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Nuts & Volts

EVERYTHING FOR ELECTRONICS!

April 2001
Vol. 22 No.4

Take A Look At The Car And Technology Of The Future As Visualized By Futurist Syd Mead

- Build A Carbon Monoxide Sniffer
- Build Your Own Arcade Game
- The PIC 16F84 Grows Up
- Cyber-Street Survival: Security And Other Things
- Mini MIDI Monitor
- Aibo Part 2

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CLONE, TEST OR REPAIR ANY HARD DRIVE

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- SUPPORTS IDE, SCSI, SCA & NOTEBOOK DRIVES
- COPIES AND SERVICES HARD DRIVES
- PRINTS TEST REPORTS ON YOUR PRINTER
- DATA RECOVERY MODE BUILT-IN

Copy entire hard drives with this pro service station. Set up any SCSI or IDE drive with your original software. Attach a blank drive and press start. Make copies quickly and easily.

Use the built-in drive service system to make used drives run like new! Eliminate defective sectors, and restore hard drives to error-free condition with the factory re-mapping system. Test hard drives for top reliability using the built-in test feature. Print analysis reports on any standard parallel printer. Get the technology used by drive repair services. Call today!

COPY ANY CD NOW NO PC REQUIRED

from $995!

- MULTI-FORMAT DUPLICATION - FAST AND EASY!
- DUAL 8X DRIVES MAKE TWO COPIES AT ONCE
- INTERNAL 25GB HARD DRIVE STORES IMAGES
- PRO AUDIO MODEL HAS SP/DIFF AND ANALOG I/O

Instantly copy music and CD-ROM compact discs. Make backup copies of your favorite music and software on rugged, permanent CDs. Produce discs quickly and economically. Make custom audio CDs with just the songs you like.

Use our dual drive units to copy two CDs simultaneously, or choose the Pro Audio modelto make crystal clear music CDs from any analog or digital source. Dupe-It copiers are totally self-contained. No additional software or hardware is required. Call today for more information!

25GB MP3 PLAYER

$395!
after mail-in rebate

- PLAYS OVER 10,000 SONGS FROM HARD DISK!
- PLAYS STANDARD AUDIO AND MP3 CDs AND CD-R
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- POWER AMPLIFIER DRIVES SPEAKERS DIRECTLY

MP3 is here! Get high performance digital sound and store over 15,000 songs on hard disk. Download over 300 songs from a single CD!

Grab new music from the net. Use your PC to create custom MP3 CDs with just the songs you like. Load them to the internal hard drive for realistic, 3-D theater sound. Patented digital signal processing gives you crystal clear sound. No PC connection is required. Connect any stereo system, or directly power external speakers. Get digital sound and room-filling bass.

The hard drive organizes your music in folders. ID-3 tags display the title, album, and artist on a large LCD. Use the jukebox feature for an entire evening of great music. Play songs randomly or in sequence from the internal hard drive. Unlike CD changers, the A/V certified 25 GB hard drive won't wear out, even under continuous use. Call now and try your MP3 player tomorrow!

MULTI DRIVE IDE DUPLICATORS

from $495!

- COPIES EVERYTHING, PARTITIONS, O/S, THE WORKS!
- BOTH STANDARD AND ULTRA, FOUR AND SEVEN DRIVE MODELS ARE AVAILABLE NOW!
- THE ULTIMATE HIGH SPEED PRODUCTION TOOL FOR SYSTEM BUILDERS AND CORPORATE MIS

Copy entire hard drives with ease. Multi-drive duplicators are an essential tool for dealers and system builders. Why spend hours installing and formatting drives when you can dupe them instantly? Work like the pros. Get your own multi-drive, stand-alone duplicators today. CSC offers a complete line of four and seven drive copiers in both standard and ultra versions. Ultra models transfer data faster than any hard drive! Rates of over 1GB per minute are supported.

Set up any IDE drive with all your original software. Attach blank target drives, and press "start". It's that easy! You can duplicate four drives in less time than it takes to copy one on a fast PC! Your duplicate drives will be identical, bit-for-bit perfect copies, with all the files, partitions, and information on the original drive. Building systems is tough enough. Why spend hours installing software? Save time. Save money. Call today and let us Fed-X your duplicator for a risk-free evaluation!

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WWW.DUPEIT.COM
408 330-5524

Over 80% of the Fortune 500 depend on CSC products. Shouldn't you? Call today. Most orders ship within 24 hours! Call now for more information and a free price comparison guide. Quantity discounts are available for dealers and system builders. Copyright laws must be observed when duplicating CDs and hard drives. © 2000 CSC.

Circle #86 on the Reader Service Card.

HSC Electronic Supply

Serving Silicon Valley since 1964!

...brings you a potpourri of high-tech goodies for the techno-tinkerer!
For thirty years we have been your source for Silicon Valley exotica!

Computer Cases!

- High quality mid-tower ATX cabinet
- Three 5.25" & two 3.5" bays
- Standard ATX power supply bay
- Special -- buy with HSC#18665 200W power supply for $29.95 for the pair!
- 90-day HSC warranty

HSC# 18663 **$19.95**

- High-quality AT-style desktop computer case
- Made for Micronics -- not a cheap knockoff!
- Two 3.5" & Three 5.25" bays, rails included
- Takes standard mini-tower supply
- Special!...buy with HSC#18351 - 150W AT power supply for $19.95 for the pair!!
- Brand new, 90-day warranty

HSC# 18633 **$14.95**

- 200 Watt ATX Power supply (if purchased separately)

HSC# 18665 **$17.50**

- 150 Watt AT Power supply (if purchased separately

HSC# 18351 **$14.95**

Browser Mouse!

- Wheel-type browsing mouse
- 3-button PS/2 interface
- Fully programmable
- Wheel also functions as a button
- New, 90-day warranty

HSC#80555 **$4.95**

Tiny Color Camera!

- Camera-On-A-Board, measures 1.87"x1.3"x1"thick
- Glass micro-lens element, not pinhole
- Std. NTSC composite video output
- 350 lines horiz. res., 7 lux sens.
- 4 - 5 VDC, only 150 mA! 3-AAA batteries would power it for over six hours!
- New, in OEM pkg (no box), 90-day warranty

HSC#18209 **$59.95**

486DX4 Motherboard!

- For 486SX/DX/DX2 and DX4 CPUs
- 128KB ram on board, expandable to 512KB
- Three PCI bus slots, supports 3 master/slave
- Four ISA slots, std. AT power conn.
- DIN kybd conn, 4-72-pin SIMM skts
- On-board IDE controller & conn
- Manual, driver diskette incl.

HSC#18529 **$19.95**

SCSI Drive Cases

Just in...two new styles of SCSI drive case. Perfect for those RAID systems, server backup, or other mass storage systems! Both feature: Power and drive status LEDs, front panel off/on switch, SCSI ID switch, fan-cooled switching power supply. Attractive beige color, curved front panels. Rear panel is punched for SCSI-1 (ICN-50) daisy-chain connectors, internal SCSI cable not included. Brand new in box, 90-day warranty

- Two-bay case
- RCA Jacks/ Sound Cable incl.
- Measures 6.3" x 7.0" x 11.25"
- 80-watt power supply

HSC# 18267 **$39.95**

- Four-bay case (similar styling to two-bay case above), no sound cable
- Measures 10.3" x 7.125" x 14.3"
- 200-watt power supply

HSC#18268 **$49.95**

...and two more cases!

- 3.5" compact SCSI cabinet
- Ideal for 1" high SCSI drives
- Built-in fan-cooled power supply
- Two 50-pin Centronics daisy-chain connectors & SCSI switch on rear panel

- New, with IEC power cord, 90 day warranty

HSC# 80545 **$9.95**

- CD-ROM drive tower case, made for Compaq Computer Systems
- Can handle 7 5/25" SCSI-I/II CD-ROM drives
- Includes 200W power supply, slides for drives
- Removable front and side panels
- Solid, heavy gauge construction
- Seven-position daisy-chain ribbon cable included
- New, 90-day warranty

HSC# 80544 **$89.00**

Disk Drive Deals!

- Seagate Full-Height 5.25" SCSI Disk Drives
- Model ST 43400N 'Elite 3' -- 3 GB Capacity
- Model ST 410800N 'Elite 9' - 10 GB Capacity
- 5400 rpm, Seek time: 11 ms
- Used, tested good
- Standard 50-pin connector
- 30-day HSC warranty

HSC# 18635 3 GB **$14.95**
HSC# 18636 10 GB **$29.95**

- Seagate ST32171N "Barracuda Ultra-SCSI"
- 3.5" 2.16 GB hard disk drive
- 7200 RPM, 9.4 mS access time
- Packaged for Motorola product
- Brand new, with slide brackets
- OEM (Motorola) box, 90-day warranty

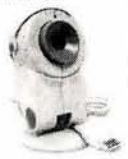
HSC# 18388 **$39.95**

- Seagate ST15150N 4.3 GB "Barracuda"
- 7,200 RPM, 8.0/9.0 ms avg. seek time
- 21 Hds, 11 Disks, 3,711 Cyl.
- Standard 50-pin SCSI
- Half-height size (1.5" tall)
- Refurbs, 90-day warranty

HSC# 18412 **$59.95**

USB Video Camera!

- 'NetView' PC camera w/high-speed USB interface
- Up to 30 fps for real-time video
- 350,000 pixel, 1/3 inch color CMOS
- Auto white balance & color correction
- Retail boxed, with CD
- New, 90-day warranty



HSC#80554 **$37.50**

Quality Enclosure!

- Desktop "AT" style case, made for Micronics
- High quality assembly for standard AT motherboards
- Uses standard mini-tower power supply (not incl.)
- Includes one set of drive rails
- Measures 16.5" wide, 6" high, 17" deep
- Two 3.5", three 5.25" drive bays, all with front access
- Brand new in box, 90-day warranty

HSC#18633 **$14.95**

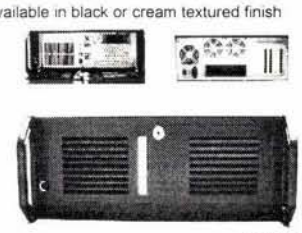
56K PCMCIA MODEM!

- 3Com/US Robitics Model MDM-XJ1560J
- 56K, V.90 PCMCIA type
- Built-in XJACK for direct phone line conn.
- New, in jewel case w/cable
- 90-day warranty
- Drivers available at: http://www.mhz.com/support/drivers.cfm?model=XJ1560

HSC# 80559 **$39.95**

Rack-mount Chassis!

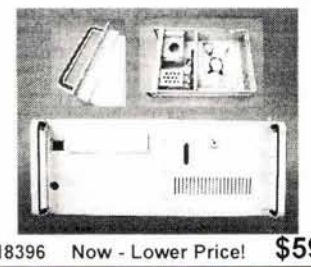
- Rugged construction for heavy duty server use
- Supports all standard ATX motherboards
- Industry standard 4U height
- 250W standard/350W surge high output supply
- Filtered cooling system, locking front panel
- Can mount up to ten drives
- Folding front handles, mounting ears & accessories
- Brand new, boxed with 90-day warranty
- Available in black or cream textured finish



HSC# 80540 Black **$195.00**
HSC# 80541 Cream **$195.00**

Do-It-Yourself Server Chassis!

- Standard 19" rack enclosure for 20-slot backplane
- 6.75"H x 24.25"D, heavy duty panels
- Brackets for 3.5" & 5.25" drives, power supply
- Front mounted 5-pin DIN with cable for keyboard
- Cabinet can be modified to accept AT-style motherboard (power extender cables included, some drilling required, no returns when drilled!)
- Hardware pack and IEC socket kit included
- Brand new, high-quality construction
- Includes 150W AT power supply!
- Inquire about higher wattage or ATX power supplies



HSC#18396 Now - Lower Price! **$59.00**

Headset for Gamers!

- Unique stereo headset has built-in mouse control!
- Keep your hands on the trigger buttons!
- "UR Gear" 3-dimensional "joystick" control
- Integrated stereo headphones, built-in microphone
- Even includes voice-recognition software!
- DOS, Win 3.1, Win 95 compatible. DirectX compliant
- Easy to install & use, full step-by-step manual
- 3-D position sense & movement detection
- 4-button hand control as well as voice command!
- Infrared pickup installs on monitor, parallel interface
- HSC 90-day warranty

HSC#18476 **$49.95**

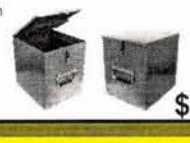
Soft-Touch Keyboard!

- 'Windows 98' keyboard
- Large 'Enter', 'Spacebar' and 'Backspace' keys
- Four extra color-coded keys for:
  - Soft Power On - 'Sleep' mode - Wake Up - Function -
- New, 90-day warranty

HSC #80551 **$12.50**

Handy Metal Case!

- Steel box with hinged lid, hundreds of uses!
- Two sturdy spring-loaded handles, over-center latch
- Foam pads inside for cushioned protection
- Measures 10" x 13" x 13" high...and it's stackable!
- Blue textured finish



HSC #18667 **$19.95**

Cat5 Cable

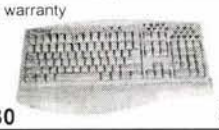
- 350+ Enhanced CAT5e 100MHz Horiz. cable
- Four pair, #24 AWG solid
- UL/CSA TIA/EIA 561A
- Esceeds proposed 1 GHz standards
- Available in White, Blue and Grey

HSC#5E8XX1001 **$59.95/1000'**

21st Century Keyboards!

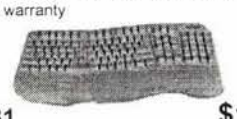
Are you still typing on a keyboard that was developed in the 70's? Try one of these modern computer keyboards and you will never go back to the old days!

- Samsung SEM-MA2 124-Key Internet Keyboard
- USB connector, ergo wrist-rest included
- 20 specialized keys let you navigate the web, start programs, control your CD, much much more!!
- New, 90-day warranty



HSC#18630 **$14.95**

- Samsung Zoom 109-Key Ergo Keyboard
- PS/2 (Mini-DIN) connector
- Wristpad helps prevent wrist injuries, increases typing speed with special ergonomic design
- New, 90-day warranty



HSC#18631 **$14.95**

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Watch HSC's Website!

- Changes are coming to our website...stay tuned!
- Simply point your browser to *http://www.halted.com*
- We plan secure shopping, with shopping basket!
- Or, you can email your orders to *hscmail@halted.com*

Weekly Web Specials!

- A new section has been added to our web page!
- Simply go to www halted com and click the top button!
- Items from our ads, as well as non-advertised items
- Also, you can download our catalog as Adobe PDF files

Terms: Some quantities limited, all items subject to prior sale. Minimum order: $10.00 plus shipping. Orders under $20.00 subject to $2.00 handling fee, in addition to shipping. All orders shipped FOB Santa Clara, CA (this means you pay freight!) by UPS Surface (no P.O. Boxes) unless otherwise specified, in which case prevailing carrier rate plus $5.00 handling fee applies. Prepaid orders that don't include shipping charges will be shipped freight COD. There is a $5.00 UPS charge added to shipping charges for COD shipments. If you have questions about your order, please call Customer Service at (408) 732-1854 M-F 9AM to 5PM PST.

Circle #91 on the Reader Service Card.

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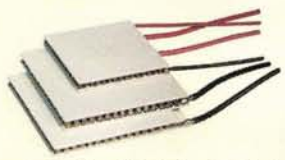
13.5V @ 20A TRANSFORMER

Input: 115 VAC 60Hz
Output : 13.5VAC @ 20A
6" Wire leads on Pri.
.250 Faston on Sec.
Magnetic & Faraday shields.
L: 4-1/4" **W:** 3-1/2" **H:** 3-1/2" **WT:** 9

12788-TR ..... 20A Transformer $19.95

12V THERMOELECTRIC



127 Couple Peltier Modules Optimized

70W (~170 BTU) heat pumping possible. 8A max, 16V max, Draws 6A@ 12VDC
L: 1-11/16" **W:** 1-9/16" **T:** .127" **WT:** .06
12326-PM ..... 70W Module $17.95

50W (~125 BTU) heat pumping possible. 5.5A max, 16V max, Draws 4.8A@ 12VDC
L: 1-11/16" **W:** 1-9/16" **T:** .18" **WT:** .06
9080-PM ..... 50W Module $14.95

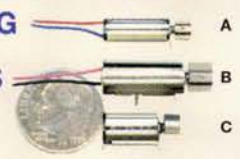
38W (~90 BTU) heat pumping possible. 3.9A max, 16V max, Draws 3A@ 12VDC
L: 1-3/16" **W:** 1-3/16" **T:** .13" **WT:** .03

DATA SWITCHES

Two set types available:
Computer sharing Set connects 2 printers to a computer. Includes: Heavy duty, metal cased A/B switch with DB-25 F connectors; One 6ft. DB-25M to DB-25M cable & two6ft. DB-25M to Centronics Cables.
Printer sharing Set connects 2 computers to a printer. Includes: Heavy duty, metal cased A/B switch with DB-25 F connectors; Two 6ft. DB-25M to DB-25M cables & One 6ft. DB-25M to Centronics Cable.
WT: 2.9

12692-SW ..... Two Printer Set $5.95
12694-SW .... Two Computer Set $5.95

VIBRATING PAGER MOTORS



Rated 1.3VDC, 75mA running, max. **WT:** .007
A: 12342-MD: 10000 RPM. 4mm dia X 16.2mm Long, 1" leads, Metal bracket with mounting tabs
12342-MD ..... 4mm Pager Motor $2.95
B: 12343-MD: 7500 RPM, 6mm dia. X 20.6mm long, 1" leads, Metal bracket with mounting tabs
12343-MD ..... 6mm Pager Motor $1.95
C: 12344-MD: 8000 RPM, 6mm dia, X 14.4mm long. PC solder tabs
12344-MD ..... PC Pager Motor $1.95

SONY COLOR CAMERA

Sony CCB-GL5 1/3" Color board camera. 2 board assembly with sensor/lens board that connector mounts at right angle to main board. Lens: 6.5mm. Resolution: H-320 V-350 lines. Min sensitivity: 5lux. Scanning: 525 lines; 2:1 interlace @ 30 frames/sec. 1V P/P NTSC composite video out. 9VDC @ 175ma power.
Sensor: L: 2" W: 13/16" D: 1-1/4
Main: L: 3-3/8" W: 2-3/16" D: 5/16
WT: .1

12742-ST ..... Sony Camera $49.95

FOLDING MAGNIFIER

Folding magnifier with a quality 4" Dia. glass lens. 7" tall when open & 1-5/8" folded. 6-1/2" X 5-1/4" open bottom has inch/cm scales. Ideal for collectors, jewlers, electronic repairs.
L: 6-1/2" **W:** 5-1/4" **T:** 7" **WT:** 1

0079-LN ..... Folding Magnifier $6.95

MINI SOLDER SUCKER

Compact Solder Sucker with aluminum body and nylon tip.
L: 7-3/4" **WT:** .2

12816-TL ..... Mini Solder Sucker $1.95

12VDC MINI FAN

MFG: T&T
P/N: MW-510H12C
INPUT: 12VDC @ .145A
CFM: 9
Small box fan with thermoplastic blades & frame. Ball bearings, 10"wire leads. 27 dB noise. UL/CSA/VDE/CE listed.
Sq: 2" **Thk:** 3/8" **WT:** .05

12773-FN ..... 2" Mini Fanr $1.65

12VDC 4-11/16" FAN

MFG: NMB
P/N: 4715KL-04W-B49
INPUT: 12VDC @ .9A
CFM: 118
Small box fan with thermoplastic blades & frame. Ball bearings, 12"wire leads. 46 dB noise. UL/CSA/VDE/CE listed.
Sq: 4-11/16" **Thk:** 1-1/2" **WT:** .55

12779-FN ..... 12V 4-11/16" Fan $9.95

CLAM SHELL FILTER

MFG: TDK
P/N: ZCAT2035 0930
Ferrite clam Shell noise filter. Plastic case with split core material. Clamps around cable up to .275" in Dia. to block noise.
L: 1-3/8" **Dia:** 3/4" **WT:** .06

12731-FL ..... TDK Noise Filter $1.95

12 VDC 1.25A SUPPLY

MFG: PHIHONG
P/N: PSA15W-120
Input: 100-240 VAC 50/60Hz
Output: 12VDC @1.25A
Regulated switching supply. 6fl. output cord with 2.5mmID coaxial connector. UL/CSA/VDE/CE listed. 6ft. power cord included
L: 4-3/8" **W:** 2-5/8" **H:** 1" **WT:** .5

12815-PS .... 12V @1.25A Desktop $8.95

GFI CORD

Small appliance power cord for such items as hair dryer, curling iron etc. Polarized plug with the conventional "TEST" & "RESET" buttons. 6ft. 18AWG SPT-2 "zip" cord. UL Listed.
L: 6ft **WT:** .3

11827-WI ..... GFI Cord $1.00

POWER CONTROL CENTER

Desk top 6 outlet surge protector with protection for telephone line. Protects equipment from power surges. Power switch with LED for 4 outlets plus master, 2 outputs are unswitched 15A circuit breaker, 6' heavy duty cord, 120VAC, 15A, 3 wire grounded outlets. RJ-12 MOD jacks for telco line. Rated: AC line Clamp 330V H-N & N-G, 400V H-G. Telco Clamp 455V. EMI/RFI filtered to UL 1283 U/L 1449 listed.
D: 13" **W:** 12-5/8" **H:** 1-3/4" **WT:** 3.6

12814-MI ..... Power Control Ctr. $995

CABLE TIES & CUTTER

200piece assortment of multi colored 3" cable ties along with a handy cushion handle cable/tie cutter. Ideal for tagging cables or bundling up wire or cable feeds.
WT: .34

12089-TL ..... Ties & Cutter $3.95

LCD PANEL METER

3-1/2 digit Meter with 200mV input, .5" char. Ht., Adj. decimal point, auto polarity indicator, >100M ohm input impedance, 2 samples/sec. .;5% +-1 digit accuracy. Requires isolated 9VDC power.
W: 2-5/8" **H:** 1-3/4" **D:** 3/8" **WT:** .1

6929-ME ..... LCD Meter $7.95
(25+ @ $6.40 100+ @ $5.95)

USB CABLE

5ft. Universal Serial Bus printer cable . Cable has a Type A male on one end and a Type B male on the other. Dark Gray jacket, molded strain reliefs.
L: 5ft **WT:** .15

12713-CB ..... USB Cable $0.99

LAPTOP COMPUTER CARRYING CASE

Targus Notepac Plus padded case with non skid rubber feet & nylon zippers. Features padded computer compartment, expanding file pocket, 2 CD pockets, Disk pocket holds four 3.5" floppies, pocket for 2 PC cards, Workstation section has pockets for cell phone, disks, pens, 3 section accordion file for papers.
For computers up to 15" X 10.6" X 2.8" **WT:** 3.1

12786-CP ..... TARGUS LAPTOP CARRY CASE $34.95

INDUSTRIAL POWER SUPPLIES

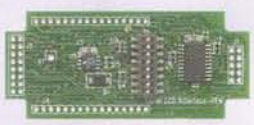
60W/100/150W

200W

Input: 110-240 VAC 50/60Hz
Specifications/Features: Enclosed switching supplies. .5% line, 1% load reg. 1% P/P noise/Ripple. Overload &overvoltage protected. Screw terminals. UL Listed.

12411-PS	5VDC/12A $29.95	12422-PS	12VDC/12.5A $44.95
12412-PS	12VDC/5A $32.95	12424-PS	24VDC/6.5A $44.95
12414-PS	4VDC/2.5A $32.95	12425-PS	48VDC/3.3A $44.95
12417-PS	12VDC/8.5A $39.95	12611-PS	12VDC/17A $59.95
12418-PS	24VDC/4.5A $39.95	12613-PS	24VDC/8.5A $59.95

UNIVERSAL LCD DRIVER BOARD



Free LCD

1 LINE X 16 CHAR. LCD DISP.

Serial driver board for 1 line X 8 character up to 4 line X 20 LCDs that use the Hitachi HD44780 controller IC. Provides all the "handshaking" needed by the LCD module. Board mounts to the back of LCD. Converts 110-19200 Baud serial data to parallel for the LCD. Access to LCD commands like scrolling, custom char. set etc. Works with Basic Stamp, PC Com Port & Single Board Computers with serial output port. Hole patterns allow use with LCDs with single row or 2 row pin configurations. Documentation.
Note that this unit is an interface and does not provide for terminal emulation; your software should "format" the data as in any LCD driver. **WT:** .1

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DATA SAMPLER KITS

DB-25 extended case package plugs into computer parallel port.

8 bit A/D Sampler monitors voltage changes over time. Software allows timed sampling from mS to months. Selectable 2V or 20V ranges. Useable as a low frequency digital "scope" for signals up to 5KHz. Powered from port. Includes Windows 3.1/95™ software to get started. Displays plot & data is saved as text files for import to spread sheets. Requires hard drive & VGA card to display plot.
12 Bit Analog Data Acquisition System monitors 4 digital inputs (TTL). 8 multiplexed analog inputs (0-4.096VDC. Drive external circuits with 4 TTL outputs. 'C', Visual Basic, Quick Basic routines provided along with Windows 95 software. Data can be viewed, stored or exported to Lotus or Excel. Requires external 12VDC @ < 100mA supply.
L: 2-1/4" **W:** 2-1/8" **H:** 3/4" **WT:** .1

8412-KT ..... 8 BIT DATA SAMPLER KIT $23.21
8418-KT ..... 12 BIT DATA ACQUISITION KIT $55.00

Circle #87 on the Reader Service Card.

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Cover illustration from *Sentinel* by Syd Mead (published 1979 by Dragon's Dream, Netherlands; ISBN: 9063325916).

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Nuts & Volts (ISSN 1528-9885) is published monthly for $19.00 per year by T & L Publications, Inc., 430 Princeland Court, Corona, CA 92879. PERIODICALS POSTAGE PAID AT CORONA, CA AND AT ADDITIONAL MAILING OFFICES. POSTMASTER: Send address changes to Nuts & Volts, 430 Princeland Court, Corona, CA 92879-1300.

AIBO the Robotic Pet

Part 2

by Jeff Mazur

AIBO and Tekno again.

Last month, we looked at the hardware side of AIBO to see what makes it tick. This month, we continue with a look at the software side of AIBO. A detailed outline of how AIBO matures from infant to adult using the AIBO Life program will be presented, as well as some of AIBO's voice commands and behaviors. We will also discuss several shareware applications that let you dissect the programming of AIBO.

AIBO Life

The standard software program for AIBO comes on the AIBO Life memory stick. When first installed, the robot will wake up in the infant stage. As it matures, the software keeps track of how much time has elapsed, as well as how much "Quality Time" (see sidebar, "Spending Quality Time with AIBO") it receives. This, in turn, determines when and how the robot matures and how it will act. This information is stored on the memory stick along with other information such as the notes/pictures that AIBO keeps in its diary.

Figure 1 shows all of the possible stages and how they are reached. The exact stage of your pet can be determined by the sound it makes when woken up or sometimes by simply asking, "How old are you?" You can also read this info from the memory stick using the Fun Pack software or the shareware program AiboTool from AiboPet.com (see Figure 2).

Playing with AIBO

AIBO responds when you call its name and will repeat its name when asked, "What's your name?" Interpreting AIBO's actions and sounds does take a little practice however. It is fairly obvious when AIBO wants something (it makes a "give me" gesture with its front paws), but its ears,

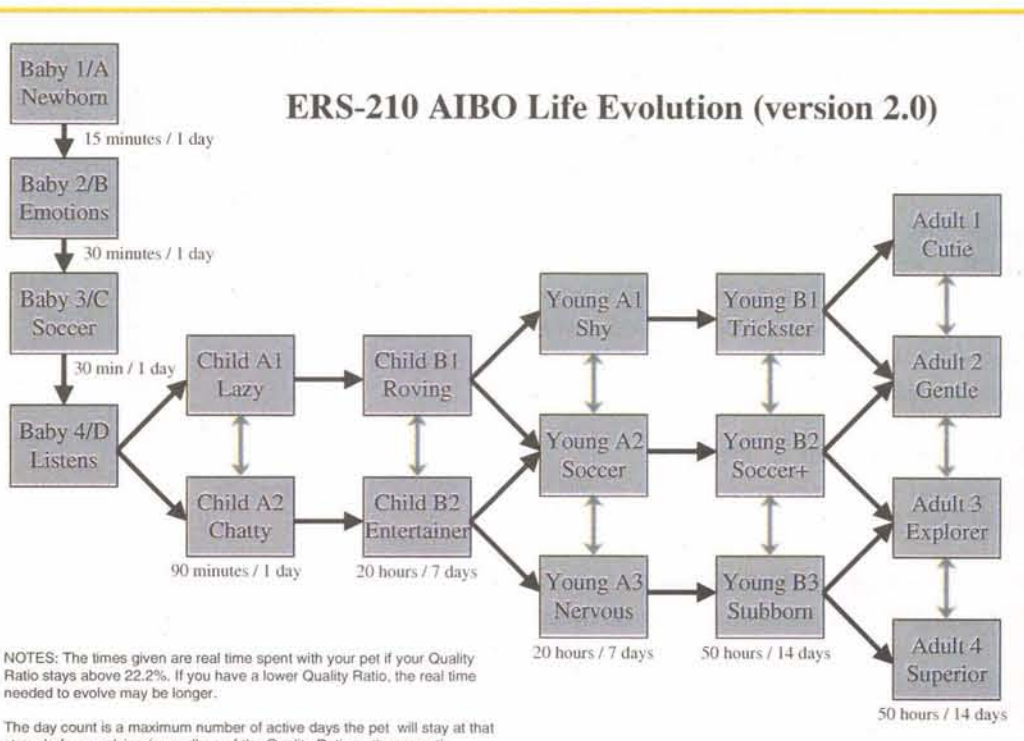


Figure 1a.

Figure 1. The evolution of AIBO using the AIBO Life software. In a) how each stage is reached, and b) *(see next page)* a description of the pet at each stage. *(Courtesy of AiboPet)*

Stage+Variant	Descriptive Name	Description
Baby 1/Baby A	Newborn Baby	newborn, helpless
Baby 2/Baby B	Emotional Baby	learns emotions
Baby 3/Baby C	Soccer Baby	learns pink ball
Baby 4/Baby D	Listening Baby	lets you name him
Child A1	Lazy Child	inactive, likes shaking paw
Child A2	Chatty Child	talkative, likes to mutter to itself
Child B1	Roving Child	future adventurer, likes exploring
Child B2	Entertainer Child	AKA JonBonet, born to entertain, dreams of becoming a star
Youth A1	Shy Youth	wants attention, disobedient, bad at soccer
Youth A2	Soccer Youth	learning to play soccer
Youth A3	Nervous Youth	"scardy cat", stumbles around, depressed, miserable
Youth B1	Trickser Youth	mischievous, comedian
Youth B2	First Rate Soccer Youth	better than a "Soccer Youth"
Youth B3	Stubborn Youth	temper tantrum, very moody
Adult 1	Cutie Adult	needy, loving, moody, plays it cool
Adult 2	Gentle Adult	gentleman/lady, social, obechent, well mannered
Adult 3	Adventurer Adult	independent, likes exploring
Adult 4	Superior Adult	responsible, perfect partner

Figure 1b.

Spending Quality Time with AIBO

When running the AIBO Life software, AIBO uses its built-in clock/calendar to keep track of three durations: Real Time, Quality Time, and Day Count. These durations determine how the pet evolves through each of its stages. Real Time represents the cumulative amount of time that the pet is actually turned on, while Quality Time only advances when someone actively interacts with the pet. Each day that you play with AIBO, the Day Count will go up by one. AIBO also calculates a Quality Ratio, which is simply:

Quality Time / Real Time.

At the start of each stage, all three durations are set to zero. The pet will evolve to the next stage when the Real Time hits a certain limit (also dependent on the Quality Ratio), or when the Day Count hits a different limit, whichever comes first. The Day Count prevents AIBO from getting stuck in one stage for too long. By comparison, the ERS-111 evolution was solely controlled by the Quality Time amount. If you didn't play with the dog, it would not mature.

The Real Time limit is always 4.5 times the Quality Time limit. Therefore, the Quality Ratio break-even point is 22.2%. If your Quality Ratio is higher than 22.2% then you are doing a good job, and AIBO will evolve to the next stage as fast as possible. If your Quality Ratio is lower than 22.2% then it will take longer for your pet to evolve. If you play with AIBO only a little each day, it will eventually hit the Day Count limit and evolve anyway.

Each stage also has several variants which depend upon how the pet has been treated, including what it has seen and done. Even after reaching the Adult stage, the pet's personality will adjust to the type of interaction it continues to receive.

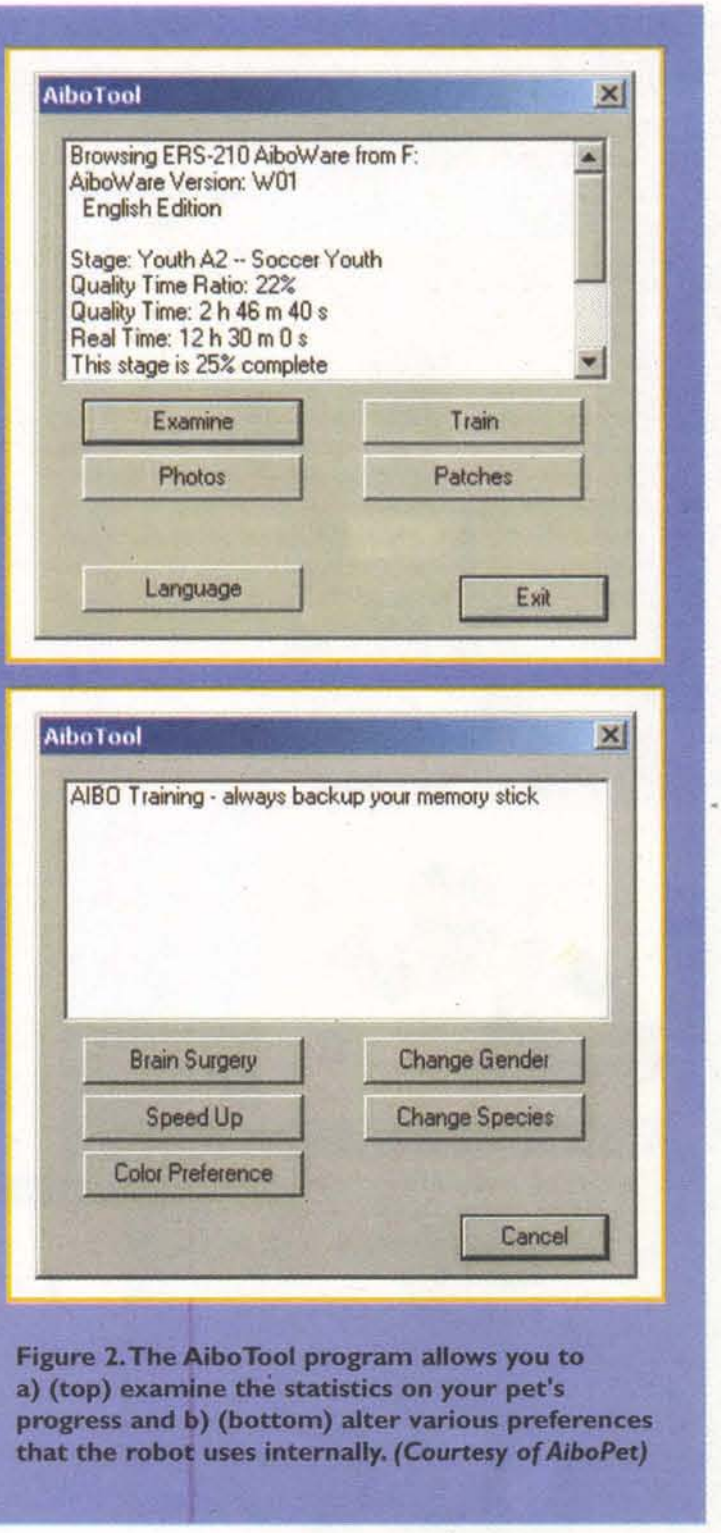


Figure 2. The AiboTool program allows you to a) (top) examine the statistics on your pet's progress and b) (bottom) alter various preferences that the robot uses internally. *(Courtesy of AiboPet)*

lights, and sounds are much more subtle. It will flap one ear for example, when it does not understand a command.

It is also quite remarkable to see AIBO walk up to a wall and stop just short of bashing into it. It will then look around and either turn left or right, or even turn completely around. If placed on a table or desk, AIBO will usually detect when it reaches the edge. It will crouch down, look at the edge, and then shake its head as if to say "no way!" It will then turn back and try exploring elsewhere. This behavior is not guaranteed, however, so it's wise not to leave AIBO unattended on a high surface.

One of AIBO's most impressive feats, however, comes when it falls over (or when someone tips it over!). AIBO will give out a yelp, but wave its free paw in the air to signal, "Leave me alone." It will then perform a rather un-mammel-like contortion that usually puts it back on its feet, after which it will "shake off" the experience.

AIBO etiquette requires that I put up the following SPOILER disclaimer: If you don't want to know most of AIBO's behaviors (i.e., you would rather discover them on your own and be surprised), please skip over the next paragraph.

Some of the other major actions performed by AIBO (and their voice commands) include:

Dancing ("Let's Dance"), Shaking hands ("Shake"), Speaking ("Speak" well, sort of), Waving ("Hello" or "Goodbye"), giving a karate chop ("Karate Chop"), and striking one of its numerous poses ("Pose"). When taking AIBO for a walk, it will respond to commands for Stand, Sit, Lie down, Go forward, Turn right, Turn left, and Stop. When asked to "Take a Picture," AIBO will snap a picture of whatever it is looking at and add it to its diary. The command "Let's Play" puts AIBO into a playful mood, which includes mimicking whatever you say to it (although whatever you say comes back in AIBO's tonal language). Although it's hard to do justice to AIBO with still photos, Figures 3a-f attempt to show how adorable it can be. Check out Sony's European website (http://www.eu.aibo.com/) for movies that show AIBO in action.

Often, AIBO will not react to your first request; sometimes a command must be repeated several times before it will respond. It is also not unusual for AIBO to wave its paw and/or shake its head in a defiant "No!" And then again, sometimes AIBO will just ignore you altogether. Just like a real pet!

All in all, AIBO is said to recognize about 50 words. Sony does not supply a list of all these commands, perhaps because they feel it will be more fun to discover them on your own. AIBO owners have even reported behaviors (e.g., having their pet automatically mount itself into the optional charger) that Sony denies having programmed into the robot. So perhaps these crea-

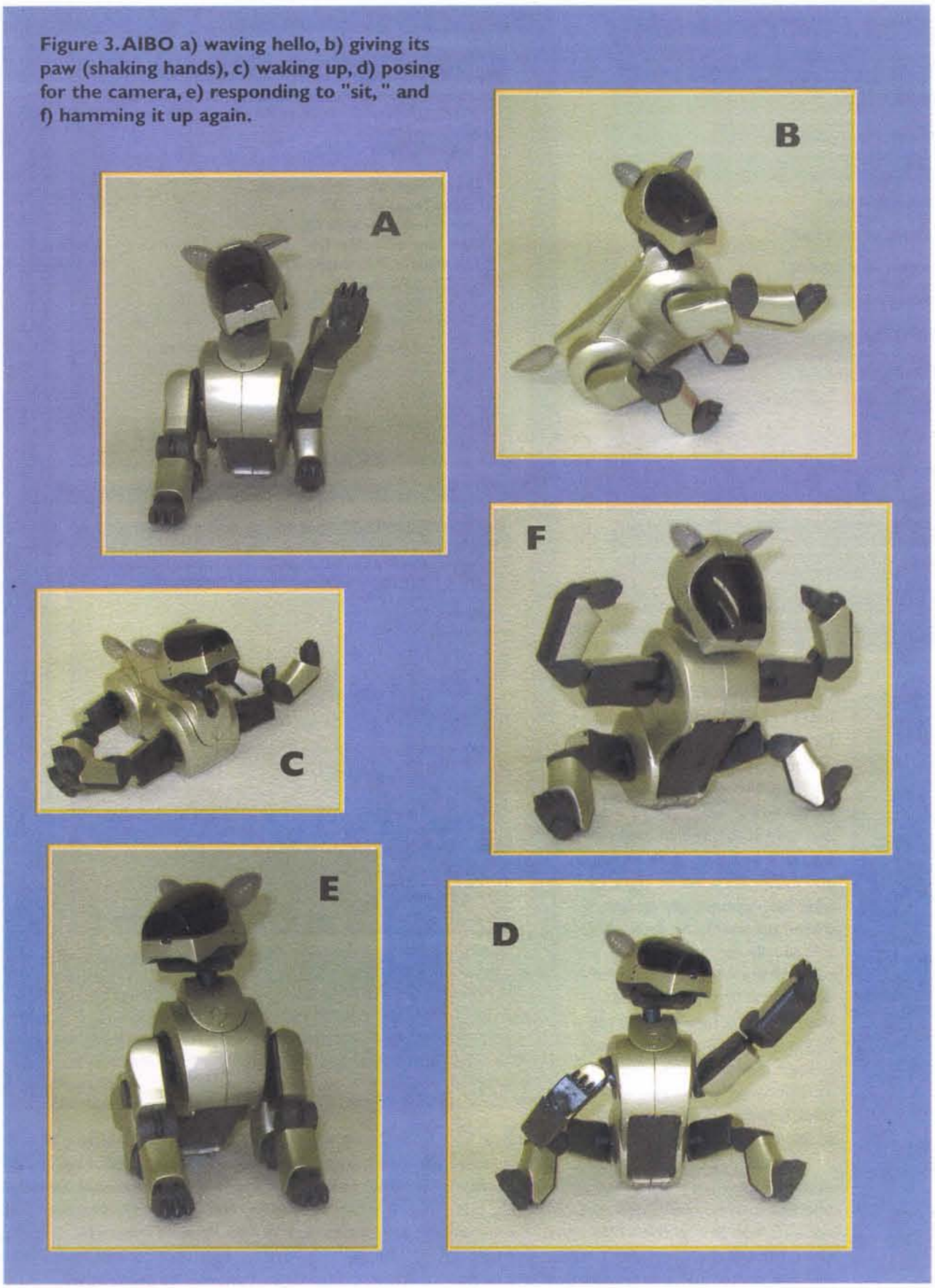


Figure 3. AIBO a) waving hello, b) giving its paw (shaking hands), c) waking up, d) posing for the camera, e) responding to "sit," and f) hamming it up again.

tures really can learn new behaviors beyond what their creators have specifically envisioned.

AIBO also responds to various tone commands. Since the earlier models had no voice recognition and relied solely on tonal communication, this seems to be a holdover from that technology. But it also provides an interesting interaction when more than one AIBO are brought together. Whether first or second generation, the robots sense each other and begin communicating. I'm not sure what they're saying, but it's cute to watch (and listen). At least one game (Spellcaster) in the Party Mascot program uses tones to allow two ERS-210s to communicate with each other. It is also possible to download MIDI files of these tones onto your computer. You can then play them for AIBO and see how it reacts.

Undoubtedly, the most complicated feat in AIBO's repertoire is its ability to play with a ball (see Figure 4). When given one of several commands such as "Find the ball" — or whenever AIBO wants to play, it will signal that it wants its ball — it's time to bring out the pink ball that comes with each AIBO. There is nothing special about this small plastic ball except that it is bright pink — AIBO's favorite color. When AIBO sees the ball, it will make a playful sound and then begin tracking it. If you move the ball in front of its face, the head will turn to follow.

If you place the ball on the floor, AIBO will navigate itself to just in front of the ball and then either kick it with one of its legs or kneel down and smack it with its head. It then tries to see where the ball went and seeks it out again. If it misses the ball, it will see that the ball has not moved and lets out a mournful sigh before trying again. Here we get a glimpse at the soccer-playing heritage of AIBO's ancestors.

Hacking AIBO

If you thought dissecting AIBO's hardware was fun last month, wait until you see how much fun you can have mucking around with its software. We've already seen how the AiboTool program can examine and alter many parameters used by AIBO such as its age and color preferences.

AiboPet also offers the ERS-210 Browser, where you can dig even deeper into the software and alter many of the characteristics of your pet (see Figure 5). This program lets you browse most of the files stored on the memory stick. It will display a vast number of parameters (Figure 5a), as well as details on AIBO's sounds and motions (Figure 5b). You can even "disassemble" the behavior code (Figure 5c) or perform "Brain Surgery" if you dare. Anyone contemplating this level of tinkering would do well to heed the warnings to back up the memory stick before making any changes.

Another tool from AiboPet is the Test AIBO program. This program is loaded onto a blank memory stick and then placed into AIBO. After the robot reboots, it will enter the test mode, laying down with its two front paws lifted, and

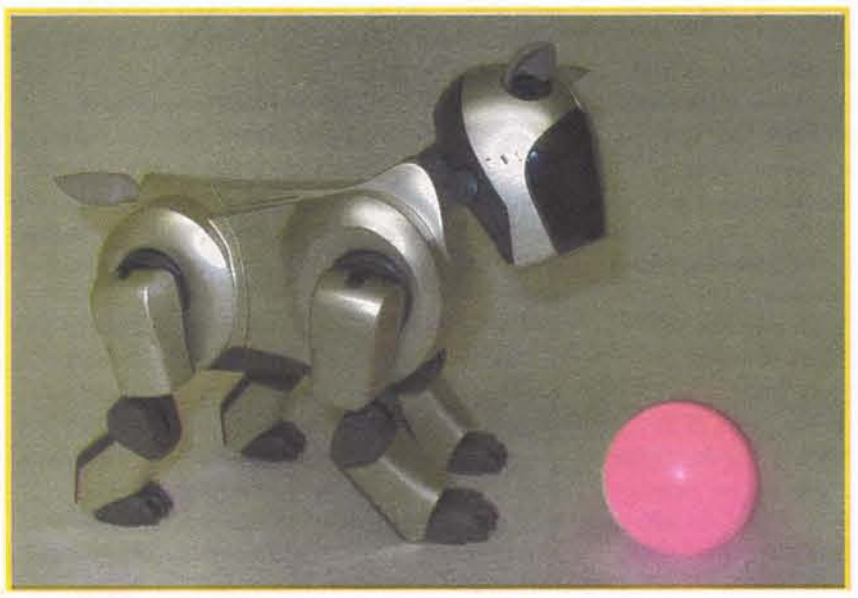


Figure 4. AIBO playing with its ball.

announce, "Welcome to Test AIBO." At this point, you can press either front paw sensor to select one of several tests that can be performed. AIBO's eyes tell you which test is selected. Currently, you can choose one of the following:

- Voice Recognition Test
- Tone Detection Test
- Sensor Test
- Vision Test

The Voice Recognition Test gives you an indication of how well AIBO understands your commands. When it hears a voice command, it will light up its eyes depending on the Voice command number (Vcmd#). Each of the six LEDs is given a binary-weighted value so there are 64 possible combinations. A list of approximately 40 deciphered Vcmds is also available on the AiboPet website.

The Tone Detection Test is very similar, but listens for tone sequences used by all AIBOs as a tonal language. In this case, the LEDs read out the TONE_NUM values (list also available). The Sensor Test checks the operation of the three touch sensors, as well as those on the front paws. Finally, the Vision Test gives feedback on what colors the CMOS camera detects within its field of view.

