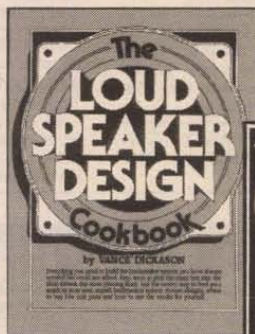


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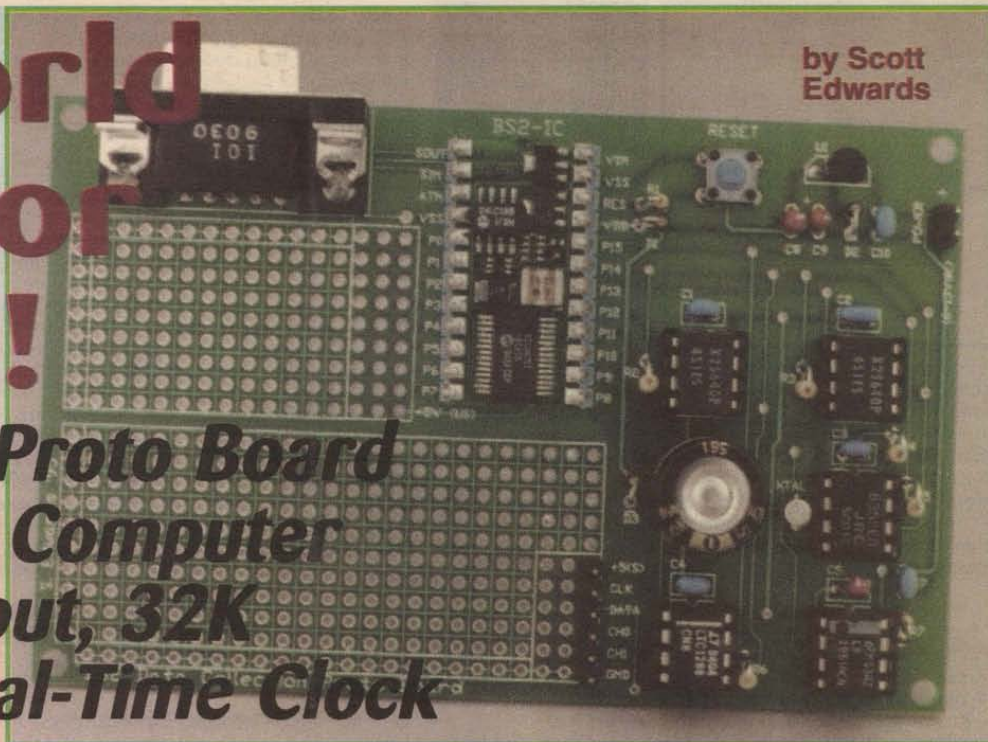
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# Real-World Power for the BS2!

by Scott Edwards

## Data Collection Proto Board for the Stamp II Computer Adds Analog Input, 32K Storage, and Real-Time Clock



The BASIC Stamp II (BS2) microcontroller is a great project just waiting to happen. Although it's no bigger than a standard 24-pin IC, it can:

- Measure and generate pulses and frequencies, including "touch" tones.
- Wirelessly control appliances through an X-10 powerline interface.
- Send and receive data via RS-232 at standard speeds up to 38,400 baud.
- Control 16 general-purpose digital input/output (I/O) lines.

- Sleep for timed intervals, reducing current draw to less than 0.5 mA.
- Run BASIC programs up to 500 instructions long.

With these capabilities, and a price tag of just \$49.00, the BS2 has attracted a large and loyal following since its introduction last fall (see the first-peek article in the Sept. '95 issue of *NEV*). But now there are signs of discontent. See, there are a few features that the BS2 doesn't have, and that users have been struggling to add to their projects: data storage, analog input, real-time clock, and

(most importantly) the design information needed to make it all work.

As readers of my Stamp Applications column here in *NEV* know, I take the wish lists of Stamp users very seriously. And this time, I've incorporated those wishes into a single printed circuit board: the BS2 Data Collection Proto Board. It features:

- Up to 32 KB of EEPROM data storage.
- Real-time clock/calendar.
- Two-channel, 12-bit analog-to-digital converter.
- Software-controlled peripheral power supply.
- Support for three-wire synchronous serial bus devices.
- Eight uncommitted digital I/O lines.
- Prototyping areas for additional circuitry.

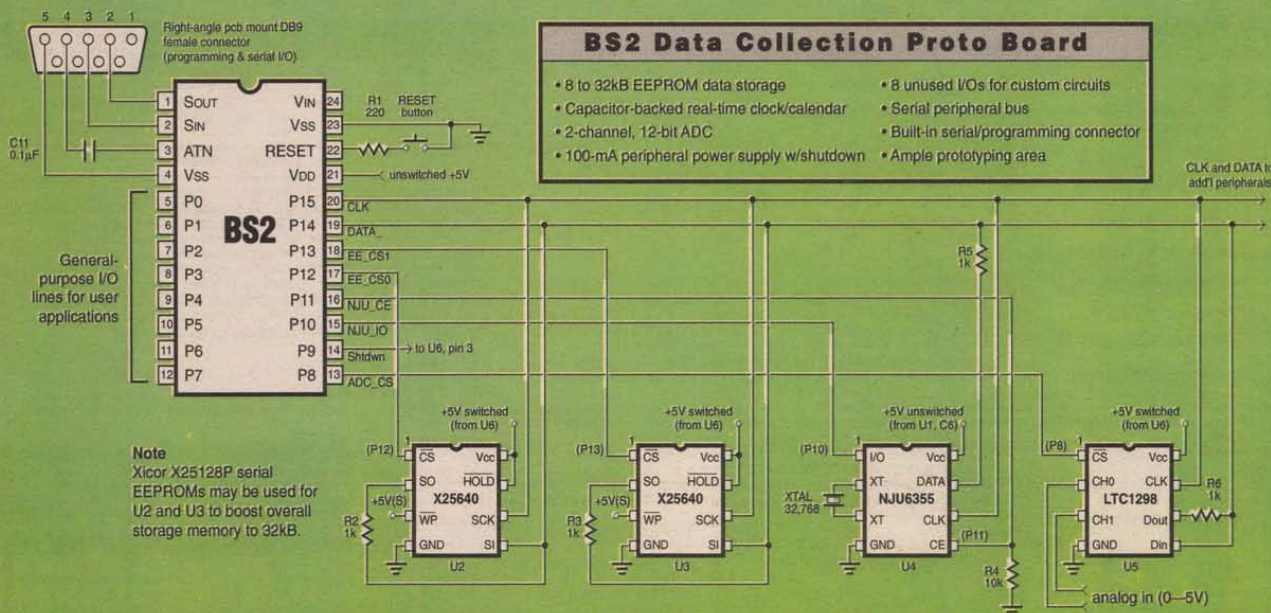
In this article, I'll describe the Proto Board's hardware features and introduce an example application that pulls them all together—a data logger that takes a pair of precision voltage measurements each minute and stores them, along with the exact time of the measurement, into the board's storage memory. Even if you don't plan to use the Proto Board, you'll gain valuable insight into using peripherals with the BS2.

### Hardware Overview

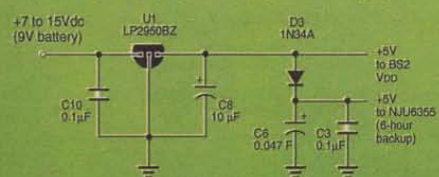
Because of its IC-style packaging, the

### BS2 Data Collection Proto Board

- 8 to 32KB EEPROM data storage
- Capacitor-backed real-time clock/calendar
- 2-channel, 12-bit ADC
- 100-mA peripheral power supply w/shutdown
- 8 unused I/Os for custom circuits
- Serial peripheral bus
- Built-in serial/programming connector
- Ample prototyping area



#### Continuous (Unswitched) Power Supply



#### Peripheral (Switched) Power Supply

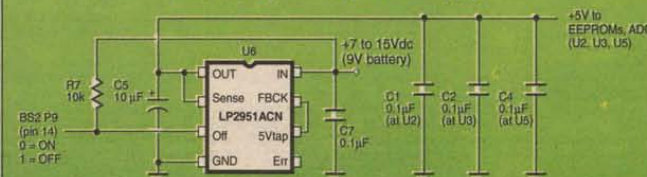
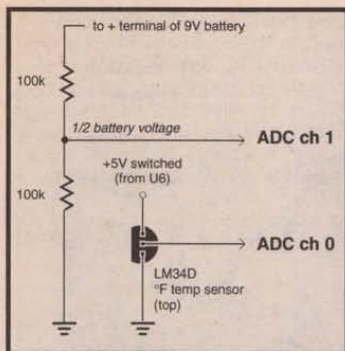


Figure 1. Schematic diagram of the Data Collection Proto Board.





**Figure 2. Sensors for demo run of data-logging program. The resistor voltage divider cut the 9V battery output in half to fit within the ADC's 0-5V range. The LM34's output voltage changes by 10mV for each 1°F change in temperature.**

BS2-IC requires a carrier board for convenient connection to peripherals, sensors, and outputs. The manufacturer (Parallax; Sources) offers a generic carrier board, consisting of a programming connector, battery clips, reset button, and grid-of-holes prototyping area. The Data Collection Proto Board extends this concept by putting commonly needed peripherals onto the carrier board. Figure 1 is a schematic of the board; Table 1 is a parts list. Here's a rundown of the hardware features:

**Main (Unswitched) Power Supply.** The BS2-IC has a 5 V, 50 mA voltage regulator built in. This regulator is adequate for powering the BS2 itself, but can't supply enough current for more than a few peripherals. Early BS2 models experienced failures of this regulator due to minor errors like touching the battery to the power terminals backwards. For flexibility and reliability, the Proto Board provides a 5 V, 100 mA regulator, consisting of U1 and associated components.

**Peripheral (Switched) Power Supply.** The Proto Board places a second 5 V, 100 mA power

supply under the control of a BS2 I/O pin (P9). This lets an application conserve power by shutting down portions of the circuit. Since the peripherals (EEPROM, ADC, clock) draw, at most, a few mA, almost all of the regulator's capacity is available for additional circuits.

**Synchronous Serial Peripheral Bus.** The BS2 has instructions for communicating with peripherals that use a three-wire serial interface. The Proto Board assigns two I/O pins (P15 and P14) as dedicated clock and data lines to be shared by all standard or user-installed serial peripherals. To talk to a peripheral on the bus, the program activates the device's chip-select or enable line, then sends or receives data using the BS2 instructions Shiftin and Shiftout.

**Solid-State Data Storage.** The Proto Board accommodates 8 KB to 32 KB of EEPROM (electrically erasable, programmable, read-only memory) for storing data. The board holds two X25640P (8 KB each) or two X25128P (16 KB each). These devices may be read and written like RAM, but retain data with power off. This makes it possible to recover data recorded by a system whose power has failed. EEPROMs eventually wear out after repeated writes, and should be replaced after 100,000 write cycles. Put in perspective, writing each address of 32 KB of EEPROM at one byte per second would take 104 years to wear out the EEPROMs.

**Real-time Clock/Calendar.** An NJU6355 clock/calendar chip keeps track of the current time, date, and day of the week. Data from the clock may be used to time tag data recorded to EEPROM, or factored into program decisions (e.g., weekday vs. weekend in a setback thermostat). Power to the clock chip is backed up by a large

capacitor, allowing it to keep time for 6 to 24 hours with system power removed.

**Analog Inputs.** An LTC1298 12-bit ADC (analog-to-digital converter) provides two analog voltage inputs with 1.22-millivolt resolution (five-volt range divided into 4096 units). Under software control, the inputs may be used as separate single-ended inputs (referenced to ground) or as one differential input. The ADC has a sample-and-hold feature that takes a snapshot of the input voltage at the instant of the measurement request, allowing it to sample noisy, or fast-changing inputs. Measurements are referenced to the peripheral power supply, which is exceptionally stable.

**Expansion Capabilities and Standard BS2 Features.** The Proto Board uses only the upper eight pins of the BS2's 16-pin I/O port. If your application requires more peripherals — say an additional ADC or digital thermometer chip — the shared clock and data lines of the serial bus are available through pads next to the lower prototyping area. Just assign one of the remaining eight I/Os as a chip-select or enable line, and write the necessary BASIC code to drive the device.

Like any BS2-based device, projects built around the Proto Board offer exceptional flexibility when it comes to driving other peripherals. The BS2 can send or receive RS-232-style serial through any of its I/O pins. As a result, there are a variety of asynchronous serial peripherals available for it, including LCD displays up to four lines by 20 characters; expansion boards that add 16 bits of digital I/O; even a board for driving radio-control positioning servos (see Sources for more information).

Don't forget the BS2's other capabilities, like X-10 appliance control and DTMF touch-tone output. Combined with large memory capacity, real-

#### Program Listing: Example Data Logger Program

Note: This program listing is available from the Parallax ftp site via the Internet, ftp.parallaxinc.com. It also comes on the disk that is included with most of the Data Collection Proto Board packages.

\* Program: LOG\_1.BS2  
\* This program demonstrates use of the BS2 Data Collection Proto Board in a typical data-logging application. It exercises all of the board's built-in peripheral devices, including two 8 KB (or 16 KB) EEPROMs, real-time clock/calendar, 12-bit ADC, and switchable precision power supply.

\* [[ NOTE: lines that were too long were split with the ~ symbol used to indicate continuation on the next line.]]

#### PIN ASSIGNMENTS, SYSTEM CONSTANTS, TEMPORARY VARIABLES

\* The BS2's upper port, pins 8 through 15, is dedicated to the operation of the data-collection peripherals. The lower port, pins 0 through 7, is available for your application.

CLK	con	15	* Clock line for all serial peripherals.
DATA	con	14	* Data line for all serial peripherals.
EE_CS1	con	13	* Chip-select line for EEPROM 1 (U3).
EE_CS0	con	12	* Chip-select line for EEPROM 0 (U2).
NJU_CE	con	11	* Chip-enable for NJU6355 clock/calendar.
NJU_IO	con	10	* IO (read/write) for NJU6355; 1=write.
Shtdwn	con	9	* Shutdown for peripheral power supply; 1=off.
ADC_CS	con	8	* Chip-select line for LTC1298(88) ADC.
b96	con	\$54	* Baudmode for 9600 bps.
timeout	con	60000	* At startup, wait 60 seconds for serial command.
pwrOn	con	\$31	* Initial state of OUTH at peripheral power-up.
			* Turns on LP2951, but deselects all chips.
temp	var	byte	* Temporary variable used in several routines.

#### SAMPLING CONSTANT(S)

smplSiz	con	8	* Each sample consists of 8 bytes—4 of data (2 ADC results in 16-bit words) 3 of time (12 BCD digits for hh:mm:ss) 1 checksum.
---------	-----	---	--

#### EEPROM CONSTANTS AND VARIABLES

WREN	con	6	* EEPROM opcode to enable writes.
RDSR	con	5	* EEPROM opcode to read the status register.
WRDI	con	4	* EEPROM opcode to disable writes.
ReadEE	con	3	* EEPROM opcode for read.
WriteEE	con	2	* EEPROM opcode for write.

\* In the lines below, use the EESize constant that matches the

\* EEPROM memory installed on your board. Delete or comment out the other EESize constant. This example uses X25640s, which have a capacity of 8191 bytes per chip.

EESize	con	16383	* Number of bytes per EEPROM (X25128).
EESize	con	8191	* Number of bytes per EEPROM (X25640).
EEmax	con	32768	* Total EEPROM capacity (X25128).
EEmax	con	16384	* Total EEPROM capacity (X25640).
EETop	con	EEmax-smplSiz	* Last EE address with room for sample.
EEaddr	var	word	* EEPROM address for reads and writes.
EEsel	var	bit	* EEPROM select (0 or 1) for address.
EEdata	var	byte	* Data written/read to/from EEPROM.
EEstats	var	byte	* Copy of the EEPROM status register.
EEbusy	var	EEstats.bit0	* EEPROM busy bit (1 = busy).
EEcksum	var	byte	* Checksum for EEPROM reads and writes.
EEincr	var	bit	* If =1, increment EEaddr after each write.
EEnoCk	var	bit	* If =1, don't do checksum for 1 EE read.
EEblank	var	bit	* If =1, then a series of EEreads was 0.

#### LTC1298 ADC CONSTANTS AND VARIABLES

\* The LTC1298 is a 12-bit ADC that measures 0-5 volts, referenced to the 5-volt output of the peripheral power supply (LP2951).  
\* The 1298 has two modes. As a single-ended ADC, it measures the voltage at one of its inputs with respect to ground. As a differential ADC, it measures the difference in voltage between the two inputs.  
\* The sglDif bit determines the mode: 1 = single-ended, 0 = differential.  
\* When the 1298 is single-ended, the oddSign bit selects the active input channel: 0 = channel 0 (pin 2), 1 = channel 1 (pin 3).  
\* When the 1298 is differential, the oddSign bit selects the polarity between the two inputs: 0 = channel 0 is +, 1 = channel 1 is +.  
\* The msbf bit doesn't matter in this application, and is set to 1 by the same logical OR that sets the start bit in the ADC subroutine.

ADcnfg	var	nib	* Stores configuration bits for ADC.
ADres	var	word	* Variable to hold 12-bit AD result.
ADstb	var	ADcnfg.bit0	* Start bit for comm with ADC (always 1).
ADmode	var	ADcnfg.bit1	* Single-ended (1) or differential (0).
ADch	var	ADcnfg.bit2	* Channel or + selection (0 or 1).
ADmsbf	var	ADcnfg.bit3	* Output 0s after xfer (doesn't matter).

#### NJU6355 CLOCK/CALENDAR CONSTANTS AND VARIABLES

\* The NJU6355 clock/calendar chip maintains a 13-digit BCD account of the current year, month, day, day of week, hour, minute, and second. The clock subroutines transfer this data to/from a 13-nibble array in the BS2's RAM called "DTG" for "date/time group." The constants below allow you to refer to the digits by name; e.g., "Y10s" is the tens digit of the year. Note that there's no "am/pm"

\* indicator—the NJU6355 uses the 24-hour clock. For instance, 2:00

Y10s	con	1	* pm is written or read as 14:00 (without the colon, of course).
Y1s	con	0	* Array position of year 10s digit.
			* " " = year 1s
Mo10s	con	3	* " " = month 10s
Mo1s	con	2	* " " = month 1s
Di10s	con	5	* " " = day 10s
Di1s	con	4	* " " = day 1s
Hi10s	con	8	* " " = hour 10s
Hi1s	con	7	* " " = hour 1s
Mi10s	con	10	* " " = minute 10s
Mi1s	con	9	* " " = minute 1s
Si10s	con	12	* " " = second 10s
Si1s	con	11	* " " = second 1s
day	con	6	* " " = day-of-week (1-7) digit.
digit	var	nib	* Number of 4-bit BCD digits read/written.
DTG	var	nib(13)	* Array to hold "date/time group" BCD digits.

#### DEMONSTRATION PROGRAM

\* This program implements a simple, user-friendly data logger.  
\* It can be used in two ways: If a PC running terminal software [9600 baud, N81, carriage returns (CR) converted to CR plus linefeed, no handshaking] is connected, the program displays a menu and prompt that allows the user to display the ADC readings; view/set the clock, read, dump, or erase memory; or start the logger. If no terminal is connected, or the user doesn't press a key within a preset time, the program automatically starts logging data. It takes samples from both ADC inputs every 60 seconds and records these, along with a time-tag and error-detection checksum, into EEPROM.

\* Initial setup.  
OUTH = pwrOn  
DIRH = \$FF  
DIRL = \$FF  
\* Get ready to turn on peripherals.  
\* Set all bits of high port to output.  
\* Set all bits of low port to output.

\* setup =====  
\* When you apply power to the board, the BS2 will send a message at 9600 bps through the built-in serial port asking for setup instructions. If you don't press a key within timeout seconds, the program will begin logging data.

setup:  
serout 16,b96,[CR,CR,"BS2 Data Logger"] \* Sign-on and choices.  
serout 16,b96,[CR,"(A)DC (T)ime (C)lock (R)ead (D)ump (E)rase - (L)og,CR,>"]  
serin 16,b96,timeout,log,[temp] \* Look for instruction.

\* If no instruction arrives within timeout milliseconds, then log data, else get choose from setup menu.  
temp = temp & \$0DF  
IF temp = "A" THEN showADC  
\* Convert to uppercase.  
\* Show current ADC measurement.  
\* Show the current time/date.

IF temp = "T" THEN time  
IF temp = "C" THEN clock  
IF temp = "R" THEN readDataLog  
\* Set the clock/calendar.  
\* Read data w/checksums.

IF temp = "D" THEN dumpDataLog  
IF temp = "E" THEN eraseLog  
\* Read entire EEPROM.  
\* Write 0s to all EEPROM bytes.

IF temp = "L" THEN log  
goto setup  
\* Start logging.  
\* Unrecognized entry; try again.

continued



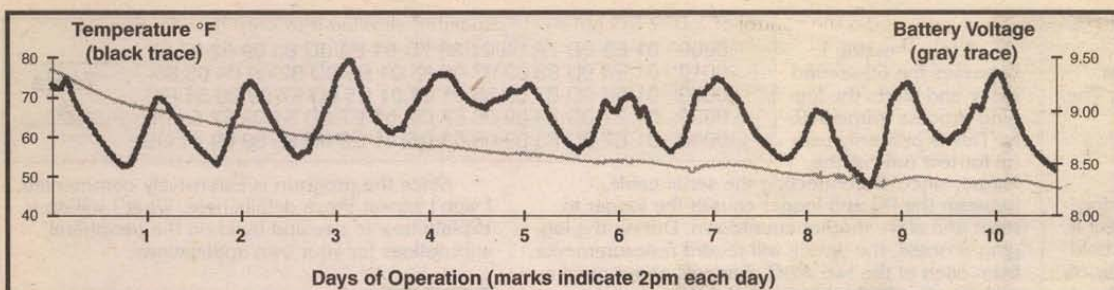


Figure 3. Strip-chart plot of temperature and battery-voltage logged by prototype, made by loading text from logging program into a spreadsheet (MS Excel).

time clock, and precise measurement capability, you have the nucleus of a versatile home-automation system.

For data-acquisition and logging purposes, the BS2 has instructions that simplify sensor interfacing. For example, it can count frequencies to 125 KHz and measure pulses down to 2  $\mu$ S, making it a natural for tachometers, humidity sensors, or voltage-to-frequency converters. Got a resistive sensor like a thermistor? Use BS2's RCTIME instruction to measure it with just a capacitor.

## Software Overview

The program listing presents an example application that uses all of the Proto Board's

peripherals to create a data logger. Despite a number of not-absolutely-essential features, the program takes only about two-thirds of the BS2's program memory.

To fully understand the example application, let's look at it from two angles: a user interacting with the data logger; and a programmer studying and modifying the code for his or her own application.

## How it Works: User's Perspective

The following discussion assumes that a BS2-IC is plugged into the Proto Board, and that the program from the listing has been downloaded to it.

To use the example data logger, connect the built-in DB9 connector to the serial (com) port of a PC or other computer and boot up terminal software. Set the terminal software for 9600 baud, no parity, eight data bits, one stop bit. Also configure it to always execute a linefeed when a carriage return is received (in ProComm, press ALT-F3).

Connect power to the Proto Board. The following menu/prompt will appear on the screen:

BS2 Data Logger  
(A)DC (T)ime (C)lock (R)ead (D)ump  
(E)rase (L)og  
>

Typing the first letter of any item executes the corresponding instruction. If you leave power connected for more than 60 seconds without pressing any key, the logger will begin logging data. If you want to prevent that, periodically press any key to restart the logger's internal countdown. Here's a description of each of the menu items:

(A)DC: Press A to view ground-referenced voltage readings (0 to 4095 representing voltages of 0 to 5 volts) from the two channels of the ADC. This is handy for testing sensors or obtaining data for calibration purposes. Data displayed on the terminal screen looks like this:

Ch0: 557

```
showADC =====
' Take a single-ended measurement from each of the two ADC
' channels and send it out the built-in serial port at 9600 baud. Handy
' for calibrating analog conditioning circuitry.
showADC:
  ADmode = 1          ' Single-ended measurement.
  for ADch = 0 to 1    ' Both channels, 0 and 1.
    gosub ADread        ' Read selected channel.
    serout 16,b96,[CR,"Ch",DEC ADch," ",DEC ADres] ' Display
    result.              ' Next channel.
  next
  goto setup

' time =====
' Put the time and date from the NJU clock chip on the screen and
' go back to the setup routine.
time:
  gosub read_clock      ' Update DTG data.
  gosub show_time       ' Display the time.
  gosub show_date       ' Display the date.
  goto setup

' clock =====
' Let the user set the current time and date via the set_clock sub-
' routine. This code just jury-rigs an IF ... THEN GOSUB ... instruction,
' which PBASIC lacks. When done, goes back to setup.
clock:
  gosub set_clock       ' Set the internal clock.
  goto setup

' log =====
' Take a single-ended reading from both ADC channels every minute
' and records the data followed by the time and a checksum byte to
' the EEPROM starting at address 0.
log:
  ADmode = 1          ' Set single-ended mode for ADC.
  EEaddr = 0          ' Start at address 0.
  EEincr = 1          ' Enable auto-increment of
                      ' EEPROM address.

  logLoop:
    if EEaddr <= Eetop then nextAddr ' If EEaddr > Eetop,
    EEaddr = 0
    EEaddr = 0
    nextAddr:
      Echecksum = 0      ' Clear the checksum for new data.
      gosub read_clock   ' Get the current time.
      for ADch = 0 to 1  ' Do both channels.
        gosub ADread      ' Get ADC result.
        Edata = ADres.highbyte ' Record the high byte of ADres
        word.              ' word.
        gosub EEnableAndWrite ' Write the data to EEPROM.
        Edata = ADres.lowbyte ' Record the low byte of ADres
        word.              ' word.
        gosub EEnableAndWrite ' Write the data to EEPROM.

      next
      Edata.highnib = DTG(H10s) ' Record hours.
      Edata.lownib = DTG(H1s)   ' Record minutes.
      gosub EEnableAndWrite

      Edata.highnib = DTG(S10s) ' Record seconds.
      Edata.lownib = DTG(S1s)   ' Record seconds.
      gosub EEnableAndWrite

      Edata = Echecksum        ' Store the checksum.
      gosub EEnableAndWrite

' Turn off the peripheral power supply and sleep for approximately
' 60 seconds (according to the BS2's internal timing). The actual
' sleep time will be the nearest multiple of 2.3 seconds (59.8)
' plus or minus about a second for oscillator tolerance.
high Shdwn
```

```
sleep 60
low Shdwn
goto logLoop

' dumpDataLog =====
' Dump the entire contents of the EEPROM(s) as hex digits separated
' by spaces. For compatibility with terminal software and convenient
' reckoning of addresses, this loop presents 16 entries on one line.
' This output mode would be handy for recovering data from EEPROM
' in the event a hardware or software problem caused the checksum
' method to fail. It's also useful for debugging new data formats, since
' it lets you look at all the values in the EEPROM.
dumpDataLog:
  EEaddr = 0
  EEincr = 1

  dumpLoop:
    serout 16,b96,[CR,hex4 EEaddr," "] ' Write line "<addr>: "
    for temp = 1 to 16                ' Put 16 entries across
                                        ' screen.
      if EEaddr = EEmax then setup     ' End of memory: exit.
      gosub ERead                     ' Read a byte from
      serout 16,b96,[hex2 EEdata," "] ' Show "address: <data
      next                             ' data...>"
                                        ' Do it again.
    goto dumpLoop

' eraseLog =====
' Erase (write 0s) to every address in the combined EEPROM storage
' bank. This process takes several minutes to complete, after which
' the "BS2 Data Logger" prompt reappears on the screen. This is a
' brute-force erase routine, in that it does not take advantage of the
' EEPROM page-write capabilities, or the possibility of writing to the
' two EEPROMs simultaneously. These steps might speed the erasure
' process to a minute or less, but at the expense of extra code.
eraseLog:
  EEdata = 0: EEincr = 0
  for EEaddr = 0 to (EEmax-1)
    gosub EEnableAndWrite
  next
  goto setup

' readDataLog =====
' Read time-tagged data entries from the EEPROM until an invalid
' checksum, a string of 0s, or the end of memory. Note that the
' string-of-zeros condition will be falsely triggered at midnight,
' January 1, if both ADC readings happen to be zero.
readDataLog:
  EEaddr = 0
  EEincr = 1

  next_entry:
    EEblank = 1
    of 0s.
    Echecksum = 0
    validity.
    serout 16,b96,[CR]
    screen.
    for ADch = 0 to 1
      ADC channels.
      gosub ERead
      ADres.highbyte = EEdata
      gosub ERead
      ADres.lowbyte = EEdata
      serout 16,b96,[dec ADres,TAB]
      next
      gosub ERead
      serout 16,b96,[hex2 EEdata," "]
      gosub ERead
      serout 16,b96,[hex2 EEdata," "]
      gosub ERead
```

```
serout 16,b96,[hex2 EEdata] ' "ss" (seconds)
EEinCK = 1 ' Now, get checksum. Turn off read checksum
calculation.
gosub ERead ' And read in the written checksum byte.
if EEdata <> Echecksum then invalid_sum ' Verify checksum.
if Echecksum = 0 and EEblank = 1 then invalid_blank ' Check for
' 0s.

if EEaddr > Eetop then endOfLog
goto next_entry ' Do the next one.

invalid_blank:
  serout 16,b96,[CR,"Stopped. End of data.",CR]
  goto setup

invalid_sum:
  ' Display message when checksums don't
  ' match.
  serout 16,b96,[CR,"Stopped. Invalid checksum.",CR]
  goto setup

endOfLog:
  ' Display message when end of memory
  ' reached.
  serout 16,b96,[CR,"Stopped. End of EEPROM.",CR]
  goto setup
```

## EEPROM SUBROUTINES

```
' Depending on the address in EEaddr, select either EEPROM 0
' (addresses 0-8191) or EEPROM 1 (addresses 8192-16383). Note
' that this routine deactivates the selected EEPROM, but leaves it to the
' calling code to reactivate it. An additional effect of the read and write
' routines is to add the value of EEaddr read or written to a variable
' called Echecksum. This checksum can serve as a marker to separate
' valid data from leftover garbage in the EEPROM. It's not infallible,
' but combined with time/date tagging, it can be very effective.

' pickEE =====
' Based on the address in EEaddr and the size of the installed
' EEPROMs, turn on the correct EEPROM's enable line.
pickEE:
  EEsel = 0
  ' If EEaddr <= EEsizel, then
  ' EEsel=0.
  IF EEaddr <= EEsizel then skip1 ' Else EEsel = 1.
  EEsel = 1
  skip1:
    low (EE_CS0+EEsel) ' Activate selected EEPROM.
    return ' Return to caller.

' EEdisable =====
' Write-protect (disable) the EEPROM.
EEdisable:
  gosub pickEE
  shiftout DATA,_CLK,msbfirst,[WRDI] ' Send the disable
  opcode.
  high (EE_CS0+EEsel) ' Deactivate the
  ' EEPROM.
  return

' EEnableAndWrite =====
' Check the EEPROM and wait until it's not busy. Then write enable
' the EEPROM, and write the byte stored in Edata to the address
' stored in EEaddr. Update the checksum byte by adding EEdata to
' the previous contents of Echecksum. Finally, if EEincr = 1,
' increment EEaddr to point to the next EEPROM address.
EEnableAndWrite:
  gosub Read_status
  if Ebusy = 1 then EEnableAndWrite
  low (EE_CS0+EEsel)
  shiftout DATA,_CLK,msbfirst,[WREN] ' Send the enable
  opcode.
  high (EE_CS0+EEsel)
  low (EE_CS0+EEsel)
```

continued



(T)ime: Press T to view the clock/calendar chip's current reckoning of the time and date. The terminal displays (for example):

```
11:09:14
01/10/96
```

(C)lock: If the time/date displayed by the logger's clock is wrong, pressing C lets you correct it. In the example display below, prompts are in bold type, user entries are light. DOW stands for day-of-week, and you may pick any day as number 1. Sunday or Monday are usual choices.

```
Year (YY): 96
Month (MM): 01
Day (DD): 10
DOW (1-7): 3
Hour (HH): 11
Minute (MM): 10
```

(R)ead: Pressing R causes the logger to read back data from its EEPROM memory. It will stop when it encounters blank memory; locates a bad checksum indicating the possibility of corrupted data; or reaches the end of the EEPROM. For neatly aligned display on the screen and compatibility with spreadsheets, the entries are separated by tab characters.

```
521 3466 10:11:06
522 3464 10:12:04
522 3461 10:13:03
523 3466 10:14:02
523 3462 10:15:00
524 3466 10:15:59
0 0 00:00:00
Stopped. End of data.
```

(D)ump: If a read operation stops, but you suspect that there may be more valid data in memory, pressing D dumps a hexadecimal (hex) listing of the entire contents of memory. Each line begins with a hex number representing the starting point in memory of that line of data. See Table A.

(E)rase: Pressing E writes 0s to all bytes of the installed EEPROM. This process can take five minutes to complete. When it's over, a new menu/prompt appears on the terminal display.

(L)og: Pressing L bypasses the 60-second delay and starts the logging process immediately. This is primarily useful for test runs of the logger, since disconnecting the serial cable between the PC and logger causes the logger to reset and start another countdown. During the logging process, the device will record measurements from each of the two ADC channels about once a minute, storing the readings, the time, and a checksum into EEPROM memory. The checksum serves as a simple indication of whether or not the data was recorded correctly, like the parity bit in serial communications. Between measurements, the logger goes into battery-saving sleep mode, reducing current draw to less than 1 mA.

Since it takes eight bytes to store the readings, time tag, and checksum, the maximum logger memory of 32 KB will hold 4096 readings; about 68 hours worth at one sample per minute. Its program could be changed to take readings more or less often; store more or less data per reading; record readings only when a significant event occurred; or operate under any rules that you can imagine and write as a PBASIC-2 program.

The whole point of this example application is customization through programming. And that is my unsavory transition to the next section of this article ...

## How it Works: Programmer's Perspective

As the schematic in Figure 1 shows, the Proto Board consists primarily of a serial bus supporting four peripheral ICs: the two EEPROMs, clock, and ADC. So it makes sense that the primary job of the program is to drive these devices using the BS2 instructions Shiftout and Shiftin.

The other defining feature is the extensive use of Serin and Serout to interact with the user as described in the section above. The program uses PBASIC's serial formatting capabilities to translate between internal data formats (like the binary-coded decimal array of the clock) and more human-friendly forms.

```
0000: 01 E3 0D 7A 09 01 08 7D 01 E3 0D 83 09 02 07 86
0010: 01 E3 0D 83 09 03 05 85 01 E5 0D 82 09 04 03 85
0020: 01 E4 0D 83 09 05 01 84 01 E5 0D 87 09 05 59 E1
0030: 01 E7 0D 83 09 06 57 DE 01 E7 0D 84 09 07 55 DE
0040: 01 E7 0D 85 09 08 53 DE 01 E8 0D 85 09 09 51 DE
```

**Table A**

Since the program is extensively commented, I won't repeat those details here. What I will do is explain how to use and build on the peripheral subroutines for your own applications.

## EEPROMs

The EEPROM routines let you write a byte of data to any address within the two-chip EEPROM memory. For example, suppose you have 16 KB of EEPROM (two X25640P chips) installed. You set the address (EEaddr) to 9000 and gosub ERead to read back the data stored at that address. ERead first determines which EEPROM contains the given address. Since 9000 is greater than the highest address available in the lower EEPROM, EEPROM 0, the subroutine pickEE selects EEPROM 1. Another subroutine, send\_addr, strips off the bits of the address exceeding 8191 — the largest address in the X25640s — when it sends out the address message to EEPROM 1. So these subroutines cooperate to make two EEPROMs look like one big EEPROM. The address value EEaddr is unaffected by these adjustments. After ERead, EEaddr still contains 9000, but EEdata now contains the byte stored at that location in the combined EEPROM.

In our data-logging example, bytes are written to sequential EEPROM addresses starting at 0 and working upward towards the maximum address of the installed EEPROM. The send\_addr subroutine can be instructed to increment (add 1 to) the address after each read or write. This is controlled by the bit EEincr; if it's 1, increment; if 0, don't increment. In the example above, if EEaddr were 9000 and EEincr were 1, after ERead, EEaddr would contain 9001.

The EEPROM routines can also maintain a checksum. What's a checksum? It's a running total of a series of values written to or read from the EEPROM. By comparing the checksum that was written to the checksum calculated when the same bytes were read back, the program can

```
shiftout DATA_CLK,msbfirst,[WriteEE] ' Send write opcode.
gosub Send_addr ' Send the address.
shiftout DATA_CLK,msbfirst,[EEdata] ' Send the data.
high (EE_CS0+EEsel) ' Deactivate the
' EEPROM.
' Update checksum.
EEcksum = EEcksum + EEdata
return ' Return to program.

' ERead =====
' Read data from the EEPROM. Use the address in EEaddr;
' put data into EEdata. Add the value of EEdata into the byte
' EEcksum as an informal check of the validity of a sequence
' of bytes. Setting the bit EEnoCk turns off checksum calculation
' for one byte read—usually the checksum itself.
' This code also clears the readZero bit whenever it retrieves
' a non-zero byte. This lets other parts of the program recognize
' unbroken sequences of zeros, which would otherwise pass the
' checksum test.
ERead:
  gosub pickEE ' Select the EEPROM.
  shiftout DATA_CLK,msbfirst,[ReadEE] ' Send the read opcode.
  gosub Send_addr ' Send the address.
  shiftin DATA_CLK,msbpre,[EEdata] ' Send the data.
  high (EE_CS0+EEsel) ' Deactivate the
' EEPROM.
' No cksum if bit=1
' Update checksum.
  If EEnoCk = 1 then noCkSum
  EEcksum = EEcksum + EEdata

noCkSum:
  EEnoCk = 0
  If EEdata = 0 then readZero
  Eblank:
    EEblank = 0
  readZero:
    return ' Return to program.

' Send_addr =====
' Send the EEPROM address for a read or write and optionally
' increment the address afterwards for writing sequential addresses.
Send_addr:
  shiftout DATA_CLK,msbfirst,[EEaddr & EEsizel]16]
  EEaddr = EEaddr + EEincr ' Increment address if bit=1.
  return ' Return to program.

' Read_stats =====
' Read the EEPROM status register, which contains the write-in-
' progress or "busy" bit. This should be checked before each write to
' ensure that the EEPROM is ready to accept new data.
Read_stats:
  gosub pickEE
  shiftout DATA_CLK,msbfirst,[RDSR] ' Send read-stats
  opcode.
```

```
shiftin DATA_CLK,msbpre,[EEstats] ' Get status.
high (EE_CS0+EEsel) ' Deactivate the
' EEPROM.
' Return to program.
return

=====
NJU6355 CLOCK/CALENDAR SUBROUTINES
=====

' read_clock =====
' Get the current date/time group from the NJU6355 clock and store
' it in the array DTG(n).
read_clock:
  low NJU_IO
  high NJU_CE
  for digit = 0 to 12
    shiftin DATA_CLK,lsbpre,[DTG(digit)4]
  next
  low NJU_CE
  return

' write_clock =====
' Get the time stored in DTG(n) and write it to the NJU6355 clock.
' Note that the NJU6355 does not allow you to write the seconds
' digits. If it clears the seconds digits when written, so if you set it for
' 08:30 (hh:mm), when the write is complete, the NJU6355 starts at
' 08:30:00 (hh:mm:ss).
write_clock:
  high NJU_IO
  high NJU_CE
  for digit = 0 to 10
    shiftout DATA_CLK,lsbfirst,[DTG(digit)4]
  next
  low NJU_CE
  return

' set_clock =====
' Set the clock/calendar based on data entered by the user at
' 9600 bps through the built-in serial-port connector.
set_clock:
  serout 16,b96,[CR,"Year (YY): "; gosub get2BCD ' Get year.
  DTG(Y1s) = temp.highbit:DTG(Y1s) = temp.lowbit ' Store.
  serout 16,b96,[CR,"Month (MM): "; gosub get2BCD ' Get month.
  DTG(Mo1s) = temp.highbit:DTG(Mo1s) = temp.lowbit ' Store.
  serout 16,b96,[CR,"Day (DD): "; gosub get2BCD ' Get day.
  DTG(D1s) = temp.highbit:DTG(D1s) = temp.lowbit ' Store.
  serout 16,b96,[CR,"DOW (1-7): "; ' wk.
  serin 16,b96,[HEX1 temp] ' Store.
  DTG(day) = temp.lowbit
```

```
serout 16,b96,[CR,"Hour (HH): "; gosub get2BCD ' Get year.
DTG(H1s) = temp.highbit:DTG(H1s) = temp.lowbit ' Store.
serout 16,b96,[CR,"Minute (MM): "; gosub get2BCD ' Get month.
DTG(M1s) = temp.highbit:DTG(M1s) = temp.lowbit ' Store.
gosub write_clock
return

' show_date =====
' Display the date stored in DTG.
show_date:
  serout 16,b96,[CR,HEX DTG(Mo1s), HEX DTG(Mo1s),"/",HEX
  DTG(D1s),"-",
  HEX DTG(D1s),"/",HEX DTG(Y1s), HEX DTG(Y1s)]
  return

' show_time =====
' Display the time stored in DTG.
show_time:
  serout 16,b96,[CR,HEX DTG(H1s), HEX DTG(H1s),":",HEX
  DTG(M1s),":",
  HEX DTG(M1s),":",HEX DTG(S1s), HEX DTG(S1s)]
  return

' get2BCD =====
' Get two BCD digits using the HEX2 modifier. Within the range 0-9,
' hex and BCD are the same, so this is useful for setting the clock
' in its BCD format.
get2BCD:
  serin 16,b96,[HEX2 temp]
  return
```

```
=====
LTC1298 12-BIT ADC SUBROUTINE
=====

' ARead =====
' Configure the ADC for the channel/mode set by the bits of ADcnfg,
' then take an ADC reading, returning the result in the word variable
' ADres. The program should set up the mode bit (ADmode; 1 = single
' ended, 0 = differential) and channel (ADch; 1 = ch1; 0 = ch 0) before
' executing a Gosub to this routine. Note that when the mode is
' differential, the channel selection indicates which channel is
' considered to be the + connection for the measurement.
ARead:
  ADcnfg = ADcnfg | %1001 ' Set start bit and msbfl.
  low AD_CS ' Activate the ADC.
  shiftout DATA_CLK,lsbfirst,[ADcnfg14] ' Send config bits.
  shiftin DATA_CLK,msbpost,[ADres12] ' Get data bits.
  high AD_CS ' Deactivate the ADC.
  return ' Return to program.
```



**Table 1. Components of the Data Collection Proto Board**

Qty	Designator(s)	Part/Value	Description	Vendor	Vendor PN
2	U2, U3	X25640P	8KB serial EEPROM	S. Edwards Elec.	16KB EEPROM
2	U2, U3	X25128P	16KB serial EEPROM	S. Edwards Elec.	32KB EEPROM
1	U1	LP2950BZ	5-volt regulator	Digi-Key	LP2950BZ-ND
1	U4	NJU6355ED	Clock/calendar	Digi-Key	NJU6355ED-ND
1	U5	LTC1298CN8	12-bit ADC	Digi-Key	LTC1298CN8-ND
1	U6	LP2951ACN	5-volt regulator	Digi-Key	LP2951ACN-ND
1	XTAL	32768 TF XTAL	32.768KHz crystal	Jameco	14584
7	C1-4, C7,10,11	0.1µF	50 WVDC cap	Hosfelt	15-696
2	C8,5	10 µF	10-16 WVDC tant. cap	Digi-Key	P2026-ND
1	C6	0.47F	5.5 WVDC backup cap	Digi-Key	P6951-ND
1	R1	220Ω, 1/8W	5% carbon film resistor	Digi-Key	220EBK-ND
4	R2,3,5,6	1K, 1/8W	5% carbon film resistor	Digi-Key	1KEBK-ND
2	R4,7	10K, 1/8W	5% carbon film resistor	Digi-Key	10KEBK-ND
1	D3	1N34A or 1N270	Germanium diode	Jameco	35941
1	J1	DB9 fem	Right-angle DB9 fem	Jameco	104951
1	J2	1x2 hdr	2-contact male header	Jameco	103341
1	—	DIP24 MP	24-pin DIP socket	Jameco	39351
5	—	DIP8	8-pin DIP socket	Jameco	112205
1	S1	Pushbutton	6mm pushbutton	Digi-Key	P8037S-ND
1	PCB	BS2 DCPB	Printed circuit board	S. Edwards Elec.	BS2 DCPB

nize its sampling with the rollover from one minute to the next; taking a new measurement every minute, on the minute, plus or minus a factor for the nap time between checks of the clock. The sampling won't drift away from the actual clock time.

This technique can be extended to cover other intervals. Want seven minutes between measurements? Create a variable called (for instance) countDown and set it to 7. Whenever the routine detects a change of the minutes digit, subtract 1 from

countDown. If countDown is 0, take a measurement, otherwise go back to the nap loop.

## ADC

The ADC is the easiest peripheral to use. There are two settings: mode and channel. To set the mode, you determine whether you want to measure the voltage between one of the channels and ground, or between the two channel inputs. If your measurement will be referenced to ground, you can use the two channels as separate inputs; otherwise you get a single "differential" channel.

The next choice is the channel itself, 0 or 1. For a ground-referenced measurement, this means just what it says — which channel to measure. For a differential measurement, it determines which channel will be considered positive with respect to the other.

## Demonstration Run

I thought it would be interesting to use a version of the demo application to gather some data about the Proto Board itself, so I connected the circuit shown in Figure 2.

I didn't have much time before my article deadline, so I modified the program from the listing to sample at 10-minute intervals and took samples for just over 10 days. The board was tucked away in a semi-heated storage/workroom throughout this period. Figure 3 is a graph of ambient temperature and battery voltage versus time generated by loading the data into a Microsoft Excel spreadsheet.