These tests serve three purposes. First, they can be used as a simple test to be sure your AIBO's hardware is working properly. Second, they can help you understand how AIBO interprets its surroundings. This is especially true for the Voice and Vision tests. Lastly, it allows better understanding of AIBO's brain, for those who like to disassemble AIBO's behavior files.

Conclusion

So is AIBO worth it — $40.00 Tekno vs. $1,500.00 AIBO? Well, that depends upon whether you want a toy or a real artificially intelligent robot pet. Certainly AIBO cannot rival a real pet (see "AIBO Vies for Attention with Roo") nor does it come close to demonstrating the state-of-the-art in robotics. What it does do is bring some of these advances to a reasonably low-cost consumer product. While some owners will undoubtedly adopt AIBO because of its cuteness or as a conversation piece, I would bet that many will be more interested in AIBO as a way to explore artificial intelligence. With fine tools such as the ERS-210 browser available online for free, this makes AIBO an ideal platform for such experimentation.

Although I certainly recognize the major accomplishments of articulated walk, speaker independent voice recognition from across a noisy room, image recognition, etc., I can't help but wish AIBO would do more. It's fun to wonder what the next generation Entertainment Robot will be like. Hopefully, it will improve on the existing technologies and add new capabilities such as facial recognition, the ability to pick things up, and — dare I say it — perhaps a tongue? And can it be that far away when we could expect a robotic pet to bring our slippers or fetch the newspaper for us? So what the ERS-210 may actually do best is whet our appetite for more advanced models to come.
NV

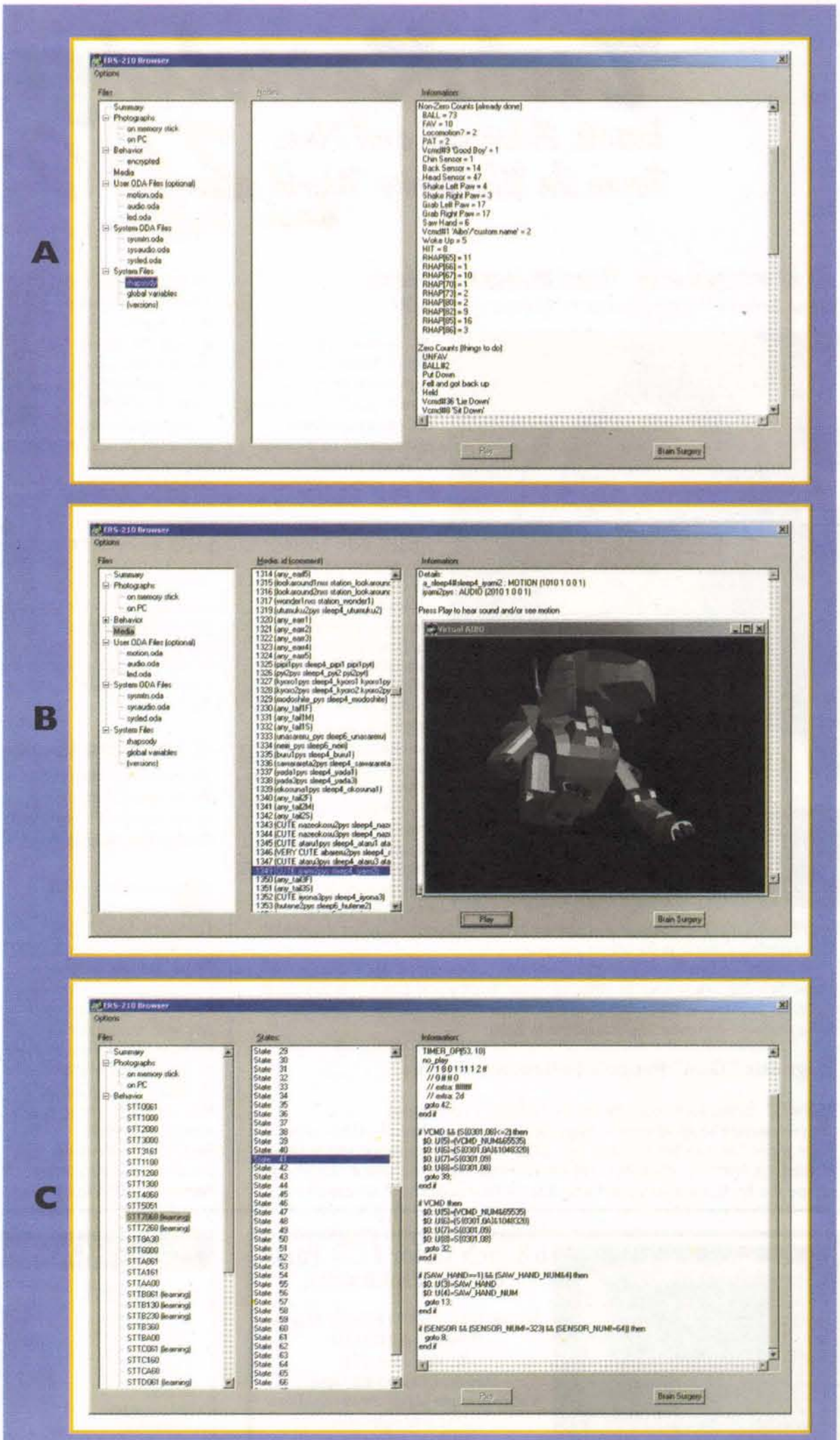


Figure 5. The ERS-210 Browser program lets you view the various files stored on the memory stick. Here you can examine a) system files such as rhapsody (which stores the main personality stage and counts), b) motion and sound data, and c) details of the behavior code used to control AIBO. *(Courtesy of AiboPet)*

TechKnowledgey

Events, Advances, and News From the Electronics World 2001

by Jeff Eckert

Advanced Technologies

New Smart Probe Detects Cancerous Cells

Karen Lauer, medical research assistant for LLNL's Medical Technology Program, examines the Smart Probe. Photo by Julie Korhummel, courtesy of LLNL.

Lawrence Livermore National Laboratory **(www.llnl.gov)** has joined with BioLuminate, Inc. (**www.bioluminate.com**), to develop a "Smart Probe" that offers earlier and more accurate detection of breast cancer. The process does not involve the removal of any tissue, but it is expected to achieve accuracy levels that are comparable to surgical biopsies in detecting cancerous cells. The first human studies are scheduled to begin this spring.

Each year, approximately 800,000 women in the USA undergo surgical breast biopsies on lesions that turn out to be benign. In addition, as many as 225,000 malignant tumors go undetected. Using the SmartProbe, many unnecessary surgeries may be eliminated, saving the health care system as much as $2 billion per year.

Sensors on the tip of the probe measure optical, electrical, and chemical properties that are known to differ between healthy and cancerous tissues. It looks for as many as seven indicators of breast cancer. The device is expected to be available commercially sometime in 2003.

Magnetic "Gun" Propels Pellets at 20 km/s

The "Z accelerator," built by Sandia National Laboratories **(www.sandia.gov)**, uses a magnetic field to propel small pellets, called "flyer plates," at a rather amazing rate of 20 km/s. For reference, this is about 20 times as fast as a rifle bullet and almost three times the speed required to escape the Earth's gravitational force (escape velocity). The Z accelerator uses 20 million amps to create the magnetic field that not only propels the plates, but also heats them to temperatures of 2,500 K, which is enough to liquefy aluminum pellets. In theory, the device could be modified to create a "kinetic kill" weapon that could pierce armor, and the concept is being studied. Less militant applications include simulation of the effects of space junk striking the metal skin of space vehicles, and generalized evaluation of the effects of pressure and temperature on various materials. An upcoming article in the Journal of Applied Physics will provide a detailed explanation of the process.

Sandia researcher Marcus Knudson holds two flyer plates in his right hand and chambers of his high-tech gun in the left. Photo by Randy Montoya.

Computers and Networking

Wireless Internet Reaches Native American Tribes via Solar-Powered Net

Installation of a six-foot segment in preparation for the final link at the La Jolla relay site, Palomar Mountain. Photo courtesy of UCSD.

Researchers at the University of California, San Diego (UCSD) have created a 45 Mbps wireless backbone that connects the low-lying San Diego County coastline with mountainous areas in the eastern region of the county, which includes the La Jolla and Pala native American reservations. The High Performance Wireless Research and Education Network (HPWREN) is an

experimental solar-powered wireless link intended to bring high-speed Internet access to the remotely-located tribes. HPWREN also links UCSD with the Mount Laguna Observatory, an earthquake-detection site, and two ecological reserves with multiple field stations. The reservations are located in geographical areas that range from mountain peaks at 5,000 ft. elevation to valleys at only 2,000 ft. No line-of-site paths were available from existing microwave towers, and the mountain ridge area of the La Jolla reservation is not connected to the electric power grid. It was therefore necessary to install a solar-powered network relay station on nearby Palomar Mountain.

The project was financed with a $2.3 million grant from the National Science Foundation. The network has provided greatly expanded communication capabilities for the La Jolla tribe's learning center, and residents are building related educational programs for both children and adults. More information about HPWREN is available at **hpwren.ucsd.edu**.

PC-Based Data Acquisition, Free

Personal computers have been used for many years in various data acquisition and control applications, including mechanical and electrical test and monitoring, process control, agriculture and aquaculture, and so on. If you have ever been curious about the possibility of putting your PC to such tasks, you might want to log onto **www.dataq.com** and ask for a free data acquisition starter kit. It includes the company's WinDaq software and various catalogs and articles on the subject, provided on a CD. You'll also get a DI-194 data acquisition hardware unit that includes four analog inputs, two digital inputs for remote control, a digital output with a squarewave generator, and selectable sample rate up to 240 samples/second. A serial port is included that connects the DI-194 to your computer's COM port, and it even has a terminal block for connecting it to the remote sensors.

Is this a full-featured data acquisition system? Of course not. Does the company want to sell you more powerful stuff? Of course. But it doesn't get any cheaper than free.

Circuits and Devices

One-Bit Technology: The Future of Audio?

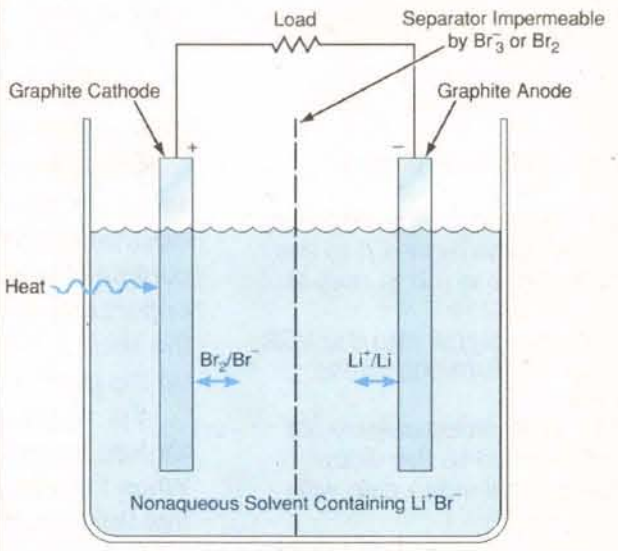
Conventional wisdom is that you need at least 16 bits of precision in digital recording to get a decent dynamic range of 96 dB (6 dB per bit). It seems to defy logic, then, that major players in the audio industry would be promoting one-bit audio technology as the format that will bring improved fidelity to the next generation of sound systems. But the one-bit Audio Consortium — formed in February by Sharp, Pioneer, and Waseda University — is doing exactly that, with fellow members that include Kenwood, Marantz, Teac, JVC, Yamaha, and others.

The technique uses sigma-delta modulation, which is an improved version of simple delta modulation developed in the 1940s for voice telephony applications. Rather than using multiple bits to represent a sample's relation to the baseline (zero), a single bit represents the change (delta) from the previous level. (For a detailed explanation, visit **http://www.cs.tut.fi/~rosti/1-bit/**.) This requires a much higher sampling rate, which is why one-bit audio will sample the analog signal at 2,822.4 kHz, which is 64 times as fast as your CD player's 44.1 kHz rate.

There are several advantages to this approach, which is the basis of the SuperAudio CD format proposed by Sony and Philips. For one thing, a one-bit audio amplifier consumes only half the power and emits one-fifth of the heat, as compared to conventional equipment. It is also said to provide reproduction that more closely tracks the true analog sound. Plus, the technology can be used for video and data signal processing as well. Sharp's first one-bit amplifier, the SM-SX-100, offers frequency response from 5 Hz to 100 kHz, a 105 dB dynamic range, and output power of 100W/channel. The suggested retail price of the 40.8 lb (18.5 kg) unit is a terrifying $14,995.00, but Sharp is said to have other models in the works that will cost less than $500.00.

Batteries Can Be Recharged with Electricity or Heat

The Jet Propulsion Lab at the National Aeronautics and Space Administration (NASA) has patented a design for storage batteries that can be recharged in the conventional, electrical manner, and also thermally, using solar energy or waste heat. In this design, an anode and a cathode, both made of graphite, are surrounded by lithium bromide that has been dissolved in a nonaqueous solvent. The electrodes are separated by an ion-exchange membrane that cannot be permeated by the bromine. In a fully-charged state, the anode is loaded with lithium, which leads to a negative charge on the graphite. The bromine atoms at this stage are freely dissolved in the solvent. As the battery discharges, bromine builds up on the cathode while lithium is freed from the anode. In the discharged battery, the cathode will have become loaded with bromine, while the anode will have lost nearly all of its lithium. The battery can be recharged conventionally by applying reverse voltage, but it can also be recharged by heating the cathode to 120°F (49°C) or so, which drives the bromine back into the solvent. After the cathode cools to room temperature, the battery is again ready for discharge. It is estimated that batteries based on this design would produce about 4V per cell. NASA holds the patent, but exclusive and nonexclusive licenses are available for commercial development. Details are available at **www.nasatech.com** (choose the "Electronic Components and Systems" option).



This rechargeable electrochemical cell exploits the reversible intercalation of lithium and bromine in graphite. Courtesy of NASA.

Industry and the Profession

Updated Web Site for Job Seekers

The Institute of Electrical and Electronics Engineers (IEEE) has updated its Job Service web site to provide expanded employment services to its members worldwide. Members can submit professional profiles and their requirements in terms of salary, type of work, and location. If the site turns up a match, the results will be emailed to the applicant. Although the advanced features are available only to IEEE members, the job database is open to all site visitors. You can take a look at **www/ieee.org/jobs**.

Lucent Announced First-Quarter Woes

Telecommunications equipment vendor Lucent Technologies has reported a first-quarter loss of $1.02 billion, which translates into a loss of $.30 per share. This is a major drop from the same period last year, when the company posted a profit of $1.08 billion, or $.33 per share. In response, Lucent plans to lay off about eight percent of its workforce, which amounts to about 10,000 employees. The company will also be restructured to cut $2 billion yearly off its operating costs, which will involve the elimination of unprofitable product lines, a spin-off of its Agere microelectronics division (and its 16,000 employees), and the sale of its facilities in Columbus, OH, and Oklahoma City. **NV**

reader FeedBack

Dear Nuts & Volts:

Your article in Vol. 22, No. 1 on page 41 seems to be in error.

The proper set-up is to connect the radio left out the VCR left in and the radio right out to the VCR right in. For mono radio, use left in only at VCR.

You will also need a video signal into the VCR or the phase locked loop will hunt and cause tone shifting on playback.

You can use another VCR, video camera, or sync pulse generator connected to the video input of the VCR. I used a small video cam with the lens cover on.

Carl L. James
Patchogue, NY

Dear Nuts & Volts:

Regarding "Light that Switch" by Bob Vun Kannon, Feb. '01, the author's circuit uses an LED and another diode connected in parallel (anode to cathode) and 0.1 mF series capacitor. This circuit is connected across the light-switch contacts.

The second diode can be another LED; this gives more light output.

The voltage rating of the series capacitor is not specified; a 200-volt capacitor rating is marginal. (At 130 volts RMS, it sees 184 volts peak. All bets are off with spikes on the power line.)

Instead of adding the author's circuit, I recommend replacing the existing light switch with a residential-grade lighted switch. They are available at a local hardware or building supply store and include an internal neon bulb and (say 47Kohm) series resistor. Okay by UL and NEC!

Charles S. Crawford, Jr.
Wellesley Hills, MA

Dear Nuts & Volts:

I have back issues for the past seven years or so. I think your magazine is the best available for electronic enthusiasts/hobbyists. Because the content is so varied, it offers everyone a great opportunity to build or just learn about some of the latest technology that we have today. Keep up the good work.

For all these past years, I have gotten issues for free through my local HSC Electronics store. When I went to get my Jan. '01 issue, they said that they would have to start charging for them from now on. That's okay with me. I feel I have gotten a wealth of information and kept up to date on technology as it happens, and it was free. So, I don't mind one bit to have to finally subscribe to a publication that is worth every penny I pay for it.

I am a 60-year-old who has been reading and enjoying electronics magazines since I was in my early 20s.

John Storms
North Highlands, CA

Dear Nuts & Volts:

Regarding the motorcycle battery charger circuit on page 85 of the Feb. '01 issue, response No. 2, as a Safety Profession (CSP #5120), I strongly advise again the use of circuit No. 2 because of the potential electrical shock hazard.

Cleve Svetlik
Cleveland, OH

Published Monthly By
T & L Publications, Inc.
430 Princeland Court
Corona, CA 92879-1300
(909) 371-8497
FAX (909) 371-3052

E-Mail — editor@nutsvolts.com
URL — http://www.nutsvolts.com

Subscription Order ONLY Line
1-800-783-4624

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News Bytes

Net4Music Introduces SmartMusic for Music Makers; Capitalizes on Internet Expertise to Deploy Customizable Sheet Music; Offers a New Innovative Subscription Service

Net4Music, Inc., the global music technology company, will be launching SmartMusic® services on the Internet.

The first phase of this new service, referred to as the SmartMusic Viewer, enables the electronic customization and distribution of sheet music.

With the SmartMusic Viewer, consumers can select a title, view it, hear it, change its key, and even select a different solo instrument. Once the music is customized to match their needs, the consumer purchases the right to print one copy permitted via security technology that manages all rights and royalty payments while not allowing the file to be used in an unauthorized fashion. SmartMusic Viewer is powered by Finale®, the music publishing industry standard for sheet music technology.

Net4Music also announced that the next phase of SmartMusic should be available later this year. It will offer home and school subscriptions to its highly acclaimed SmartMusic® Studio, the complete music practice system, and its accompaniments of more than 5,000 titles and 50,000 skill development exercises. SmartMusic Studio Online will feature Intelligent Accompaniment® that listens while you sing or play through a microphone and follows your spontaneous tempo changes. Intelligent Accompaniment allows you to make music in your individual style, to express yourself and project your personality into the music. Only SmartMusic offers this patented Intelligent Accompaniment technology that has been demonstrated by Wynton Marsalis, James Galway, and other leading musicians at major conferences for musicians and music teachers.

"SmartMusic is music tailored to the needs of musicians. You can customize it to have the key and solo instrument desired and then have it delivered electronically to your home," explained Sean Lafleur, Net4Music Chief Executive Officer. "It will include accompaniments that are individualized because they listen to you sing or play and follow your spontaneous tempo changes. It will include music practice tools that use computer technology to make your practicing productive and fun! And it will include music lessons that hear what you do wrong and can teach you how to do it right."

"We are featuring SmartMusic at Demo this year not just because it's great technology that's fun for music makers," commented Chris Shipley, Executive Director of the Demo Conference, "but also because of the subscription program. It really changes the value proposition for consumers. I believe we are going to see more of these types of subscriptions offered on the Internet."

The third phase of SmartMusic will offer music performance assessment and instruction. It will listen to how a musician sings or plays a passage, compare it to a perfect performance and help the musician understand how to improve their performance. This technology will be supported with master classes by great musicians such as Wynton Marsalis, James Galway, Joe Alessi, Eddie Daniels, Jim Walker, and others who believe in SmartMusic and advocate its use with teachers, students, hobbyists, and fellow artists.

About Net4Music, Inc.

Net4Music, Inc., formed in October 2000 by merger of Net4Music S.A. and Coda Music Technology, provides musicians and the music publishing industry with digital solutions. Since its launch in December 1999, Net4Music's Internet technology has rejuvenated the distribution of sheet music, allowing for secure downloads of the world's largest collection of digital sheet music files in all music genres, each one protected by the company's own copyright protection system. The merger with Coda, now the Coda Music Division of Net4Music, Inc., brings together the best of digital content creation, digital distribution, and solutions for musicians, thereby also increasing revenue opportunities for composers and publishers. Net4Music has obtained digital rights to some of the world's leading catalogs including EMI Music Publishing and Schott Music International. Finale is the world's best-selling music notation software product, and is widely regarded as the music publishing industry's notation standard. SmartMusic Studio is a comprehensive interactive music practice system that listens to musicians sing or play and follows spontaneous tempo changes. With these technologies and a host of other innovative services for professional musicians, music educators, students, and hobbyists, Net4Music, Inc. is poised to transform and improve the way musicians around the world create, secure, distribute, learn, and play music. The company can be reached at www.net4music.com or at www.codamusic.com.

SPECIAL NOTICE TO OUR READERS

Last month, Dennis Shepard's article **BUILD YOUR OWN VOICE RECOGNITION ALARM SYSTEM** was inadvertently run with some errors that will impact your success in building this project.

Rather than explaining the problems here, a complete, corrected downloadable version of the article is posted on our web site at **www.nutsvolts.com** as **vralarm.pdf**.

Sorry for the mix-up!!

Happy (better) Building!!
Nuts & Volts Editor

The PIC16F84 Grows Up

by Al Williams

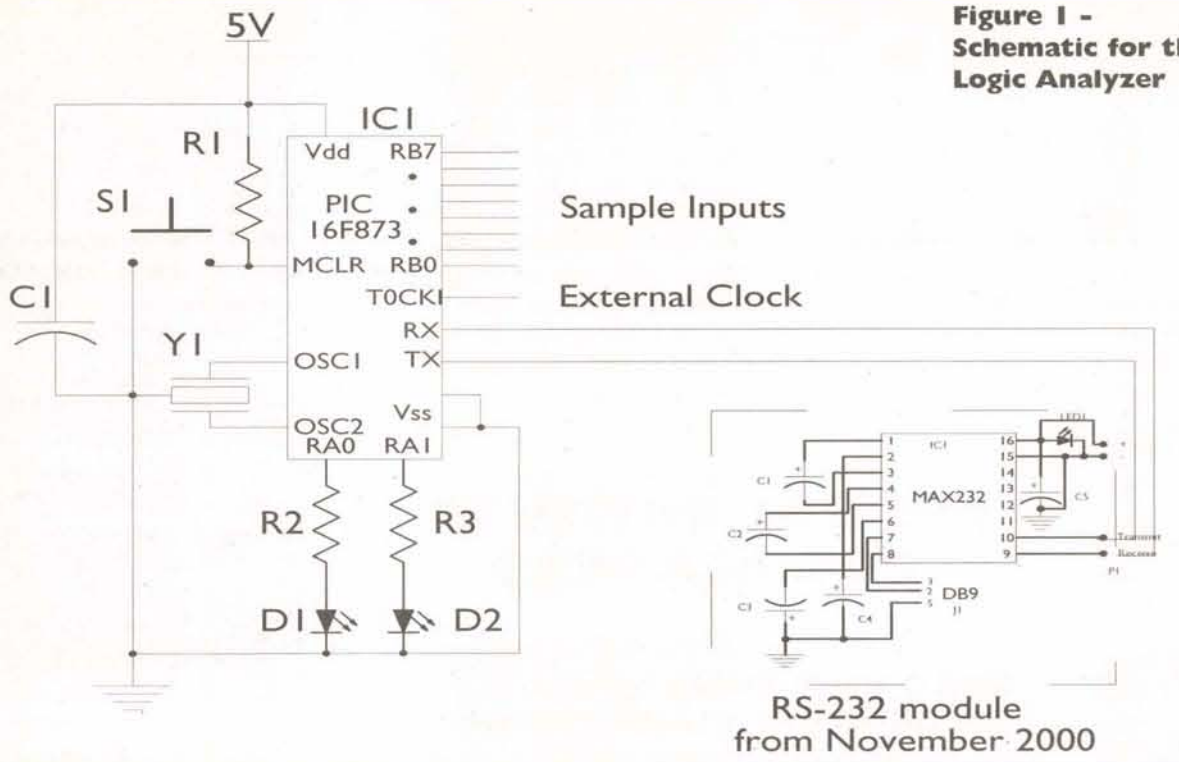

Figure 1 - Schematic for the Logic Analyzer

For many people, the popular Microchip PIC16F84 (or its little brother, the PIC16C84) was their introduction to microprocessor programming. The '84 is easy to work with because it is inexpensive, doesn't require special erasing lamps, and there are many cheap (nearly free) programmers for it. On top of that, there are a plethora of cheap or free assemblers, software simulators, and compilers for the chip.

However, the '84 has some limitations. For one, it has practically no special I/O modules. If you want a serial port, for example, you'll have to do it in software. What's more, the device only has 1K word of program memory and a small amount of RAM.

Other PIC devices have UARTs, PWM modules, A/D converters, and other powerful features but, until recently, to use those you had to use a UV-erasable device to get them. Now, with the PIC16F87x family of parts, you can get all the features you want in an electrically-erasable package.

What do you get? The biggest member of the family (the 16F877) features 33 I/O pins, eight channels of 10 bit A/D, 8K of program storage, 368 bytes of RAM, and 256 bytes of EEPROM. In addition, the part can speak RS-232 (0 and 5V, of course) and communicate with I2C devices. All that for under $10.00.

In this article, I'll show you a simple logic analyzer program developed with the 16F873 (a smaller member of the family). The analyzer uses my RS-232 converter board from the November 2000 issue to communicate with a PC that commands its operation.

Getting Started

You can program the 16F87x series in several different ways. The most common is to use high-voltage programming. This is just the way that the 16F84 programs — you provide a programming voltage (12V or so) and use two pins on the chip to send programming commands. The 16F87x also has a low-power programming mode. In this mode, you don't need a high voltage to write to the chip's program memory. Since a program can even write to the program memory on the fly, you can write a monitor program that can load (and even debug) your code via the serial port or any other method you might want to use.

There are many programmers you can build on the Web (see the online resources box). I used the Warp 13 from Newfoundland Electronics. You can buy this programmer for about $100.00, and it programs everything Microchip makes (along with some EEPROMs and AVR chips). Even better, it is MPLab-compatible. That means that you can build your project and program the PIC right from Microchip's development environment. MPLab thinks it is talking to a PICStart programmer (which sells for $200.00 and doesn't even program the many

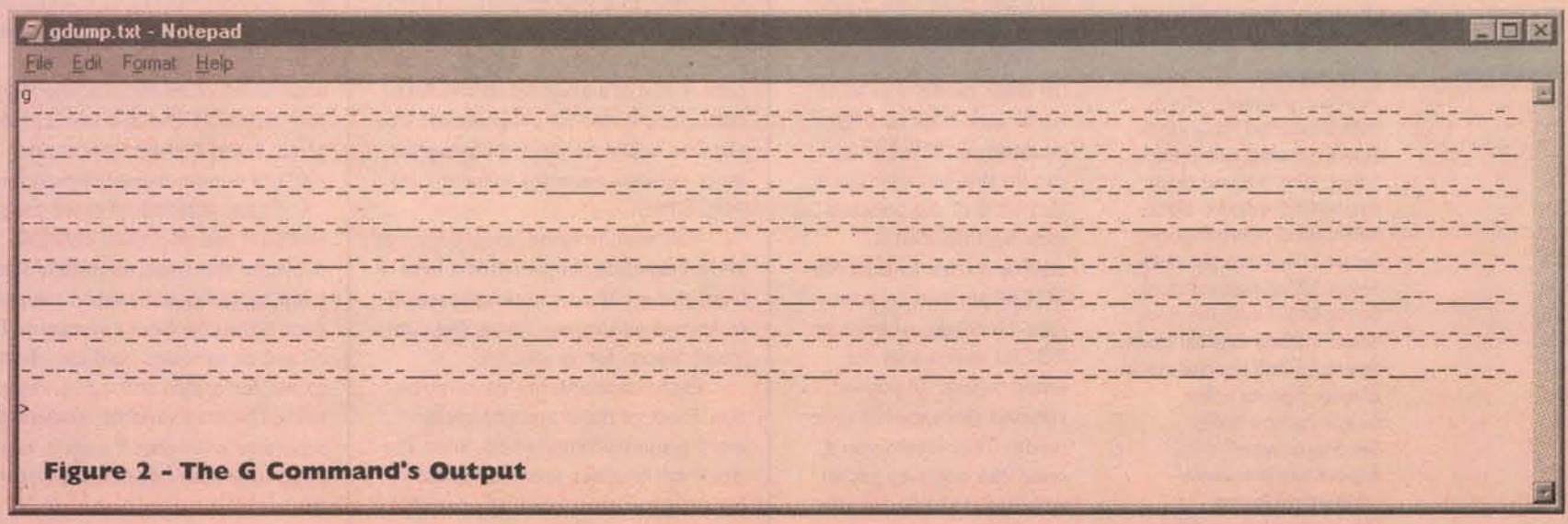

Figure 2 - The G Command's Output

non-Microchip devices that the Warp does).

The only drawback to the Warp 13 is that it doesn't seem to work well under Windows 2000 using MPLab. Newfoundland says that is Microchip's fault, and since their supplied software seems to work, that sounds like it is probably true. With Windows 2000, the Warp will occasionally fail to program the part. For a flash part, that isn't a big deal. You can simply reprogram it. For an eraseable part, you'd have to waste time placing the part under the eraser. For a one-time programmable part, it might be fatal! With Windows 98, the Warp seems to work very well, though.

The Warp has an in-circuit programming connector so you can attach it to your chip while it is still in the system. This is a great time saver (see the sidebar, In-Circuit Programming). If you use another programmer, you can still connect the programming socket to your system (you only need to connect RB6, RB7, MCLR, and ground).

About the Logic Analyzer

To exercise the 16F873, I decided to build a very simple eight-channel logic analyzer. You can use any serial terminal to command the analyzer (see Table 1). It samples each channel on a periodic clock (as fast as 20uS) or on an external rising or falling edge.

You can specify a trigger word consisting of 1s, 0s, and Xs. When the input matches this trigger (X is, of course, a don't care state), the analyzer captures 128 samples. Before sampling can occur, you have to arm the analyzer. One LED shows the armed status and another shows if a trigger has been detected.

The circuit is quite simple (see Figure 1). The processor requires 5V and a ceramic resonator or crystal to operate. Other than that, the circuit adds a switch, two LEDs, and the RS-232 converter board.

Inside the Logic Analyzer

The logic analyzer uses two special features provided by the 16F873 — the serial UART and the periodic timer interrupt. This project wouldn't be well-suited for a 16F84, because the F84 would require a software UART, and does not have very much RAM to store samples. Software UARTs require processing power which could interfere with the analyzer's ability to poll the inputs frequently (or, conversely polling the inputs could interfere with serial communications).

Even though the 16F873 has more RAM than the 16F84 (192 bytes total), it uses banking so you can't access all 192 bytes as a single chunk. To circumvent this problem, I store the logic analyzer's 128 samples in two equal-sized portions. The first buffer resides in locations 0x20 to 0x5F. The second buffer is the same size, but resides at 0xA0 to 0xDF (in bank 1). This leaves location 0x60 and beyond (in bank 0) free for program variables. Also, the interrupt routines require a duplicate variable in bank1 to temporarily store the W register, so there is one program variable in bank 1 at 0xE0.

You can find the complete program listing on the *Nuts & Volts* web site at www.nutsvolts.com. You'll notice that the instruction set is just like the 16F84's so if you are comfortable programming that processor, you won't have any problems with the 16F873. Of course, the memory map is different and there are new registers to handle the new hardware, but the core instructions are identical.

If you look at the program's variables, you'll see that the first four are dedicated for the interrupt handling. Since the interrupt handler can't change anything the program might use, it has to cache away important registers so it can reload them when it finishes. The code to do this is right out of the Microchip manuals. The DATAP variable points to the current sample location. Much of the code's logic is making the DATAP pointer wrap through the two separate buffers to make them appear as one.

The trigger byte (TRIGBYTE) works with the mask (TRIGMASK) to select the trigger condition. Both are necessary since the trigger can contain don't care bits (represented by 0s in the TRIGMASK variable). The analyzer also needs to know which sample contains the trigger, which is the purpose of the TRIGPOINT variable.

The MSGI and TEMP variables are just general-purpose bytes used for a variety of purposes. The remaining variables help with special display modes to present or export the data (more on that later).

Interrupt Handling

If you are familiar with interrupt handling on any Microchip processor, you won't find any surprises. The interrupt service routine (ISR) starts at location 3. When an interrupt fires, it disables future interrupts, so there are no re-entrance problems. The ISR must clear the bits that signal what type of interrupt occurred before returning with the special RETI instruction.

The first and last part of the ISR is straight from Microchip and saves the current execution context. The middle part is what does the real work. The program only turns on the timer interrupt when armed. However, just in case, the ISR refuses to do anything if the ARMED flag is not set.

If the analyzer is armed, the ISR reads a byte and stores it at the current data pointer. Next, it checks the triggered state (bit 1 in ARMED). If the current state is not triggered, the ISR examines the fresh byte to see if it matches the trigger pattern. In either case, the analyzer increments the data pointer and — if the trigger mode is active — tests to see if the buffer is full. When full, the ISR extinguishes the LEDs and sets the two flags in ARMED to zero.

The current software doesn't take advantage of it, but since the device stores data before the trigger, it would be possible to display sam-

In-Circuit Programming

In-circuit programming allows you to program a flash part while it is still connected to your circuit. You just program and run it. No fumbling to get the part out of a socket, no bent pins — a great idea. However, you can use nearly any PIC programmer this way if you meet a few requirements. First, you shouldn't have anything exotic tied to the reset pin (MCLR). Whatever you have connected to the reset pin will have to withstand the programming voltage (more than 12V). A simple resistor to +5V will be fine. A direct connection to 5V will not be fine.

In-circuit programming uses RB6 and RB7 of the PIC. The best way to handle this is not to use those pins in your circuit. If whatever you have connected to these pins will not interfere with programing, you should be able to leave them connected — there are no high voltages involved on these pins. However, at worst you could use a header to disconnect these pins while programming (in fact, some people use the same header to connect the programmer — if you place jumper caps on the headers, the circuit runs. If you unplug the caps, you can plug in the programmer.

If you want to try your programmer in circuit, just use a 16-pin spring-loaded DIP test clip. These snap over the pins of the chip and provide test points. You can easily connect MCLR, ground, RB6, and RB7 using clip leads to go from the test clip to the programmer's socket. A 16-pin clip will handle 18-pin and 28-pin devices since there are only three or four connections you need to make anyway (you can ground the programmer at any handy ground point).

Table 1. Analyzer Commands

Command	Description
A	Arm the analyzer
C+	Select external rising clock
C-	Select external falling clock
C0	Select 20uS internal clock
C1	Select 40uS internal clock
C2	Select 80uS internal clock
C3	Select 160uS internal clock
C4	Select 320uS internal clock
C5	Select 640uS internal clock
C6	Select 1.28mS internal clock
C7	Select 2.56mS internal clock
D	Display capture buffer
G	Graph capture buffer
T	Set trigger word
X	Export bits in comma-delimited format
?	Show short help message

ples before the trigger, or make the trigger appear in the middle of the data.

The ISR has to deal with two different modes: internal clocking and external clocking. When using the internal clock, the ISR should run every 256 instruction clocks (51.2uS). However, that's an odd number, so when in internal mode, the ISR adds a constant to the timer register to force it to overflow in 20uS (assuming no prescaling). Too much faster, and the ISR wouldn't have time to finish its work. The prescaler allows you to slow the clock rate if you need slower sampling.

When using the external clock mode, you want each clock edge to trigger an interrupt. The INT pin can do this, but that pin is also bit 0 of the sampled data. So, I decided to employ a trick to turn the TOCKI pin into an interrupt. Normally, an edge on TOCKI increments the timer register (if you've selected the external timer mode). That means you'd need 256 edges to get an interrupt. However, if you prime the timer register with 0xFF, a single edge will cause an interrupt. As long as the ISR always resets the timer register to 0xFF, TOCKI acts like an interrupt pin. So in internal or external mode, the ISR modifies the timer register — but how it modifies it depends on the mode.

The Main Program

When the processor starts, it begins execution at the START label (thanks to a GOTO at address 0). There is only a bit of housekeeping required to set the initial conditions. One thing that is different from a similar 16F84 program is the handling of port A, however. By default, some port A pins are assigned to the A/D converter. Since this program will use them as digital outputs, the program must reassign them (by manipulating ADCON1).

The main program loop begins at ITOP. This code simply reads a byte from the serial port and compares it to known commands (using the command macro, for simplicity).

Each command has its own routine. Most of these are straightforward assembly language routines. The clock set routines seem complex because you must observe special steps when switching the prescaler to prevent accidental resets.

There are two ways to display data. The D command simply dumps the buffer in binary, starting with the trigger byte. The G and X commands, however, shows bits, not bytes. When using G or X, the first character displayed represents bit 0 of the trigger byte, and the next character shows bit 0 of the next byte. After the program is done with bit 0, it goes back to the beginning and displays bit 1 for all bytes. This repeats until there are no more bits.

The only difference between the G and X commands is what characters they display. The G command displays a dash for a one and an underscore for a zero. This gives the impression of an oscilloscope display (see Figure 2). The X command shows actual 1 and 0 characters. It also places a comma between each bit.

There is plenty of spare program space on the chip, but I hated to duplicate this code, so instead I added a few variables and reused the same code to handle both commands. The c0 and c1 variables hold the character to use for a zero and a one, respectively. The csep variable contains the separator character. If csep is zero, the program doesn't print a separator at all.

The arm command bears examination. Of course, it sets the initial buffer state. If you are using an external clock, it also has to prime the timer register. Finally, it enables interrupts and goes into a short loop waiting for the armed status to become false. At this point, all the work occurs in the ISR. I didn't use serial interrupts, so the controlling terminal does nothing while the device is in this state. If you select a trigger state that never occurs, you'll have to reset to regain control.

Since the serial I/O is a hardware function, the serout and and serin commands are embarrassingly simple. Another advantage to a hardware UART is that it buffers input until the program reads it — something a software UART can't do without using interrupts.

Wrap Up

This simple analyzer won't replace my 100MHz 32-channel workhorse on my bench, but it makes a great example of the capability the new Microchip processors offer. A 16F84 doesn't have a serial port, nor does it have enough RAM to make this project feasible. Larger members of the family have even more RAM (up to 368 bytes) and would require a few changes to make them work with this code.

Since the chip has a built-in A/D converter, you could even alter the code to handle analog samples instead of digital. There are many other enhancements you could add. Delayed triggering would be easy. You could use some spare port A and port C pins to make trigger or clock qualifiers.

However, logic analyzers aside, next time you have a microcontroller project and you think of using a 16F84 — think again. Why not spend the extra couple of bucks and get more program space, more RAM, A/D, a UART, and all the other features of this great family of chips.

NV

www.microchip.com - Information on the PIC family of processors
buy.microchip.com - Buy Microchip parts online
www.new-elect.com - The Newfound Warp 13 is an MPLab-compatible programmer
www.piclist.com/techref/piclist/index.htm - General information about PICs including links to programmers
http://www.piclist.com/techref/piclist/index.htm - My list of Stamp and PIC links

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ELECTRONICS Q & A

With TJ Byers

In this column, I answer questions about all aspects of electronics, including computer hardware, software, circuits, electronic theory, troubleshooting, and anything else of interest to the hobbyist.

Feel free to participate with your questions, as well as comments and suggestions.

You can reach me at:

TJBYERS@aol.com

or by snail mail at Nuts & Volts Magazine, 430 Princeland Ct., Corona, CA 92879.

What's Up:

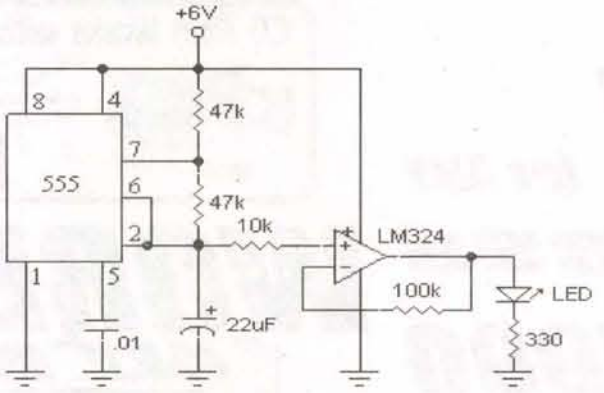
A real battery saver, and a medley of low-voltage battery indicators. More LED answers and circuits, and a peak AC voltmeter. Adding USB to an old PC, and what to do with old PCs not worth upgrading. Replacing lost remotes and web sites that have answers to your questions.

Multi-Color LEDs On Parade

Q. I am looking for a circuit to drive a four-chip, six-pin multi-colored LED — an LF69EMBGMBW that I bought at a local Gateway Electronics store in Denver. I'd like to adjust the brightness of each LED separately and in random order to produce a rainbow of colors as the LED colors meld. I was considering using a BASIC stamp and PMW, but it seems too expensive for such a simple output. Any help would be appreciated.

Chris Tauscher
via Internet

A. Here is a circuit that will brighten and dim a single LED in the pattern you want. For all four LEDs, you have to copy the circuit four times. Because of the variations between circuit components, the LEDs won't be in sync and will give you the blending effect you desire.



The circuit is a 555 squarewave oscillator that produces a triangularwave across the 22 uF capacitor. This waveform, which is buffered by the LM324 voltage follower, smoothly drives the LED from off to full brightness. The actual brightness is controlled by the 330-ohm resistor: The lower the resistance, the greater the LED current and the brighter the LED. You may wish to adjust the LED currents to produce the color balance you want.

Keep Your Inputs On The Ground

Q. In the Oct. 2000 issue, you gave a circuit for making a noise level alarm. I am trying to use this circuit to act as a knock detector for my Chevy truck engine. I'll be using an LED and a buzzer for the indicators. My question is, what do I do about the inputs to the other comparators in the device LM339 that aren't being used? Ground them or let them float?

Jim Zink
via Internet

A. All unused inputs of an IC should be returned to ground. This applies to both analog and digital ICs.

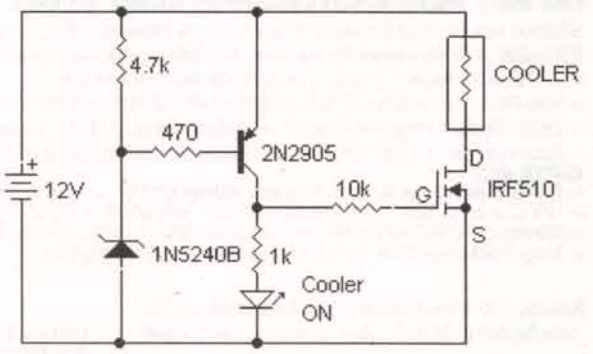
Low-Battery Cut-Off

Q. I have a cooler which uses a TEC (Peltier) element. Is there a simple circuit that I could build that would shut it off when the battery voltage drops to a preset level?

Jerry Hill
via Internet

A. I assume you're talking about a Koolatron Krusader-type chest which consumes 3 amps at 12 volts — the kind you plug into the cigarette lighter of a car. For those readers who don't know what a Peltier element is, let me tell you that it's a semiconductor which acts like a heat pump. When current flows through this device it produces a hot plate (side) and a cold plate (side). Reversing the current reverses the plates; i.e., hot becomes cold and cold becomes hot. In a Koolatron and similar cooler, the cold plate is placed inside the ice chest where it transfers the heat from inside the chest to the outside air, thus keeping your Pepsi and Coors cold.

To prevent the battery from being drained too low, all you need are a couple of transistors and a zener diode, as shown below.



With a fully-charged battery (12.6 volts), the zener conducts and turns Q1 on, which turns on Q2 MOSFET (metal-oxide field-effect transistor) via the 10k resistor. Confused? Bipolar transistors, like Q1, are current operated. When current flows through the base, the transistor conducts and effectively ties the 10k resistor to +12 volts. An enhanced MOSFET, like the IRF510, is voltage operated. when the gate voltage is 7 volts higher than the source (S), the transistor conducts — and the cooler runs. If the battery voltage drops below 10.6 volts, though, Q1 ceases to conduct — as does Q2 — and the cooler is disconnected from the battery.

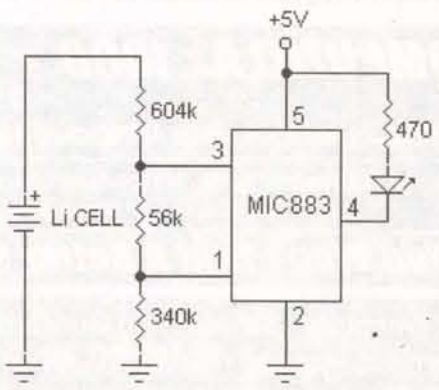
I purposely didn't add hystersis to this circuit because there is still life in that battery even after cut-off. After a short recovery period, the "breaker" will turn back on and power the cooler for a short period before the voltage drops below the trigger point again. This keeps the cooler cold for a bit longer without endangering the battery. When you see the LED blinking, however, it's a warning sign that the battery is close to expiring.

Low-Battery Indicator

Q. Do you know of a solid-state device that will turn on an LED when the battery voltage falls below a set point?

Thomas V. Wahl
via Internet

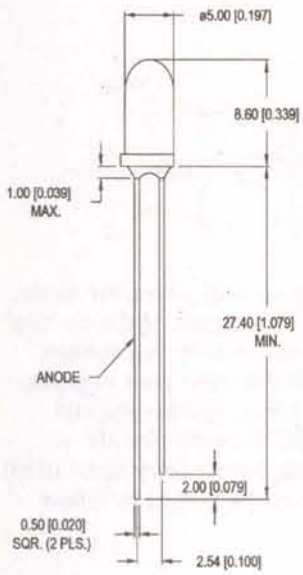
A. Several. Let me serve up a medley of them. The first is built around an MIC833 made by **Micrel (www.micrel.com/index.shtml)** and available from Future Electronics, now **Future Active, (800-655-0006; www.future-active.com)**.



The MIC883 is a precision dual-voltage comparator

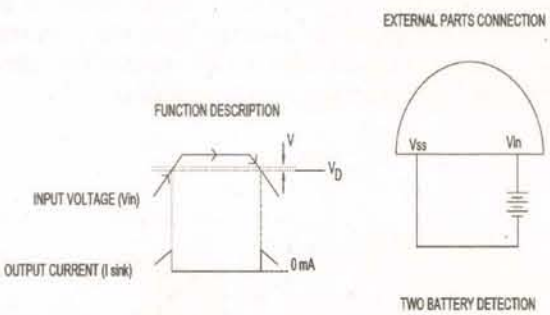
that pulls the open-drain output low when the voltage points are exceed. In other words, as long as the voltage remains within the window of overvoltage and undervoltage, the output is high. Once the voltage drops below the resistor-network-defined level, the output goes low and stays low until reset by a fresh battery. This prevents battery-voltage chattering, where the voltage raises slightly when disconnected, then drops low again when reconnected. Sometimes chattering is good, as in the example above ("Low-Battery Cut-Off"), but not this time. Note that the maximum battery voltage is 5.5 volts and the maximum input voltage is 6 volts.