I was gratified to see that there was plenty of life left in the battery after a week and a half, and amused to see some of the events recorded in the data. Between day markers 4 and 5, I forgot to turn off the storeroom's small electric space heater overnight, resulting in the higher-than normal low-temperature reading. And after a week of operation, I began to wish that I had added some sort of indicator to show that the board was working properly. Just before the day-7 mark, and between days 8 and 9, you can see small jiggles in the supply voltage. These reflect the additional current draw of a loud piezo buzzer that I connected to the peripheral power supply. Each time the logger took a sample, the buzzer would let out a squawk. The additional demand it placed on the supply showed up as small variations in the voltage trace.

## Conclusion

The Data Collection Proto Board offers users of the BASIC Stamp II an excellent foundation for designing data loggers and intelligent controllers with data acquisition, storage, and time-stamp capabilities. The circuit and source code presented here show valuable techniques for interfacing with EEPROM memory, a real-time clock, and a precision ADC. **NV**

detect most kinds of errors in the data. If the checksums match, there's an error in the data or checksum itself.

The example program uses a faulty checksum as one of the conditions for ending a read of the data log. There are only two non-automatic aspects of using checksums: (1) The checksum byte, EECsum, must be cleared to 0 before a set of data is read or written. (2) Before reading the checksum byte itself, checksum calculation must be turned off by setting the bit EEnoCk to 1.

## Clock

The NJU6355 maintains 24-hour time and calendar information in an array of 13 four-bit digits. As long as its supply voltage is 2 volts or better, it keeps very good time. The memory-backup capacitor (C6) on the Proto Board can keep it running for more than 24 hours (at room temperature; less at extremes of heat and cold). Because of this backup capability, you don't have to rush to change the battery or worry about power failures.

The time/date is stored as binary-coded decimal (BCD) digits. Each digit is represented by a four-bit value. Four bits can represent values from 0 to 15, but BCD uses them only to represent the numbers from 0 to 9. It reserves values greater than 9 for error codes or other purposes.

A side effect of this way of storing a series of digits is that the hexadecimal (hex) numbering system is also based on four bits. Where hex over-

laps BCD, the two are the same; the numbers 0 through 9 hex have the same bit patterns as 0 through 9 BCD. So the example program uses the BS2's hex formatting instructions to read and write the BCD digits of the clock.

Your program can access the digits of the date and time through the array called DTG(). The program includes 13 constants that identify the array entry that contains a particular digit. For instance, the tens digit of the seconds is in DTG(S10s).

This brings up a couple of issues related to time. The program uses the BS2's Sleep function to power down the controller for 60 seconds between samples. Since it records the actual time each sample was taken, the relative inaccuracy of the Sleep interval doesn't matter much.

But suppose you wanted to sample at exact intervals; how would you handle that? Since our units of time don't follow normal math rules (22:25 + 4:40 is not 26:65!), adding the interval to the current time and waiting 'til then involves some awkward programming. A method I like works like this: Suppose you want an interval of one minute. Record the current minute digit in a variable, then enter a loop in which the BS2 naps for, say, 1.3 seconds at a time. When it wakes up, it gets the current time and compares the minutes digit to the stored digit. If it's the same, it goes back to sleep. If it's different, the program takes a measurement. It records the new minute digit, and goes back into the nap loop.

Using this method, the program will synchro-

## Sources

Components, kits, and assembled Data Collection Proto Boards are available from Scott Edwards Electronics, 964 Cactus Wren Lane, Sierra Vista, AZ 85635; phone 520-459-4802; fax 520-459-0623; E-Mail 72037.2612@compuserve.com

Note that none of the packages listed below include the BS2-IC, sold by Parallax, Inc. If your application requires storage memory, make sure to order either the 16 KB or 32 KB component packages at the end of the list. If you require large quantities of the Xicor EEPROMs, contact a component distributor like Hamilton Hallmark (800-332-8638) for best pricing and availability.

DCPB Board, bare (no instructions, no disk) \$29.00

DCPB Board, with instructions, disk \$49.00

Complete kit of parts with instructions, disk (0 KB) \$79.00

Assembled with instructions, disk (0 KB) \$119.00

EEPROM memory, 8 KB (one each Xicor

X25640P) \$15.00

EEPROM memory, 16 KB (two each Xicor

X25640P) \$25.00

EEPROM memory, 32 KB (two each Xicor

X25128P) \$45.00

Add \$3.00 for standard shipping and handling; expedited (one- or two-day) shipping available at additional cost. Visa, MasterCard, American Express accepted for phone/fax orders. Personal checks, money orders welcome for orders by mail. Scott Edwards Electronics also offers related products like the serial LCD displays, controller kits, and servo controllers. Contact them for a catalog.

The BS2-IC is available for \$49.00 (at the time of this writing) from Parallax, Inc., 3805 Atherton Road, #102, Rocklin, CA 95765; phone 916-624-8333; fax 916-624-8003; BBS 916-624-7101; E-Mail info@parallaxinc.com

Note that first-time users of the BS2-IC also require a programming package (\$99.00).

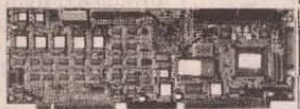
## Other Vendors

**Digi-Key**, 701 Brooks Avenue South, P.O. Box 677, Thief River Falls, MN 56701-0677; phone 800-344-4539.

**Jameco Electronic Components**, 1355 Shoreway Road, Belmont, CA 94002-4100; phone 800-831-4242.

**Hosfelt Electronics, Inc.**, 2700 Sunset Blvd., Steubenville, OH 43952-1158; phone 800-524-6464 or 614-264-6464; fax 800-524-5414.





### ADAPTEC SCSI HOST ADAPTER

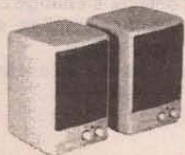
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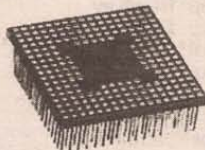
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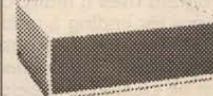
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**RC3120C** - Front panel 19" x 3.4375" 3.25"H x 16.625"W x 13.1875"D - **\$53.00**  
**RC3120D** - Front panel 19" x 5.1875" 5"H x 16.625"W x 13.1875"D - **\$58.00**  
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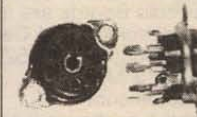
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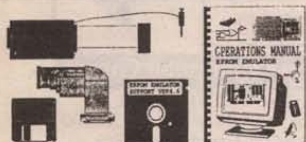


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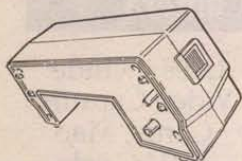
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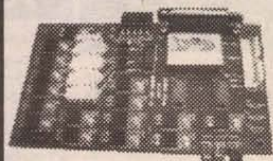
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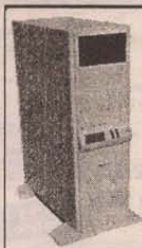
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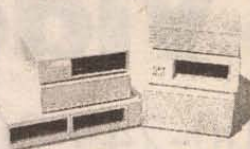


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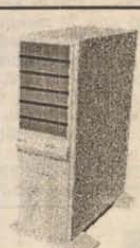
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





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



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



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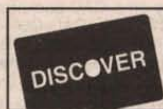
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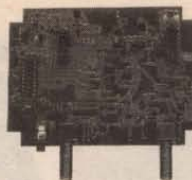
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# THE LASER

## EXPERIMENTER

Conducted by  
Anthony Charlton

**W**elcome! In the past, many amateurs have built homemade lasers. This era was one of equal parts exploration, engineering, problem solving, parts procurement — and frustration. Many amateurs built lasers in their basements or other workplaces for various reasons — holography, for example, or for use as measurement and research tools. There was a day of a fledgling technology with all the usual problems associated with technological emergence.

Nowadays, those who lived during this era are amazed that one can go out and buy a basic He-Ne laser powerful enough for most amateur experiments for just \$50.00. Then make a case for it, connect it up to a battery, and have the beam come on instantly and stay on for time periods now measured in years. With no muss or fuss.

In the old days, He-Ne lasers were extremely prone to problems such as gas mixture contamination, impurities annoyingly donated by the vacuum pump (which had to run continuously during laser operation), rapid electrode degradation, and so forth. Nevertheless, it was a fascinating era and a good part of the history of lasers.

Lasers have now become so commonplace and technologically advanced that the comparison is akin to setting the Space Shuttle aside primitive solid fuel rockets used to loft fireworks. Still, we thought you'd like to continue peeking into history for a column or two more, and look at amateur-built projects from the past.

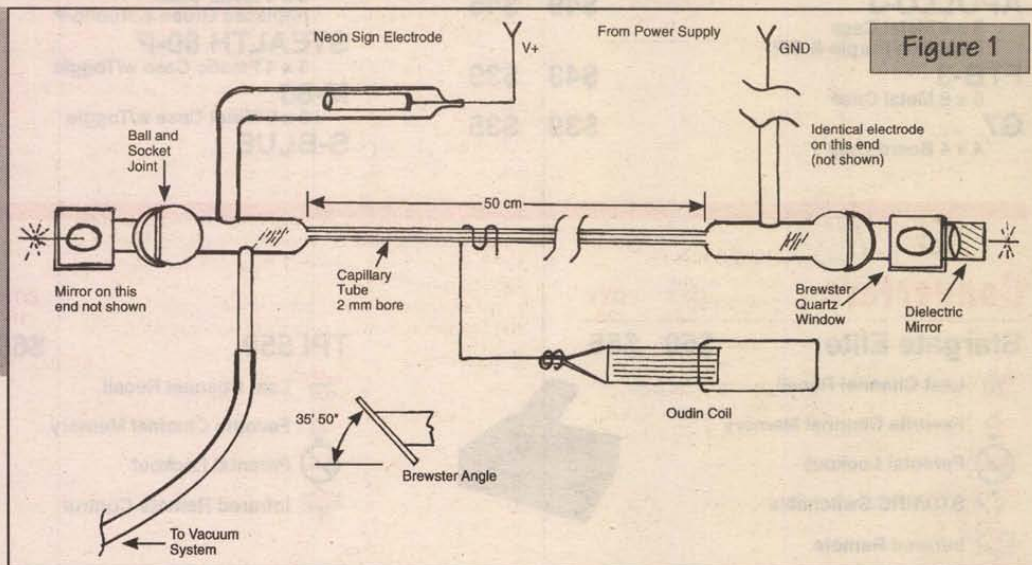
Like with last month's column, the output of the laser we'll cover this month is too powerful, and its power supply too dangerous, to present specific construction details. Should some people undertake building it, it might conceivably lead to someone's personal injury, and no one wants that. And this laser also requires good glassblowing skills — a craft one doesn't pick up overnight. Nevertheless, some amateurs were (and still are) willing to educate themselves with the required skills to accomplish their dreams — whatever they may be. Read on if you would like to learn about the trials and successes of one homemade argon laser.

### Pulsed Argon Laser

The argon laser, in this example, is made largely of Pyrex glass construction. Figure 1 shows a sketch of the apparatus. Quartz windows cover both output ends of the plasma tube, and quartz is used because of its low coefficient of thermal expansion and high degree of transparency to the wavelengths of light outputted by this kind of laser. The output ends are cut at the Brewster angle so that the output of the laser is polarized.

Argon lasers are "multi-line," in other words, several wavelengths are generated simultaneously. Commercial argon lasers use different methods to select the wavelength desired; the most common I understand being a DIFFRACTION GRATING — a glass plate precisely ruled with many thousands of grooves per inch. The beam is refracted according to the angle of incidence, and the desired wavelength selected in this manner. Note the beam from this laser exits from both ends. Usually, the beam exits from one end of a laser only. I imagine the output could be intensified in one direction by using a fully reflective mirror, as with other lasers.

To energize this particular laser, a current source of about 2,000 volts is used. The circuit is sketched in Figure



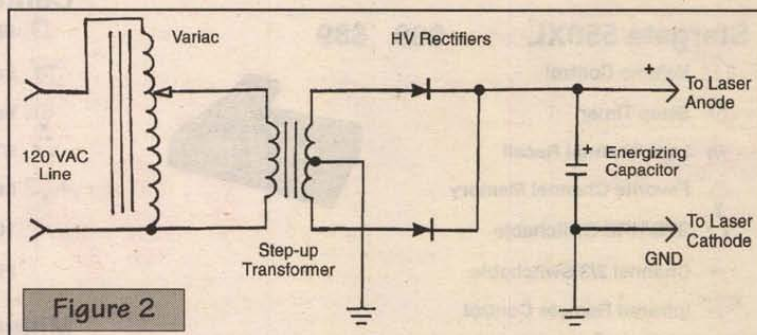
2. A variac controls the voltage to the primary of a neon sign transformer. Two HV rectifiers convert the AC output from that transformer to pulsed DC, which is stored in the energizing capacitor. Referring back to Figure 1, note the Oudin coil attached to the capillary of the laser tube. This ionizes the argon gas within, and allows it to conduct at the rate of 120 pulses per second. As the capacitor charges, it eventually reaches a potential sufficient to fire the laser. A pulse of 15 to 20 amperes at roughly 2,000 volts (we told you this supply was dangerous!) courses through the gas, causing it to become sufficiently pumped to lase.

Although the current discharge occurs in just a few microseconds, the output beam persists for 50 microseconds or so, and at a 120 Hz rate, the beam appears continuous to the eye. Should the laser be operated on a current-continuous basis, the whole assembly would melt in short order.

Commercial argon lasers used to be entirely water cooled, but new advances in design technology have permitted air cooling. However, the heatsink fins are huge and the systems still require forced air cooling.

Commercial argon lasers are a lot less awkward than their amateur brethren. But they aren't cheap either, being on the order of several thousand dollars for a unit whose output is measured in watts. Now they are all self-encapsulated with just a gas reservoir required, in some cases, to restore depleted argon. Only the power supply is distinctly separate from the laser, and this is usually within the laser's enclosure cabinet. Contrast this with the amateur laser which requires:

- 1) A roughing pump.
- 2) A diffusion pump.
- 3) A cold trap to get that annoying pump contamination from getting mixed in with the lasing gas.
- 4) The required gas reservoir (and ultra-pure argon gas).
- 5) A manometer and a vacuum gauge, both of which are used to monitor the argon gas pressure as the laser is



operated.

6) The home-built laser plasma tube which is a definite engineering challenge.

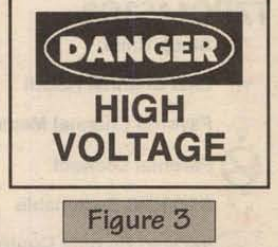
7) And, of course, the power supply.

Whew! All this adds up to lots of money and time, and we surely can salute those who have the persistence (plus skills and resources) to build a working argon laser.

The attraction of the argon laser is due to not only its useful multi-line output, but the high power levels that can be achieved. Both are valuable for research and medical procedures. And who can forget those wonderful computer-animated laser light shows which use the argon laser at the pinnacle of its aesthetic grandeur?

### Homemade Capacitor Fabrication for Amateur Lasers

Legend has it that workable capacitors require advanced techniques and fabrication facilities. This is not so! At least not for many of our amateur projects. I thought I'd share with you info for making YOUR OWN capacitors, if you have a laser system(s) which requires





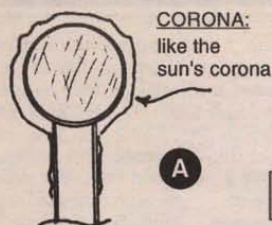


Figure 4

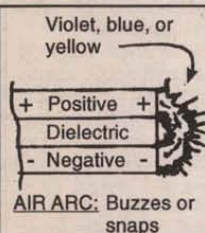
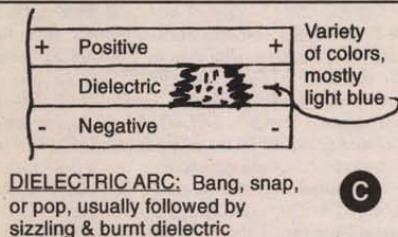
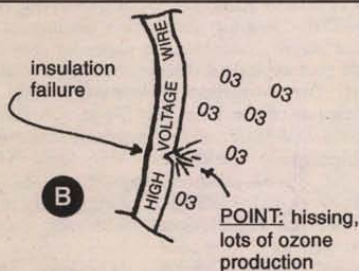


Figure 5

them or if you are a HV experimenter.

Although one cannot vouch for the integrity of homemade capacitors for extended MTBF [1], people have been instrumental in giving out some advice to Tesla coil builders and HV experimenters over the years, who have combined different sources of knowledge to successfully make capacitors. Homemade capacitors have been known

to withstand 20,000 VAC-plus at high frequencies for extended lengths of time without failing.

So in other words, it works. Such capacitors are used in nitrogen lasers, small argon lasers, pulsed single heterostructure infrared lasers, in the copper vapor laser described in the last column, and with other types of lasers. Practical considerations limit the amount of capacity of these home-lab built devices, so we can't reasonably expect to build huge electrolytic capacitors or similar types. Such mammoth components are used for energizing ruby lasers and the like.

Expect about 0.1 uF (100 nanoFarads or 100,000 picoFarads) to be the largest practical size. Yet you can build them for high voltages like 10 KV, 20 KV, or even 100 KV using the following techniques. So limited storage

capacity if the application requires it is not a shortcoming if you examine the price of some commercial products vs. your own efforts.

## Capacitor 101

First, one has to decide whether the capacitor is to be oil immersed or dry. One advantage of oil immersion is it multiplies the capacity by a property called DIELECTRIC CONSTANT.

Most of us have heard of this term, and to refresh the memory, let's imagine a capacitor whose plates are separated by an air gap, and one whose plates are of equal size and spacing but immersed in mineral oil.

Mineral oil? Oh yes! This pharmaceutical product is used for more reasons than to settle upset human digestive systems. It is very refined, containing few impurities, as it's approved for human consumption. It is also an excellent insulator. Plus, it's much easier to get a hold of than commercial transformer/capacitor oil.

Let's take a look at Equation 1 which describes the formula of how to determine capacity on paper:

### Equation 1

$$C = 0.224 \frac{K \cdot A}{d} [n-1]$$

Where: C = Capacitance in picoFarads (pF)

K = Dielectric constant of insulator

A = Area of one side of one plate in square inches

d = Separation of plates in inches

n = Number of plates

Go ahead and work out an imaginary capacitor on your calculator. Let's just say it's 1,000 pF (0.001 uF) for the moment. Now, by separating the plates with window glass [2], you'd increase its capacity to 7,800 pF, although glass is not recommended, explained in the footnote. Next, refer to Chart 1.

### Chart 1 Dielectric (K) Constants

Air = 1.0
Paper (bond) = 3.0
Polystyrene = 2.6
Plexiglas = 2.8
Polyethylene Terphthalate (Mylar) = 3.0
Pharmaceutical Mineral Oil (Squibb) = 2.7
Ordinary Window Glass = 7.8
Polycarbonate (Lexan) = 2.96
Epoxy Circuit Board = 5.2
PVC (rigid type) = 2.95
Polyethylene = 2.3
Teflon = 2.1
Pyrex = 4.8
Silicone RTV = 3.6
Nylon = 3.2
Shellac = 3.3

Measurements are made at 1 MHz. Where several values of dielectric K constant are given, the lowest value was chosen.

Notice mineral oil has a dielectric constant of 2.7. This data was gathered by measurements using a technician-grade Heathkit multimeter. It may be off by a tenth of a decimal place or so, relative to high-cost lab equipment, but the data is fine for our general use. Mineral oil would increase our capacity to 2,700 pF.

Actual measurements of homemade capacitors come in about  $\pm 20\%$  of calculated, if your assembly techniques are careful. Not bad! That particular dielectric (among certain others) has the advantage of being "self-healing." That's a term applied to dielectrics that have the capacity to recover partially or totally from transient overvoltages applied to them.

Another crucial parameter is the PUNCTURE VOLTAGE of a dielectric. To be conservative, this should be given a 2x margin over what is expected. So, if 1 mil (0.001 inch) Lexan is used for a capacitor expected to be subjected to 400 volts DC, then opt for using 2 mil Lexan.

Peak voltage, kilovolts	Diameter of spherical electrodes, cm				Needle points
	2.5	5	10	25	
	Length of spark gap, cm				
5	0.13	0.15	0.15	0.16	0.42
10	0.27	0.29	0.30	0.32	0.85
15	0.42	0.44	0.46	0.48	1.30
20	0.58	0.60	0.62	0.64	1.75
25	0.76	0.77	0.78	0.81	2.20
30	0.95	0.94	0.95	0.98	2.69
35	1.17	1.12	1.12	1.15	3.20
40	1.41	1.30	1.29	1.32	3.81

Figure 6

Peak voltage, kilovolts	Diameter of spherical electrodes, cm				Needle points
	2.5	5	10	25	
Length of spark gap, cm					
45	1.68	1.50	1.47	1.49	4.49
50	2.00	1.71	1.65	1.66	5.20
60	2.82	2.17	2.02	2.01	6.81
70	4.05	2.68	2.42	2.37	8.81
80		3.26	2.84	2.74	11.1
90		3.94	3.28	3.11	13.3
100		4.77	3.75	3.49	15.5
110		5.79	4.25	3.88	17.7
120		7.07	4.78	4.28	19.8
130			5.35	4.69	22.0
140			5.97	5.10	24.1
150			6.64	5.52	26.1
160			7.37	5.95	28.1
170			8.16	6.39	30.1
180			9.03	6.84	32.0
190			10.0	7.30	33.9
200			11.1	7.76	35.7
210			12.3	8.24	37.6
220			13.7	8.73	39.5
230			15.3	9.24	41.4
240				9.76	43.3
250				10.3	45.2
300				13.3	54.7

Figure 7

### CORRECTIONS FOR TEMPERATURE AND PRESSURE

Values found in the above table may be corrected for temperature and pressure by multiplying the values given by the appropriate correction factor found below:

Pressure mm				
Temp. °C.	720	740	760	780
0	1.04	1.06	1.09	1.12
10	1.00	1.02	1.05	1.08
20	0.96	0.99	1.02	1.04
30	0.93	0.96	0.98	1.01

Figure 8

Here we have to closely examine the type of voltage the capacitor has to stand up to. A smooth DC voltage is one thing, and AC voltage or a DC voltage with a parasitic AC component is another. The peak DC voltage rectified from an AC transformer type power supply will be 1.41 times the sinewave RMS measurement [3], aside

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Although not related to lasers, reader's responses to the request for information about how to locate the out-of-print book *Build-It-Yourself Science Laboratory* have been extremely helpful. I would like to sincerely thank John M. Grosvenor of Sylvania, OH; John Harrell of Salina, KS; A. Paradis of Akron, OH; and J. Wisnia of Winchester, MA for all their considerate efforts providing valuable information and library book lending data. The object in finding this book is for its resource of innovative ideas. They can now be adapted using modern technology. The plan is to write a book for the young and intermediate student and experimenter who are excited to learn about and experiment with science in many forms, including lasers, and the *Build-It* book is one a person can justifiably call a classic resource for its day and targeted audience.

1. MTBF= (M)ean (T)ime (B)etween (F)ailures.

2. I am deliberately drawing your attention to window glass because it is a rotten choice for a dielectric! When compared to modern, highly-purified plastics, it can't hold a candle. Glass was the dielectric choice of amateurs for the past, but since its slightly green tint (look edgewise into a pane to see this) is due to iron impurities, its MTBF is often. These impurities manifest themselves in spots where high voltage can break through. For example: I once hooked a 15 KVAC neon sign transformer to a window glass capacitor, only to have it fail with a resounding mini-explosion that cracked several panes, and bored a hole through two of them! It SHOULD have held up, according to calculations. Refined glass is used in commercial capacitors with few of the problems that common window glass presents.

3. RMS= (R)oot (M)ean (S)quare.

4. Expressed in "Length of spark gap, cm" where one cm (centimeter) is roughly 0.394 inches.



from any possible voltage spikes present.

Figure 3 shows the primary consideration above failure, and even though it's a bit melodramatic, several copies of this label should be attached to any HV project. Photocopiers can enlarge this label to any size, so it's recognizable even by children, should they become curious about your capacitor project and need to get warned off.

Figure 4 shows common sources of failure from capacitors. Figure 4A is CORONA DISCHARGE, a leakage of electricity directly into the air from uninsulated surfaces at high voltages. The cure for this is to insulate the affected surfaces with products like Corona Dope or High-Voltage Putty. These sundries can be purchased from dealers who cater to the TV industry.

Products like these, and similar ones, are used to insulate the TV's HV components like capacitors, flybacks, and PC boards. Figure 4B shows the leakage from a cracked or aged HV wire. Replacement of the wire is required in general. Silicone-covered, stranded HV wire is recommended in all cases by many technicians as a superior interconnecting wire involved with high voltages.

Next, in Figure 4C, we see the trouble that happened with the aforementioned glass capacitor. Any dielectric will break down if excessive voltage, temperature, or cycling of current at high frequency are individually or mutually applied.

Note the symptoms of this failure. Arcing can be between plates or directly over the edge of adjoining plates as shown in Figure 5. Edge arcing is also called "flashover."

In either case, it is likely that disassembly and replacement of the dielectric elements are required. This problem is manifested with many dry dielectrics, since sometimes a momentary overload will wreck your capacitor permanently. Various troubles arise when a capacitor isn't designed with an overbuild mind-set.

In all cases, except with very tightly sealed or oil immersed capacitors, you'll perceive that characteristic "electrical" smell of ozone gas. This gas is toxic — about 200 times more so than carbon monoxide — so apparatus giving it off as a by-product of operation or by accident needs to be operated in a well-ventilated area.

Ozone has the advantage of being detected in small amounts easily by its characteristic odor. Some people compare it to chlorox bleach. You'll also get a headache pretty quickly after being exposed to it. In that case, get out of the area and into fresh air.

## Paraffin Wax as an Insulator?

Interestingly, paraffin is a rather super-cheap and effective insulator for the edges of capacitors. The caveat here is it must not get too hot, or it'll drip all over the place. Who hasn't taken apart an old radio, to discover the wax-sealed capacitors have dripped in their lifetime? The value of this substance is its availability and inexpensive price tag. Chart 2 shows the breakdown voltages of different dielectrics.

**Chart 2**  
**DC Puncture Voltages**

Air = (See "Spark-Gap Voltages" Figures 6-8)
Paper (bond) = 200
Polystyrene = 500
Plexiglas = 450
Polyethylene Terphthalate (Mylar) = 7500
Pharmaceutical Mineral Oil (Squibb) = approx. 200
Ordinary Window Glass = 200
Polycarbonate (Lexan) = 400
Epoxy Circuit Board = approx. 700
PVC (rigid type) = 725
Polyethylene = 450
Teflon = 1000
Pyrex = 335
Silicone RTV = 550
Nylon = 407
Shellac = 200

Where different values were given for the same substance, the lowest value was chosen.

Insulation-wise, the distance between two electrodes with any capacitor, regarding their geometric shape, is

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critical to maintaining a good MTBF. Figure 6 shows the breakdown voltages [4] compared to several sizes of spheres and to needle points. This covers the span of 5 KV to 40 KV for air-dielectric capacitors, the most common voltage range of experimenter fabrications.

Notice how much lower the needle point breakdown voltages are? That is because of the fact that electrons are concentrated at any sharp point, thus precipitating lower breakdown voltages. Up to a point, as the spherical electrode diameter increases, the breakdown voltage increases. Then, a limit is reached whereby increasing the diameter of the electrode has little improvement upon the breakdown distance.

Figure 7 shows REALLY high-voltage capacitor data. These measurements go up to 300 KV. Techniques allied with the storage of such tremendous voltages are proprietary (industry secrets), but we can and will examine SOME of the known techniques in our next installment. Finally, Figure 8 shows mathematical correction factors for capacitors operating at different atmospheric pressures and ambient temperatures.

## Conclusion

I received a couple of comments regarding a negative voltage power supply for our ongoing laser video project.

(Refer to last month's *Nuts & Volts*.) Since the MAX4112 current-mode feedback amplifier presented in that issue requires a NEGATIVE power supply of minus five volts potential, it's only logical to follow up with an example supply for this chip. I hadn't realized this was somewhat of a puzzle to some readers, so we'll give the schematic of an on-board minus five-volt supply, which we'll integrate into the video project as it continues to appear in future columns.

Next time, we'll take a look at how lasers might be used to communicate over astronomical distances, and look at how laser light can be shifted by present and future technological advances into x-rays, and possibly shorter wavelengths. Such wavelengths will retain information-carrying power over interplanetary or even interstellar distances. Plus, we'll continue our projects in progress with a closer look at homemade, high-voltage capacitors and laser video transmission. **NV**

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**FREQUENCY SYNTHESIZER** HP 8660C frame with HP 86603A and HP 86633B plug-ins. Frequency range 1 to 2600 MHz including AM/FM capability. Has sweep capability and calibrated RF output from -140 to +10 dBm. Includes opt. 5 with HP1B. Units are in excellent condition and come with certificate of calibration (NIST) including 30-day warranty. Priced at \$3,850. Coppes Electronics, 520-432-1229.

**WANTED: WESTERN** electric test equipment. Tube-type only please. Freq. measuring sets, oscillators, amplifiers, parts, tubes, etc. 1-800-251-5454.

# Quality Reconditioned Test Equipment



### Tektronix 485 Oscilloscope

350 MHz bw, dual trace, 5 mV/div sensitivity, 1 ns/div sweep rate, 3.0 div/ns writing speed, selectable input impedances.

**Special \$1000.00**

### Tektronix 465 Oscilloscope

100 MHz portable scope, dual trace, 5 mV/div sensitivity, 5 ns/div sweep rate, 8 x 10 cm CRT. Includes 2 probes.

**Special \$595.00**

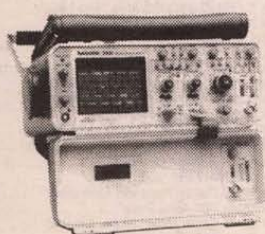
### Tektronix 7834 Oscilloscope

Storage oscilloscope mainframe, 2500 c/ps stored writing speed, dc to 400 MHz, multimode storage. Includes (1) 7A19 amplifier, (1) 7A26 dual trace amplifier, (1) 7B85 delaying time base & (1) 7B80 time base.

**\$1000.00**

### Tektronix 2336 Oscilloscope

100 MHz field service oscilloscope, 5 mV/div to 5 V/div, 5 ns/div sweep rate, delta time on the flip top cover.



**\$1250.00**

### Tektronix 454 Oscilloscope

Dc to 150 MHz, 5 mV/div sensitivity, dual trace, .05 µs to 5s/div timebase plus sweep delay circuit.

**Special \$450.00**

### Hewlett-Packard 8447A

RF Amplifier, 0.1 to 400 MHz, 20 dB gain. Options available.

**\$350.00**

### Hewlett-Packard 8569B

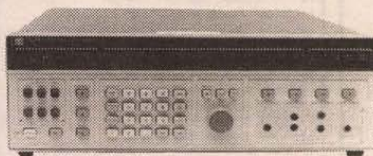
Spectrum Analyzer, 0.01 to 22 GHz with internal mixer, expendable, internal preselection, 1.7 to 22 GHz, 100 Hz to 3 MHz resolution range.

**\$9200.00**

### Hewlett-Packard 3336B Synthesizer/Level Generator

Frequency coverage is from 10 Hz to 21 MHz, making the 3336B useful for telephone circuit loop testing on most FDM systems. Includes opt 005. Like new.

**\$850.00**



### Hewlett-Packard 3586B Selective Level Meter

Makes carrier measurements to 32.5 MHz, voice channel measurements from 50 Hz to 100 kHz, can use the 3336B Level Generator as an automatic tracking generator. Opt 004. Like new condition.

**\$850.00**

### Hewlett-Packard 5334A

Universal Counter, two channel, 100 MHz counter with 9 digits in one second resolution and 2 ns single shot time interval resolution. Automatic rise/fall time, pulse width and peak amplitude measurements.

**\$1650.00**

### Hewlett-Packard 3456A

Digital Voltmeter, 6.5 digit system is ideal for bench/system applications. Measures dc, true RMS, ac voltage and resistance. Five full scale dc ranges from 0.1 V to 1000 V. 100 nV resolution, 100Ω to 1 GΩ resistance in 8 ranges.

**Special \$800.00**

### Hewlett-Packard 8656B Signal Generator

100 kHz to 990 MHz, 10 Hz resolution, ±1.0 dB absolute level accuracy, amplitude offset and phase adjustment capability, 150 ms frequency switching speed, versatile simultaneous modulation including dc FM, fully HP-IB programmable, options available.

**\$5000.00**

### Hewlett-Packard 8901A

Modulation Analyzer, 150 kHz to 1300 MHz, measures AM/FM to 1% accuracy. Measures RF frequency and RF power, completely automatic. Options available.

**\$5500.00**

### Hewlett-Packard 8903A

Audio Analyzer, measures distortion, SINAD, signal-noise, frequency (20 Hz to 150 kHz), and ac and dc level voltage. Options available.

**\$2750.00**

### Tektronix 2754P

Programmable Spectrum Analyzer, 10 kHz to 21 GHz, -117 to +30 dBm, resolution 1 kHz to 3 MHz.

**Special \$9900.00**

### Hewlett-Packard 3325A

Synthesizer/Function Generator, 1µHz to 21 MHz, wideband sweeper, programmable, 11 digit.

**\$2000.00**

### Tektronix 492 Opt 01, 02

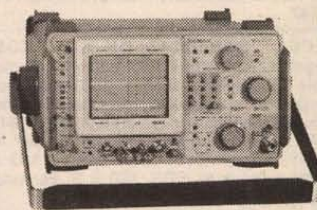
Spectrum Analyzer, 50 kHz to 21 GHz, 80 dB dynamic range, amplitude comparison in 0.25 dB steps, opt 01 internal preselection & opt 02 digital storage.

**\$7500.00**

### Tek 492 opt 01, 02, 03

Spectrum Analyzer see above. Opt 03 adds frequency stabilization/100 Hz resolution.

**\$8250.00**



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**SIGNAL GENERATORS/OSCILLATORS** HP 8656A/001 100kHz to 990MHz synthesized signal generator \$2,995, HP 8640B 512MHz signal generator \$1,795, HP 8640B/001/002 1024MHz signal generator \$2,795, HP 8683B 2.3 to 6.5GHz signal generator \$1,550, HP 8620C sweeper mainframe \$395, HP 86290C 2 to 18.6GHz RF plug-in \$2,395, HP 86222B 0.01 to 2.4GHz RF plug-in \$1,795, HP 204C 5Hz to 1.2MHz audio oscillator \$125, HP 651B 10Hz to 10MHz test oscillator \$125, HP 654A 10Hz to 10MHz test oscillator \$175, HP 8660D/100 synthesized signal generator \$2,500, HP 86602A 1200MHz RF plug-in \$895, HP 4204A 10Hz to 1MHz digital oscillator \$150, GIGATRONICS 900/0.5-12 50MHz to 12.4GHz synthesized signal generator \$2,995, WAVETEK 1062A 400MHz sweep generator \$595, WAVETEK 952 1 to 4GHz microwave source \$995. **30-day warranty & manual.** Calibration available. MasterCard & Visa accepted. **CALL 1-800-435-1516, FAX 908-280-0111.**

**HP 3570A Network analyzer** in good condition \$350. 415-24-9254.

**PORTABLE SCOPES:** Tek 465 (100MHz) \$425. Tek 465B/DM44 (100MHz, multimeter) \$590. Tek 475A (250MHz) \$675. Tek 485 (350MHz) \$790. HP 1727A (275MHz, storage) \$890. Tek 466 (100MHz, storage) \$790. Tek 2465 (300MHz) \$2,190. All with bright CRTs; excellent condition, warranty. Pepper Systems, 214-353-0257.

**METERS** HP 419A null meter, \$200; HP 427A multifunction VM, \$100; HP 403B, \$100; HP 415E SWR meter, \$150; Boonton 934A RF VM, \$150; HP 432A power meter and probe, \$300; HP 435A, \$150; HP 3400A, \$250; HP 400E, \$250; HP 331A distortion ana., \$300; HP 334A, \$500; Fluke 893A, \$150; HP 428B current meter and probe, \$300; HP 4328A milliohmeter and probe \$650; HP 400F, \$250; HP 3420A differential VM, \$200; HP 3420B, \$250; Fluke 8010M, \$100; Fluke 8010A, \$100; HP 3455A, \$500; HP 3465A, \$150; Tektronix 130 LC meter, \$200; Keithley 503 milliohmeter, \$200. A-Comm Electronics, 303-290-8012, FAX 303-290-8133.

**HP 6453A power supply** 0-15 volt 0-200 amp, \$995. Dexis, 612-944-7670.

**DISTORTION ANALYZERS** HP 334A \$495, HP 332A \$295, HP 331A \$195, SOUND TECHNOLOGY 1700B distortion measurement set \$895, **30-day warranty & manual.** MasterCard & Visa accepted. **CALL 1-800-435-1516, FAX 908-280-0111.**



**DIGITAL PHASE METERS** 10Hz to 30MHz 0.01 Deg resolution, 1/2 LED display, autogain autozero, no adjustments, accepts any waveforms from 5mV to 50V peak. Prices start at \$395. **FREE** application manual for asking. **DIGITAL C, L METERS** Accurate bench top instruments with 0.001 pF and 0.001 uH resolution. Test frequency 1MHz down to 1kHz, accuracy 0.2%. Many more features, factory new. Prices start at \$380. All equipment manufactured in USA by TBE Electronics, PO Box 42, Candor, NY 13743. Tel. 607-659-3030/FAX 607-659-3650.

**WANTED: MEASURING & Test equipment,** microwave components, RF connectors, etc. **Top price paid!** Write or FAX you list to: Steigerwald GmbH, Ungerstrasse 180, D-80805 Munich, Germany. FAX 011-49-89-3615899.

**NEW MINIATURE** rubidium oscillators type FRS manf'd. 1995. Sealed boxes. \$1,100. Edward, 718-336-2015.

**EQUIPMENT MANUALS** we have 1000's of service and operators manuals for all types of test and measurement equipment from 1950 to present. All test equipment manufacturers are represented. Call, write, or fax your want list. Please include mfg.'s manual P/N unit serial numbers if known. **Manuals Plus**, Box 937, Spanaway, WA 98387. 206-531-8031 or FAX 206-536-1121.

**POWER SUPPLIES, ETC.** Sorensen SRL 40-50 0-40V 0-50A \$800. HP 6002A/001 autoranging 200 watt programmable \$700. HP 6227B 0-25V 0-2A dual tracking \$475. HP 6443B 0-120V 0-2.5A \$425. Tek PS 503A \$235. Xentek EIT 2.5-2 extreme isolation transformer (2.5KVA, 115V) \$250. Other ratings available. Kikusui PLZ 300W electronic load \$425. Pepper Systems, 214-353-0257.

**TEKTRONIX VERTICAL AMPS:** 7A42 350MHz 4 channel \$595. 7A13 105MHz differential \$350. 7A22 1MHz high sensitivity, differential \$375. 7A18 75MHz \$50. 7A18A 75MHz \$75. 7A18/6 (variable offset) \$110. 7A26 200MHz \$135. 7A24 400MHz \$250. 7A29 1000MHz \$750. Excellent condition, warranty. Pepper Systems, 214-353-0257.

**FUNCTION GENERATORS,** TEK FG501 2Hz to 2MHz \$195, TEK FG502 1KHz to 11MHz \$295, HP 3311A 0.1Hz to 11MHz \$195, Philips PM5191 programmable synthesized function generator 0.1MHz to 2MHz/IEEE \$895, **30-day warranty & manual.** Calibration available. MasterCard & Visa accepted. **CALL 1-800-435-1516, FAX 908-280-0111.**

**FLUKE BENCH METERS.** 8010A, 3.5 digit, has bat. opt. \$150. 8012A, 3.5 digit, has bat. opt. \$175. 8050A, 4.5 digit, has bat. opt. with factory carrying case, \$250. 8810A 5.5 digit \$250. 8840AF, 5.5 digit \$650. All units sold with cord, probes, certificate of calibration (NIST), and 90-day warranty. All units in excellent condition. Coppes Electronics, 520-432-1229.

**TIRED OF** paying high prices to get Tektronix, Hewlett Packard, Wavetek, IFR, etc., repaired, calibrated, certified? Give us a call. Free estimates, fast service. We also sell and rent test equipment. For information: Feitek, 2752 Walton, St. Louis, MO 63114. 314-423-1770.

**POWER SUPPLY SPECIALS.** HP 6291A, new color, exc. cond. 0-40 VDC, 0-5 amps, \$300. HP 6267B, new color, exc. cond. 0-40 VDC, 0-10 amps, \$350. Sorensen DCR 150-12B, good cond. 0-150 VDC, 0-12 amps, \$650. Electronic Measurements TCR 160T15, exc. cond. 0-160 VDC, 0-15 amp \$650. Lambda LK-350 0-20 VDC, 0-35 amps, good cond. \$350. All units come complete with calibration certificate and 90-day warranty. Coppes Electronics, 520-432-1229.

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## FM STEREO TRANSMITTER

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

FMST-100 Cabinet \$8.95 KIT \$29.95



## PHONE TRANSMITTER

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

TEL-B1 BUILT \$29.95 KIT \$12.95



## SUPER SNOOPER BIG EAR

Listen through walls, hear conversations across the room. Add a parabolic reflector and hear blocks away. The BIG EAR can be hidden about anywhere. Makes an ultra sensitive intercom. Can be used as a 1.5W AMP. We supply a mini-electret mike in the kit. Power requirement 6 to 12v DC. SIZE: 1.75" x 1"

AA-1 BUILT \$29.95 KIT \$10.95



## Press a button and learn every number dialed on your phone

Okay. Caller ID's tell you what number is calling you. But what about the calls made from your phone? Now, return from work or vacation and know the answer. The new DTMF Recorder electronically logs and saves every number dialed. This is the same high-tech magic used by detectives and government spies. Now yours. Does your wife or husband make expensive long-distance calls and then deny it? Does your son or daughter call that low-life you forbade them to talk to? Now know.

- Decodes digits 0 thru 9, \*, #, A, B, C, on a 2 line 16 character LCD display.
- Clicks into your phone or extension in seconds, with no special wiring or hassles, or jack it to the incoming service panel in your garage.
- Records all numbers dialed, including local numbers that don't appear on your bill.
- Records credit card numbers entered through your phone key-pad.
- Records Voice mailbox, answering machines, and modem access numbers.
- Records Cellular or repeater phone numbers heard over your phone. Even hook to a scanner, and learn scores of emergency phone numbers. Also decodes tones stored on a tape recorder. Never before has such sophisticated gear been available to the public. And not at this price. Power requirement 9v DC. SIZE: 3.5" x 4" x 1" BLACK ANODIZED ALUMINUM CABINET

DIS-1 KIT \$119.95 BUILT \$159.95



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

## KIT BOOK \$14.95

\$9.95 with the purchase of any kit.

## Press a button and learn every number dialed on your phone

Okay. Caller ID's tell you what number is calling you. But what about the calls made from your phone? Now, return from work or vacation and know the answer. The new DTMF Recorder electronically logs and saves every number dialed. This is the same high-tech magic used by detectives and government spies. Now yours. Does your wife or husband make expensive long-distance calls and then deny it? Does your son or daughter call that low-life you forbade them to talk to? Now know.

- Decodes digits 0 thru 9, \*, #, A, B, C, on a 2 line 16 character LCD display.
- Clicks into your phone or extension in seconds, with no special wiring or hassles, or jack it to the incoming service panel in your garage.
- Records all numbers dialed, including local numbers that don't appear on your bill.
- Records credit card numbers entered through your phone key-pad.
- Records Voice mailbox, answering machines, and modem access numbers.
- Records Cellular or repeater phone numbers heard over your phone. Even hook to a scanner, and learn scores of emergency phone numbers. Also decodes tones stored on a tape recorder. Never before has such sophisticated gear been available to the public. And not at this price. Power requirement 9v DC. SIZE: 3.5" x 4" x 1" BLACK ANODIZED ALUMINUM CABINET

DIS-1 KIT \$119.95 BUILT \$159.95

## WIRELESS FM MICROPHONE

Small but mighty this little jewel will out perform most units many times its price. It really stomps out a signal. The WM-2 kit is a buffered wireless mike that operates from 80MHz to 120MHz

FM, the frequency of any broadcast FM radio. Includes a mini-electret mike. 6 to 12v DC. SIZE: 1.25" x 1"



## MICRO-MINIATURE PHONE TRANSMITTER

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

MMPT2 KIT \$29.95



## MICRO-MINIATURE WIRELESS MIKE

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

MMWM5 KIT \$34.95



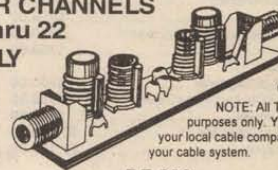
## STROBE LIGHT

Do you need an attention getter, warning light, or flashing light for model airplanes? Then this kit is for you. Use it as an emergency light for your auto, radio tower, even use it on your bicycle. Has a variable flash rate.

Power requirement 6 or 12v DC. Size 3.5" x 1.9"

ST-1 KIT \$11.95

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## OSCILLOSCOPES & ACCESSORIES

### TO 100 MHz

TEK 5440 50 MHz 4-Trace Oscilloscope System, w/25A48, 5B42	\$650.00
TEK 7A22 1 MHz High CMRR Differential Amplifier	\$350.00
TEK 7B53A 100 MHz Dual Time Base	\$175.00
TEK SC502 15 MHz Dual Trace Oscilloscope, TM500 series	\$375.00

### ABOVE 100 MHz

TEK 475 200 MHz Dual Trace Oscilloscope	\$850.00
TEK 485 350 MHz Dual Channel Oscilloscope	\$1,100.00
TEK 7104 1 GHz Oscilloscope, with 7A29, 7A29-04, 7B10, 7B15	\$5,000.00
TEK 7854 400 MHz Waveform Processing Oscilloscope frame	\$1,250.00
TEK 7904 500 MHz 4-slot frame	\$500.00
TEK 7904 500 MHz System, with 7A24, 7A26, 7B92A	\$1,000.00
TEK 7904 500 MHz System, with 7A24, 7A26, 7B80, 7B85	\$1,000.00
TEK 7A19 600 MHz Single Channel Amplifier	\$175.00
TEK 7A24 400 MHz Dual Trace Amplifier	\$350.00
TEK 7A26 200 MHz Dual Trace Amplifier	\$175.00
TEK 7A29 1 GHz Single Channel Amplifier	\$550.00
TEK 7B15 1 GHz Delaying Time Base	\$450.00
TEK 7B80 400 MHz Delayed Time Base	\$175.00
TEK 7B85 400 MHz Delta Delaying Time Base	\$200.00

### STORAGE

TEK 7834 400 MHz Storage Oscilloscope, w/7A24, 7A26, 7B80, 7B85	\$1,250.00
TEK SC503 10 MHz Dual Trace Storage Oscilloscope, TM500 series	\$700.00

### SAMPLING

TEK 7511 Sampling Unit	\$300.00
TEK 7111 Sampling Sweep Unit	\$750.00
TEK 7903/7511/7111/S-4 12 GHz Sampling Oscilloscope System	\$1,750.00
TEK S-4 14 GHz Sampling Head	\$500.00

### PROBES

TEK 1101 Accessory Power Supply, for FET probes	\$250.00
TEK P6201 900 MHz 1X/10X/100X FET Probe	\$500.00
TEK P6205 750 MHz 10X FET Probe, for TDS/DSA/CSA/11000 series	\$275.00
TEK P6701 opt.01 O/E Converter, 450-1050 nm/0-1 mW: DC-700 MHz, FC conn.	\$675.00

### CALIBRATION

TEK CG551AP/TM506A Oscilloscope Calibrator, with pulse head & power module	\$3,500.00
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## WAVEFORM GENERATORS

### FUNCTION

HP 3310A 5 MHz Function Generator	\$325.00
HP 3310B 5 MHz Function Generator, mono cycle & var phase trigger	\$425.00
HP 3312A 13 MHz Function Generator, sweep, AM, FM	\$850.00
HP 8015A 50 MHz Dual Output Pulse Generator	\$650.00
TEK D0501 Digital Delay & Burst Gen., for function & pulse gen's	\$375.00
TEK FG502 11 MHz Function Generator, TM500 series	\$325.00
TEK FG504 40 MHz Function Generator, TM500 series	\$875.00
TEK RG501 Ramp Generator, TM500 series	\$225.00
WAVETEK 148A 20 MHz Function Generator, AM/FM/PM modulation	\$750.00
WAVETEK 188 4 MHz Sweep/Function Generator, 20 Vp-p waveform generators	\$275.00

### PULSE

HP 214B 10 MHz Pulse Generator, 50 V/50 Ohms, auto duty cycle	\$1,950.00
HP 8005B 20 MHz Dual Output Pulse Generator	\$450.00
HP 8007B 100 MHz Pulse Generator	\$650.00
HP 8013B 50 MHz Dual Output Pulse Generator, 3.5 nS fixed Tr	\$600.00
HP 8015A-002 50 MHz Dual Output Pulse Generator, burst mode option	\$750.00
HP 8080A/81A/82A/83A 300 MHz Word Generator	\$600.00
HP 8080A/91A/92A/93A 1 GHz Single Channel Pulse Generator	\$950.00
HP 8080A/91A/93A 1 GHz Clock Generator	\$600.00
HP 8082A 250 MHz Dual Output Pulse Generator	\$1,400.00
PHILIPS PM57/85B 125 MHz Dual Output Pulse Gen., burst mode, 1 nS Tr	\$1,100.00
TEK PG501 50 MHz Pulse Generator, TM500 series	\$300.00
TEK PG502 250 MHz Pulse Generator, Tr<1nS, TM500 series	\$700.00
WAVETEK 801 50 MHz Pulse Generator	\$550.00

### PROGRAMMABLE

HP 3325A Synthesizer / Function Generator, 1 uHz-21 MHz	\$2,500.00
HP 3325A-002 Synth/Function Gen., 1 uHz-21 MHz, 40V out 1 uHz-1 MHz	\$2,650.00
HP 8160A 50 MHz Programmable Pulse Generator, HP1B	\$2,500.00
HP 8165A Programmable Signal Source, 1 mHz-50 MHz	\$2,600.00
TEK AWG5102 Arb. Waveform Gen., 20 MS/s, 12 bits, 50ppm synthesis <1MHz	\$1,400.00
TEK AWG5105 Arbitrary Waveform Generator, 50 MS/s, 12 bits	\$1,700.00
TEK AWG5105-opt.02 Arbitrary Waveform Generator, dual channel option	\$2,200.00
TEK PFG5505 Programmable 12 MHz Pulse/Function Generator	\$900.00

## VOLTAGE & CURRENT

### VOLT METERS

HP 3456A 6-1/2 Digit Voltmeter	\$850.00
SOLARTRON 7150 5-1/2 digit Multimeter, GPIB	\$450.00

### CALIBRATION

FLUKE 332B/AF DC Voltage Calibrator, 0-1111V, 0-50 mA, 7 decades	\$675.00
FLUKE 343A DC Voltage Calibrator, 0-1100V, 7 decades, 20 ppm acc	\$1,375.00
FLUKE 5100B-03.05 Calibrator, DC/Wideband AC/ Ohms, GPIB	\$4,750.00
FLUKE 515A Portable Calibrator, DC/AC/Ohms, line & battery power	\$1,700.00
HP 11049A AC Thermal Converter, 3V, 20 Hz-100 MHz	\$175.00
VALHALLA 2703 AC Volt.Std., 0-120V/10 Hz-100 kHz; 120-1200V/10 Hz-1 kHz	\$2,500.00

### VOLTAGE SOURCES

HP 6114A Precision Dual Range Power Supply, 20V 2 A / 40 V 1 A	\$875.00
HP 6115A Precision Dual Range Power Supply, 50V 0.8A / 100V 0.4A	\$875.00

### CURRENT METERS & SOURCES

DRANETZ 656A (3)TR2019A Current Demand Analyzer, w/3 current probes 300A max.	\$5,000.00
HP 6177C DC Current Source, to 50V, 500mA	\$600.00
HP 6181C DC Current Source, to 100V, 250 mA	\$675.00
HP 6186C DC Current Source, to 300V, 100mA	\$750.00
KEITHLEY 414A Picoammeter, 0.1 nA-10 mA	\$325.00
KEITHLEY 642 Electrometer	\$3,900.00
LEEDS & NORTHROP 4360 Precision Current Shunts, 15-500 Amp	\$650.00
TEK CT-5 High Current Transformer for P6021/A6302, to 1000A	\$650.00
VALHALLA 2575A AC/DC Active Current Shunt, 20 mA-100 A, DC-10 kHz	\$1,000.00

## IMPEDANCE & COMPONENT TEST

### L.C.R.

BOONTON 62AD 1 MHz Inductance Meter, 2-2000 uH	\$700.00
E.S.I. 296V 4-1/2 Digit LCR Bridge, 120 Hz & 1 kHz	\$850.00
HP 4261A 3-1/2 digit LCR Meter, 120 Hz/1 kHz	\$1,100.00
HP 4262A-003.004 3-1/2 digit LCR Meter, 120 Hz/1 kHz, HP1B	\$2,000.00
HP 4271B-101/16022A 1 MHz LCR Meter, 10 pF-10 nF/ 1-1000 uH, HP1B, w/fixture	\$900.00
E.S.I. RS-925 9-Decade Resistor, 0.01 ohm-1.2 Megohm	\$1,600.00
E.S.I. SR1010 Resistance Transfer Standards, 1 ohm-100 K/step	\$700.00
FLUKE 5450A Programmable Resistance Standard, 2 & 4 wire	\$2,750.00
GR 1409-SERIES Standard Mica Capacitors, 0.05% accuracy	\$1,500.00
GR 1413 5-Decade Precision Capacitor, 0-1.1110 uF, 1 pF res.	\$1,375.00
GR 1432-N 5-Decade Resistor, to 11,111 ohms, 0.1 ohm res.	\$275.00
GR 1432-U 4-Decade Resistor, 0-111.1 ohms, 0.01 ohm resolution	\$125.00
GR 1433-X 6-Decade Resistor, to 111,111.0 ohms, 0.1 ohm res.	\$550.00
GR 1434-G 7-Decade Resistor, 0-1,111,111.0 ohms, 0.1 ohm res.	\$500.00

### HI & LO RESISTANCE

GR 1666 DC Resistance Bridge, 1 micro-ohm - 100 kilohms	\$750.00
HP 4329A High Resistance Meter, 5E5-2E16 Ohms, 10-100V test	\$1,350.00
VALHALLA 4150-ATC 4-1/2 digit Ohmmeter, 20 milliohms-2 kilohms, 4-wire	\$1,000.00

### CURVETRACERS

TEK 576 Curve Tracer, with standard test fixture	\$2,350.00
TEK 577D1/177 Storage Curve Tracer, with standard test fixture	\$2,250.00
TEK 7CT1N Curve Tracer, to 0.5W, 7000 series	\$400.00

### T.D.R.

TEK 1503-opt.04 Time Domain Reflectometer, 0-50,000 feet, chart recorder	\$2,000.00
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### SINGLE OUTPUT

HP 6023A Autoringing Power Supply, to 20V / 30 A / 240 Watts	\$1,000.00
HP 6031A Autoringing Supply, to 20V / 120 A / 1000 W max., HP1B	\$2,000.00
HP 6038A Autoringing Supply, to 60V / 10 A / 200 W max., HP1B	\$1,600.00
HP 6201B 20V at 1.5A CV/CC Power Supply	\$200.00
HP 6207B 160V at 200 mA CV/CC Power Supply	\$300.00
HP 6228B Dual 50V at 1 A CV/CC Power Supply, tracking	\$650.00
HP 6260B-027 10V at 100A CV/CC Power Supply	\$675.00
HP 6261B-027 20V at 50 A CV/CC Power Supply	\$675.00
HP 6263B 20V at 10 A CV/CC Power Supply	\$400.00
HP 6266B 40V at 5 A CV/CC Power Supply	\$400.00
HP 6267B 40V at 10 A CV/CC Power Supply	\$550.00
HP 6268B-027 40V at 30 A CV/CC Power Supply	\$850.00
HP 6299A 100V at 750 mA CV/CC Power Supply	\$250.00
HP 6384A 4.0-5.5V at 8 A CV/CC Power Supply	\$175.00
HP 6439B 60V at 15 A CV/CC Power Supply	\$550.00
HP 6448B 60V at 1.5 A CV/CC Power Supply	\$850.00
KEITHLEY 240A HV Power Supply, 0-1200V, 0-10 mA, CV/CL	\$250.00
SOERENSON DCR 110-45T 110V at 45 A CV/CC Power Supply	\$2,200.00
SOERENSON DCR 300-8A 300V at 8 A CV/CC Power Supply, 208/230VAC line	\$950.00
SOERENSON SRL 60-8 60V at 8 A CV/CC Power Supply, low noise	\$950.00

TEK PS501-1 Power Supply, 0-20V, 2 mV res., 400 mA, TM500 series	\$175.00
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### MULTIPLE OUTPUT

HP 6227B Dual 25V at 2 A CV/CC Power Supply, tracking	\$650.00
HP 6253A Dual Output 20V 3 A CV/CC Power Supply	\$500.00
HP 6255A Dual Output 40V 1.5 A CV/CC Power Supply	\$500.00
TEK PS5010 Programmable Triple Power Supply, TM5000 series	\$800.00

### MISCELLANEOUS

HP 59501A HP1B Isolated DAC/Power Supply Programmer	\$175.00
HP 6824A Bipolar Power Supply/Amplifier, to 50V, 1 A	\$400.00
HP 6827A Bipolar Power Supply/Amplifier, to 100V, 500 mA	\$800.00
KEPCO BOP-100-4M 100V, 4 A Four Quadrant Bipolar Supply / Amplifier	\$1,000.00
KEPCO BOP-36-5M Bipolar Op Amp/Power Supply, to 36V, 5 A	\$550.00

## TIME & FREQUENCY

### UNIVERSAL COUNTERS

HP 5314A 100 MHz/100 nS Universal Counter	\$225.00
HP 5315A-001 100 MHz/100 nS Universal Counter, TCXO reference	\$650.00
HP 5316A-003 100 MHz/100 nS Universal Counter, HP1B, 1.0 GHz C-chan.	\$1,000.00
HP 5335A 200 MHz Universal / Statistical Counter	\$1,500.00
HP 5370B-001 100 MHz Univ. Time Int. Counter, 20 pS single shot, OCXO	\$2,250.00
HP E1420A-010, 030VXI card 200 MHz/2 nS Univ. Counter, TCXO & 2.5 GHz C-ch	\$900.00
PHILIPS PM6654/056 120 MHz/2 nS Programmable High Res. Counter, OCXO, GPIB	\$950.00
TEK 7D15 225 MHz Universal Counter/Timer, 7000 series	\$275.00
TEK DC500A Programmable 100 MHz/100nS Counter/Timer, TM5000 series	\$350.00
TEK DC5009 Programmable 135 MHz Univ. Counter/Timer, TM5000 series	\$600.00
TEK DC5010 350 MHz/3.125 nS Univ. Counter, TM5000 series	\$1,000.00
TEK DC503A 125 MHz Universal Counter/Timer, TM500 series	\$450.00
TEK DC509 135 MHz High Resolution Universal Counter/Timer, TM500	\$550.00
TEK DC510 350 MHz/3.125 nS Universal Counter, TM500 series	\$750.00

### FREQUENCY COUNTERS

FLUKE 7220A-opt.111 1.3 GHz Communications Counter, TCXO option	\$650.00
HP 5305B/5300B-001 1.3 GHz Counter Package w/TCXO ref., high res. audio	\$450.00
HP 5340A-001, 011 18 GHz Frequency Counter, OCXO reference, HP1B	\$1,900.00
HP 5340A-005, 011 23 GHz Frequency Counter, HP1B	\$2,000.00
HP 5342A 18 GHz Frequency Counter	\$2,350.00
HP 5342A-001, 011 18 GHz Frequency Counter, OCXO, HP1B	\$2,750.00
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 5343A-001 26.5 GHz Frequency Counter, OCXO reference	\$4,250.00
HP 5345A/5355A/5356A-06 Pulse/CW Frequency Counter, 0.4-18.0 GHz, HP1B	\$3,500.00
HP 5361A-006 20 GHz Pulsed/CW Frequency Counter, 10 Watt protection	\$6,750.00
HP 5382A 225 MHz Frequency Counter	\$200.00
SYSTRON-DONNER 6054B 24 GHz Frequency Counter	\$1,875.00
SYSTRON-DONNER 6245A-opt. 12 18 GHz Frequency Counter, OCXO option	\$1,500.00
TEK 7D14 525 MHz Frequency Counter, 7000 series	\$175.00
TEK DC504 80 MHz Frequency Counter	\$125.00

### STANDARDS

HP 105A Quartz Oscillator, 0.1/1.0/5.0 MHz	\$750.00
HP 5087A-031 Distribution Amp., 0.1/1.0/5.0 MHz x 4 channels each	\$1,800.00
HP 5359A Time Synthesizer, pulse width 5 nS-160 mS, jitter <200pS	\$2,000.00

## AUDIO & BASEBAND

### SPECTRUM ANALYZERS

HP 3581A Wave Analyzer, 15 Hz-50 kHz	\$850.00
HP 3586C Selective Level Meter, 50 Hz-32.5 MHz, 50 & 75 ohms	\$1,200.00
HP 8556A LF Section, 20 Hz-300 kHz	\$500.00
TEK 7L5-opt.25/R7603 Spectrum Analyzer, 20 Hz-5 MHz, 10 Hz res., w/display	\$2,250.00

### DISTORTION ANALYZERS

HP 334A Distortion Analyzer, 5 Hz-600 kHz, -60 dB, auto nulling	\$550.00
HP 339A Distortion Analyzer, built-in low distortion osc.	\$2,400.00
HP 8903A Audio Analyzer, 20 Hz-100 kHz, THD, SINAD, S/N	\$2,750.00
TEK DA408A Programmable Distortion Analyzer, 0.0025% THD, w/frame	\$1,500.00

### RMSVOLT METERS

FLUKE 8920A True RMS Voltmeter, 180 uV-700V, 10 Hz-20 MHz	\$700.00
HP 3400A RMS Voltmeter, 10 Hz-10 MHz	\$250.00
HP 400FL AC Voltmeter, 100 uV-300 V f.s., 20 Hz-4 MHz	\$200.00





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## OSCILLATORS

FLUKE 6011A Synthesized Generator, 10 Hz-11 MHz, 10 Hz res.	\$1,200.00
HP 204D Oscillator, 5 Hz-1.2 MHz, 5 VRMS, 80 dB step attenuator	\$200.00
HP 209A Sine/Square Wave Generator, 4 Hz-2 MHz, 5 VRMS max.	\$225.00
HP 652A Test Oscillator, 10 Hz-10 MHz	\$300.00
ROCKLAND 5100 Synthesizer, 1 mHz-1.999999999 MHz	\$400.00
TEK SG502 Sine/Square Osc., 5 Hz-500 kHz, 70 dB step atten, TM500	\$350.00

## MISCELLANEOUS

HP 3575A-002 Phase-Gain Meter, 1 Hz-13 MHz, dual display	\$900.00
HP 4437A Step Attenuator, 0-119.9 dB, DC-1 MHz, 600 ohms unbal.	\$200.00
KROHN-HITE 3202 / 3202R Dual High-Pass/Low-Pass Filter, 20 Hz-2 MHz, 24 dB/oct	\$600.00
KROHN-HITE 3342 Dual HP/LP Filter, 0.001 Hz-99.9 kHz, 48 dB/octave	\$1,100.00
TEK AM502 Differential Amplifier, 0.1 Hz-1 MHz, TM500 series	\$575.00

## RF & MICROWAVE

## SPECTRUM ANALYZERS

HP 11970A WR28 Harmonic Mixer, 26.5-40 GHz	\$1,100.00
HP 11970K WR42 Harmonic Mixer, 18.0-26.5 GHz	\$1,100.00
HP 11970QWR22 Harmonic Mixer, 33-50 GHz	\$1,400.00
HP 11970UWR19 Harmonic Mixer, 40-60 GHz	\$1,400.00
HP 11971A WR28 Harmonic Mixer, 26.5-40 GHz, for 8569B	\$1,100.00
HP 11971K WR42 Harmonic Mixer, 18.0-26.5 GHz, for 8569B	\$1,100.00
HP 5371A Modulation Domain Analyzer, 125 mHz-500 MHz	\$5,900.00
HP 8406A Comb Generator, 1/10/100 MHz increments, to 5 GHz	\$450.00
HP 8443A Tracking Generator, for 8553B, LED display	\$700.00
HP 8444A Tracking Generator, 0.1-1300 MHz, for 8554B	\$800.00
HP 8444A-059 Tracking Generator, 0.5-1500 MHz, for 8554, 8568, etc.	\$1,500.00
HP 8445B Preset Selector, 1.8-18.0 GHz, for HP 8555A	\$800.00
HP 8552B IF Section	\$750.00
HP 8553B RF Section, 1 kHz-110 MHz	\$500.00
HP 8554B RF Section, 0.1-1250 MHz	\$800.00
HP 8554B/8552B/141T Spectrum Analyzer, 100 kHz-1250 MHz, 100 Hz resolution	\$2,000.00
HP 8555A RF Section, 0.01-18 GHz	\$950.00
HP 8555A/8552B/141T Spectrum Analyzer System, 10 MHz-18 GHz, 100 Hz res.	\$2,250.00
HP 8555A/8552B/8445/141 As above, w/1.8-18 GHz Preset Selector, opt.003 freq display	\$3,000.00
HP 8558B/181TR Spectrum Analyzer, 0.1-1500 MHz, 1 kHz res., w/display	\$2,250.00
TEK 496P Spectrum Analyzer, 10 kHz-1.8 GHz, 30 Hz res., GPIB	\$5,500.00
TEK 712/7613 Spectrum An., 100 kHz-1.8 GHz, 300 Hz min res., w/display	\$1,875.00
TEK 718/7603 Spectrum Analyzer, 1.5-18.0 GHz, 30 Hz res., w/display	\$3,400.00
TEK TR503 Tracking Generator, 0.1-1800 MHz, for 492/4/5/6	\$1,750.00

## NETWORK ANALYZERS

HP 11590A Bias Network, 1.0-12.4 GHz, N(f)	\$375.00
HP 11590A-001 Bias Network, 1.0-18.0 GHz, APC7	\$450.00
HP 11665B Modulator, 0.15-18.0 GHz, for use with 8755/6/7	\$375.00
HP 8407A/8412A/8601A Network Analyzer, 100 kHz-110 MHz, with sweep generator	\$1,250.00
HP 85021A Directional Bridge, 0.01-18.0 GHz, APC7, for 8755/6/7	\$1,200.00
HP 85027E Directional Bridge, 10 MHz-26.5 GHz, for 8757 series	\$2,000.00
HP 85050D APC7 Calibration Kit, for 8510 series	\$1,100.00
HP 8505A-005/8503A Network An., 0.5-1300 MHz, w/S-Parameter & phase lock	\$5,000.00
HP 8755C(3)/11664A/181T 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
NARDA 7000A/7202/7206 Microwave Multimeter System: scalar analysis 0.1-18 GHz	\$1,950.00
WILTRON 560/3x-7550 Scalar Network Analyzer, w/3 detectors, 0.01-18.5 GHz	\$2,000.00
WILTRON 640/G50E(2)/7B50(2) Network An., w/1-1500 MHz source, (2) log amp, (2) det.	\$1,675.00

## SIGNAL GENERATORS

FLUKE 6060A/AN Synthesized Signal Gen., 10 kHz-520 MHz, 10 Hz res, GPIB	\$2,000.00
FLUKE 6060A-488.651 Synth. Signal Gen., 0.1-1050 MHz, 10 Hz res., GPIB	\$3,200.00
FLUKE 6062A Synthesized Signal Gen., 0.1-2100 MHz, 10 Hz res., GPIB	\$8,000.00
GIGATRONICS 600/10-18, opt.06 Synthesized Source, 10-18 GHz, 1 MHz res., OCXO, GPIB	\$3,000.00
GIGATRONICS 6050/01-8.0, opt.3 Synthesized Source, 10 MHz-8 GHz, 1 kHz res., GPIB	\$3,000.00
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	\$7,000.00
GIGATRONICS 910/12-18, opt.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 Signal Generator, 0.5-512 MHz, AM, FM	\$1,500.00
HP 8640B-001,002,003 Signal Gen., 0.5-1024 MHz, AM, FM, var. audio osc.	\$2,750.00
HP 8654A Signal Generator, 10-520 MHz, calibrated AM & uncal. FM	\$625.00
HP 8656A Signal Generator, 0.1-990 MHz, AM, FM, HPIB	\$2,900.00
HP 8660C/86602B/8663B Synthesized Signal Generator, 1-1300 MHz, AM, FM	\$2,750.00

HP 8660C/86603A/86633B Synth. Sig. Gen., 1-2600 MHz, AM, FM, digital sweep	\$4,500.00
HP 8683B Signal Generator, 2.3-6.5 GHz, AM, WBFM, Pulse	\$5,000.00
HP 8684B Signal Generator, 5.4-12.5 GHz, AM, WBFM, Pulse	\$5,000.00
WILTRON 6742A Synthesizer/Sweep Generator, 18.0-26.5 & 26.5-40.0 GHz	\$9,000.00

## SWEEP GENERATORS

GIGATRONICS 900/0.05-12, opt.3 Synthesized Sweep/Sig. Gen., 50 MHz-12 GHz, 1 kHz res.	\$4,500.00
HP 8350A/86290B-H08 Programmable Sweep System, 2.0-22.0 GHz, +4 dBm lvd	\$5,500.00
HP 8601A Generator/Sweeper, 0.1-110 MHz, +20 dBm levelled	\$500.00
HP 8620C Sweep Oscillator Frame \$550.00	
HP 8620C-011 Sweep Oscillator Frame, HPIB programmable	\$675.00
HP 86220A RF Plug-in, 10-1300 MHz, +10 dBm levelled	\$800.00
HP 86222B RF Plug-in, 10-2400 MHz, +13 dBm levelled, xtal markers	\$1,500.00
HP 86222B-002 RF Plug-in, 1.8-4.2 GHz, +10 dBm unlevelled	\$1,750.00
HP 86230B RF Plug-in, 1.8-4.2 GHz, +10 dBm unlevelled	\$675.00
HP 86240A RF Plug-in, 2.0-8.4 GHz, +16 dBm levelled	\$1,000.00
HP 86241A-001 RF Plug-in, 2.0-8.4 GHz, +13 dBm levelled	\$1,000.00
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-001 RF Plug-in, 8.0-12.4 GHz, +10 dBm levelled	\$700.00
HP 86260A RF Plug-in, 12.0-18.0 GHz, +10 dBm unlevelled	\$1,000.00
HP 86260A-H04 RF Plug-in, 10.0-15.0 GHz, +10 dBm unlevelled	\$1,100.00
HP 86290A RF Plug-in, 2.0-18.0 GHz, +7 dBm levelled	\$1,750.00
HP 86290B RF Plug-in, 2.0-18.6 GHz, +10 dBm levelled	\$2,250.00
HP 86290C RF Plug-in, 2.0-18.6 GHz, +10 dBm levelled	\$2,500.00
WAVETEK 1001A Sweep Generator, 0.5-300 MHz	\$350.00
WAVETEK 907 Sweep/Sig. Gen., 7.0-11.0 GHz, 0 dBm levelled	\$1,000.00
WAVETEK 954 Signal/Sweep Generator, 3.7-7.6 GHz, +7 dBm unlevelled	\$1,750.00
WAVETEK 962 Sweep Generator, 1.0-4.0 GHz, markers, +12 dBm unlvld	\$2,000.00
WILTRON 6619A-003 Prog. Sweep Gen., 2.0-8.0 GHz, +10 dBm levelled, GPIB	\$1,900.00
WILTRON 6637A-40,02 Sweep Gen., atten., 2.0-18.6 GHz, +14 dBm levelled, 70 dB	\$4,500.00
WILTRON 6647A-40,02 Sweep Gen., 0.01-18.6 GHz, +14 dBm levelled, 70 dB atten.	\$6,500.00

## POWER METERS

BOONTON 4200-01B/-4G Power Meter w/sensor, 1 MHz-26.5 GHz, -60 to +10 dBm, GPIB	\$1,500.00
BOONTON 42B41-4E Analog Power Meter, with 1 MHz-18 GHz sensor	\$650.00
BOONTON 42B42A-S3 Analog Power Meter, with 1 MHz-8.4 GHz N(f) sensor	\$375.00
GENERAL MICROWAVE 476/4240A Power Meter & Sensor, 0.01-18 GHz, -35 to +10 dBm	\$375.00
HP 11683A Range Calibrator, for HP 435/6/7/8	\$750.00
HP 432A/478A Power Meter, 0.01-10 GHz, -20 to +10 dBm f.s.	\$375.00
HP 432A/8478B Power Meter, 0.01-18 GHz, -20 to +10 dBm f.s.	\$500.00
HP 432C Autoranging Digital Power Meter, 10 uW-10 mW f.s.	\$425.00
HP 435A/8481A Power Meter, 10 MHz-18 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/8483A Power Meter, 0.1-2000 MHz, -30 to +20 dBm, 75 ohms	\$1,000.00
HP 435A/8484A Power Meter, 10 MHz-18 GHz, -70 to -20 dBm	\$1,000.00
HP 436A Digital Power Meter	\$1,200.00
HP 436A-022 Digital Power Meter, HPIB option	\$1,400.00
HP K486A/WR42 Thermistor Mount, 18.0-26.5 GHz, for 432 series	\$400.00
HP Q486A Power Sensor, 33.0-50.0 GHz, WR22, for 435/6/7/8	\$1,500.00
HP R486A WR28 Thermistor Mount, 26.5-40.0 GHz, for 432 series	\$400.00

## RF MILLIVOLTMETERS

RACAL 9303TRMS Level Meter, 10 kHz-2 GHz, -77 to +23 dBm, GPIB	\$875.00
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## AMPLIFIERS, MISCELLANEOUS

ALITECH 7616 Noise Source, 10-12.4 GHz, N(m), 15 dB ENR	\$375.00
ALITECH 7618E Noise Source, 10 MHz-18 GHz, SMA(m), 15 dB ENR	\$500.00
AMPLIFIER RESEARCH IW1000 Amplifier, 30 dB gain, 1-1000 MHz, 1 Watt output	\$650.00
BOONTON 824D FM/AM Modulation Meter, 10-1200 MHz	\$800.00
ENI 3100LA Amplifier, 55 dB, 0.25-150 MHz, 100 Watts	\$4,250.00
ENI 403LA Amplifier, 37 dB gain, 150 kHz-300 MHz, 3 Watts	\$700.00
ENI 550L Amplifier, 50 dB, 1.5-400 MHz, 50 Watts	\$3,750.00
ENI A300 Amplifier, 55 dB, 0.3-35.0 MHz, 300 Watts	\$3,500.00
HP 11720A Pulse Modulator, 2-18 GHz, +80 dB on/off ratio	\$500.00
HP 8447A-001 Dual Amplifier, 0.1-400 MHz	\$500.00
HP 8801A-001,002,010 Modulation Analyzer, 150 kHz-1300 MHz, OCXO, int. cal.	\$5,500.00
HP 8901B-001,003 Modulation Analyzer, 150 kHz-1300 MHz	\$9,000.00
HUGHES 1177H02R000 TWT Amplifier, 30 dB, 4-8 GHz, 10 Watts	\$1,750.00
M.P.D. LAB2-1020-2A Amplifier, 34 dB, 1.0-2.0 GHz, 2 Watts	\$1,000.00
M.P.D. LAB2-714-3A Amplifier, 34 dB, 0.7-1.4 GHz, 3 Watts	\$1,000.00
MARCONI TET204 AM/FM Modulation Meter, 18-1000 MHz, FM dev. 1.5-150 kHz	\$500.00
MICROWAVE SEMI.CORP MC5112 Noise Source, 25.5 dB ENR, 1.0-12.4 GHz, N(m), +28VDC	\$325.00

## COAXIAL & WAVEGUIDE

ADAMS-RUSSELL 1538-5013 High Power Coaxial Jumper Cable, 5 ft. length, LC(m/m)	\$50.00
AMERICAN NUCLEONICS AM-432 Cavity Backed Spiral Antenna, LHC, 2-18 GHz, TNC(f) "NEW"	\$95.00

BIRD 8325-30 30 dB Attenuator, 500 Watts, DC-500 MHz	\$325.00
FXR/MICROLAB S3-02N Triple Stub Tuner, 200-1000 MHz, 100 Watts max., N(m/f)	\$90.00
GR 874-LTL Constant Impedance T rombone Line, 0-44 cm, DC-2 GHz	\$450.00
GR 900-LB Precision Slotted Line, 0.3-8.5 GHz, 50 Ohms 0.1% tol.	\$450.00
GR 900-Q GR900 14mm Interseries Adapters	\$125.00
HP 11691D Directional Coupler, 22 dB, 2-18 GHz	\$500.00
HP 11692D Dual Directional Coupler, 22 dB, 2-18 GHz	\$900.00
HP 11742A DC Blocking Capacitor, 0.01-26.5 GHz, APC3.5(m/f)	\$135.00
HP 33300 Detector, 0.01-33.0 GHz, APC3.5(m)/SMC(f)	\$275.00
HP 775D Dual Directional Coupler, 20 dB, 450-940 MHz	\$275.00
HP 776D Dual Directional Coupler, 20 dB, 940-1900 MHz	\$275.00
HP 777D Dual Directional Coupler, 20 dB, 1.9-4.1 GHz	\$275.00
HP 778D Dual Dir. Coupler, 20 dB, 100-2000 MHz, N(m/f/r/f)	\$550.00
HP 778D-011 Dual Dir. Coupler, 20 dB, 100-2000 MHz, APC7(N/f/r/f)	\$400.00
HP 8472A Crystal Detector, 10 MHz-18 GHz, neg. pol., SMA(m)	\$150.00
HP 8497K-004 Programmable Step Attenuator, 0-90 dB, DC-26.5 GHz, APC3.5	\$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 Q752D WR22 Directional Coupler, 20 dB, 33-50 GHz	\$650.00
HP R422A WR28 Flat Broadband Detector, 26.5-40 GHz	\$400.00
HP R532A WR28 Frequency Meter, 26.5-40.0 GHz	\$500.00
HUGHES 45342H-1110WR22 Dual Directional Coupler, 10 dB, 33-50 GHz	\$875.00
KRYTAR 20202016 Directional Det., 2-20 GHz, SMA(f/m)/SMC(f), 10 uV/uW	\$200.00
M/A-COM 3-19-300/10WR19 Directional Coupler, 10 dB, 40-60 GHz	\$450.00
MILLIWAVE S91-1777B Amplifier, 0.1-18.6 GHz, +19 dBm Po, SMA(f)	\$150.00
MINI-CIRCUITS ZHL-2000 Amplifier, 20 dB, 10-2000 MHz, +15 dBm Po, 15VDC	\$85.00
NARDA 26298 20 dB Attenuator, 150 Watts, DC-1 GHz, N(f)	\$200.00
NARDA 3000-SERIES Directional Couplers	\$150.00
NARDA 3022 Bi-Directional Coupler, 20 dB, 1-4 GHz	\$350.00
NARDA 3024 Bi-Directional Coupler, 20 dB, 4-8 GHz	\$300.00
NARDA 3090-SERIES Precision High Directivity Couplers	\$225.00
NARDA 3696NF High Power Termination, 175 Watts, 0.7-18 GHz, N(f)	\$325.00
NARDA 4000-SERIES SMA Miniature Directional Couplers	\$75.00
NARDA 4203-6 Directional Coupler, 6 dB, 2-18 GHz, SMA(f/r/f)	\$225.00
NARDA 4246B-10 Directional Coupler, 10 dB, 6-18 GHz, SMA(f)	\$100.00
NARDA 5070-SERIES Precision Reflectometer Couplers	\$300.00
NARDA 769-30 30 dB Attenuator, 150 Watts, DC-6 GHz, N(f/m)	\$275.00
NARDA 792F Variable Attenuator, 0-20 dB, 2.0-12.4 GHz	\$375.00
OMNI-SPECTRA 2082-5810-02 Adj. Phase Trimmer, 8-18 GHz, 10 deg./GHz range, SMA(m/f)	\$50.00
PAMTECH KYG1014WR42 Junction Circulator, 18.0-26.5 GHz	\$250.00
PRD N233A/232 Slotted Line, 3-12 GHz, N(m/f), w/cariage & detector	\$175.00
SPACE LABS DQ-1WR22 Flat Broadband Detector, 33-50 GHz	\$550.00
TRG V510WR15 Precision Rotary Vane Atten., 0-50 dB, 50-75 GHz	\$1,000.00
TRG V551 WR15 Frequency Meter, 50.0-75.0 GHz	\$600.00
TRG V559-10 WR15 Directional Coupler, 10 dB, 50-75 GHz	\$400.00
WEINSCHEIB 3200-1 Programmable Step Attenuator, 0-127 dB, DC-2 GHz, SMA "NEW"	\$200.00
WILTRON 60A50-opt.1 SWR Bridge, 5-2000 MHz, APC7 test port, 46 dB dir.	\$550.00
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HP 5005A Signature Multimeter	\$350.00

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HP 8170A-002 Logic Pattern Generator, 2 MB/s, address driver option	\$1,400.00
TEK 1240 Logic Analyzer, w/(36) 50 MHz channels	\$1,500.00

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HP 59401A HPIB Bus Analyzer	\$700.00
TEK 1410R-opt.04 NTSC Test Signal Gen. w/SPG2.TSG1.TSP1.TSG3.TSG5.TSG6	\$2,750.00
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## News

### LOW-COST 2.4 GHZ VIDEO/AUDIO TRANSMITTER SYSTEM



This video/audio transmitter system combines low cost, long range, and broadcast-quality FM synthesized performance. The reliable FCC approved transmitter penetrates walls and floors for an effective range of up to 300 feet. The transmitter accepts standard NTSC video and stereo audio. The receiver offers line video and stereo audio outputs, as well as modulated channel 3 VHF output.

The system offers four-channel operation, with the ability to operate all four channels simultaneously in the same area. This provides the user with tremendous flexibility for wireless security/surveillance applications. Antennas are circular polarized patch style for broadcast-quality reception.

Power requirement is 12 volts DC on both the transmitter and receiver, making battery operation an easy option. The system comes complete with DC power supplies and all necessary connecting cables.

Security/surveillance, multiple satellite reception, and robotics/toyvision are just a few of the many potential applications of this system. Complete system is available directly from Supercircuits for \$199.95.

For more information, contact:

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### UNIVERSAL SCPC-200



The new Universal SCPC-200 Audio Receiver is the latest state-of-the-art, microprocessor-controlled audio SCPC receiver which incorporates every needed feature for high-quality reception of

all SCPC audio networks. This fully flexible receiver allows the reception of all SCPC channels on any satellite. The SCPC-200 is completely frequency and transponder agile with automatic LNB drift compensation.

Transponder, frequency, bandwidth, service name, and memory channel in use are prominently displayed on an easy-to-read LCD display.

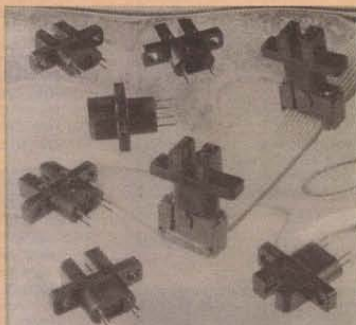
Some of the SCPC-200 features are: Easy direct frequency tuning — 50 to 90 MHz; direct transponder tuning; large memory bank — 50 channels; automatic LNB drift compensation (ADC); companding, 1:1, 2:1, 3:1 (automatic); bandwidth selection, wide or narrow; automatic tuning indicators; digital frequency lock-on (DFL); service name on LCD display; commercial digital synthesizer; and baseband 70 MHz output.

A totally new audio section produces high-quality, low distortion broadcast-quality sound at the line output or 8 ohm speaker output. The input frequency of the SCPC-200 receiver is 950 to 1450 MHz. All C-Band and Ku-Band channels are compatible with the SCPC-200. The SCPC-200 measures 12"W x 1-3/4"H x 8"D and weighs 8 lbs. Power requirements are: 110 volts AC, 60 cycles or 12 volts DC at 500 mA.

For more information, contact:

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### PRIM OPTICAL POSITION SENSOR



**RADOVAN** introduces the "Plug Ready Interrupter Module" (PRIM) optical position sensor.

Each sensor gives an "in position" or "position limit" indication on a TTL compatible signal line. Position is sensed when an opaque "flag" blocks a PRIMs infrared light beam.

PRIMs differ from similar sensors in that they plug directly into commonly available 10-pin IDC ribbon cable connectors. That eliminates soldering, individual wire crimping, and additional circuit boards at the sensor mounting location. Wiring is further simplified by using a single 10-conductor ribbon cable for each pair of PRIMs.

The suggested retail price is \$4.95.

For more information, contact:

**RADOVAN ROBOTICS**  
1-800-400-2654

### VIDEO TX



**MTX 2000**, from M & G Technology, is a video transmitter using Frequency Modulation (FM) for both audio and video, which allows transmission of images (black and white or color) and sound up to 4 KM in ideal conditions. Working frequency is 1 to 2.5 GHz and RF power output is 50 mW + 1-3 dB.

The device is ready for installation of an omni-directional antenna directly mounted on the RF output connector and may be used in any situation where power is provided by a battery. Receivers and antennas of several types, filters, and amplifiers for a variety of uses are also available.

For more information, contact:

**M & G TECHNOLOGY**  
262 CHAMBERLAYNE RD.  
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### 50Ω AND 75Ω RETURN LOSS BRIDGES

**AVCOM** introduces three new Return Loss Bridges, models RLB-1000-50, RLB-1300-50, and RLB-1000-75. The RLB-1000-50 and RLB-1300-50 are 50Ω bridges with a broad frequency coverage of 5 to 1000 MHz and 5 to 1300 MHz respectively, and excellent directivity of >45 dB. The RLB-1000-75 has an impedance of 75Ω with a directivity of >45 dB in the 5 to 600 MHz band, and slightly less machined aluminum housings, with a choice of SMA, N, and BNC connectors.

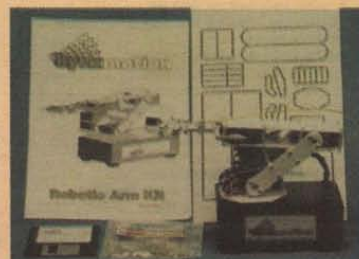
Size is 5" x 2.25" x 1", and weight 1 pound.

US domestic price RLB-1000-50 \$375.00, RLB-1300-50 \$435.00, and RLB-1000-75 \$435.00.

For more information, contact:

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The arm has light power requirements and can be powered from a nine-volt and a six-volt lantern battery.

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The Level 1 kit is \$60.00 and uses RC servos you provide. It includes all hardware, structural components, software, and illustrated assembly manual with information on the MiniSSC Servo Controller by Scott Edwards Electronics. The Level 2 kit is \$180.00. It includes the Level 1 kit plus servos and controller. Add \$7.50 S & H USA, \$15.00 all others.

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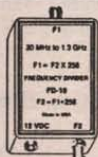
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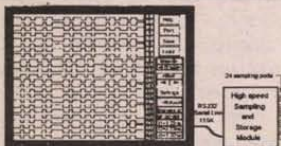
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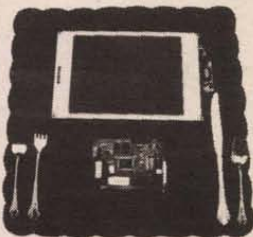


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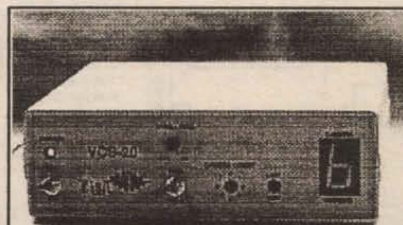
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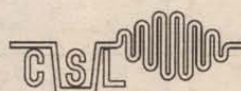
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# Voice Recording and Playback: Look — No Tape!

by Ronald Reis  
and  
Jimmy Te

No tape, no CDs, no complex A/D or D/A converters, and no microprocessor. It's all done with a unique, readily available, inexpensive Direct Analog Storage Technology (DAST) integrated circuit from Information Storage Devices, found at Radio Shack and other distributors.

With the most popular DAST chip — the ISD1020A — up to 20 seconds of sound (voice, music, dogs barking, etc.) can be recorded simply by speaking into an inexpensive microphone. The chip stores up to 128,000 analog sample-and-hold bits into an on-board EEPROM. After data has been stored, the memory is maintained without power. Playback, through an eight-ohm speaker, is accomplished with the flick of a switch.

The ISD1020A chip requires just a few external components and in a power down application runs forever on four AA cells.

Applications abound: fridge-box message center, portable voice notepad, medicine chest alert, talking toys, doorbell announcer — the list is endless.

## How the ISD1020A Works

The ISD1020A is an amazing chip. In one 28-pin DIP package, there is contained a microphone preamp, an automatic gain control (AGC), anti-aliasing and smoothing filters, a storage array, a speaker driver, a control interface, and an internal precision reference clock (Figure 1). There are, as mentioned above, no analog-to-digital or digital-to-analog circuits.

Using an analog-sampled data system, the ISD1020A takes each sample, temporarily stores it in a sample-and-hold circuit, and eventually records it into a single Electrically Erasable Programmable Read Only Memory (EEPROM) containing 128,000 cells. With a sample rate of 6.4 KHz, a waveform element is "grabbed" every 156.25 microseconds ( $T = 1/f; = 1/6.4 \text{ KHz}; = 156.25 \text{ uS}$ ). Thus, with 128,000 cells available, 20 seconds of sound can be recorded ( $156.25 \text{ uS} \times 128,000 = 20$

seconds).

The ISD1020A can be made to begin recording or playing at any point within a 20-second period. When a record or play cycle is initiated by the chip enable (CE) pin, the IC reads the address pins' states and operation starts at the indicated address. More on this later.

The IC also has a special Operation Mode. When pins 9 and 10 are both tied high, several special features, including automatic looping and sequence message generation, can be activated. I'll discuss the Operation Mode shortly.

Actually, the ISD1020A is one of two chips in the ISD1000A series, the other being the ISD1016A. "Our" chip will record for 20 seconds, that's what the 20 in the part number means. The ISD1016A will record for 16 seconds.

## The ISD Voice Record and Playback Family

Besides the ISD1000A series, Information Storage Devices offers other voice record and playback integrated circuits. The ISD1200 series, with the ISD1210 and ISD1212 chips, record and playback for 10- and 12-second durations, respectively.

There is the ISD1400 series (identical to the ISD1000A series except it has an automatic power down mode), consisting of the ISD1416 and ISD1420, having 16- and 20-second delays, respectively. And the ISD2500 three-chip series, made up of the ISD2560, ISD2575, and ISD2590, can record and playback

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yacking — boy, will  
it blow your mind!

sound for 60, 75, and 90 seconds, as indicated in the last two digits of their part number.

For more information on the entire line of ISD Voice Recording and Playback ICs, you might want to obtain the company's 1996 Data Book (Part #2001195B001). Contact ISD at 2045 Hamilton Avenue, San Jose, CA 95125; Tel: (408) 369-2400, Fax: (408) 369-2422.

## The ISD1020A, Pin-for-Pin

In Figure 2, we see the pinouts for the ISD1020A. In Figure 3 is a detailed description of each pin function. Here are the highlights:

### \*Ground Inputs (VSSA, VSSD)

The ground inputs are at pins 12 (VSSD) and 13 (VSSA). Separate analog and digital ground busses are used.

### \*Voltage Inputs (VCCA, VCCD)

The voltage inputs are at pins 28 (VCCD) and 16 (VCCA). To minimize noise, the analog and digital circuits in the ISD1000A series devices use separate power busses.

### \*Power Down Input (PD)

The chip should be placed in the power down mode (pin 24) when not recording or playing back.

### \*Chip Enable Input (CE)

When the active-low CE pin (23) is taken low, all playback and record operations are enabled.

### \*Playback/Record Input (P/R)

When this pin (27) is brought low, the chip is in the record mode. When it is brought high, the IC will play back.

### \*End-of-Message (EOM)

At the end of each recorded message, a non-volatile marker is automatically inserted (pin 25). It remains there until the message is recorded over. During playback, the EOM output pulses low for 16 milliseconds.