Another option is the ssL-Lx5093Lbi-SRD from **Lumex (847-359-2790; www.lumex.com/pls/lumex/subproduct_galary?iproduct_id=1000588)**. This indicator is a single-device solution. As long as the battery voltage stays at its nominal 3 volts, the LED is dark. If the battery voltage drops to 2.5 volts (the absolute minimum for a lithium cell), the LED comes on. This is a perfect indicator for cordless communication devices.



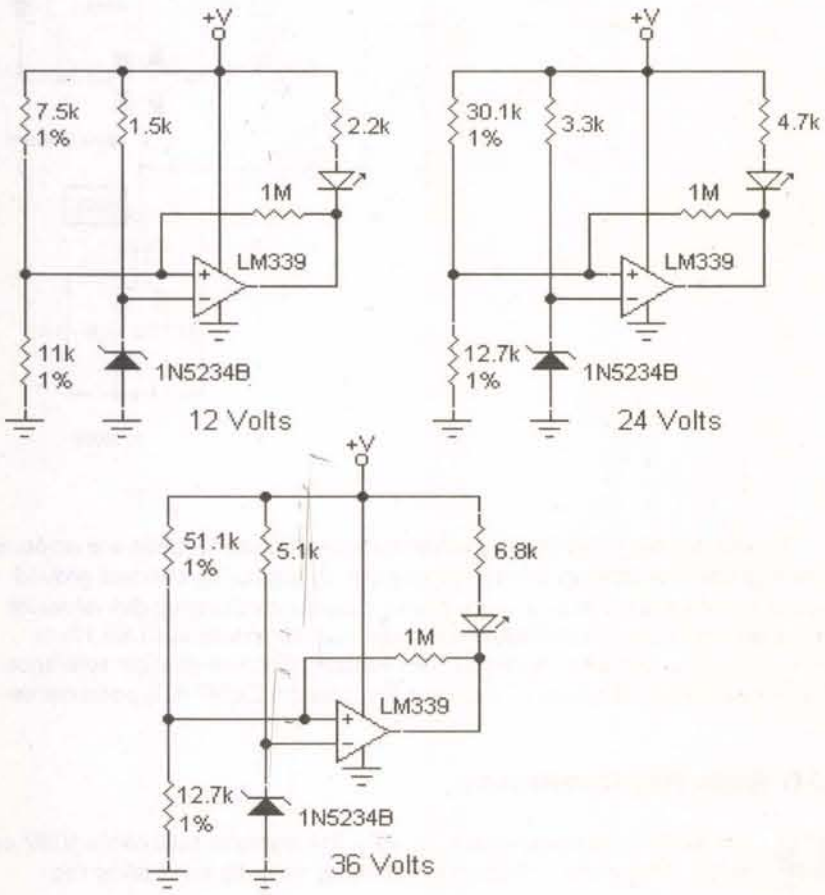
ELECTRO-OPTICAL CHARACTERISTICS T =25°C Vin=3.0V

	PARAMETER	MIN	TYP	MAX	UNITS	TEST COND
	PEAK WAVELENGTH		660 (RED)		nm	I =6.5mA
E	INPUT VOLTAGE (Vin)		3.0		V	
	DETECTION VOLTAGE (Vd)	2.35	2.5	2.65	V	
	AXIAL INTENSITY	3.0			mcd	I =6.5mA
	STANDBY CURRENT (Iin)		5.0	10.0	µA	Vin=3.0V
	HYSTERESIS VOLTAGE (Vhyst)		100		mV	
	OUTPUT SINK CURRENT (Isink)	6.0	6.5		mA	Vin=2.3V
	VIEWING ANGLE		60		2x theta	
B	OPERATING TEMPERATURE		0 TO +85		°C	
	STORAGE TEMPERATURE		-40 TO +100		°C	
	EMITTED COLOR:	SUPER RED				
	EPOXY LENS FINISH:	RED DIFFUSED				



TWO BATTERY DETECTION

And lets not ignore the ubiquitous LM339 quad comparator, which can monitor battery voltages up to 36 volts.



In this figure, I show three popular LM339 low-voltage detection circuits, each representing a multiple of the venerable 12-volt lead-acid battery. As the

battery voltage steps from 12 volts to 24 volts to 36 volts, the resistors have to keep in step so that the cutoff voltage is proportionally the same. A small amount of hystersis has been added via the 1M feedback resistor from the output to the positive input. This prevents chattering.

ATX Motherboard, AT Power Supply

Q - I have an ATX motherboard and a cabinet with an AT power supply. I can adapt the cabinet to accept the ATX motherboard, but the power connector is not compatible. Does anyone market an adapter to connect the ATX to the AT? If not, does the AT supply have the proper voltages and current capacity for me to make my own adapter?

Curtis Powell
via Internet

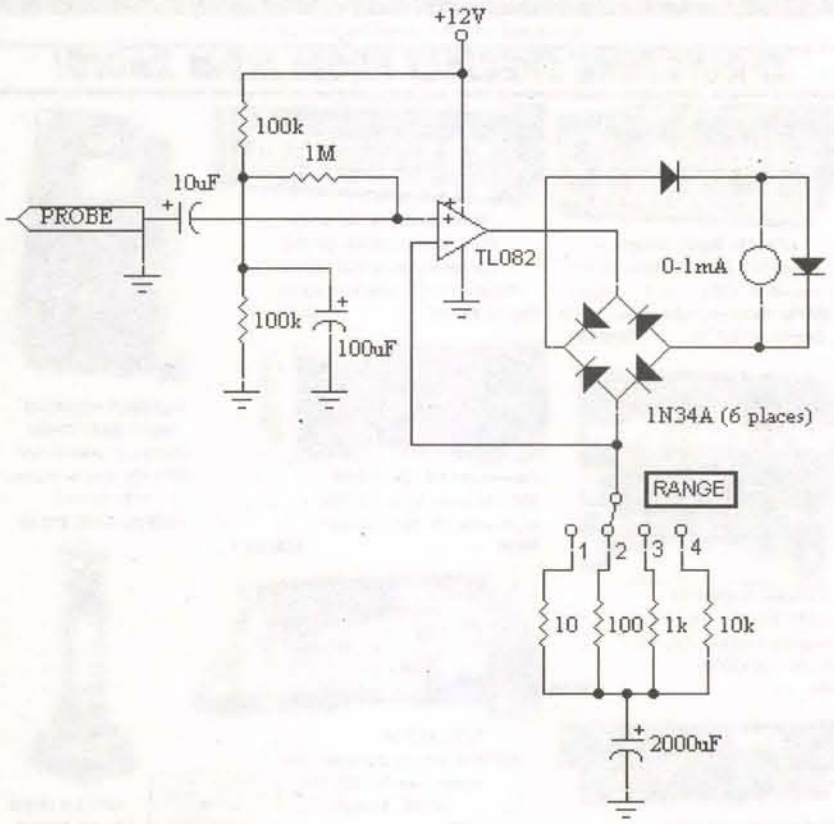
A - There is a big difference in the way an AT and an ATX power supply operate. For example, the AT power supply has an external on/off power switch, whereas the ATX uses an internal power off function to power down the motherboard, but not turn it completely off. I understand you have this cabinet just laying around and you want to make use of it, but your time and money is better spent on an ATX cabinet with an ATX power supply. You can find them for $50.00 or less anywhere in town or on the Internet.

Sensitive AC Voltmeter Fixed

Q - I've been trying to build the "Sensitive AC voltmeter" you describe in the Dec. 2000 column, but I'm having little luck. I am sure that the 100uF cap is drawn wrong in the diagram, as it would short all AC input directly to ground. I suspect it should connect to the junction of the three nearby resistors. I also wonder about the diode that appears to short out the meter.

Alan May
via Internet

A - You're absolutely right! The 100uF capacitor should connect to the resistor junction, as shown in the corrected schematic below.



As for the diodes around the meter, they protect the meter from overvoltage and reverse currents. Don't forget that these diodes have a forward voltage drop (Vf) 0.3 volts and a reverse blocking voltage (Vr) of 75 volts. The resistance of the meter is about 80 ohms. Using Ohm's Law we see that the voltage across the meter is 0.08 volts, so the diodes present no short-circuit threat. For details on how to make this meter even more versatile, check out "Peak Reading AC Voltmeter" later in this column.

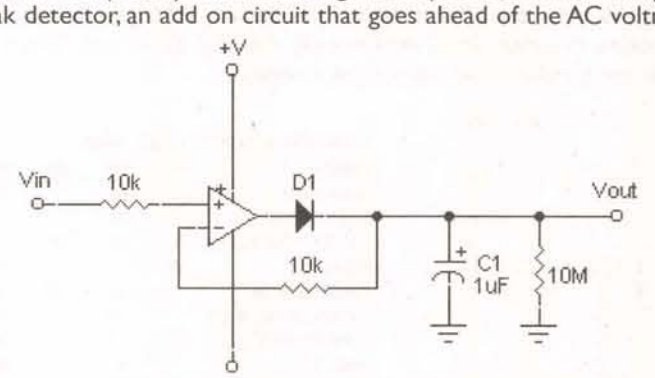
Peak Reading AC Voltmeter

Q - In your December 2000 column you described a "Sensitive AC Voltmeter" which I thought would be a nice feature to add to a function generator (similar to the "Simple Sinewave Generator" in the same column). How would you adapt it to also measure the output level in the triangle- and squarewave modes?

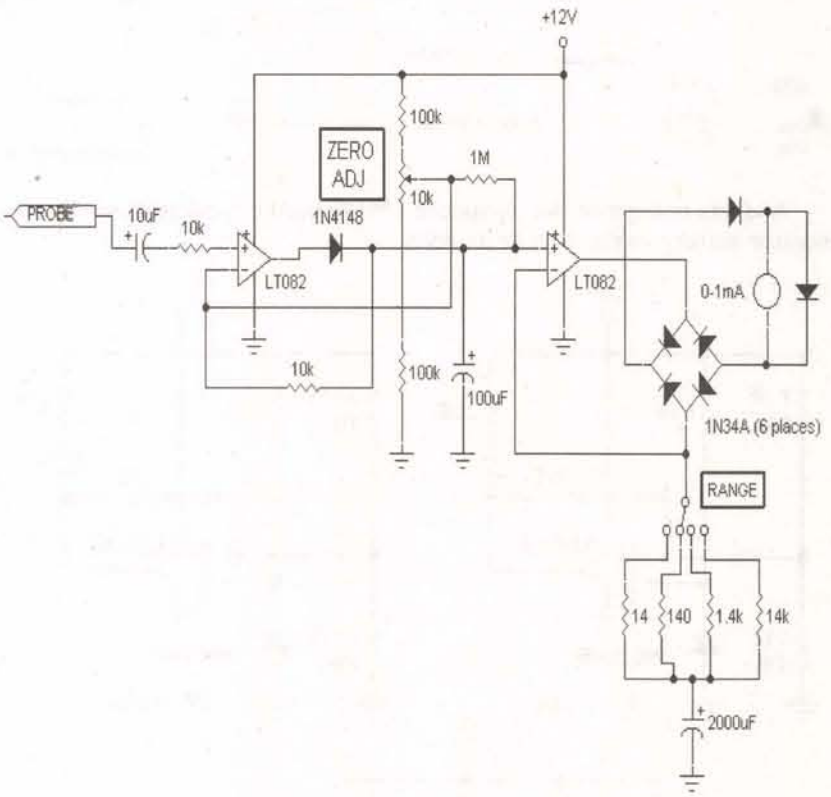
Gary
via Internet

A - The voltmeter will measure both square and triangularwaves as it is with no modification — just a recalibration. The meter is presently calibrated for an RMS sinewave (effective voltage value), which is 0.707 times the peak voltage. The equivalent RMS value for a squarewave is 0.50 and 0.58 for a triangularwave.

However, it's often more important to know the peak voltage rather than the RMS value — especially when working with squarewaves. For this, you need a peak detector, an add on circuit that goes ahead of the AC voltmeter.



The basic circuit is built around a non-inverting op amp, a rectifier diode, and a storage capacitor. With a positive input signal, the output of the op amp rises until the inverting input voltage equals the peak non-inverting voltage, while at the same time charging capacitor C1. When the input goes negative, D1 becomes reversed biased thereby preventing C1 from discharging and holds the peak voltage value. C1 would remain in this state indefinitely — unless discharged by an external force, like a shorting switch (very often used) or a discharge resistor, like a 10M resistor. This allows the output to follow the peak input voltage as it changes value.



To add this circuit to the AC voltmeter, certain modifications are made, as shown above. The changes include biasing the op map using a virtual ground so that it can operate from a single power supply, and changing the values of the calibration resistors. As before, all range resistor values must be 1% or better, as well as the peak detector 10k resistors. Because of slight tolerance differences even in the best of resistors, I've added a ZERO ADJ potentiometer.

LED Bulb Replacements

Q - I need an LED replacement for a T-1 3/4 standard bulb, like a #387 or a #327. Where can I obtain them (making them by hand takes too long)?

Evelyn Marcy
via Internet

A - While LED bulb replacements are not plentiful, they do exist. In fact, they are most popularly used to replace traffic signals because they last a lot longer and consume less power. Here is a list of LED panel lamp replacement manufacturers I'm familiar with.

Dialight Corp
732-223-9400; www.dialight.com/products/pdfs/pmp_pdfs/pg38.pdf

LEDTronics
800-579-4875; http://datasheets.led.net/minbased.htm

Lamp Technology, Inc.
631-567-1800; www.lamptech.com

Starled
310-603-0403; www.starled.com

Universal Garage Door Remotes

Q - I'm in need of an 18-pin in-line IC with the following markings on it.

22758C 30008 SMCC9116

It's a Genie Garage Door opener model SD8000, year 1991. The IC is inside the remote (AT90). I called Genie, but got no help. Can you help?

Art Heyman
Apple Valley, CA

A - Sorry, I wasn't able to find this chip anywhere in my sources; it appears to be long obsolete. Fortunately, not all is lost. You can replace your old remote with a universal remote. They generally cost between $20.00 and $25.00, and are readily available. Here is a short of list of vendors I found on the Internet.

Install Masters
800-216-4991; www.imdoors.com/TableRemotes.htm

Metro Overhead Door
888-813-6772; www.metrooverheaddoor.com/Remotes.html

Universal Electronics
800-843-3251; www.oneforall.com/ugdo2pro.html

Cool Web Sites

Have questions? These web sites have answers.

In-depth theory and practical designs on transistor amplifier design, LC filters, and oscillators. A lighter look at receivers, transmitters, and test equipment.

http://www.electronics-tutorials.com

Good answers on everything from arts & entertainment to cars to religion from "experts" in the field. Gave very accurate answers on "test" PC question. Free Q&A service.

http://www.allexperts.com/

Fundamentals of electricity sponsored by Cutler-Hammer, manufacturer of switches, circuit breakers, control transformers, and relays. A course in Basic Electricity 101.

www.ch.cutler-hammer.com/training/slfstudy/navigate/webmanualmenu.htm

The classic How Does It Work? Everything from chocolate to submarines to asteroids.

www.howstuffworks.com/

What happened to all the futuristic stuff that was supposed to change our lives by year 2000?

http://www.retrofuture.com/

USB Primer: Kosta Koeman and Stuart Allman of Cypress Semiconductor Corporation present a comprehensive overview of USB 2.0, addressing bandwidth, translators, connectors and electrical characteristics, but perhaps most notable is the side-by-side comparison with IEEE 1394a.

http://tm0.com/sbct.cgi?s=118417869&i=309095&d=1111008

Electronics Q & A

Upgrade To USB

Q. I'm hearing a lot about the USB port with all of its bells and whistles. There are plenty of USB peripherals available, but where is the port? As you may have guessed, my PC doesn't have a USB port, and I can't find any information on how to get plugged in short of buying a new motherboard. Is there any way to retrofit or upgrade a PC that didn't come with a USB port? Also, where can I get in-depth information on the USB?

Chris
Bieber, CA

Q. I'm looking to make a cable that goes from a parallel connector to USB port. I want to convert over my zip drive and camera to a USB interface.

Joe Clifford
via Internet

A. You can easily and inexpensively add as many as seven USB ports (via a USB controller adapter card) to any PC with a PCI slot and a 486DX-66 or better processor. **Jameco (800-831-4242; www.jameco.com)** sells three models. Jameco also sells a number of adapters that can change everything from parallel to RS-232 to Ethernet to USB.

Two Type A USB port ISA board
Part No. 155299; Product No. KW-580.
$29.95

Four Type A USB port ISA board
Part No. 172953; Product No. KW5804
$49.95

Seven Type A USB port ISA board
Part No. 172961; Product No. KW5807
$69.95

USB to parallel
Part No. 173008; Product No. UPC200
$39.95

USB to serial (RS232)
Part No. 164048; Product No. USC1000
$49.95

USB to Centronix
Part No. 155352; Product No. UC1284
$29.95

USB to Ethernet
Part No. 168815; Product No. EP1427
$59.95

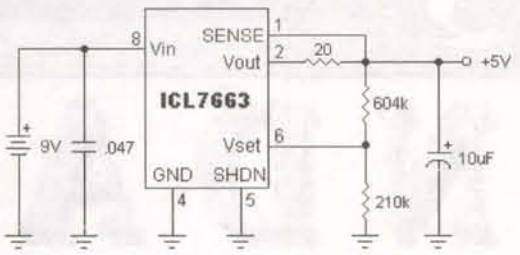
To control the USB port, you need Windows 95 or Windows 98, which contain the needed drivers. For a very detailed discussion of the USB and how to develop custom USB peripherals, check out *USB Complete* by Jan Axelson. This book is also available from Jameco for $49.95 (Part No. 171900), or save yourself a few bucks by shopping Amazon.com.

Phantom Power Losses

Q. Using a 16F84, I have built a keypad application operating from a 9-volt battery. Unfortunately, the processor can run only a few days before the battery goes dead. I am using the internal pull-ups on PORTB, a 4-MHz clock and operating the PIC in the sleep mode, so I can't see why the battery isn't lasting longer. When the MCLR is pulled low, the processor wakes up and the keypad is once again responding. Ironically, when the processor is in the sleep mode, the current draw doesn't change. I have been working on this for over a month, posting at various sites, and rewriting code without any progress. My latest attempt was placing sleep with a NOP in an assembly language routine. This failed as well. Any help is greatly appreciated.

Brad Hammer
via Internet

A. It's quite obvious the current drain isn't coming from the PIC chip, so I asked Brad for more details, specifically the voltage regulator section. Brad responded, "I'm using a 3.3-volt zener diode, not a 5-volt regulator. Could this cause problems?" Aha, just what I suspected. He was using either a 7805 or a zener diode, both of which require about 6mA of quiescent current. Using a little math (time = 650mAH / 6mA), we see that a 9-volt battery will last about 108 hours under these conditions — 4-1/2 days. It also explains why there is no measurable drop in current when the PIC goes to sleep. The solution is a low-power voltage regulator, like the ICL7663.



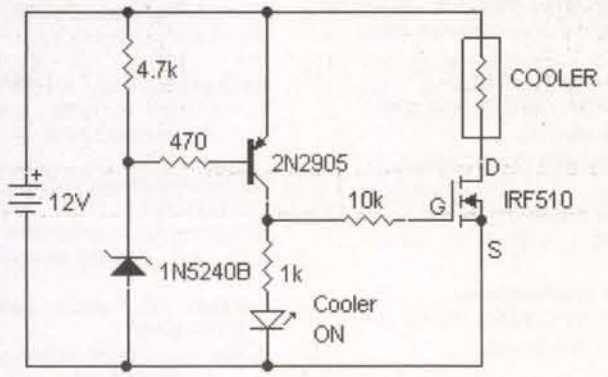
When the PIC is in the sleep mode, the ICL7663, which is always awake, draws a mere 3.5uA from the battery — a far cry from the 6mA appetite of the zener. This chip sells for about $3.15 and is available from **Future Electronics (800-655-0006; www.future-active.com)** and **Newark Electronics (800-463-9275; www.newark.com)**.

Telephone Line LF Antenna Revisited

Q. In your Jul. 1996 column, you mentioned using a high-pass filter to utilize the phone line as a SW (short-wave) radio antenna. Is something like this available off-the-shelf assembled or in kit form?

Tom Lakia
via Internet

A. Not that I know of, but you can find it popularized on the Internet now that the genie is out of the bottle. I've seen responses where it worked great, and others where the phone lines actually made things worse. Because this circuit was published five years ago, let me bring our new readers up to date. The original question was "How do I create a LW or SW antenna in a small apartment?" I suggested using the telephone lines (because they extend beyond the local power pole) and this simple circuit.



To block the ringer and voice signals, I inserted a high-pass filter between the phone line and the receiver input. Should your receiver use a ferrite loopstick antenna, and not sport an ANT connection, simply wrap several turns of 26-gauge magnet wire (you can buy small spools of magnet wire from Radio Shack, part number 278-1345) around the ferrite rod and connect it to the output of the filter through a 47-ohm resistor. While some readers may suggest using the power lines instead of the phone line, they present a shock hazard and aren't as effective.

Don't Bury That Old Printer, Recycle It

Q. Is there a practical and inexpensive way to use an Apple Colorstyle Writer 2200 printer with a standard IBM type PC computer? The printer has an 8-pin DIN connector, so it must have to interface with the PC's serial port. Does anyone make a PC adapter cable or converter for this printer?

D.L. Hartley
Yellville, AR

A. I know it's tempting, if not almost sinful, not to recycle old PC components for other use and applications. But, like in the question above ("ATX Motherboard, AT Power Supply") there comes a point of diminishing return. Foremost, you have to ask yourself: "How long will printer supplies for this model be available?" No printer is supported forever. And how does the print speed and resolution compare to today's inkjet printers, many of which sell for less than $100.00?

Yes, I used to be a lot more ambitious about recycling old 286 systems and peripherals for less-demanding applications, too. But as technology progresses, we find more and more embedded microcontrollers, like Microcode's PIC series, running circles around even a 466-DX PC. So what do you do with a PC-XT or Apple II dinosaur? I haul them off to a local computer recycler, where the semiconductors and plastics are separated from metals, and each finds a niche in the recycling process — much like recycling aluminum beverage cans. I know that not everybody has a computer recycler in their back yard, but it's up to us to search out recyclers and make sure we don't overload our landfills with obsolete PCs — they're already overpopulated with more than enough old TVs, and we certainly don't want them to get together and procreate another lame set-top box threat.

MAILBAG

Dear TJ:

Regarding several letters in the Jan. 2001 issue, I came across an interesting web site for Cue Cat information. The site http://cuecatastrophe.com/ has a stated vow of listing all Cue Cat web sites. As of 2/19/01 they list 239 mirror sites and have 49 posted messages. This is the starting place for anyone looking into the Cue Cat for both hardware and software modifications and applications.

Dave Gulkis
via Internet

Events

CALENDAR

The Events Calendar is a free service for publicizing electronic events such as amateur radio hamfests, flea markets, etc. If your organization is sponsoring an event and would like a free listing, contact us at least 60 days in advance. 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:
Nuts & Volts Magazine
Events Calendar
430 Princeland Court
Corona, CA 92879
Phone 909-371-8497
Fax 909-371-3052
E-mail events@nutsvolts.com

APRIL 2001

April 1

CT - SOUTHINGTON - Hamfest. Southington High School. Talkin: 145.49, 224.80, and 444.25. Southington ARA, Chet Bacon KA1ILH, 860-628-9346. Email: ka1ilh@chetbacon.com Web: http://www.chetbacon.com/sara/htm

April 6-7

WI - MILWAUKEE - AES Superfest 2001. Amateur Electronic Supply, Ray Grenier K9KHW, email: rayk9khw@aol.com

April 7

IN - COLUMBUS - Hamfest. Bartholomew County 4H Fairgrounds, Community Bldg., State Rd 11. 8am-2pm. Talkin: 146.790/146.190. Columbus ARC, Marion Winterberg WD9HTN, 812-342-4670. Email: carc_in@yahoo.com
MO - LEBANON - Hamfest. Lebanon ARC, Chuck Sears AA0RK, 417-589-8122. Email: freedom1@advertisnet.com
NH - LONDONDERRY - Hamfest. Lion's Club Hall, Mammoth Rd., Rt. 128. VE sessions. Talkin: 146.850-/PL 85.4. Interstate Repeater Society, Paul Gifford K1LL, 603-883-3308. Email: K1LLX@juno.com
WA - SPOKANE - Hamfest. Spokane Community College, Mission and Greene Sts. 9am-5pm. VE testing. Talkin: 146.52 simplex, 147.38 repeater. Lilac City ARC, Warren Kelsey KJ7BB, 509-534-8443

April 8

NC - RALEIGH - Hamfest. NCS Fairgrounds, Jim Graham Bldg. 8am-4pm. Raleigh ARS, Chuck Littlewood K4HF, 919-872-6555. Email: k4hf@arrl.net Web: http://www.rars.org
WI - STOUGHTON - Hamfest. Mandt Community Center, Stoughton Junior Fairgrounds. Talkin: 147.150. Madison Area Repeater Assn., Paul Toussaint N9VWH, 608-245-8890. Email: n9vwh@arrl.net Web: http://www.qsl.net/mara/

April 13-14-15

GA - AUGUSTA - Hamfest. Radisson Hotel & Conference Center, Two 10th St. Garden City Channel Masters CB Club, Inc., Moses 706-793-7828

April 14

AL - ALBERTVILLE - Hamfest. Marshall County ARC, Buddy Smith AC4B, 256-593-7741. Email: kc4url@bellsouth.net
MO - JOPLIN - Hamfest. Joplin ARC, Ray Brown KB0STN, 417-781-4967. Email: raybrown@ipa.net Web: http://www.joplin-arc.org
WV - GASSAWAY - Hamfest. Pioneer ARA, Ed Messenger N8OYY, 304-462-5312. Email: n8oyy@rtol.net

April 15

MA - CAMBRIDGE - Hamfest. MIT Radio Society/Harvard Wireless Club/MIT UHF Repeater Assn., Steve Finberg W1GSL, email: w1gsl@mit.edu (Nick Altenbernd KA1MQX, 617-253-3776 9am-5pm.) Web: http://web.mit.edu/w1mx/www/swapfest.html

April 20-21

AR - LITTLE ROCK - Hamfest. Expo Center. Fri: 4pm-8pm, Sat: 8am-4pm. Jim Blackmon K5VZ, 870-246-6734 office, 870-246-7833 home. Email: k5vz@ezclick.net Web: http://www.aristotle.net/~hamfest
TN - NASHVILLE - Hamfest. Holiday Inn, Brentwood. Southeastern VHF Society, Bob Lear K4SZ, 706-864-6229. Email: k4sz@alltel.net Web: www.svhfs.org

April 21

FL - CORAL GABLES - Hamfest. Flamingo Net, Univ. of Miami ARC, Physics Parking Lot. Talkin: 146.865. Bill Moore, 305-264-4465 days. Email: WA4TEJ@beethoven.com
FL - TAMPA - Hamfest. Tampa ARC, Biff Craine K4LAW, 813-265-4812. Email: k4law@arrl.net Web: http://www.hamclub.org
IN - MICHIGAN CITY - Hamfest. Michigan City High School, 8466 W. Pahs Rd. 8am-1pm. Michigan ARC, Inc., Ron Stahoviak N9TPC, 219-325-9089
KY - MURRAY - Hamfest. MSUARC, Bill Slayman KE4JFS, 270-437-4215. Email: ke4jfs@arrl.net
NC - MORGANTON - Hamfest. Burke Co. Fairgrounds. Talkin: 146.745. Catawba Valley, Tom 828-433-6205, Larry: af4hx@worldnet.att.net
NJ - WEST ORANGE - Hamfest. West Orange High School, 600 Pleasant Valley Way. 8:30am-1pm. VE session. IRAC, Jim Howe N2TDI, 973-402-6066. Email: jimn2tdi@att.net Web: www.qsl.net/k2gq
OH - COALTON - Hamfest. Jackson County ARC, Edgar Dempsey KD8XL, 740-286-3239. Email: kd8xl@ohiohills.com
TX - BELTON - Hamfest. Bell County Expo Center. Talkin: 146.820-, PL 123. Temple ARC, Mike LeFan WA5EQQ, 254-773-3590. Email: hamexpo@tarc.org Web: http://www.tarc.org
VA - CHESAPEAKE - Hamfest. Chesapeake ARS, Richard Siff WA4BUE, email: melody@pilot.infi.net

April 21-22

FL - CORAL GABLES - Hamfest. Flamingo

April 28

AL - MOULTON - Hamfest. Bankhead ARC, Lee Creuzer N8MHC, 256-351-7916. Email: n8mhc1@cs.com Web: http://www.n4idx.org
CA - SONOMA - Hamfest. Sonoma Valley Veteran's Memorial Bldg., 126 First St. W. 8am-12pm. VE exam. Talkin: 145.35, -600, PL 88.5. VOMARC, Darrel Jones WD6BOR, 707-996-4494
FL -GAINESVILLE - Hamfest. Alachua County Fairgrounds, SR222 (3400 NE 39th Ave). Walt W4TKE, 352-332-3386, email: w4tke@arrl.net or Mike KE4UVQ, 352-336-6361, email: ke4uvq@bellsouth.net
SC - WINDSOR - Hamfest. Salkehatchie ARS, Adam Hoffman AF4QZ, 803-245-4673. Email: af4qz@arrl.net Web: http://www.qsl.net/kf4cvo

April 29

IL - ARTHUR - Hamfest. Moultrie/Douglas County Fairgrounds. 8am-1pm. Talkin: 146.055/146.655 and 449.275/444.275. Moultrie ARK, Ralph Zancha WC9V, 217-543-2178 days or 217-873-5287 eves. Email: rzancha@one-eleven.net
OH - ATHENS - Hamfest. Athens Community Recreation Center. 8am-1pm. Athens County ARA, Drew McDaniel W8MHV, 740-592-2106. Email: dmcdaniel1@ohiou.edu
OH - CANFIELD - Hamfest. Mahoning County Career and Technical Center, 7300 N. Palmyra Rd. 8am-2pm. VE exams. Twenty Over Nine Radio Club, Don Stoddard N8LNE, 330-793-7072. Email: n8lne1@juno.com
PA - WASHINGTON - Hamfest. Washington Amateur Communications Club, Jim Burtoft KC3HW, 724-228-0546. Email: jbur@mlynk.com

MAY 2001

May 4-5

LA - BAKER - State Convention. Baker Municipal Auditorium, 3225 Groom Rd. Fri: 5-9pm, Sat: 8am-4pm. VE testing Sat. Talkin: 146.19/79. Baton Rouge ARC, Herb Ramey W5LSU, 225-654-6087, 1-800-256-FEST. Email: W5LSU@att.net

May 5

AZ - SIERRA VISTA - Hamfest. Cochise ARA, Robert Warren KF7TJ, 520-803-1453. Email: warnel@juno.com Web: http://www.qsl.net/k7rdg
MI - CADILLAC - Hamfest. Cadillac Junior High School. 8am-12pm. VE exams. Talkin: 146.980/K8CAD-R. Wexaukee ARC, Rick Hockridge K8WZS, email: k8wzs@arrl.net
SC - GREENVILLE - Hamfest. Blue Ridge ARS, Bob Watson W4RGW, 864-833-2204. Email: w4rgw@arrl.net Web: http://www.brars.org
WI - CEDARBURG - Hamfest. Ozaukee Radio Club, Gene Szudrowitz KB9VJP, 262-377-6792. Email: szudg@msn.com

May 5-6

AL - BIRMINGHAM - Hamfest. Zamora Temple. Sat: 9am-5pm, Sun: 9am-4pm. FCC exams. Talkin: 146.88. BARC, Glenn Glass KE4YZK, 205-681-5019. Email: ke4yzk@bellsouth.net Web: http://www.w4cue.com
NJ - EDISON - Trenton Computer Festival. NJ Convention Center, Raritan Center. Sat: 10am-5pm, Sun: 10am-4pm. KGP Productions, Inc., 1-800-631-0062. Web: www.tcfshow.com
TX - ABILENE - West TX State Convention. Abilene Civic Center. Sat: 8am-5pm, Sun: 8am-2pm. VE exams. Talkin: 146.160/760. Key City ARC, Peggy Richard KA4UPA, 915-672-8889. Email: ka4upa@arrl.net Web: http://www.angelfire.com/tx/kcarc76/hamfest.html

May 6

IL - SANDWICH - Hamfest. Sandwich Fairgrounds. 8am-1pm. Talkin: 146.73- or 146.52 simplex. KARC, Bob Yurs W9ICU, 815-895-3310. Email: w9icu@home.com http://tbcnet.com/~jleonard/hamfest.htm
MD - HAGERSTOWN - Hamfest. Washington County Agricultural Center. VEC exams. Talkin: 147.090. Antietam Radio Assn., Carl Morris WN3DUG, 717-267-3411. Email: morriscw@cvn.net Web: http://www.qsl.net/w3cwc
NY - YONKERS - Flea Market. Lincoln High School, Kneeland Ave. 9am-3pm. VE Exams. Talkin: 440.425 PL 156.7, 223.760 PL 67.0, 146.910, 443.350 PL 156.7. Metro 70cm Network, Otto Supliski WB2SLQ, 914-969-1053. Email: wb2slq@juno.com Web: http://www.metro70cmnetwork.com
PA - WRIGHTSTOWN - Hamfest.

Events CALENDAR

Middletown Grange Fairgrounds. VE testing. Talkin: 147.09 and 443.950. Warminster ARC, Tony Simek N3YNH, 215-674-5218. Email: tsimek@aol.com Web: www.voicenet.com/~juno.com
WV - RIPLEY - Hamfest. Jackson County ARC, Valerie Hunter KC8PPT, 304-372-9518. Email: salamander54_25239@yahoo.com

May 12

NY - NEWBURGH - Hamfest. Temple Hill Academy, 525 Union Ave. 6am-2pm. VEC exams. 146.16 input (100 Hz PL), 146.76 output. Orange County ARC, Inc., Ed Moskowitz N2XJI, 845-534-3492 after 7:30pm
OK - EUFAULA - Hamfest. Community Center, corner of High & First St. Talkin: 146.955 -600, 144.250 USB. Lake Eufaula Hamfest, Mark Magreevy N5PNE, 918-689-5366. Email: n5pne@yahoo.com Web: http://go.to/eufaulahamfest
WA - STANWOOD - Hamfest. Stanwood-Camano ARC, Dave Huppert KA7FDC, 360-387-6123. Email: huppert@whidbey.net

May 18-19-20

OH - DAYTON - Hamvention. Dayton ARA, Jim Graver KB8PSO, 937-276-6930. Email: info@hamvention.org Web: http://www.hamvention.org/

JUNE 2001

June 1-2

MS - PASCAGOULA - Hamfest. Jackson County Fairgrounds. Fri: 5-9pm, Sat: 8am-2pm. VE testing. Talkin: 144.510/145.110. Jackson County ARC, Ira Groff NN5AF, 228-826-5095. Email: nn5af@arrl.net

June 1-2-3

NY - ROCHESTER - Atlantic Division Convention. Monroe County Fairgrounds, Rt. 15A. Fri: 6am-5:30pm, Sat: 8:30am-5:30pm, Sun: 8:30am-1:30pm. Rochester ARA, Harold Smith K2HC, 716-424-7184. Email: harold@rochesterhamfest.org Web: http://www.rochesterhamfest.org
OR - SEASIDE - Northwestern Division ARRL Convention. Convention Center. SEAPAC, Randy Stimson KZ7T, 503-297-1175. Web: www.seapac.org

June 2

GA - MARIETTA - Convention. Jim Miller Park. 9am-4pm. License Exams. Talkin: 146.82-. Atlanta RC, Gwinnett ARS, & Paulding ARC, John Talipsky, Jr. KA4VQH, 770-995-6446. Email: johnka4vqh@aol.com Web: http://www.saf.com/arc/atlfest.htm
IL - SPRINGFIELD - Hamfest. IL State Fairgrounds, Cooperative Extension Bldg. AR exams. Talkin: 146.685. Sangamon Valley RC, Edmund Gaffney KA9ETP, 217-628-3697. Email: egaffney@family-net.net Web: http://www.w9dua.net
MI - GRAND RAPIDS - Hamfest. Hudsonville Fairgrounds. VE exams. Talkin: 147.16. IRA, Kathy KB8KZH, 616-698-6627 between 4-7pm EST. Web: www.iserv.net/~w8hvg

June 3

IL - PRINCETON - Hamfest. Bureau County Fairgrounds. Talkin: 146.955 -600 PL 103.5. Starved Rock RC, Jerry Hagemann N9ZJK, 815-538-6932. Email: w9mkshamfest@hotmail.com Web: http://www.qsl.net/w9mks
MI - CHELSEA - Hamfest. Talkin: 145.450-. Chelsea ARC, Inc., Bill Altenberndt WB8HSN, 19501 Bush Rd. Email: wd8iel@hotmail.com
NY - QUEENS - Hamfest. Hall of Science parking lot, Flushing Meadow Corona Park, 47-01 111th St. VE exams. Talkin: 444.200 repeat, PL 136.5, 146.52 simplex. Hall of Science ARC, Inc., Steve Greenbaum WB2KDG, 718-898-5599 eves only. Email: WB2KDG@Bigfoot.com or Andy Borrok N2TZX, 718-291-2561, email: N2TZX@webspan.net
VA - MANASSAS - Hamfest. Ole Virginia Hams ARC, Mary Lu Blasdell KB4EFB, 703-369-2877. Email: mblasd1638@aol.com Web: http://www.qsl.net/olevahams

June 8-9

IN - GREENFIELD - Spring Festival. Hancock County 4-H Fairgrounds. IN Historical Radio Society, Glenn Fitch 765-565-6911. Email: glenn.fitch@cnz.com. Herman Gross, 765-459-8308. Email: w9itt@mindspring.com

June 9

MO - MACON - Hamfest. Macon County, Tri-County, Nemo, & Schuyler County ARCs, Dale Bagley K0KY, 660-385-3629. Email: n0pr@arrl.net Web: http://www.istmacon.net/~kfoster/hamfest.htm
PA - BLOOMSBURG - Eastern PA Section Convention. Columbia-Montour ARC, George Law N3KYZ, 570-784-2299. Email: n3kyz@jlink.net Web: http://www.bafn.org/~cmarc
WI - EAU CLAIRE - Hamfest. Eau Claire ARC, Jim Staatz KG9RA, 715-838-9108. Email: w9eau@ecarc.org Web: http://www.ecarc.org

June 10

IL - WHEATON - Hamfest. DuPage County Fairgrounds, 2015 Manchester Rd. VE testing. Talkin: K9ONA 146.52; K9ONA/R 146.37/97 (107.2). Six Meter Club of Chicago, Joseph Gutwein WA9RIJ, 630-963-4922 or 708-442-4961. Email: wa9rij@mc.net Web: http://www.cyberconnect.com/orion/smcc.html
IN - WABASH - Hamfest. Wabash County 4-H Fairgrounds, State Rd. 13N. Talkin: 147.03/147.63 -442.325/447.325. Wabash County ARC, Ralph Frank KB9PLV, 219-563-8487. Email: wia1@netusal.net
KY - INDEPENDENCE - Hamfest. Northern KY ARC, Robert Blocher N8JMV, 513-797-7252. Email: nkarc@juno.com Web: http://home.fuse.net/dom/
OH - SUFFIELD (AKRON) - Hamfest. Goodyear ARC, Rich Kuster N8ZDQ, 330-796-3951. Email: rich.kuster@goodyear.com
NY - BETHPAGE - Hamfest. Briarcliffe College, 1055 Stewart Ave. Talkin: 146.850 (PL 136.5). Long Island Mobile ARC, Ed Muro KC2AYC, 516-520-9311. Email: hamfest@limarc.org Web: http://www.limarc.org

June 16

NJ - DUNELLEN - Hamfest. Columbia Park. 7am-2pm. Talkin: 146.025/625, 447.250/442.250, PL 141.3 146.520 simplex. Raritan Valley Radio Assn., Doug Benner W2NJH, 732-469-9009. Email: wb2njh@aol.com Web: http://www.w2qw.com

June 17

IN - CROWN POINT - Hamfest. Lake County Fairgrounds. VE testing. Talkin: 147.00 repeater, 146.520 simplex. Lake County ARC, Lee Raue, 6401 Kentucky St., Merrillville, IN 46410. Email: leeraue@msn.com

June 23-24

CA - FERNDALE - State Convention. Humboldt ARC, Redwood ARC, Farwest Repeater Assn., & Southern Humboldt ARC, Marci Campbell K6IAU, marcidon@quik.com Web: http://www.geocities.com/clem95501

JULY 2001

July 1

PA - WILKES-BARRE - Hamfest. Murgas ARC, Bob Michael N3FA, 570-288-3532. Email: wb3faa@aol.com

July 4

PA - BRESSLER - Hamfest. Emerick Cibort Park. W3UU, Pete deVolpi K3PD, 717-705-1370 weekdays. 717-938-8249 eves 6-9pm & weekends. Email: w3uu@aol.com Web: http://members.aol.com/w3uu/

July 7

IN - INDIANAPOLIS - Central Division Convention. Indianapolis Hamfest Assn., Rick Ogan N9LRR, 317-257-4050. Email: oganr@in.net Web: http://www.indyhamfest.com

July 8

IL - PEOTONE - Hamfest. Kankakee Area Radio Society, John "Chip" Moore K9IOC, 815-933-1323. Email: karsfest@yahoo.com Web: http://www.w9az.com

July 14

GA - GAINESVILLE - Hamfest. Lanierland ARC, Terry Jones W4TL, 770-967-6364. Email: w4tl@arrl.net Web: http://www.mindspring.com/~w4tl/hamfest.htm
TX - TEXAS CITY - Hamfest. Tidelands ARS, Joe Wileman AA5OP, 409-945-6794. Email: aa5op@aol.com Web: http://www.tidelands.org

July 15

PA - KIMBERTON - Hamfest. Mid-Atlantic ARC, Bill Owen W3KRB, 610-325-3995. Email: gem@op.net Web: http://www.marc.org/hamfest.html

July 22

IL - SUGAR GROVE - Hamfest. Waubonsee Community College, Rt. 47 at Harter Rd. VEC exams. Talkin: 147.210 (+600) PL 103.5/107.2. Fox River Radio League, Maurice L. Schietecatte W9CEO, 815-786-2860. Email: w9ceo@arrl.net Web: http://www.frrl.org/hamfest.html

July 27-28

OK - OKLAHOMA CITY - Hamfest. OK State Fair Park, Intersection I-40 and I-44. Fri: 5-8pm, Sat: 8am-5pm. Talkin: 146.82. Central OK Radio Amateurs, Inc., email: corahams@swbell.net Web: www.geocities.com/heartland/7332

July 28

OH - CINCINNATI - Hamfest. OH-KY-IN ARS, Mr. Lynn Ernst WD8JAW, 859-657-6161. Email: wd8jaw@arrl.net Web: http://www.qsl.net/k8sch

AUGUST 2001

August 4

OH - COLUMBUS - Hamfest. Voice of Aladdin ARC, James Morton KB8KPJ, 614-846-7790. Email: kb8kpj@cs.com

August 5

IN - ANGOLA - Hamfest. Land of Lakes ARC, Sharon Brown WD9DSP, 219-475-5879. Email: sharon.1.brown@gte.net
NY - WILLIAMSVILLE - Western NY

Write in 53 on Reader Service Card.