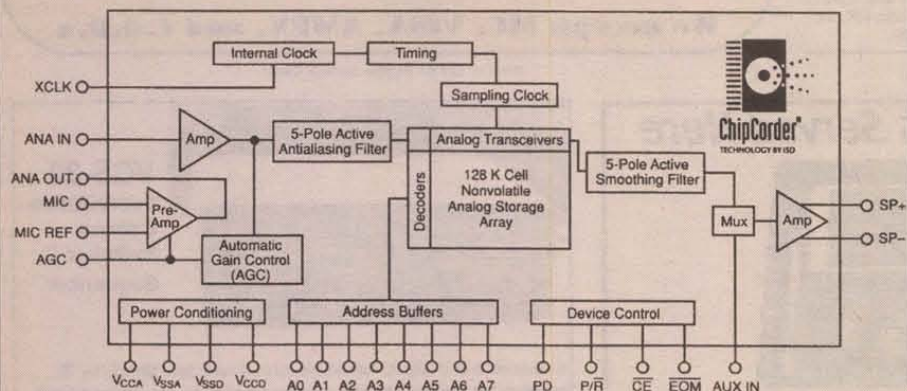
### \*Address/Mode Inputs (AX/MX)

The address/mode inputs (pins 1, 2, 3, 4, 5, 6, 9, and 10) provide two functions: 1. Message address (A6 or A7 = low); and 2. Operation mode options (A6 and A7 = high).

We'll look at other ISD1020A pins as we progress with circuit descrip-

ISD1000A SERIES BLOCK DIAGRAM

FIGURE 1



ISD1000A SERIES  
PINOUTS

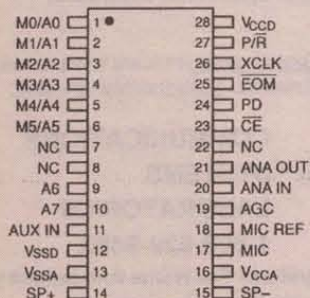


FIGURE 2

OPERATIONAL MODES TABLE

TABLE 1

Control Mode	Function	Typical Use	Jointly Compatible*
M0	Message cueing	Fast-forward through messages	M4, M5
M1	Delete EOM markers	Position EOM marker at the end of the last message	M3, M4, M5
M2	Cascading	Adding devices to extend message	
M3	Looping	Continuous playback from Address 0	M1, M5
M4	Consecutive addressing	Record/Play multiple consecutive messages	M0, M1, M5
M5	CE level-activated	Allow message pausing	M0, M1, M3, M4

NOTE: An asterisk (\*) indicates additional operational modes which can be used simultaneously with the given mode.



## PIN DESCRIPTION

FIGURE 3

Pin No.	Name	Function
1, 2, 3, 4, 5, 6, 9, 10	A0 — A7	Defines the starting address for messages or sets the device to an operation mode.
7, 8, 22	NC	No connection. Do not connect to these pins.
11	AUX In	When the device is in the play mode and not playing a message, the AUX input drives the speaker output. This lets other circuits use the speaker driver. This input is also used in cascading applications.
12, 13	VSSD, VSSA	Analog and digital grounds.
14, 15	SP+, SP-	These pins connect directly to a 16-ohm speaker without coupling capacitors. You can connect an 8-ohm speaker, but there will be distortion. Do not use a less than 8-ohm speaker. You can use either pin single-ended, with capacitive coupling. If either pin is not used, leave it disconnected. <b>Never short the pins or tie either to ground.</b>  When operating, the speaker pins are at about 1.5 volts. When not operating or recording, the speaker outputs are pulled to ground. <b>Do not parallel the speaker outputs with other signals. Doing so could damage this device or the other signal source.</b>
16, 28	VCCD, VCCA	Analog and digital power supplies. The device uses separate power buses for the analog and digital sections to minimize noise.
17	Mic	The microphone preamp can amplify 1- to 20-millivolt signals. This preamp has a 10 K ohm input impedance and a 24 dB maximum gain.
18	Mic Ref	This is the inverting input to the microphone preamp. This provides a noise-cancelling or common-mode rejection input to the device. Normally, connect a capacitor from this pin to analog ground. This capacitor should have the same value as the input coupling capacitor.
19	AGC	Connect a 470 K ohm resistor and a 4.7 $\mu$ F capacitor from this pin to ground. These components set the attack and release time constants for the Automatic Gain Control circuit in the microphone preamp.
20	Ana In	This pin goes to an input amp that drives the internal storage array.
21	Ana Out	This pin is the direct output of the Mic preamp.
23	CE	This pin starts play and controls record operations. CE is active low.
24	PD	This pin controls the power-down mode and resets the memory after the device records or plays to the end (overflow). The device powers down when this pin is high.
25	EOM	This pin outputs a 16-millisecond wide low pulse during play to indicate a message is finished. It outputs a constant low to indicate memory full.  <b>Note:</b> When the device records or plays to the end, you must pulse PD high and then return it low before you can begin additional record or play operations.
26	XCLK	Normally connect to ground. This enables the internal clock. You can drive this input with an external 819.1 KHz TTL-level clock.
27	P/R	The state of this pin when CE falls determines whether the device is in record (low) or play (high) mode.

**Note:** This book uses *low* and *high* for logic states of parts of the circuit. An input low is 0 volts or ground. An input high is the VCC supply — usually 5 volts. If a circuit output is low or high, the voltage is within a few tenths of a volt of these levels.

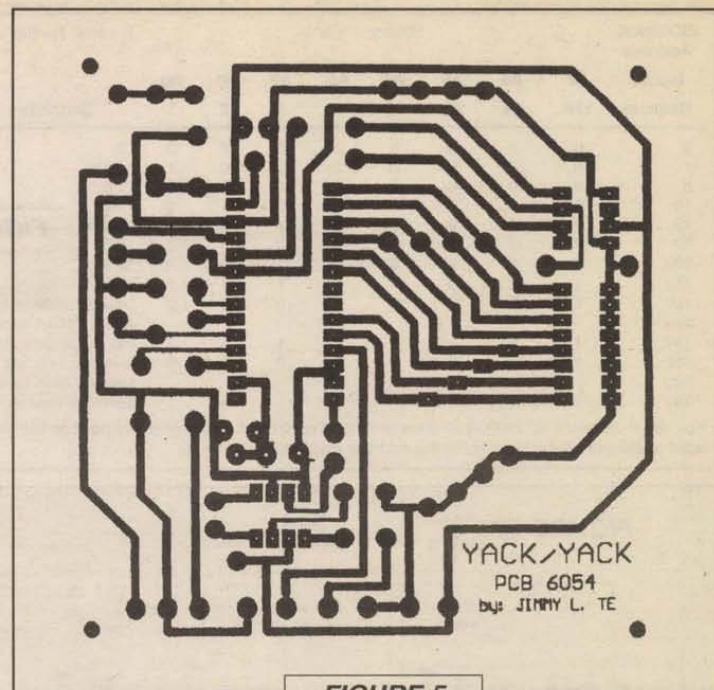
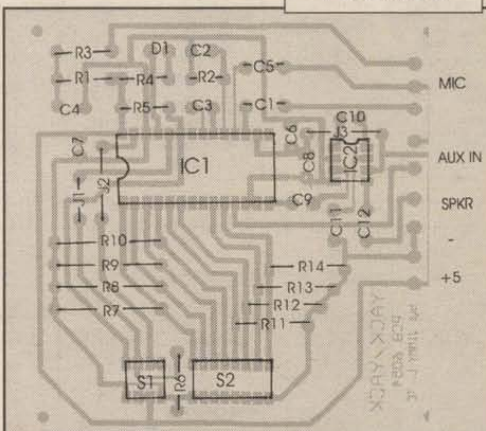


FIGURE 5



down, playback, and record functions.

- An LED detects an end-of-message condition. It remains off during record or play and turns on when a message ends.

- A three-terminal Electret microphone is used for recording. It is available at Radio Shack (Part No. 270-092).

- While a power amplifier is not mandatory, we've included one to boost audio

output.

- The only off-board components are the microphone, speaker, and power supply. For optimum sound, the speaker should be baffled, that is, placed in an enclosure. Four 1-1/2-volt AA cells can be used as a power source.

Assembly of the project is straightforward. Just be sure to place the right component in the right location and, if polarized, in the right direction. Also, follow standard, professional soldering techniques. When assembly is completed, check closely for solder bridges.

Once you've assembled the Yack/Yack project, and double-checked component placement and solder integrity, apply power and follow these steps to record and play a message:

### To record a message:

1. Load the start address with the eight-section DIP switches. For simplicity, set all switches closed. This begins recording at the start of the ISD1020A's memory space.
2. Set S3 (P/R) on the four-section DIP switch to off, or open. (Play is deactivated.)
3. Set S4 (P/R) on the four-section DIP switch to on, or closed. (Record is activated.)

- The eight active-high address lines — A0-A7 — are connected to an eight-section DIP switch, with eight 47 Kohm resistors used to pull respective pins high.

- A four-section DIP switch is used to activate the chip enable, power

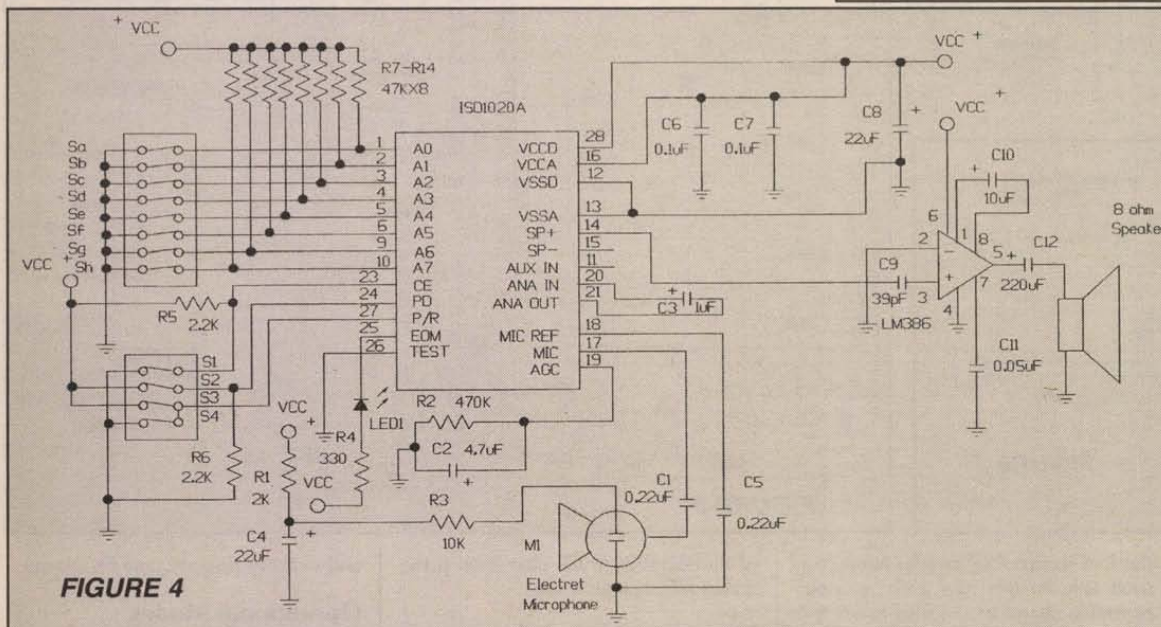


FIGURE 4

tions. Let's now turn to an examination of a basic record/playback circuit.

## The Yack/Yack: A Simple Record/Play Project

The schematic for a simple

record/play project — the Yack/Yack — with an audio power amplifier added is shown in Figure 4. The PCB board layout for the circuit is presented in Figure 5A, with the assembly drawing in Figure 5B. Note the following with regard to the circuit:



ISD1000A Address		Binary								0 = low; 1 = high
Inputs	A7	A6	A5	A4	A3	A2	A1	A0		
Decimal	128	64	32	16	8	4	2	1	Seconds	
0	0	0	0	0	0	0	0	0	0	
1	0	0	0	0	0	0	0	1	0.125	
8	0	0	0	0	1	0	0	0	1.0	
10	0	0	0	0	1	0	1	0	1.25	
13	0	0	0	0	1	1	0	1	1.625	
50	0	0	1	1	0	0	1	0	6.25	
100	0	1	1	0	0	1	0	0	12.5	
159	1	0	0	1	1	1	1	1	19.875	
160	1	0	1	0	0	0	0	0		
thru										
191	1	0	1	1	1	1	1	1		
192	1	1	0	0	0	0	0	0		
thru										
255	1	1	1	1	1	1	1	1		

Unused address space.  
An ISD1000A addressed in this region defaults to an overflow. This address space is used by the operation modes.

**FIGURE 6**

You can think of the ISD1000A as an analog tape recorder with the ability to position the record/play head anywhere on the tape within the address resolution.

**FIGURE 9**

section DIP switch. The previously recorded message plays. (If you keep S1 closed, the entire contents

However, by setting the ISD1020A's address lines, 160 different starting points can be obtained, 125 mS apart ( $160/20 \text{ sec.} = 0.125 \text{ seconds}$ ). You can now access multiple messages.

In Figure 6, we see a selection of address settings for the ISD1020A. The address-input decimal values are as follows: A0=1, A1=2, A2=4, A3=8, A4=16, A5=32, A6=64, and A7=128.

To start the record or playback function at a desired time, obtain the decimal value by dividing the time in seconds by 0.125. For example, if you want your record/playback to begin at the 10-second point in memory, divide 10 by 0.125. The result is 80. Thus, switches  $S_e$  and  $S_q$  would be set open.

FIGURE 10

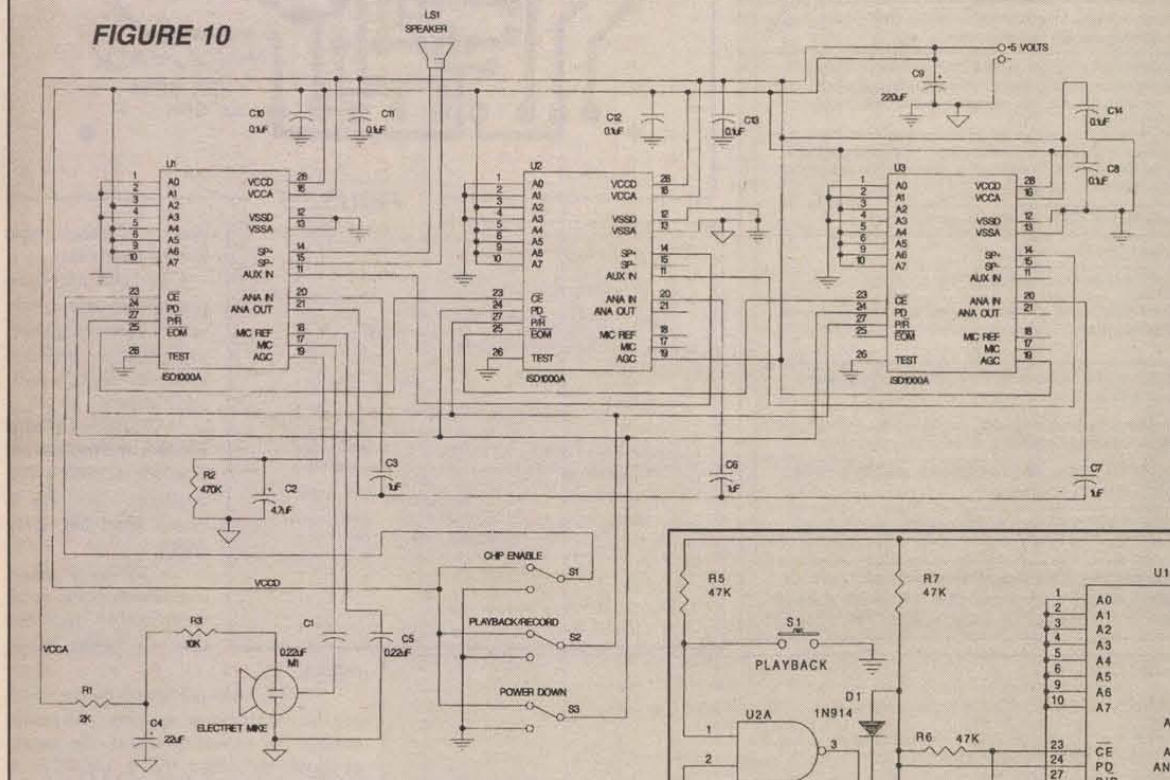
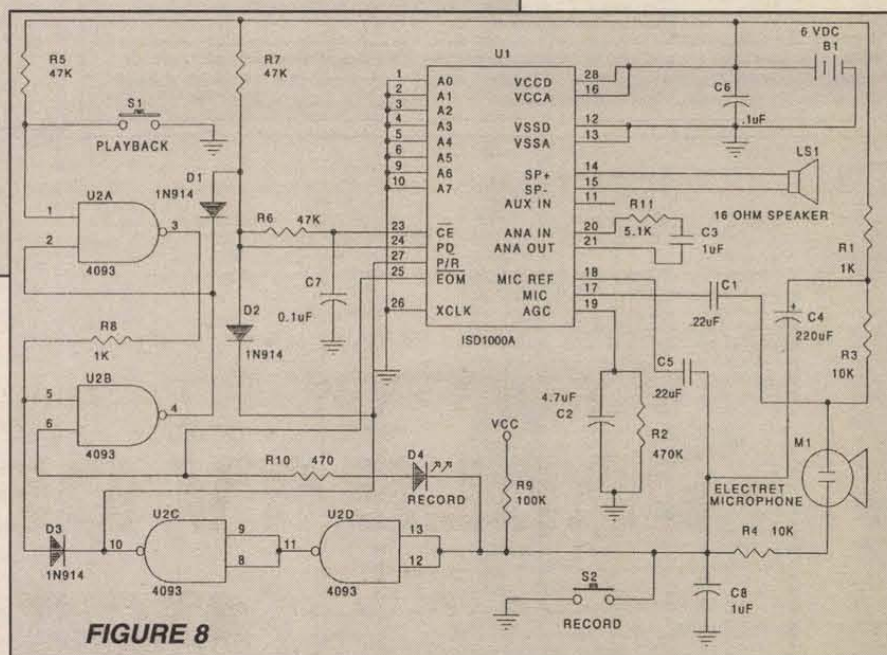


FIGURE 7



**FIGURE 8**

4. Set S1 (CE) on the four-section DIP switch to on, or closed, and begin recording. Open S1 to stop recording.

**To play a message:**

1. Set the eight-section DIP switches to the start address of the message. If you recorded from the beginning of the message space, set all switches low.

of the ISD1020A will play, even if the end-of-message bit is set.)

## Memory Addressing

By grounding all address inputs (A0-A7; DIP switches Sa through Sh are closed), the ISD1020A starts to record or play at the beginning of its allotted time. In fact, if you were content with always beginning record and play at the



sequential recording of messages to be combined into a single message. And there is message looping (M3), where you'll have a continuous playback from address 0. The complete listing of operational modes is shown in Table 1.

The operational modes are selected with the address pins. When the two Most Significant Bits (MSBs) are high (A6=1, A7=1), the remaining address signals are interpreted as mode bits, not as address bits. Hence, operational modes and direct addressing are not compatible and cannot be used simultaneously.

### A Simple Play-Only Circuit

You could stop here, that is, build the Yack/Yack project, fool around with various operating modes, and have fun recording and playing back messages. However, the ISD1020A cries out to be experimented with. If you're so inclined, grab your solderless circuit board, an ISD1020A, and a few support components. It's time to look at alternate circuits.

In Figure 7, we see a simple play-only circuit. After using your Yack/Yack project to make a recording, place the ISD1020A in a solderless circuit board and wire it as shown. Only two additional components are required: an on-off SPST switch and a speaker.

To play a message, set the switch to the +5-volt position. The ISD1020A plays the entire contents one time then stops. Because CE is tied low, the set

end-of message bits are ignored. Momentarily changing the switch to open then back to +5 volts makes the ISD1020A play again.

What can you do with such a play only circuit? How about embedding it within an object you would pick up to admire. Perhaps a picture frame? Imagine grandma's thrill the next time she visits and stops to admire her grandson's portrait on the mantle. As she picks it up, closing a hidden switch, little Johnny's prerecorded voice gushes forth with: "I love you grandma, you're the best." You get the "picture."

### Automatic Power Down Applications

Many applications for sound recording and reproduction, where battery power is necessary, require minimum power consumption. A circuit that achieves automatic power down in a record and play application is shown in Figure 8. Let's see how it works.

The cross-coupled latch, consisting of a 4093 Schmitt Trigger Quad two-input NAND package (U2A and U2B), works to control the PD and CE pins for the play mode.

Circuitry for the record mode consists of U2C and U2D plus several support components.

To start the record cycle, S2 supplies the ground to the microphone circuit and takes the input to U2D low. The Schmitt Trigger action of U2 debounces the logic inputs to the

ISD1020A. The output of U2C takes the P/R signal low and provides a low to the PD and CE pins through D2. Resistor R6 and capacitor C7 provide the CE set-up time between P/R going low and the beginning of the record cycle. Diodes D4 and D2 perform an OR function for the play and record operations. Diode D3 ensures that the cross-coupled gates cannot be set during a record operation.

### Playback Looping

If you want a message to repeat over and over again, automatically, the simple circuit in Figure 9 will do the trick. It uses the Operation Mode to accomplish playback looping as long as the message starts at Address 0 (the beginning of the memory) and does not require the full 20 seconds of analog storage.

A message is first recorded into an ISD1020A using the Yack/Yack project, with all address bits tied low. Next, connect the circuit in Figure 9. Note that Address bits A6 and A7 are tied high to enable the Operational Mode. Bit A3 is also tied high to enable Continuous Repeat. With PD low, P/R high, and CE held low, the beginning message in the ISD1020A will repeat.

### A One-Minute Cascade Circuit

You can cascade several ISD1020As to increase a system's

capacity.

A circuit to create a one-minute message is shown in Figure 10. With this configuration, a message is stored across chip boundaries in a manner transparent to the user. Changing from record to play resets the MSP to the beginning of the first message in the series. The next play proceeds under control of CE. The circuit operates exactly like that for a single device.

Believe it or not, we've only looked at a few select applications for sound recording and playback. To examine the complete range of chips in the ISD line of products, try obtaining a copy of the data book mentioned at the beginning of this article.

Now, have fun yakking away and recording every word. **NV**

PARTS LIST	
R1	2 kohm
R2	470 kohm
R3	10 kohm
R4	330 ohm
R5, R6	2.2 kohm
R7-R14	47 kohm
C1, C5	22 uF
C2	4.7 uF
C3	1 uF
C4, C8	22 uF
C6, C7	0.1 uF
C9	39 pF
C10	10 uF
C11	0.05 uF
C12	220 uF
IC1	ISD1000A
IC2	LM386
S1	4-section DIP switch
S2	8-section DIP switch
MIC	Electret microphone (Radio Shack 270-092)
SPKR	8-ohm speaker
6V	power supply

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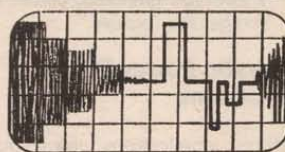
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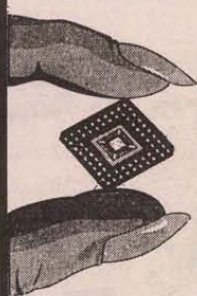
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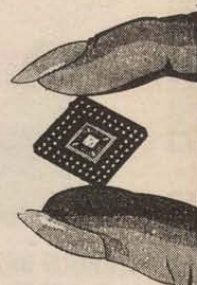
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**NIDEC-TORIN TA600S**  
.250/.20 AMP 3200 RPM  
IMPEDANCE PROTECTED.  
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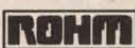
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100 PCS. @ 10¢ EA.  
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\*3.2VDC \*6.8AMP \$2.25



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Power Products  
Linear power supply module  
Input: 115VAC 50/60 271 ma  
OUTPUT: 5VDC 5000 ma  
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**CMOS EPROM #NMC27C256Q-200**  
28 PIN DIP 256K (32 X 8)  
SPEED 200 NS  
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**CURTIS INDUSTRIES #F1200AA20**  
10 AMP 250VAC - 20AMP 115VAC  
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.250" QUICK Connect terminals D.  
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PART # 615-8500

CONTROL VOLTS: 3-32VDC  
RATED: 10AMP @ 250VAC  
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OPTO ISOLATED - SPST  
Connection: screw or quick Connects

PRICE... 1 - 99 PCS. 100 PCS - UP  
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6 FT. RCA MALE TO RCA MALE  
BLACK CABLE MOLDED ENDS-  
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**3 COND 14 AWG**  
\* LENGTH: 4 FEET \* O.D. .375"  
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\* CSA APPROVED  
\* strip and untinned ends.  
Standard 3 prong molded plug.  
PRICE ..... \$1.25 EA.



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#23LQ-C202-01H

\*144 STEPS \*30 oz in. Hold torque  
\*BI POLAR - 2 PHASE

\*4 WIRE \*1.9 Vdc/PHASE  
\*0.75 AMP/PHASE

\*WEIGHT 3/4 LB  
\* SIZE: 1-1/2"H X 2-1/4"DIA

\*Mounting plate: 2-1/4"sq.  
SPECIAL SALE.. \$12.95



**CONTROL TRANSFORMER #522013**

\* PRIMARY: 120VAC  
\* Secondary 12V C.T. @ 4 AMP

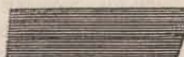
SIZE: 3 3/4"W X 3 1/8"H X  
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BASE MOUNT  
WEIGHT: 7 1/4 LBS

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Operates on a single  
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19.8W 30.6 Ohm

Int. Duty - Style D11

Quick connect terminals

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Lift & Stroke: 1/16" @ 55 oz.

3/4" @ 6 oz.

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PIN PART#	MFG	WIDTH	PACKAGED
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20 Som-320-G	Preci	.3"	18/TUBE 40¢ ea.
24 824-AG48D	AUGAT	.3"	20/TUBE 48¢ ea.
24 524-AG67D	AUGAT	.4"	18/TUBE 48¢ ea.

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Low Profile ic socket with chip capacitor. A more noise free alternative to sockets with leaded capacitors. GOLD plated pins - Body is Glass Epoxy Laminate.

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24	4462408446-1	EMC	.6"	25/TUBE	56¢

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HVY. DUTY AUDIO POWER CONNECTOR

5A @ 250VAC

HOUSING: DIE CAST-NICKLE PLATE

Contacts: copper

Insulator: red

polyamide

UL94V-0

3 POLE SOCKET

PRICE...



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"SUPERTWIST" modules utilize surface mount technology. Displays blue pixels on yellow/green background. modules have E-B backlighting - Graphic-Figure-Character display. Built in Drivers & 4 bit tti interface.

\*Control LSI: T6963C Toshiba

\*View Angle: 6:00

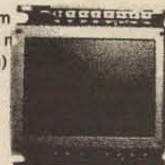
\*Dot Size .44(w) x .57(h) mm

\*Dot Pixels 143(w) x 153(h) n

\*View area 74.8(w) x 98.4(h)

\*Dc Voltage: 5vdc

List Price \$69.95



OUR PRICE..\$14.95

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FREQUENCY CONVERTOR #33-002

INPUT: 7.5 HORSE POWER, 3PHASE 60 HZ

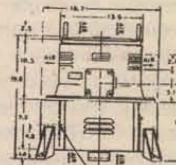
OUTPUT: 5 KVA, 1 PHASE 400 HZ

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WEIGHT 290 LB - NEW COST \$5400.00

BRIGAR SALE PRICE \$1400.00





# OVERBOARD ALARM

**A** water-activated emergency transmitter and companion alarm receiver has numerous applications for water and wet-snow emergencies. The best feature of the emergency transmitter unit is the capability of actually going underwater, and continuing to work once it floats free. The alarm system was so unique in its multitude of water-related applications that it was

The aeronautical and marine ELTs and EPIRBs are designed to international standards, and are monitored by low-earth-orbit COSPAS/SARSAT satellites. Marine and air ELT activations trigger satellites to retransmit the signal for Doppler analysis, or through the 406 MHz system store and forward on demand.

This modest ALERT has nothing to do with EPIRBs or ELTs. ALERT is different, and more along the proximity scheme of transmitters and receivers. This water-acti-

*by Gordon West*

ear interpolations.

With these FCC constraints on how much little power the emergency transmitter can put out to its built-in antenna, we were concerned that someone slipping overboard on a boat might drift out of range before they had enough time to hold the unit at water level or out of the water to get this small signal back to the receiver.

And most important, exactly how far away will the activated ALERT transmitter at 1 milliwatt on 418 MHz trigger the receiver?

To find this out, we first looked at the receiver design. The receiver is a superheterodyne, non-tunable, single-conversion, radio receiver with a local oscillator operating at 10.7 MHz. The heart of the receiver to offer the ultimate in sensitivity at 418 MHz is a sur-

need for individual inductors and capacitors in a regular filter network, and the SAW filter meets a variety of amplitude-response and time-delay requirements, and, most important for the manufacturing process, a relatively low cost.

The receiver draws 100 milliamps and contains a piezoelectric buzzer that is extremely loud when the reception of a signal and 512 Hz modulation is detected at 418 MHz. A latching transistor keeps the buzzer turned on after approximately two seconds of recognizing time. The buzzer may be manually reset, and a red light continues to illustrate an activated alarm.

The receiver works from 12 volts DC, at 500 mA, and incorporates a SAW filter.

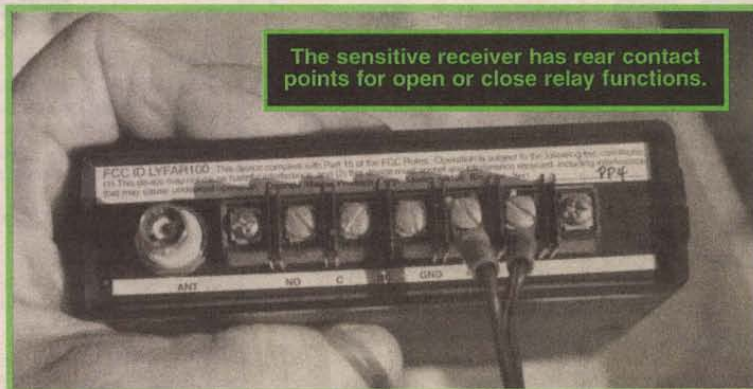


awarded the prestigious National Marine Manufacturer's Association product innovation award at a recent international marine trade show (IMTEC) held in Chicago. This prompted me to further investigate the product, and review its seaworthiness and allied applications in the snow.

This under-\$500 system is simply called "ALERT," and is designed and marketed by Emerald Marine Products in Seattle, WA (800-426-4201). The package contains the eight-ounce floatable emergency transmitter, quick-deploy pouch, two AAA batteries, and the 12-volt receiver/alarm unit that may operate fixed 12-volts, or part of a portable emergency beacon locator pack.

The transmitter is not your customary ELT (emergency locator transmitter) nor is it a marine EPIRB (emergency position indicating radio beacon). The aeronautical ELTs and marine EPIRBs operate on 121.5 MHz, plus simultaneous harmonic transmission on military 243 MHz, and category 406 marine EPIRBs transmit on 406.000 MHz.

The sensitive receiver has rear contact points for open or close relay functions.



ated and fully-submersible transmitter operates at 418.000 MHz maximum 1 milliwatt output, AM modulation with a 512 Hz. The 418 MHz is assigned as a fixed/mobile, catch-all band for proximity devices, including garage doors, car alarms, bugs, and other transmitters rated at -106 dBm with no more output than 1 milliwatt to classify as a Part 15 device.

FCC Rule 15.201(2)(e), a transmitter employed for radio control purposes during emergencies involving fire, security, AND SAFETY OF LIFE may, when activated to signal an alarm, operate during the pendency of the alarm condition.

FCC Rule 15.205(b), fundamental frequency 260 to 470, field strength of fundamental uV/M at three meters, 3750 to 12,500, lin-

face-acoustic-wave (SAW) filter consisting of 10 aluminum electrodes, like fingers, deposited on the surface of a piezoelectric substrate, usually Lithium Niobate (LiNbO3).

When an RF signal is applied to the input transducer, the electrodes generate an electric field between the fingers, causing the piezoelectric material to vibrate, creating an acoustic wave on the surface. When the wave reaches the output transducer, it is converted back to an electric field between the fingers. It is within this field that a voltage across a load resistor is generated. The center frequency of the SAW device is 407.3 MHz, and this frequency, along with the physical fingers, determine the Q of the filter. This SAW filter eliminates the

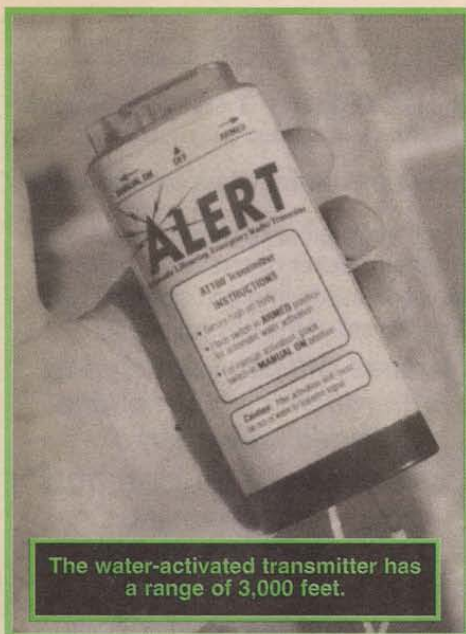


A bright orange pouch will affix the transmitter to a life vest for water activation.

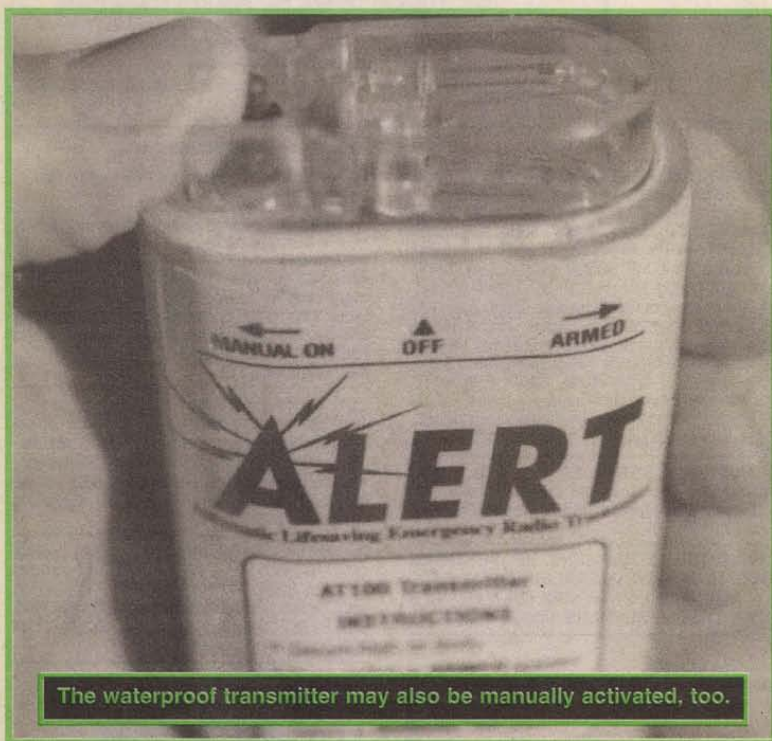
On the back of the receiver are contact points for normally open or normally closed auxiliary alerting devices. This could be an electronic siren, bell, buzzer, or even a kill-switch on a boat's engine. The receiver terminates to a BNC receptacle, and the included rubber-duck antenna is only for proximity testing, and not designed for longer range reception.

Josef Tuttle, Vice-President of Emerald Marine Products, recommends a variety of auxiliary gain antennas that will dramatically boost reception range to an in-water alert device. Emerald Marine works closely with Morad, a well-known commercial marine radio antenna manufacturer located nearby in the Pacific Northwest.





The water-activated transmitter has a range of 3,000 feet.



The waterproof transmitter may also be manually activated, too.

Our test antenna was a half wave-length, industrial-quality Morad antenna cut specifically for 418 MHz, requiring no additional ground plane. Coax was low-loss RG/213 to permit the receiver to be mounted down below in a boat, with the antenna up on the bridge.

The transmitter is water-activated automatically when switched to the armed position. When fresh water or sea water, or even wet-snow, bridge the bottom contact points, the transmitter automatically cycles on, and a tiny strobe light confirms the activated ALERT. You don't hear anything other than the strobe oscillator doing its sweep thing. The strobe is truly anemic and really couldn't help much for a nighttime rescue. However, it would

give the overboard person the confidence (if you have any left over, after going overboard) that the device is operating properly.

The transmitter features a variety of washers, gaskets, seals, and O-rings to allow it to pass a one-hour, under-10-feet-of-water test. "The unit only has to be waterproof on the surface, so a 10-foot test should allow for pressure of waves, falling off of a speed boat," comments Tuttle. I ran it in the water for several hours, and the unit continued to operate properly.

Our first tests were conducted over a dry sandy beach. We immediately concluded that the

enced on land increased by five times. Same thing with fresh water tests at a nearby lake — get the unit over water, and reception range dramatically increases.

We later determined that sea water and mineral-laden fresh water are good reflectors at 418 MHz, and this is why the tremendous increase in range over dry sand or pavement.

There was also a test on snow with this device, and the snow pack gave us the same range reflectivity as did fresh water. Several emergency groups were contemplating using the alert device as an avalanche victim locator. Someone getting covered up by an avalanche would probably have enough moisture within the snow around his or her body for the unit to self-activate, and a portable alert receiver would begin to sound off when taken to the proximity of a buried transmitter. At this point, the antenna system would be reduced in capabilities until the alert would only go off directly over the buried victim. Start shoveling.

In boat activations, it is imperative that the alert transmitter be at water level or held slightly above water level. The attenuation of UHF signals just one inch below the ocean or lake level is so great that absolutely no reception is obtained beyond 30 feet. The manufacturer recommends placing the unit high up on a personal floatation device (PFD) so an unconscious victim could still achieve automatic water activation. Once the contact points see water between them, the unit still continues to transmit even though the connection dries out. There is also a manual switch for manual transmitter activation.

One mariner was going to purchase several transmitters and affix them to dog harnesses for their pets onboard. Between the shoulder blades on a big animal would certainly achieve automatic water activation, plus probably above-water positioning once the animal comes up for air.

It is the submersible capabilities of the transmitter that truly make this unit stand out from simple security activator devices. I have monitored the 418 MHz channel and have heard little activity on it. Most garage door activators have their own frequencies well separated from this channel.

So, if you are looking for an industrial-strength, water-activated, UHF alarm system, give them a call at Emerald Marine Products, and see how this type of transmitter and companion receiver/alerting device could very well save a life this summer when out on the water, or right now in the winter out in the snow. **NV**

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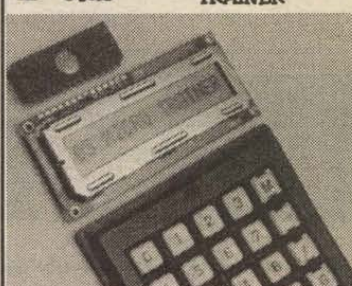
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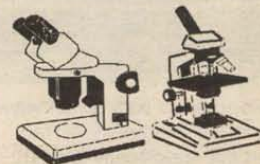
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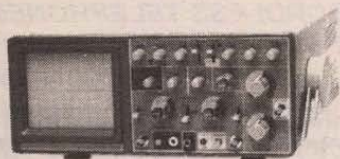
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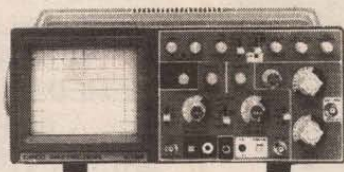
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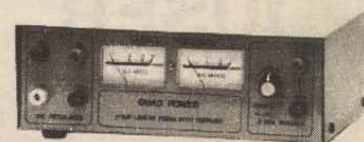
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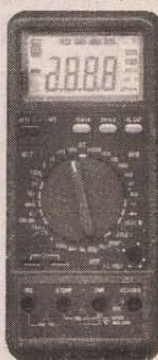
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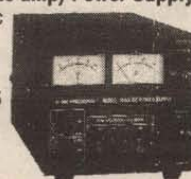
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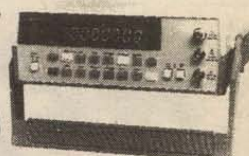
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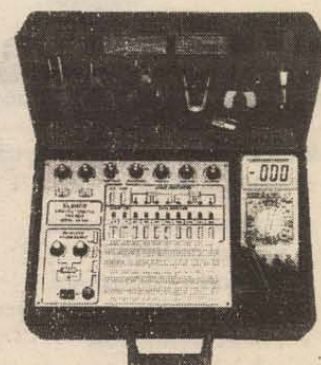
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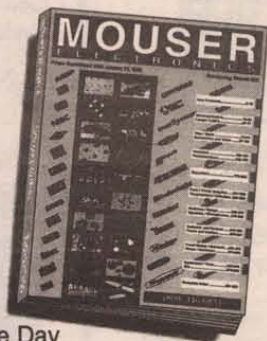


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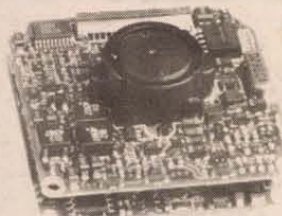


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# Questions & Answers

# 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 am looking for information on an EPROM programmer Model EP 804 made by a company named Digelec. Does anyone know anything about this programmer or the company?

**3961** **Mike Young**  
Newville, AL

I am designing a particular receiving antenna for my stereo so that the signal "coming in" will keep its "composure" whenever somebody walks through the room. Do I need an inside or an outside antenna? And if so, would a TV antenna "extend" the reception? I am now experimenting with an element from an electric stove that looks like a circle and/or spiral. Any more ideas that I could try, or any suggestions?

**3962** **Sean Ingram**  
Amelia, VA

I need a belt diagram for a Telefunken Magnetophon 204TS-4 reel-to-reel tape machine (German). I have a manual and circuit diagrams. I need to know where drive belts go.

**3963** **David Pickwell**  
Austin, TX

How can I read tire air pressure in a car with gauges mounted on the car's dash?

**3964** **Roland Siller**  
Benson, NC

I need a 10 minute timer that lights up one LED each minute, with low-battery drain, resettable by means of a light touch, no noise, and useable in an office environment.

**3965** **LeRoy W. Ferber**  
Voorhees, NJ

Does anybody have an idea how to build a universal sync generator that will be able to restore vertical and horizontal sync? A schematic and a parts list would be great.

**3966** **Ernst Faublas**  
Brooklyn, NY

I do not own a computer. I own several video machines for creating amateur films. Where can I buy a color processor or video device that will enable me to copy a color video tape and make the copy into a black and white tape? I want a device that will let me control the colors.

**3967** **Sal Favia**  
Aberdeen Township, NJ

My Radio Shack ET 900, 900 MHz cordless phone, suffers from low volume to second party unless I deliberately talk directly into mouthpiece. The microphone has been changed. It has

done this since new, works well otherwise.

**3968** **Anonymous**

I need help with two (IPS 400 and 600 Elgar) power backups. Both suddenly quit switching to battery power on, power off conditions. Batteries are new and voltage stays up at 28 volts. The first one quit last year, so I got another from ERAC. It quit in eight months. They are flat and fit under the monitor which I really like. I don't want any upright models. (ERAC does not advertise in *Nuts & Volts* anymore.)

**3969** **G. Schneeweiss**  
Forrest, IL

A profound hearing loss requires  $\pm$  2 dB output of audio frequencies from 125 to 1,500 Hz. What instruments are available to measure tape deck output at these frequencies?

**39610** **Carl Stevenson**  
Monroe, LA

What are your reader's ideas for constructing a transmitter receiver combination, much like a garage door opener that has the following characteristics:

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**39611** **George W. Iwasko**  
Ontario, NY

My keyboard freezes in Windows 3.1 or is sluggish passing characters to applications like MS Word 6.0 or Excel. It misses characters sometimes. It also returns to operation if you restart Windows or sometimes if you unplug and replug the keyboard at the motherboard while operating. I have tried the obvious, like swapping out keyboard without results. I even swapped keyboard BIOS with an identical replacement. The machine is a 486DLC40 clone, 128K cache, Cyrix 387, FPU 8 meg memory, DOS 6.0, Smartdrv 5.0. How do you start troubleshooting this problem?

**39612** **George Persico**  
Thiells, NY

My '87 Nissan Pulsar's low-fuel sensor has quit. Verified by grounding the sensor lead at the gas tank which

lights the indicator lamp. The sensor is not available separately from the dealer, who wants \$245.00 for new fuel pump unit which includes the sensor. It appears to be similar to a thermistor, with low resistance when not immersed in gasoline and high resistance when wet with gas. Can someone suggest a replacement device or put me onto an alternate source?

**39613** **George Persico**  
Thiells, NY

I would like information on the connector connections, voltage levels, and signal protocols of the "LANC" connector on the Sony CCD-FX310 Handycam. I have a service manual from Sony entitled "Protocol of Control L/Lf," but it covers the Sony VTR.

**39614** **Cliff Mueller**  
Reno, NV

I have a Radius TPD-19 grey-scale monitor that has a "fold-over" on the left portion of the display. I need assistance in getting this monitor repaired. I have removed the diodes in the horizontal area, and they look fine on a VOM. When I originally got this monitor, the horizontal sync was off, and I was able to at least get a stable picture by adjusting the horizontal frequency control (R413).

**39615** **Mike Schwendeman**  
Hampton, MN

## ANSWERS

### ANSWER TO #29618 - FEB. 1996

If you are asking if you can hook a camcorder up to your computer and use its real time output as moving wallpaper, the answer is no. You can, however, purchase a video caption board, hook it to your camcorder, capture some images and save the images as BMP files in the Windows directory. Then go into Windows and set the wallpaper to these newly created BMP files. An easier solution is to buy a 12-exposure roll of 35mm film. Go out and take some pictures you would like as wallpaper. Have them developed on a picture CD-ROM, which is available at many processing locations, and use a graphics file converter utility to change the pictures from whatever format they come in to BMP files. I did this with pictures of my family and converted them to BMP files. I use them as wallpaper and even transmitted them over the Internet to friends!