Events CALENDAR

Section Convention. Greater Buffalo Hamfest & Expo. Main Transit Fire Hall, 6777 Main St. Talkin: 147.255. Lancaster ARC, Luke Calianno N2GDU, 716-634-4667. Email: luke@towncountryflorist.com Web: http://hamgate1.sunyerie.edu/~larc

August 11

IL - QUINCY - Hamfest. Western IL ARC, Bob Crockett N9KUT, 217-222-4467. Email: w9awe@arrl.org Web: http://www.qsl.net/w9awe

August 12

IA - AMANA - Hamfest. Cedar Valley ARC, Chuck Bassett N0OUTS, 319-378-0448. Email: n0outs@rf.org Web: http://cvarc.rf.org/
IN - GREENTOWN - Hamfest. Kokomo & Grant County ARCs, L. B. Nickerson K9NQW, 765-668-4814. Email: k9nqw@skyenet.net Web: http://www.netusa1/~ka6nqwnick/hamfest.html
KY - LEXINGTON - Hamfest. National Guard Armory adjacent to airport. 8am-4pm. VE sessions. Talkin: 146.760-. Bluegrass ARS, John Barnes KS4GL, 859-253-1178. Email: ks4gl@juno.com Web: http://www.BluegrassARS.org/

August 19

KS - SALINA - Hamfest. Central Kansas ARC, Ron Tremblay WA0PSF, 785-827-8149. Email: tremblay@midusa.net

August 26

IL - JOLIET - Hamfest. Bolingbrook ARS, Thomas Ballard N9LJY, 630-739-3740. Email: tb1303@mediaone.net Web: http://geocities.com/k9bar/

SEPTEMBER 2001

September 7-8-9

CA - RIVERSIDE - Convention. Inland Empire Council of AR Organizations, Judy Ann Lowman W6YBS, 909-941-2367 or 909-862-1886. Email: w6ybs@juno.com

September 9

NY - BETHPAGE - Hamfest. Long Island Mobile ARC, Ed Muro K2EPM, 516-520-9311. Email: hamfest@limarc.org Web: http://www.limarc.org
OH - FINDLAY - Hamfest. Findlay ARC, Bill Kelsey N8ET, 419-423-4604. Email: kanga@bright.net Web: http://www.brightnet/~kanga/w8ft/hamfest.html

September 15

PA - SCHNECKSVILLE - Hamfest. Delware-Lehigh ARC, Dick Dech KA3MOU, 610-837-1585. Email: ka3mou@enter.net

September 16

CT - NEWTOWN - Hamfest. Candlewood ARA, Ken Weith KD1DD, 203-743-9181. Email: weithranch@snet.net

September 29

NY - HORSEHEADS - Hamfest. ARA of the Southern Tier, Randy Viele N2SYT, 607-625-5893 (days) or 607-738-6857 (eves). Email: n2syt@arast.org Web http://www.arast.org

September 30

NY - YONKERS - Flea Market. Lincoln High School, Kneeland Ave. 9am-3pm. VE Exams. Talkin: 440.425 PL 156.7, 223.760 PL 67.0, 146.910, 443.350 PL 156.7. Metro 70cm Network, Otto Supliski WB2SLQ, 914-969-1053. Email: wb2slq@juno.com Web: http://www.metro70cmnetwork.com

OCTOBER 2001

October 7

OH - MEDINA - Hamfest. Medina Two Meter Group, Mike Rubaszewski N8TZY, 330-273-1519. Email: n8tzy@m3net.net Web: http://www.qsl.net/m2m

October 21

NY - QUEENS - Hamfest. Hall of Science parking lot, Flushing Meadow Corona Park, 47-01 111th St. VE exams. Talkin: 444.200 repeat, PL 136.5, 146.52 simplex. Hall of Science ARC, Inc., Steve Greenbaum WB2KDG, 718-898-5599 eves only. Email: WB2KDG@Bigfoot.com or Andy Borrok N2TZX, 718-291-2561, email: N2TZX@webspan.net

October 27

CANADA - QUEBEC - LONGUEUIL - Hamfest. Montreal South ARC, Micheline Simard VE2XW, 450-446-0477. Email: ve2xw@amsat.org
MN - ST. PAUL - Hamfest. Twin Cities FM Club, Amanda Roberts KG0AY, 612-535-0637 or 651-460-6050. Email: kg0ay@pclink.com Web: http://www.hamfestmn.org

October 28

NY - LINDENHURST - Hamfest. GSBARC & SCRC, Phil Lewis N2MUN, 631-226-0698. Email: info@gsbarc.org Web: http://www.gsbarc.org

NOVEMBER 2001

November 17-18

IN - FORT WAYNE - State Convention. ACARTS, James Boyer KB9IH, 219-489-6700. Email: jboyer@ail.com Web: http://www.acarts.com

HIGH FLYING HAM TV

by Gordon West

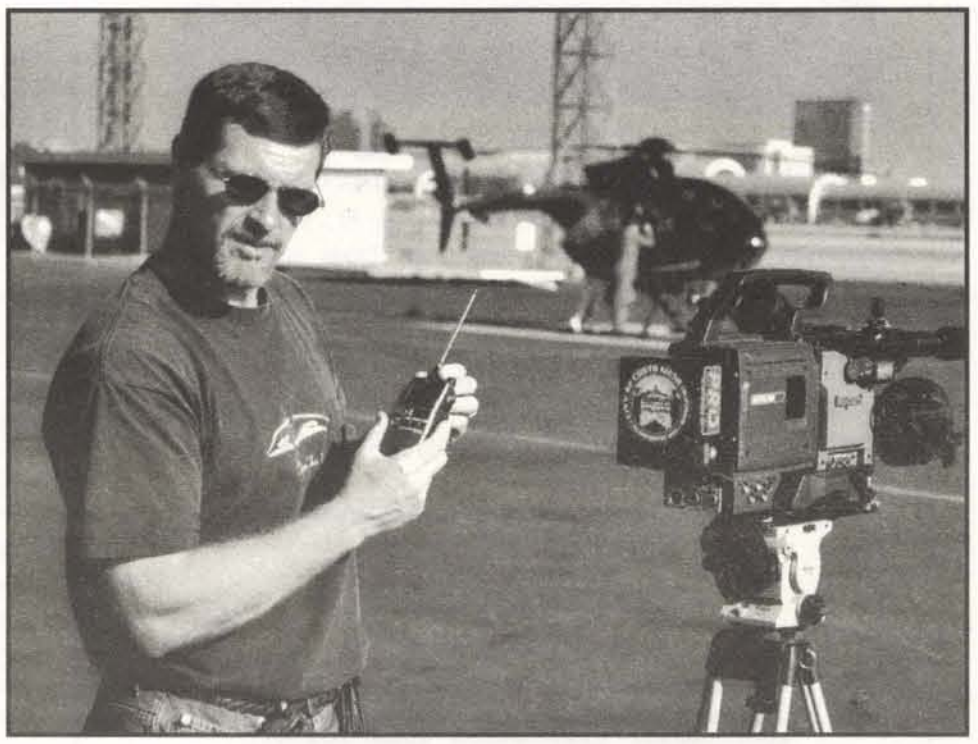
Sending and receiving *live* ham radio audio and video is nicknamed "ATV." Ham ATV signals are identical to NTSC M standards throughout the United States, using 6 MHz wide AM modulation to carry color video and sound just like you see over the air on television Channels 2 through UHF. Some ham operators may also call this ATV mode FAST SCAN TELEVISION. Because ATV fast scan ham TV is a rather 6-MHz wide emission, it is authorized on amateur radio bands only on UHF and higher frequencies.

420 MHz - 442 MHz
910 MHz - 916 MHz
922 MHz - 928 MHz
1240 MHz - 1246 MHz
1252 MHz - 1258 MHz
1260 MHz - 1270 MHz
1276 MHz - 1282 MHz
1288 MHz - 1294 MHz

Fast scan amateur TV is not permitted on the lower ham bands because of the 6-MHz wide emission. No live ham TV on the 222 MHz band, nor the popular two-meter band, nor six meters, nor the worldwide frequencies. Ham TV is only on 420 MHz and higher ham bands. Log onto www.hamtv.com for a closer look at the precise ham radio television frequency allocations, and what frequencies may be active in your area.

Another form of imaging over the amateur radio bands is full-color, high-resolution, SLOW-SCAN TELEVISION sending and receiving. This emission is a scant 3 kHz wide, making it skinny enough to fit onto any of the worldwide ham bands from 160 meters through two meters. Sparkling, still-frame, video images take approximately 60 seconds to receive, and most hams use the Scottie II method of sending and receiving these images. The portable Kenwood VC-H1 video unit simply plugs into any Kenwood handheld or into almost any worldwide radio, and locks onto transmitted video signals in seconds. There is also software available to download radio video images on your computer. Hot worldwide frequencies to find video would be 14.230 MHz, 21.340 MHz, and in the evenings, 7.171 MHz.

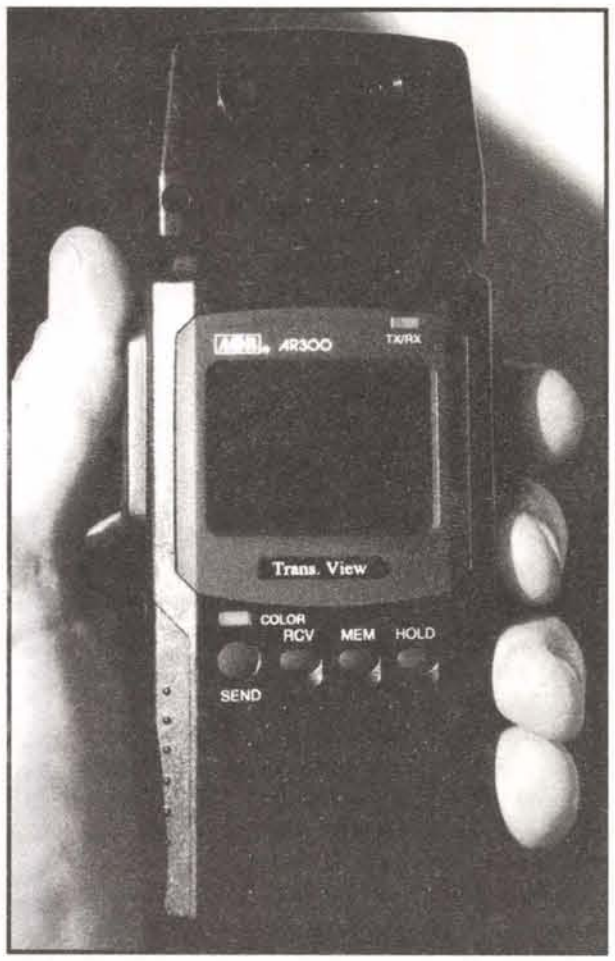
The Kenwood VC-H1 is a popular slow-scan TV sender and receiver when hooked into a handheld transceiver because everything is right on that single video handheld unit — camera, color LCD screen, speaker microphone, and a curly cable that plugs into any Kenwood VHF/UHF handheld or an optional cable for any Kenwood HF transceiver. For other brands of equipment, accessory cable kits may be purchased at most ham radio swapmeets.



TV newsman finds the little ICOM R3 video receiver fascinating!

Both slow-scan ham TV and fast-scan ham TV have their unique advantages, and there is pretty much an even mix of ham operators who experiment with one type of emission or the other, or both. Some hams enjoy the artistic challenges of sending full-color, high-resolution images over worldwide frequencies, or perhaps downloading an image from astronauts from the Space Shuttle or the international space station.

Yet, other ham radio operators see the utility of fast-scan TV, sending live television pictures up to 40 miles away simplex (same frequency), or sending live television signals up to a mountain-top, cross-band repeater that will now



AOR portable slow-scan ham TV handheld sender/receiver.

share your shots over hundreds of miles. Amateur television repeater operation almost always uses two completely separate ham bands to simultaneously receive a signal on the input while sending that same running video on another band for output.

"There are many emergency service applications where the on-site commander must remain in an emergency operations vehicle or inside command post, but would love to see what others are seeing. This is especially true when decisions must be made quickly and cannot wait for a voice description or interpretation," comments Tom O'Hara W6ORG, well-known and respected amateur radio fast-scan TV equipment provider and operator.

"A picture IS worth a thousand words," adds O'Hara, talking about his amateur television equipment which is so versatile it can go in a hard hat, in a model plane or boat, or in a helicopter. O'Hara is an accomplished helicopter pilot and knows what it takes to get good signals from aircraft to ground.

Sending signals over amateur radio frequencies requires a valid ham radio license. For live video fast-scan ATV sending, the entry-level, no-code Technician class license, FCC Element 2, is all that is necessary. This makes ham television a "can do" proposition for the radio enthusiast not much interested in learning Morse Code. No Morse Code requirements for the Technician Element 2 exam.

For slow-scan imaging on the popular two-meter and above frequencies, just the Technician class license is required. No code test.

And for the R/C enthusiast wanting to get off of crowded 74 MHz garage door channels and onto ham radio R/C channels on the six-meter band, the Technician class no-code license is all that is necessary for six-meter R/C along with the two-meter ATV reception.

It is only the worldwide slow-

scan imaging on frequencies below 30 MHz (high frequency) where the amateur operator needs to hold the General class license, requiring one additional written exam and the required 5 wpm Morse Code test. Recent FCC rule changes have dropped the General class code requirement from 13 wpm down to a palatable 5 wpm. Very good news!

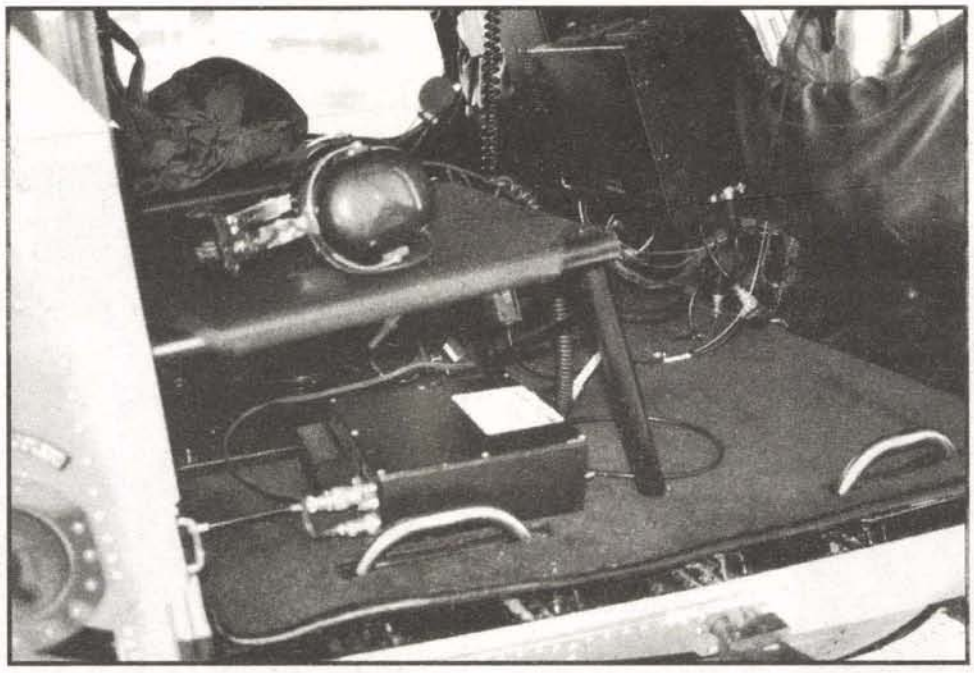
Transmitting fast-scan, NTSC-type, live video is relatively straightforward once you have the license and the necessary pieces. You will need a simple color camera, a simple antenna, and the transmitter. If you're looking just to send a 100 miliwatt signal about a half mile at 434 MHz mounted on a hard hat, PC Electronics (www.hamtv.com) has a plug-and-play video transmitting system for under $250.00. You provide the hard hat. So does MFJ for $119.00, their "micro video" transmitter model #MFJ-8704. I tried it and it works up to a half mile!

For more elaborate, higher power video sending, you will want to upgrade your camera or use a nice CCD video camera and go with about 10 to 20 watts output, and get it into an antenna system that will offer outstanding simplex results up to 30 miles away, for extended capabilities when switched over to the input of a cross-band, ham radio, mountain-top repeater.

To view these ham radio live TV signals, you will need a little bit more than the regular TV set that has been pre-set to over-the-air TV Channels 2 through 70. You *could* pick up some nearby ham transmitting on 434 MHz by tying in a cable-ready TV to an outside antenna, and selecting a cable TV channel around 59, but most cable TV "front ends" are relatively insensitive to weak signal reception, expecting a cable TV coax input of several millivolts, as opposed to some ham signals that may be only a couple of microvolts.

Downconverters will take the amateur radio 430 MHz, 900 MHz, 1200 MHz, and 2.4 GHz signals and downconvert them to television Channel 3 or 8 signals, or better yet, a composite output that goes IN to separate video and separate audio to a color monitor. I like this approach best because it eliminates the unknown of whether or not the incoming ham fast-scan signal is amplitude modulated or frequency modulated. Most 70 cm 430 MHz signals are amplitude modulated, and this NTSC format means your downconverter will work quite nicely off of a common USA television. But ham operators on 900 MHz and 1200 MHz, plus some little tiny wireless TV transmitters at 2.4 GHz, may run either amplitude modulation, frequency modulation, or inverted frequency modulation. It's best to check which transmitting system is in use in your area before ordering up the downconverter from PC Electronics or other suppliers.

"It makes a difference what part of the country they are from," adds O'Hara with PC Electronics, one of the world's largest providers of transmitting and ham TV downconverters.



(Left)
The FLIR 7000 is seen mounted on the rear of the front seats and feeds video to the ham transmitter under the seat.

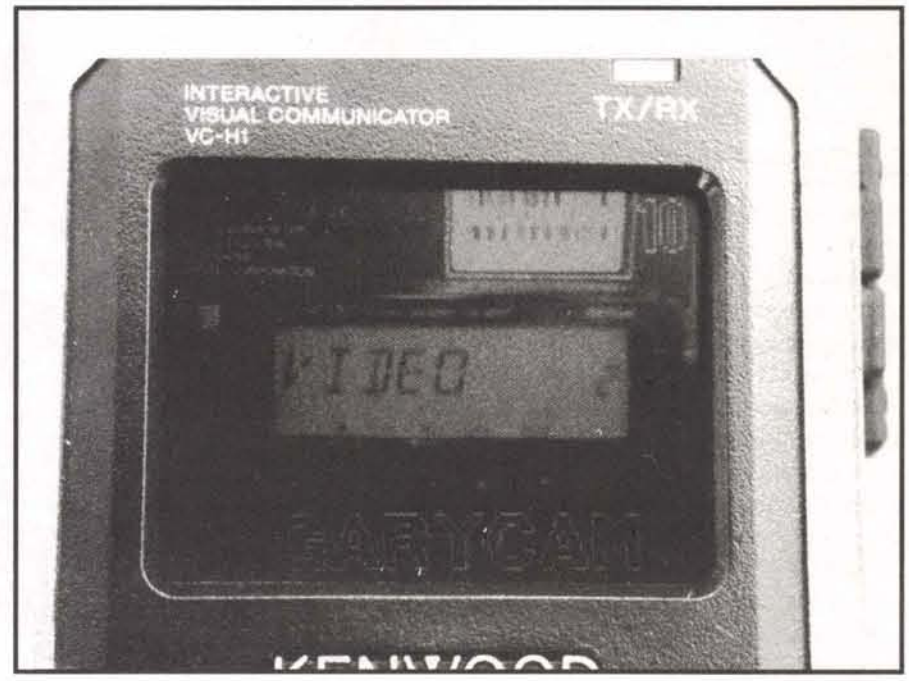
(Below)
Author West (right) ready to take ham TV aloft with ham pilot (left). Police use of ATV ham video gear is limited to brief tests or actual emergencies, with a licensed ham on board.

A most unique handheld TV scanner/monitor has now become available by ICOM America — the IC-R3 — offering a built-in, thin-film-transistor, daylight viewable screen and a built-in scanning receiver that may tune from the bottom of the AM broadcast all the way through 2,450 MHz. The TV side of this handheld receiver activates above 54 MHz, giving you over-the-air preset commercial television broadcast reception from Channel 2 all the way up through UHF Channel 68. This little handheld receives regular television NTSC "wide AM" TV signals, just like a little portable TV set. But with a few front-panel keystrokes, this same little receiver also tunes in *any* TV signal between 55 MHz to 800 MHz, including any ham ATV 430 MHz band signal interstitial to regular Channels 13 and 14. The instruction book gives you the precise keystrokes to unlock the normal TV channel number tuning over to full-frequency TV signal hunting.

Above 900 MHz, this same ICOM IC-R3 has a little known feature of being capable of operating in *any* TV mode, including ham TV wide AM, ham TV wide FM, and wireless 2.4 GHz TV transmitters in the inverted mode. Ray at ICOM also points out there are capabilities of sub-carrier adjustment to precisely lock onto the audio component of the TV signal when the picture is coming in clear. There are also capabilities of taking the video and audio out to be displayed and heard on a much larger screen.

But this color screen with its trans-reflective LCD system gave us an unbelievable clear color image when tuned into local ham radio ATV repeaters, as well as to our local police department airborne law enforcement helicopter. And for radio control (R/C) enthusiasts, the little ICOM IC-R3 with its telescopic whip is a perfect com-

A 430 MHz beam helps pull in ATV to the portable ICOM R3 receiver.



Kenwood slow-scan portable video communicator.

police department that substituting ham equipment in place of expensive, commercially-available live television transmitting equipment for *routine* surveillance is specifically not allowed. However, in an emergency, the Costa Mesa MESAC ham radio team would have full capabilities of sending live television pictures down to their emergency operation center by the police helicopter pilots that were also licensed ham operators. We also tested the little ICOM receiver to see how well it could pick up the police helicopter 434 MHz simplex signals, and were surprised that the little telescopic whip gave us reception out to 10 miles line-of-sight.

The police helicopter has installed a FLIR forward-looking, infrared system, 7000, which outputs NTSC video to either an onboard VCR deck or to the onboard amateur television 20-watt transmitter from PC Electronics. The transmitter runs off of a portable battery and is carried aboard the craft as a portable electronic device in order to conform to air frame FAA rules. A quarter wavelength whip offers a wide radiated downward pattern and is separated far enough from the FLIR camera and lens to keep RF from distorting the picture. Audio is carried by a separate mike circuit so that the amateur operators would identify every 10 minutes on the RF video signal. Additionally, Costa Mesa home operators would voice coordinate their ATV simplex operation on a 144 MHz two-meter FM channel with a separate handheld transceiver.

The little ICOM allowed us to check our own transmitted signals, directly off the air, both on the ground, as well as in the craft. The PC Electronics 20-watt UHF 430 MHz transmitter also has a dedicated video output jack, but this would require a separate video screen in addition to what was already installed in the craft — we opted for the little ICOM R3.

But don't overestimate the minimum range of 6 MHz wide video — it works out to be an almost watt a mile for good P5 snow-free reception. And if the helicopter dips down below a ridge or buildings, expect the picture to instantly disappear. In fact, when the helicopter was on the pad, transmitting 20 watts output, our local emergency operation center just a few miles away could not see a thing. We figured something must be wrong until after the craft ascended above 200 feet, and presto, the image quickly locked in.

There were also lots of multipath flutters, jitters, and color dropouts — this is what happens when running 10 to 20 watts in the air with all sorts of ground reflections and blockage. But seeing through the FLIR in either the video or infrared mode was fascinating — at night, we could easily see what the pilots were viewing on the infrared screen while searching for a lost person — heat can really show up blazing white on the screen.

If all this sounds interesting, tune into all sorts of video excitement with a downconverter, or your ICOM IC-R3, or a Kenwood VCH1, or free video SSTV shareware on the web.

Although fast-scan video is short range, there is plenty of excitement out there on the video airwaves. **NV**

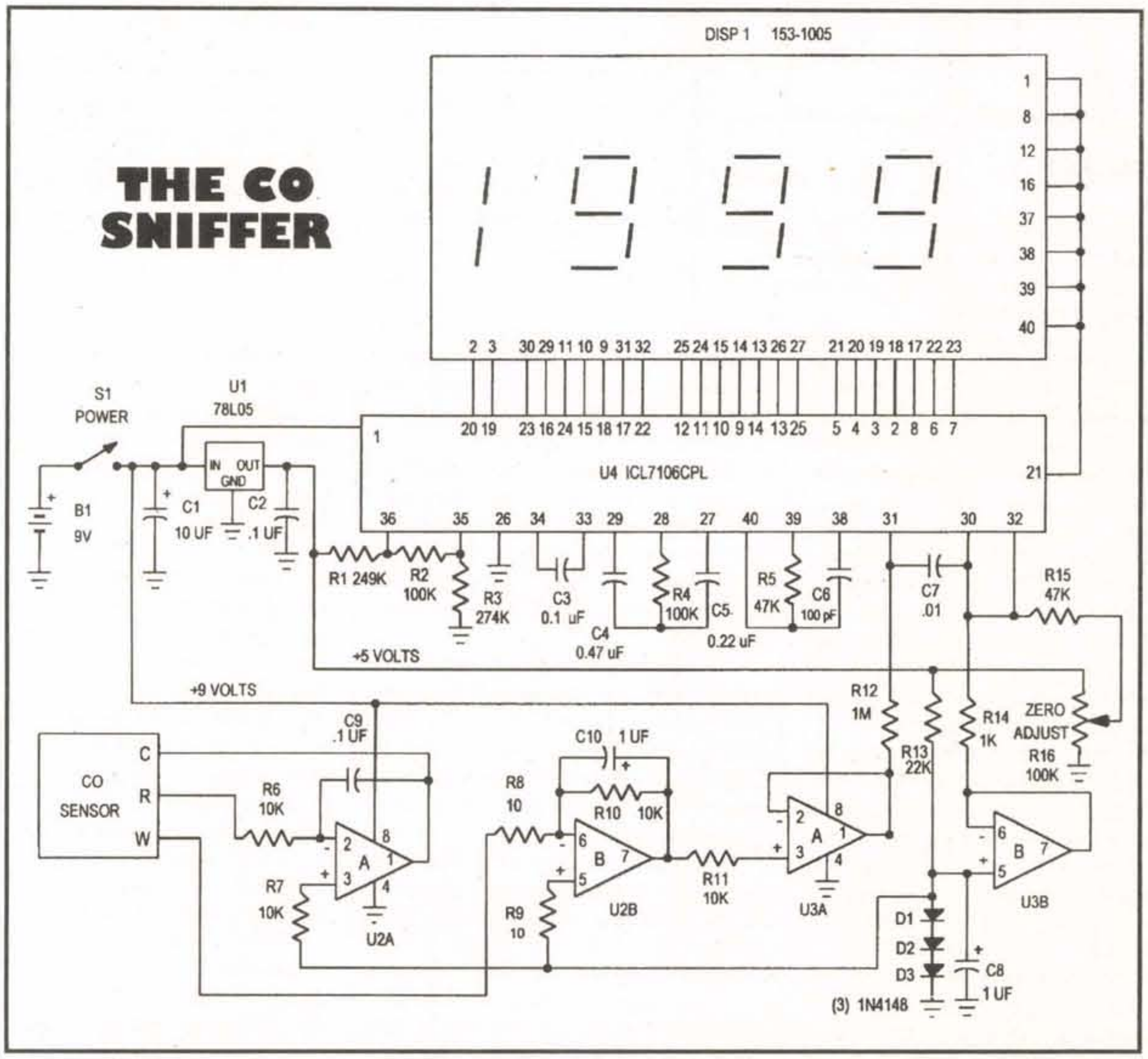
panion for that little ham TV or little 2.4 GHz no-license "rabbit" transmitter to see a bird's eye view of your model in flight.

In our local police department helicopter trials, licensed ham operators worked the PC Electronics equipment as part of an emergency exercise test. Hams are quick to point out to any

BUILD A CARBON MONOXIDE SNIFFER

by Anthony J. Caristi

SENSITIVE ELECTRONIC DETECTOR CHECKS FOR DANGEROUS LEVELS OF CARBON MONOXIDE



You probably have read newspaper accounts of tragedies caused by carbon monoxide (CO) poisoning, usually happening as a family is sleeping. Oftentimes, the cause is a faulty heating system. For this reason, every home should have at least one carbon monoxide detector. This insidious gas — known as the silent killer — is very deadly since if present in sufficient concentration, will quickly cause unconsciousness and death.

The instrument described here is not a substitute for a carbon monoxide detector, but a supplement to one. With it you can perform regular check-ups of the heating system, flue, water heater, gas dryer, and fireplace to determine the extent (if any) of carbon monoxide emissions seeping into the living space. Such preventative maintenance will reveal a problem long before it becomes severe enough to activate an alarm.

The CO Electronic Sniffer is an easy-to-build instrument that uses a very long-life (seven year) sensitive electrochemical cell that is capable of detecting carbon monoxide levels far below lethal levels. A concentration of just 100 parts per million (PPM) of CO will cause symptoms of poisoning.

The level of detected CO is indicated on a liquid crystal display (LCD), which has a resolution of one PPM, and a range of zero to 1999 PPM. No calibration of the unit is required. Power is provided by a common nine-volt transistor radio battery, which permits a compact assembly and complete portability. Since the circuit uses just three milliamperes of current, battery life will be extremely long.

CARBON MONOXIDE FUNDAMENTALS

Carbon monoxide is a colorless and odorless gas that is formed by the result of incomplete combustion of any material containing carbon such as oil, natural gas, wood, coal, propane, gasoline, and even cigarettes. When such matter is burned, most of the combustion process produces carbon dioxide, which is harmless. However, there always is the possibility that some carbon monoxide will also be present. That's why it is mandatory that furnaces and other heating appliances be vented to the atmosphere where any harmful products of combustion are safely dissipated.

When a furnace or other appliance develops a defect, it is possible that harmful CO can enter the living space through cracks in the heat exchanger or a blocked flue. Unless detected in time, there is a strong possibility that carbon monoxide poisoning can occur. This can result in serious injury or death. Table 1 illustrates the affect of carbon monoxide on human beings, depending upon its concentration in the air.

THE CARBON MONOXIDE SENSOR

A basic rendition of the carbon monoxide sensor is depicted in Figure 1. Two electrodes — called the working and the counter electrodes — are placed in a conductive solution called an electrolyte. A small quantity of sulfuric acid is used to produce an acidic condition.

Carbon monoxide molecules react with water at one of the electrodes, picking up an oxygen molecule to become carbon dioxide. This generates protons and electrons which migrate to the other electrode, shown as ionic flow in the diagram. The hydrogen molecules then react with oxygen to regenerate water molecules. The net reaction is the conversion of carbon monoxide to carbon dioxide, in the presence of oxygen.

If a resistor is connected between the two electrodes, a current will flow when the sensor is in the presence of

TABLE 1
EFFECT OF CARBON MONOXIDE ON THE HUMAN BODY

CONCENTRATION OF CO	TOXIC SYMPTOMS
100 PPM	SLIGHT HEADACHE WITHIN TWO OR THREE HOURS
400 PPM	FRONTAL HEADACHE WITHIN ONE TO TWO HOURS
800 PPM	DIZZINESS, NAUSEA, CONVULSIONS WITHIN 45 MINUTES
1600 PPM	HEADACHE, NAUSEA, DIZZINESS WITHIN 20 MINUTES; DEATH WITHIN 2 HOURS
3200 PPM	HEADACHE, NAUSEA, DIZZINESS WITHIN 10 MINUTES; DEATH WITHIN 30 MINUTES
6400 PPM	HEADACHE, NAUSEA, DIZZINESS WITHIN 2 MINUTES; DEATH WITHIN 10 TO 15 MINUTES
10,000 PPM	DEATH WITHIN 1 TO 3 MINUTES

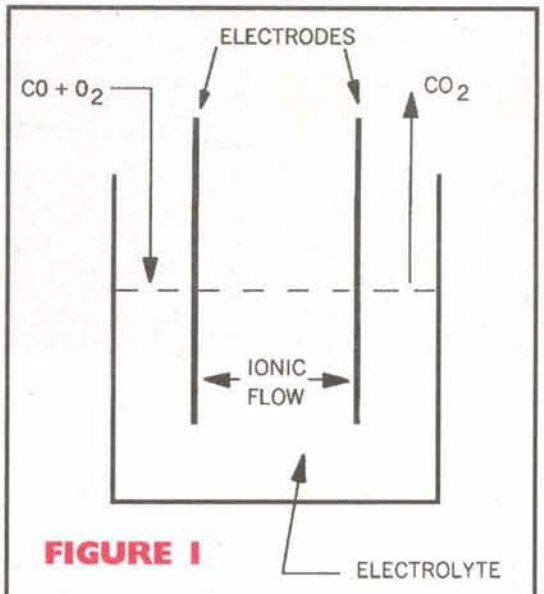


FIGURE 1

Basic electrochemical sensor. In the presence of carbon monoxide, current will flow through an external resistor connected across the electrodes.

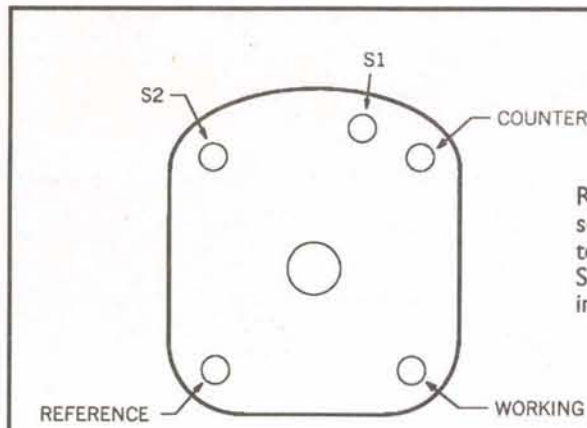


FIGURE 2

Rear view of CO sensor showing terminal identification. S1 and S2 are not used in this application.

carbon monoxide and the ionic flow exists. The magnitude of the current is proportional to the concentration of CO. The relationship is linear within 5%, and the current generated is equal to 80 nanoAmperes per PPM. As an example, if the resistor value was 10,000 ohms and the CO concentration was 100 PPM, the voltage developed across the resistor would be 80 millivolts. The voltage developed across the resistor, therefore, is an indicator of the concentration of CO gas as detected by the sensor.

In the two-element design of Figure 1, the output current has a tendency to drift in the presence of high levels of CO. To overcome this limitation, a third electrode — called the reference electrode — is introduced. Although the reference electrode is immersed in the conductive solution, it does not take part in the electrochemical reaction. Its sole purpose is to provide a stable potential against which the current passing through the working electrode can be measured.

Figure 2 illustrates the terminal identification of the sensor, as seen from the bottom.

ABOUT THE CIRCUIT

Refer to the schematic diagram. The circuit consists of two parts, called the analog section and the digital section. Power is provided by a nine-volt battery which drives a five-volt fixed regulator, U1. The analog section is composed of U2 and U3, each of which is a dual op-amp chip.

U2A and U2B are a pair of op-amps that form what is called a potentiostat circuit. Op-amp U2A, with a large value of capacitance connected between its output terminal and negative input, forms an integrator or filter that drives the counter electrode of the sensor.

The positive input terminals of U2A and U2B are returned to a positive potential of about 1.5 volts as determined by D1, D2, and D3. Since the reference and working electrodes of the sensor are returned to the negative inputs of the two op-amps, they are each held at a virtual potential of +1.5 volts.

When CO enters the sensor, the output of U2A pin 1 swings negative relative to the reference electrode. Conventional current then flows through R8 and R6 at a value of 80 nanoAmperes per PPM of carbon monoxide.

U2B is a current to voltage converter, with the value of R10 determining the output voltage at pin 7. This voltage rises from its nominal value of about 1.5 volts, and will increase at the rate of 0.8 millivolts per PPM of carbon monoxide.

The output voltage of U2B pin 7 is fed to the positive analog input terminal of an analog-to-digital (A/D) converter chip, U4 pin 31, through voltage follower U3A.

The negative analog input of the A/D converter, pin 30, is driven by the +1.5 volt source developed by the diodes through voltage follower U3B. Thus, it can be seen that any CO entering the sensor will cause the voltage at pin 31 of the A/D to rise with respect to its negative input, pin 30, resulting in a reading on the LCD.

In order to null out any baseline voltage that is developed by the sensor in the absence of carbon monoxide, potentiometer R16 is used to inject a small positive voltage to pin 30 of the A/D converter to zero the reading of the display.

ANALOG-TO-DIGITAL CONVERTER

U4 and its associated components form a complete 3-1/2 digit voltage measurement system that drives an LCD. The maximum display reading is 1999, which represents 1,999 PPM of carbon monoxide as sensed by the detector. The negative sign of the display is operational to help with zeroing the reading at start-up.

U4 measures and displays the analog voltage appearing between terminals 30 and 31 of the chip. Pin 31 is the positive analog input terminal and is driven by the output of U2B through voltage follower U3A.

Pin 30 is the negative analog input and is driven by the +1.5 volt bias that is applied to U2A and U2B positive input terminals. The zero adjust potentiometer allows a small amount of positive bias to be applied to pin 30 to negate any baseline output of the sensor when no CO is present.

The sensitivity of the A/D converter is determined by the reference voltage appearing between pins 35 and 36. In this circuit, it is necessary that the A/D converter has a full scale (1,999) sensitivity of 1.6 volts, which requires a reference voltage of 0.8 volts. This is accomplished by a voltage divider stick composed of R1, R2, and R3 which provides the required voltage drop between pins 35 and 36 of U4.

With a reference voltage of 0.8 volts, U4 will generate a display of zero to 1999 when the A/D input voltage varies from zero to 1.6 volts as the CO level reaching the sensor varies from zero to 1999 PPM.

CONSTRUCTION

The circuitry of the CO detector is contained on two printed circuit assemblies called the analog board and display board. The analog board contains the five-volt regulator chip U1, and dual op-amps U2 and U3. The display board contains the LCD, plus the A/D converter, U4.

The two boards have been designed so that they may be stacked upon each other, if desired, using suitable spacers and hardware, to produce a compact assembly that can be placed into a small enclosure. See Figure 8. The top of the enclosure will have a rectangular cutout to allow viewing the display. The only operating controls are power switch S1, and zero set potentiometer R16.

Full-size layouts of the printed wiring of the two boards are illustrated in Figures 3 and 4. A source for etched and drilled boards is given in the parts list. Alternatively, the circuit is not critical and may be hardwired on a perfboard, using good construction techniques.

Figures 5 and 6 illustrate the parts placement of the boards as seen from the top or component side. Refer to these illustrations to ensure that all polarized components such as solid-state devices and electrolytic capacitors are properly oriented. Just one part placed backwards in the circuit will render the circuit inoperative, and may cause damage to one or more components.

Sockets for the integrated circuits are optional. The use of sockets is well worth the slight additional cost and will permit ease of service and troubleshooting should it become necessary. It is very difficult to remove a multipin component soldered into a PC board without damaging the component or board wiring.

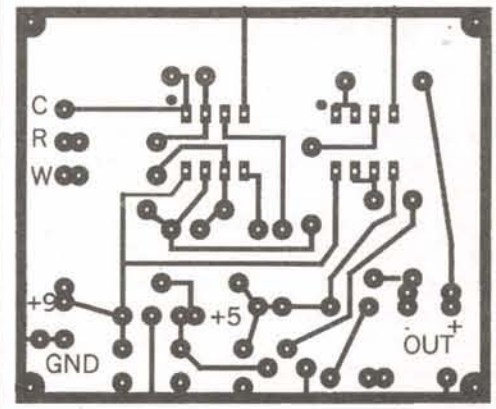


FIGURE 3. Printed layout of the analog board shown full size as seen from the copper side.

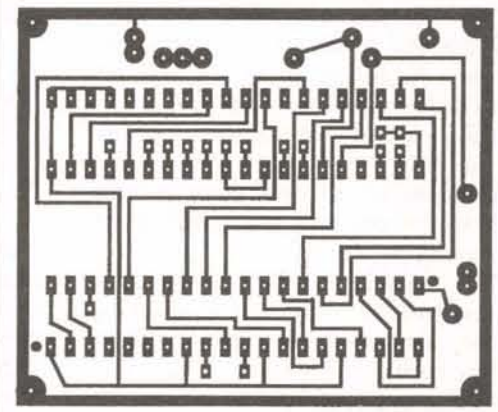


FIGURE 4. Printed layout of the display board shown full size as seen from the copper side.

DISPLAY BOARD

The display board will require three jumper wires as depicted in Table 2. Place these in the board first, using flexible insulated #24 gauge wire. Be sure to allow sufficient lead length where required to allow the wires to be routed around U4.

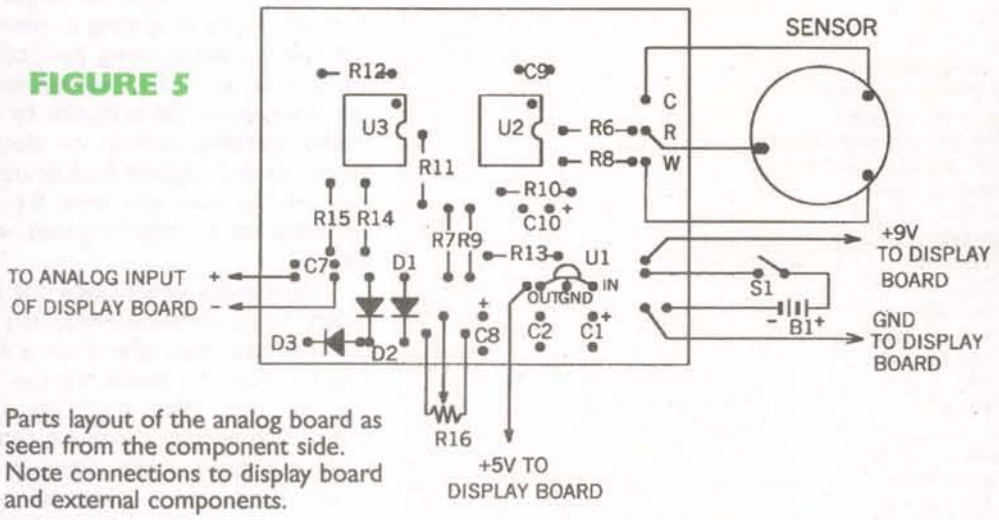
DISPLAY BOARD JUMPER WIRES

An optional socket for the display may be fabricated by taking a 40-pin

Jumper #1	U4 pin 18 to display pin 9
Jumper #2	U4 pin 24 to display pin 11
Jumper #3	U4 pin 26 to circuit common

TABLE 2
DISPLAY BOARD JUMPER WIRES

FIGURE 5



Parts layout of the analog board as seen from the component side. Note connections to display board and external components.

FIGURE 6. Parts view of display board showing the location of components, jumper wires, and interconnections. Note that the LCD module is placed on the opposite side.

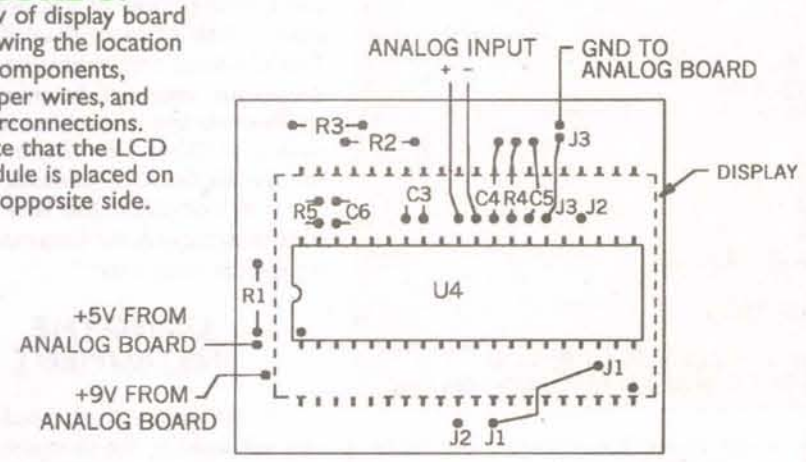
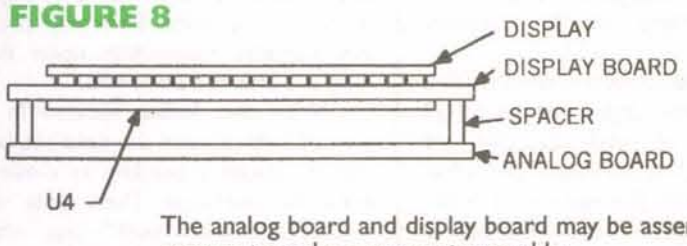


FIGURE 8



The analog board and display board may be assembled with spacers to make a compact assembly.

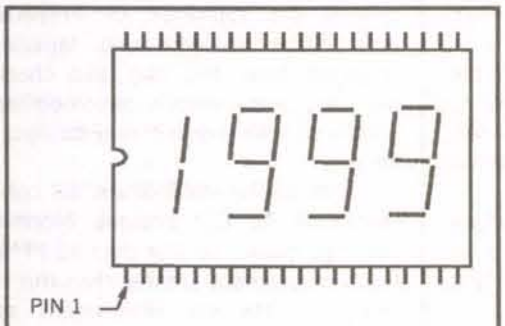


FIGURE 7.
Display module. Pin 1 is located at the lower lefthand corner.

DIP socket and cutting it in half lengthwise. To solder the two socket sections to the copper side of the board, they must be set above the surface of the board so that a very narrow soldering iron tip can be used to make the connections.

Handle the glass LCD module carefully to avoid breakage. Refer to Figures 6 and 7, which show how this component should be placed into the display PC board on the copper side. Proper orientation is indicated by a small boss at one end of the LCD module. A small dot shown in Figure 6 indicates the location of pin 1 of the printed wiring pad for the display.

When both printed circuit boards are completed, examine each of them very carefully for opens, short circuits between closely spaced conductors, and bad solder connections which may appear as dull blobs of solder. Any solder joint which is suspect should be redone by removing the old solder with desoldering braid, cleaning the joint, and carefully applying new solder. It is far easier to correct problems at this stage rather than later on if you discover that your CO Sniffer does not work.

SENSOR LOCATION

Refer to Figure 2 for the identification of the sensor terminals. It should be placed at a convenient location on the enclosure where its port will be readily accessible to detect any possible CO gas. A circular hole for the port may be drilled in the enclosure, and the sensor secured with silicone rubber adhesive. Use light gauge insulated flexible wire to make the three connections to the analog board as indicated in the schematic diagram. Use minimal heat when soldering to the sensor terminals, to avoid damage to this component.

INTER-CONNECTIONS

Completion of the wiring includes making five connections between the analog and digital boards. Table 3 illustrates the identification of these wires.

Figures 5 and 6 serve to identify the location of the interconnecting wiring between the two boards, plus connections to the external components. Follow these illustrations, along with the schematic diagram, as you go. Use flexible stranded wire for the connections. Do not use solid wire; it will break.

A battery clip may be salvaged from an old nine-volt battery. Solder a red and a black wire to the terminals, noting that the polarity will be opposite to that of a battery. When finished, plug the clip on to a new battery and use a DC voltmeter to verify that the red wire is positive and the black one is negative.

Mount S1 and R16 to any convenient location on the enclosure. R16 is the zero adjust potentiometer and will require a knob.

Use insulated stranded wire of different colors to make the connections between the battery clip, panel controls, and PC boards. Use the schematic diagram as a guide as you go.

When mounting the display board to the enclosure, use suitable length spacers to prevent the LCD module from touching the panel. No stress may be placed on this component since it is constructed of glass and can easily fracture.

When the CO Sniffer is fully assembled, examine the wiring very carefully for proper connections. Do not attempt the check-out procedure unless you are satisfied that the assembly and wiring are 100% correct.

CHECK-OUT

Check-out of the CO detector requires the use of a digital voltmeter or VOM with a high input resistance. The use of an oscilloscope should not be necessary unless the circuit is inoperative due to faulty construction.

Before inserting a battery into the clip, measure the resistance across the terminals of the clip with S1 set to the ON position. Normal indication is 50K or more. Then measure the resistance from the five-volt buss to circuit common. Normal indication is about 4,000 ohms. If you obtain resistance readings substantially lower than specified

PARTS LIST

B1 9-volt alkaline transistor radio battery
C1 10 uFd 25-volt radial electrolytic capacitor
C2, C3, C9 0.1 uFd 50-volt ceramic capacitor
C4 0.47 uFd 50-volt metal film or polyester capacitor
C5 0.22 uFd 50-volt metal film or polyester capacitor
C6 100 pF 50-volt ceramic disc capacitor
C7 0.01 uFd 50-volt ceramic disc capacitor
C8 1 uFd 50-volt radial electrolytic capacitor
C10 1 uFd 16-volt tantalum capacitor
D1, D2, D3 1N4148 silicon diode
Disp 1 3-1/2 digit, Digi-Key 153-1005
R1 249K 1/4 watt 1% metal film resistor
R2 100K 1/4 watt 1% metal film resistor
R3 274K 1/4 watt 1% metal film resistor
R4 100K 1/4 watt carbon resistor
R5, R15 47K 1/4 watt carbon resistor
R6, R7, R11 10K 1/4 watt carbon resistor
R8, R9 10 ohm 1/4 watt carbon resistor
R10 10K 1/4 watt 1% metal film resistor
R12 1 Megohm 1/4 watt carbon resistor
R13 22K 1/4 watt carbon resistor
R14 1K 1/4 watt carbon resistor
R16 100K linear potentiometer, front panel mount
U1 78L05 5-volt fixed regulator
U2, U3 Maxim MAX407CPA dual op-amp
U4 ICL7106CPL 3-1/2 digit A/D converter display driver
Sensor Electrochemical carbon monoxide, Monox S
Misc: Enclosure, knob, battery clip and holder, hook-up wire, hardware.

SOURCES OF SUPPLY

Digi-Key 1-800-344 4539; www.digikey.com
Mouser 1-800-346 6873; www.mouser.com
Monox Ltd. (sensor) www.monox.com; sales@monox.com

Note: The following parts are available from A. Caristi, 69 White Pond Road, Waldwick, NJ 07463
Etched and drilled PC boards @ $29.50 per set, U1 @ $3.00, U2 @ $8.50, U3 @ $8.50, U4 @ $13.50, CO sensor @ $45.75. Please add $6.00 postage/handling.

above, there is most likely a short circuit or incorrectly placed component in one of the boards. Troubleshoot the circuit and correct the fault before proceeding.

Insert a fresh nine-volt alkaline battery onto the clip. Turn power on and verify that the voltage at the output terminal of U1, measured with respect to circuit common, is between 4.75 and 5.25 volts DC. Do not proceed with the check-out if you do not obtain the proper voltage. Check the battery voltage under load to be sure it is delivering at least +8 volts to the circuit. Check the polarity of the battery, C1, and the orientation of U1, U2, U3, and U4. Check the circuit boards for short circuits. Try a new regulator IC.