**Paul Stafford**  
Abilene, TX

### ANSWER TO #29622 - FEB. 1996

The fax machine you refer to is most probably a Murata M1200. I've had two of these with the exact same

## ANSWER INFO

- Include the question number that appears directly below the question you are responding to.
- Payment of \$25.00 will be paid within four weeks of publication if your answer is printed.
- Only one answer per question will be printed.
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## 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.

symptom as yours. The problem is with the switching power supply located in the back of the unit. I'd be willing to bet that the 5-volt supply is now putting out an unregulated 8 volts. This causes the logic circuits to go berserk turning on all of the indicator lights and activating the audible alert.

Since this seems to be a common failure mode for these machines, I would tend to believe that this is either a design flaw in the power supply or the case of one component being marginally defective. Indeed, I found that it was the same capacitor in both of my



units that had gone bad. Of course, the manufacturer might argue that your machine has operated correctly for over six-eight years — this model was sold around 1988-89 — but that's a different story.

Having a lot of experience in the repair business, I know that many devices have certain parts which are most likely to fail. I'm sure Murata has repaired countless numbers of these units due to this same failure in the power supply. So when my units first failed, I called Murata and talked to one of their service technicians. Although it seemed obvious to me that the technician knew exactly which part had gone bad, he was unwilling to part with this information. In fact, he would not even tell me what voltages the supply was supposed to put out (okay — that's their prerogative; I know they make much of their income on service). Their only suggestion was that the entire power supply could be swapped out at a cost of over \$125.00.

Being a rather low-end model, these machines were not worth spending that much money. However, after a little more time on the bench — without a schematic, mind you — I did trace the problem down to a single electrolytic capacitor. So here's a little gem that should save you \$125.00 (minus 20 cents for the cap): Check C9 on the power supply (you'll probably find it shorted). My notes also indicate that you should take a look at R103 which may have overheated.

Jeff Mazur

## ANSWER TO #2966 - FEB. 1996

There is no switching on the motherboard to allow for the higher capacity SIMMs. Simply install the 1 meg SIMMs in lots of four a bank, and boot. If you have a 386SX, a bank is only two SIMMs. One can assure oneself by borrowing a bank of SIMMs and trying them. As an afterthought, the 256K SIMMs are just about worthless. Don't every buy a PC or motherboard with one or two megabytes of RAM; they are usually 256K SIMMs and can't be upgraded without throwing them out.

Travis Brackeen  
St. Louis, MO

## ANSWER TO #29623 - FEB. 1996

A good source of inexpensive software programs is PC SIG 408-730-9291. They are a large, well known distributor of shareware software. A search of their CD produced at least two programs that claim to have voice mail capability. One is MAILBOX by American, Inc. 503-452-8196, and the other is BACKMAIL by Alethic Software, Inc. 902-423-9860. Of course, you will also need a modem. You might want to check your local library, many are now offering access to shareware programs such as PC SIG. The nice thing about the shareware arrangement is that if you try the program, but are dissatisfied, you don't have to pay for it.

Michael Young  
Newville, AL

## ANSWER TO #2963 - FEB. 1996

If you already have the fax modem, then this will be a little complicated. You may be better off letting someone else have your present modem and

buying a new one. There are devices that you can hook on your phone line that will pick it up and switch to either the voice phone or the fax modem. These switches detect the fax tone and switch all non-fax calls to the voice line. Now the gotcha. These devices have to pick up the phone to work. There is then a several second wait (waiting to detect the fax tone) then the phone starts ringing again. Only at this point do you know the phone is ringing. This annoys callers and costs them extra because they start paying long distance charges from the time the switch picks up, and if you don't pick up, they are still charged for the call. This can seriously annoy people.

Now the better solution — a better modem. Your modem may already have this feature, or it may not. Many fax modems have a feature called "silent answer." In this case, the modem listens for a fax tone and picks up the phone when it hears one. You would need a device called a teleprotect which is available from a number of sources including Radio Shack. This device is connected between the phone line and your phone. When you pick up the phone and it is a fax call, the tone sounds and the fax modem takes over. The teleprotect device disconnects your phone from the phone line. This solution really works slick with an answering machine. The fax tones can be a little annoying, but at least it is you instead of your callers/customers that is being annoyed.

Ray Todd Stevens  
Bedford, IN

## ANSWERS TO #2969 - FEB. 1996 Question #1

You may be able to correct the display problem with your monitor without going inside it. Try using the DOS MODE command. It can be used to shift the screen display right or left and to set screen length and width. The command is MODE[n] . m . [T] where n = video mode (40,80,BW80,CO40,CO80,MONO), m = R or L shifts display right or left one or two characters and T = test pattern for aligning display. It can set screen length and width with the command MODE CON LINES\* \* L COLS=c where L = 24,43,50 onscreen lines and c = 40 or 80 columns per line. Try experimenting with this command and if you find a combination that works, install that command in your autoexec.bat so that the monitor display is set each time you boot up.

Michael Young  
Newville, AL

## ANSWER TO #29611 - FEB. 1996

In reference to upgrading a multimedia 486 SX2-66 PC with 4 MB of RAM:

1. To upgrade from 4 meg to 8 meg, I would suggest that you bite the bullet and buy the SIMM modules you need to upgrade your motherboard. If you're not sure what you need, check the system manual that came with your computer or call the company that assembled your computer.

Regarding "RAM Doubling" software (i.e., RAM compression), the industry experts have found that in its present state such software is less than impressive. The March '96 issue

## ANSWER TO #2961 - FEB. 1996

The Divisor Latch sets the baud rate for the 8250 (16450 and 16550 also) UART. The Divisor Latch shares ports with the Receive/Transmit Buffer Register, and the Interrupt Enable Register. In order to access the Divisor Latch, one must first set the Divisor Latch Access Bit (DLAB),

which is Bit 7 (Most Significant Bit) in the Line Control Register. Then you may write to the Divisor Latch. After setting the Divisor Latch you must clear the DLAB bit to regain normal access to the UART Receiver Buffer Register (RBR), Transmitter Holding Register (THR), and Interrupt Enable Register (IER).

The place to access the Line Control Register (for DLAB) and the Divisor Latch in a PC Compatible are the specific I/O ports. A single 8250 uses 7 I/O ports. The Divisor Latch will be accessed at the first two ports, and the Line Control Register is at the fourth port on a standard PC.

The standard I/O port addresses for Com1 thru Com4 are as follows:

Com1	03F8H thru 03FEH
Com2	02F8H thru 02FEH
Com3	03E8H thru 03EEH
Com4	02E8H thru 02EEH

A 'C' code example written in Borland (or Turbo) C follows. Some other C compilers may have different names for the inportb() and outportb() functions which input and output bytes to I/O ports. In BASIC, these functions usually go by the names INP (port%) and OUT port%, data%. Call this function with your NewLatchValue (in your case, 0010H) to set the baud rate. The I/O ports are referenced off a base address CBase which is shown set for Com1 and which may be modified for other Com ports.

```
#include <dos.h>
```

```
void SetBaud(unsigned NewLatchValue)
```

```
{
    unsigned char D1;      /* Temporary storage */
    unsigned char LCR;     /* LineControlRegister; access DLAB here */
    unsigned char DL_LSB;  /* I/O port for DivisorLatch_LeastSignificantByte */
    unsigned char DL_MSB;  /* I/O port for DivisorLatch_MostSignificantByte */
    unsigned char BCH;     /* Value for DivisorLatch, MSB */
    unsigned char BCL;     /* Value for DivisorLatch, LSB */
}
```

```
/* The following #define sets the base I/O base address for Com1 */
/* Substitute 0x2F8 for Com2, 0x3E8 for Com3, 0x2E8 for Com4 */
#define CBase 0x3F8
```

```
DL_LSB = CBase;
DL_MSB = CBase + 1;
LCR = CBase + 3;
```

```
BCH = NewLatchValue / 256;
BCL = NewLatchValue % 256; /* % is Modulo or Remainder */
```

```
D1 = inportb(LCR); /* Set DLAB=1 */
D1 = D1 | 0x80; /* to access DivisorLatch */
outportb(LCR,D1); /* of the 8250 */
```

```
outportb(DL_MSB,BCH); /* Set Baud Rate MSB */
outportb(DL_LSB,BCL); /* Set Baud Rate LSB */
```

```
D1 = inportb(LCR); /* Set DLAB=0 */
D1 = D1 & 0x7F; /* for normal access to RBR, THR and IER */
outportb(LCR,D1); /* of the 8250 */
}
```

A good reference for the UART information is *DataCommunications Local Area Networks UARTs HandBook* (the book with the data sheets for the 8250 etc.). Published by National Semiconductor Corp.

An interesting book which contains some good references to communications is *Mastering Turbo Assembler*. Published by Howard W. Sams.

I/O ports are described in detail in the book *Interfacing to the Personal Computer*, which is also published by Howard W. Sams.

Todd Schifferdecker  
Belleville, IL

of *Windows Magazine* reviewed Soft RAM, RAM Doubler, and MagnaRAM. All three software products reported that RAM was increased, but none of the machines showed any speed increases or reduction in disk activity which would be evident if the RAM were, in fact, increased. All three also showed various incompatibilities with Windows 95.

Even though buying the SIMM modules is a bit more expensive, you won't be throwing your money away. If you put 8 meg in it, you'll get 8 meg out of it without the inconsistencies, incom-

patibilities, or bogging the processor with additional tasks like compressing and decompressing RAM.

2. Regarding buying a six-function multifunction printer, fax, copier, etc. device versus buying a color bubble-jet is really personal preference. The question of buying black and white versus color is an easy one. For what it costs (ink-jet, of course) hands down go color; you'll be glad you did.

As far as the multifunction device versus just purchasing a printer goes, a multifunction device is nice because

Continued on page 118



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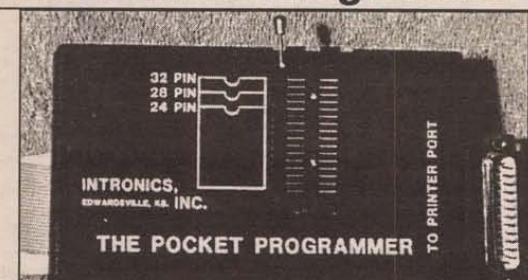
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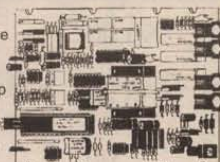
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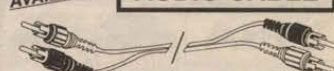
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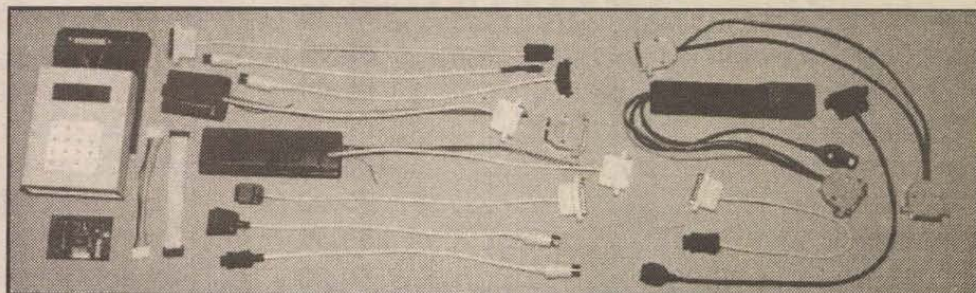
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Don Lancaster's

# RESOURCE BIN

number fifty

## Injection molding and plastic prototyping

Our 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.

A portion of my PSRT RoundTable on *GENie* has also been set aside for you *Nuts & Volts* readers. This is the place you go for instant tech answers. Among the many files in our library, you will find complete reprints for all the *Resource Bin* columns.

*GENie* is under new owners. It now offers lower rates, plus a direct flat fee full Internet access.

See the trailer blurb for details.

### Plastics and Polymers

I sure do get a lot of helpline calls that concern plastics in one way or another. Maybe as a custom part for a project. Or for fancier cases. Or to create unique packaging or effective presentations. Or to explore several new desktop publishing options.

Nearly all of the plastics industry does appear to be snotty and inbred. You will often find steep minimums, arrogant resellers, unanswered calls, and insanely high set-up charges. Even finding suppliers can be a real bear.

The reasons for these hassles are simple: Plastics form a high-volume industry. Onesie-twosies can end up more trouble than they are worth.

The term "custom" means different things to different outfits. One blow molder I tried working with defined "custom" as "On our regulation one gallon milk container, do you want a green or a blue cap?" Their minimum order was two million units.

When I tried to sort all my plastics resources out, I was utterly amazed at how big the pile ended up. Let's see if we can't rearrange it...

### The Usual Suspects

There's zillions of different plastic options out there today. These vary

in cost, strength, and flexibility. Picking the wrong plastic for any ap is bound to cause you grief. Here's some of the more popular candidates...

**ABS** is a durable family of plastics used for everything from water pipes to ads. Foam core expanded versions make light and rigid displays. The typical brands are *Sintra* and *Kydex*. A solid textured version is *Royalite*.

**Acrylic** is a low-cost and somewhat brittle plastic that can offer extreme clarity. *Plexiglass* is one trade name for the thicker sheets. It's available in many colors and patterns. *Plexiglass* is easily cut by scoring and snapping. It is also easily heat-formable.

**Butyrate** is a clear and modestly flexible plastic. It is mainly used for mailing tubes and point-of-purchase parts containers. These cut easily with plain old scissors.

**Delrin** is one brand name for acetal, a versatile engineering and structural plastic. It often outperforms

**NEXT TIME:**  
Don takes a second look at some solar winners and losers.

nylon at a modest cost premium. This can be turned, milled, or otherwise cut up by using normal shop tools.

**Fiberglass** is a misnomer. Instead, you really have an epoxy or polyester plastic resin that has been reinforced using glass fiber mats. Boats, flexible antennas, and printed circuit boards are three important uses.

**Mylar** is one name for a polyester plastic. It is very dimensionally stable and extremely strong in thin films. An older use is recording tape. The Mylar sheets have good temp resistance and may safely be sent on through a laser printer. Mylar also mirrorizes quite well. For decorative or solar aps.

**Nomex** is a stable plastic with very high temperature capabilities. It even gets used for fire suits. Although its typical electrical properties are very good above a critical

high temp, it chars and can become a conductor. *Kapton* is a related brand name.

**Nylon** is a common and a highly useful engineering thermoplastic. It is easy to machine, quite stable, and can make excellent bearings. It injection-molds beautifully. This one is often your best all around choice for many mechanical and support parts.

**Phenolic** is an older, quite brittle thermosetting plastic. Your available colors are brown, brown, and brown. It has real good electrical properties and reasonable temp performance. It cracks fairly easily.

**Polycarbonate** is a very tough and clear replacement for acrylic. Lexan is one brand. "Bulletproof" windows are one use. The standard sizes used for windows are often cheapest.

**Polypropylene** is just a variation on polyethylene that offers incredible flexibility. "Living hinge" applications are found on everything from car gas pedals to file card holders. It is very difficult to bond.

**Polyethylene** is a very flexible and slippery low-cost plastic. It gets used for lots of items from food bowls to adhesives. Ziploc shipping bags and construction films are two of the high-volume uses. Linear polyethylene is an improved and stronger product.

**Polystyrene** is an improved form of styrene. It can be very clear and has quite good high-frequency electrical properties. But it is brittle and has a very low melting point. Do beware of using soldering irons or solvents near polystyrene capacitors!

**PVC** is short for *poly vinyl chloride*. You'll see some members as the thick gray slabs in printed circuit etchers, as thin films in vinyl page protectors, or as a plain old black plastic sewer pipe. It has good resistance to most chemicals and heat forms beautifully. PVC can also be welded with a heat gun and a PVC rod.

**Styrene** is an economic, but brittle plastic. It is also made in light foams or expandable beads. When you heat these, they will expand into a mold to create your classic beer cooler or such. A hot wire cutter is one easy way to work with these materials. Make your own by smashing a power resistor to get some nichrome wire.

**Teflon** is but one tradename for a fluorinated hydrocarbon. Featuring extreme surface slip and outstanding chemical resistance. Although a lot cheaper than before, teflon is still very expensive for most aps. It is normally reserved for "Uh, compared to what?" uses. And then only sparingly.

**Tyvec**. Whoever invented this one should get chopped up and fed to the cows. The "paper" replacement made from ground-up polypropylene fibers, it makes for totally impossible to open packages; envelopes that

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# RESOURCE BIN

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forcibly eject themselves from bicycle carriers and dump your mail all over the road; and mailers that instantly destroy electric letter openers.

**UHMW** is a specialized variant of polyethylene which has an ultra high molecular weight. It is very slippery and has extreme cut resistance. "Self healing" cutting blocks and conveyor rails are two important uses. UHMW impact resistance is unbeatable.

**Urethane** is that incredibly durable rubber-like plastic. Its durometer can be adjusted all the way from rigid to ultra flexible. It is also an outstanding low temperature casting resin.

### Getting Started

One source for engineering plastics in very small quantities is *Small Parts*. They also custom-cut sheets and rods of nylon, delrin, teflon, and a few of the other engineering plastics.

Real bargains in plastic items can often be found at *American Science & Surplus*. Since these are left over from some other use, it's strictly catch as catch can. And WYGIWYG — what you get is what you get.

One traditional plastics distributor that I've found to be fairly reasonable is *U.S. Plastics*. A competitor is *Ain Plastics*. Free catalogs from both.

The classic old line name brand big distributor is *Cadillac Plastics*.

But the best sources I've found for price and delivery are the outfits who aim at the school markets. Especially those that advertise in *School Shop* and similar magazines.

Let's see. *Iasco* is short for *Industrial Arts Supply Company*. They have now got everything from a liquid plastisol for use in fish lures to

acrylic powder casting to real injection molding and vacuum forming machines. A useful second source is *Delvies Plastics* who also offer lots of books and patterns.

Model and hobby sources are also useful. See the ads in *Model Railroader* and similar mags. One leader here for styrene parts is *Evergreen*. They offer a free *Styrene Handbook*. Subtitled *Tips and Basic Techniques on Working With Styrene Plastic*.

Be sure to get this one.

### Injection Molding

It sure is infuriating to go down to your hobby store and look in a cheap kit and see bunches of highly detailed injection molded parts, but have the molders laugh in your face when you want to get anything injection molded on your own.

The problem is that most injection molded parts can be extremely cheap. But only when ordered in humongous quantities. There are major front end charges involved in making the molds and in machine set-up.

Because of the steep front end costs *injection molding is totally unsuitable for most low volume uses*.

Surprisingly, there are several low-cost injection molding machines for do-it-yourself users. The cheapest is that *Quick Shooter* sold by *Haygeman Machine* at \$560.00 list. This one uses a drill press to create the injection force. Shots up to 1/3 ounce are possible at a 100 shot per hour rate.

Higher performance machines are offered by *Morgan Press*. They offer a \$20.00 book called *Cutting Costs in Short Run Plastics Injection Molding*.

Alternates include the *Tri-Tron* 303, the *X-Tron* 300A, an *Alumi-Tron* 66M, and others distributed by *Iasco*. A *Plasticor* PLA-63 is offered by *Delvies*.

### My Glue Gun Trick

There's one ultra-cheap alternative to injection molding that I sometimes use. Yeah, this one is crude, slow, and produces rather wimpy products. But the cost is nearly zero. You simply use polyethylene rods in a glue gun!

Squirted into any cavity, you can build up a solid and reasonably useful plastic part. This stunt is particularly handy to build up oddball connectors. Just find some mating pins and plug them into the connector to be fit. Then polyglop them. For extra strength and a better final appearance, you can coat everything with epoxy.

At one time, many larger glue gun suppliers did stock the polyethylene rods. Sadly, these are unlikely to be available at your hardware store. *Ain* has them at 20 cents a foot.

### Vacuum Forming

A low-cost and sometimes alternative to injection molding is called *vacuum forming* in which you lay a thin sheet of plastic on a form, heat it, and then suck it down onto the surface. Zillions of tiny holes in the form are routed to a vacuum pump. Vacuum forming is often used for larger size signs.

Again, vacuum forming machines are stocked by both *Iasco* and *Delvies*. Another school-shop oriented supplier is *Pitsco*. They also resell rotational molders and blow molders.

These are not at all that expen-

sive. And it is possible to build your own.

One superb resource for all sorts of books involving do-it-yourself home machinery is *Lindsay Publications*. One of their hundreds of titles is *How to Cast Small Metal and Rubber Parts*.

### Rigid Vinyl

What is the cheapest sheet plastic you can get? Often it is a variation on PVC known as *rigid vinyl*. This one is the standard plastic used for interior signs and advertising displays. Prices start at 50 cents per square foot.

Lots of colors and textures.

You can cut this using any simple Plexiglass scoring tool. It heat forms and bends easily. This bonds just fine using super-glue or model cements. I have used it for custom dials.

*Ain* is one source. Others advertise in normal trade resources — *POP* and *Sign Design*, *Signcraft*, and in the *Sign Business* magazines.

### Special Effects

One little known resource for many types of highly useful plastics in small quantities is the movie *special effects* industry. All the folks that create the movie magic. While some of this info appears in *Film and Video*, the leading top secret insider pub is *Cineflex*.

Two suppliers here include *Polytek* and *Special Effects Supply*.

A listing of dozens of other special effects resources is in *HACK72.PDF*.

### Santa Claus Machines

Well, that's what the science fiction folks call them. Replication machines that, on software command, can make a copy of anything for you. Roast beef sandwich, a new girlfriend, hundred dollar bill, you name it.

Surprisingly, these devices do exist today. But the roast beef sandwiches, while low in calories and fat free, do leave a distinctly acrylic aftertaste.

These also go by the names of *rapid prototyping machines*. In which plastic or metal parts get built up by several processes such as selective hardening of a photopolymer, sintering of some powder, extruding some sticky string, injection of a binder, or cutting of a gasket-like layer. Three leaders here are *3-D Systems*, *DTM*, and *Stratsys*.

While Santa Claus machines remain rather expensive (a house and two cars), it should be possible to build a crude version yourself for



## RESOURCE BIN

\$200.00 or so. Such as adding X-Y movement to a polyethylene loaded glue gun to make house letters or whatever.

More on Santa Claus machines is found in HACK01.PDF, HACK36.PDF, HACK40.PDF, HACK54.PDF, and in HACK77.PDF.

### Random Stuff

A fine collection of glues, sealants, bonding agents, and casting plastics gets distributed by Ellsworth.

Two manufacturers include Devcon and Master Bond who also sell epoxy stripping chemicals.

Plastic sheets for printing and new desktop aps appear in Paper, Film, and Foil Converter, or Converting. Catalina Plastics sells printing mylar.

Stevens is one source for electronic and structural fiberglass items.

Decorative holographic, prismatic, and diffraction grating plastics sheets are manufactured by Coburn. Sources for poly shipping bags include Ipac, and Associated Bag.

One leading supplier for epoxy and fiberglass casting resins and such is West Systems. Free tech manuals.

That ordinary deeper red plexi-

glass makes an acceptable infrared filter for IR remotes. But Rohm and Haas has special opaque plexiglass sheets that are optimized for IR uses.

They have an *Infrared Transmittance of Opaque Plexiglas Colors* ap note. The #2711 "color" costs only a few cents per square inch.

*Adhesives and Sealants Industry* is a trade journal that really knows how to stick to their subjects.

Lots of photopolymer resources are reviewed in HACK66.PDF.

Silicon rubber and sealants are now made by Dow Corning. They've got a freebie *Solutions* newsletter. There are lots of plastics industry insider trade mags. Such as *Modern Plastics*.

The leading source of plastic caps, protectors, and coverings is Caplugs.

Free sample pacs on request.

Plastic cases and enclosures did get reviewed in NUTS15.PDF on my *Genie* PSRT. This one is also available in my *Resource Bin* book.

The premium printed circuit plastic is G-10 fiberglass. But more economic FR-4 variants are available. These use fewer glass layers with more plastic. Ultra-cheapo high-volume consumer aps still stick with brittle phenolic.

*Kepra* is a good supplier for all of these materials in smaller quantities. The higher frequency materials get sold by *Rogers*. *Circuits Manufacturing* is a typical trade journal.

Plastic Grecian urns are offered by *Outwater Plastics*. Who carry scads of other goodies from store fixture clips on up to architectural columns.

Plastic Gargoyles are created by the *Design Toscano* folks.

Vinyls suitable for cut lettering are available from *Gerber*. *Struhl* has static cling vinyls. They all stick to windows without using any glue.

A plastic synthetic kale is available from *Garden Fresh Products*. For 100% authenticity, they do use real powdered kale as a filler.

I sure sleep better at night knowing that there are those of you out there who have dedicated your lives to the perfection of synthetic kale.

### This Month's Contests

For our contest this month, just tell me about any plastics resource I don't already know about. Or tell me about the oddest thing you have ever done with a glue gun. Best of all, find me a new use for synthetic kale.

There will be a largish pile of my

new *Incredible Secret Money Machine II* books going to the dozen or so better entries, plus an all-expense-paid (FOB Thatcher, AZ) tinaja quest for two that will go to the very best of all.

Send all your written entries to me here at *Synergetics*, rather than to *Nuts & Volts* editorial.

Let's hear from you. NV

**Microcomputer 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 has two free catalogs full of his resource secrets waiting for you. Your best calling times are 8-5 on weekdays, Mountain Standard Time.

Don is now the sysop of *Genie PSRT*, where a special *Resource Bin* topic has been reserved for *Nuts & Volts* readers. For modem access: (800) 638-8369. When prompted, enter JOINGENIE. When asked for an offer code, enter DMD524.

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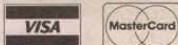


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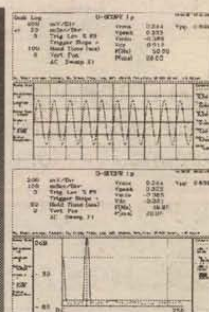
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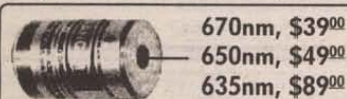
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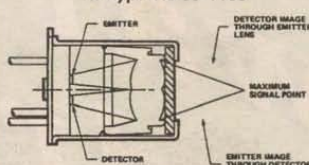


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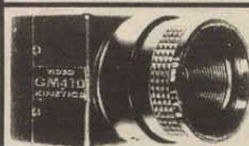


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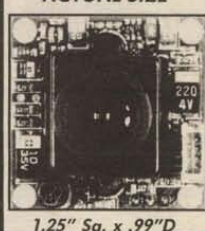


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by  
**Harry Helms**

**W**

When I first began writing this column, I managed to stir up a real hornet's nest by declaring that any software developer interested in maximizing their income should focus exclusively on Windows PC hardware and software and forget about other operat-

When I first began writing this column, I managed to stir up a real hornet's nest by declaring that any software developer interested in maximizing their income should focus exclusively on

# Software Wizardry

programs, like screen savers and virus detection software, are among the worst offenders in this regard.

Here's an actual example I recently ran into. I had been using a popular

virus detection program with my 486 Windows 3.1 system.

When I added a 100 MHz Pentium Windows 95 system to my tools, I installed the virus detection software when I did my system set-up and software installation. I soon became convinced there was some sort of major hardware flaw with my new Pentium system.

The mouse, keyboard, and monitor display would sometimes unexpectedly "freeze," forcing me to completely re-boot the system. My hard drive would sometimes go into extended read cycles when accessing a file, and sometimes a couple of "beeps" would be emit-

ing systems like the Macintosh, OS/2, etc. Several angry proponents of other operating systems sent letters to *Nuts & Volts* pointing out the advantages these systems have over Windows PCs.

This column is Windows-oriented for a reason that has nothing to do with its technical strengths or weaknesses, namely the sheer number of Windows PCs in use, and the large number of applications and development tools available for Windows. In fact, I always considered Windows 3.1 to be grossly inferior to both the Mac OS and IBM's OS/2 (although I feel Windows 95 is competitive with both, and Windows NT to be clearly superior to either the Macintosh or OS/2).

My advocacy of Windows as the preferred development environment for independent software developers has always been based on the number of Windows users and the ease with which software for Windows PCs could be developed by one-person operations. From a technical standpoint, Windows 3.0/3.1 and — yes! — Windows 95 PCs have some shortcomings and pitfalls for developers and end users of software.

There are two ways to react to this situation. You can adopt a "morally pure" stance, and advocate and develop for non-Windows operating systems that have a market share that's already in the single digits and still declining. The other is to understand the most common causes of Windows problems and how to correct them, and then use that knowledge to your advantage. I know of several people who are making a very good living advising Windows users how to handle the problems we'll discuss in this month's column. If you can't convince people to switch to OS/2 or the Mac, why not at least make some money off them?

## TSR Troubles

Windows is notorious for problems caused by conflicts when two or more applications programs "multitask" (that is, the programs are simultaneously "open" and using the operating system's resources). This reputation is a little unfair to Windows, since the problems are usually caused by applications programmers deviating from Windows development guidelines and "sneaking around" Windows in order to squeeze out a little more performance. Terminate and stay resident (TSR)

ted from my PC during the process. All of these symptoms were the sort that could be caused by hardware problems, and I spent a good bit of time on the phone to technical support at my PC's manufacturer. It seemed as if there were some weird transients in my PC's hard drive controller and keyboard/mouse interface boards, and that I would have to send my PC in to a repair facility for major surgery.

I postponed sending my new PC in for repair as long as I could since it was my only Pentium and Windows 95 machine, and I wanted to get up to speed on both before being without my new PC for a few weeks. When I ordered my new PC, I had also ordered Windows 95 upgrades of my existing Windows software such as Visual Basic and Word. When those upgrades arrived, I decided to install them even though I knew the PC would soon be going in for repairs. And that's when I solved my problems.

The solution came in the form of a new problem. The guidelines for Windows 95 software call for the installation programs for each new application to scan the PC's hard drive to make sure there is adequate storage space available before proceeding with the installation. When I tried to install my new software, the "hard disk scan" portion of each installation routine caused my PC to totally freeze. Nothing worked — the mouse, the keyboard, the monitor — nothing! And this happened for each and every Windows 95 package I was trying to install!

It was at this point that I had the sort of inspiration

you get when you're really desperate. It occurred to me that some computer viruses scan a PC's hard drive in order to locate system.ini, config.sys, and other important files to trash. Maybe my virus detection software — which was TSR software loaded every time my PC was started — was interpreting the disk scan action of the new software as a virus attack and was "freezing" the PC to protect it from a virus attack. It was a theory worth trying out, so I removed the virus protection software from my PC and tried installing the new software once more.

You can probably guess the end of this story. Removing the virus protection software cured my installation problems with my Windows 95 applications. But there was more.

The mouse, keyboard, and monitor "freezes" stopped, as did the extended hard drive read cycles and sporadic beeps. In fact, the overall operating speed of Windows 95 improved markedly after removing the virus protection — apparently the virus protector was fighting Windows 95 every step of the way! I've since added a virus protection program written expressly for Windows 95, and so far the problems haven't returned. It looks like my new PC won't be making a trip to a service facility after all!

Screen saver programs are another common source of software conflicts. They can be so troublesome in video-intensive applications (like multimedia) that it's a good idea to disable all such screen savers before attempting to use a multimedia CD-ROM or video editing program. Like my experience with the virus protection software, the symptoms of conflicts between screen savers and Windows can strongly mimic the symptoms of hardware problems and send you on some extended wild goose chases.

In fairness to my original virus protection software and Windows 95, the virus protector worked fine under Windows 3.1. A lot of software written for Windows 3.1 deviated significantly from Microsoft's guidelines, and there's no way Windows 95 could handle every weird exception individual programmers may have made to normal practice (especially in such areas as memory allocation). No, the fault for the situation lies with me and my assumption that any Windows 3.1 software that extensively addresses the PC's internals would work fine under Windows 95. But I know I'm not the only one out there making that mistake.

While this column focuses on Windows PCs, both Macintosh and OS/2 PCs can be afflicted by software conflicts. My Macintosh IIsi was once brought to its knees when I tried adding a screen saver featuring the "Energizer Bunny" character. The problem turned out to be with an existing screen saver on my IIsi; even though I had "turned off" the previous screen saver in the Mac's control panel, it still had a conflict with the new one. The problem cleared up only when I removed one of the two screen savers from the IIsi's hard drive. I could have either the Energizer Bunny or flying toasters on my hard drive, but not both!

If you've recently installed any new software — whether a major application like a word processing package or a dinky little printer driver — and start experiencing any abnormal conditions with your PC, a conflict between the new software and the old software on your PC should be your prime suspect. By the way, this doesn't mean the new software is "at fault." The new software could be written in conformance with Windows guidelines, but have a conflict with software already on your PC that's not written to Windows guidelines.

## Driven Crazy by Drivers

A driver is a program intended to let a PC "talk to" a piece of hardware such as a printer, video or sound card, disk drive, etc. Drivers are simple programs com-



# Software Wizardry

pared to operating systems or large applications like databases, but they are essential "glue" for holding all the pieces of PC hardware together. Most drivers are sold as part of a hardware package, and as a result are often not developed with the same degree of care (or programmer competence!) as operating systems and major applications. Moreover, drivers are often not tested on as wide a range of PC systems as operating systems and major applications. As a result, a disproportionate share of PC problems involve drivers.

For some reason, video card drivers seem to be especially "buggy." It seems like some video card manufacturers are constantly updating the drivers for their cards. Even if you don't have any current problems with your PC or video display, you might want to contact the manufacturer of your video card to see if an updated driver is available. Drivers are also a likely problem source with add-in hard drives and CD-ROM drives.

Many development tools or applications programs will install their own drivers. If you should later remove the tool or program, the driver can remain installed even if you've removed the major program files. If your config.sys, autoexec.bat, or system.ini files were modified to load a driver you no longer need, you may get a series of baffling general protection fault (GPF) messages produced by the unneeded driver. This condition is especially common with some multimedia CD-ROMs that modify a PC's system files as part of their installation routine. I started experiencing random GPF messages after I had used a poorly designed and developed CD-ROM package (hint: it had obviously been developed on a Macintosh using Director and then been "ported over" to Windows). I spent some fruitless hours trying to figure out what was wrong until I finally looked at the list of drivers in Window's control panel. I saw a MPEG driver that had apparently been installed by the CD-ROM I had used (I knew I hadn't installed it!). I first copied the MPEG driver to a floppy, in case I really needed it, and then deleted the driver from the list. I re-booted, and my random GPF messages disappeared.

A very important point to remember is that drivers must be written specifically to accommodate the hardware they work with. Despite what you may have heard (or read), there's no such thing as a "generic" video card or printer driver. If you install the wrong driver for a video card — or don't install the correct new driver when installing a new video card — your display may not work correctly, or even work at all, when you re-boot your PC after installing the new card and/or driver. Always save a copy of any driver you delete from your PC, in case the new or replacement driver does not work. And don't install a driver that you "think" will work; if you're not

certain that it's the correct driver, don't install it!

## More Memory!

My golden rule is that you can never have too much RAM in your PC, regardless of whether you're running Windows, OS/2, or the Macintosh OS. In fact, I don't think there is an easier or more cost-effective way to improve the performance of your PC and prevent many random software glitches than to add more RAM to your PC.

This is especially true because the minimum RAM requirements for many popular software packages is grossly understated. For acceptable performance with most software, I normally double the minimum amount of RAM that is supposedly necessary. For example, if the software is supposed to require four megabytes of RAM to run, I assume it will require eight megs to run really well!

The improvement in PC from adding additional RAM is often dramatic. My company has several different PCs available for software testing, and these range from 386DX to 133 MHz Pentium systems. One remarkable thing we've discovered is how a 386 PC with 16 megs of RAM will generally outperform a comparable 486 PC equipped with eight megs of RAM. Files open faster, video and sound playback is better, and computation-intensive operations (like graphics) are quicker on the lower-end microprocessor (the 386) addressing additional memory. One real surprise is how Windows 95 runs better on a 386 PC with 16 megs of RAM than it does on a 486 PC with eight megs of RAM!

Your minimum RAM requirement goes up with the power of your processor. While eight megs of RAM is plenty for 386 PCs and most 486 PCs, it is too low for the most effective use of a Pentium or PowerPC system. I know most PowerPC and Pentium PCs are sold with only eight megs of RAM installed, but that's like selling a Ferrari with an eight gallon fuel tank. The incredible performance of the Ferrari would be interrupted by frequent fuel stops, and that would grow old in a hurry. In a PC, "fuel stops" involve reading and writing to your hard drive, which cuts down on the speed with which files can be opened, video displayed, etc. A lot of the extra computing power in your processor will sit idle while data is loaded into and out of RAM. Extra RAM means your PowerPC or Pentium stays busy computing.

## Settings

Both Windows and Macintosh PCs have "control

panels" or "settings" controls to allow changing screen colors, display resolution, and other system characteristics. It's easy to mis-set a setting or not realize the default setting is not the one you need.

For example, the standard installation of Windows 3.1 sets the video display to 16-color mode. However, most Windows software (and all multimedia CD-ROMs and graphics software) is designed to work with a 256-color display. When the display is set to 16-color mode, the result is a grainy, "washed out" image. A lot of "something's wrong with the video on your CD-ROM" calls that CD-ROM publishers get are the result of users having their video displays set to 16-color mode!

Screen resolution settings are another trouble spot. The "small" screen display setting is 640x480 (VGA), which is the default setting for most consumer PCs. Most PCs are also capable of 800x600 (SVGA) resolution, and 1024x768 (UltraVGA/8514A) resolution is becoming increasingly common. However, an increasing number of software packages (especially editing, graphics, and development tools) are designed to use a SVGA display. If a user tries to use a program like Visual Basic or PageMaker on a VGA resolution display, toolbars, controls, and panels used by the application will be "off screen." Users can scroll horizontally and vertically to reach those elements, but most users will want all such elements to be visible. Believe it or not, having the wrong screen resolution setting is a common source for calls to PC and software company technical support lines!

Another problem that can be encountered with SVGA and UltraVGA/8514A resolution is when the "large" screen fonts setting is selected. With some applications and CD-ROM titles (but not all!), screen fonts will appear distorted with the "large" setting. Changing the setting to "normal" or "small" will cure the problem.

Finally, many default buffer settings for such things as cache memory will be set to their minimums. With higher end PCs, this can seriously impair operation. For example, some PCs have trouble with audio "breakup" and interruption when playing sound (.wav) files from either CD-ROMs or hard drives. Increasing the buffer size of your sound card driver to eight seconds will often cure this problem.

Of course, a lot more can go wrong with Windows PCs than we've covered this month. However, it is surprising how often these problems are found and how they can confound non-technical PC users. Knowing these techniques can quickly turn you into your office's (or school's) PC-wizard-in-residence! NV

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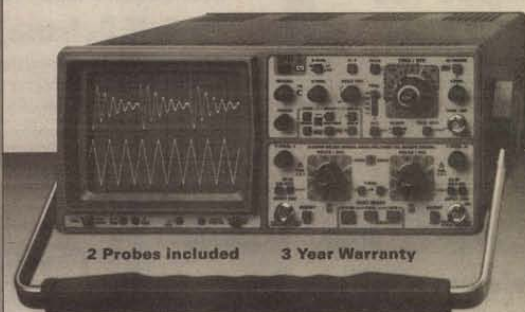
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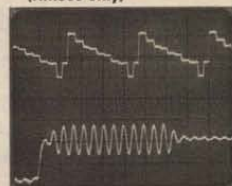
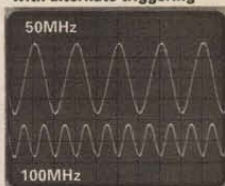


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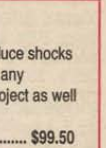
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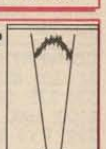
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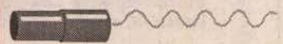


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**TEST MODULES, DESCramBLERS, DESCramBLERS, REMOTES, REMOTES, REMOTES. BEAT LOWEST PRICE. VISA, MC, DISCOVER, AMEX. NO TEXAS SALES. 713-392-2323.**

**CABLE HACKERS!** Program your own! Complete set of master files for Scientific Atlanta, Jerrold, Tocom, Pioneer, Zenith, and Starcom 71 Wow! Blowout Sale. Only \$150! With complete instructions! Send to: Bates, 733 N. Wells, Chicago, IL 60610. 312-213-7023.

**WE SPECIALIZE** in 5 and 10 lot pricing of NEW converters, descramblers and other cable equipment. One year warranty. No minimum purchase. D&M 1-800-550-8796.

**PIONEER CABLE BOX FULL TEST MODE** without opening the box! Our external PIO-SC will FULLY activate all channels for TEST mode on ANY Pioneer unit from 5XXX up to 67XX. Does NOT destroy serial/ESN number. Also has 7 other testing options \$175. External PIO-REG does all 5XXX-61XX units or does 1 CUSTOM 63/67XX unit for \$150. 1-800-663-8530.

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**UNIVERSAL DESCRAMBLER.** Unscramble signals using your VCR as the tuner. Works with virtually any system, this is the only one you need. Declare cable box independence! Fully assembled. \$129.95 + \$5 S&H. VISA/MC/AMEX. ELECTROMAN, Box 24474, New Orleans, LA 70184. 504-482-3017.

**REMOTES, NEW AND USED.** SA beige remotes, checked and working, \$2.50 each. SA Black remotes, \$3 each. Other brands available as low as \$1.50. Below wholesale. Credit cards okay. Write or fax 501-223-9406. Software City, Box 23016, Little Rock, AR 72221.

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**CABLE DESCRAMBLER!** Anyone can build in SEVEN STEPS with RADIO SHACK parts. Plans \$5. 1-800-818-9103.

**MMDS, ITFS, OFS** antenna and downconverter include AC adapter and mounting accessories. \$150 + S&H. Aljon Technologies, 310-793-1788.

**RECEIVE STOCK** prices, news, trucking and other info free of monthly fees on TV. Send \$10 and SASE to Electrotec, 2626, W. Parish Ave. #261, Owensboro, KY 42301-3313.

**SPRING SPECIAL,** multi-frequency, fast, automatic, BFTs for sale. 1-5 \$100, 6-10 \$90, 11-20 \$80. Pioneer programmable tester \$15 extra. Major brand converters in stock. Call 212-926-5284 or 1-800-216-BEEP #48410.

**MASTER FILES & TEST MODULES** for all types of CATV converter units. TK 503-507, Zenith, SCM-6 only \$6. 909-986-0971.

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# Events

## MARCH 1996

### MARCH 2

**AL - TUSCALOOSA** - Black Warrior Swapfest. Kelly Bruce 205-339-7882  
**CA - OAKLAND** - Robert Austin Computer Show. Convention Center. 800-346-0100  
**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052  
**FL - FORT LAUDERDALE** - Narisaam Computer Show. Holiday Inn-West. 800-436-6707  
**GA - COMER** - NE Georgia Bubba Net Hamfest. Madison County Fairgrounds. Dan 706-742-2777  
**KY - GLASGOW** - Mammoth Cave ARC Hamfest. Cave City Convention Center. Mark 502-651-8777  
**ND - BISMARCK** - Annual Hamfest. Radisson Inn. Central Dakota ARC, POB 7162, Bismarck ND 58507  
**NH - TWIN MOUNTAIN** - North County ARC & Littleton ARK Ham Radio/Computer Flea Market. Townhall. Richard Force 603-788-4428  
**NJ - ABSECON** - Shore Points ARC "Springfest '96". Holy Spirit High School. SPARC, POB 142, Absecon NJ 08201

### MARCH 2-3

**OH - CINCINNATI** - Computer Fair. Cincinnati Gardens. Mark Hanslip 513-263-3378

### MARCH 3

**CA - LIVERMORE** - Swapmeet. Las Positas College. Noel Anklam 510-447-3857  
**FL - WEST PALM BEACH** - Narisaam Computer Show. Palm Beach Airport Hilton. 800-436-6707  
**MA - BRAintree** - South Shore ARC Ham Radio Flea Market. DAV #29 Hall. William 617-288-6906  
**MA - SWANSEE** - Computer Show. Venus De Milo. Northern Computer Show 508-744-8440.  
**MI - FLINT** - Super Computer Show. Holiday Inn. Computers & You 313-283-1754.

### MARCH 8-9-10

**LA - LAFAYETTE** - Acadiana ARC Hamfest & ARRL State Convention. Holidome - Holiday Inn Central. Nolen Griffith, Jr 318-989-9039  
**NE - NORFOLK** - ARRL State Convention. Patrick Adams 402-371-7295

### MARCH 9

**AZ - SCOTTSDALE** - Scottsdale ARC Hamfest. Ron Reynolds 602-240-0473  
**CA - FONTANA** - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves  
**CA - LOS ALTOS HILLS** - Perham Foundation Electronics Flea Market. Foothill College, Parking Lot A. 408-734-4453  
**FL - LAKE WORTH** - West Palm Beach ARC Semi-Annual Free Flea. John Prince Park @ Mound Circle. Marvin 407-683-2930  
**KS - COLBY** - Trojan ARC Hamfest. Jim Robison 913-462-4548  
**KY - HAZARD** - Kentucky Mountains ARC Hamfest. John Farler 606-435-5354  
**MI - LIVONIA** - Super Computer Show. Elks Lodge Hall. Computers & You 313-283-1754.  
**ND - FARGO** - Red River RAC Amateur Radio/Computer Fair. Red River Valley Fairgrounds. 701-282-2876  
**NH - PORTSMOUTH** - Northern Computer Show. Frank Jones Center. 508-744-8440  
**NY - SYRACUSE** - Computer Show & Sale. New York State Fairgrounds/International Bldg. Peter Trapp Shows 607-369-2796.  
**TX - VICTORIA** - Swapfest 1996. Knights of Columbus Hall. Victoria ARC 512-573-0821  
**WA - PUYALLUP** - Electronics Fleamarket. Pavilion Exhibition Hall, Western Washington Fairgrounds. Mike & Key ARC, 637 2nd Ave S, Kent WA 98032

### MARCH 9-10

**CA - SAN FRANCISCO** - Robert Austin Computer Show. Cow Palace. 800-346-0100  
**NC - CHARLOTTE** - Mecklenburg ARS Hamfest. Merchandise Mart. Mary Hunt 704-841-4267  
**NJ - PENNSAUKEN** - KGP Computer Show. South Jersey Expo Center. 908-297-2526

### MARCH 9-10-11

**FL - ORLANDO** - 50th Annual Orlando HamCation. Ken Christenson 407-291-2465

### MARCH 10

**IL - ORLAND PARK** - Computer Show. Civic Center. 24-Hour Hotline 708-974-3123  
**IN - INDIANAPOLIS** - Morgan County Repeater Assn. Hamfest. Brian Elliot 317-342-7236  
**ME - AUGUSTA** - Northern Computer Show. Augusta Armory. 508-744-8440  
**MI - GRAND RAPIDS** - Super Computer Show. Crown Plaza. Computers & You 313-283-1754.  
**NY - LINDENHURST** - Great South Bay ARC/

# CALENDAR

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.