When you are satisfied that the regulator is operating properly, disconnect power. Insert U4 and the display module into the board, making sure that proper orientation is observed and all pins are seated firmly in the sockets with none inadvertently bent under the body of the component.

Apply power to the circuit and set the zero adjust potentiometer to mid-position. If the CO Sniffer has been properly assembled and wired, you should see a display of digits which will decrease in reading as the sensor conditions itself. This may take a few minutes. When the reading has stabilized, operate the zero adjust potentiometer over its range and verify that the reading can be adjusted from a negative number to a positive one. Clockwise rotation should result in an increasing display. If not, simply interchange the two outside wires of the potentiometer.

Verify that all digits are properly formed. If the display is totally blank or has deformed digits, or does not respond to the zero adjust control, review the following paragraphs to locate and repair the fault.

If the display is totally blank, U4 is not functioning or the display module has been placed backwards into the board. Check all components associated with U4. Check the waveform at pin 21 of U4 and pin 1 of the display with an oscilloscope to verify the presence of a squarewave backplane signal. Check the orientation of both U4 and the LCD module by reviewing Figures 6 and 7. Make corrections, if necessary.

If any of the display digits are not properly formed or the display is blank, there may be a short or open circuit between one or more of the connections between U4 and the LCD. Any improperly formed digit will lead you directly to the fault if you consult the schematic diagram to see which connection controls the faulty segment. The three sets of seven wires that feed the segments are shown in an "a" segment to "g" segment sequence.

Check the jumpers shown in Table 2. Measure the output voltage of U3 pins 1 and 7 to verify that they are both about 1.5 volts. Check the reference voltage to U4, measured between pins 35 and 36. Normal indication is 0.8 volts. If not, check R1, R2, and R3. Check the boards visually, and also with an ohmmeter (with power off), to locate the fault.

Check the wiring between the sensor and the analog board. Refer to Figures 2 and 5, and the schematic diagram. Be careful not to put any stress on the pins of the sensor.

When the display and zero adjust potentiometer operate normally as described, the check-out procedure is complete.

FINAL TEST

Then final test of the CO Sniffer is to expose it to a source of carbon monoxide gas and verify that the instrument responds properly. This is a simple test that must be performed outdoors, since a substantial concentration of carbon monoxide will be generated. ***Do not attempt this procedure indoors.***

Carbon monoxide can be generated very easily by igniting a common charcoal briquette. Using your cookout grill or any other suitable metal container, ignite the briquette by any means available, such as an electric starter, charcoal lighter fluid, or newspaper. Allow sufficient time for the briquette to become covered with ash.

Using metal tongs, place one briquette into a common, empty, dry tin can that has been placed on a fireproof surface. Be careful; the can will become hot. Then hold the CO Sniffer high enough above the can to avoid hot gases, while allowing the carbon monoxide to enter the sensor. When it does, the display reading will slowly increase. The maximum reading obtained will depend upon the concentration of gas, and could reach a high of more than 500 PPM. This is a vivid demonstration of how dangerous charcoal briquettes can be. Remove the instrument from the source of CO and the display reading will quickly decrease towards zero.

This completes the final test. Be sure to extinguish the briquette by filling the can with water.

USING THE INSTRUMENT

A reasonably fresh alkaline battery will operate the instrument satisfactorily. Turn the instrument on and allow sufficient time for the display reading to stabilize. This may take a few minutes, depending upon how long the unit has been idle.

With the Sniffer located in an area of fresh air, use the zero set control to obtain a reading as close to zero as practical. Then take the instrument and "sniff" out areas where carbon monoxide gas may be present, such as the flue of a heating system, gas appliance, or fireplace area. Allow at least two minutes response time. You may also check out any area where automobiles, trucks, or lawn mowers may be operating.

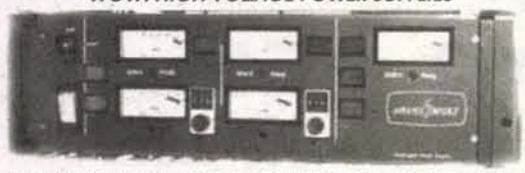
The display will indicate the concentration of CO present. Normal readings should be less than 10 PPM. If a measurement greater than this is obtained, use the instrument to determine the source of the gas by locating the point where the readings are highest. Once this is done, use corrective action to eliminate the source of CO. If necessary, call in professional personnel to repair and correct the problem.

If the display reading becomes dim or unstable, replace the battery with a new one. Since the circuit uses about three milliamperes of current, battery life will be extremely long. **NV**

Connection #1	Analog board +5 volts to display board, R1
Connection #2	Analog board +9 volts to display board U4, pin 1
Connection #3	Analog board R12 to display board U4, pin 31
Connection #4	Analog board R14/R15 to display board U4, pin 30
Connection #5	Analog board GND to display board GND

TABLE 3 — BOARD-TO-BOARD CONNECTIONS

WOW! HIGH VOLTAGE POWER SUPPLIES



Top photo, Advance Hivolt, Quadrupole power supply with three outputs: -30KVDC@ 1.5mA, +30KVDC@ 1.5mA and -300V fixed. The 30KV supplies are adjustable via the front panel multi turn controls with counting dials. Voltage and current is displayed on five front panel meters. Standard rack mount package, 5 1/2" high. 120VAC operation. Like new condition.
AH30KVQW....$995 with HV cable. AH30KVQN....$895 No HV cable.

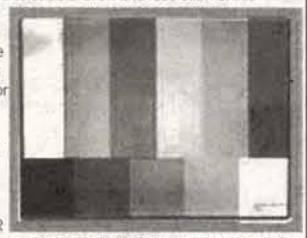
Bottom photo, Glassman, EH series, EH02N50-0XS3, -2KVDC@50mA power supply. Voltage and current limit are adjustable via the front panel multi turn controls with counting dials. Voltage and current is displayed on two front panel meters. Standard rack mount package, 3 1/2" high. 120VAC operation. Excellent condition. **GLASS-02N50.....$349**

Not shown, Glassman, ER series, ER040N05, -40KVDC@5mA power supply. Blank front panel model for remote control applications. Voltage and current limit are adjustable via the rear panel connector by application of a control voltage. (0-10VDC) Voltage and current is read back as a proportional signal at the rear panel as well. Standard rack mount package, 3 1/2" high. 120VAC operation. With HV output cable and manual.
BRAND NEW, GLASS-040N05.....$1295

350MHz, TEKTRONIX 2467, MICRO CHANNEL PLATE CRT! 4 Channels, 500ps per div. in normal room light.

Displays intermittent variations as they happen. Captures the slowest one shot events with 4ns per division a 100 fold increase in the visual writing rate over conventional CRT. Features: 1 ns rise time, 500ps/Div time base, 2mV/Div. vertical sensitivity at 350MHz, 20ps time interval resolution, 1Mohm / 50-ohm input, 500Mhz trigger bandwidth, four channels. On-screen waveform cursors provide vertical & horizontal scale factors, trigger level, voltage, time, freq., phase, ratio values and mode indication. Complete with 2 probes, pouch, and manual. Mint cond. 90 day warranty.
New.....$12K Now TEK2467.....$3250.

NEW! 6.8" LCD COLOR, TFT, ACTIVE MATRIX DISPLAY A huge 23sq. inch VIEWABLE AREA, Super Deal. 2.8X the VIEWING AREA of a 4" panel and 1.5X a 5.6"



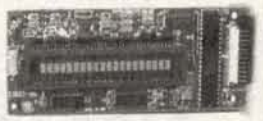
WOW! We wish you could see the color saturation and resolution of this superior LCD display, it is fantastic. Excellent contrast ratio, high quality, full color images are comparable to a CRT. Perfect as a portable, general purpose color monitor for standard NTSC color or B&W video systems. Fully compatible with all our cameras as well as Camcorders, VCR's, DVD's etc. OEM "component" style unit has no outer cabinet. Designed to be installed in YOUR housing. Specifications: Resolution, 1152H x 234V, 270K Pixels! Viewing angle, Top 10°, Down 30°, Left 45°, Right 45° , Brightness, 300 nit, Size: W x H x D (mm/in), 157.2 x 122.6 x 8.0, 6.2" x 4.83" x 1.1", Weight (gm./oz.) 280 gm, 10oz. Supplied with 30" input cable. Video input via BNC jack , 12VDC input via a standard barrel connector. Regulated 12VDC @700mA power adapter included. **BRAND NEW, FIRST QUALITY. GMTFT68....$169ea.**

NEW! 0.005 Lux, COLOR NIGHT VISION CAMERA! UNBELIEVABLE LOW LIGHT PERFORMANCE. Our GMV-3K, DOES it ALL!

For covert, military & scientific applications that must be color, this is it. Unbelievable 0.005Lux @ f1.2 performance is enhanced through low speed electronic shuttering, digital frame integration and advanced DSP. Auto sensitivity mode starts as it becomes dark. 24 hour surveillance is possible with the optional f1.2 auto iris lens shown below. Seven Gain/Shutter modes are user selectable. Normal, X4, X8, X16, X24, X32, X64. These provide frame rates of 60, 15, 8, 4, 3, 2 and 1 per second. Auto/Man. white balance 3200° to 10000°K, auto/man BLC, S/N >52dB, Mirror on/off, Gain on/off, auto electronic shutter 1/60 to 1/120,000 sec., Alum. housing, dual 1/4x20 mtg. Specs: 1/2" CCD, 768(H) X 494(V), with 380K pixels, 470 Lines, 12VDC ±1V@200mA, Std. video out on BNC. Size: 51mm x 51mm x115mm long. Regulated power adapter included. All functions can be externally controlled. Use standard c-mount lens not included. **SPECIAL GMV-3K.....$499ea.**

High performance auto iris lens, 12mm, f1.2....$199ea.

IEE, 1X20 VACUUM FLUORESCENT DISPLAY MODULE



New, model S03601-82-02C series. The module includes the VFD, microcomputer and driver. Connects directly to the system bus via 8 bit, TTL compatible input. Display up to 20 dot matrix, 5 x 7 characters (96 character U.S. ASCII-7), 5mm H x 3.5mm W with cursor. Display color is green at 505nm. Brightness is 170fL, Weight: 4 oz. Size: 6.63"L x 2.2"H x 0.6" thick. Power required is 5VDC@ 386mA. Perfect for any high visibility display requirement. With data. ***SPECIAL IEE-VFD20.....$12ea. or 4 for $39***

LCD, 128X64, GRAPHIC DISPLAYS from Varitronix,

type MGLS12864T-G-HT-HV, 128 x 64 pixel module. Standard Toshiba T6963 driver with 8 bit parallel interface. Module size: 78mmW x 70mmH x 10mmD, Viewing area: 62mmW x 44mm H. Dot size: 0.39mm x 0.55mm, Dot pitch: 0.44mm x 0.60mm. with data. An excellent display. Removed from new equipment. Very Limited Quantity. **LCD-MGLS128..$24ea. or 3/69**

12VDC DC GEAR MOTOR, HEAVY DUTY, HIGH TORQUE. ALL METAL.

These are brand new, very rugged, right angle drive, gearmotors originally intended as car window motors. They are very substantial, weighing over 2 pounds each! They offer a 0.9" diameter x 0.3"H, 9 tooth steel gear drive, located centered between three 0.28" diameter cast aluminum "spider" mounting points. Each offset 120° and on a diameter of 2.5". Overall size: 3.7"W x 7.25"L x 2"H (including the gear) with standard automotive style 2 pin connector. Motor will operate with good torque with as little as 3VDC, nominal is 12VDC @ 850mA no load. WITH AN RPM OF 70/MINUTE. Also it is of course, reversible. ***Special, WINDOW MTR-248.....$20ea. or 4 for $69***

DUAL RAIL, Motorized LINEAR SLIDE with HEFTY, 3/8" thick construction.

These used slides are a super find. Extremely rugged, each weighs in at an impressive XX pounds. The 8" Square x 3/8" thick carriage plate sits atop two, TWN series Thompson, ball bearing "Super pillow blocks" riding on two parallel, 3.75" spaced, 1/2" diam. steel guide rods. As if this were not already enough, the base is a 9"W x 23 1/2"L x 3/8" thick black anodized aluminum plate! The underside of which supports the Vexta PH268-21, 2 phase stepper motor, rated at 5.4VDC @1.5AMPS. This five wire stepper drives a 1.5" diameter toothed pulley which in turn drives a 1/4" re-enforced toothed belt drive attached to the carriage. This impressive unit provides 19" of travel. Very limited quantity, don't wait. ***DUAL SLIDE-19.....$249ea.***

NEW, 470 LINE "DSP COLOR Micro CAM" The HIGHEST PERFORMANCE you can get in a MICRO SIZE.

Yes 470 lines with a 60db S/N ratio to back it up! That's 16X better than a typical 46dB standard camera! The GM-4500, 1/4" CCD camera with its' DSP technology provides high speed white balance with no color rolling. Auto shutter speed of 1/60 to 1/120,000 second. Truly state of the art. Sleek cast aluminum housing protects the 18mm x 26mm pc board inside. Removable mtg. bracket & a 18" cable with BNC video and DC pwr. jack for, no sweat hook up. requires only 12VDC@ 65mA. Optional mirror function available. Why fool around with an open P.C. board? This camera has it all.
• 1/4" CCD • 470 Lines • 1 Lux • AGC • Auto Shutter
• Pwr. 12V @65mA • 270k pixels • Std. 3.7 mm, 68° FOV lens • Focus:10mm to infinity
• 3<ounce! • Size (mm): 33W x 29H x 30D ***GM-4500-STD,*** **SPECIAL...$99ea.**

ULTRA MINI and WEATHERPROOF, "LIPSTICK" CAM

Sleek black anodized, alum. housing, O-Ring sealed & RAINPROOF. Adj. tilting mount. 1/3" CCD, 380 Lines, 0.3 Lux, AGC, Auto Shutter. 9-12VDC @100mA, 4mm, f1.8, 78° FOV real glass lens, NTSC video. <1ounce! IR SENSITIVE. 23mmdX50mm, 36" cable with BNC video & DC barrel jack. Also available as a pinhole model, so tiny you can install it directly into a door. Only a 0.9" diameter hole! 90° FOV real glass lens, 1/2 once! Size only 23mm d.x35mm long. Think of the places you could put this little jewel.
GM-200K-STD. or GM-200KPH.....$69ea.
Power adapter.....$4.95ea.

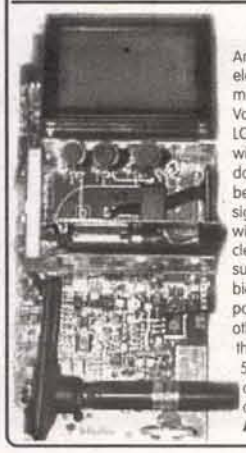
NEW, "STEALTH CAM", MICRO SIZE, with AUDIO!

The sleek aluminum housing fits like a glove! Removeable mtg. bracket & a 1.3M cable with BNC vid., RCA aud., (internal mic) & DC pwr. jack for, no sweat hook up. Why fool around with an open P.C. board? Now you can have the "STEALTH CAM" • 1/3" CCD • 410 Lines • 0.3"Lux • AGC • Auto Shutter • Pwr. 12V @110mA • 250k pixels • Std. 4mm, 78° FOV lens • Pinhole, 90° FOV • Focus:10mm to inf. • NTSC video • <1 ounce! • IR SENSITIVE • Size Std: 30mm sq. x 29mm d. PH: 16mm d, Don't confuse with LOW RES., HIGH LUX C-MOS CAMERAS ***GM-2000S-STANDARD OR PINHOLE,*** **with audio, SPECIAL...$69ea.**

NEW, "COLOR STEALTH CAM" MICRO SIZE, with AUDIO!

That's right! COLOR! In the same size package too! Sleek aluminum housing fits like a glove! Removeable mtg. bracket & a 1.3M cable with BNC vid., RCA aud., (internal mic) & DC pwr. jack for, no sweat hook up. Why fool around with an open P.C. board? Now you can have the "COLOR STEALTH CAM" • 1/3" • 350 Lines • 0.7 Lux • AGC • Auto Shutter • Pwr. 6-12V @30mA • 270k pixels • Std. 7 mm, 56° FOV lens • Focus:10mm to inf. • NTSC video • 1<ounce! • Size: 31mm sq. x 28mm d. ***GM-4000S-STD*** **w/audio, SPECIAL...$89ea.**

PHOTON COUNTING SYSTEM, An OPTICAL EXPERIMENTERS DELIGHT



An advanced photon counting system with state of the art electronics including a Hamamatsu, R647 photo-multiplier tube sensor. with solid state power supply, A Varitronix type, MGLS12864T-G-HT-HV, 128 x 64 Graphic LCD display, a Micro thermal printer and a 80C320 micro with 581000AP external memory. Essentially a portable data logging system designed to detect photons. We believe it also has an RS-232 port. As well as associated signal processing for the PMT. An unbelievable gadget with big potential. Originally intended to monitor the cleanliness of surfaces in food and beverage plants, supermarkets, restaurants etc. Monitor efficiency of biocides. Detect contamination in water samples in the paper and pulp industry, water treatment industry and other water applications. (printer uses std. 2.2" wide thermal paper rolls) Power required: external regulated 5VDC. Size: 3.75"W x 7.6"L x 2.75"H Units are mounted on removeable plastic chassis. Guaranteed to power up and initialize only. **PHOTON-T.....$59ea.**
Also Untested.....Photon-U.....$49ea.

SUPER, MINI C-MOUNT CAMERAS, Super sensitive, GM410 or the general purpose GM412,

The GM-412 specs: B&W, size 1.5"sq. X 2.4"L, 250,000 Pixels, 380 Lines Resolution, Sensitivity 0.3 Lux, The GM410 specs: size only 1.5" SQ. x 1.6"L, >270,000 Pixels, 410 Lines Res., Sens. 0.05 LUX., Both cameras are 1/3" CCD with AGC & Electronic shutter. 12V @110mA power. NTSC out. IR SENSITIVE, BNC video out, Both use std. DC pwr. jack. Aluminum housings with dual threaded top and bottom mounting. True performance not hype! These cameras will outperform ANY camera in this magazine. Multi-lens options are available to exploit their superior performance.GM412 shown bottom. GM410 shown top.

GM412, less lens..$99,
GM410, less lens..$149

C-MOUNT LENSES

LOW LIGHT	STANDARD
16mm, f1.6, 15° FOV $39	4mm, 80° FOV $24
8mm, f1.3, 40° FOV $49	8mm, 40° FOV $24
4mm, f1.4, 78° FOV $49	12mm, 28° FOV $24

NEW, 9" SECURITY MONITORS,

Hi-resolution, 700 Line, B&W units. 90 day warranty. BNC video in and loop through. Rugged steel case. Current production model. Limited qty. They will make your video look super!
SPECIAL.....$99.00ea.

PORTABLE MINI PRINTER, 40 COLUMN, with INTERNAL NI-CAD POWER!

The model SD222-1000 is a NEW & very cool, self contained, alphanumeric/graphic, impact printer. Standard parallel port, internal Ni-Cad power supply. Can be powered via the 9VDC pwr. adapter supplied. Standard 2" paper and Epson ERC-09 ribbon (included) both available at Staples etc. Has self test & diagnostic mode. Can emulate Epson and Citizen 560. It will print from the LPT port of your PC. Very rugged & well made. Perfect for remote printing or data logging application. Size: 8"L x 4.1"W x 3.5"H. STD. **SPECIAL SALE.....$39ea. or 2 for $69**

KOLLMORGEN, ServoDisc MOTOR with 2500ppr optical encoder!

S6M4H Type, Rugged, ironless, low inertia rotor for high acceleration and zero cogging. Very compact 3.4" diameter x 4.2" high including the encoder. Peak torque 214 oz-in, rated speed 3000 RPM, cont. torque, 21 oz-in, Power output 46W, Max. speed 6000 rpm, Peak acceleration, 251 kRads/s², Rated voltage 17.7V@ 5.2Amps, Weight 2.3lbs. A fantastic motor for difficult applications. Removed from like new equipment.
KOLLMORGEN, S6M4H..$189ea. or 2 for $350

WORLDS SMALLEST ••100mW•• VIDEO TRANSMITTER,

Only 0.9"x0.8"x 0.37" Transmits crystal controlled, hi-res., color or B&W images @100mW output! Shown actual size. Smaller than the 9V battery which powers it. Draws only 35mA! Factory tuned Receive on cable channel 59. UHF Bow tie antenna with balun, 3'F cable for TV incl. **TVX-100.....$159ea.**

NEW & IMPROVED, 0.003Lux, UNDERWATER B&W CAMERA, 16X MORE SENSITIVE. Now with 12 INTERNAL, INFRA-RED LEDs!

Sleek black anodized, BRASS, housing. O-Ring sealed & WATERPROOF down to 60feet. Adjustabe mount included. Specs: 1/3" CCD, 400 Lines res.,super 0.003 Lux sensitivity, AGC, Auto Shutter. 12VDC @200mA, 4mm, 78° FOV lens, A real glass lens. NTSC video out. Superior construction. SENSITIVE to IR. Ultra small Size only: 1.25"diam. X 2" long. With 60 ft. cable. Perfect as a remote area, pipe or ductwork inspection camera. Excellent for general outdoor use as well. **GM-300KX-12..$179**

NEW and IMPROVED, COLOR (down to 60 ft.) UNDERWATER. now with 12, Built-in WHITE LIGHT LED'S,

Sleek black anodized, BRASS, housing. O-Ring sealed & WATERPROOF. Adjustabe mount incl. Specs: 1/4" CCD, 350 Lines res., 0.5 Lux sensitivity, AGC, Auto Shutter. 12VDC @200mA, 4mm, 78° FOV lens, A real glass lens. NTSC video out. Superior construction. Ultra small Size only: 1.25"diam. X 2" long. With 60 ft. cable. Perfect as a remote area inspection camera. TWELVE, super white LED'S! **GM-400K-12LED.....$229ea.**

DAYLIGHT/LOW LIGHT MINI CAM & A/I LENS,

For dawn 'till dusk applications. Rugged alum. housing, dual mtg. sockets. 1/3" CCD, 420 lines res., 0.1 Lux sens., AGC, 12VDC @120mA. Take full advantage of camera sensitivity with super, 4mm, f1.4, 78° FOV Auto Iris lens included. BNC video out. 50mm sq. X 65mmL. With pwr. adapt. **GM-510A/I...$179 or 2/$349**

B&W QUAD PROCESOR,

The GM4-BQ is an unbeatable value. Four camera inputs with loop through. Full screen image, REAL TIME display, high resolution: 960 x480, brightness adj. for each chan. Alarm time (1-20 sec.) 4 alarm inputs. Auto Sequencing mode with adj. dwell:1-4 sec. Quality video processing. Specs: •4 video inputs. •1 monitor out and VCR in/out, •4 alarm inputs •Buzzer •2 Alarm Out •Dim: 239 x166 x55 mm. ***GM4-BQ QUAD.....$179***

ULTRA RESOLUTION & HIGH SENSITIVITY, SCIENTIFIC QUALITY for demanding applications.

Type GM-6000, offers 410K pixels, 570 Lines resolution, < 0.1 LUX sensitivity. >45db s/N with AGC off. Access all operating parameters, outside the camera! C or CS mount. Adjustable shutter speed from 1/60 to 1/100,000sec, BLC on/off, AGC on/off, gain auto/off., Auto iris selectable, DC/Video with level control, external/internal sync. 24VAC powered, adapter included. Video out on BNC. Industrial quality metal housing.Just the thing for scientific or low light. **SPECIAL, GM6000.....$199ea.**

HP 85640A Tracking Generator, 300 kHz-2.9 GHz, for HP 8560 series $5,000.00
HP 8565A-100 Spectrum Analyzer, 10 MHz-22 GHz, 100 Hz min. res. bw. $3,000.00
HP 8568B Spectrum Analyzer, 100 Hz-1.5 GHz, 10 Hz min. res $8,500.00
HP 8569B Spectrum Analyzer, 10 MHz-22 GHz, 100 Hz min.res.bw. $5,500.00
TEK 492-opt.02 Spectrum Analyzer, 50 kHz-18 GHz, 1 kHz res. $4,250.00
TEK WM782V WR15 Harmonic Mixer, 50-75 GHz $1,500.00

NETWORK ANALYZERS

HP 11650A Network Analyzer Accessory Kit, APC7 ..... $600.00
HP 11665B Modulator, 0.15-18 GHz, for HP 8755/6/7 ..... $250.00
HP 8502B 75 Ohm Transmission/ Reflection Test Unit, 0.5-1300 MHz $675.00
HP 85054A Type N Calibration Kit, for HP 8510 series $1,800.00
HP 8717A Transistor Bias Supply $500.00
HP 8756A Scalar Network Analyzer, HPIB $1,375.00
HP R85026A WR28 Detector, 26.5-40 GHz, for HP 8757 series $1,200.00

SIGNAL GENERATORS

FLUKE 6060A Synthesized Signal Gen., 0.1-1050 MHz, 10 Hz res. $1,500.00
FLUKE 6060B/AK Synthesized Signal Gen., 0.1-1050 MHz, 10 Hz res. $1,900.00
GIGATRONICS 600/6-12 Synthesized Source, 6-12 GHz, 1 MHz res., GPIB $1,800.00
GIGATRONICS 6000/8-16 Synthesized CW Gen., 8-16 GHz, 1 MHz res., +10 dBm $2,250.00
GIGATRONICS 875/50 Levelled Multiplier, x4, 50.0-75.0 GHz output, -3 dBm $2,500.00
GIGATRONICS 900/2-8 Synthesized Signal/Sweep Gen., 2-8 GHz, 1 MHz res.,GPIB $2,000.00
HP 11707A Test Plug-in for HP 8660 series $500.00
HP 11720A Pulse Modulator, 2-18 GHz, 80 dB on/off ratio $450.00
HP 3335A-001 Synthesizer/ Level Gen., 200 Hz-81 MHz, -87 to +13 dBm $3,500.00
HP 8656B-001 Signal Generator, 0.1-990 MHz, 10 Hz res., HPIB, OCXO $2,750.00
HP 8660C/86603A/86633B Synthesized Signal Generator, 1-2600 MHz, AM, FM $3,250.00
HP 8660D/86603A-002 Synthesizer, 1-2600 MHz, phase modulation (86635A) $6,000.00
HP 8672A Synthesized Signal Generator, 2-18 GHz, +3 dBm output $4,500.00
HP 8673H-212 Synthesized Signal Generator, 2.0-12.4 GHz, 1 kHz res. $8,750.00
HP 8673M Synthesized Signal Generator, 2-18 GHz, +8 dBm Po $9,500.00
HP 8684B Signal Generator, 5.4-12.5 GHz, AM/ WBFM/ Pulse $3,000.00
HP 8684D-001 Signal Generator, 5.4-18.0 GHz, AM/WBFM/Pulse, +10 dBm $3,750.00
WAVETEK 952 Signal Generator, 1-4 GHz, +10 dBm, AM, FM $750.00
WAVETEK 954 Signal Generator, 3.7-7.6 GHz, +7 dBm, AM, FM $750.00
WAVETEK 957 Signal Generator, 12-18 GHz, +7 dBm, AM, FM $750.00

SWEEP GENERATORS

HP 8350B/83522A Sweep Oscillator, 10-2400 MHz, +13 dBm levelled $3,900.00
HP 8350B/83540A-002,004 Sweep Oscillator, 2.0-8.4 GHz, 70 dB step attenuator $3,900.00
HP 8350B/83545A-002 Sweep Oscillator, 5.9-12.4 GHz, 70 dB step attenuator $3,900.00
HP 8350B/83590A Sweep Generator, 2-20 GHz, +10 dBm levelled $6,500.00
HP 83570A RF Plug-in, 18.0-26.5 GHz, +10 dBm levelled $6,000.00
HP 8601A Generator/Sweeper, 0.1-110 MHz, +20 dBm levelled $400.00
HP 8620C Sweep Oscillator Frame $550.00
HP 86222B-002 RF Plug-in, 10-2400 MHz, +13 dBm lvld., 70 dB step att. $1,250.00
HP 86222B-E69/8620C Sweep Oscillator, 0.01-2 GHz & 2-4 GHz, +10 dBm, w/frame $1,200.00
HP 86235A-001 RF Plug-in, 1.7-4.3 GHz, +16 dBm levelled $400.00
HP 86241A-001 RF Plug-in, 3.2-6.5 GHz, +8 dBm levelled $300.00
HP 86245A RF Plug-in, 5.9-12.4 GHz, +16 dBm external levelling $450.00
HP 86260A-H04 RF Plug-in, 10.0-15.0 GHz, +10 dBm unlevelled $400.00
HP 86290A RF Plug-in, 2.0-18.0 GHz, +7 dBm levelled $1,200.00
HP 86290B RF Plug-in, 2.0-18.6 GHz, +10 dBm levelled $1,650.00
HP 86290C RF Plug-in, 2.0-18.6 GHz, +13 dBm levelled $1,850.00
WAVETEK 2001 Sweep Generator, 1-1400 MHz, +10 dBm, 70 dB step atten. $900.00
WAVETEK 2002A Sweep Generator, 1-2500 MHz, +10 dBm, 70 dB step atten. $1,200.00
WAVETEK 962 Sweep Generator, 1.0-4.0 GHz, markers, +12 dBm unlvld. $950.00
WILTRON 6717B-20 Freq. Synth./ Sweeper, 10 MHz-8.4 GHz, +13 dBm, AM, FM $6,500.00

POWER METERS

BOONTON 42B/41-4E Analog Power Meter, with 1 MHz-18 GHz sensor $450.00
HP 432A/478A Power Meter, -30 to +10 dBm, 10 MHz-10 GHz $300.00
HP 435B/8481A Power Meter, -30 to +20 dBm, 10 MHz-18 GHz $900.00
HP 435B/8482B Power Meter, 0 to +43 dBm, 100 kHz-4.2 GHz $1,500.00
HP 436A-022/8481A Power Meter, -30 to +20 dBm, 10 MHz-18 GHz, HPIB $1,200.00
HP 436A-022/8484A Power Meter, -70 to -20 dBm, 10 MHz-18 GHz, HPIB $1,200.00
HP Q8486A Power Sensor, 33.0-50.0 GHz, WR22, for 435/6/7/8 ..... $1,500.00
HP R8486A WR28 Power Sensor, 26.5-40 GHz, for HP 435/6/7/8 ..... $1,500.00

RF MILLIVOLTMETERS

BOONTON 92C RF Millivoltmeter, 3 mV-3 V f.s., 10 kHz-1.2 GHz $500.00
RACAL-DANA 9303 RF Millivoltmeter, 10 kHz-2 GHz, -70 to +20 dBm $750.00

AMPLIFIERS, MISCELLANEOUS

AMPLIFIER RESEARCH 4W1000 Amplifier, 40 dB gain, 4 Watts, 1-1000 MHz $950.00
BOONTON 82AD Modulation Meter, AM / FM, 10-1200 MHz $650.00
C.P.I. VZC6961K1 TWT Amplifier, 35 dB gain, 4-8 GHz, 20 Watts $3,500.00
HP 11729B-003 Carrier Noise Test Set, 5 MHz-3.2 GHz $2,250.00
HP 415E SWR Meter $200.00
HP 8406A Comb Generator, 1/ 10/ 100 MHz increments, to 5 GHz $500.00
HP 8447A Amplifier, 20 dB, 0.1-400 MHz, 5 dB NF, +6 dBm output $375.00
HP 8447E Amplifier, 22 dB, 0.1-1300 MHz, +13 dBm output $750.00
HP 8447F-H64 Dual Amp., 9 kHz-50 MHz 28 dB & 0.1-1300 MHz 25 dB $900.00
HP 8901A Modulation Analyzer, 150 kHz-1300 MHz $1,500.00
HP 8901B-1,2,3 Modulation An., 0.15-1300 MHz, rear input, OCXO, ext.LO $2,000.00
HP 8970A Noise Figure Meter $3,750.00
HUGHES 1177H01F000 TWT Amplifier, >30 dB gain, 2-4 GHz, 10 Watts output $1,750.00
HUGHES 1177H10F000 TWT Amplifier, >30 dB gain, 1.4-2.4 GHz, 20 Watts $2,500.00
HUGHES 8010H13F000 TWT Amplifier, >30 dB gain, 3-8 GHz, 10 Watts $2,500.00
RF POWER LABS ML50 Amplifier, 2-30 MHz, 47 dB gain, 50 Watts, metered, 28V $275.00
ROHDE & SCHWARTZ ESH2 Test Receiver, 9 kHz-30 MHz $3,750.00

COAXIAL & WAVEGUIDE

AEROWAVE 28-3000/10 WR28 Directional Coupler, 10 dB, 26.5-40 GHz $300.00
AMERICAN NUCLEONICS AM-432 Cavity Backed Spiral Antenna,LHC, 2-18 GHz,TNC(f) *NEW* $95.00
AVANTEK AMT-400X2 WR28 Active Doubler, +10 dBm in/ +10 dBm out 26-40 GHz $450.00
BIRD 6735-300 1 kW Load, 25-1000 MHz, LC(f), with wattmeter $650.00
BIRD 8201 500 Watt Oil Dielectric Load, DC-2.5 GHz, N(f) $350.00
FXR/MICROLAB SL-03N Stub Stretcher, 0.3-6.0 GHz, 100 Watts max., N(m/f) $75.00
GR 874-LTL Constant Impedance Trombone Line, 0-44 cm, DC-2 GHz $400.00
HP 11590A-001 Bias Network, 1.0-18.0 GHz, APC7 ..... $450.00
HP 11691D-001 Directional Coupler, 22 dB, 2-18 GHz, N(f)-all ports $450.00
HP 11692D Dual Directional Coupler, 22 dB, 2-18 GHz $800.00
HP 33321K Programmable Step Atten., 0-70 dB, DC-26.5 GHz, 3.5mm $475.00
HP 33327L-006 Programmable Step Attenuator, 0-70 dB, DC-40 GHz, 2.9mm $1,000.00
HP 778D-011 Dual Dir. Coupler, 20 dB, 100-2000 MHz, APC7 test port $450.00
HP 8431A 2-4 GHz Band Pass Filter, N(m/f) $150.00
HP 8494G-002 Programmable Step Attenuator, 0-11 dB, DC-4 GHz, SMA $350.00
HP 87300C-020 Directional Coupler, 20 dB, 1.0-26.5 GHz, 3.5mm $475.00
HP K422A WR42 Flat Broadband Detector, 18.0-26.5 GHz $350.00
HP K532A WR42 Frequency Meter, 18.0-26.5 GHz $450.00
HP K752A WR42 Directional Coupler, 3 dB, 18.0-26.5 GHz $450.00
HP K752C WR42 Directional Coupler, 10 dB, 18.0-26.5 GHz $450.00
HP K752D WR42 Directional Coupler, 20 dB, 18.0-26.5 GHz $450.00
HP K870A WR42 Slide Screw Tuner, 18.0-26.5 GHz $275.00
HP K914B WR42 Moving Load, 18.0-26.5 GHz $300.00
HP Q752D WR22 Directional Coupler, 20 dB, 33-50 GHz $650.00
HP R422A WR28 Crystal Detector, 26.5-40 GHz $400.00
HP R752D WR28 Directional Coupler, 20 dB, 26.5-40 GHz $450.00
HP R914B WR28 Moving Load, 26.5-40 GHz $250.00
HP V365A WR15 Isolator, 25 dB, 50-75 GHz $750.00
HP V752D WR15 Directional Coupler, 20 dB, 50-75 GHz $650.00
HP X870A WR90 Slide Screw Tuner $150.00
HUGHES 45322H-1110/1120 WR22 Directional Couplers, 10 or 20 dB, 33-50 GHz $350.00
HUGHES 45712H-1000 WR22 Frequency Meter, 33-50 GHz $750.00
HUGHES 45714H-1000 WR15 Frequency Meter, 50-75 GHz $900.00
HUGHES 45721H-2000 WR28 Direct Reading Attenuator, 0-50 dB, 26.5-40 GHz $1,000.00
HUGHES 45722H-1000 WR22 Direct Reading Attenuator, 0-50 dB, 33-50 GHz $1,000.00
HUGHES 45724H-1000 WR15 Direct Reading Attenuator, 0-50 dB, 50-75 GHz $1,000.00
HUGHES 45732H-1200 WR22 Level Set Attenuator, 0-25 dB, 33-50 GHz $250.00
HUGHES 45752H-1000 WR22 Direct Reading Phase Shifter, 0-360 deg.,33-50 GHz $1,400.00
HUGHES 45772H-1100 WR22 Thermistor Mount, -20 to +10 dBm, 33-50 GHz $400.00
HUGHES 45773H-1100 WR19 Thermistor Mount, -20 to +10 dBm, 40-60 GHz $650.00
HUGHES 45774H-1100 WR15 Thermistor Mount, -20 to +10 dBm, 50-75 GHz $750.00
HUGHES 47316H-1111 WR10 Tuneable Detector, 75-110 GHz, positive polarity $600.00
HUGHES 47741H-2310 WR28 Phase Locked Gunn Osc., 32.000 GHz, +18 dBm $2,000.00
HUGHES 47742H-1210 WR22 Phase Locked Gunn Osc., 42.000 GHz, +18 dBm $2,750.00
KRYTAR 201020010 Directional Detector, 1-20 GHz, SMA(f/f)/SMC $200.00
KRYTAR 2616S Directional Detector, 1.7-26.5 GHz, K(f/m)/SMC $200.00
M/A-COM 3-19-300/10 WR19 Directional Coupler, 10 dB, 40-60 GHz $450.00
MICA C-121S06 Circulator, 17.5-24.5 GHz, SMA(f/m/m) $75.00
NARDA 3000-SERIES Directional Couplers $150.00
NARDA 3020A Bi-Directional Coupler, 50-1000 MHz, N $500.00
NARDA 3024 Bi-Directional Coupler, 20 dB, 4-8 GHz $375.00
NARDA 3090-SERIES Precision High Directivity Couplers $225.00
NARDA 368BNM Coaxial High Power Load, 500 Watts, 2.0-18 GHz, N(m) $500.00
NARDA 3752 Coaxial Phase Shifter, 0-180 deg./GHz, 1-5 GHz $1,000.00
NARDA 3753B Coaxial Phase Shifter, 0-55 deg./GHz, 3.5-12.4 GHz $1,000.00
NARDA 4000-SERIES SMA Miniature Directional Couplers $75.00
NARDA 4247-20 Directional Coupler, 20 dB, 6.0-26.5 GHz, 3.5mm(f) $200.00
NARDA 4247B-10 Directional Coupler, 10 dB, 6.0-26.5 GHz, 3.5mm(f) $200.00
NARDA 5070-SERIES Precision Reflectometer Couplers $300.00
NARDA 562 DC Block, 10 MHz-12.4 GHz, 100 V max., N(m/f) $65.00
NARDA 765-10 10 dB Attenuator, 50 Watts, DC-5 GHz, N(m/f) $165.00
NARDA 791FM Variable Attenuator, 0-37 dB, 2.0-12.4 GHz $600.00
NARDA 792FF Variable Attenuator, 0-20 dB, 2.0-12.4 GHz $375.00
NARDA 793FM Direct Reading Variable Attenuator, 0-20 dB, 4-8 GHz $225.00
NARDA 794FM Direct Reading Variable Attenuator, 0-40 dB, 4-8 GHz $375.00
OMNI-SPECTRA 2085-6010-00 Crystal Detector, 1-18 GHz, negative polarity, SMA(m/f) $50.00
PAMTECH KYG1014 WR42 Junction Circulator, 18.0-26.5 GHz $250.00
SONOMA SCIENTIFIC 21A3 WR42 Circulator, 20 dB, 20.6-24.8 GHz $75.00
TEKTRONIX 2701 Step Attenuator, 0-79 dB, DC-1 GHz, AC or DC coupled $175.00
TRG B510 WR22 Direct Reading Attenuator, 0-50 dB, 33-50 GHz $900.00
TRG V551 WR15 Frequency Meter, 50-75 GHz $600.00
TRG W510 WR10 Direct Reading Attenuator, 0-50 dB, 75-110 GHz $1,000.00
TRG W551 WR10 Frequency Meter, 75-110 GHz $750.00
WAVELINE 100080 WR28 Terminated Crossguide Coupler, 30 dB $200.00
WEINSCHEL 150-110 Programmable Step Attenuator, 0-110 dB, DC-18 GHz, SMA $450.00
WEINSCHEL DS109 Double Stub Tuner, 1-13 GHz, N(m/f) $150.00
WEINSCHEL DS109LL Double Stub Tuner, 0.2-2.0 GHz, N(m/f) $150.00

COMMUNICATIONS

HP 4935A Transmission Impairment Measuring Set $600.00
HP 59401A HPIB Bus Analyzer $375.00
TAMPA MICROWAVE LAB BUC1W-02-W-CST Ku band Upconverter, 1 Watt 14.0-14.5 GHz WR75 *NEW* $225.00
TEK 1411R PAL Gen.,w/SPG12 sync; TSG11 color bars;TSG13 linearity $750.00
TEK 1411R PAL Test Gen., w/SPG12,TSG11,TSG13,TSG15,TSG16 ..... $1,000.00
TEK 1411R PAL Test Gen., w/SPG12,TSG11,TSG12,TSG13,TSG15,TSG16 ..... $1,100.00
TEK 1411R-opt.04 PAL Test Gen., w/SPG12,TSG11,TSP11,TSG13,TSG15,TSG16 ..... $1,400.00
TEK 147A NTSC Test Signal Generator, with noise test signal $800.00
TEK 148 PAL Insertion Test Signal Generator $700.00
TEK 520A NTSC Vectorscope $750.00
TEK 521A PAL Vectorscope $750.00

MISCELLANEOUS

EG&G / P.A.R. 5302 / 5316 Lock-in Amplifier, 100 mHz-1 MHz, GPIB / RS232C $2,250.00
FLUKE 2180A RTD Digital Thermometer $500.00
HP 59307A HPIB VHF Switch $200.00
P.A.R. 5206-95,98 Two-Phase Lock-in Amp., 2 Hz-100 kHz, GPIB $1,500.00
TEK TM5003 5000-series 3-slot Programmable Power Module $450.00
TEK TM5006 5000-series 6-slot Programmable Power Module $500.00
TEK TM504 500-series 4-slot Power Module $175.00
TEK TM506 500-series 6-slot Power Module $250.00
TEK TM515 500-series 5-slot Traveller Power Module $250.00

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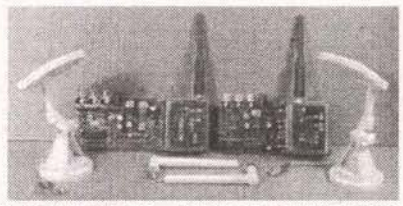
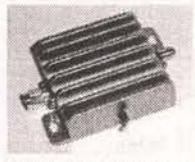
WANTED: ROCKWELL-Collins HF-80 equipment, 851S-1, 237B-3 log periodic, Collins literature. Jim Stitzinger 805-259-2011, 805-259-3830 (fax), bfl-jfs@smartlink.net



2.4GHz ATV — 8 channel TRANSMITTERS AND RECEIVERS. 35mW output power, 1 video channel, 2 audio. SMA connectors. NTSC/PAL compatible. Includes 1/4 wave rubber duck antenna. Standard frequencies are: 2398, 2405, 2412, 2416, 2420, 2428, 2435, 2442 MHz. Custom frequencies are available. See ad in this section for power amplifier. **$79/each for transmitter. $79/each for receiver**. EzATV. Visit our web-site for dealers or order on-line at www.4atv.com

FOR SALE: Collins receiver model 51S-IF with instruction book. Range 0.2 to 30MC, clean, operational. $100 OBO. Call Mike 727-786-3481.



2.4GHz POWER amplifier with power supply. 10-40 mW input, 1 (one) watt output with in-line SMA connectors and built-in heat sink. Approx. 2" x 2" x 5/8" size. Frequency range 2.3GHz-2.5GHz. **$189/each**. Compatible with all ATV product lines. See our website for more info on accessories and transmitter and receiver modules. EzATV. Visit our web-site for dealers or order on-line at www.4atv.com

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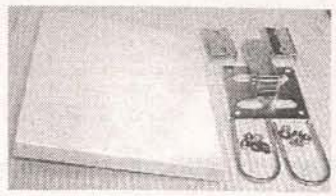
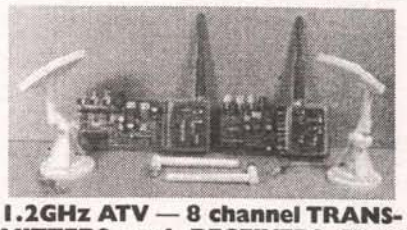


SUPER HIGH GAIN 14 dbi flat antenna with N or SMA connector tuned for 2.3-2.5 GHz. Use with 2.4GHz ATV 8 channel transmitter or receiver. **$179/ea**. SPECIAL PRICE. EzATV. Visit our web-site for dealers or order on-line at www.4atv.com



1.2GHz ATV — 8 channel TRANSMITTERS and RECEIVERS. 75mW output power, 1 video channel, 2 audio. SMA connectors. NTSC/PAL compatible. Includes 1/4 wave rubber duck antenna. Standard frequencies are: 1250, 1255, 1260, 1265, 1270, 1275, 1280, 1290 MHz. Custom frequencies are available. **$79/each for transmitter. $79/each for receiver**. EzATV. Visit our web-site for dealers or order on-line at www.4atv.com

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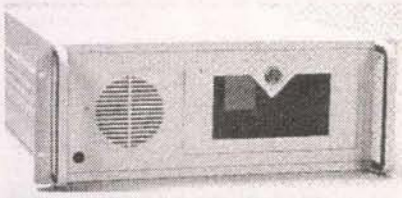

19" RACKMOUNT ATX PC chassis, $149 (with ad). www.stores.yahoo.com/ctitexas, 972-242-8087.

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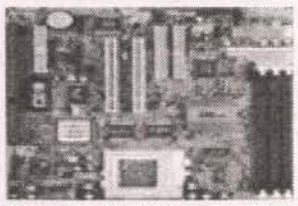

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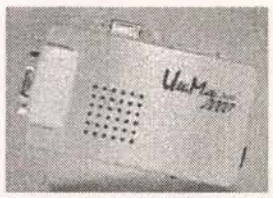

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MAC PRAM batteries: 4.5V square $9.99, 3.6V round $7.99. Qty discounts. 10-6 Pacific 360-698-4828 or www.oasishobby.com

SCSI CABLES new DB25M to SCSI-II M $8.99, DB25M to SCSI-I M $5.99, SCSI-II M-M $9.99. Others available. 10-6 Pacific 360-698-4828 or www.oasishobby.com

DATA ACQUISITION: This very compact and low-cost kit will allow virtually any PC to be used for quick and easy data acquisition and control. It connects to any standard parallel printer port, and despite its tiny size provides eight analog inputs, four digital inputs, and four digital outputs. www.electronickits.com

RAMSEY

Doppler Direction Finder

Track down jammers and hidden transmitters with ease! This is the famous WA2EBY DF'er featured in April 99 QST. Shows direct bearing to transmitter on compass style LED display, easy to hook up to any FM receiver. The transmitter - the object of your DF'ing - need not be FM, it can be AM, FM or CW. Easily connects to receiver's speaker jack and antenna, unit runs on 12 VDC. We even include 4 handy home-brew "mag mount" antennas and cable for quick set up and operation! Whips can be cut and optimized for any frequency from 130-1000 MHz. Track down that jammer, win that fox hunt, zero in on that downed Cessna - this is an easy to build, reliable kit that compares most favorably to commercial units costing upwards of $1000.00! This is a neat kit!!