All listing information should be sent to:

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Events Calendar**

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Fax 909-371-3052

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### MARCH 12-13-14

**CA - LOS ANGELES** - Computer Telephony Conference. Convention Center. 212-691-8215

### MARCH 15-16

**AR - LITTLE ROCK** - Hamfest & ARRL State Convention. Expo Center. Jim 501-246-6734

### MARCH 16

**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052  
**FL - ENGLEWOOD** - Englewood ARS HAMCOM '96. Dennis Babcock 941-698-0248  
**GA - MARIETTA** - Kennehochee ARC Hamfest. Margaret Durham 770-977-4405  
**MI - MARSHALL** - 35th Annual Crossroads Hamfest. Marshall High School. SMARS 616-979-3433  
**NH - HUDSON** - Interstate Repeater Society Hamfest. John Brunelle 603-881-5796  
**NH - SALEM** - Northern Computer Show. Rockingham Park Track. 508-744-8440  
**NJ - PHILLIPSBURG** - Micro Mart Computer Show. Holiday Inn. 609-924-2344  
**PA - WILKES-BARRE** - Computer Show & Sale. Woodlands Inn. Peter Trapp Shows 607-369-2796.

### MARCH 16-17

**FL - FORT WALTON BEACH** - Playground ARC Ham/Swapfest. Fairgrounds. Bud 904-243-5404  
**GA - PERRY** - Middle Georgia Computer Show. Georgia National Fairgrounds & Agricenter. Computer Show 770-907-6225  
**NJ - WAYNE** - KGP Computer Show. William Paterson College, Recreation Center. 908-297-2526  
**TX - MIDLAND** - Midland ARC Hamfest. Larry Nix 915-699-5441

### MARCH 17

**MA - STURBRIDGE** - Northern Computer Show. Sturbridge Host Hotel. 508-744-8440  
**MI - FLINT** - Computer Show. Holiday Inn-Gateway Centre. Five Star Productions 810-230-0988  
**MI - MADISON HEIGHTS** - Super Computer Show. UF & CW Hall. Computers & You 313-283-1754.  
**MI - NOVI** - Great Lakes Computer Expo. Sheraton Inn. 313-416-1015  
**OH - MAJUMEE** - Toledo Mobile Radio Assn Hamfest/Computer Fair. Lucas County Recreation Center. Brian, 4463 Holly Hill Dr, Toledo OH 43614  
**OR - MILTON-FREEWATER** - Walla Walla Valley ARC Hamfest. David 509-525-2529  
**PA - DOVER** - 9th Keystone VHF Club York Springfest. Dover Firehall. Ted Rodas 717-259-8063  
**PA - MONROEVILLE** - Two Rivers ARC Hamfest/Computer Fair. Greater Pittsburgh Expo Mart. TRARC, POB 225, Greenock PA 15047  
**PA - YORK** - Keystone VHF Club Hamfest. John Shaffer 717-764-4805  
**WI - JEFFERSON** - Tri-County ARC Hamfest. Jefferson County Fairgrounds. TCARC 414-963-6502

### MARCH 23

**FL - STUART** - Martin County ARC Hamfest. Martin County Fairgrounds. Dave 407-288-7100  
**FL - SEBRING** - 3rd Highlands County ARC Hamfest. National Guard Amory. Clyde 941-453-7181  
**IL - KANKAKEE** - The Kankakee River Valley

Computer Users Group Computer Expo. County Fairgrounds, Main Bldg. Gary Johnson 815-935-1605  
**IN - INDIANAPOLIS** - AGI Computer Fair. Beech Crest Center. 317-299-8827  
**MA - BOSTON** - Northern Computer Show. Boston College High School. 508-744-8440  
**MI - CANTON** - Great Lakes Computer Expo. Summit on the Park. 313-416-1015  
**MO - KANSAS CITY** - Ararat AR Shrine Club Hamfest. Roger Bessmer 816-842-0400  
**NJ - WEST ORANGE** - Irvington-Roseland ARC Hamfest. West Orange High School. 201-402-6066  
**PA - BETHLEHEM** - Computer Show. Lehigh Univ/Stabler Arena. Peter Trapp Shows 607-369-2796.

### MARCH 23-24

**AL - HUNTSVILLE** - Computer Show. Von Braun Civic Center. ComputerShow 770-907-6225  
**OK - TULSA** - Green County Hamfest & ARRL Section Convention. Maxwell Convention Center. Merlin Griffen 918-272-3081  
**PA - FORT WASHINGTON** - KGP Computer Show. EXPO Center. 908-297-2526

### MARCH 24

**CA - SAN DIEGO** - Computer Show. Convention Center. 619-295-1221  
**IL - GLEN ELLYN** - Computer Central. Harper College. 708-940-7547  
**IL - STERLING** - 36th Annual Sterling-Rock Falls ARS Hamfest. Sterling High School Fieldhouse. Lloyd 815-336-2434  
**IL - TAYLORSVILLE** - Christian County ARC Hamfest. Taylorville Jr High School Gym. Walter Harwell 217-287-2010  
**MI - ANN ARBOR** - Colossal Computer Sale. Washtenaw Community College. 313-971-0990  
**MI - DEARBORN** - Super Computer Show. Civic Center. Computers & You 313-283-1754.  
**MI - MIDLAND** - Computer Show. Holiday Inn. Five Star Productions 812-230-0988  
**NJ - TRENTON** - Hamcomp '96. Trenton State College, Student Recreation Center. Delaware Valley Radio Assn Hotline 609-882-2240  
**NY - YONKERS** - WECAfest. Yonkers Raceway. Thomas Rafelli 914-741-6606  
**PA - ASTON** - Camera & Video Show. Neumann College Life Center. Adam Rifkind 610-527-5903  
**PA - YORK** - Computer Show & Sale. York Fairgrounds. Peter Trapp Shows 607-369-2796.  
**OH - MADISON** - Lake County ARA Hamfest. Roxanne 216-256-0320  
**WV - CHARLESTON** - Hamfest & Computer Show. Civic Center. Jimmie Hewlett 304-768-1142

### MARCH 29-30

**GA - COLUMBUS** - Columbus ARC Hamfest. Randy Hancock 706-596-8820

### MARCH 29-30-31

**CO - GOLDEN** - 5th Annual ENTOM. Denver Marriott West Hotel. Midnight Engineering Magazine 719-254-4558

### MARCH 30

**CT - WATERFORD** - Radio Amateur Society of Norwich's Ham Radio Auction. Senior Center. Tony 203-859-0162  
**FL - FANNING SPRINGS** - Dixie ARK Darkfest '96. Suwannee River Fair & Livestock Assn Bldg. Glenda Filipponi 904-542-3033  
**IN - COLUMBUS** - Columbus ARC Hamfest. Bartholomew County 4-H Fairgrounds, Community Bldg. Marion Winterberg 812-342-4670  
**KY - ELIZABETHTOWN** - 17th Annual Lincoln Trail ARC Hamfest. James R. Pritchard Community Center. LTARC, POB 342, Vine Grove KY 40175  
**MI - MICHIGAN CITY** - Michigan City ARC Hamfest & Computer Flea Market. Michigan City High

School. Ron Stahoviak 219-872-6594  
**MI - TAYLOR** - Super Computer Show. Democratic Club. Computers & You 313-283-1754.  
**MI - WESTLAND** - Great Lakes Computer Expo. Wayne-Dodge Civic Center. 313-416-1015  
**NJ - UPPER SADDLE RIVER** - Chestnut Ridge Radio Club Flea Market. Saddle River Reformed Church, Education Building. Andy 201-261-3783  
**OH - AKRON** - Computer Show & Sale. Tadmor Shrine Temple. Peter Trapp Shows 607-369-2796.  
**TN - TULLAHOMA** - Middle Tennessee ARS Hamfest. Ernest Moore 615-728-9473  
**TX - WEATHERFORD** - ARC of Parker County Hamfest. Bob Sonnenberg 817-594-1017  
**VA - VIRGINIA BEACH** - Computer Show. Pembroke Hall. Pro Am Shows 804-463-1136

### MARCH 30-31

**GA - NORCROSS** - Atlanta Computer Show. North Atlanta Trade Center. ComputerShow 770-907-6225  
**MD - TIMONIUM** - Baltimore ARC Hamfest/Computerfest & State Conv. Timonium Fairgrounds. William Dobson 410-426-3378

### MARCH 31

**CA - SANTA ANA** - Swapmeet. ACP Parking Lot. Mary Russo 714-558-8813  
**CT - SOUTHTON** - Southington ARC Area Flea Market. Southington High School. Chet 860-628-9346  
**IL - GRAYS LAKE** - Libertyville/Mundelein ARS LAMARSFEST '96. Lake County Fairgrounds. Frank Avelone 708-234-4124  
**NC - KINSTON** - Down East Hamfest. Lenior County Fairgrounds. Jean DuPre 919-524-5724  
**OH - YOUNGSTOWN** - Computer Show & Sale. Holiday Inn. Peter Trapp Shows 607-369-2796.  
**VA - NEWPORT NEWS** - Computer Show. Knights of Columbus Hall. Pro Am Shows 804-463-1136

## APRIL 1996

### APRIL 5-6

**AL - ALBERTVILLE** - Marshall County ARC 5th Sand Mountain Fest. Recreation Center. Buddy Smith 205-593-2516

### APRIL 5-6-7

**GA - AUGUSTA** - Garden City Channel Masters CB Club 14th Annual Break. Radisson Hotel. Moses 706-793-7828

### APRIL 6

**CA - OAKLAND** - Robert Austin Computer Show. Convention Center. 800-346-0100  
**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052  
**CO - LONGMONT** - LARCFEST. Boulder County Fairgrounds. Longmont ARC, POB 86, Longmont CO 80502-0086  
**MI - WATERFORD** - Super Computer Show. NOCC CAI Building. Computers & You 313-283-1754.  
**PA - PHILADELPHIA** - Micro Mart Computer Show. Holiday Inn. 609-924-2344  
**SC - AIKEN** - Aiken Contest Club Hamfest & Computer Show. Aiken County Jaycee Fairgrounds. Doug 803-648-4754

**TX - WICHITA FALLS** - Wichita ARS Hamfest. Jimmy Dodson 817-586-0215  
**VA - VIRGINIA BEACH** - Chesapeake ARS Springfest. Preston Ippock 804-543-4610

### APRIL 7

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

### APRIL 12-13

**MS - TUPELO** - Tupelo & Booneville ARC's Hamfest.



# Events CALENDAR

Furniture Market, Mississippi Bldg. Jack Ellis 601-842-7255

**OK - LAWTON** - ARRL State Convention & Hamfest. Commanche County Fairground Coliseum. Robert Morford 405-355-6120

## APRIL 13

**CA - FONTANA** - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves  
**CA - HANFORD** - Kings ARC Swapmeet. Fraternal Hall. Rick 209-945-2266

**CA - LOS ALTOS HILLS** - Perham Foundation Electronics Flea Market. Foothill College, Parking Lot A. 408-734-4453

**IN - INDIANAPOLIS** - AGI Computer Fair. Beech Crest Center. 317-299-8827

**KY - BOWLING GREEN** - Kentucky Colonels ARC Hamfest. Leon Garrett 502-842-5307  
**ME - PORTLAND** - Portland Amateur Wireless Assn Hamfest. University of Southern Maine, Sullivan Gym. Marty Feeney 207-839-5072

**MO - JOPLIN** - Joplin ARC Hamfest. Andy Gabbert 417-673-8371  
**OH - JACKSON** - Jackson County ARC Hamfest. Dan Moore 614-286-6870

**PA - FREDERICKSBURG** - Appalachian AR Group Hamfest. Mark Schropp Jr 717-754-7700  
**VA - GOOCHLAND** - Six Meter Ham Radio Team Swapmeet. County Fairgrounds. Buddy 540-894-0406

**VA - VIRGINIA BEACH** - Computer Show. Independence Hall. Pro Am Shows 804-463-1136  
**WA - SPOKANE** - Inland NW Hamfest. Al Lalky 509-924-3475

## APRIL 13-14

**CA - SAN FRANCISCO** - Robert Austin Computer Show. Cow Palace. 800-346-0100

**OK - MOORELAND** - Northwest ARA Hamfest. Bill Wyatt 405-256-3248

**TN - NASHVILLE** - ComputerShow. Tennessee State Fairgrounds. ComputerShow 770-907-6225

## APRIL 14

**MA - FRAMINGHAM** - Framingham ARA Ham, Radio, Electronics Flea Market. Framingham High School. Martin Bayes 508-435-0564

**NC - RALEIGH** - Raleigh ARS Hamfest, Convention & Computer Fair. NCS Fairgrounds, Jim Graham Bldg. Rollin Ransom 919-269-4406

**NE - OMAHA** - Ak-Sar-Ben ARC Hamfest. Todd 402-397-7465

**NJ - NEWARK** - Micro Mart Computer Show. Holiday Inn. 609-924-2344

**PA - ALLENTOWN** - Computer Show. Leesport Farmers Market. Peter Trapp Shows 607-369-2796

**VA - NEWPORT NEWS** - Computer Show. Knights of Columbus Hall. Pro Am Shows 804-463-1136

**WI - MADISON** - Madison Area Repr Assn Hamfest. Dane County Expo Center. Jim 608-245-8890

## APRIL 19-20-21

**CA - VISALIA** - ARRL Int'l DX Convention. Don Bostrom 818-784-2590

## APRIL 20

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

**FL - MIAMI** - University of Miami ARC & Flamingo Net Tailgate/Swapmeet. University of Miami Parking Lot #102. Bill, 73 Palm Ave., Miami Beach FL 33139

**MI - MUSKEGON** - Muskegon County ARES/RACES Hamfest. Tom Vander Mel 616-733-2963

**MN - FERGUS FALLS** - Lake Region ARC Hamfest. William Morgan 218-736-4448

**PA - HARRISBURG** - Computer Show. Farm Show Complex. Peter Trapp Shows 607-369-2796

**TX - BELTON** - Temple ARC Ham Expo/Tailgate. Bell County Expo Center. Mike 817-773-3590

## APRIL 20-21

**AL - BIRMINGHAM** - State Convention. James Pilman 205-970-0737

**GA - ATLANTA** - ComputerShow. Cobb County Civic Center. ComputerShow 770-907-6225

**NJ - WEST WINDSOR** - Trenton Computer Festival. Mercer County College. TCF '96 717-529-6134

## APRIL 21

**CA - SONOMA** - Valley of the Moon ARC Hamfest. Veteran's Memorial Building. Darrell 707-996-4494

**DE - NEWCASTLE** - Penn-Del ARC Hamfest. Nur Temple. Hal Frantz 302-798-7270

**IL - ARTHUR** - Moultrie ARK Hamfest. Moultrie/Douglas County Fairgrounds. Ralph 217-873-5287

**IL - ORLAND PARK** - Orland Park Computer Show. Civic Center. 24-Hour Hotline 708-974-3123

**MA - CAMBRIDGE** - Flea Market. MIT. Nick 617-253-3776

**MI - FLINT** - Computer Show. Holiday Inn-Gateway Centre. Five Star Productions 810-230-0988

## APRIL 27

**IA - DES MOINES** - Des Moines RAA Hamfest. Carmi Smith 515-262-5478

**ID - LEWISTON** - Clearwater Valley & Camas Prairie ARC's Hamfest. Dennis Burgess 509-758-5343

**KY - OWENSBORO** - Owensboro ARC Hamfest. Davess County Fairgrounds. Steve 502-926-4451

**MI - WESTLAND** - Great Lakes Computer Show. Wayne-Ford Civic Center. 313-416-1015

**MN - SHAKOPEE** - SMARTS Radio Club SMART-FEST. Canterbury Downs. Dave 612-445-8071

**MT - BUTTE** - Butte ARS Hamfest. Bob Evans 406-494-3066

**NY - SYRACUSE** - Liverpool ARC Hamfest. Larry Taft 315-668-8219

**OR - ROSEBURG** - Umpqua Valley ARC Amateur Radio & Computer Show. Douglas County Fairgrounds. Ed Pahl 503-673-1310

**SD - HURON** - Huron ARC Swapmeet. National Guard Armory. Lloyd Timperley 605-352-7896

**WA - VANCOUVER** - Clark County ARC Hamfest. Wayne Schuler 360-896-8909

**WV - FLATWOODS** - Pioneer ARC Hamfest. Ed Messenger 304-462-5312

## APRIL 27-28

**FL - GAINSEVILLE** - Hamfest & Computer Show. Alachua County Fairgrounds. Bill 904-454-3105

**KY - LOUISVILLE** - Computer Fair. Kentucky Fair & Expo Center. Mark Hanslip 513-263-3378

## APRIL 28

**IL - CHICAGO** - Chicago ARC Ham Auction. DeVry Institute of Technology. George 312-545-3622

**IL - GLEN ELLYN** - Computer Center. College of DuPage. Phys Ed Bldg. 708-940-7547

**MI - GROSSE POINT WOODS** - Southeastern Michigan ARA Hamfest. North High School. Thomas 313-527-3497

**NJ - BUDD LAKE** - Northwest Jersey Hamfest. Budd Lake Firehouse. 201-584-6550

**NY - Poughkeepsie** - Mt. Beacon ARC Hamfest. Ken Akasofu 914-485-9617

**OH - ATHENS** - Athens County ARA Hamfest. City Recreation Center. Drew McDaniel 614-592-2106

## MAY 1996

### MAY 3-4-5

**CA - LA MIRADA** - So Calif Six Meter Club West Coast VHF/UHF Conference. 714-990-9203

### MAY 4

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

**IN - INDIANAPOLIS** - AGI Computer Fair. Beech Crest Center. 317-299-8827

**MD - GRASONVILLE** - Kent Island ARC Hamfest/Computer Flea Market. VFW. Glenn 410-643-1125

**MO - KANSAS CITY** - PHD ARA Hamfest. Chuck Miller 816-781-7313

**OR - KLAMATH FALLS** - Keno ARC Hamfest. Tom Hamilton 541-883-2736

**SC - GREENVILLE** - Blue Ridge ARS Hamfest. Anderson County Fairgrounds. Jeff 864-967-3284

**WI - SUPERIOR** - Arrowhead RAC Hamfest. George Mead 218-729-6882

### MAY 4-5

**CA - SAN FRANCISCO** - Robert Austin Computer Show. Cow Palace. 800-346-0100

**GA - DALTON** - ComputerShow. NW GA Trade & Convention Center. ComputerShow 770-907-6225

**TX - ABILENE** - Key City ARC Hamfest & ARRL Section Convention. Civic Center. Peg 915-672-8889

### MAY 5

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

**IL - DECATUR** - Cenois ARC Hamfest. Richland Community College. Bert Ruble 217-423-0314

**IL - SANDWICH** - Kishwaukee ARC Hamfest. Sandwich Fairgrounds. Howard, POB 264, Sycamore IL 60178

**IN - WABASH** - Wabash County RC Hamfest. Donald Spangler 219-563-5564

**MD - HAGERSTOWN** - Antietam Radio Assn Hamfest. Bill Harclerode 304-274-3355

**MI - MIDLAND** - Computer Show. Holiday Inn. Five Star Productions 812-230-0988

**MN - BEMIDJI** - Paul Bunyon ARC Hamfest. NorthWest Technical College. Roben 218-751-4801

**NY - YONKERS** - Metro 70cm. Network Flea Market. Lincoln High School. Otto 914-969-1053

**OH - AKRON** - Computer Show & Sale. Tadmor Shrine Temple. Peter Trapp Shows 607-369-2796

**PA - WRIGHTSTOWN** - Warminster ARC Hamfest. Middletown Grange Fairgrounds. 215-443-5656

### MAY 11

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

**CA - LOS ALTOS HILLS** - Perham Foundation Electronics Flea Market. Foothill College, Parking Lot A. 408-734-4453

**CA - OAKLAND** - Robert Austin Computer Show. Convention Center. 800-346-0100

**IL - PEOTONE** - Kankakee ARS Annual Hamfest. Will County Fairgrounds. Willis 815-472-2079

**WI - MANITOWAC** - Mancorad ARC Lakeshore Hamfest. County Expo Center. Glenn 414-684-7096

## MAY 12

**OH - MEDINA** - Medina 2 Meter Group Hamfest. Robert Romaniello 216-722-6019

**PA - YORK** - Computer Show & Sale. York Fairgrounds. Peter Trapp Shows 607-369-2796

## MAY 17-18-19

**OH - DAYTON** - Dayton ARA Hamvention. Dayton Hara Arena & Exhibition Center. 513-276-6930

## MAY 18

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

**MI - WESTLAND** - Great Lakes Computer Expo. Wayne-Ford Civic Center. 313-416-1015

**PA - ALLENTOWN** - Computer Show. Merchants Square. Peter Trapp Shows 607-369-2796

**RI - FORESTDALE** - Rhode Island Amateur FM Repeater Service Spring Auction & Flea Market. VFW Post 6342. Rick 401-725-7595

## MAY 18-19

**WA - YAKIMA** - Yakima ARC Hamfest. Mark Tharp 509-965-3379

**VA - NEWPORT NEWS** - Computer Show. Knights of Columbus Hall. Pro Am Shows 804-463-1136

## MAY 19

**CA - CARMICHAEL** - North Hills ARC Hamfest. Tim Lewis 916-722-7037

**IL - ORLAND PARK** - Orland Park Computer Show. Civic Center. 24-Hour Hotline 708-974-3123

**MA - CAMBRIDGE** - Flea Market. MIT. Nick 617-253-3776

**MI - FLINT** - Computer Show. Holiday Inn-Gateway Centre. Five Star Productions 810-230-0988

**VA - VIRGINIA BEACH** - Computer Show. Pavilion. Pro Am Shows 804-463-1136

## MAY 25-26

**CA - SAN FRANCISCO** - Robert Austin Computer Show. Cow Palace. 800-346-0100

## MAY 26

**CA - SANTA ANA** - Swapmeet. ACP Parking Lot. Mary Russo 714-558-8813

**IL - CHICAGO** - Chicago ARC Annual Hamfest. DeVry Institute of Technology. Jack 312-736-1587

**IL - GLEN ELLYN** - Computer Central. College of DuPage. Phys Ed Bldg. 708-940-7547

**OH - CANFIELD** - 20/9 Radio Club Hamfest. Canfield Fairgrounds. Don Stoddard 216-793-7072

## MAY 31-JUNE 1

**NE - SOUTH SIOUX CITY** - Midwest & Dakota Division Convention. Dick Pitner 712-258-1520

## MAY 31-JUNE 1-2

**NY - ROCHESTER** - Atlantic Division/New York State Convention. Harold Smith 716-424-7184

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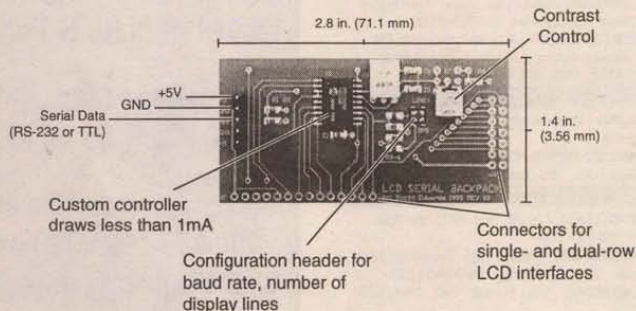


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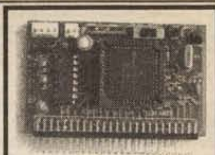
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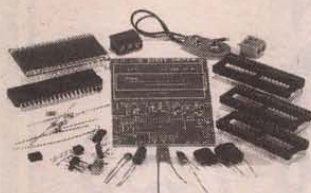
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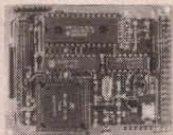
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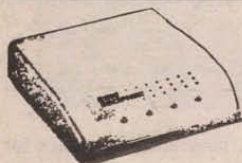
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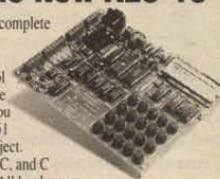
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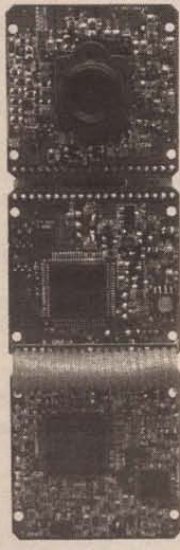
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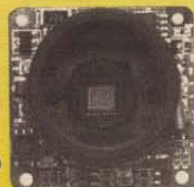
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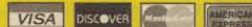
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# AMATEUR ROBOTICS

I've had a lot of fun building robopets and other small machines, but they've all had a common lack; none of them included wheel encoders.

Now that hasn't actually been much of a problem. Line followers don't need wheel encoders to run simple mazes; they react to the line in front of them. Robots for the Rapid Deployment Maze don't need encoders, either; the operator controls them with a joystick.

Even Huey, my original robopet, does just fine without encoders. The subsumption architecture

struct, and it had to work with as wide a variety of motor systems as possible. Failing the last, it had to fit onto a motor or wheel system that was as widely available as possible.

As usual, the Seattle Robotics Society (SRS) provided the answer I needed. Mark Castelluccio showed off a robot some months ago, driven by hobby servo motors. His machine competed in the Dead-reckoning contest, an event that requires accurate drive systems. Since "hobby servo motors" and "accurate drive systems" don't usually go together, I was surprised when his robot took first place against some stepper-based designs.

Mark said that he had installed a home-built encoder system inside the servo motor housing itself. I really like this concept; the encoder goes where the motor goes, and you don't have to worry about special shaft adapters or drive systems.

Based solely on Mark's statement that he had installed the

new, for \$0.50 each. They also list a price for 1,000 pieces, so I figure they have a bunch on hand.

You will also need some simple tools, such as an electric drill and a 1/8" bit, some ribbon cable, some 1/16" heatshrink, and a hot glue gun.

Begin by removing the four Phillips screws on the bottom of the servo motor case, then removing the top of the case (the part that has the Futaba name embossed on it).

You need to locate and drill a hole in one side of this case top. When you are done, whichever side you use will have a blob of hot glue stuck on it, and it will have a short length of three-conductor cable coming out of it. If you intend to mount this motor on its side, take the effects of this mod into account when you choose which side of the case to drill. The mod will work with either side, but subsequent motor mounting could get tricky.

The mod requires you to mount the IR emitter/detector (E/D) inside the servo's case, so the component sits about 1/4" above one of the gears and looks down on the gear's surface. This means the placement of the hole you are about to drill is critical; you don't have a lot of room to work with inside the reassembled motor case. The hole must be placed exactly 1/4" up from the bottom edge on the top of the case (the open section that fits over

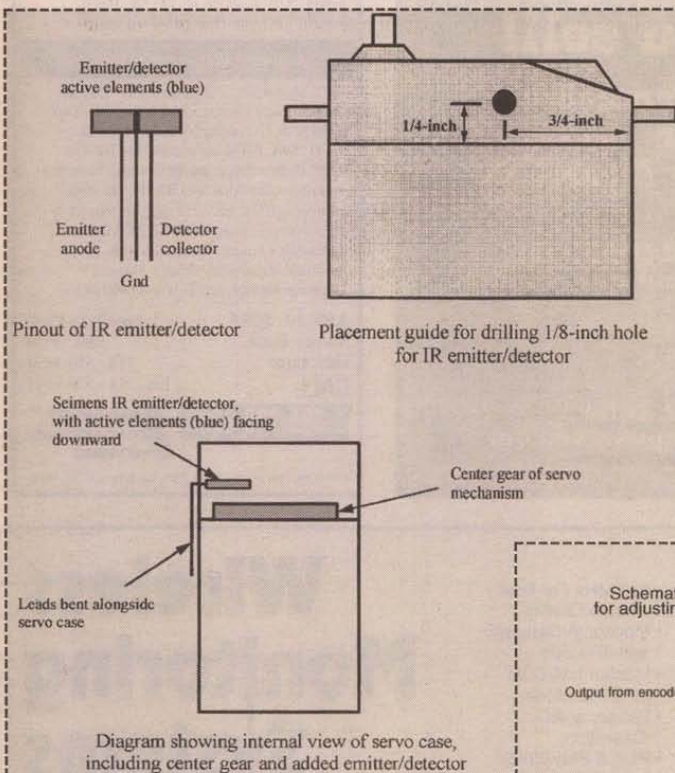
the servo PCB), and exactly 3/4" from the wall next to the Futaba legend. See the accompanying hole placement guide for details.

Mark the hole's location, then clamp the case top in a bench vise or other holder. Carefully drill out the hole, then clean and deburr the inside of the case. Remove any loose plastic shavings so they don't get into the gear mechanism later.

Now temporarily insert the E/D through

the hole in the case from the inside, with the leads sticking out. Make sure you have the E/D's active elements coated with a deep blue epoxy, pointed downward, toward the open part of the case top.

With the bottom edge of the E/D flush against the inner wall of the case top, carefully bend the device's leads so they fit flat against the outer wall. You should bend the leads toward the open part of the case top, so they extend beyond the edge of the



design of Huey's software means that it reacts to its environment, so path planning and navigation aren't essential. Note, however, that encoders could be added, and then Huey's code could be modified to show other behaviors.

Wheel encoders open up a whole new world of experimentation for the amateur robot builder. With encoders attached to your machine's drive system, your software can measure distance of travel, detect wheel slippage, and use dead-reckoning to make reasonable guesses as to present location.

Despite all of the advantages offered by wheel or shaft encoders, I haven't used them on a machine yet for a simple reason. I hadn't seen an encoder that I felt was suitable for designing into a robot for this column.

Sure, I've seen some real deals on the surplus market; encoders with gobs of resolution for pennies on the dollar. But if I built a machine using such a device, would the thousands of *Nuts & Volts* readers be able to duplicate my design? Probably not.

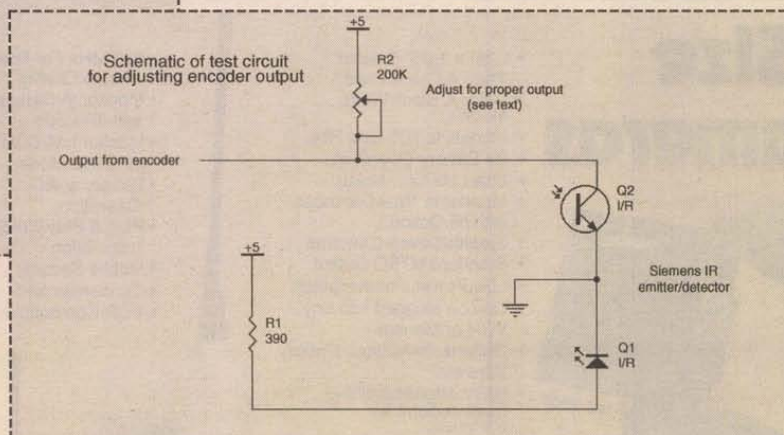
And generally, mounting an encoder on a shaft or motor requires some form of machining or special adapters. These devices would likely be unavailable to readers, as well.

So, for a long time I had to do without encoders, waiting for a design that matched some pretty tough criteria. It had to be cheap, reliable, easy to con-

struct, and it had to work with as wide a variety of motor systems as possible. Failing the last, it had to fit onto a motor or wheel system that was as widely available as possible.

My design fits inside the case of a Futaba S148 hobby servo, one of the more popular servos used in hobby robotics. The servo with encoder looks and works just like a servo without the encoder, except that it has an extra three-wire cable coming out of the side of the case.

The only special component you need to make this mod is a Siemens SFH-900-1 IR emitter/detector unit. Granted, most of you may not have such a device in your junk box, but they are actually quite easy to get, and very cheap, to boot. Just pick up your Electronic Goldmine catalog and look up their part number G3355. EG sells these devices, brand-



**EDITOR'S NOTE:** Last month, the last paragraph of the column was inadvertently cut off. Here, for your convenience, is the complete text:

The catalog sports everything from ammo boxes to parking meters, glow-in-the-dark human skulls to rubber iguanas, gearhead motors to pencil sharpeners shaped like a human nose. If the Mondo-tronics catalog is weird, the AS&S catalog is totally bizarre. Get one, you'll love it. **NV**



```

InstallServo set up a timer output channel to control a servo
Invocation: gosub InstallServo, toc
            or: n = usr(InstallServo, toc)

When called as a function (USR format), InstallServo returns a 0
if the setup worked, or -1 if the toc argument was invalid.

Upon exit, the specified TOC is set to 0, effectively stopping the
motor.

InstallServo:
select pick(0)
case TOC2
push $c0
push $40
endcase
' if this is TOC2...
' push the proper TCTL1 value
' push the proper OC1D/OC1M value

case TOC3
push $30
push $20
endcase

case TOC4
push $0c
push $10
endcase

case TOC5
push $03
push $08
endcase

drop 1
return -1
endselect
' drop invalid TOC argument!
' report a failure

pokeb oc1d, peekb(oc1d) and (pick(0) xor $ff) ' clear bit on TOC1
pokeb oc1m, peekb(oc1m) or pull() ' connect to TOC1
pokeb tctl1, peekb(tctl1) or pull() ' set bit on TOC
poke pull(), 0 ' clear TOC for now
poke tctl1, 0 ' TOC1 hits at 0
return 0 ' show all went well
    
```

case. Tape the leads in place, using a small piece of masking tape. This should leave the E/D positioned inside the case, with the leads taped flat against the case.

Carefully put the pieces of the servo back together. You don't need to install the four screws; you are simply checking for fit and alignment. Make sure that the E/D doesn't interfere with rotation of the servo's gears in either direction. You can test this by clamping a control horn or wheel onto the motor, then gently turning the motor shaft back and forth. If necessary, reposition the E/D, using the masking tape to hold the device in place.

When you are satisfied with the alignment, separate the case top from the rest of the servo assembly. Heat up the hot glue gun, then apply a large bead of hot glue to the hole on the outer wall, filling the hole and covering no more than 1/8" of the device's leads. Remember that you still have to solder wires to the leads; make sure you leave yourself with enough length on the leads.

After the hot glue sets, put the servo back together without using the screws, and verify that the motor still turns freely. If necessary, reheat the glue and reposition the E/D.

Separate the top case again and prepare a length of three-conductor ribbon cable. You can use a piece as long as the servo motor cable, if you like. Strip 1/16" of insulation from each wire at one end of the cable, then tin the three wires. Separate the three wires for about 1", then slide a 1/4" length of heatshrink over the center wire and move the heatshrink down the wire, safely away from the bare end of the wire.

Carefully solder each wire to a pin on the E/D. Make sure you connect the center lead of the ribbon

cable to the center lead of the E/D. After the leads are soldered in place, slide the heatshrink up over the connection to the center lead, then shrink it in place using the tip of your soldering iron.

With the wiring complete, apply a blob of hot glue to the E/D's leads to complete fixing it in position. Make sure you apply glue to both the case material and the leads, and be sure to cover as much of the leads as you can. Note that you will still have bare leads protruding beyond the lower edge of the case top.

Now set aside the case top and pick up the gear assembly. Note the large center gear, sitting flat against the gear platform, positioned midway between the outer two gears.

Find a 45-degree arc section of the upper surface of this gear that is as free of gear grease as possible. If necessary, use a cotton swab dipped in rubbing alcohol to clean off a 45-degree section. Take care to remove only the smallest amount of grease necessary, and do not disturb the grease on any other gears in the assembly.

Using a black Sharpie marker, carefully fill in the cleaned 45-degree section of the gear surface. Apply one coat of ink, let it dry, then apply a second coat. When dry, this ink will serve as the encoder signal for the E/D.

Carefully rebuild the servo motor and tighten the four screws to complete the assembly. This completes installation of the servo motor encoder system.

The encoder you have just added provides 45 pulses per each wheel rotation. While this isn't up to the hundreds or thousands of pulses per rev available from commercial units, it will only set you back a buck or two. What's more, you can move this motor from one robot to another without having to deal with mounting problems beyond where to put the motor.

Next up is testing the encoder and adding some simple electronics.

## Electronics

The E/D detects the darkened section on the servo gear by the amount of IR light reflected off the gear's surface. When the IR is emitted by the LED, half of the E/D falls on the white, untreated surface of the gear, and a large amount of IR reflects back to the detector. This, in turn, creates a low resistance across the phototransistor and a correspondingly low output voltage.

Conversely, the darkened section of the gear reflects much less IR. This causes the phototransistor to show a large resistance. By adding a resistor pulled up to +5 VDC, you can use the resulting voltage across the phototransistor to determine when the dark section of the gear falls underneath the E/D.

Finding the proper pull-up resistor takes a little tweaking. The resistor's value will vary from servo to servo, depending on many conditions. It is affected by the alignment and orientation of the E/D, by the density of the ink you put on the gear, and even by the type of pen you use when you mark the gear.

Fortunately, you can build a simple test circuit on a Radio Shack plug-in experimenter's board, and quickly find the best resistor value to use. Refer to the accompanying test circuit schematic for details.

Always begin your tests with a current-limiting resistor of 390 ohms. You may need to change this value later, but it will work in most cases. This is far

larger than I usually use for driving LEDs, but the reduced current is important. If you use

too much current to drive the IR emitter, you end up with IR bouncing all over the inside of the servo's case, giving you false readings.

Set the trimpot to its midrange, then apply power and monitor the voltage at the junction of the detector's collector and the trimpot. Very slowly rotate the motor's drive shaft until you get as high a reading as possible; this shouldn't require more than 90 degrees of turn.

Adjust the trimpot until you measure a voltage of at least 2.7 volts. If you get a reading above 3.0 volts, adjust the trimpot to bring the voltage down below 3.0 volts.

Now, slowly turn the motor shaft until the voltage drops dramatically. This means the darkened section of the gear has moved underneath the E/D. The voltage should be below 2 volts, ideally below 1.5 volts. If it is not, adjust the trimpot until the voltage falls below 1.5 volts.

Repeat this rotate-and-tweak operation until you read a voltage above 2.7 volts for the light portion of the gear, and below 1.5 volts for the dark portion of the gear. When you are satisfied, disconnect the trimpot and measure the resistance between the two terminals you had connected to the circuit. This value represents the optimum pull-up resistor value for that motor.

You will have to perform this same set-up with any servo to which you add an encoder. It's a good idea to mark the pull-up value for each motor somewhere on the motor's case, or on the cable coming from the motor's case. You will need this information later, when you go to hook up multiple motors in a robot.

You can now add circuitry, similar to the test circuit, to your robot computer boards. Add one set of the circuitry for each encoder you intend to use. Note that you don't have to find the exact value for the pull-up resistor, as determined by your set-up. Just use the nearest common value. For example, if your test shows a 107K resistor is optimum, you can use a 100K or 110K without any problems.

If you choose, you can also leave the trimpot in place when you add the encoder circuitry to your robot. You would need to re-adjust the trimpot if you change motors, but that would only take a few minutes, and would only need to be done once.

In some cases, you may not be able to get the above cited voltage range from your encoder. If so, you have a couple of options available. The easier option involves the darkened area of the gear. Go over the arc you marked out again, making it as black and evenly-coated as you can. In extreme cases, you might try cutting out an arc-shaped piece of black construction paper and actually gluing it to the gear's surface.

Less easy, but also worth trying, is to vary the LED current-limiting resistor. If you cannot get the encoder's output voltage to fall below 1.5 volts, try increasing the current-limiting resistor to 470 ohms. If the output voltage won't go above 2.7 volts, try decreasing the resistor to 270 ohms.

If possible, you need to use the same current-limiting resistor for all of your encoder circuitry. This will make it easier to move your encoder-equipped motors between robots.

I hook the output of the encoder circuitry to one of the three input-capture pins on the 68hc11. These are port A pins 0 through 2, though some 'hc11 variations let you configure other port A pins for this function, as well.

## Software

Now that you have the electronics and mechanics taken care of, you need a little software. The accompanying listing provides an SBasic program for moving a motor a prescribed number of pulses.

As always, you can reach me at:

Karl Lunt  
2133 186th Pl., S.E.  
Bothell, WA 98012  
E-Mail: karl@mav.com

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encoder.bas Program for testing encoder-equipped servo motors

This program allows the user to enter one-character commands from a serial port and control the behavior of an encoder-equipped Futaba S-148 servo motor. Available commands include speed and direction control as well as number of rotations.

This program assumes the servo motor is hooked to TOC2 and the encoder output line goes to IC1. You can change the InstallServo call below if you want to use a different TOC.

You must compile this program with SBasic11 version 1.0a or higher.

```
include "regs11.lib" 'define the 68hc11 regs
include "servos.bas" 'use the servo library

const DELAY = 60 'update rate (60 * 4.2 msecs)
const PULSES = 45 'pulses per revolution
const FWD = 1
const BKWD = 2

declare n
declare wait
declare mtr_cntr
declare target
declare running
declare fspeed
declare bspeed
declare direction

interrupt $ff0 'RTI isr
if wait < 0 'if timer not yet at 0...
wait = wait - 1 'drop it
endif
pokeb tfig2, %01000000 'rearm RTI
end

interrupt $fee 'ic1 isr
mtr_cntr = mtr_cntr + 1 'count this pulse
pokeb tfig1, $04 'rearm ic1
end

main:
pokeb baud, $30 '9600 baud
pokeb socr2, $0c 'turn on SCI

mtr_cntr = 0 'init the pulse counter
pokeb tmsk1, $04 'allow interrupts on ic1
pokeb tfig1, $04 'clear flag for ic1
pokeb tcl2, $10 'interrupt on rising edge only

wait = 0 'clear the wait timer
pokeb tmsk2, peekb(tmsk2) or %01000000 'start RTI system
pokeb tfig2, %01000000

gosub InstallServo, toc2 'install a servo on toc2

interrupts on 'allow interrupts

target = 0
running = 0
fspeed = $f800
bspeed = $f200
direction = FWD

print
print "encoder.bas"
print
do
if wait = 0 'if time to update...
wait = DELAY 'rearm wait timer
printu "vmtr_cntr = "; mtr_cntr; " "
printu "target = "; target; " "
if direction = FWD
```

```
printx "fwd speed = "; fspeed; " "
else
printx "bkwd speed = "; bspeed; " "
endif
endif
```

Check for a key from the user; if key is pressed, do the command.

You can add extra commands by inserting your own CASE statements in the large SELECT structure below.

```
n = inkey() and $ff
select n
case 'z' 'zero the pulse counter
mtr_cntr = 0
endcase

case 'f' 'go forward
poke toc2, fspeed
direction = FWD
endcase

case 'b' 'go backward
poke toc2, bspeed
direction = BKWD
endcase

case ' ' 'stop the motor
poke toc2, 0
endcase

case '+' 'increase speed
if direction = FWD
fspeed = fspeed + $40
else
bspeed = bspeed + $40
endif
endcase

case '-' 'decrease speed
if direction = FWD
fspeed = fspeed - $40
else
bspeed = bspeed - $40
endif
endcase

case '1' 'set pulse count = n * 45
case '2'
case '3'
case '4'
case '5'
case '6'
case '7'
case '8'
case '9'
target = (n - '0') * PULSES
running = 1
endcase

endselect
```

This code checks the motor. If it is running, the code then tests to see if the pulse counter has hit the target. If so, this code stops the motor and resets the target value.

```
if running <> 0
if mtr_cntr >= target
poke toc2, 0
running = 0
target = 0
endif
endif
loop
end
```

gram's flow. You would need to use similar code in your robot to do navigation or path-planning.

I have also included the listing for an SBasic file called SERVOS.BAS. This library file contains code for setting up interrupts needed to control servo motors. This code shows how easily you can develop powerful modules in SBasic, then reuse your code in other projects.

## Other ideas

After I developed my encoder system, I got an up-close look at what Mark did to install his encoders. Basically, he had used a Dremel motor tool and a tiny saw blade to remove the plastic walls inside the servo motor case, where the servo potentiometer fit originally. In the hollowed-out space, Mark fitted a dime-sized piece of perfboard containing one IR LED, two separate IR detectors, and resistors similar to those used in my circuit.

Using two detectors gives 90 pulses per revolution, and Mark was able to align the detectors so he actually got quadrature signals from his encoders. This means his encoders cannot only determine rotational speed, but direction as well.

Also, because all of his circuitry fitted inside the case, Mark was able to steal +5 VDC from the servo electronics. Thus, he only needs three wires for his encoder system: ground and two encoder outputs. I encourage readers with the proper tools and ambition to consider Mark's mod when deciding how to add an encoder. Though his technique isn't for everyone, the added capabilities may be what your project needs.

Marvin Green developed a method midway between those used by Mark and me. Marvin also carved out the plastic walls inside the motor housing, but he installed just a single Siemens IR E/D.

The Siemens E/D units really lend themselves to this type of mod, and I'm sure many of you will be able to fit them into encoders of your own design.

You can use one of these techniques or create your own, but putting the encoder mechanics directly

inside the servo case is a big win. You eliminate perhaps the biggest hurdle in optical encoders on robots — the uneven results caused by fluctuations in ambient light. Whether it's direct sunlight sneaking into the emitter, or noise from overhead fluorescents, optical encoders can prove hard to design. The dark, light-tight interior of a servo case is a perfect mounting place.

Well, that's it for this month. I'll close with a comment regarding software. I've avoided including software listings in the past, since it tends to fill up the article and I wasn't sure how much value it gave.

But I've received a lot of support for my SBasic listings, and will try to make them a regular feature in the column. Apparently, many readers enjoy actually seeing how to solve some tough programming problems, and use my examples as jumping-off points for their own designs. **NV**

With it, you can determine how well your encoder system works. Plus, the program can serve as the starting point for developing your own encoder-based programs.

The program uses encoder interrupts on input IC1 (port A, pin 0) to increment a counter; each interrupt bumps the value in variable MTR\_CNTR by one. The program also expects the servo motor to be hooked to OC2 (port A, pin 3).

This software sets up the interrupts needed to handle the servo motor and the encoder, then sits in a loop, waiting for input from the user via the serial port (SCI). You can enter several one-letter commands to control the servo motor. Additionally, the software reports vital information back, concerning servo pulse width used to control direction and speed of rotation.