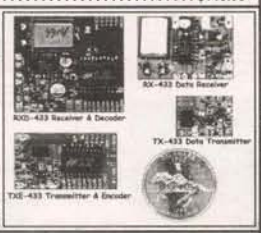
DDF-1, Doppler Direction Finder Kit $149.95

1 GHz RF Signal Generator

A super price on a full featured RF signal generator! Covers 100 KHz to 999.99999 MHz in 10 Hz steps. Tons of features; calibrated AM and FM modulation, 90 front panel memories, built-in RS-232 interface, +10 to -130 dBm output and more! Fast and easy to use, its big bright vacuum florescent display can be read from anywhere on the bench and the handy 'smart-knob' has great analog feel and is intelligently enabled when entering or changing parameters in any field – a real time saver! All functions can be continuously varied without the need for a shift or second function key. In short, this is the generator you'll want on your bench, you won't find a harder working RF signal generator - and you'll save almost $3,000 over competitive units!

RSG-1000B RF Signal Generator $1995.00

Wireless RF Data Link Modules



RF link boards are perfect for any wireless control application; alarms, data transmission, electronic monitoring...you name it. Very stable SAW resonator transmitter, crystal controlled receiver - no frequency drift! Range up to 600 feet, license free 433 MHz band. Encoder/decoder units have 12 bit Holtek HT-12 series chips allowing multiple units all individually addressable, see web site for full details. Super small size - that's a quarter in the picture! Run on 3-12 VDC. Fully wired and tested, ready to go and easy to use!

RX-433 Data Receiver..... $16.95 TX-433 Data Transmitter..... $14.95
RXD-433 Receiver/Decoder..... $21.95 TXE-433 Transmitter/Encoder..... $19.95

Super Pro FM Stereo Transmitter

Professional synthesized FM Stereo station in easy to use, handsome cabinet. Most radio stations require a whole equipment rack to hold all the features we've packed into the FM-100. Set freq with Up/Down buttons, big LED display. Input low pass filter gives great sound (no more squeals or swishing from cheap CD inputs!) Limiters for max 'punch' in audio - without over mod, LED meters to easily set audio levels, built-in mixer with mike, line level inputs. Churches, drive-ins, schools, colleges find the FM-100 the answer to their transmitting needs, you will too. Great features, great price! Kit includes cabinet, whip antenna, 120 VAC supply. *We also offer a high power export version of the FM-100 fully assembled with one watt of RF power, for miles of program coverage. The export version can only be shipped if accompanied by a signed statement that the unit will be exported.*

FM-100, Pro FM Stereo Transmitter Kit $249.95
FM-100WT, Fully Wired High Power FM-100..... $399.95

World's Smallest TV Transmitters

We call them the 'Cubes'.... Perfect video transmission from a transmitter you can hide under a quarter and only as thick as a stack of four pennies - that's a nickel in the picture! Transmits color or B&W with fantastic quality - almost like a direct wired connection to any TV tuned to cable channel 59. Crystal controlled for no frequency drift with performance that equals models that cost hundreds more! Basic 20 mW model transmits up to 300' while the high power 100 mW unit goes up to 1/4 mile. Their very light weight and size make them ideal for balloon and rocket launches, R/C models, robots - you name it! Units run on 9 volts and hook-up to most any CCD camera or standard video source. In fact, all of our cameras have been tested to mate perfectly with our Cubes and work great. Fully assembled - just hook-up power and you're on the air! One customer even put one on his dog!

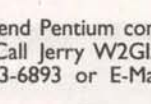
C-2000, Basic Video Transmitter..... $89.95 C-2001, High Power Video Transmitter... $179.95

CCD Video Cameras

Top quality Japanese Class 'A' CCD array, over 440 line line resolution, not the off-spec arrays that are found on many other cameras. Don't be fooled by the cheap CMOS single chip cameras which have 1/2 the resolution, 1/4 the light sensitivity and draw over twice the current! The black & white models are also super IR (Infra-Red) sensitive. Add our invisible to the eye, IR-1 illuminator kit to see in the dark! Color camera has Auto gain, white balance, Back Light Compensation and DSP! Available with Wide-angle (80°) or super slim Pin-hole style lens. Run on 9 VDC, standard 1 volt p-p video. Use our transmitters for wireless transmission to TV set, or add our IB-1 Interface board kit for super easy direct wire hook-up to any Video monitor, VCR or TV with A/V input. Fully assembled, with pre-wired connector.

CCDWA-2, B&W CCD Camera, wide-angle lens $69.95
CCDPH-2, B&W CCD Camera, slim fit pin-hole lens.. $69.95
CCDCC-1, Color CCD Camera, wide-angle lens $129.95
IR-1, IR Illuminator Kit for B&W cameras $24.95
IB-1, Interface Board Kit $14.95

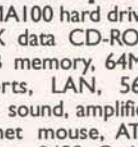
AM Radio Transmitter



Operates in standard AM broadcast band. Pro version, AM-25, is synthesized for stable, no-drift frequency and is setable for high power output where regulations allow, typical range of 1-2 miles. Entry-level AM-1 is tunable, runs FCC maximum 100 mW, range 1/4 mile. Both accept line-level inputs from tape decks, CD players or mike mixers, run on 12 volts DC. Pro AM-25 includes AC power adapter, matching case and bottom loaded wire antenna. Entry-level AM-1 has an available matching case and knob set that dresses up the unit. Great sound, easy to build - you can be on the air in an evening!

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

Mini Radio Receivers



Imagine the fun of tuning into aircraft a hundred miles away, the local police/fire department, ham operators, or how about Radio Moscow or the BBC in London? Now imagine doing this on a little radio you built yourself - in just an evening! These popular little receivers are the nuts for catching all the action on the local ham, aircraft, standard FM broadcast radio, shortwave or WWV National Time Standard radio bands. Pick the receiver of your choice, each easy to build, sensitive receiver has plenty of crystal clear audio to drive any speaker or earphone. Easy one evening assembly, run on 9 volt battery, all have squelch except for shortwave and FM broadcast receiver which has subcarrier output for hook-up to our SCA adapter. The SCA-1 will tune in commercial-free music and other 'hidden' special services when connected to FM receiver. Add our snazzy matching case and knob set for that smart finished look!

AR-1, Airband 108-136 MHz Kit..... $29.95
HFRC-1, WWV 10 MHz (crystal controlled) Kit..... $34.95
FR-1, FM Broadcast Band 88-108 MHz Kit..... $24.95
SR-1, Shortwave 4-11 MHz Band Kit $29.95
SCA-1 SCA Subcarrier Adapter kit for FM radio.... $27.95
FR-6, 6 Meter FM Ham Band Kit $34.95
FR-10, 10 Meter FM Ham Band Kit..... $34.95
FR-146, 2 Meter FM Ham Band Kit..... $34.95
FR-220, 220 MHz FM Ham Band Kit..... $34.95
Matching Case Set (specify for which kit).... $14.95

PIC-Pro Pic Chip Programmer

Easy to use programmer for the PIC16C84, 16F84, 16F83 microcontrollers by Microchip. All software - editor, assembler, run and program - as well as free updates available on Ramsey download site! This is the popular unit designed by Michael Covington and featured in Electronics Now, September 1998. Connects to your parallel port and includes the great looking matching case, knob set and AC power supply. Start programming those really neat microcontrollers now...order your PICPRO today!

PIC-1, PICPRO PIC Chip Programmer Kit $59.95

FM Stereo Radio Transmitters

No drift, microprocessor synthesized! Great audio quality, connect to CD player, tape deck or mike mixer and you're on-the-air. Strapable for high or low power! Runs on 12 VDC or 120 VAC. Kit includes snazzy case, whip antenna, 120 VAC power adapter - easy one evening assembly.

FM-25, Synthesized Stereo Transmitter Kit $129.95

Lower cost alternative to our high performance transmitters. Great value, easily tunable, fun to build. Manual goes into great detail about antennas, range and FCC rules. Handy for sending music thru house and yard, ideal for school projects too - you'll be amazed at the exceptional audio quality! Runs on 9V battery or 5 to 15 VDC. Add matching case and whip antenna set for nice 'pro' look.

FM-10A, Tunable FM Stereo Transmitter Kit..... $34.95
CFM, Matching Case and Antenna Set $14.95
FMAC, 12 Volt DC Wall Plug Adapter..... $9.95

RF Power Booster

Add muscle to your signal, boost power up to 1 watt over a freq range of 100 KHz to over 1000 MHz! Use as a lab amp for signal generators, plus many foreign users employ the LPA-1 to boost the power of their FM transmitters, providing radio service through an entire town. Runs on 12 VDC. For a neat finished look, add the nice matching case set. Outdoor unit attaches right at the antenna for best signal - receiving or transmitting, weatherproof, too!

LPA-1, Power Booster Amplifier Kit..... $39.95
CLPA, Matching Case Set for LPA-1 Kit..... $14.95
LPA-1WT, Fully Wired LPA-1 with Case $99.95
FMBA-1, Outdoor Mast Mount Version of LPA-1 ..... $59.95

FM Station Antennas

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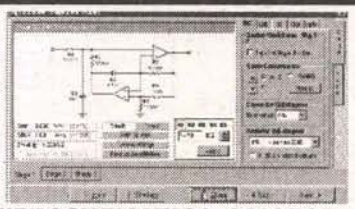

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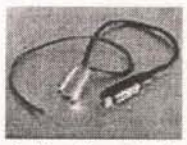

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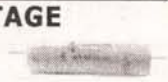

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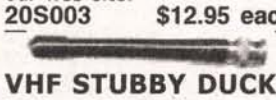

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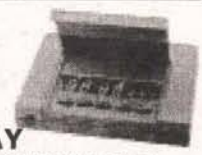

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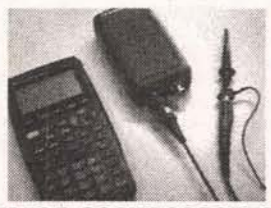

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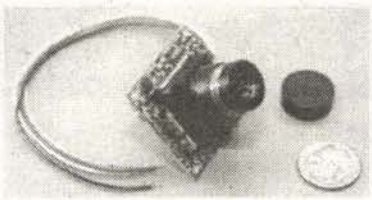

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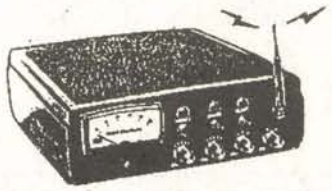

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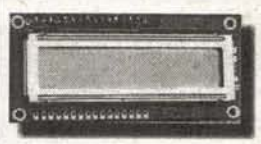

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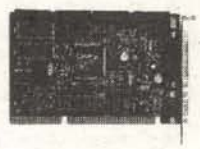

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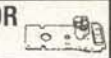

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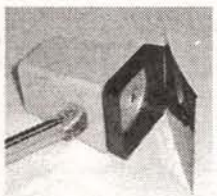

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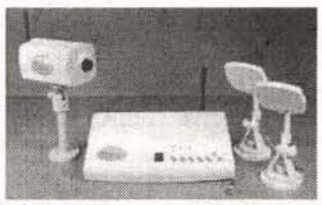

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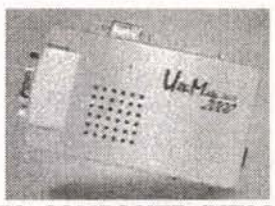

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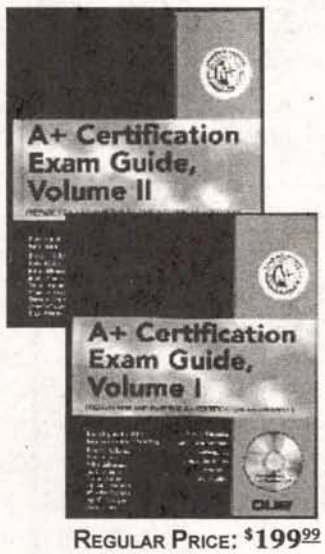

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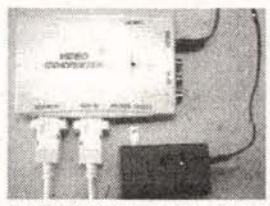

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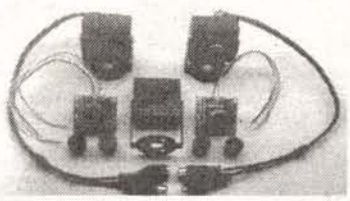

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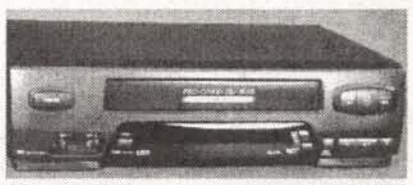

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Continued on page 56

BUILD YOUR VERY OWN ARCADE MACHINE

by Kerry Barlow

Have you ever had a desire to own your very own arcade machine?

If you are like me, you always wanted to play all the new arcade games when they came out, but just could not afford all the quarters they swallowed. I always liked Moon Patrol, but never had more than two quarters to spend on playing the game. Now I can play it every day if I wish, along with more than 2,000 other arcade games.

A friend of mine introduced me to the MAME (multi arcade machine emulator) system of arcade games that runs on any PC-compatible computer. You do not need blazing speed or a large amount of hard drive space, the majority of the older vintage games play fine on my Pentium 166 system with a one-gig hard drive. If you wish to play the latest games available, a PII 300 MHz should run just about anything, and I recommend a larger hard drive for the fancier newest games.

Much detail was gone into on the MAME system and the available ROMs by Phil Combs in the Oct. 2000 issue of *Nuts & Volts*, so I will not add anything to this here. (Check out Fuzzball's "Pick-of-the-Week" section at www.nutsvolts.com for a downloadable version of this article.) I would like to mention that there is another type of emulator system called MESS (multiple emulator super system).

MESS is similar to MAME and is based on the MAME front end, however, MESS emulates console computers, instead of arcade machines. I play all of my old Atari 800XL and TI99/4A games on the MESS system. MESS emulates practically all of the older generation computer systems. MESS comes in both DOS and Win95 versions. The Win95 version is still in BETA testing and I myself use the DOS-based MESS version.

MESS works very much like MAME. I highly recommend it to people who wish to play their old computer games. My arcade machine is set up so that I can play either MAME arcade games, or the MESS computer games. MESS requires you to download the computer ROMs, which are the operating system for each computer. You then can download the games for that computer, either cartridges or floppy disks. Some of the older computers had both available at the time. The screen quality playing my old TI99/4A games is so much better than a TV or monitor going through an old RF interface. MESS Internet addresses can be found in the table of Parts and Links sidebar.

The arcade machine shown in Photos 1 and 2 is based upon the old Defender game. My friend Steve made the majority of these cabinet measurements and he is owed credit for this. People who may recall this game will recognize the cabinet's shape. Happ Controls products were used for all the micro switches and the arcade joysticks. Happ has an excellent magazine and many thousands of actual arcade machine parts available. Happ Control prices are very reasonable for the push-button switches and joysticks. The switches cost $1.50 each, and include the long life micro switch. The joystick is priced at approximately $11.00; this is a digital stick, with four micro switches. A digital switch works fine for the majority of the games, because the original codes were written for digital switches. Happ also sells analog joysticks and roller balls, for those people who really wish to re-create a particular arcade game. Prices on analog sticks are higher, of course, but I am sure they are built to the same high quality standards. These are the actual controls as used by arcades around the world, so they are built to industry standards. (Again, refer to the accompanying Parts List and Internet addresses.)

Readers may be interested in a different method of keyboard and joystick control, which was used in my machine. You may use Phil Comb's keyboard wiring method, or my method outlined as follows.

In the MAME system, you can assign any switch or joystick command to any key on your keyboard. By default, the arrow keys are used for player 1 joystick, number 1 key for coin 1, number 2 key for single player mode, number 3 key for two-player mode, etc. Switches were wired directly to the keyboard button circuits and the wires were brought out the back of the keyboard to the actual panel switches. Photo 3 shows this wiring.

If you look at Photo 4, you will see that there is a fold-out keyboard door built into the cabinet. A working keyboard is very handy for setting up the MAME system, as well as being able to access Windows 95 for other uses. After you get your games up and running, you can access everything you need from the upper button panel/joystick panel. However, when initially setting up your game selections and favorite games, you are going to need a standard keyboard attached. You will also need the keyboard in case your game locks up, or you wish to play other games on the arcade machine.

All of the switches and joysticks were wired directly into a standard IBM compatible keyboard. These cheap keyboards are available almost anywhere and, in the worst case if you bought a new one, it would not cost more then $20.00 these days. A keyboard that had the tiny rubber push-button cups that push upon carbon traces was used in my machine.

On the back side of these keyboards are conventional copper traces that go out through a keyboard matrix to the keyboard's matrix chip. There are also numerous resistors and diodes soldered on the back of these keyboards. The keyboard was opened up to gain access to the back side copper trace section of the keyboard, and then one at a time, I traced out the actual push-button circuit itself from the carbon trace through the PCB board and to the solder side. On so many keyboards, you will eventually find a place where a resistor or a diode is soldered to the circuit board. At this point, I simply attached a new pair of wires, and labeled them for that particular switch.

This modification was really an easy method of

Photo 1

stealing switch contacts. I did not have to scratch any carbon off the pads, nor did I ruin a keyboard. You can now use the same keyboard for both the switch inputs, as well as for a conventional keyboard. It will get to be messy looking with all the wires, so be sure to label each switch as you do them.

The left, right, and up keys may share a single common wire — do not worry about this, simply label your switch accordingly. For example, bring out a single wire labeled as COMMON, Left, Right, and Up. After the single wire is outside the keyboard case, you can then wire separate wires to each switch in the cabinet. At the same time as the switch wires were labeled, I also wrote down on a paper what I was doing.

Different colored wire was used for all the switches. When you are crawling around inside the cabinet wiring things, it will make it much easier for you if you can do this.

You can test the newly-wired keyboard by plugging it into your PC and testing the switch wires. To do this, open a text editor (notepad.exe) and simply short the labeled wires together to see if you are getting the proper keyboard code output letter (Ctrl, Alt, Q, W, E). Some letters do not show of course, such as Ctrl and Alt. MAME has a recommended default keyboard scheme, and I advise using that.

If you are clever and do not mind extra wire, you can also solder the micro switches to the actual wires at this time. After assembly of the cabinet, all you will need to do is snap the micro switch into its button assembly. This really will make life easy; leave approximately two feet of wire, going into the micro switch.

It is also recommended to steal +5V power from the keyboard and bring it out on separate wires. I use this power to light up a tiny LED bulb behind my coin switch. The amperage draw is minimal, just be careful not to short these power wires to anything else! I found the +5V line that went to the Numlock LED and was able to take power from there. On a different keyboard, it was easier to take power directly off the keyboard-input cable where it connects to the circuit board. Be patient, I am sure you will not get all switches operational on the first try. My keyboard was apart five times before everything was correct; part of this was because I was working when tired, and making lots of mistakes. The wiring is simple but can get distracting with 40 wires floating around. Again, colored wires helped here. With your keyboard finished, you will be anxious to begin building the actual arcade cabinet.

This cabinet was designed to be held together from the inside out. To do this, I used many corner blocks inside the cabinet; driving screws through these and into the sides and fronts will hold the cabinet together. This makes a fine external finish. Glue is not necessary; it is more than strong enough with the screws alone. I drilled all the corner blocks with a small drill bit, so that the screw does not bind in the block; this allows the screw to tighten itself in the cabinet and not in the corner blocks. An electric screw gun was used for assembly. If you do not own one, a screwdriver bit chucked in a corded drill will work almost as well; these are available at any hardware or lumberyard. Photo 5 shows the internal corner blocks.

The actual cabinet is built from two sheets of 3/4" particle board, 4' x 8' size. Particle board was used, because it so nearly duplicates the actual arcade machine look. Wafer board and plywood just don't have the correct look to them. By particle board, I mean the stuff that looks like sawdust mixed with glue. If you look at the dimensions, you will see that the overall height is 72 inches and the overall maximum depth is 32 inches.

When you buy your particle boards, ask the lumberyard to cut the main dimensions for you. Lowe's and Home Depot will make two cuts for free and then it is around 50 cents per cut. Have them cut the boards to 32 inches wide and six feet long. This makes it much easier transporting the sheets home in your car, and it also gives you a nice straight edge to work with. Using a circular saw, it is difficult to get a nice straight edge. Bring all the extra chunks of wood home, you will need them for other sections of the cabinet.

The other materials needed are the corner/bracing blocks used inside. The entire cabinet is screwed together from the inside out. This hides all external attachments and makes the job look more professional. I used 1-1/2 inch wood blocks; these can be bought at a lumberyard. I myself used 2" x 4" x 8' boards and ripped them to size on my tablesaw. A normal 2" x 4" is actually 1-1/2" by 3-1/2", so I ripped an amount off the width first of all, leaving enough for the saw kerf to rip the middle of the 2" x 4" into two sections. When finished, you want a true 1-1/2" square board.

If buying the corner blocks already to size, you will need approximately 20 feet of 1-1/2" boards. You will also need 2" screws. I used cheap drywall screws and they worked fine. Buy a 1-1/8" wood drill at this time, as well.

For better looks internally, I used fender washers under all screw heads. Stores also sell nice cup-shaped washers that the countersunk screwhead will fit down into nicely. These cup washers cost quite a bit more, and are not really necessary. I did use them, but ran out, and used the fender washers to finish the job.

Begin by cutting the outside shape of the two side walls of your cabinet. The dimensions in Figure 1 are pretty straightforward. It is easiest to cut one side, and then lay it on top of the second panel and trace around it. This will save measuring all over again, and also makes the two sides compatible with each other, in case you made a measurement wrong.

Your corner blocks are going to be screwed to the inside of your sides. Notice that the fronts, tops, and button panel are all indented exactly 3/4-inch all the way around. This means that your corner blocks will have to be 1-1/2 inch indented because you will be screwing the 3/4" particle board to them, thereby leaving the final 3/4" indentation. The only *places* this does not hold true is first for the upper-lighted marquee, shown in Photo 6. For the marquee, thin Plexiglas was used so I only indented that section 3/4" not 1-1/2". The second place is the actual button panel, Photo 7. The front edge of the panel is flush with the sides of the cabinet; the button panels sides are indented however. Finally, on the very bottom, blocks were

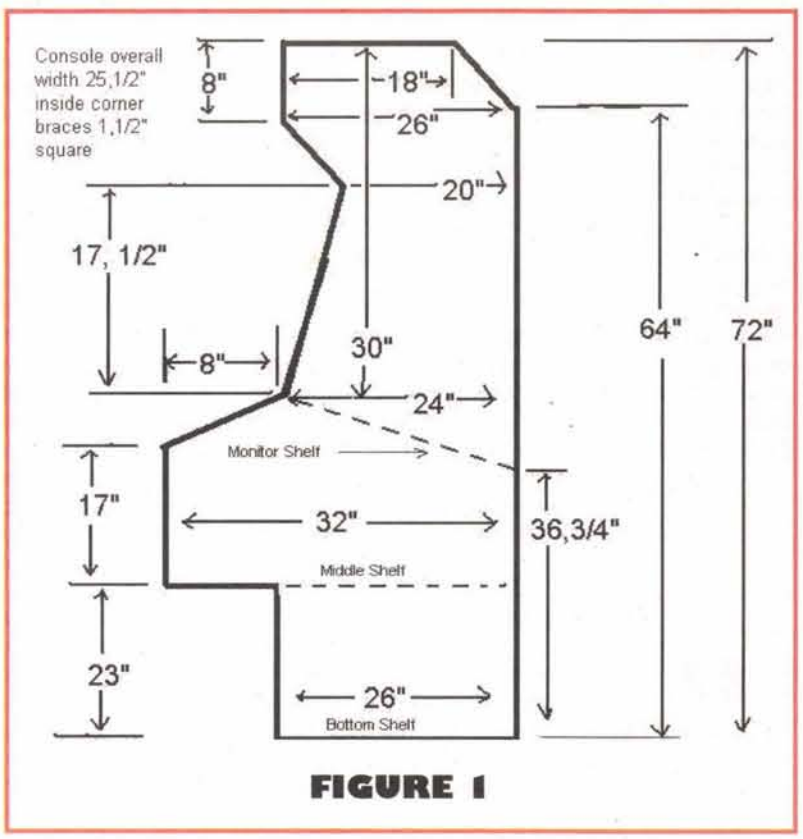

FIGURE 1

mounted to each side, and the lowest bottom shelf was screwed to them. This gives some strength to the bottom of the cabinet as it is moved around. The cabinet will sit on blocks attached to the sides, instead of only on the thin 3/4" sides.

An easy way to find your block positions is to use two pieces of scrap particle board; place their thickness together, and this gives an overall 1-1/2" thickness. Trace around the inside of your cabinet using this template and you will get all the lines necessary for your block positions.

Start by tracing the entire perimeter of the cabinet on the inside to the 1-1/2" measurement (or use the block template). Internally, there are also three shelves, the lowest shelf is the bottom where your computer will sit, there is a middle shelf that is not really used, but anything can be placed upon it (my speakers are placed here) there is an upper monitor shelf, as well. Please note that the middle shelf extends forward out of the cabinet and forms the lower section of the keyboard/button section of the cabinet. In effect, the middle shelf is a combination internal shelf and outside panel.

The shelves will require internal blocks screwed to the sides, to support them (Photo 5). The length of the blocks is not critical; many places in my cabinet the blocks are an inch short, only because scrap wood was being used up. Keep the overall length of your blocks shorter than your 1-1/2" indentation. Don't forget, the front edge will need to be indented the 1-1/2" measurement, so do not run your block all the way up to the front edge. The same thing goes for the back, but the back is not critical unless you plan to have it completely enclosed.

For the bottom shelf, screw your corner blocks flush with the bottom of your sides. Then you can screw the bottom shelf onto these lower blocks. This serves as support for the actual sides of the cabinet, as well.

Photo 4

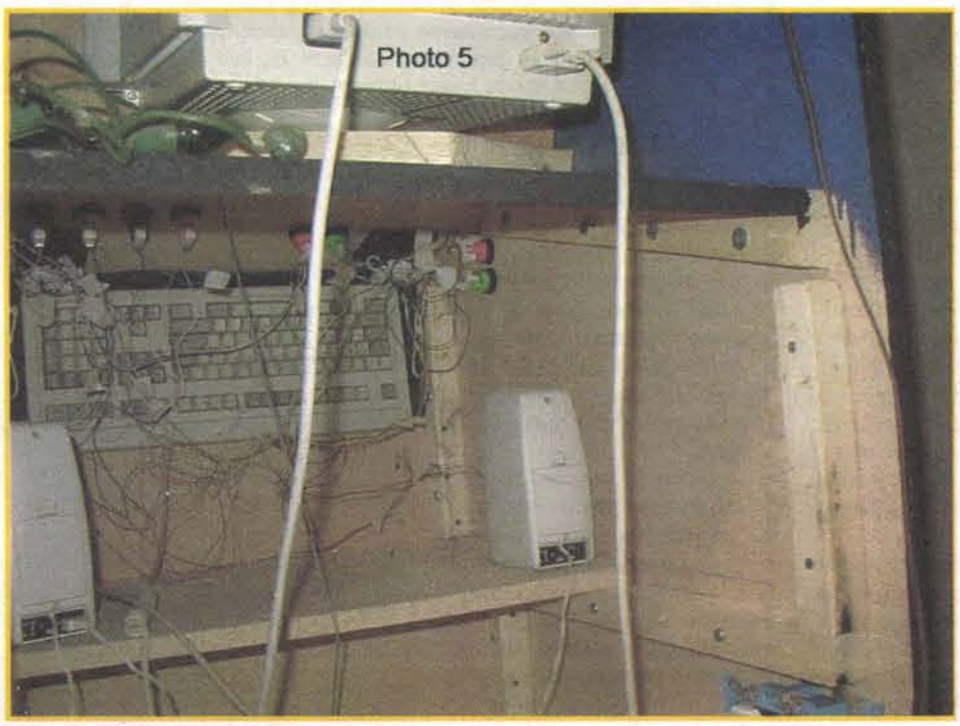

Photo 5

Button panel layout including Joysticks,
All measurements taken from left side of panel

Joystick #2	4" from left
Joystick #1	20" from left
Both Joysticks	5" up from bottom
Joystick #1 fire button 2	7-1/2" from left
Joystick #1 fire button 1	9" from left
Fire buttons	6-1/2" up from bottom

5 utility buttons along top of button panel

Player 1 start	14-3/4" from left
Player 2 start	16-3/4" from left
Enter	18-3/4" from left
Escape	20-3/4" from left
Scroll Lock	22-3/4" from left
(used for MESS games)	
All 5 buttons	8-1/2" up from bottom

Coin button is mounted on front of cabinet, under keyboard door.

FIGURE 2

The middle shelf rests on a block that is 23-1/2" up from the floor. This block will support the middle shelf, which is also the underside of the lower front of the cabinet. Don't forget your indentations for the front panels. At this point, you may see why I do not recommend glue. If you screw on a block that is too long, you can always take it off and shorten it at a later time.

The final monitor shelf (Photo 5) is not critical as far as its sloping angle is concerned. The front edge of the monitor shelf is going to butt up against the button panel; the two shelves (button panel and monitor shelf) are both angled and this makes a nice V-notch that a sheet of glass can be placed into to cover over the monitor section of the cabinet. Please note the glass is removed in my photographs.

For this monitor shelf, I mounted all other panel pieces first, including the front button panel, and then laid out the location for the monitor shelve's corner blocks. The angle of this shelf is not critical, pick an angle that is appealing to your own eyesight. Some people may be short, others taller than myself. You can always adjust the actual monitor on its swivel base later.

My measurements for the monitor shelf block came out as 30-3/4" down from the top front edge to the top of the block, and 36" up from the bottom back edge to the top of the block. Your measurements may vary slightly.

After you have your lines laid out on the sides, begin screwing the corner blocks on to the sides. Don't forget to leave room at the front of the blocks for your 1-1/2" indentation. With your leftover pieces of particle board, begin cutting the bottom shelf, middle shelf, front, keyboard door, button panel, and top sections.

The overall width of all pieces is designed to be 24 inches. I am not a perfect carpenter and had to shave a little bit off the measurements here and there throughout assembly. This may have been because the corner blocks were not mounted perfectly square and some warping may also have occurred. Leave the lower section of the marquee for last, because you will want to bevel the front edge. If you cut it now, and it's too short for the bevel, you may have problems. The top and the rear/top where it is angled were beveled, as well. This is not necessary and really won't show, but I did it anyway. Please refer to the Parts List that includes measurements for cutting your pieces.

Two people will be required for initial assembly of the cabinet. Possibly the best initial order of assembly is to mount the bottom shelf, front lower panel, button panel, and a back brace. Back braces are leftover scrap that I used to tie the back of the cabinet together. Don't worry about drilling the button panel at this time. You could drill it now, but you may wish to get the initial cabinet assembled first, so you can see what it is going to look like and then lay out your button locations later. Now assemble the front keyboard door panel, the middle shelf and the top, and lower marquee section. Your cabinet will be self-standing now.

When all these panels are installed and fit properly, go ahead and mount your monitor shelf. You can line up the front of the shelf with the button panel, to form the nice V notch. You will want both edges of these two panels to match at a level, then tilt the monitor shelf down in the back to the approximate measurement of 36-3/4" up from the floor to the top of shelf. This angle of the shelf is not critical; I picked a nice appealing angle for my own eye height (5'11" tall).

Some notes on the marquee section are necessary, as seen in Photo 6. The front of the lower marquee panel was beveled, so that my Plexiglas would screw flush to it. To get the proper angle, slide the lower marquee panel out until it is flush with the front of the cabinet sides and trace a pencil line onto it. This gives you an angle to set your circular saw to. The flat top and the rear/angled corner also are beveled at their edges; they are not critical, and really do not show, but I angled the cuts anyway. Use the same method as the marquee bottom, slide the top board aft until it is flush with the rear angle, and trace a pencil line on the top panel edge. Cut this angle with your circular saw. The same thing was done for the angled corner at the rear of the

cabinet top.

The top marquee is made from translucent Plexiglas with lights behind it. The logo saying MAME was printed out on my printer using its banner setting for a long length printout. You may download the banner from my website or you may use anything of your own choosing. Be sure to print in reverse mode onto transparencies so that your text is properly orientated.

The size to print out was 24" long by 6-7/8" high on my machine. Spray adhesive was used to glue the transparency to the front of the Plexiglas. The glue did not make the ink run; I have used this method many times before. The actual ink is inside between the transparency and the Plexiglas so that people cannot affect the ink at all by touching the marquee. Flashing Christmas lights were used and strung inside the cabinet behind the Plexiglas. If you have them, speaker grills can be mounted under the marquee in the angled lower section. Small car door speaker grills would work for this.

Around the monitor, cut a sheet of paneling board for the monitor bezel and build a bezel panel to hide the inside of the monitor shelf area. (I used some old interior wall paneling that was laying around.) Cut the bezel to just fit the screen size of your monitor and make it butt up against the side of the cabinet.

Small blocks were placed behind this monitor bezel, and you can simply lean the cover against the monitor. This way you can get at the controls on the monitor easily if you ever need to adjust them. The monitor itself was screwed to the monitor shelf with a wood screw through the plastic swivel base on the monitor. You can also use a piece of scrap wood and screw it behind the bottom of the monitor base into the shelf.

The keyboard door can now be removed and cut exactly in half. The keyboard will be mounted to the upper section of the door. I used tiny cabinet hinges between the door halves. Screw the lower door section to the cabinet, and then screw the keyboard to the upper door. I drilled directly through the keyboard and used long screws to secure it. Be careful you don't drill through a circuit board trace! My cabinet did not need anything to hold the door closed, it fit snuggly up under the button panel. Small eyebolts and string can be used to support the door when open.

At this point, you are ready to lay out the button panel. Please refer to the button layout measurement in Figure 2. The very front edge of my button panel was sanded to a slight radius; this is the point that your wrist and arms will be leaning upon, and a rounded corner will make playing more enjoyable. You may notice that many desks have a slight rounded edge on the front side, as well.

My cabinet was recently modified for two players. This can become crowded with buttons. I recommend laying out your joystick and buttons for a single player in the most comfortable position initially. Single players will be playing more often then two players. You will want a wide spacing between the joystick and the fire buttons. On my system, I have Joystick #1 on the right, and its fire buttons are 11" to the left of it, with the left hand's index finger set up for fire button 1 and the middle left finger for fire button 2.

A 1-1/2" spacing between fire buttons felt comfortable for my hand. You should try a spacing that feels good for you personally. You may also refer to my button/joystick layout in Figure 2.

Button drill bit size and joystick hole size are 1-1/8" in diameter. A row of buttons along the top of the panel — for such items as single player, two players, enter key — escape key can now be laid out. You will need those extra buttons for playing MAME games and it's handy to have them out in the open.

A coin button was placed on the lower right front panel. Happ Controls also sells actual coin-activated buttons. One of these coin slots is placed on the left front of the cabinet, and the +5V keyboard power runs the button's light.

I could not find room for an easy placement for fire buttons for the second player because, in effect, this is really a single player console design. What I finally did was place the second joystick to the far left of the button panel. Joystick #2 is at 4" from the left of the button panel, and Joystick #1 is at 20" from the left side of the button panel. Joystick #1's fire buttons are at 7.5" and 9" from the left of the panel. Joystick #2's buttons were then placed on the left vertical side of the cabinet. They are actually on the outside of the cabinet. The player's left hand then rests on the left/top of the button panel, and their fingers extend down the side of the cabinet to press the fire buttons. This layout is not as awkward as it seems. As I mentioned earlier, this was done at a later date, because I wanted to play two-player games.

Another thing you can do, is if you like to play pinball arcade games, place a button on the right vertical side of the cabinet located the same way you did for the second player's fire buttons on the left side of cabinet.

A pinball player can now rest his/her hands on each side of the cabinet and reach over the side with a finger and activate the fire buttons. The right side fire button can be wired to player one's fire button, and on the left side of the cabinet you can use Joystick #2's fire button. MAME allows you to redefine keys for any game, so you may simply redefine those two buttons for your pinball games. I find these two buttons to be very handy in pinball, and it really gives a much better feel of authenticity. This button can be seen in Photo 2. Player 2's buttons are similar on the opposite side.

The entire cabinet was painted using one quart of oil-based enamel paint. I highly recommend oil-based paint over water-based. The final finish has a much higher gloss using oil-base. A roller was used to paint the entire cabinet. However, I recommend a high-quality roller. I myself used an older roller, and had problems with it leaving tiny hairs and dust behind. The front edge of the cabinet was painted with black paint. After the sides are dry, any excess black paint can be wiped off of the outer color.

All my buttons and joystick functions were labeled using dry rub-on stencils. These have held up well for the past year; no stencils are peeling off at this time.

If you are an artist, you could make a very nice image on your computer and print it out using the marquee method outlined above. You could also print labels, and then put a thin layer of Plexiglas over the top of the button panel to protect any labeling.

In the center top of my button panel, there is a flat mouse panel. This mouse is used for some DOS-based games I play and it is not necessary. Previously, a mouse was connected inside the keyboard door, and you can do this also. Normally for MAME, you will not be using the mouse, except on initial set up of games.

You can modify your cabinet in many ways for the type of games you prefer. Happ Controls sells roller balls for games such as golf that spin a ball,

steering wheels can be purchased, and driving pedals mounted for car racing games; light guns may be purchased for shooting games.

Many vintage arcade machines and parts can be purchased on EBAY. Prices vary widely; it depends on how lucky you are. I bid on a steering wheel assembly from an original Pole Position game and gave up at $100.00. My friend found another steering wheel assembly for $15.00. You can also purchase the original monitor bezels that are from original games. The entire cabinet could be built wider into a true two-person machine.

There are also cabinet designs for sit down car racing cabinets, or space flight simulation cabinets. Many people with artistic talents paint the outside of their cabinets to match the original games. As you have seen, arcade machines are designed for eye-catching appeal, and this is done with many designs and sound effects to draw your attention, and your quarters.

In case anyone is curious, the angled top of the cabinet was not designed to fit the ceiling line of my home; this is the actual Defender cabinet shape. It was fortunate the cabinet fit the ceiling so well. Possibly my grandfather 60 years ago had arcade machines in mind when he built this home.

I hope you have found this article useful. If you have any further questions, you may contact me at Admin@MntnWeb.com. I will answer your questions in a timely manner. **NV**

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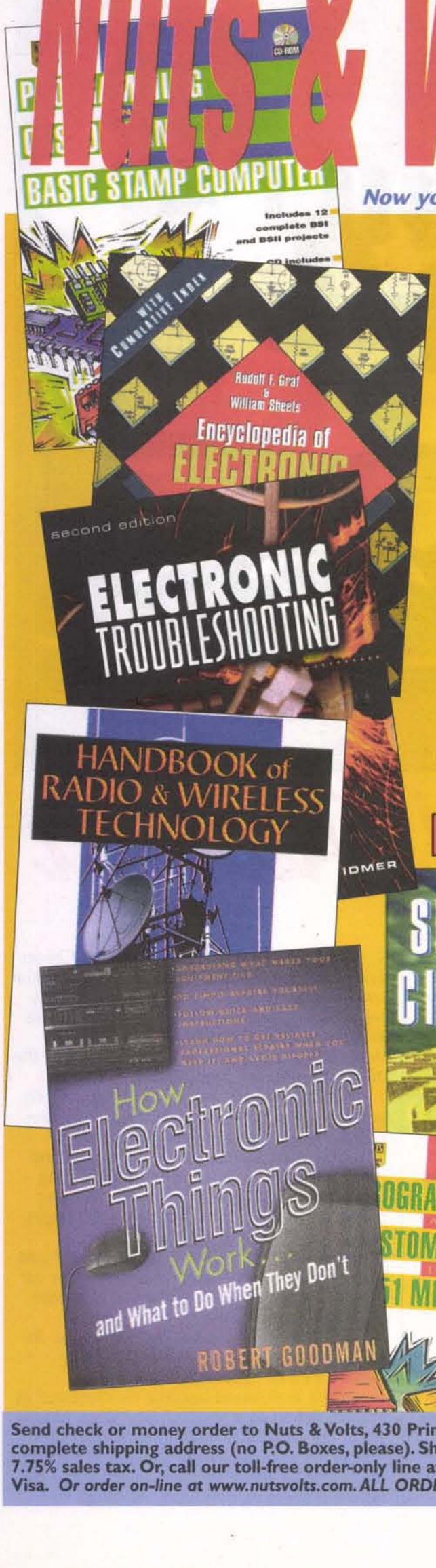

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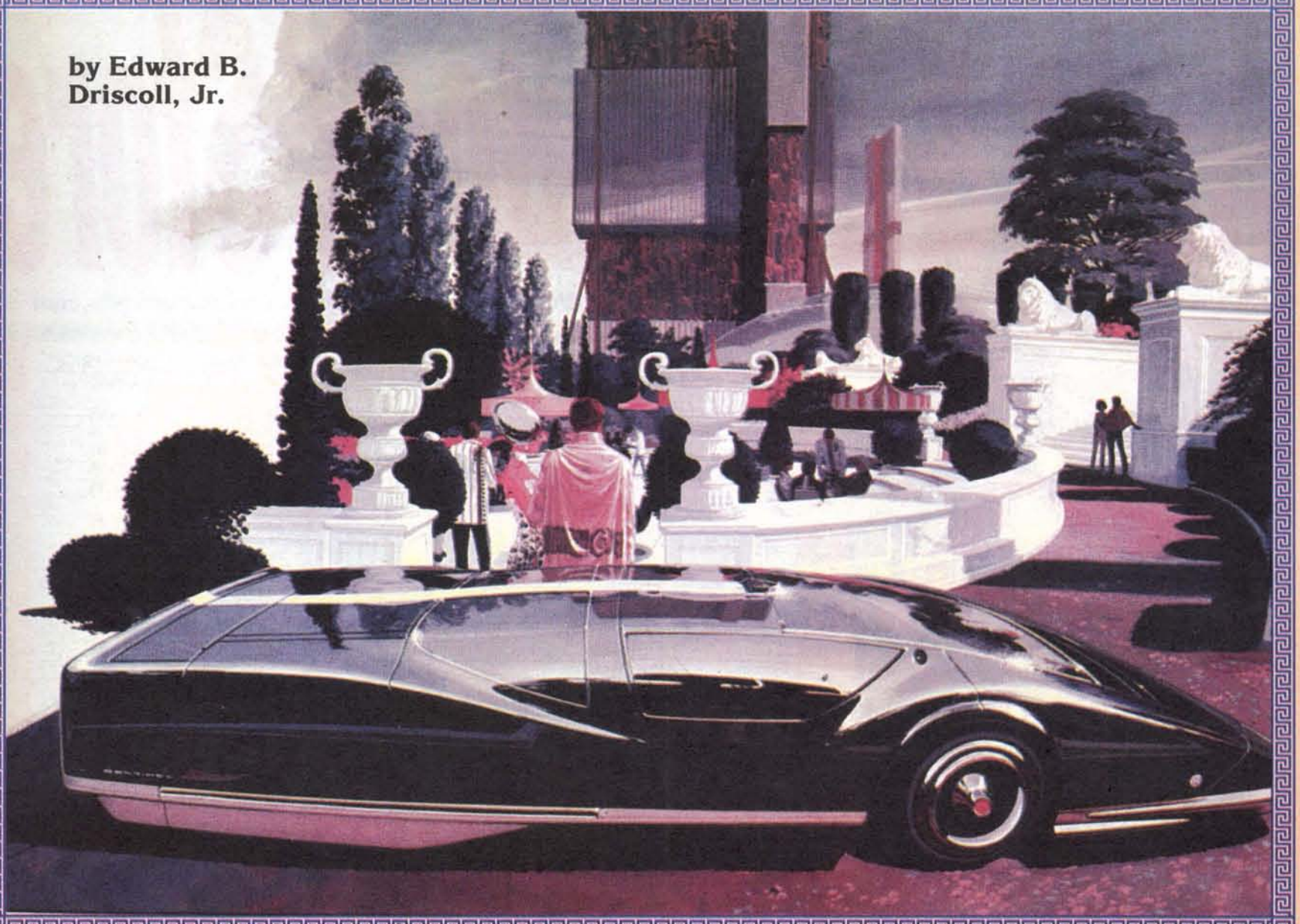
by Edward B. Driscoll, Jr.



Syd Mead: *Visual Futurist*

Syd Mead is a bit like Marshall McLuhan with an airbrush and Foamcore board. In the 1960s, McLuhan would issue amazing sounding predictions of the future, many of which eventually became true (not the least of which were his famous "global village" and "the medium is the message" aphorisms). Similarly, Mead draws amazing illustrations of the future, which look fantastic upon first glance, but are all built on solid engineering principles.

As someone who combines a brilliant artistic talent with sound engineering principles, Mead is a rare type of artist – sort of a Raymond Loewy (who Mead once worked with) of the 21st century. Now 67 years old, he balance's his time working on production designs for Hollywood (remember the Spinner flying car in Blade Runner, V'Ger in Star Trek: The Motion Picture? The Russian Leonov spacecraft in 2010? Their appearances were all created by Mead) – and as a design consultant for business clients. Mead calls himself a 'visual futurist,' a title he invented for his prestigious single title card credit on Blade Runner.

Blade Runner's flying police car – the Spinner – seemingly incredible on first glimpse, was simply a result of Mead's strong engineering background. Mead says, "The Spinner vehicle presupposed a robust aerodyne lift scheme, similar to the existing Harrier combat jet. Since the film was released in 1983, vertical lift car-sized vehicles have already been developed, tested, and built on a semi-custom basis."

This combination of engineering and imagination started young with Mead who, as a five-year-old child in first grade in 1939, drew rocket ships, trucks, and cars.

As a teenager, after a brief hitch in the Army Corps of Engineers, Mead learned about design ("as opposed to drawing," he observes) at Art Center School in Los Angeles, where he graduated in 1959. The Art Center provided Mead with a methodology that eventually lead him to a profitable design profession, "as opposed to being an 'artist' with bad teeth, bad breath, and a penchant for simplistic arrangement," Mead sardonically says. "I could already draw very well prior to Art Center. The school's curriculum taught the connection between commercial process and creative idea."

Much of Mead's work, both at Art Center, and since, has been drawing the car of tomorrow – either concept cars that could readily be built, or elaborate, often fantastic designs that are several generations away. He describes automobiles as "the 'high art' of the 20th and now the 21st century."

After Art Center, Mead spent the next 18 years working on a variety of consulting projects for major international corporations, including Ford, NASA, US Steel, Phillips, and numerous others. Much of his work during this period was highlighted in the stunning coffee table-sized book, *Sentinel* (155 pages, published 1979 by Dragon's Dream, Netherlands; ISBN: 9063325916), whose title came from Mead's favorite name for new car designs. Many of Mead's futuristic cars have that name somewhere on their bodies.

In 1970, Mead formed Syd Mead, Inc. In 1976, Mead relocated the firm from the Detroit area to Capistrano Beach, CA.