For example, you can enter a single number

from 1 to 9. The software will turn the motor that number of revolutions, based on 45 counts per wheel rotation. After the prescribed number of rotations, the software will stop the motor in place.

Other commands available include a space for stopping the motor immediately, plus and minus to increase or decrease the motor's speed, 'f' and 'b' to set the direction either forward or backward, and 'z' to zero the encoder pulse counter MTR\_CNTR.

While the motor is turning, the software also displays the current value of the servo timer, TOC2. This directly controls both the speed and direction of rotation. The values shown in the listing work for my motor, though you may need to tweak them for yours.

As you review this program, notice the simple code used to track encoder pulses, and how I use the information stored in MTR\_CNTR to control the pro-



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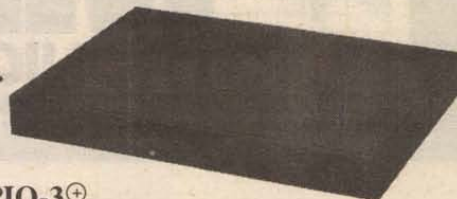
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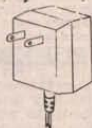
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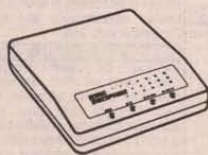
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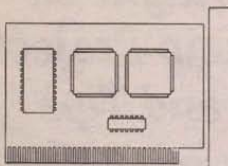
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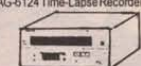
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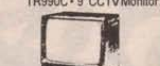
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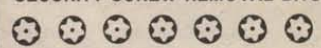
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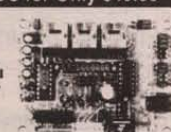
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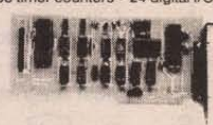
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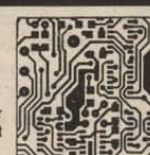
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# Stamp Applications:

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

by Scott Edwards

**This is the 13th installment of Stamp Applications, so it's a perfect opportunity to talk about bad luck. In the microcontroller world, misfortune can take the form of garbled communications, power glitches, software bugs, hardware malfunctions, stuck motors, bad solder joints, electrostatic zaps, crazed users, and unread user's manuals. Some of these we can prevent; some we can control; and some we can neither prevent nor control, but only worry about.**

### When Good Luck is not Enough: Watchdogs and Error Recovery Catching and Correcting Operating Errors and a Few Bits of Boolean Logic

We'll start our exploration of bad luck with a class of applications known as "watchdogs." These are circuits that monitor computers or processes for a telltale sign of proper operation. If they don't find it, they attempt to fix the problem, or to notify someone who can. A watchdog can restart a stuck PC, cut power to a stalled motor, or signal a technician for help.

I'll also show you how to use the BS2's serial timeout feature to resend data if a peripheral (or other BS2) doesn't respond within a reasonable amount of time. And since unexpected resets are often a symptom of hardware problems, I'll demonstrate a simple method of detecting them.

#### Watchdog Timer

Many microcontrollers, including the PBASIC interpreter chip used in the Stamp and Counterfeit, include a watchdog timer. This is a circuit that periodically increments (adds 1 to) a counter. When the counter is full and increments one more time, it overflows. This causes the PBASIC chip to reset, almost as if the reset button were pushed. (I say almost, because the chip can tell the difference between a watchdog reset and a hardware reset.)

The chip itself has no control over the watchdog timer. It cannot stop it from incrementing the counter. But it can clear that counter to 0, making the watchdog start all over in its march toward a reset.

If the chip resets the timer to 0 often enough, the watchdog reset never occurs.

What good is this? Let's take an example from desktop computers. With just a glance at the instructions, you install the latest software on your PC. You fire it up, and a program screen appears. So far, so good. Then ... nothing. Press a key, move the mouse; nothing. Your PC is locked up. Sigh. Press ctrl-alt-delete to reset and try again.

In many control applications, there may not be a human standing by to decide when a program is locked up, so a watchdog timer serves the same purpose. The program is written in such a way that normal operation prevents the watchdog timer reset — but if the controller starts operating abnormally and forgets to clear the counter, the watchdog resets it.

PBASIC handles all the details of its own watchdog timer automatically, so you don't have to worry about it. But it can be useful to mimic the operation of the watchdog in your own programs.

For example, a reader asked me how to monitor a motor to ensure that it wasn't stalled. I suggested the watchdog approach illustrated in Listing 1.

The program is set up as a big loop. Each trip through the loop PBASIC checks an input from a switch that is periodically pulsed by the rotation of the motor. Figure 1 shows a suitable magnetic-switch arrangement.

When the Button instruction detects a switch closure, the program clears the watchdog counter. Otherwise, the program increments the watchdog counter. If the watchdog counter exceeds a preset value (determined by trial runs), the program judges that the motor is stalled, and hollers for help. The program in Listing 1 expects at least one pulse per second to prevent the watchdog from barking.

Other readers report using a similar method to monitor and reset PCs used in remote locations. They program the PC to periodically pulse an output line, such as one of the bits of the parallel port. Or they tap into the hard-drive activity light, if the application that's running uses the hard drive on a regular basis. The Stamp or Counterfeit monitors the pulse output. If no pulse arrives within before the watchdog counter reaches the maximum value set by the program, the Stamp or Counterfeit resets the PC,

either by closing a relay across the reset button, or by opening a relay between the PC and its AC power source. (The latter approach seems a bit brutal to me, but reports from the field are that it's effective.)

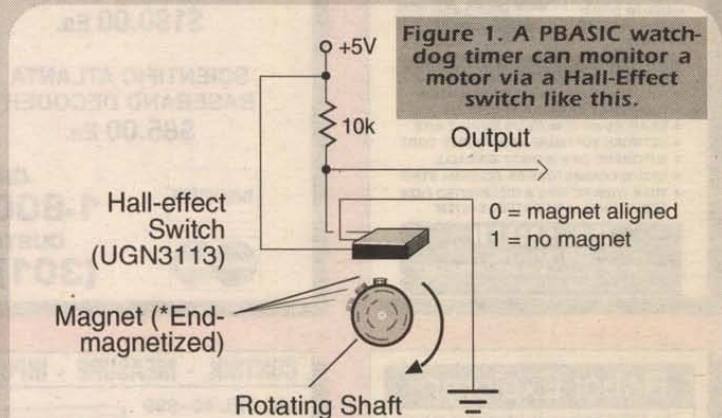
#### Serial Retry

The BASIC Stamp 2 (BS2) has many new instructions and improvements to existing instructions. One such improvement is the addition of a timeout feature to the serial-input instruction Serin. It allows you to specify a number of milliseconds (up to 65535; over a minute) for the Stamp to wait for serial data. If the data doesn't arrive within that time, the program goes to a routine that you specify.

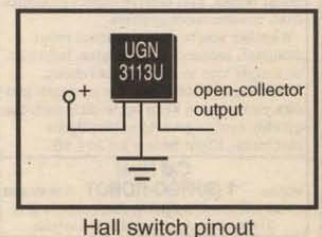
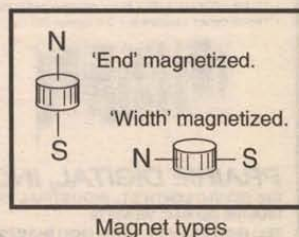
So, where the older Stamp could get stuck waiting for serial input, the new one can unstick itself.

At first blush, I didn't see this feature as being terribly useful, since it addresses a symptom rather than the underlying problem. A corollary to Murphy's Law says that if you give up waiting for data now, the data you expected will arrive one millisecond later!

However, there's a common, real-world situation in which the serial timeout can be helpful. In two-way conversations between the BS2 and a serial peripheral or other Stamp, the timeout can provide



\*To avoid affecting the balance of the shaft, use a button magnet that is magnetized across its width and mount it coaxially on the end of the shaft. The Hall-effect switch will turn on whenever the correct pole lines up with it.





# Stamp Applications:

## Listing 1. Watchdog Monitors 1-Hz Pulse (PBASIC 1)

' Program: WATCHDOG.BAS (PBASIC 1 detects motor stall)  
' This program implements a watchdog timer — a device that monitors  
' a pulsebeat and takes action if the pulse is absent for a  
' predetermined amount of time. Applications for watchdogs include  
' resetting a locked-up PC or cutting power to a stalled motor.

```
SYMBOL state = bit0 ' Trigger state for button command.
SYMBOL dog = w1 ' The watchdog counter.
SYMBOL pulse_n = 0 ' Pin number for pulsebeat input.
SYMBOL pulse_p = pin0 ' Pin name for pulsebeat input.
SYMBOL btn = b4 ' Workspace for button command.
SYMBOL timeout = 300 ' Max value of "dog" before alarm.
```

```
begin:
  let dog = 0 ' Clear watchdog variable to 0.
  state = pulse_p ^ 1 ' State = inverse of pulse pin.
```

' In the routine below, if the pulse input changes state, the OK  
' routine shows us the count in variable "dog," then clears "dog"  
' by looping back to the beginning of the program. Otherwise,  
' it increments dog and, if dog exceeds the timeout value, shows  
' the alarm message.

```
watchDog:
  button pulse_n,state,0,1,btn,1,OK
  let dog = dog + 1
  if dog > timeout then alarm
  Goto watchDog
```

```
alarm:
  debug "alarm!",cr ' Dog exceeded timeout.
  goto begin
```

```
OK:
  debug dog,cr ' Show us how high "dog" got.
  goto begin ' Then goto beginning to clear.
```

## Listing 2. Serial Retry Overcomes Communication Glitches (PBASIC 2)

' Program: TIMEOUT.BS2 (Demonstrate serial timeout function of BS2)  
' This program demonstrates how to use the serial-input timeout  
' capability of the BS2. If the BS2, interfaced to a Stamp Stretcher 1B,  
' does not receive a response to an analog-conversion request within  
' 1 millisecond, it displays the message "Timeout" on the PC debug  
' screen. If the Stretcher does return the data in time, the BS2  
' does not execute the error code, but displays the ADC result on the  
' debug screen. In a real program, the error handler would probably be  
' more elaborate — tracking the number of retries, lighting a warning  
' light, sounding a buzzer, reinitializing the Stretcher, etc. Since  
' communication errors are relatively rare under normal circumstances,  
' you can unhook the serial connection between the BS2 and Stretcher  
' while the program is running to demonstrate the error routine.

```
N96N con $4054 ' Set 9600 baud, inverted, no parity.
result var byte ' Store ADC result in this byte.
maxtime con 1 ' Allow this many milliseconds for reply.
comPin con 0 ' Connect this pin of BS2 to Stretcher "S" pin.
```

```
serout comPin,N96N,["****"] ' Reset the Stretcher.
again: ' Endless loop.
  pause 1000 ' Wait a second between tries.
  serout comPin,N96N,["A"] ' Send (A)nalog request.
```

' The line below is the key to the program. It waits "maxtime" milli-  
' seconds for serial start bit from the Stretcher. If the data doesn't  
' arrive in time, it sends the program to the label "error." If the  
' data does arrive, it stores it in the variable "result."

```
serin comPin,N96N,maxtime,error,[result] ' Get response.
```

```
debug ? result ' Display result.
goto again ' Do it again.
```

```
error:
  debug "Timeout",cr ' Serin timeout occurred: show error
  goto again ' message.
  debug "Timeout",cr ' Display "Timeout" on PC debug screen.
  goto again ' Try again.
```

a way to resend an instruction if the peripheral doesn't respond.

For example, take the Stamp Stretcher 1B. This board lets a BS1 or BS2 access 16 additional I/O lines through a one-wire serial hookup at 2400 or 9600 baud. It also has a single-channel, eight-bit

a good point — the serial-retry concept would be especially useful in dealing with error-prone communications over the phone line. If you wrote a program to interact with a remote computer, online service, or bulletin-board system, chances are good that the connection would eventually fail. The serial

## Listing 3. EEPROM Flag Locks Out Resets (PBASIC 2)

' Program: NO\_RESET.BS2  
' This program illustrates a method for letting a program detect the  
' fact that the BS2 has reset since programming. This can be helpful  
' in situations in which an unintended reset might cause loss of data,  
' damage to equipment, etc. Note that an actual program should include  
' some method for clearing the EEPROM reset flag other than just the  
' data statement. Otherwise, the reset that occurs when a program is  
' loaded, followed by the reset that occurs when the BS2 is disconnected  
' from its programming cable, would trigger the reset-trapping routine.  
' A button that causes the program to execute "write reset,0" would  
' do the trick. To see the demo work, run the program. Watch the  
' numbers go by on the debug screen, then press the reset button.  
' The screen will display "Reset detected!"

```
x var byte ' Variable for busy work in demo.
reset data @0,0 ' Write 0 to EEPROM address 0 as a flag to
' indicate that the program has not reset.
```

```
Demo:
  read reset,x ' Copy the value of reset into x
  if x = 0 then run ' If x is 0, then the BS2 has not reset, so run.
  debug cls, "Reset detected!" ' If x is not 0, then a reset occurred, so stop.
  END
```

```
run:
  write reset,255 ' Record first startup of BS2
```

```
busy_work:
  debug ? x ' Dummy program to show activity:
  x = x+1 ' Display value of x on PC screen.
  pause 500 ' Add 1 to x.
  goto busy_work ' Wait a half second.
  ' Repeat endlessly.
```

analog-to-digital convert-  
er (ADC).

To use the ADC, the Stamp sends the instruction "A" to the Stretcher with Serout, then waits for a response with Serin. Fine and dandy, unless the serial transmission got garbled and was received as something other than "A." The Stretcher is programmed to ignore characters that aren't in its command set, so the Stamp could end up waiting for a reply that isn't going to come.

If the garble was caused by some noise on the serial line, then it makes sense to try again by resending the instruction. Listing 2 shows how.

The retry loop of Listing 2 offers all sorts of opportunities for customization. You could add a counter to the loop that would try three times, then flash an error light. Or continue the program without the analog data. Or connect to a modem and send a message to a human maintenance technician.

That last one brings up a good point — the serial-retry concept would be especially useful in dealing with error-prone communications over the phone line. If you wrote a program to interact with a remote computer, online service, or bulletin-board system, chances are good that the connection would eventually fail. The serial

timeout would allow the BS2 to try again later.

## Reset Lockout

Many different hardware problems can cause unintended resets of the PBASIC chip. Any glitch that takes the 5-volt power supply lower than 4 volts, even for a fraction of a second, can cause a reset. Voltage transients that disrupt the relationship of ground to the +5-volt rail, or that put noise on the reset line, can also reset the chip. Of course, a curious finger poking the reset button will do it every time!

There are lots of applications in which you want to prevent the Stamp from resetting, because a reset would disrupt a process, reinitialize variables, or cause the loss of data. Elsewhere in this issue is my BS2 Data Collection Proto Board. I set it up to gather data on battery voltage and ambient temperature to get a general idea about battery longevity and generate sample data for the article. If the BS2 were allowed to reset during the data-gathering period, some or all of the earlier data would have been lost. So I devised a trapdoor approach that prevented the program from starting over if reset. See Listing 3.

The idea is as simple as locking a door behind you. When the BS2 is first programmed, a Data directive writes 0 to address 0 of the EEPROM. The program reads this location, and, if it's 0, writes 255 to it and continues with the program. If the location does not contain 0, the program halts.

When the program is downloaded to the BS2, the door is unlocked, because the downloading process writes 0 to EEPROM address 0. When the program executes, it locks the door by writing 255 to it. If the BS2 resets, it will find 255 (locked) in the EEPROM address, and will stop.

This technique is also open to modification. In the data-logging application, I added a menu item that allowed the user to unlock the program manually. Another variation would be to use a switch instead of a byte of the EEPROM to lock out resets. The user would turn the device on, then move the



# Stamp Applications:

switch from run to stop. The BS2 would check the run/stop switch at the beginning of the program, and continue only if it was in the run position.

In either case, a flashing light or buzzer could signal a reset that occurred after lock out.

## BASIC for Beginners

Last month, we looked at the logic of IF/THEN instructions. We saw that PBASIC can look at a relationship such as "x < 10" and, if the current value of x makes that statement true, can go to a specific line in the program. In other words, PBASIC can make decisions.

We also touched on the fact that PBASIC can combine relationships using AND and OR to make decisions about more complicated matters. This month, we're going to look at the rules that govern this kind of logic. This logic not only works with IF/THEN decisions, it also lays the foundations for bit manipulations — efficient shortcuts for testing or changing the states of bits (1s and 0s).

Starting on familiar turf, let's take another look at a compound IF/THEN instruction.

IF pin1 = 1 OR pin2 = 1 THEN Alarm

So, if either of those comparisons — "pin1 = 1" or "pin2 = 1" is true, then the alarm goes off. Suppose we needed to make a table of all the conditions that could set off the alarm. It would look like this:

pin1	pin2	Alarm
FALSE	FALSE	OFF
FALSE	TRUE	ON
TRUE	FALSE	ON
TRUE	TRUE	ON

If those pins represent switches connected to doors and windows of a house, then that logic makes good sense. You want an alarm to go off in the event that bad guys are coming through the door, the window, or both. But suppose pin 1 represented the state of the door switches, and pin 2 was

## Sources

For more information on the BASIC Stamp, contact:

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the state of the arming switch (0=off; 1=on). You'd want the alarm to sound only if the system were armed and a door opened. The new IF/THEN instruction, just like the plain-English description, uses AND instead of OR:

IF pin1 = 1 AND pin2 = 1 THEN Alarm

The new table expressing all possible states of the pins and alarm would be:

pin1	pin2	Alarm
FALSE	FALSE	OFF
FALSE	TRUE	OFF
TRUE	FALSE	OFF
TRUE	TRUE	ON

If AND and OR were useful only with IF/THEN instructions, they'd still be darn useful. But IF/THEN

## Scott offers Stamp-related kits, including:

The Counterfeit controller, a kit alternative to the BASIC Stamp, is \$29.00. Double- and quad-speed options are \$2.00 and \$4.00, respectively. The Counterfeit Development System, required to program Counterfeits, is \$69.00 and includes a 150-page manual, downloading cable kit, Parallax software, and one Counterfeit controller kit.

The Stamp Stretcher 1B adds 16 digital I/O lines, plus an eight-bit analog input to your Stamp I, Counterfeit, or Stamp II. It interfaces with these controllers via a 2400- or 9600-bps serial connections. The Stretcher 1B is \$30.00 in kit form, \$45.00 assembled.

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The UGN3113U Hall-Effect switch is available from Newark Electronics. To get the number of the Newark office nearest you, phone their national administrative office at 312-784-5100; Canada, 416-670-4187; overseas, 312-638-7652.

is only the tip of the iceberg. If you're just now encountering the power of logical operators like AND and OR for the first time, you're in about the same position as someone who's first encountered the arithmetic operators + and -. Not only are there more logical operators, but there's a whole system for understanding and applying them, called Boolean logic.

I want to leave you with a thought for next time, when we'll start digging around in the Boolean toolbox in earnest: AND and OR work on expressions that have two possible values, True and False. We could represent those states with individual bits, since they also have two possible states, 1 and 0. What if there were a way to apply logical operators directly to bits, or groups of bits in PBASIC? There is, and some of the most powerful techniques for writing efficient programs spring from this application of logic. **NV**

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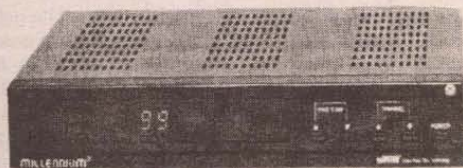
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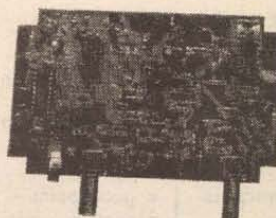
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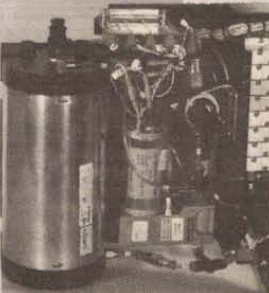
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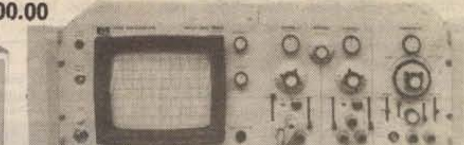
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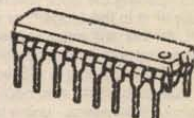
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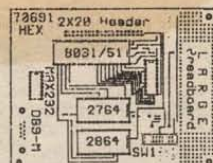
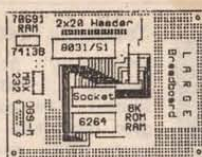
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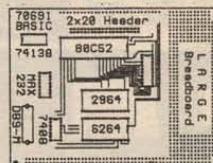
## MICROCONTROLLERS

**MAGPRO-11 KIT.** Download \$19 files to internal EEPROM via RS-232, \$45. MagTroll-11 KIT, HCx11 single board computer \$39. Includes instructions and disk. \$3 S&H. Send check to: **Magiland**, 4380 S. Gordan, Fremont, MI 49412. 616-652-2368. 8 am to noon Eastern.



**ECONOMICAL 8051 SBCs.** The 70691RAM, a complete SBC with large breadboard area, serial port, 8K RAM/ROM and 40 pin Header for Easy interfacing. Also includes programming software (3.5 or 5.25in), documentation and sample .ASM codes. Assembled/ Tested \$50 plus S/H. Suncoast Technologies, PO Box 5835, Spring Hill, FL 34606. 904-596-7599. V/MC accepted.

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**DID YOU KNOW** that old personal computers, monitors, modems, electronic cash registers, and even old calculators contain valuable IC chips that are plated with pure gold! My "Big Color Photo" (8" x 10") shows over 25 of the most common gold plated IC Chips and the price I will pay for them. Chips are shown actual size. The price of gold keeps climbing higher and higher and is making it worthwhile to tear apart old equipment. To order "The Big Photo" send \$15 to Jim Sciuto, Box 128, Methuen, MA 01844.

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That's right, Muscle Wires HAVE COME TO GATEWAY! At room temperature, Muscle Wires (thin highly processed strands of Nitinol) are easily stretched by a small force. However, when conducting an electric current, the wire heats and changes to a much harder form that returns to the "unstretched" shape - the wire shortens in length with a usable amount of force! Pretty cool, huh! There is a really cool project book (\$17.95) that explores the properties of muscle wires, details design, construction, and power of muscle wires, and provides detailed instructions for fifteen Muscle Wires projects. Gateway has a starter kit to with different diameter Muscle Wires get you going (\$19.95), a meter of 100uA muscle wire for \$14.95, and a nifty thing for the kids called Live Wires - similar to muscle wires but activated by hot and cold water - it "remembers" whatever shape you bend it into! (\$2.95)

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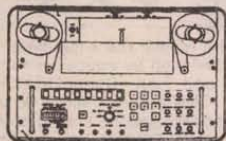
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**MILITARY COMPONENTS** wanted. Capacitors, resistors, diodes, transistors, semiconductors, ICs. Electronic Material Industries, 818-842-5953, FAX: 818-845-3613.

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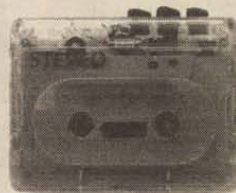
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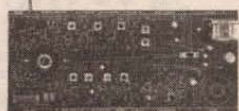
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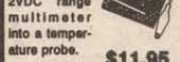
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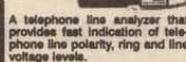
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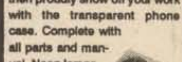
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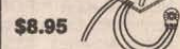
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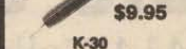
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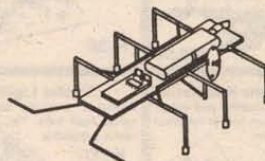
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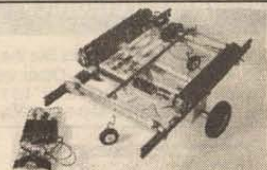


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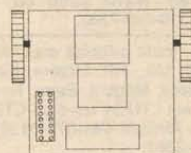
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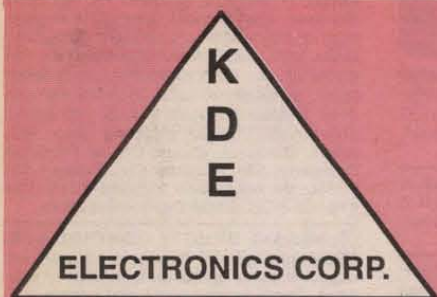
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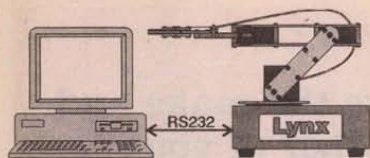
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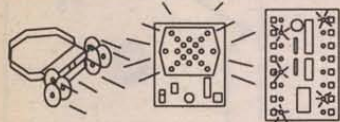
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# THE SOLDERLESS BREADBOX

by Donald Wilcher

## Playing Around with Potentiometers

Potentiometers play an important role in the field of electronics. These three-terminal, sliding contact or rotary devices allow lights to be dimmed, sound to increase/decrease, and speed settings of mechanical machines to be adjusted. Although potentiometers are simple devices, they can be used in a variety of electronic and science projects.

To understand potentiometers doesn't require a lot of knowledge in math or mechanical engineering. Basically, a good background in simple DC electrical circuits is all that is required in comprehending voltage divider networks, Wheatstone Bridges, and null voltage measurements as they relate to potentiometer applications.

One of the most important roles for a potentiometer in a circuit application is user input interface. With potentiometers, the user of the device has input control of the unit's function. This control can either be a sliding contact or wiper motion of the product's feature.

The paragraphs to follow will investigate the function and application of potentiometers. Several circuit examples will illustrate how to apply the potentiometer in electronic simulators and user input devices. To get started on this discussion of potentiometers, let's look at the physical make-up of the device.

## Description of a Potentiometer

Basically, a potentiometer is an electrical variable transducer whose resistance value can be changed by moving a sliding contact or wiper along its resistive element. Figure 1 shows a pictorial diagram along with its schematic symbol of a potentiometer. As seen in the diagram, three terminals connect the potentiometer to the outside world. All three terminals are located on the cylindrical body of the potentiometer. Two of the terminals are tied to the resistive element inside of the device, and the third terminal is coupled to the mechanical wiper or sliding contact. The resistance value decreases or increases depending on the location of the wiper on the winding coil. Rotating or sliding the contacts will change the value of resistance for the potentiometer. In the real world, the resistive element is circular and spans an angle of about 300 degrees.

Potentiometers, like active components (e.g., transistors, diodes, and ICs), have some important characteristics that should be understood by the hobbyist or experimenter. The two most important electrical characteristics for the potentiometer are linearity and resolution.

Linearity of a potentiometer is the mechanical movement of the wiper or sliding contact that produces a given change in resistance no matter where the wiper or sliding contact happens to be on the resistive element. In other words, the resistance of the element is evenly distributed along the length of the element. The precise degree of linearity of a potentiometer is very important when it comes to selectivity or adjustment of a device or system; for example, the volume control of a radio. Selectivity of the sound level and how to adjust or maintain that level is quite important for the listener of the radio.

Resolution of a potentiometer is the minimum

possible resistance variation expressed as a percentage of the total resistance. The formula used to calculate this value is:

$$\text{Resolution} = \frac{\text{Resistance per turn}}{\text{Pot Resistance Value}}$$

To see how this formula works, let's take the following example: A potentiometer's resistance value is 500 ohms with a 200 turn resistive element winding. Its resistance per turn or "rpt" would be calculated as

$$\text{rpt} = \frac{\text{Pot Resistance Value}}{\text{No. of turns}}$$

Making the appropriate substitutions into the equation, rpt equals

$$\text{rpt} = \frac{500 \text{ ohms}}{200 \text{ turns}}$$

Resolution for this example equates to:

$$\text{Resolution} = \frac{2.5}{500 \text{ ohms}}$$

$$\text{Resolution} = 0.5\%$$

Electronics parts catalogs will have information on linearity and resolution of potentiometers. If not, using these two simple formulas will allow you to evaluate the characteristics of your potentiometer quite easily. One final note about potentiometers is the number of turns of their resistive element will either classify it as either a single-turn or multi-turn potentiometer. More turns will definitely make it a multi-turn device, and less turns puts it into the single-turn potentiometer category.

Resolution is guaranteed with multi-turn pots, as well as linearity. So, depending on the application, single-turn devices might serve well. But if fine adjustments and control are desired, then use a multi-turn potentiometer instead.

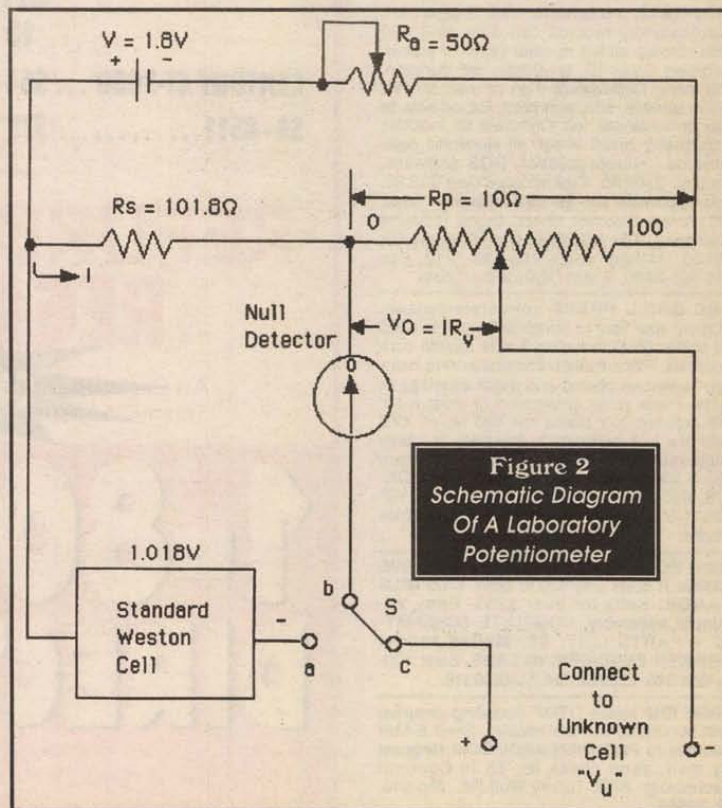
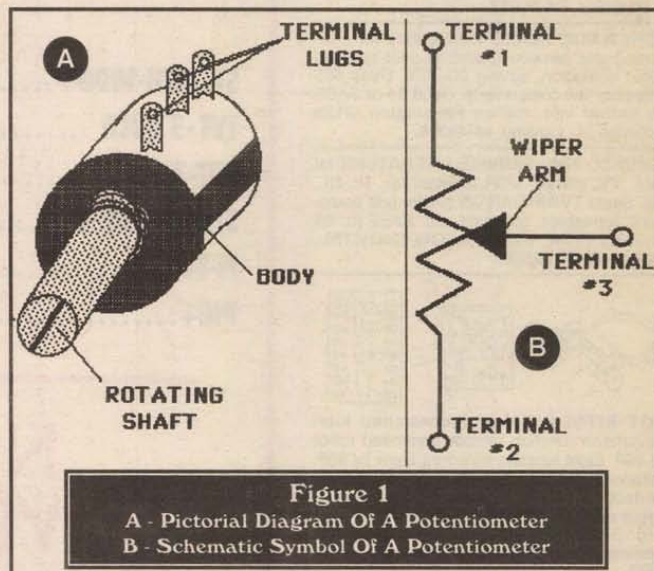
Now that the basic characteristics of potentiometers have been reviewed, let's take a look at the science behind a potentiometer.

## The Laboratory Potentiometer

Back in the days of classical physics, scientific labs had a device which could measure

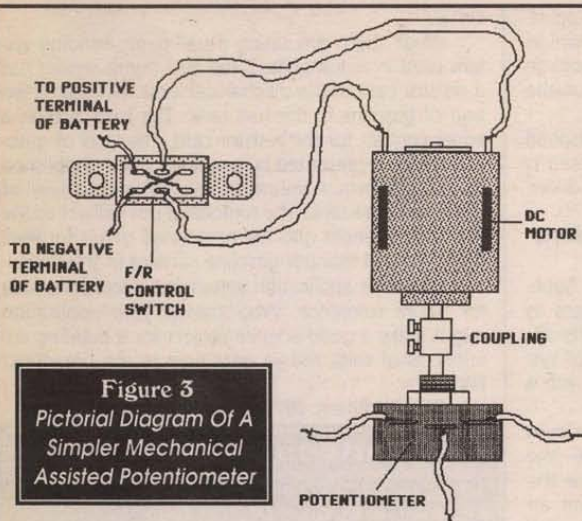
unknown voltages with great precision. The standard laboratory potentiometer was a classical measurement device of its time. It combined an adjustable voltage source with a sensitive null detector in a single instrument.

Figure 2 shows the schematic diagram for a laboratory potentiometer. The unit measures voltage by the null comparison technique. The null comparison voltage method detects the difference between two voltage sources.

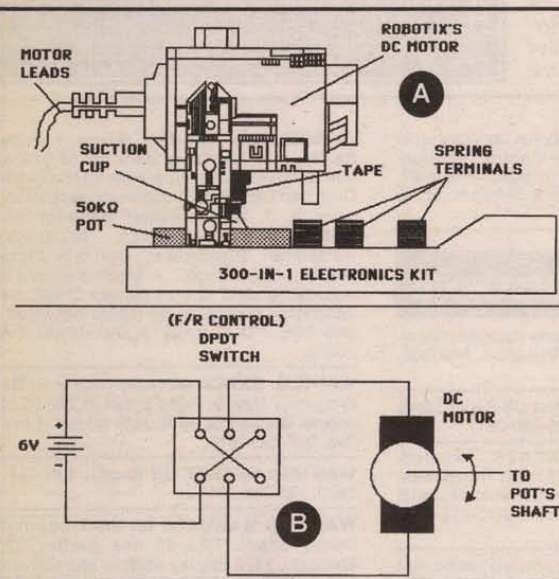




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**Figure 3**  
Pictorial Diagram Of A  
Simpler Mechanical  
Assisted Potentiometer



**Figure 4**  
A - Mechanical Assist Potentiometer Using 300-In-1 Kit  
And ROBOTIX DC Motor  
B - Schematic Circuit For F/R Control Of A DC Motor

An adjustable reference voltage is in opposition to an unknown voltage. The reference voltage is adjusted in small increments to make it equal to the unknown voltage source. This method of measurement is the heart of the laboratory potentiometer.

The laboratory pot uses a Weston Cell as the voltage reference for the equipment. The circuit works by using a single slide wire potentiometer for its full scale value of voltage measurement. The switch labeled "S" is for calibration of the potentiometer. Move the contacts from bc to ba and adjust resistor "Ra" until the null detector meter reads zero. This reading is supported by the 1.018 volt Weston Cell potential.

The 1.018 voltage value is related to the  $I \times R$  drop across the 101.8 ohm resistor. The current flowing through this resistor is 10 mA (milliamperes). To measure an unknown voltage, switch "S" is set to close contacts bc, and the precision divider consisting of the 10-ohm potentiometer is then varied until  $I \times R_v$  equals the unknown voltage indicated by the null detector meter.

This circuit is a good example to illustrate the basic concepts of a potentiometer's linearity and resolution characteristics, and how they can be used to

construct a precision scientific instrument.

Let's take a look at other devices that the potentiometer can be used for in scientific and engineering applications.

## Experimental Circuits and Projects

The following paragraphs will illustrate applications for the potentiometer in science and engineering. The method used to convey these projects is by "Mechatronics." Mechatronics is a new buzz word for the integration of electronics and mechanics. Sensors, motion controllers, and integrated circuits are examples of mechatronics. If a product is developed using electrical/electronic and mechanical processes, or incorporates those characteristics into its operation, then it's a mechatronics candidate. To understand this concept further, read the latest issue of *Machine Design Magazine*. The first project to investigate is a Motorized Assisted Potentiometer.

### Motorized Assisted Potentiometer

This project will allow the use of a potentiometer-controlled circuit to be operated via remote control. Figure 3 shows a pictorial diagram for building a motorized assisted potentiometer. As one can see, to construct such a device is quite simple. The key element in accomplishing this function is the method of coupling the motor to the potentiometer.

The easiest way to attach the two devices together is by taping or gluing. The mechanical method of joining the potentiometer to the motor is by using a coupler. I used a small wire clip with a suction cup for hanging Christmas lights taped to a "ROBOTIX" motor for my mechanical coupler. The suction cup will then stick to the control knob of the 50K ohm pot mounted inside a 300-In-1 Radio Shack Electronics Lab Kit. The construction of this mechanical coupler is shown in Figure 4A.

To control the motorized device requires a F/R (Forward/Reverse) switch and a power supply. Figure 4B shows a wiring diagram for such a circuit. This remote switching feature

will allow the potentiometer to vary its resistance depending on the location of the motor attached to it. With this motorized unit available, let's look at simulating a seismic sensor.

### An Experimental Seismic Sensor

A good example of a potentiometer used in detecting motion is a seismic sensor. A seismic sensor or instrument uses a voltage divider pot for sensing the relative displacement between the frame and the seismic mass. Figure 5 shows a sectional view of such a sensor.

To provide the damping for the system, the case of the instrument might be filled with viscous liquid which interfaces with the frame and the mass. The vibration or motion of the vibratory source will cause the mass to move a direction perpendicular

lar to the potentiometer. Therefore, what is measured at the output terminals would be the amount of displacement related to the vibratory nature of the source producing it.

The motorized assisted potentiometer could be used to simulate such a sensor. By moving the motor in a forward or reverse direction, the potentiometer is being displaced by some value "x" in proportion to the motor movement. To make this simulated sensor useful, accelerometers will be discussed.

### An Accelerometer Demo

An accelerometer is a sensor used to detect the acceleration of a moving object. Basically, the diagram shown in Figure 5 provides a clear and simple example of how these sensors are designed and constructed.

Accelerometers can be used to trigger passenger airbags, to detect and control engine knock, and to record acceleration variations in moving objects. The unit of measurement for the acceleration is  $m/sec^2$  (meters-per squared seconds) or  $ft/sec^2$  (feet-per squared seconds).

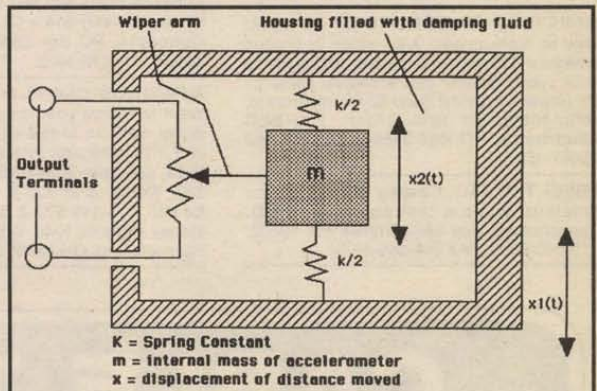
With the development of micromachining technology, accelerometer sensors are being packaged in the size of ICs.

Table 1 shows a list of applications for accelerometers. In this table, you will notice the "g" after each number. The letter "g" refers to gravity in which acceleration was based on in terms of a free falling object.

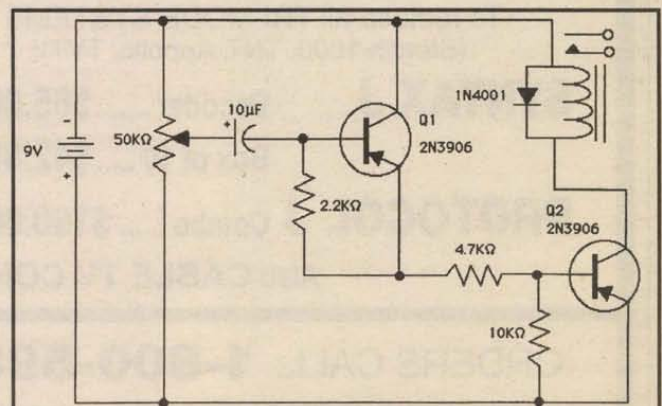
In the metric system, an object will free fall at a rate of 9.8  $m/sec^2$ , and in English units 32.2  $ft/sec^2$ .

As stated earlier, the motorized assisted potentiometer can be used to simulate an accelerometer sensor.

Figure 6 shows a simple circuit for producing the



**Figure 5 - Cross Section Of An Accelerometer**



**Figure 6 - An Accelerometer Simulator Circuit**



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Application	Range
Knock-control	1... 10g
Passenger Protection	
Airbag, belt tightener	50g
Rollover bar	4g
Seatbelt Retention	0.4g
Antilock Brake System	0.8...1.2g
Ride Control	
Body	1g
Axle	10g
<b>Source:</b> Automotive Handbook, Bosch, 3rd ed., 1993	

**Table 1**  
Automotive Applications  
And Their Acceleration Values

simulator. By adjusting the 50K-ohm pot via the motorized unit, the 10-microfarad capacitor begins to charge. At the appropriate negative voltage level, transistor Q1 turns on. With this component switched

on, it drives Q2 on as well. The relay, at this point, turns on driving the electrical or electromechanical load wired to its contacts. By measuring the voltage across the potentiometer, the values displayed on the meter could represent "g" values of the sensor.

This circuit could also demonstrate an overspeed indicator system, as well. If a speed-to-not-exceed is desired, an alarm could be tripped alerting the driver.

## Further Thoughts and Experimentations

The potentiometer applications discussed, hopefully, have shown the potentiometer's usefulness as an input control device. The projects and circuits discussed should have illustrated the importance of system functionality and a means of controlling it with a rotary or sliding control device.

Some additional projects to explore on your own using the information provided are to tie the accelerometer system to a computer. Every time the relay contacts close, the computer should print an alarm status on its screen.

Another circuit to explore the motorized assisted potentiometer is with a Wheatstone Bridge. Breadboard the bridge network using the motorized unit as the null detector adjustment element of the

circuit.

What about simulating a fuel pump sending system used in automobiles? The fuel pump sender has a resistor card and a mechanical lever for float detection of gasoline in the fuel tank. The lever acts as a wiper contact for the resistor card. The level of gasoline will be represented by a voltage value established by the float arm. A voltmeter will indicate the level of gasoline in the tank. The motorized pot will act as the fuel pump sender and the associated circuit for level detection will monitor gasoline content in the tank.

Whatever application you invent, record the idea for future reference. Who knows, your application might make a good science project for a budding scientist. Enuf said, see ya next time in the breadbox!

NV

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## References

- Automotive Handbook, Bosch, 3rd ed., 1993.
- Experimental Methods For Engineers, 6th ed. J.P. Holman: McGraw-Hill Inc. 1994.
- Electronics And Instrumentation For Scientists, Malmstadt, Enke, Crouch: Benjamin/Cummings 1981.
- Industrial Solid-State Electronics: Devices And Systems, T.J. Maloney: Prentice Hall 1979.

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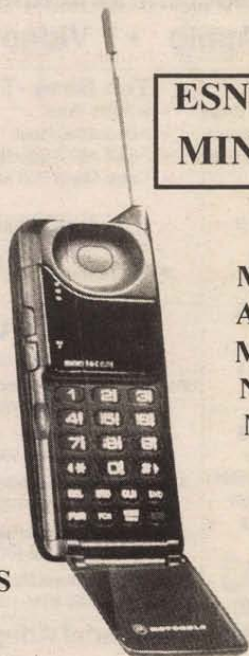


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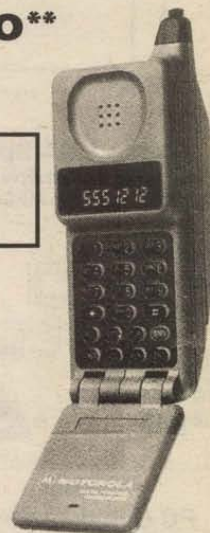


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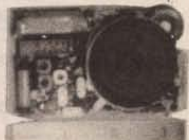
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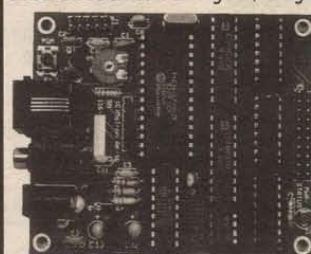
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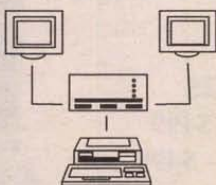
one computer to multiple monitors  
Transmission Distance: 210 feet per outlet

up to 4 monitors

#CA-VGA1-4  
**\$119**

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**\$139**

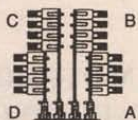


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30 Pin memory can be used in 72 Pin mother Board  
Ideal for all service, repair and upgrade business  
Left and right versions - use of all available slots

**\$15<sup>00</sup>** each

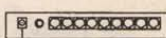
#CA-MEM-A  
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#CA-MEM-C  
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<b>\$4<sup>00</sup></b>	6 ft	#TE-068-L5
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<b>\$14<sup>00</sup></b>	50 ft	#TE-508-L5
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3.5mm F/F stereo coupler

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4 pc stick-on rubber feet 1" diameter

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Blank slot filler plates for case

**25¢ #TM-BKT**

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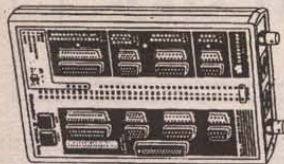


### Paladin

#### PC Cable Tester

Tests DB9, DB15, DB25  
36 centronics  
RJ-45, RJ-11, BNC & HD15  
36 Individual L.E.D's for each line

#TM-157 **\$139<sup>00</sup>**



#### MAC Cable Tester

Tests DB9, DB15, DB25,  
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50 Individual L.E.D's for each line

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1.5v - 12v DC 6 different  
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500ma #TM-307 **\$3<sup>00</sup>**

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2 **\$3<sup>00</sup>**

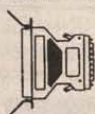


### SCSI II Adaptors

HD 50 male to  
50 Centronics female  
#CA-015 **\$17<sup>00</sup>**

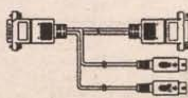
HD 50 female to  
50 Centronics male  
#CA-017 **\$17<sup>00</sup>**

HD 50 female to  
DB25 male  
#CA-018 **\$21<sup>00</sup>**



### MIDI Cables

Musical Interface  
Soundblaster compatible  
4' DB15 male-female  
2 - 5 pin DIN male



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### SCSI II Adaptor

HD50 male to DB25 female



#CA-016 **\$21<sup>00</sup>**

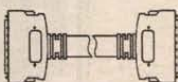
### SCSI I and SCSI II

3' SCSI I to SCSI II  
**\$18<sup>00</sup> #CC-679**

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**\$24<sup>00</sup> #CC-686**

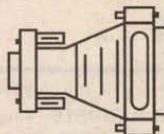
3' SCSI II to SCSI II  
**\$24<sup>00</sup> #CC-678**

6' SCSI II to SCSI II  
**\$30<sup>00</sup> #CC-678-6**



SCSI III also available

### Serial Adaptor



DB9 male to DB25 Female

#CA-259 **50¢**

### CD Jewel Case



#TM-CD-1 **50¢**

Exact replacement  
of original cases

### Portable CD Case

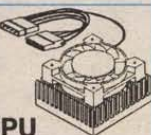


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Detachable wrist strap

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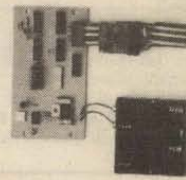
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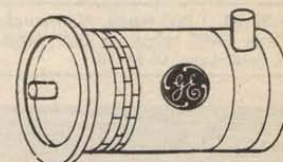
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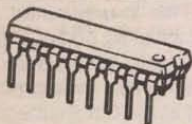


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**STOCK TICKERS**, Edison, Western Union, Postal Telegraph, or others. Telegraphy instruments, keys, sounders, etc. Railroad dining car china, silverware, holloware, linens, menus, time tables. 217-345-6771, Goodman.