When Hollywood became re-interested in science fiction as a result of Star Wars, Mead spent the early '80s illustrating concepts for numerous futuristic films. Arguably, it was on the landmark Blade Runner, where Mead did his most stunning film work. Although he

developed several other concepts for the film, the Spinner is perhaps his most celebrated car design.

When Can We Expect The Spinner?

Like most of his work, the Spinner was based on sound engineering principles.

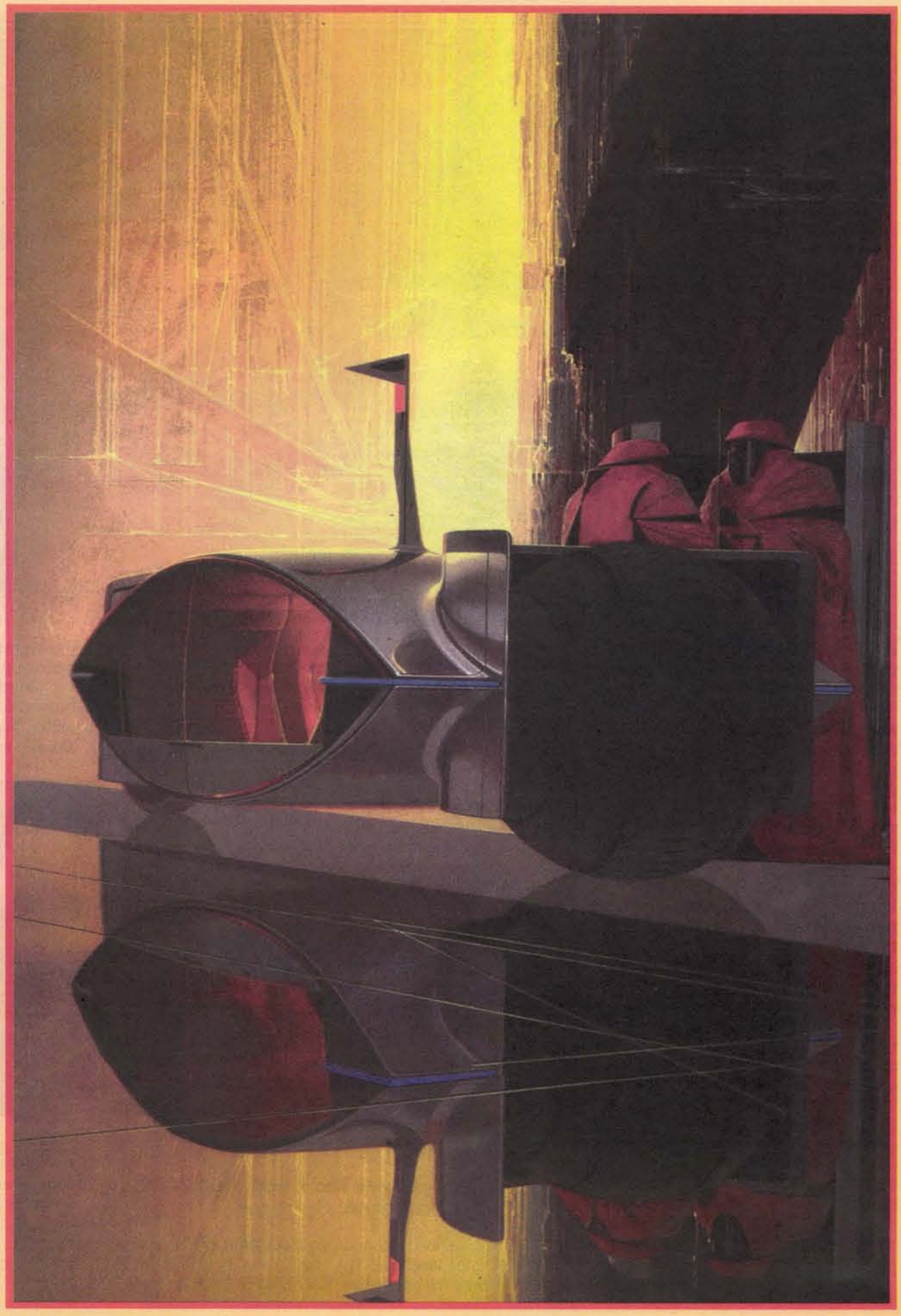
While car-sized aircraft have been built, Mead is rather leery of the idea of a flying car in everyone's garage. He says, "Civil and commercial and para-military aerial traffic is already at the level of imminent disaster in every urbanized area in the world. Allowing thousands of 'civil' aircraft to fly the skies sounds like an absolute nightmare."

Will The Car Still Be With Us In 50 Years?

Since Mead quite logically discounts the concept of flying cars in the foreseeable future, what does he think the car of the future will be like? What role will the Internet play? And will cars even be around in the next 20 or 30 years?

Unlike many politicians, who see mass-transit such as trains and buses as an inevitably, Mead has a rather contrarian belief that the concept of the auto will be with us for a long time to come. He thumbs his nose at even the words 'mass transit.' "'Mass transit' is purely an academic term," he says. "With half the world's population living in cities by 2050, owning a private automobile becomes a default response to the imperfect and often inconvenient availability of so-called 'mass transit' mobility."

Or, as he wrote in *Oblagon* (170 pages, $49.95, published 1996 by Oblagon, Inc., Los Angeles, CA; ISBN: 4062015250), "The mass transit system of choice worldwide is the automobile." Mead has equally strong feelings about why. He says, "The 'car' will remain viable as a commercial product as long as the 'mass transit' is unreliable, subject to labor strikes, sabotage, anti-personal behavioral controls, ill-conceived routing, poor maintenance, insecure surveillance at off-peak hours, and a magnet for the poor, the disaffected, the anti-social, the thugs, and riffraff that accumulate in metropolitan centers."



Where The 'Net Meets The Road

While Mead feels that the car will be with us for quite some time, he has equally strong feelings that its outer appearance and inner 'guts' will change radically in the course of the 21st century.

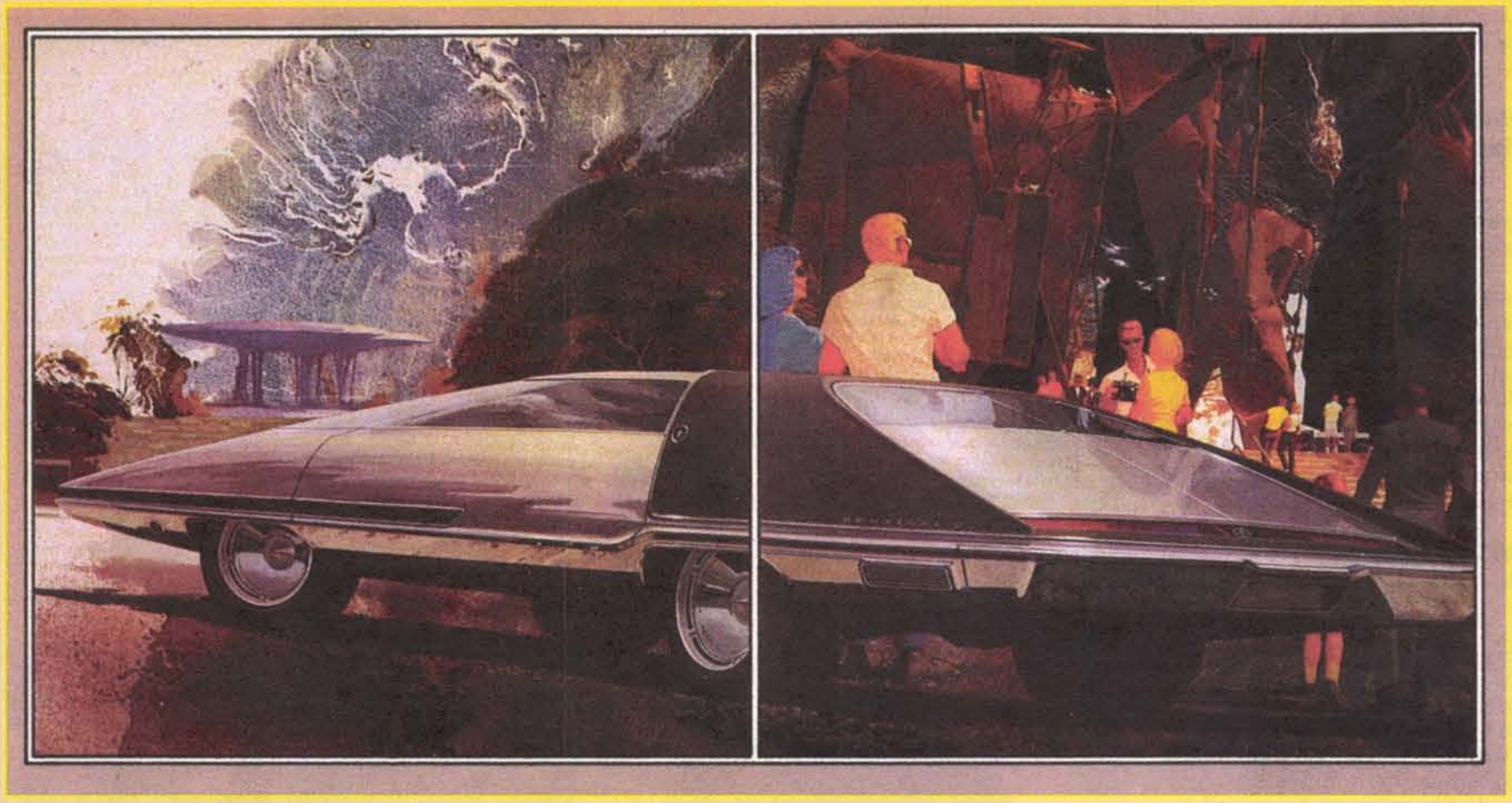
Does Mead see an Internet connection in the automobile becoming important over time? He says, "If private vehicle transport persists, then yes. Time spent in transit, as it gets more tedious and time consuming, encourages elaborate world access while 'trapped' in the vehicle by extended transit time, which is otherwise non-productive."

What sorts of things does Mead think an automobile's Internet connection will be used for? He says, "the uses would range from a ubiquitous 'always on' link, used now, to a complete monitoring of where, when, who, why, and for how long kind of location awareness. The government's insistence to 'know' about everything will slowly and relentlessly pervert this technology to be a sort of 'eye on everybody' resource for privacy intrusion."

What if he's right? Mead feels there could be a strong backlash to this government eavesdropping. "Eventually, not being 'on the 'Net' as an identifiable 'person' will be a kind of privacy preference, sort of like the current 'blind' Delaware corporation avatars that anonymously represent large capital entities."

The Electronic Superhighway — In 3D!

Syd Mead also sees computers and electronics playing a role in automobile navigation. He sees automated transit control as an



absolute must, if a highway is to be actually usable. "Freeways are already jammed as soon as they are opened," Mead says, "because their design and construction is usually 10 to 20 years 'out-of-date' due to 'not in my backyard' or 'NIMBY' activists, shrill anti-progressive pro-bono legal assaults, and simple legislative atrophy. Allowing 20,000 operators to all make their own amateur, egoistic second-by-second decisions means instant lane flow disaster."

Eventually, Mead says that automated transit control is a must to break this logjam. For each vehicle to be allowed on public routes, Mead says it must eventually have "an onboard transponder, elaborate computer control apparatus, and a willingness on the part of the 'driving' public to rearrange their notion of 'private' vehicle operation."

Automatic transit control is also a way to return some of the benefits of commuting via mass-transit to those who choose to use their own vehicles. "Automatic transit control turns "the private automobile into a 'car' in a 'train' of similarly linked vehicles going to similar destinations," Mead says. "I have illustrated this usage profile for the last 30 or so years. Thus freed of actually driving the vehicle for the larger part of the journey, the private car then becomes an office, a TV lounge, an information transfer node, and a social meeting place."

Of course, telecommuting could reduce the need for automatic transit control. Mead says, "This is all counterbalanced by eliminating the need to go anywhere in the first place. 'Telepresence,' if it ramps up to expected levels of technical competency, will replace physical transit in large chunks at the top of the social hierarchy."

Even if the roads don't become smart themselves, ultimately, Mead says that, "automobiles will become intelligent entities that move. Who rides inside them will be the use purpose, but the vehicle itself will become a self-aware, self-preservational entity.

By extension, the owner/user will benefit by this inference. Current high-end vehicles already control their steering, their braking, their dynamic weight transfer, fuel delivery, and several other in-use parameters (via microprocessors and other computerized technology). Artificial intelligence, or 'AI,' will be the cue of future automotive components."

Check Under The Hood. And Refill The Hydrogen. Hydrogen?

David Frum, a popular Canadian journalist, once wrote what an awesome achievement it was that man had the ability to take the fossilized remains of dinosaurs locked uselessly for millions of years underground and turn them into the fuel that powers the industrial revolution – and still powers our cars. Mead says that in the not too distant future, that petroleum-driven internal combustion engine is scheduled to join those same dinosaurs in obsolescence. While the odd electric car can now be seen on California roads, Mead sees another source of power as dominating the highways of the not too distant future: hydrogen.

Mead says "Hydrogen cycle 'engines' will be installed on commercially available vehicles within five years. These power sources are already increasing their viability rapidly, using existing gasoline delivery infrastructure. (Even now, there really is no actual need for each vehicle to have a two or three hundred horsepower engine installed. The average speed on the Los Angeles basin roadway system is about 35 miles per hour.)

Since the hydrogen systems eventually produce electrical energy, the end use is an induction coil drive. Test models, soon to be reduced to 50% of current laboratory size, already achieve energy conversion efficiency percentages that exceed the most efficient internal combustion engine technology."

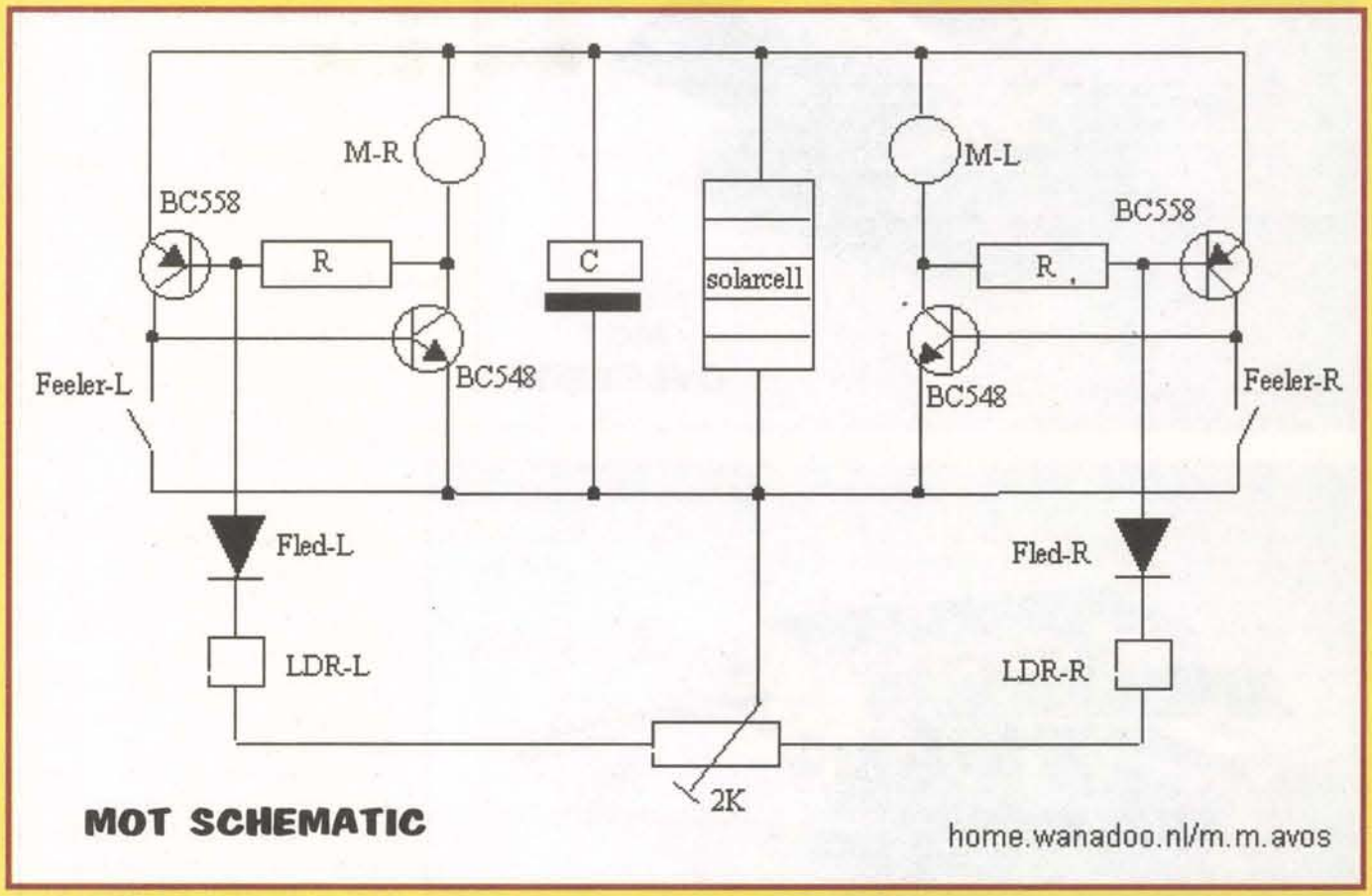
Stroke Of The Brush, Turn Of The Key

Syd Mead's technological expertise and drawing skills make his auto of the future not only plausible, but logical and expected, as well. In Mead's eyes, the future is merely a stroke of the brush (and a turn of the ignition key) away. **NV**

by Robert Nansel

Amateur Robotics

This month, I'm doing two reviews; one of a fabulous new robot kit, and the other of an essential book for the robot builder's bookshelf. I know the multitude of folks out there following the Heavy Iron CNC project will be disappointed that I don't have anything on that project this month — I get email from y'all every day urging me on. I have been doing lots of work on Heavy Iron, but it's not the sort of work that lends itself to an article (glamorous work like ordering parts and designing power supplies); my policy is I don't write about what I'm going to do, I write about what I've actually built and tested. Rest assured, it is still THE project here at the Robot Ranch — but not this month. Kits I can put together in late night hours when my boys are asleep, and books I can (sometimes) read while holding Nadav or playing with Yonatan. Hence, this month's column.



MOT SCHEMATIC

ScoutWalker 2.2 Kit

Aside from a couple solar engines, I've never built any BEAM-style robots, nor any walking robots, so it was with great anticipation that I opened the package from Solarbotics containing their ScoutWalker 2.2 walking robot kit. ScoutWalker 2.2 is a four-motor walker using Bicore technology (developed and patented by Mark Tilden, the creator of the BEAM robotics philosophy/religion/lifestyle). The robot features an adaptive gait and obstacle-avoiding behavior, all implemented without a microcontroller. Plus, it can be interfaced to the Solarbotics SunSeeker light-seeking head, which I'll be reviewing next time; this month, I'll concentrate on the walker itself.

I gotta tell y'all, this is one cool kit. Photo 1 shows everything you get with it. Yes, those are batteries (included), and no, the ScoutWalker isn't solar-powered. It is a good challenge to build, and while it's definitely not a beginner's kit — it took me over nine hours to build — the instructions are superb. It took me a little longer to build than it otherwise might have because I was photographing everything and taking notes as I went.

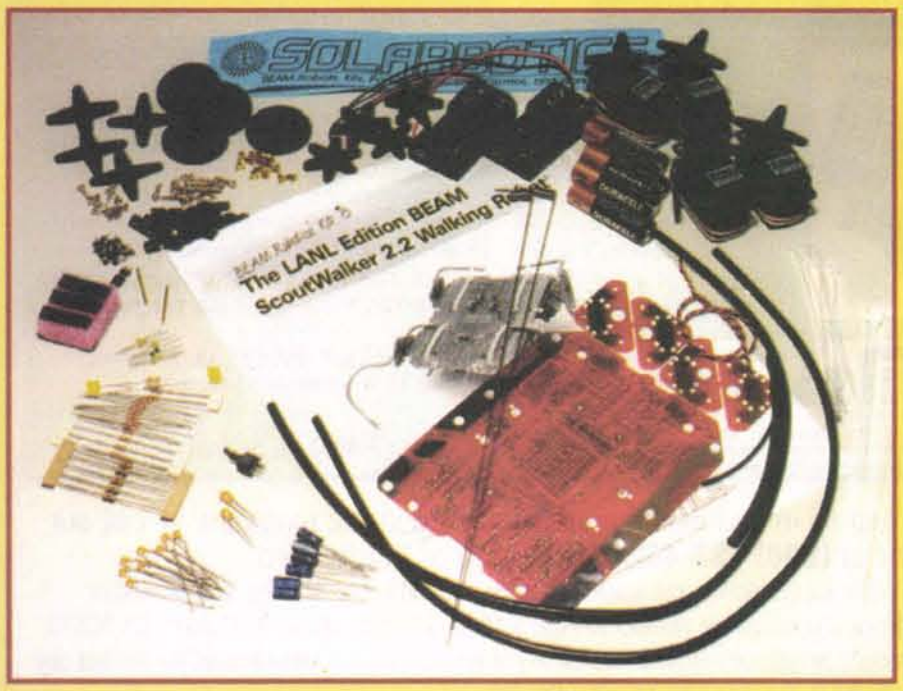


Photo 1: The ScoutWalker 2.2 kit of parts.

Photo 2 shows the main board almost done; all that remains is to flip it over to install LEDs and socket pins on the opposite side. Photo 3 shows a trick I used to get the socket pins straight. You solder 18 of these socket pins so you can later plug in resistors that program the ScoutWalker's behavior. It's much easier to get them straight if you first insert lengths of scrap resistor leads; the leads act as heatsinks to keep the pins from overheating, and you can use them to square the pins one at a time by reheating each solder joint and wiggling the end of the lead around as a sort of temporary joystick.

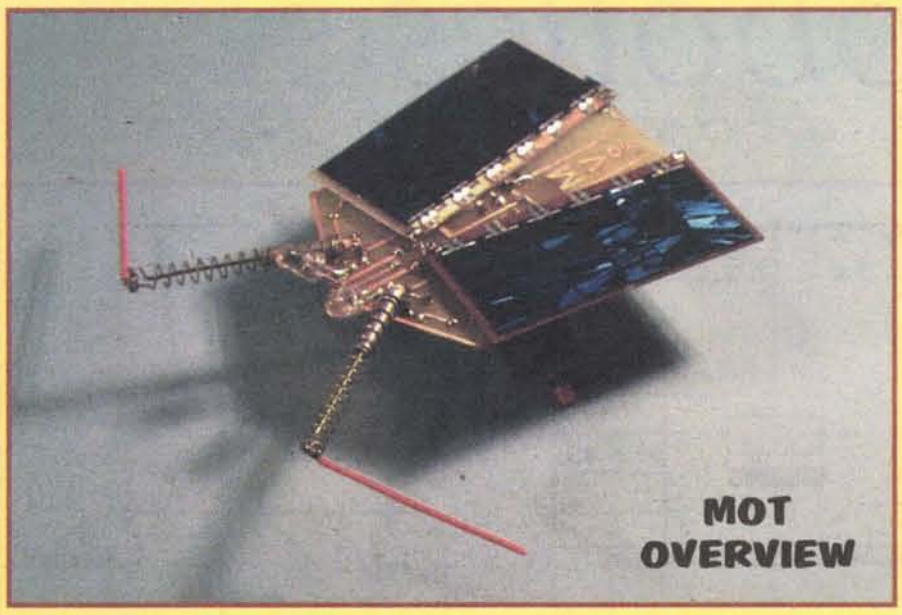
Let There Be Motion

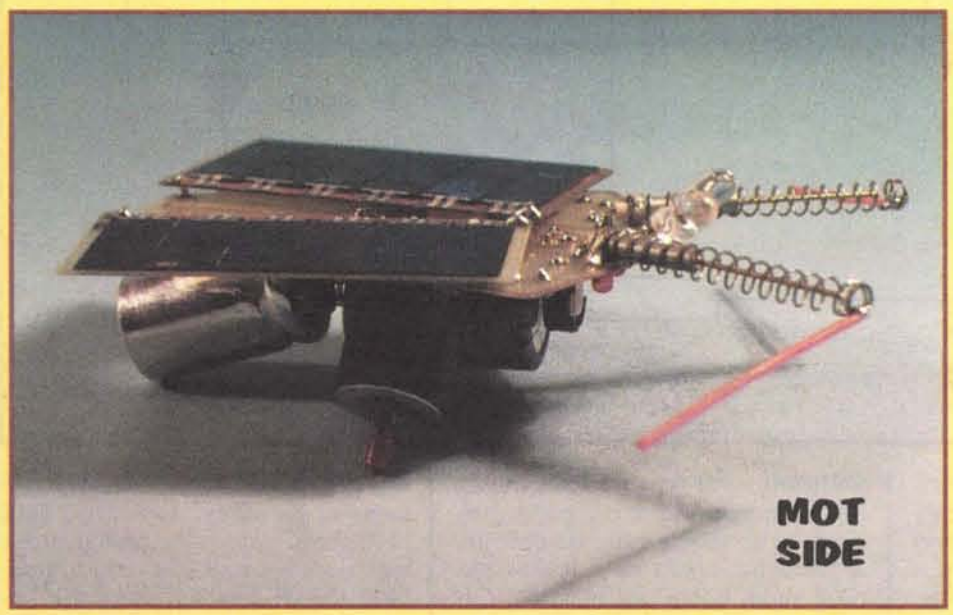
The 'bot walked first time I powered it up. Er, actually, it walked the first time I powered it up with all four motors wired. The kit requires you to hack the servos by removing their controller board gizzards. I'd somehow managed to reassemble one of the servos without soldering the wires to its motor. The blinky light LEDs made it clear the driving circuit was working, so it was easy to troubleshoot. Photos 4-7 show the finished robot in various poses.

The legs are made of heavy-gauge copper wire, so you bend them to get the right shape for walking. The ends of the cable ties sticking out the back are functional, by the way; they operate as end-travel springs for the rear legs.

The robot walks much better than I would have guessed. It has a curious high-stepping gait that changes to a different rhythm whenever the legs encounter different load conditions, so the walker really seems, by gosh, to adapt its gait to the terrain. The fact that all this is implemented using just six 74AC240 octal inverter/buffer chips is simply amazing.

Four of the chips are wired as "Suspended Bicores" — basically, a ring oscillator — one for each motor. A Bicore uses two buffers (along with two capacitors and a resistor), leaving six buffers on each chip to be paralleled in two groups of three to make a dirt-cheap H-bridge motor driver. Two "master" Bicores in the front oscillate independently, but are weakly coupled by a resistor to establish a subtle left/right coordination of the front leg motions. The front Bicores also control their "slave"





Bicores which, in turn, drive the rear legs.

The remaining two 74AC240 chips are used as multiplexors in a clever circuit that changes the relative phasing of the rear legs with respect to the front. This causes the robot to turn in place or back up, depending on whether one or both whisker sensors are activated.

(No, I don't really understand every detail of how all of the above works. I plan to devote an entire column to it soon.)

Such a Deal

I like the ScoutWalker kit a lot. The kit has everything you need to get started in the world of BEAM Bicores and walkers. The documentation is clear and complete, very much in the tradition of the old Heathkit construction manuals. The kit is worth the $295.00 US that Solarbotics charges.

I do understand that this will seem steep to some folks. If you're a starving student and just can't afford that much money at once, you can download the entire construction manual in PDF format from Solarbotics (www.solarbotics.com). I haven't costed out the separate parts you'd need, but none of the them are exotic, so if you're willing to put some time into it, you should be able save some money by ordering parts directly from Digi-Key and Tower Hobbies.

Be sure to check out Solarbotics first, though, because they do sell most of the individual parts separately (everything but the whiskers and the circuit board). Their prices are competitive, and you'll save time, too. If you do build a ScoutWalker from scratch, you're bound to learn a lot (i.e., make lots of mistakes). Be sure to subscribe to the BEAM email list (www.egroups.com/subscribe/beam) so you can get help when you run into trouble.

Symbols vs. Connections

All of this has really got me questioning some of my basic assumptions about robotics. What role, for instance, should microcontrollers play in my Tall Grass robots – or will they even need a microcontroller? Could I do it all with Bicore technology?

Though Bicores are new on the scene, the question is as old as the first computers. There have always been two broad approaches to building machines that perform functions ordinarily thought of as requiring intelligence: the symbolic-computational and the connectionist-cybernetic approaches. The former is the domain of digital computers, and the latter is the domain of analog control, though there is much overlap.

Fifty years ago, it theoretically would have been a toss-up which method would be best suited for building mobile robots. In practice, the analog approach would have been the only practical way to con-

Robotics

Memistors?

Memistors were three-terminal devices in a metal can similar to a TO-5 transistor package inside of which was a glass ampule containing a copper sulphate solution. Leads one and two were connected to the ends of a carbon rod, while the third lead was connected to an electrode to control the resistance change. You changed the resistance of the carbon rod by impressing a DC voltage — less than a volt — of the appropriate polarity between the rod and the control electrode, which caused plating or deplating of metallic copper onto the carbon rod. You read off the resistance between leads one and two with an AC current of less than 50mV RMS so as not to cause plating or deplating.

Starting resistance ran about 25 ohms, and minimum resistance was less than one ohm. Apparently they were fairly reliable, though a tad slow; a change from 25 ohms to two ohms typically took about 15 seconds. Back in 1965, they cost $40.00 in singles, but the price went down to $28.00 each if you bought more than 10. If any Memistors are still around, I expect they would fetch quite a bit more money as collector items.

Nowadays, if you really wanted to emulate the analog function of Mnemotrix wire, you might use something a little easier to integrate onto a chip. There are digitally-programmable resistor chains and potentiometers out there, or you might use something like an analog EEPROM cell where you carefully control the amount of charge transferred to the floating gate of a FET and thus control the resistance from drain to source. There are complications concerning polarity and small available range of resistance, but the point is that there are viable solid-state circuits that can do the job of Mnemotrix. Add a diode and a delay element and the same device can emulate Ergotrix.

trol a real robot since even the simplest digital computers of 1950 weighed many tons and filled entire rooms. Analog control systems of the time, in contrast, were well-proven and had flown in thousands of aircraft and missiles during World War II. They were light-weight, compact, reasonably reliable, and well understood.

Within 20 years, that situation was almost entirely reversed; digital computer technology improved dramatically in every way, whereas analog controls saw only modest, evolutionary improvements. The connectionist-cybernetic approach eventually lost those early battles and, as a consequence, lost enough "mind-share" that most people believe it lost the war, as well.

Vehicles

Valentino Braitenberg is not one of those people. In his classic book, *Vehicles, Experiments in Synthetic Psychology* (MIT Press, Cambridge, MA 1984), Braitenberg draws on the honored scientific literary form of the thought experiment to explicate an unabashedly connectionist, unashamedly cybernetic view of AI.

Some thought experiments are analytic in that the object is to tease apart principles behind imagined observations, a famous example of which is Einstein wondering what he would see if he could ride a light beam. Braitenberg's thought experiments, however, are synthetic, aiming to build models of intelligence by bringing together well-defined operating principles and then imagining what behavior such models might exhibit.

Braitenberg is a respected neuroanatomist and cybernetician, so when he speaks about neurons and neuronal networks, he speaks from first-hand observation. More important than that, though, is the crispness, clarity, and humor with which Braitenberg makes his case. The first half of the book concerns the vehicle thought experiments, and the second half gives detailed notes on the biological motivations for these vehicles. All of the book is pure joy to read.

In each of the first 14 chapters, Braitenberg constructs imaginary vehicles — robots — comprised of various configurations of motors, sensors, and threshold devices, each vehicle more complex and capable than the previous. Vehicle 1 is an admittedly dim-witted creature with a single motor and a sensor that directly controls the speed of the motor. Vehicle 1 cannot steer on its own, it can only move slower or faster in response to external stimulus.

Vehicle 2 combines two motors and sensors in a left/right configuration, which you can think of as two of the previous vehicles stuck together side-by-side. The sensors can be

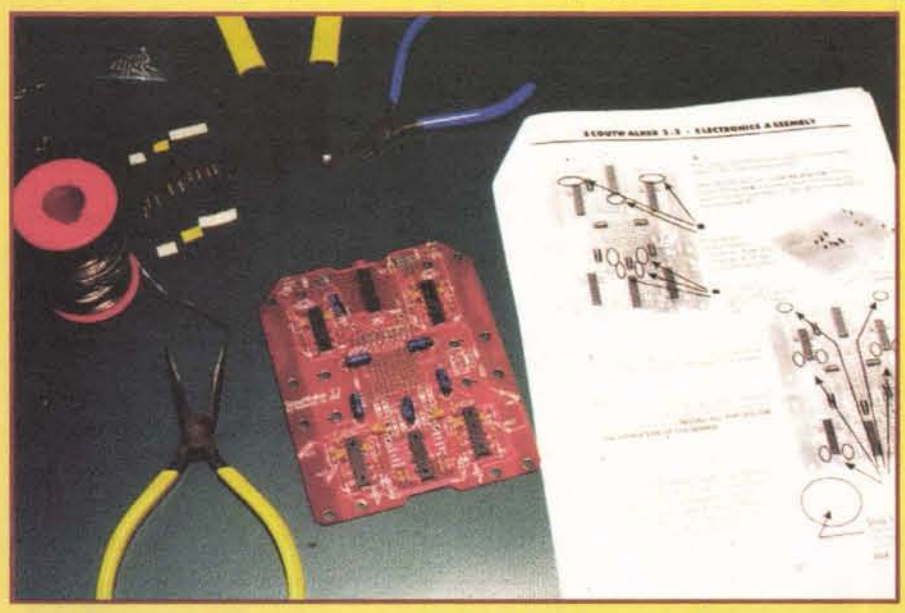


Photo 2 (above): Assembled board ready for mechanics.

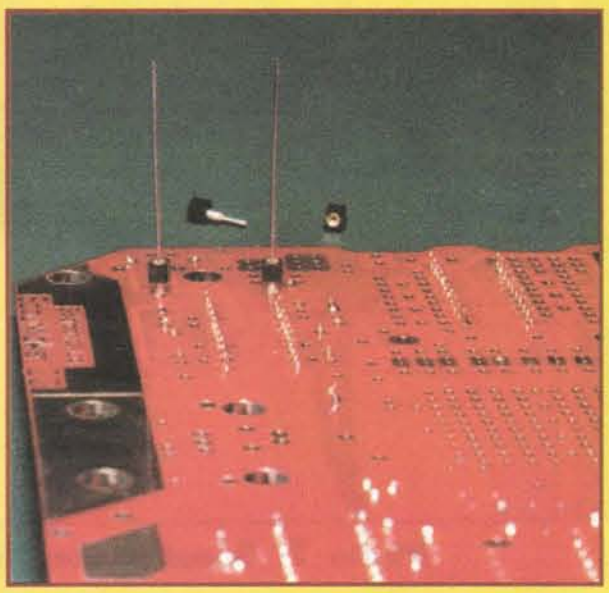


Photo 3 (right): A trick to aid mounting the socket pins.

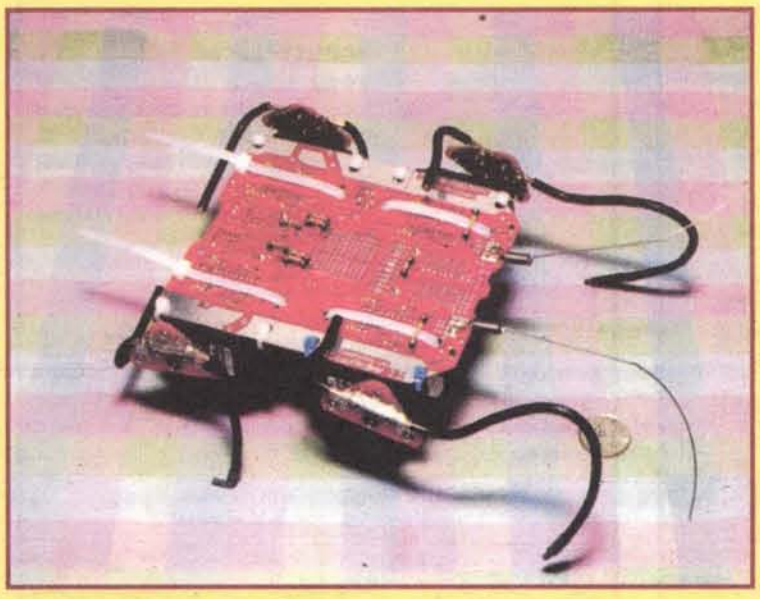


Photo 4: Top view of completed ScoutWalker.

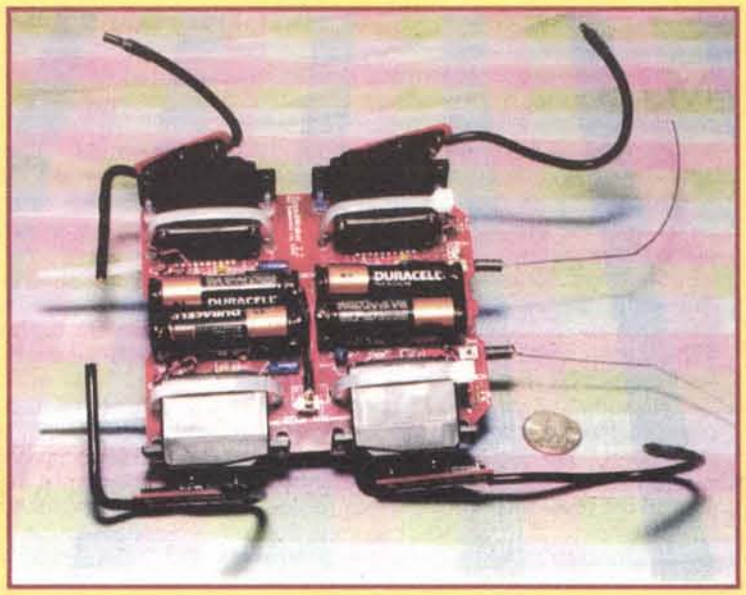


Photo 5: Bottom view of ScoutWalker.

wired as before, or the wires can cross so the left sensor controls the right motor and vice versa. The former will tend to steer away from the direction of the sensor that produces a stronger signal, while the latter – sensor lines crossed – will tend to steer toward the stronger signal.

Sounds Familiar ...

Those of you who've tinkered with BEAM robots will immediately recognize that Solarollers are a version of Braitenberg's Vehicle 1, with the added characteristic that a Solaroller's sensor is also its power source. As for Vehicle 2, the crossed-sensor version is also a familiar BEAM robot type, the so-called Photovore.

It's no accident that BEAM robots can be so easily compared to Braitenberg vehicles. Braitenberg's vehicles inspired the blooming of bottom-up robotics design at MIT's Media lab, home of the famed subsumption architecture robots of Rodney Brooks and his students. They, in turn, inspired Mark Tilden when he was first working out the BEAM philosophy. BEAM robots are Braitenberg vehicles, at least the simpler ones.

What makes this book still so relevant is that very few real robots of any stripe exceed the capabilities of, say, Vehicle 5. I would rate the ScoutWalker as a Vehicle 5, though most BEAM robots don't get any further than Vehicle 3. This is not a criticism of BEAM robot builders – it's harder to build a working robot than it is to dream one up. Rather, the point is there's lots more vehicles to be built, and we ought to get cracking.

Unobtanium

One reason why more haven't been built is, well, because Braitenberg cheats a little with some of his vehicles. Vehicle 7, for instance, requires a kind of exotic wire that exhibits high resistance, but which resistance falls a little each time the two threshold elements (neurons) to which it's connected are active simultaneously. Connections made with such wire allow associations to form between pairs of threshold elements. He calls this wire "Mnemotrix," and, though it would be useful stuff to have when building artificial neuronal networks, it is nonetheless imaginary.

Likewise, Vehicle 11 requires "Ergotrix," another wire similar to Mnemotrix, except it conducts only in one direction and changes its resistance when two neurons interconnected by it are activated in a specific sequence, A followed by B, but not B followed by A. Again, a handy kind of wire, but not real.

The reason why I say Braitenberg cheats only a little when he presents vehicle designs requiring "unobtanium" to function is that these are, after all, thought experiments. Also, there does exist plenty of methods to realize the functions of Mnemotrix and Ergotrix. For instance, the Perceptron Mark I – a real neurocomputer built in 1957/58 – used motor driven potentiometers to produce the same function as Mnemotrix wire – clunky, but it worked. Then, too, between 1962 and 1965 the Memistor Corporation sold a variable-resistance electrochemical cell – called a Memistor – that could be used to implement the equivalent of Mnemotrix wire connections.

Digital Connections

You probably wouldn't want to do all this with analog electronics. Most neural networks are implemented these days in software. Around the time Braitenberg's book first appeared is when the connectionist approach to AI really began to reassert itself. The irony here is that the enormous success of digital computing made it possible to reconsider the old connectionist methods.

A useful digital CPU can be built with just a couple thousand gates, each connected to no more than a handful of other gates. Neural networks, on the other hand, don't become interesting until you get up into hundreds of thousands of neurons, each with thousands of connections to other neurons. With memory so cheap and processors so fast, you often don't need physical neurons – or Mnemotrix or Ergotrix wire – if you use software to emulate them.

I'll close out this extended book

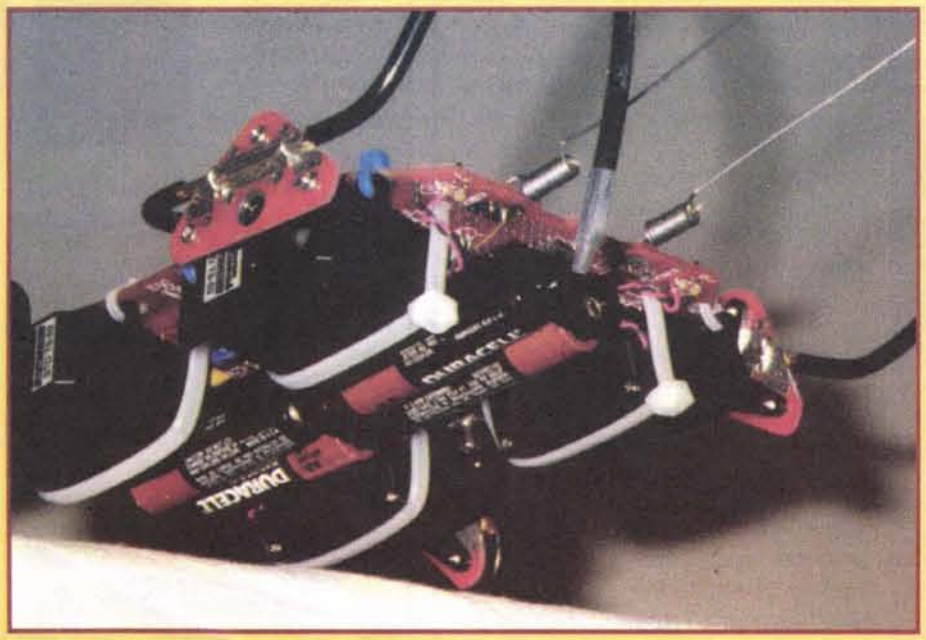


Photo 6: Leg mount and antennae sensor detail.

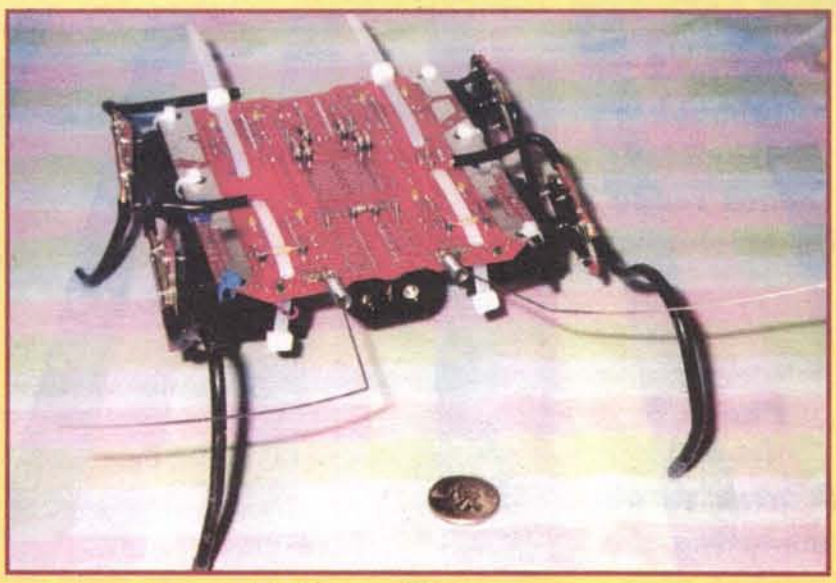


Photo 7: ScoutWalker front view.

Robotics

review with these notes. The schism between connectionism-cybernetics and symbolic-computational may seem stark, but it never was really as sharp a divide as it's been portrayed. John von Neumann, though extremely influential in the development of computers (most computers to this day are known as "von Neumann machines"), did not believe the roots of natural intelligence could be found in formal Boolean logic. Rather, he believed that brains use a form of statistical logic. He published a paper on this in 1957, the last year of his life; the paper was called "Probabilistic Logics and the Synthesis of Reliable Organisms from Unreliable Components." Then, too, it's often forgotten that George Boole himself also wrote about statistical logic in the last two sections of *Laws of Thought*, the book which introduced the world to Boolean logic in the 19th century.

To go deeper, check out the sidebar for more reading on Cybernetics, Neurocomputing, and their history.

Meet "Mot"

The robot of the month this time is, fittingly, a Braitenberg Vehicle 2: a beautiful little BEAM bot named Mot built by Math Vos of the Netherlands. Photos 8 and 9 show Math's handiwork, and the figure gives Math's schematic for Mot. You can also look at his circuit board layout, as well as his other robots at his website: http://home.wanadoo.nl/m.m.avos/.

As you can see, it's two modified FLED SE circuits (see last month's column) that share a common solar cell and energy storage capacitor; it really is a Vehicle 2. Note that LDR-l and LDR-R in the schematic refer to the BPW40 photodiode, though you could use photoresistors in their place. I'll let Math further describe his robot:

"Mot is the Dutch word for moth. Mot is a photovore, which means it tends to move toward brighter light. It's the third robot I've built using BEAM technology. BEAM stands for Biology, Electronics, Aesthetics, and Mechanics.

Mot uses two FLED (flashing LED) solar engines which draw their energy from a solar cell and capacitor. When the capacitor reaches a certain trigger voltage, one of the solar engines fires and its motor will turn for a short time until the voltage has dropped below 0.7 volts.

Thanks to the light-sensitive BPW40 photodiodes, there is a difference in the trigger voltage for the two solar engines. This robot always wants to go to the brightest light spot, so it will avoid shadows or dark places.

The most critical part of these solar engines is the combination of the motor and the resistor R. You'll have to do some experiments to find the right combination. In my 'bot, a resistor of 2.2K ohms gave the best result. While doing your experiments, it's useful to measure the voltage across the solar cell or the capacitor, so you'll get a feeling of what is going on.

If the voltage doesn't rise and one of the motors hasn't fired, try a smaller resistor, but remember that a smaller value also means more waste of energy. The FLED will flash, but the motor won't start turning. All the energy of the small solar cell is being consumed by the FLED in this case.