**WANTED: FLYBACK** transf. #JF278 for Mitsubishi projection TV model #VS-506U. 2922-73 St., Kenosha, WI 53143. Call John, 414-652-5073.

**ATTENTION.** I am looking for an assembled device to change human voice into a robotized electronic digitized voice. Hoping the device you have is clear to the ear, vowels clear, outlet powered. John Guillen, 314 Zecca, Gallup, NM 87301. Phone 505-722-8881.

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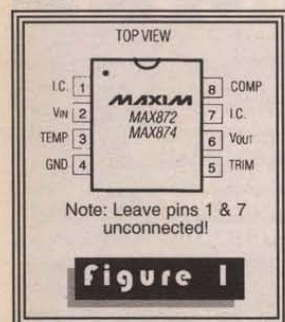
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To begin this article, let's take a look at one outstanding example of what is currently available in integrated circuit voltage references. A voltage reference, especially the high-precision type that will be discussed, is useful for any number of applications. You'd be surprised at its diversity! Just a few uses are:

- For establishing an internal baseline reference DC voltage level for instrumentation of all kinds.



fect for what one might call "unusual" applications. Many examples are possible. Here's just one to stimulate your creativity ...

Consider a battery-powered, 60 Hz synchronized inverter. Inverters are used for any application where a battery voltage is stepped up to a standard AC voltage; 120 VAC and 240 VAC at 60 Hz being the most common configuration by far.

Most common-market inverters utilize a power transformer in conjunction with an RC feedback network to get approximately a 60 Hz output, but this varies under load due to complex interactions between the transformer, battery, and power elements of the circuit. Not good for frequency-sensitive equipment used in audio or video, and double-plus "ungood" for precision timekeeping applications!

Rather than abandon the synchronized 60 Hz inverter, there are circuits that amplify the precisely timed signals leaked from and broadcast by 60 Hz power lines — even if they are miles apart. Those amplifiers then adjust the frequency of the inverter to match. No more audio, video, or timing problems.

This is accomplished by first processing the weak AC signal input from the distant power line and then comparing it to a fixed DC voltage reference. Excursions beyond the threshold values

## Integrated Circuit Voltage Regulators

detected are treated as valid signals, and the circuit will proceed to click on the power oscillator in synchronism. Then, the inverting transformer outputs a signal in phase with the distant AC line.

### Greater Precision

What makes the modern references so much better than their predecessors are their tighter tolerances in several areas. Maxim puts out several voltage references; the ones discussed here are the MAX872/MAX874 series. These are available in both SMT and DIP versions, so you can choose which package you'd like to work with. Digi-Key carries the more common versions of each, and the more specialized types (such as have extended operating temperature range) are available from the manufacturer. Exact part numbers are listed in the Parts List to help selection.

There are two voltages available. The MAX872 provides 2.500 volts, and the MAX874 provides 4.096 volts. Both have a precision of  $\pm 0.2\%$  and require just 10 microamps of current to operate. While the MAX872 can be used with a

variety of analog circuits, the MAX874 lends itself as a reference for analog-to-digital and other circuits whereby an analog voltage is converted to a sensible equivalent for a digital circuit. Note the value of 4.096 volts. We see that 2 to the power of 12 is 4096. So this voltage could be used to reference 4096 binary bits — each

ture of this line is that output can be shorted to either supply rail indefinitely without damage.

### Circuits

Figure 1 gives the pinout of the ICs. Figure 2 shows a test circuit. This is untrimmed and suitable for most projects, as is. By adding a precision, low-temperature coefficient potentiometer, the output voltage can be trimmed for even greater accuracy. The COMP input at pin 8 does the job for us. Just such an arrangement is shown in Figures 3A and 3B. Note the trim range is not equal in voltage from the center point of the output. However, as shown, the range is adequate for compensating out any minor discrepancies from the design voltage. In other words, you can "nail" the exact output voltage with the simple trim circuit shown. Be sure and use low-tempco 1% resistors with this circuit for best performance.

Current drain on each reference should be limited to 300  $\mu$ A or less. If the drain exceeds 300  $\mu$ A, Maxim suggests connecting a 1000 pF capacitor between Vout and GND terminals. The maximum current source or sink value for these parts is  $\pm 500 \mu$ A.

Figures 4A and 4B show the output voltage plotted against the input voltage for the MAX872 and MAX874, respectively. Note the extreme stability of the output voltage despite the large excursion of DC input.

Figures 5A and 5B show another important stability factor, and that is the change in output voltage vs. temperature. Note the drop-off from 'specs at either end of the temperature extremes. These ICs are normalized to  $\pm 0.2\%$  tolerance at 25 C (77 F), so that's where the greatest compliance to stated output voltage occurs.

A very neat feature of these chips is the availability of the TEMP output at pin 3. With an external circuit, this feature can insure the chips are operated within their functional temperature range.

Let's take the extended temperature range versions as an example. Their operating range is  $-40^\circ\text{C}$  to  $+85^\circ\text{C}$ . The TEMP voltage increases linearly at the rate of 2.3 mV/C, depending upon temperature, as referenced to Centigrade degrees above absolute zero ( $-273^\circ\text{C}$ ). Thus, at  $-40^\circ\text{C}$ , it is 233 degrees C above

absolute zero, and multiplying this by 2.3 mV/C we get 0.536 volts. At the upper extreme of  $+85^\circ\text{C}$ , we are 358 C degrees away from absolute zero ( $273 + 85$ ) and we can solve for:  $358 \times 0.0023 = 0.8234 \text{ V}$ .

It is a relatively simple matter to make a circuit addition that will warn of excess temperatures either to the cold or hot side. A useful type of circuit is called a WINDOW COMPARATOR, and that can detect excursions beyond the extremes of two

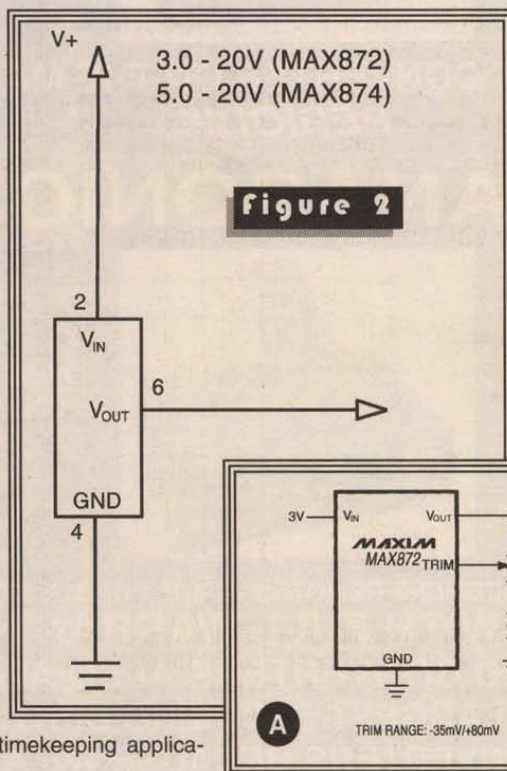


Figure 2

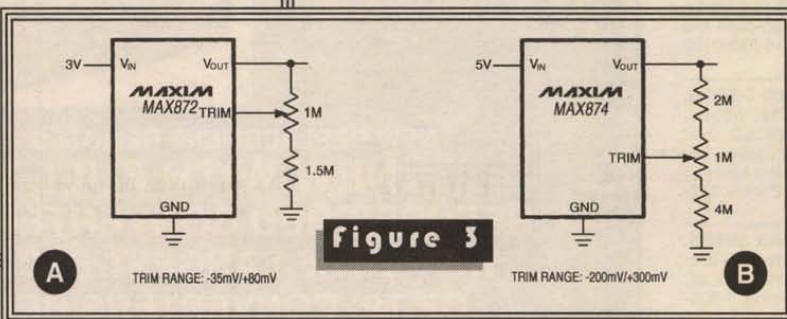


Figure 3

bit being one millivolt — utilizing a 12-bit ADC.

Both references feature "low dropout." That means the input voltage doesn't have to be much higher than the reference output for the IC to work. In both cases, it is just 200 mV, which lends the MAX872 operation from three-volt power supplies, and the MAX874 from five-volt supplies. Recommended top input voltage is +20 V, with an absolute maximum of +24 V, which is not to be exceeded or the device will destruct. One nice fea-



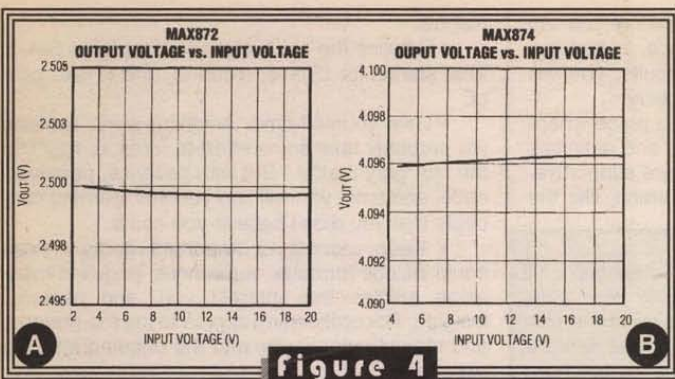


Figure 4

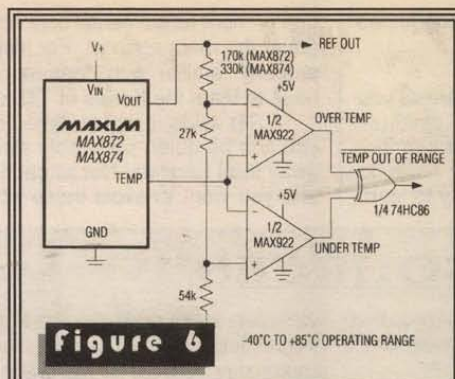


Figure 6

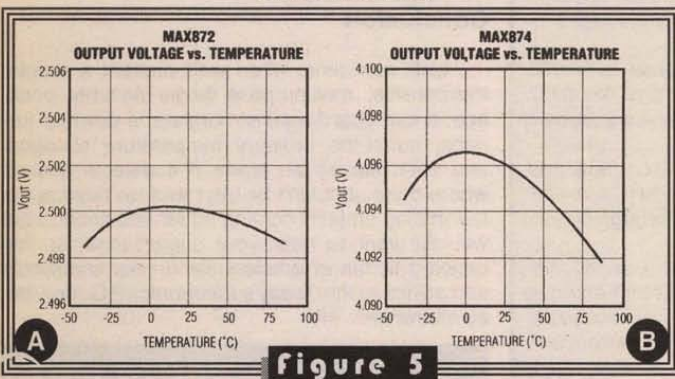


Figure 5

shows the implementation of a window comparator. An LED or other indicator can be connected to the active-low TEMP OUT OF RANGE signal for a visual indicator, or that signal may be connected to a computer input port, etc. Use 1% resistors with this circuit for premium accuracy.

### Another Interesting Surfboard™ Project

Modifications to the Surfboard™ breadboarding medium enable a lot of diverse

Or even a worse nightmare is re-designing the PCB layout and re-building the circuit! (Don't laugh, such things have happened to me!) But in cases like this, building the pull-up resistor network on a Surfboard and then connecting it into the circuit may be an awful lot more expedient than a re-wire or a re-build. It's a good idea to add several of these handy PCB breadboards to your parts inventory, as they always seem to come in handy. Digi-Key is a distributor of the Surfboard line.

While there are several diverse types of Surfboards available, not all will custom-fit your application as is. Here's where a simple technique helps: Pre-plan your circuit, drawing in where the components will be. Then you can cut the foil traces where needed to modify the Surfboard for your circuit.

Next, apply a small amount of solder to the section to be lifted away. Using an X-Acto or similar modeler's knife, heat the section carefully and peel off the unwanted trace. Be careful not to heat adjacent traces, or you may find them peeling off too!

Jumpers, if required, complete the job. It is suggested to remove the solder flux using commercial solvent or isopropyl alcohol and a toothbrush.

Now your circuit is ready for testing and installation in its application. Surfboards are available both as a plain board and with pins that will fit DIP sockets, so you have a lot of latitude here.

### Beginning Electronics

Several readers have written requesting advice on how to get started in electronics. This is great! While the primary purpose of *Today's Electronics* is to examine moderately advanced, state-of-the-art devices and techniques, the person wishing to get started or to hone his or her basic skills might consider checking out the reference material listed in the box. Please note this is just a fraction of the material available; like any general field, there is a mountain of data to be found if one does the looking. The listing is just

what I'm familiar with at this moment.

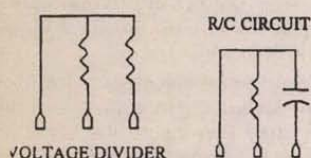
In many cases, the person is going to wind up teaching him or herself. Sometimes this gets con-

## BUILD CUSTOM NETWORKS TO YOUR SPECIFICATIONS

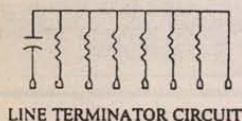
### SURFBOARD 6000 AND 6100 SERIES PROVIDE THE PERFECT PLATFORMS

With SURFBOARDS you can build a wide range of different surface mount based network configurations. Your networks can incorporate the component types and values for your specific need. Many times it is possible to also include additional devices on the same module and increase packaging density even further. While a wide range of standard commercial networks are available, they are somewhat limited to a few general types with a limited choice of component values. Surfboards are the perfect solution for building prototype and short run production custom networks to your specifications, and the S.I.P. (single in line) pins on Surfboards will make your custom networks compatible with breadboards or sockets.

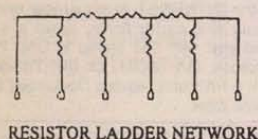
#### A FEW BASIC NETWORK CIRCUITS AND SURFBOARD ASSEMBLY LAYOUT CONCEPTS



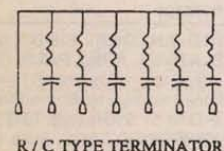
VOLTAGE DIVIDER



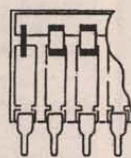
LINE TERMINATOR CIRCUIT



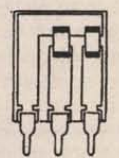
RESISTOR LADDER NETWORK



R / C TYPE TERMINATOR

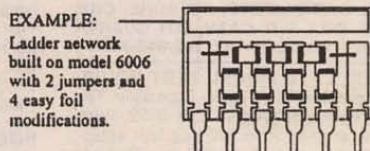


6000 TYPE  
BUSSED ARRAY

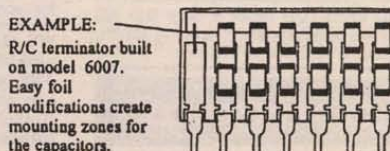


6100 TYPE  
ISOLATED ARRAY

A WIDE RANGE OF MODELS ARE AVAILABLE IN THE 6000 AND 6100 SERIES. SEE OUR 6000 SERIES DATA SHEET FOR AVAILABLE PIN AND FOIL CONFIGURATIONS.

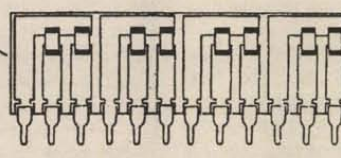


EXAMPLE:  
Ladder network  
built on model 6006  
with 2 jumpers and  
4 easy foil  
modifications.

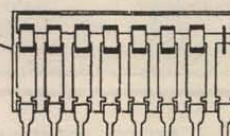


EXAMPLE:  
R/C terminator built  
on model 6007.  
Easy foil  
modifications create  
mounting zones for  
the capacitors.

EXAMPLE:  
Quad voltage  
divider network  
built on  
Surfboard  
model 6112



EXAMPLE:  
Pull-up resistor  
network built on  
model 6008  
with 7 resistors  
and 1 jumper.



As you can see, the universal foil structures offer a wide range of assembly options. The gaps between foils permit mounting of various device sizes such as 0805, 1206, mini-melf, etc. Simple foil modifications and jumpers expand the assembly options for Surfboards. These examples show only a few of the many possibilities for Surfboard based surface mount networks.

Figure 7

setpoints. If just one setpoint is required, one can simplify the circuit and use a single comparator, like discussed last time in this forum. Figure 6

circuits to be built with a minimum of hassle. Such are the examples provided by Capital Advanced Technologies (see Sources) in Figure 7. One likes



fusing, so the following general plan is suggested to ease the way:

- Choose what part of electronics interests you the most. TTL logic? Linear circuits? Communications? Computer circuits? Or just "tinkering?" In many cases, expect these fields to overlap. In that event, it will be necessary to learn

one or more fundamental concepts before you can grasp the main concept. For instance, to become properly familiar with computer circuits, you will have to learn the basics of TTL circuitry.

- Set aside a regular time and a place where you can be quiet, preferably alone, and definitely away from hecklers. Not all people are supportive, and you want to avoid those who aren't, like the

plague.

- Practice the old military philosophy of S-A-T. That stands for (S)ave, (A)dd-to, and (T)ake care of.

- Give yourself time. Anything worth learning will probably take some effort to force its way into the old "gray matter." But with patience, perseverance, and time, you will find yourself learning concepts that you didn't believe you could.

- Keep records of important items. These could include formulas, references, pages of magazine articles that interest you, and personal insights. Recordkeeping serves to jog the memory and maintain continuity with the ongoing learning experience.

## Conclusion

Until next time, when we'll present a simple, inexpensive, multipurpose home security package. It can guard against burglars, a downed furnace, out-of-the ordinary temperature changes, and even set off an alarm if it detects sounds where there shouldn't be any! And we have some fascinating projects coming up for you soon ... but we still want to hear your suggestions for this ongoing series of articles! Send your comments and advice to the *Today's Electronics* P.O. Box listed elsewhere. **NV**

## PARTS LIST

**MAX872CPA-ND +2.500 volt precision reference in 8-pin DIP package**  
**MAX873BCSA-ND +2.500 volt low power, low drift reference in 8-pin SMT package**  
**MAX874CPA-ND +4.096 volt, 10 uA precision voltage reference in 8-pin DIP**

*These ICs are rated to operate from 0.0 C to +70 C. Numbers are exact Digi-Key part numbers.*

## Today's Electronics Reader Helpline

"*Today's Electronics*" is a reader interactive forum. We appreciate your interest, and would like to hear your comments, questions, and suggestions, for future articles. Address your letters to:

**Today's Electronics**  
 Attn: Anthony Charlton  
 P.O. Box 74  
 Cornwall Bridge, CT 06745

Your fax number, which will be kept confidential, will greatly speed replies.

### Contact East, 335

Willow Street, North Andover, MA 01845-5995. Ph: (508) 682-2000, FAX: (508) 688-7829. SMT and electronic repair tools; chemicals. Free catalog.

**Datask Corporation**, 55 Freeport Blvd., Unit #23, Sparks, NV 89431. Ph: (702) 359-7474, FAX: (702) 359-7494. Dry transfers for PWB fabrication, chemicals, Circuit-Fix™ products. Free catalog.

**Digi-Key Corporation**, 701 Brooks Avenue South, P.O. Box 677, Thief River Falls, MN 56701-0677. Ph: (800) 344-4539, FAX: (218) 681-3380. Top-of-the-line supplier of SMT components; features a large selection. Free catalog.

**Dyna-Art Designs**, 3535 Stillmeadow Lane, Lancaster, CA 93536-6624. Ph: (805) 943-4746. Provider of and seller (through distributors, as well) of the Toner Transfer System (TTS) method of PCB fabrication. Also sells a desk-top integrated package for small OEM and prototype PCB fabrication.

**Electronic Goldmine**, P.O. Box 5408, Scottsdale, AZ 85261. Ph: (602) 451-7454, FAX: (602) 451-9495. SMT surplus PWBs and SMT components. Some great values here. Free catalog.

**ESP Solder Plus**, 14 Blackstone Valley Place, Lincoln, RI 02865-1145. Ph: (401) 333-3800, FAX: (401) 333-4954. Small manufacturer, educational, and industry SMT repair kits and solder cream.

**Garrett/IEU, Inc.**, 3130 Skyway Drive #104, Santa Maria, CA 93455. Ph: (805) 922-0594, FAX: (805) 922-3643. Small and bulk quantities of surface mountable components.

**Hobby Lobby International, Inc.**, 5614 Franklin Pike Circle, Brentwood, TN 37027. Ph: (615) 373-1444, FAX: (615) 377-6948. Supplier of all kinds of hobby kits and supplies; mentioned here because of their large selection of instant-setting glues and some tools that are useful to any precision endeavor such as with electronics. Catalog \$2.50.

**Maxim Integrated Products, Inc.**, 120 San Gabriel Drive, Sunnyvale, CA 94086. Ph: (408) 737-7600, FAX: (408) 737-7194. Specialty analog and digital integrated circuits of amazing diversity and use. Call for nearest distributor or sales rep (in the case of OEMs). Will give out free info and samples to qualified companies.

**Micro-Mark**, 340 Snyder Avenue, Code 340-1892,

## SOURCES

Berkeley Heights, NJ  
 07922-1595. Ph: (800)

225-1066, FAX: (908) 665-9383. This company calls itself "The Small Tool Specialists" and indeed they are. Listed here because of the many precision hand and power tools they offer that are useful in SMT and other electronic work. Also carries hard-to-find supplies for model making. Full-color catalog \$1.00.

**Pace, Inc.**, 9893 Brewers Court, Laurel, MD 20723-1990. Ph: (301) 490-9860, FAX: (301) 498-3252. Manufacturer of SMT soldering/desoldering equipment and workstations.

**Techni-Tool**, 5 Apollo Road, P.O. Box 368, Plymouth Meeting, PA 19462. Ph: (215) 941-2400, FAX: (215) 828-5623. Soldering/desoldering equipment and electronic tools of all types.

**All Electronics Corporation**, P.O. Box 567, Van Nuys, CA 91408-0567. Ph: (800) 826-5432, FAX: (818) 781-2653. Some SMT parts and occasional surplus SMT boards useful for parts salvage and experimentation. Free catalog.

**Capital Advanced Technologies Inc.**, 309-A Village Drive, Carol Stream, IL 60188. Ph: (708) 690-1696, FAX (708) 690-2498. Manufacturer of the Surfboard™ breadboarding medium for SMT, sells mostly through distributors such as Digi-Key. OEMs can contact Capital directly for large quantity pricing.

**Carolina Biological Supply Company**, 2700 York Road, Burlington, NC 27215. Ph: (919) 584-0381, FAX: (503) 656-4208. Laboratory supplies including test tubes, plastic, and glass vials handy for use categorizing SMCs. Contact for current price of their 30,000 item, full-color catalog.

**PRB Line**, P.O. Box 176, Whitewater, WI 53190. Ph: (800) 533-9654, FAX: (800) 635-8101. Carries an inexpensive SMC removal kit called ChipQuik.

**Circuit Board Express**, 2 Avco Road, Haverhill, MA 01835. Ph: (508) 521-9288, FAX: (508) 521-9388, Modem: (508) 373-9272, E-Mail: fastpwb@tiac.net Time crucial manufacturer for industry. Produces prototype circuit boards in 24 to 48 hours. Not a hobbyist supplier.

**Be sure to mention Nuts & Volts when you contact the above suppliers so they can process your requests properly.**

### MISC. ELECTRONICS WANTED cont.

**WANTED TO BUY:** Omega OM-700 data acquisition controller, or source. Manufacturer? 603-394-0167. Internet E-Mail: karl.christofferson@castle.shore.net

**WANTED:** SONY Beta Hi-Fi processor model #HFP-100. Phone: Henry, 202-767-7901.

**WANTED:** AVIONICS test equipment. IFR 1200Y3, 401L, 750B, 600A, Also Collins, King, Microline, Proline, Silver, Gold Crown Ground Power Units, Fox Carts. Avionics Plus, 28000 Airport Rd., Box A17, Hangar 97, Punta Gorda, FL 33982. 941-575-0138 P, 941-575-2361 F.

**WANTED:** BALANCING machines & vibration analyzing equipment manufactured by the following: Spectral Dynamics, Hofmann, Bentley Nevada, Schenck, IRD Mechanalysis, Gishott. Contact Mike Park at E.T. Balancing, 12823 Athens Way, Los Angeles, CA 90061. 310-538-9738, FAX: 310-538-8273.

**DEC EQUIPMENT WANTED!!!** We are buying DEC systems, boards, terminals, drives and peripherals. Also Scientific Micro Systems (SMS), DSD, Datability, Dialog, other DEC compatibles, and Computer Output Microfilm (COM) units. Please call for a quote or fax us your equipment list. We buy, sell, and trade. **KEYWAYS, INC.**, 513-847-2300 OR fax 513-847-2350.

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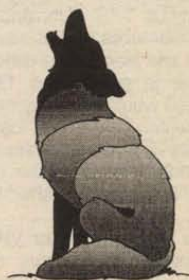
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Continued from page 59

## TECH FORUM

it saves space and can sometimes be more cost effective. If you're running a business, however, it could be devastating if something were to go wrong with it. You'd be without the said functions until you can get the unit replaced or repaired.

**Brandon Etto  
Austintown, OH**

### ANSWER TO #29613 - FEB. 1996

The answer depends upon many things: Is the old TV antenna a VHF/UHF, or a VHF only? Do you want to get up on the roof and modify the antenna in any way? Does it have an operating rotor? Does the antenna have any corrosion, and what is the condition and length of the feedline?

Several uses come to mind that don't require any modifications.

Use it as a long-distance FM broadcast reception antenna. Usually such antennas are very good at FM, even if they were not originally designed to receive FM broadcasts. A rotor would be a definite plus in this application.

To have any hope of extending a 900 MHz cordless phone, the antenna must have UHF capabilities. If so, the antenna would probably work very well at 900 MHz. However, the beam of a large antenna is apt to be quite directional, so the roaming direction for the 900 MHz phone would be very narrow. This would not be in technical compliance with the original FCC regulation concerning radiated signal strength. If you wish to modify the antenna, find the shortest UHF element, measure it, subtract about 1/2 inch, and cut all other UHF elements to that size. In this application, the length and condition of the feedline is paramount. Old 300 ohm twinlead would probably make any antenna performance be lost. Even replacement 300 ohm twinlead is still lossy. Consider replacing the twinlead with foam-filled coax or other low-loss coax.

Do you wish to monitor VHF/UHF scanner traffic? If so, this antenna would be worth a try. Sometimes height can make up for a lot of other inefficiencies. Performance on VHF public service bands might be accept-

able; on UHF it probably would be fine. Again, a rotor would be a plus, and you could monitor services normally considered outside of the usual scanner range.

You could tie both ends of the feedline together and use the entire antenna and feedline as an external antenna for an AM receiver. If your AM receiver doesn't have an external antenna connection, a few loops of wire near the internal loopstick can do wonders. Tie one end of the loops to the feedline, the other end to a ground, such as a water pipe.

Are you a shortwave radio listener? Same trick as above, except most shortwave radios have provisions for external antenna connections.

Other things to consider are the condition of the antenna itself and the 300-ohm feedline. If the antenna is well worn and rife with corrosion, you will probably pick up more noise than signal. Same applies to the feedline. Remember that TV stations run from 100 KW to 2 MW, so receiving deficiencies can be overwhelmed. Public services and other users run a few hundred watts at most. Hope this gives you some ideas.

**Gary Bishop  
Marion, IA**

### ANSWER TO #2964 - FEB. 1996

The MS-2 is an early synthesized scanner that covered 31.18 to 50 MHz (low band), 151.18 to 170 MHz (high band), and 451.18 to 470 MHz (UHF band). Here is a procedure to allow you to compute frequency codes and program it.

**1.** Subtract 31.18 MHz from a low-band frequency, 151.18 MHz from a high-band frequency, or 451.18 MHz from a UHF frequency you wish to program.

**2.** Divide the result you got in step 1 by .005 and round off to the nearest whole number. This should give you a number between 0 and 3764.

**3.** Convert the result you got in step 2 to a hexadecimal number. This should give you a number between 0 and EB4. This is more easily done if you have a calculator that can make base 10 to hexadecimal conversions.

**4.** Convert the step 3 result to a 12-digit binary number, using leading zeros if necessary. This should give you a number between 0000 0000 0000 and 1110 1011 0100.

**5.** Put a binary 0000 for low band, 0010 for high band, or 0001 for UHF band to the left of the step 4 result.

**6.** Press the scanner's SCAN/MANUAL button in to stop the unit from scanning.

**7.** Advance to the channel you want to program using the CHANNEL SELECT button.

**8.** Press the PROGRAM button in.

**9.** Enter the 16-digit code for the desired frequency by pressing the 0 and 1 buttons in the exact order that the code is written, left to right.

**10.** Release the PROGRAM button and then press it in again; if the lamps light in the correct sequence, the code has been entered correctly in the memory.

**11.** If you see that the code has been entered correctly, release the PROGRAM button.

**12.** Advance to the next channel to be programmed using the CHANNEL SELECT button. Repeat steps 1 through 12.

**Ron Wing  
Wichita, KS**

### ANSWER TO #29614 - FEB. 1996

Yes, there are many manufacturers of lasers with varying size and power levels to do your job. There are low-power lasers that are delicate enough to cut tissue paper, and high-power lasers that will cut through six inches of cold steel. If you intend to cut through single layers of cloth, and the cutting rate (feet per minute) isn't a large consideration, then a moderate size laser of around 20 watts should do the job. If you intend to cut multiple layers of cloth, at very high rates of feed, you may need a laser of around 60 to 75 five watts to do this job. The question you have to ask yourself is, "What are my requirements and how much do I want to spend?" You have to choose between cost and efficiency. If your budget will permit, you can purchase a brand new variable power, ND/YAG laser from such companies

as Lumonics, and set this up on a milling machine bed, complete with CNC mirror controls, and cut through dozens of feet of multiple layer cloth at a time.

Expect this type of setup with a 100 watt laser, CNC mirror controls, computer, and a small used Bridgeport milling machine (manual type controls) to cost you around \$75,000.00. You will still have to do the modifications yourself to fit the laser onto the milling machine, or your assembly line table. This setup has a CNC controlled mirror on the head of the laser and will cut out patterns that you program into the 486 computer. You must also purchase separate software and educate yourself how to program and use the machinery. The Department of Radiology and OSHA require that you build around the laser work area.

A safe work environment includes shielding from the light to any passers-by, and exhaust fans for the operator, depending on the toxicity of the vaporized material.

If all this cost is not what you had in mind, then you will have to assemble a laser from second hand parts and build a smaller and simpler version. You will need the help of a good machinist, a mechanic, and an electronic hobbyist if you are to keep the price down. You should be able to assemble a modest low-power cutting laser, complete with bed and feed, for probably under \$5,000.00, depending on who and what you know. Expect to pay at the very least around \$15,000.00 if you have no knowledge or associates who can help you in this endeavor.

You can purchase a modest YAG laser for about \$1,500.00 for parts only, or a fully assembled unit for considerably more. You will need to have a fully adjustable power supply complete with pulse width and repetition rate for the laser. You may have to manufacture a cooling system depending on how large your laser is and what settings you will be running it at. Overheating the laser assembly will damage it permanently and replacement heads are expensive. You can purchase an old Bridgeport milling



machine table, with manual feed, for less than \$1,000.00 and modify it with simple CNC controls. (See *Nuts & Volts* Nov. '94 issue for CNC controls.) The bed of the milling machine will move instead of having a motorized mirror assembly. However, you can purchase a complete CNC controlled mirror assembly, but don't expect to get one for under a couple thousand dollars new. If you shop around, you might be able to purchase a used assembly that has the correct mirror coating, or you can have it refurbished to suit your laser frequency. If you intend to use any CNC controlling at all, either on the bed assembly, or a more expensive mirror head, you will need, at the very least, an 8088 or a 286 computer. You should be able to purchase one of these computers second hand for around \$100.00. You can buy surplus stepper motors for \$5.00 to \$10.00. Homemade wiring should be less than \$10.00, and a back copy of *Nuts & Volts Magazine* will get you started. The other parts are minor, and the whole CNC assembly should cost you less than \$250.00.

The advantage of the YAG laser over a gas laser, especially on cloth, is that it uses short hot pulses which can be adjusted to vaporize holes through the material and yet cool off between pulses so the cloth doesn't smolder or catch fire. You vaporize and cool hundreds of times per second depending on your settings and thickness of cloth. Balancing the feed rate of your table and the pulse rate of the laser will allow a clean cut while reducing the risk of fire to the cloth. You can use a carbon dioxide laser, but this approach increases the overall cost and risk of fire.

There are at least a couple of dozen used laser dealers advertising throughout the country, and some of them advertise in *Nuts & Volts*. Meredith, MWK, and Midwest to name a few. The final cost of building a small laser cutting assembly will vary greatly depending on your knowledge and skills.

**Chris  
Beiber, CA**

## ANSWER TO #1962 - JAN. 1996

Public safety officials operate on certain channels, or frequencies, just like you tune in certain channels on your TV. All modern scanners can be programmed with these frequencies by punching in the frequency on the keypad, much like dialing a telephone. Your Bearcat scanner is crystal-controlled, which means you must buy a crystal for each frequency you want to listen to. When you moved, you discovered that officials in your new town are operating on different frequencies than your old town, since you can't hear anything. To find out these frequencies, visit your local scanner dealer and ask for a sheet of local frequencies. Sometimes they have these printed out and will give them to you free. If not, go to Radio Shack and buy the Michigan/Ohio edition of "Police Call." You could also join the Bearcat Radio Club at 1-800-423-1331 or U.S. Scanner News at 1-800-890-6999, both of which publish scanning newsletters and frequency lists.

Now that you know what frequen-

cies you wish to listen to, you must open up your radio and see which boards are installed in it. There are three boards available: 30-50 MHz, 150-174 MHz, and 400-512 MHz. They are usually labeled, or you can notice which module the current crystals are plugged into. There is only room for two boards, module A and module B. If your scanner has only one board installed, you may have difficulty finding another one. Another problem is that many public safety agencies are moving to 800 MHz. If this is the case in your area, or they are using frequencies other than the ones covered by your boards, you are out of luck since your scanner cannot receive these frequencies. If all these problems are solved, now you are ready for new crystals. Your local Radio Shack can order them for you, or try Jan Crystals, P.O. Box 60017, Ft. Myers, FL 33906, 1-800-526-9825. Now you can remove your old crystals and plug in your new ones.

As for service and parts, Bearcat was purchased by Uniden. Write Uniden Parts Dept., 9900 Westpoint Dr., Indianapolis, IN 46250 or call 1-800-297-1023. Your scanner will not quite achieve the sensitivity and selectivity of today's scanners, but I feel the sound quality and volume of your Bearcat to be superior.

Finally, you must consider economics. At \$5.00 a pop for crystals from Radio Shack for eight channels, that's \$40.00. If your scanner needs parts, repairs, or another board, that's more money. You still have only eight channels, and cannot search for new frequencies or reprogram your channels at the touch of a button. I have seen 60-channel scanners on sale for as low as \$120.00. Keep in mind that most cheaper scanners do not cover 800 MHz, but you may not need that coverage if 800 MHz is not being used in your area. If your crystal and repair costs approach \$80.00 to \$100.00, I would advise you to put that money toward a new scanner unless you are terribly attached to this one or just want the satisfaction of owning a piece of vintage gear.

**Steven Vail  
Martinsville, IN**

## ANSWER TO #29620 - FEB. 1996

Your battery charger connected to the 240-volt line should not be returned through the "ground" wiring. The ground is the green wire, and is connected to the frame or metal box holding the charger. This is to protect you so that when you touch the metal box, you can never get shocked as it is already grounded. No current must ever flow through this connection. Power is supplied from the "hot" side of the line, through a circuit breaker, and then through your charging apparatus, and returning back to the "common" side of the line which is the white wire.

If your machinery uses considerable current, the circuit breaker is rated at more amperes, i.e., instead of 15 amps, it's rated at 20 or 30 amperes, and the wiring is also of a higher gauge. An electric stove takes a 60-amp breaker, and the wiring is 8/0 gauge, returning to the "common," not the "ground!" Even though these two

eventually come together in your electric box, they are separate circuits and should not be confused as one.

**Joe Kish  
Clackamas, OR**

## ANSWERS TO #2969 - FEB. 1996

### Question #2

The second question involves the use of the true name function in a batch file. Try this:

```
truname [find "/":xyzzy.1
echo set pathname=xyzzy.2
copy xyzzy.2+xyzzy.1 xyzzy.bat
call xyzzy
del xyzzy.*
```

Then use the variable %pathname% anywhere you need the original path of the disk. This assumes that pathname and xyzzy are available and are not used by other programs, and that the current path is writable. If the desire is to be able to change to another drive and directory and then change back, then there is a simpler way. There are two programs called pushdir and popdir that allow you to set the current directory out into memory and then come back to it as desired.

**Ray Todd Stevens  
Bedford, IN**

## ANSWER TO #29616 - FEB. 1996

The answer to your question is, no. It's not practical or cost-effective to try and convert a 400 cycle 440 volt generator to the lower and less efficient voltage and cycles that you require. There are many things you can do to achieve your goal, but all of them would be very costly. It might be cheaper in the long run to purchase a new or used 220 volt/60 cycle generator frame and install it to your unit. The inexpensive way to achieve 120/240 single phase out of your generator will cause a loss of power so great that you will end up with only a 2,000 watts — maybe — out of the 35,000 watts

that you started with, and not without problems. If you add a gear reduction to the generator of 6.66 to 1, you will achieve 60 cycles, but your voltage will drop drastically to around 66 volts or less, and the current will also drop drastically to probably less than 5,000 watts theoretical. Running the generator at the slower cycle will overheat the windings because they were wound with a specific impedance in mind, allowing the wire size to be reduced for weight and efficiency. The whole purpose of 400 cycles is that you can achieve more power from less size and weight. You may not even be able to run it at half this current because of overheating and the output of the unit is still three phase. You will still have to add a very large and expensive three-phase transformer just to convert it back to single phase. I don't know if a standard transformer exists to convert the 66 volts up to 240 volts, and again; this just isn't practical. The voltage regulation system on the generator also will be effected by the low voltage and might drop out altogether and lose its control over the windings. Then you have the problem of the cycle regulator which will have to be replaced to keep the motor running at the exact RPM necessary to maintain 60 cycles. They generally sense the output of the generator in cycles, and then they manually control the motor speed to maintain the desired cycles. There are just too many losses with this approach and it may end up costing you more in the long run by burning out the windings.

This generator is still very useful for resistive loads such as lighting and heating with no modifications necessary, and you might consider trading it with someone who has that need, such as search and rescue, fire department, or construction lighting.

**Chris  
Beiber, CA**

## ANSWER TO #2962 - FEB. 1996

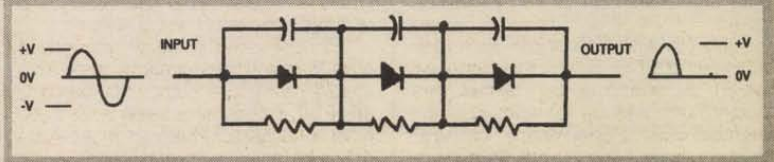
### Question #1

Check out an older edition of the *ARRL Radio Amateur's Handbook* and you'll see that series diode stacks were often used in high voltage supplies for linear amplifiers. This increases the peak inverse voltage (PIV) of the rectifier by a factor equal to the number of diodes in the stack. You must be careful when you series-connect rectifier diodes because each diode can exhibit a different reverse resistance when reverse-biased. If you have four 600-volt PIV diodes in series that must withstand 2000 volts PIV and one of the diodes has an exceptionally high reverse resistance compared to the other three, it would drop the bulk of the reverse voltage, exceed the individual diode's PIV rating and be destroyed. To prevent this, put a high-value resistor (10MW is a good start) in parallel with each diode to distribute the reverse voltage across each diode. The reverse leakage current this creates is minimal

in most applications. Reverse voltage spikes can also cause problems in stacked rectifier circuits. A 0.01µf disc ceramic capacitor in parallel with each diode will prevent spike damage. Make sure that the voltage rating of the capacitor is greater than the PIV of the diode.

As a side note, you'll find that there are rectifiers out there that are rated for high PIVs, e.g., 5 KV (Tektronix uses them a lot in oscilloscope high-voltage supplies). Internally, there are two or more diodes in series to withstand the higher PIV. If you don't know that little tidbit of information, a check with most ohmmeters will falsely indicate the rectifier to be open because the meter's battery is unable to forward bias two or more diode junctions. They have to be tested with an older meter that used a higher-voltage battery, in a circuit that will forward bias the diode or with a semiconductor curve tracer.

**Dean Huster  
Oklahoma City, OK**





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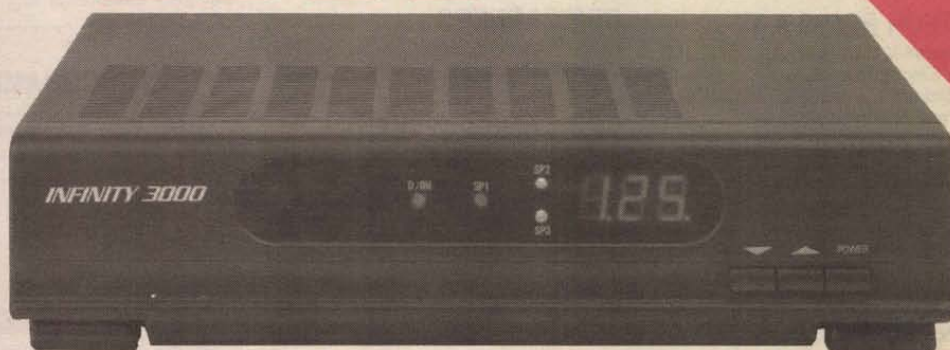
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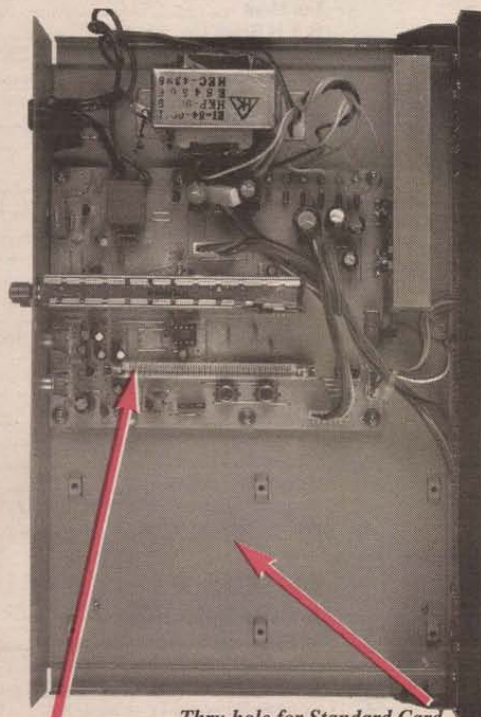


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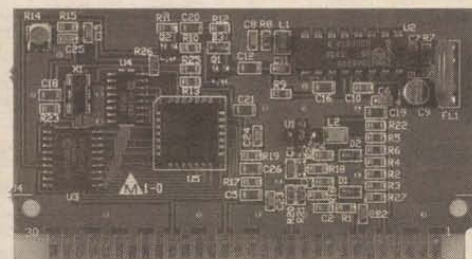
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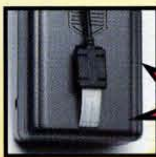
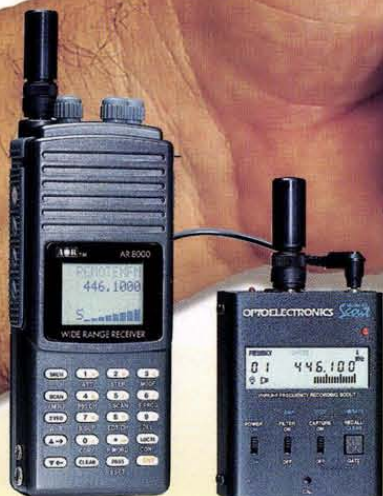
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### SHIFTOUT \*

Uses two pins to control common shift registers. Can be used as a means of controlling many devices without using too many pins.

74HC595

OUT1	1	16	VCC
OUT2	2	15	OUT0
OUT3	3	14	SERIN
OUT4	4	13	OE
OUT5	5	12	RCLK
OUT6	6	11	SCLK
OUT7	7	10	SCLR
GND	8	9	OUT7

### BASIC Stamp II Module (BS2-IC)

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2048-byte program space (600 instructions)  
**\$49, \$69** with optional carrier board

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8 general-purpose I/O lines  
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### DTMFOUT \*

Generates DTMF tones with just one I/O pin. Another related instruction, **FREQOUT**, generates one or two tones simultaneously. Each tone is programmable from 0-32767 Hz.



Marvin Green (first row, 2nd from left) uses BASIC Stamps in his Explorer Scouts robotics classes in Hillsboro, Oregon. These are some of his students with their Explorer-Bots, which are small Stamp-based robots that follow a light source while playing a tune.

**BS1-IC Module**  
(FaxBack #6002)

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