When Mot touches an obstacle with one of its feelers, the solar engine on the opposite side won't fire. This 'bot will go around an obstacle until the feeler gets free, then it will try to go to the brightest light spot again.

As you can see in the pictures, this 'bot is made on a printed circuit board. With some small adjustments it's possible to make it on uniboard, so you don't have to work with chemicals to make your own printed circuit.

***Other tips**:*

Do some experimenting with small tubes on the motor axles. Use different diameters. I made mine by cutting off some pieces of wire insulation.

Always keep in mind to use good motors. Cheap hobby motors normally won't work; they use too much current.

And last but not least: don't give up. Do your experiments and believe me, there is a lot of information on this subject on the Internet. I'm sure that every BEAMer will help you with some advice building your first BEAM 'bot.

Use a good, smooth surface to let your bots play. My 'Jurassic Park,' 24 by 32 inches, is illuminated with two 150-watt light bulbs. Under these conditions, Mot will take small steps every five seconds or so. In full sunlight, it steps once a second.

Good luck with BEAM!

Math Vos"

Braitenberg, Valentino; *Vehicles, Experiments in Synthetic Psychology* (MIT Press, Cambridge, MA, 1984)
ISBN 0-262-02208-7 (hard), 0-262-52112-1 (paper)

Dyson, George B., *Darwin Among the Machines: the Evolution of Global Intelligence* (Perseus Books, Cambridge, MA, 1997)
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Hecht-Nielsen, Robert, *Neurocomputing* (Addison-Wesley Publishing, Reading, MA, 1990)
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Holland, John H., *Emergence: from Chaos to Order* (Perseus Books, Cambridge, MA, 1998)
ISBN 0-201-14943-5 (hard), 0-7382-0142-1 (paper)

Levy, Steven, *Artificial Life: a report from the frontier where computers meet biology* (1st Vintage Books ed. 1993)
ISBN 0-679-74389-8 (paper)

Wiener, Norbert; *Cybernetics: or Control and Communication in the Animal and the Machine, 2nd ed.* (MIT Press, Cambridge, MA, 1961)
ISBN 0-262-23007-0 (hard), 0-262-73009-X (paper)

Next Time

More Heavy Iron stuff, I promise. Also, I'll review the Solarbotics Sunseeker and see how it works in conjunction with my ScoutWalker. And, oh, what the heck, I'll review another book of interest. **NV**

If you have suggestions, questions, or comments about amateur robotics topics, you can now reach me at:

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Continued from page 42

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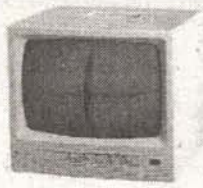

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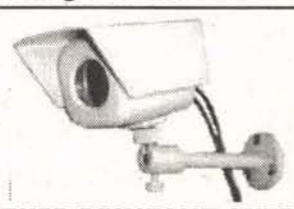

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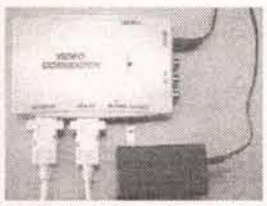

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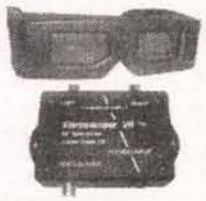

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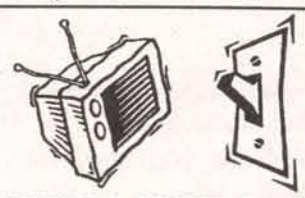

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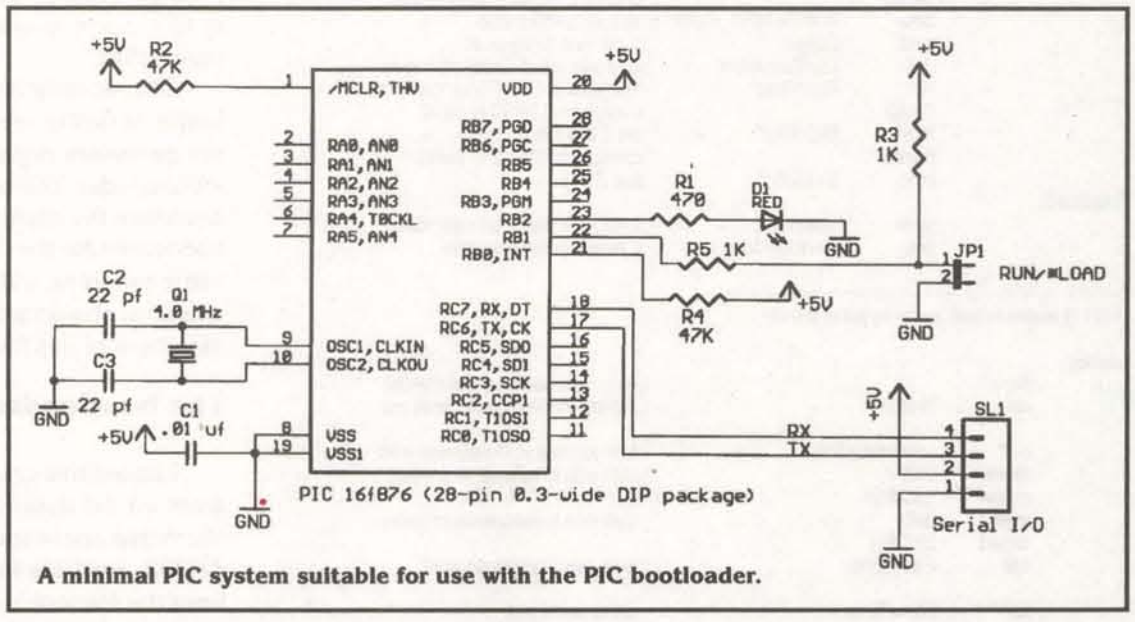
Continued on page 73

Using a PIC Bootloader

by Karl Lunt

The Motorola 68hc11 has long been a staple in the robot builder's arsenal. The rich set of I/O elements such as timers, counters, pulse-width modulation (PWM) generators, and serial interfaces, coupled with a powerful register set, reasonable memory resources, and low cost let you build small robots with just a single chip.



A minimal PIC system suitable for use with the PIC bootloader.

But one of its most powerful features is the on-chip bootloader, permanetly stored in a section of ROM in several older variants of the device. This bootloader allows you to transfer a small program into the chip's memory over an RS-232 serial line following power-up, then begin execution of the loaded program. If that program is itself a larger, more sophisticated loader, you can eventually bootstrap your way into completely rewriting the device's memory using nothing more than the serial port.

This bootloader feature permits 68hc11 program development without needing a chip programmer or special programming voltages. Thousands of experimenters have started out in robotics on the 68hc11 precisely because they could avoid the expense and hassle of buying an external device programmer.

It was this lack of bootloader that held me back for so long in

Figure 1: Listing of PIC 16f87x bootloader

```
;
; bootldr.asm   Flash-resident bootloader for the PIC 16f876/7
;
; Derived from the original Microchip program, boot877.asm
;

;
; This bootloader uses the state of PB1 to determine action. If PB1 is low on reset, the bootloader prepares
; to download a user file into memory. If PB1 is high on reset, the bootloader tests the value in
; a reserved flash cell, CodeStatus, to see if memory contains a valid code image. If CodeStatus is zero, the
; code image is assumed valid and control jumps to StartUserCode to run the downloaded image.
;

        list p=16f876, st=OFF, x=OFF, n=0
        errorlevel -302
        #include <p16f876.inc>

        #include "bank.mac"

        __CONFIG _BODEN_OFF & _CP_OFF & _PWRTE_ON & _WDT_OFF &
                        _WRT_ENABLE_ON & _XT_OSC & _DEBUG_OFF & _CPD_OFF &
                        _LVP_OFF

;-----------------------------------------------------------------
;Constants
;

;
; I changed the download selector input to PB1 from the original of PB0. I didn't want to tie up the valuable
; INT* pin for this selection.
;

TEST_INPUT      EQU     1       ;Port B Pin 1 input indicates download

;
; The following baud rate constants assume a 4.0 MHz crystal.
;

BAUD_9600       equ     0x19
BAUD_19200      equ     0x0c

BAUD_DEFAULT    equ     BAUD_9600

;-----------------------------------------------------------------
;Variables in bank0

        CBLOCK  0x20
        AddressH:  1        ;flash program memory address high byte
        AddressL:  1        ;flash program memory address low byte
        NumWords: 1         ;number of words in line of hex file
        Checksum: 1         ;byte to hold checksum of incoming data
        Counter:   1        ;to count words being saved or programmed
        TestByte:  1        ;byte to show reset vector code received
        HexByte:   1        ;byte from 2 incoming ascii characters
        DataPointer:1       ;pointer to data in buffer
        DataArray: 0x40     ;buffer for storing incoming data
        ENDC

;=================================================================
;Reset vector code

        ORG     0x0000

ResetVector:
        movlw   high Main
        movwf   PCLATH              ;set page bits for page3
        goto  Main                  ;go to boot loader
;=================================================================
;Start of boot code in upper memory traps accidental entry into boot ;code area

;       ORG     0x1e00              ;Use last part of page3 for '876/7
;       ORG     0x0e00              ;Use last part of page1 for '873/4
;       ORG     0x0600              ;Use last part of page0 for '870/1

        ORG     0x1e00              ;leave lots of room for loader

StartOfBoot:
        movlw   high TrapError      ;trap if user code hits boot code
        movwf   PCLATH              ;set correct page
TrapError:
        goto    TrapError           ;trap error and wait for reset

;-----------------------------------------------------------------
;Relocated user reset code to jump to start of user code
;Must be in bank0 before jumping to this routine

StartUserCode:
        clrf    PCLATH              ;set correct page for reset
        nop                         ;relocated user code replaces this
        nop                         ;relocated user code replaces this
```

```
                nop                             ;relocated user code replaces this
                nop                             ;relocated user code replaces this
                movlw   high TrapError1         ;trap if no goto in user reset code
                movwf   PCLATH                  ;set correct page
TrapError1:
                goto    TrapError1              ;trap error and wait for reset

;-----------------------------------------------------------------------
;Program memory location to show whether valid code has been programmed

CodeStatus:
                DA      0x3fff                  ;0 for valid code, 0x3fff if no code

;-----------------------------------------------------------------------
;Main boot code routine
;Tests to see if a load should occur and if valid user code exists

Main:
                Bank0                           ;change to bank0 in case of soft
                btfss   PORTB,TEST_INPUT ;check pin for boot load
                goto    Loader                  ;if low then do bootload
                call    LoadStatusAddr          ;load address of CodeStatus word
                call    FlashRead               ;read data at CodeStatus location
                Bank2                           ;change from bank3 to bank2
                movf    EEDATA,F                ;set Z flag if data is zero
                Bank0                           ;change from bank2 to bank0
                btfss   STATUS,Z                ;test Z flag
TrapError2:
                goto    TrapError2              ;if not zero then is no valid code
                goto    StartUserCode           ;if zero then run user code

;-----------------------------------------------------------------------
;Start of routine to load and program new code

Loader:
        Bank0                                   ; entry from vector at end of ROM
        clrf    TestByte                        ; indicate no reset vector code yet

        call    LoadStatusAddr                  ; load address of CodeStatus word
        movlw   0x3f                            ; load data to indicate no program
        movwf   EEDATH
        movlw   0xff                            ; load data to indicate no program
        movwf   EEDATA
        call    FlashWrite                      ; write new CodeStatus word

        call    SerialSetup                     ; set up serial port
        goto    GetCmd                          ; skip initial prompt

;-----------------------------------------------------------------------
;Get new line of hex file starting with ':'
;Get first 8 bytes after ':' and extract address and number of bytes

GetNewLine:
        call    SendCRLF
        movlw   '>'                             ; issue prompt
        call    SerialTransmit
GetCmd:
        call    SerialReceive                   ; get new byte from serial port
        xorlw   0x0a                            ; linefeed?
        btfsc   STATUS,Z
        goto    GetCmd                          ; yes, just skip silently
        xorlw   0x0a                            ; restore char
        call    SerialTransmit                  ; echo char
        xorlw   ':'                             ; check if ':' received
        btfsc   STATUS,Z
        goto    GetRec                          ; got :, start processing record
        xorlw   ':'                             ; restore the char
        xorlw   0dh                             ; not :, is it CR?
        btfsc   STATUS,Z
        goto    GetNewLine                      ; got CR, just start over
        xorlw   0dh                             ; restore the char
        xorlw   'G'                             ; was it GO command?
        btfsc   STATUS,Z
        goto    DoGoCmd                         ; do the GO

;
; Control reaches this point if the user sent an unknown command.
; Receive and echo all characters until CR.
;

EatLine:
        call    SerialReceive                   ; get char from serial port
        xorlw   0ah                             ; line-feed?
        btfsc   STATUS,Z
        goto    EatLine                         ; yes, ignore it
        xorlw   0ah                             ; recover char
        xorlw   0dh                             ; CR?
        btfsc   STATUS,Z
        goto    GetNewLine                      ; yes, done with this line
        xorlw   0dh                             ; recover char
        call    SerialTransmit                  ; echo the char
        goto    EatLine                         ; loop until hit CR

;
; Control reaches this point after user enters a semicolon, marking the start of a HEX record. Note that
; the leading semi has already been echoed.
;

GetRec:
        clrf    Checksum                        ; start with checksum zero
        call    GetHexByte                      ; get number of program data bytes in line
        andlw   0x1F                            ; limit number in case of error in file
```

Bootloader ...

using the PIC devices. I tend to work on the bare metal, and prefer the raw speed of assembly language over the ease of programming in Stamp BASIC. But the PIC devices have all required either an external programmer, such as the PICStart Plus, or additional circuitry to support in-system programming (ISP).

The recently released 16f87x family of flash-based PICs have the necessary registers to support a bootloader. This article describes the design and use of a bootloader for the 16f876; the same program, with minor changes, should work for other members of this family.

The bootloader design

I based this bootloader program on the design given in Microchip application note AN732, available for download from the Microchip web site (www.microchip.com). The bootloader given in this app note has several good features. It occupies less than 512 bytes of flash, so even if you install it on the smallest PIC in this family — the 16f872 — you still have 1.5K bytes of code space left for your own program.

The bootloader has almost no impact on system resources, so you can essentially write your own program as if the bootloader isn't present. The only vector used by the bootloader — the reset vector at address 0 — points to code inside the bootloader that automatically passes control either to your program or to the bootloader, depending on the state of an input pin.

Once started, the bootloader tests the state of RB0. If RB0 is low, the bootloader reads characters from the serial port, looking for a semicolon (':'), which marks the beginning of a INHX8M record. This is the common format for PIC object records created by the free MPLAB suite of programs available from the Microchip web site. When the bootloader detects an object record, it processes the record, checking for a valid checksum, then burns the object bytes into the proper locations in memory. Note, however, that the bootloader will not overwrite itself, nor will it alter addresses 0 through 3, where the reset vector lives. These low four addresses must always point to the bootloader.

The bootloader processes each object record until it receives the special end-of-file (EOF) record. Processing this record causes the bootloader to write a special flag value into flash, indicating that memory contains a valid object image. The bootloader then sits in a loop, allowing you to change RB0's state to high and reset the PIC.

If the PIC is reset with RB0 high, the bootloader tests the value in the flash variable to see if flash memory contains a valid object image. If it does, the bootloader immediately jumps to the start of the downloaded program. If it does not, the bootloader code sits in a loop, forcing you to change RB0 to a low and load a valid program image.

My version of the bootloader

As you can see, there isn't much to the design of a bootloader, and it certainly doesn't require much code space. Naturally, I couldn't leave well enough alone, so I added a few tweaks of my own. The following paragraphs discuss features from the original program and some of my own enhancements. Refer to the accompanying listing (Figure 1).

First off, you'll notice that I changed the bootloader's tested input pin from RB0 to RB1. RB0 is not only a general-purpose input, but also serves as the INT* input. This makes it the primary source of external interrupts, and I didn't want to tie up such a valuable resource simply to provide an input to the bootloader.

As written, this bootloader starts up at 9600 baud. I've included the constant for 19.2K baud, as well; you can modify the source file to use either constant, or add different ones of your own. Note that these constants assume a 4.0 MHz crystal; change them as appropriate if you use a different crystal.

The ORG statement immediately before the label StartOfBoot determines where the bootloader resides in memory. Uncomment the ORG statement appropriate to your device. Remember that the bootloader requires $200 bytes of code space.

Bootloader ...

Note that the reset vector at 0 points to Main, not StartOfBoot. The code at StartOfBoot provides a trap to stop runaway code should your program crash. The code at StartUserCode contains four NOP instructions; these will be eventually overwritten with the four bytes from your downloaded code's reset vector. This block of code allows the bootloader to set up the proper PC page, then dive into your program's reset vector and launch your program.

The address at CodeStatus acts as a flash variable for recording the state of a program download. This "variable" contains 0x3fff if no valid code image has been downloaded, or 0 if a valid image is available. Since the variable lives in flash, it survives power-cycling without corruption.

The code at Main marks the beginning of the real bootloader code. Instructions of the form Bankx are really banking macros used to change the bank control bits in the PIC. Your code sometimes must alter these bits to reach different I/O registers. I've included the file bank.mac as a separate listing (Figure 2).

The code at Main tests the state of the input pin; if low, control passes to the bootloader at address Loader. If the pin is high, the code then tests to see if the CodeStatus variable indicates valid code exists. If so, control passes to StartUserCode to launch the program; otherwise, the code locks up in the trap loop, forcing a reset.

The code at Loader resets the CodeStatus variable, effectively wiping out any existing program. Note, however, that if a program did exist in memory, it hasn't been altered. All that has changed is the CodeStatus variable; this works to our advantage later.

Next, the code sets up the serial port, then jumps into the command loop at GetCmd. Note that at this point the bootloader does not send any prompt to announce its presence; it just waits silently for you to type a character on your terminal program. I did this because some wireless modems, notably the InfoWave RF modem, flip out if you send data to its serial port before it has completed its two-second power-up initialization. If you don't need the silent delay, change the code so control passes to GetNewLine instead.

The code at GetCmd tests the first character it sees, looking for the beginning of a valid command. If the character is a colon (':'), control passes to GetRec to collect the rest of the object record. The only other valid command is an uppercase-G, which marks the start of either the G or G! command. Note that this code also detects but ignores linefeeds. Any other character is treated as an error, causing control to pass to EatLine. EatLine simply reads and echoes incoming characters until it sees a carriage return (CR), at which point it returns to GetNewLine.

GetRec processes a single object record, checking for a checksum and, if valid, writing the record's contents into the appropriate area of flash. Note that code in this section guards against overwriting the bootloader. It also

```
;-------------------------------------------------------------
;Macros to select the register bank
;Many bank changes can be optimised when only one STATUS bit changes

Bank0   MACRO                   ;macro to select data RAM bank 0
        bcf     STATUS,RP0
        bcf     STATUS,RP1
        ENDM

Bank1   MACRO                   ;macro to select data RAM bank 1
        bsf     STATUS,RP0
        bcf     STATUS,RP1
        ENDM

Bank2   MACRO                   ;macro to select data RAM bank 2
        bcf     STATUS,RP0
        bsf     STATUS,RP1
        ENDM

Bank3   MACRO                   ;macro to select data RAM bank 3
        bsf     STATUS,RP0
        bsf     STATUS,RP1
        ENDM
```

Figure 2: Listing of banking macros

```
        movwf   NumWords
        bcf     STATUS,C
        rrf     NumWords,F      ; divide by 2 to get number of words
        call    GetHexByte      ; get upper half of program start address
        movwf   AddressH

        call    GetHexByte      ; get lower half of program start address
        movwf   AddressL

        bcf     STATUS,C
        rrf     AddressH,F      ;divide address by 2 to get word address
        rrf     AddressL,F

        call    GetHexByte      ;get record type
        xorlw   0x01
        btfsc   STATUS,Z        ;check if end of file record (0x01)
        goto    FileDone        ;if end of file then all done

        movf    HexByte,W
        xorlw   0x00
        btfss   STATUS,Z        ;check if regular line record (0x00)
        goto    LineDone        ;if not then ignore line and send '.'

        movlw   0xe0
        addwf   AddressH,W      ;check if address >= 0x2000 (was <)
        btfsc   STATUS,C        ;which is ID locations and config bits
        goto    LineDone        ;if so then ignore line and send '.'

;-------------------------------------------------------------
;Get data bytes and checksum from line of hex file

        movlw   DataArray
        movwf   FSR             ;set pointer to start of array
        movf    NumWords,W
        movwf   Counter         ;set counter to number of words

GetData:
        call    GetHexByte      ;get low data byte
        movwf   INDF            ;save in array
        incf    FSR,F           ;point to high byte

        call    GetHexByte      ;get high data byte
        movwf   INDF            ;save in array
        incf    FSR,F           ;point to next low byte

        decfsz  Counter,F
        goto    GetData

        call    GetHexByte      ;get checksum
        movf    Checksum,W      ;check if checksum correct
        btfss   STATUS,Z
        goto    ErrorMessage

;
; Get saved data one word at a time to program into flash
;
        movlw   DataArray
        movwf   FSR             ;point to start of array
        movf    NumWords,W
        movwf   Counter         ;set counter to half number of bytes
;
; Check if address is in reset code area
;
CheckAddress:
        movf    AddressH,W      ;checking for boot location code
        btfss   STATUS,Z        ;test if AddressH is zero
        goto    CheckAddress1   ;if not go check if reset code received

        movlw   0xfc
        addwf   AddressL,W      ;add 0xfc (-4) to address
        btfsc   STATUS,C        ;no carry means address < 4
        goto    CheckAddress1   ;if not go check if reset code received

        bsf     TestByte,0      ;show that reset vector code received
        movf    AddressL,W      ;relocate addresses 0-3 to new location
        addlw   low (StartUserCode + 1) ;add low address to new location
        Bank2                   ;change from bank0 to bank2
        movwf   EEADR           ;load new low address
        movlw   high (StartUserCode + 1) ;get new location high address
        movwf   EEADRH          ;load high address
        goto    LoadData        ;go get data byte and program into flash

;-------------------------------------------------------------
;Check if reset code has been received
;Check if address is too high and conflicts with boot loader

CheckAddress1:
        btfss   TestByte,0      ;check if reset vector code received first
        goto    ErrorMessage    ;if not then error

        movlw   high StartOfBoot ;get high byte of address
        subwf   AddressH,W
        btfss   STATUS,C        ;test if less than boot code address
        goto    LoadAddress     ;yes so continue with write
        btfss   STATUS,Z        ;test if equal to boot code address
        goto    ErrorMessage    ;no so error in high byte of address

        movlw   low StartOfBoot ;get low byte of address
        subwf   AddressL,W
        btfsc   STATUS,C        ;test if less than boot code address
        goto    ErrorMessage    ;no so error in address
```

Bootloader ...

ensures that any code originally intended for addresses 0 through 3 is written instead to the proper area in flash near StartUserCode.

If GetRec successfully processed the object record, it issues a period ('.') to tell you that the code was copied correctly. If the object record was not successfully processed, GetRec instead issues two exclamation marks ('!!') as a warning. In the case of an EOF record, GetRec changes the CodeStatus variable to show a successful download, then sends OK to the serial port.

Note that you will see the OK even if one or more records were not processed successfully. You need to watch the download stream for any error markers. Alternatively, you could modify the bootloader to keep a download status variable, then test that variable before issuing the OK.

Assuming that the download operation worked and you see the OK on your terminal screen, you can issue the G command. The code at DoGoCmd tests for either of two strings. The string "G<CR>" forces the code to test the CodeStatus variable, and it will not start the downloaded program if the CodeStatus variable does not contain 0. The string "G!<CR>" bypasses this test of the CodeStatus variable, and causes a blind jump to StartUserCode.

This last feature can come in handy if your downloaded program somehow restarts the bootloader. Rather than having to reload your file, you can force the bootloader to rerun the existing program by issuing the G! command.

The remainder of the bootloader program contains subroutines needed to support the various functions. Two routines in particular — FlashRead and FlashWrite — read and write the contents of a selected address in flash. These routines use the contents of the EE-related registers

```
;-----------------------------------------------------------------
;Load address and data and write data into flash

LoadAddress:
        movf    AddressH,W      ;get high address
        Bank2                   ;change from bank0 to bank2
        movwf   EEADRH          ;load high address
        Bank0                   ;change from bank2 to bank0
        movf    AddressL,W      ;get low address
        Bank2                   ;change from bank0 to bank2
        movwf   EEADR           ;load low address

LoadData:
        movf    INDF,W          ;get low byte from array
        movwf   EEDATA          ;load low byte
        incf    FSR,F           ;point to high data byte
        movf    INDF,W          ;get high byte from array
        movwf   EEDATH          ;load high byte
        incf    FSR,F           ;point to next low data byte

        call    FlashWrite      ;write data to program memory

        Bank0                   ;change from bank3 to bank0
        incfsz  AddressL,F ;increment low address byte
        goto    CheckLineDone   ;check for rollover
        incf    AddressH,F      ;if so then increment high address byte

CheckLineDone:
        decfsz  Counter,F  ;check if all words have been programmed
        goto    CheckAddress    ;if not then go program next word

;-----------------------------------------------------------------
;Done programming line of file

LineDone:
        movlw   '.'             ; line has been programmed so
        call    SerialTransmit  ; transmit progress indicator back
        call    SerialReceive   ; eat the trailing CR (hopefully!)
        goto    GetNewLine      ; go get next line hex file

;
; Control reaches this point after loading a file. Change the status indicator to show that a legal file has
; been loaded, then issue the success indicator and return to the top for the next command.
;

FileDone:
File1:
        call    SerialReceive   ; need to eat checksum for file record
        xorlw   0x0d            ; hit the CR yet?
        btfsc   STATUS,Z
        goto    File2           ; got the CR, finish the report
        xorlw   0x0d            ; need to echo, restore the char
        call    SerialTransmit  ; do the echo
        goto    File1           ; loop until CR

File2:
        call    LoadStatusAddr  ;load address of CodeStatus word
        clrf    EEDATH          ;load data to indicate program exists
        clrf    EEDATA          ;load data to indicate program exists
        call    FlashWrite

        call    SendCRLF
        movlw   'O'             ; show success
        call    SerialTransmit
        movlw   'K'
        call    SerialTransmit

        goto    GetNewLine

;
; An error occurred in the file download. Send an error indicator, then return to the top for another command.
;

ErrorMessage:
        call    SendCRLF
        movlw   '!'             ; show failure
        call    SerialTransmit
        call    SerialTransmit
        goto    GetNewLine

;
; Control reaches this point to process the GO command. Check for a valid file (CodeStatus). If OK, jump
; to user program, otherwise, send an error code. Note that this code is copied from the code at Main that
; runs on power-up in user mode.
;
; There are two forms of this command:
;
; G <CR>   code status must be good before jump to user code.
; G! <CR>  jumps to user code WITHOUT checking code status
;
; Note that the G! form forces the CodeStatus word to 0 before jumping to the user code. This means
;  subsequent resets with the bootloader select line high will also jump to user code. There had better be
; something there!
;

DoGoCmd:
        call    SerialReceive           ; get next char
        xorlw   0x0d                    ; check it
        btfss   STATUS,Z
        goto    GoCmd1                  ; no CR, might be !
        call    SendCRLF                ; echo CR and LF
```

```
        call    LoadStatusAddr          ; load address of CodeStatus word
        call    FlashRead               ; read data at CodeStatus location
        Bank2                           ; change from bank3 to bank2
        movf    EEDATA,F                ; set Z flag if data is zero
        Bank0                           ; change from bank2 to bank0
        btfsc   STATUS,Z                ; skip if code status is bad
        goto    StartUserCode           ; run the user program

        call    SendCRLF                ; make it pretty
        movlw   'N'                     ; get the failure marker
        call    SerialTransmit          ; send it
        movlw   'O'                     ; get rest of marker
        call    SerialTransmit          ; send it
        goto    GetNewLine              ; back to the top

GoCmd1:
        xorlw   0x0d                    ; restore char
        xorlw   '!'                     ; force char?
        btfss   STATUS,Z
        goto    EatLine                 ; not !, must be trash...
        movlw   '!'                     ; need to echo
        call    SerialTransmit          ;
        call    SerialReceive           ; get next char
        xorlw   0x0d                    ; better be CR
        btfss   STATUS,Z
        goto    EatLine                 ; no CR, ignore it
        call    SendCRLF                ; echo CR and LF
        call    LoadStatusAddr          ;load address of CodeStatus word
        clrf    EEDATH                  ;load data to indicate program exists
        clrf    EEDATA                  ;load data to indicate program exists
        call    FlashWrite
        goto    StartUserCode           ; run the user program (hopefully)


;
; SendCRLF  send a CR/LF sequence
;

SendCRLF:
        movlw   0x0d                    ; CR
        call    SerialTransmit
        movlw   0x0a                    ; LF
        call    SerialTransmit
        return


;
; LoadStatusAddr  load address of CodeStatus word to flash addr
;
; This routine returns in bank2.
;

LoadStatusAddr:
        Bank2                           ;change from bank0 to bank2
        movlw   high CodeStatus         ;load high addr of CodeStatus location
        movwf   EEADRH
        movlw   low CodeStatus          ;load low addr of CodeStatus location
        movwf   EEADR
        return

;
; GetHexByte  get two ASCII digits, convert to a byte
;
; This routine reads and echoes two characters from the USART and converts them to a single byte,
; returned in W. No check is made for legality. The byte is added to the checksum.
; This routine returns in bank0.

GetHexByte:
        call    SerialReceive           ;get new byte from serial port
        call    SerialTransmit          ;echo the character
        addlw   0xbf                    ;add -'A' to Ascii high byte
        btfss   STATUS,C                ;check if positive
        addlw   0x07                    ;if not, add 17 ('0' to '9')
        addlw   0x0a                    ;else add 10 ('A' to 'F')
        movwf   HexByte                 ;save nibble
        swapf   HexByte,F               ;move nibble to high position

        call    SerialReceive           ;get new byte from serial port
        call    SerialTransmit          ;echo the character
        addlw   0xbf                    ;add -'A' to Ascii low byte
        btfss   STATUS,C                ;check if positive
        addlw   0x07                    ;if not, add 17 ('0' to '9')
        addlw   0x0a                    ;else add 10 ('A' to 'F')
        iorwf   HexByte,F               ;add low nibble to high nibble
        movf    HexByte,W               ;put result in W reg
        addwf   Checksum,F              ;add to cumulative checksum
        return

;
; SerialSetup  initialize the USART
;
; Configure the USART for transmit and receive at the default baud rate.
;
; Note that this routine returns with the banking registers set for bank0.
;

SerialSetup:
        Bank1
        movlw   BAUD_DEFAULT            ;set baud rate
        movwf   SPBRG
        bsf     TXSTA,BRGH              ;baud rate high speed option
        bsf     TXSTA,TXEN              ;enable transmission
        Bank0                           ;change from bank1 to bank0
        bsf     RCSTA,CREN              ;enable reception
        bsf     RCSTA,SPEN              ;enable serial port
        return

;
; SerialReceive  read a byte from USART, return it in W
;
; Note that this routine returns with the banking registers set for bank0.
;

SerialReceive:
        Bank0                           ;change from unknown bank to bank0
        btfss   PIR1,RCIF               ;check if data received
        goto    $-1                     ;wait until new data
        movf    RCREG,W                 ;get received data into W
        return

;
; SerialTransmit  transmit byte in W register from USART
;
; Note that this routine returns with the banking registers set for bank0.
;

SerialTransmit:
        Bank0                           ;change from unknown bank to bank0
        btfss   PIR1,TXIF               ;check that buffer is empty
        goto    $-1
        movwf   TXREG                   ;transmit byte
        return

;
; FlashWrite  write to a location in the flash program memory.
;
; The calling routine should write the address of interest in EEADRH
; and EEADR, and the data in EEDATH and EEDATA.
;
; Note that this routine returns with the banking registers set for bank3.
;

FlashWrite:
        Bank3                           ;change from bank2 to bank3
        movlw   0x84                    ;enable writes to program flash
        movwf   EECON1

        movlw   0x55                    ;do timed access writes
        movwf   EECON2
        movlw   0xaa
        movwf   EECON2
        bsf     EECON1,WR               ;begin writing to flash
        nop                             ;processor halts here while writing
        nop
        return

;-----------------------------------------------------------------

;
; FlashRead  read from a location in the flash program memory
;
; Address is in EEADRH and EEADR, data returned in EEDATH and EEDATA
; This routine returns in bank3.
;

FlashRead:
        Bank2                           ; get it right
        movlw   0x1f                    ; keep address within range
        andwf   EEADRH,F

        Bank3                           ; change from bank2 to bank3
        movlw   0x80                    ; enable reads from program flash
        movwf   EECON1
        bsf     EECON1,RD               ; read from flash
        nop                             ; processor waits while reading
        nop
        return

;
; The following instructions act as vectors to permit other programs access to routines within the monitor.
; Programs should execute a CALL to one of these addresses, rather than a CALL directly to
; the target routine, as the target routine might move in future versions of this program!
;
; Pay close attention to the banking when these routines exit, as they often change the current register bank.
;
; Note that entry to the Loader at $xxff should be via a GOTO, not a CALL.
;

        org     StartOfBoot+0x1f8

        return                          ; $1ff8
        return                          ; $1ff9
        return                          ; $1ffa
        return                          ; $1ffb
        goto    SerialSetup             ; $1ffc
        goto    FlashRead               ; $1ffd
        goto    FlashWrite              ; $1ffe
        goto    Loader                  ; $1fff

;-----------------------------------------------------------------

        END
```

Bootloader ...

during execution; refer to the comments for details.

The final block of code isn't really code at all. The instructions in the top eight bytes of the bootloader act as vectors for accessing key routines within the bootloader code. For example, the instruction at 0x1fff contains a jump to the start of the bootloader. This means that your downloaded program could, on a special condition, jump to 0x1fff and automatically restart the bootloader. Other vectors in this area allow your code access to FlashRead and FlashWrite, as well as the serial setup code. If you choose to call these vectors in your code, pay close attention to the banking register setup upon exit; your code may need to change the register bank after the call.

That's all ...

This bootloader makes development of PIC code a snap. Just wire up the included PIC circuit (schematic), bringing out the serial data lines from the USART to an RS-232 level shifter and appropriate DB9 connector. Set RB1 low so the bootloader starts on reset, then start some type of terminal program; I've used Hyperterm with success. When you reset the PIC, press Enter on your PC's keyboard and you should see the bootloader's prompt, a greater-than sign ('>').

To allow sufficient time for programming the flash after each object record, set Hyperterm so it delays 50 milliseconds before sending each line of a text file transmission; for other terminal programs, you can force a delay until a CR is received. Start a text file transfer of a PIC object file; you should see each line of the file echoed on the screen, with an appended period. When you see the OK followed by the bootloader prompt, just enter GO to start your program. Alternatively, you can pull RB1 high and hit reset. In either case, your program should be up and running.

The only real problem with this whole system is that you must first get the bootloader into a PIC. Unfortunately, this does require a device programmer of some type. But it's only needed once, so if you don't have a PIC programmer, you might be able to take some chips over to a buddy's house and borrow some quality time on his programmer. Once you have the bootloader installed, it's almost impossible to damage or overwrite it, so it should be there whenever you need it.

And even though I do have a PIC programmer, the bootloader is way easier to use. I just leave Hyperterm running, and do all of my coding in the Microchip MPLAB program. When it's time to try some code, I just flip over to Hyperterm, download the program, and give it a whirl.

This utility should open the doors for PIC development to hobbyists long shut out by the need for a device programmer for every code revision. Load this into one of the newer PICs, then put your PICStart Plus on the shelf; you won't be needing it again any time soon ... **NV**

As always, you can contact me by email at karllunt@seanet.com. Feel free to stop by my web page at www.seanet.com/~karllunt. Besides information on my book, *Build Your Own Robot!*, you can find lots of tools and tips for the hobby robot builder.

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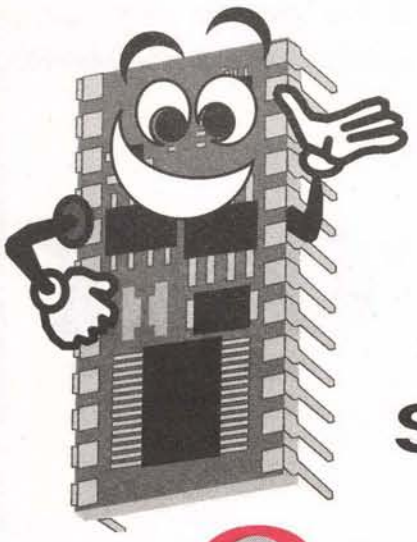

by Jon Williams

Stamp Applications

SEARCHING THE 1-WIRE™ BUS

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

Of its many neat new features, the BS2p has native support for Dallas 1-Wire™ components. Remember that 1-Wire components are uniquely identified by an eight-byte serial number. The first byte indicates the device (called the Family Code), the next six bytes are the serial number, and finally, the last byte is a CRC of the first seven. This unique serial number allows up to 150 devices to coexist on a single-wire bus that can be up to 100 meters long – and those numbers grow with proper cabling and drive circuitry.

Working with a single 1-Wire device is easy since we can simply ignore its serial number (by using the SKIP ROM command). When two or more devices are on the bus, however, we need to know the serial number of each so that we can communicate with them individually. Issuing the SKIP ROM command on a bus with more than one device will cause data collisions and a big, garbled mess of data coming back to the Stamp.

Practicalities

When we're simply experimenting, individually reading the serial numbers from our 1-Wire™ devices and embedding them into our project code is no big deal. It would be a problem, however, if our project turned into a real product and we were going to manufacture 100 units a day. Manually recording individual serial numbers just isn't practical; there's got to be a better way. So what do we do when we have multiple devices on the 1-Wire bus and we don't want to record the serial numbers manually?

Dallas Semiconductor knew this would be an issue in the design phase of the 1-Wire bus and implemented a command that is common to all 1-Wire parts that is called SEARCH ROM ($F0). With SEARCH ROM and a bit of code, we can individually identify any number (up to the limits of our EE storage space) of 1-Wire devices connected to the BS2p. The search algorithm code seems easy now, but trust me, it was a bear ...

A few months ago, Parallax introduced their newest Stamp, the BS2p microcontroller. I'm happy to report that, after a bit of a rocky production start (getting raw parts was tough), it's in full production now and doing very well. I really love the BS2p — it is definitely my favorite Stamp of the bunch.

Get Ready For A KISS

For a really good description of the 1-Wire search algorithm, please download the **iButton Standards** documentation from Dallas Semiconductor. It was in this document that I found a description and flowchart that actually helped me implement the 1-Wire search algorithm. Here's my "Keep It Simple, Stamp-Guy" description of the process:

The 1-Wire bus is reset and the SEARCH ROM command is issued. Two bits are read from the bus (this process actually takes place 64 times – once for each bit in the serial number). Each 1-Wire device will return a bit, then its compliment. Since the design of the 1-Wire bus causes the output of the devices to logically AND with each other, four possible combinations of bits will be returned to the Stamp:

00 - Bus conflict (some zeros returned; some ones returned)
01 - All devices have a zero in this bit position
10 - All devices have a one in this bit position
11 - There are no devices present

The second two combinations are the easiest to deal with. We simply note the bit in our temporary serial number variable, then write the bit back to the bus. This keeps the devices online (this will make more sense in a moment).

When 00 is returned, there has been a conflict – that is, some devices have a zero in this bit position and some have a one (ANDing them together will return zero). In the beginning, the algorithm will arbitrarily select zero as the "hot bit" and write it back to the bus. When this happens, any device that just returned a one bit will be disabled until a new search is initiated. The bit location of the collision is saved.

As the search continues, a new collision location is compared with the last. If the new location is in the same spot as the last (this would only happen on a new device search), one is selected as the "hot bit" and the process continues. If the new location is greater than the last, a zero is used (because we're probably in the same device as the last collision). If the new location is less than the previous, the last known bit value is used.

Yes, it can be a bit confusing and if you're anything like me, it may take a few days to sink in. The nice part is that it does work. As each device is identified and stored, it is taken offline. We know that we've found all the available devices when there are no reported bus collisions. If there are no devices connected to the bus, the pull-up will cause 11 to be returned, indicating that there are no devices. You must be sure that your bus pin is pulled-up (through 4.7K). If it's not, 00 could be returned and the algorithm will attempt to search forever (I know this from having knocked a resistor loose in a late-night programming session).

Implementing The Search Algorithm

Have you ever been told not to believe anything unless you see it in writing? Me too. What I learned when it came to implementing the search algorithm for 1-Wire parts, is that not everything in writing is worth reading or helpful. Now, I'm not trying to knock Dallas Semiconductor. They're home-town guys, build cool parts, and have been very nice to me. That said (or typed, as it were), I was a bit frazzled after staying up until 4 a.m. one morning trying to make the

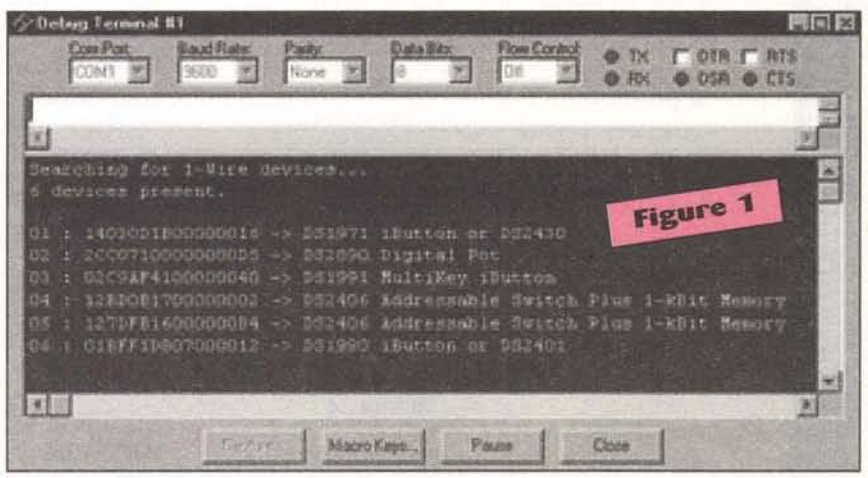

Figure 1

Searching The 1-Wire™ Bus

search algorithm work. I wasn't alone. A good friend and great BS2p programmer couldn't make it work either.

I felt just a bit better when I called one of Dallas' Applications Engineers later that morning (after a few hours of sorely needed sleep) and heard him refer to the 1-Wire search algorithm as a nightmare. Really. It's not easy. The good news for you is that after finding a third document on the algorithm, I was able to implement it successfully. So, the hard work is done and as you'll see in just a bit, you can easily integrate the 1-Wire search algorithm in your own BS2p programs. As I indicated earlier, the **iButton Standards** manual had the right combination of text and flowchart to make sense of the algorithm. After spending a long sleepless night, the right docs helped me get the code working in under an hour.

The Code In All Its Parts

Last month, we talked about using extra program slots to hold additional code and data. This month, we're going to put that theory to practical use with our project.

Remember me mentioning – okay, harping on – program design; you know, knowing what your program is supposed to do before you actually write it? Well, here's what I wanted to do this month:

- Check to see if the 1-Wire bus has been searched for devices.
- If not, search the bus (and use an external program for portability).
- If a device is found and the CRC is good, write the serial number into the caller's EE space.
- If there are any CRC errors, ignore the bad device and report errors to the calling program.
- When the bus has been searched, display the number and type of devices found.

I broke the project into three separate files since I wanted to reuse the search algorithm and I didn't want to burden my main project file with all the string data that describes the devices. What we'll do here is take advantage of information passing between programs (using PUT and GET), as well as the new BS2p command – STORE – that allows one program to READ or WRITE the EEPROM from another.

The main project file (Listing 1) is called SRCHDEMO.BSP. At the top, you'll see the $STAMP directive that causes the support files, OWSEARCH.BSP and DSNAMES.BSP – to be opened, syntax-checked, and downloaded to the BS2p.

Let's get back to the main program. After defining useful constants and the variables we need, EEPROM space is allocated for possible 1-Wire devices. There is a location labeled Num_OW that is initialized to $FF to indicate that the bus has not been searched. I'm hedging here that I will never need to have 255 devices on my 1-Wire bus. When the search routine is complete, this location will be updated with the number of devices found. Keep in mind that the value of $FF is written to this location only on download. If it is modified later, the program will run with the new information.

At the next location, 80 bytes are set aside for serial number storage. At eight bytes per device, this is enough room for 10 devices. Of course, more could be allocated. As your program grows, be sure to use the Memory Map facility of the compiler to make sure you'll have EEPROM space for data that you want to store.

Okay, let's move on to initialization. The first thing we do is look at that location called Num_OW. The first time this program runs, we will find a value of $FF (put there during download). This indicates the necessity of a search. Before we run the search, we'll grab our own calling program (just in case we do an update and are not in slot 0). This information, the pin number for the 1-Wire bus, and the starting location for serial number storage are passed to the search program using **PUT**. The search program is launched with the **RUN** command.

The search program (OWSEARCH.BSP – Listing 2) initializes by grabbing its own slot number, the calling program's slot number, the 1-Wire bus pin, and the start of data storage in the caller. Then the search begins. When a device is located, the CRC is checked to make sure that what we got back was, in fact, valid data. The CRC algorithm is also described in the Dallas documentation and, as you can plainly see, is very easy to implement.

Program listings 2 (OWSEARCH.BSP) and 3 (DSNAMES.BSP) are not printed here due to space limitations. You may view or download them from the Nuts & Volts website.
www.nutsvolts.com

The CRC can be calculated manually, bit-by-bit, but it's much easier to use a table-drive algorithm when there is storage space available. We have plenty of space, so the CRC table is stored in this slot. If the CRC check is good (the process returns a zero when good), the device count is incremented and the serial number is written in the caller's EEPROM space.

This is possible only in the BS2p with the new **STORE** command. Now you can see why we have to keep track of our own program slot, as well as the caller's. When reading the CRC table, we have to use our own slot number; when writing serial numbers to the caller, we have to point to the caller first.

When the searching is complete, the number of devices found is written in the caller's EEPROM (just ahead of the serial number table) and any CRC errors are passed back through the scratchpad with **PUT**. Then we return to the caller which, in our case, will display a list of any found devices.

When the **RUN** command is issued, the slot is run. The difference is that any EEPROM changes made by code are maintained. So, the search demo code will have different values in its EEPROM than when we downloaded it. At the very least, the number of devices reported will be something other than $FF.

The rest of the demo program is very simple: Errors are reported and then the found devices, if any, are displayed (serial numbers and device types). Since I didn't want to burden my main program with the device name strings, I used another module (DSNAMES.BSP – Listing 3) to hold them. When you look at this listing you'll see that it consists of one constant definition and a whole lot of EEPROM storage. The trick was to devise a way of finding the description string for a given device.

There's probably a dozen good ways to do it and here's what I decided to do: The string descriptions are stored first, with each string being identified with a useful label, in this case, the device part number. After the strings, pointers to their starting locations are stored. This is done mathematically – and automatically – thanks to the nature of the Stamp compiler.

The Stamp compiler converts **DATA** labels into numbers that can be used in math expressions. So, the formula for the storage address of the string pointers is:

(device id * 2) + base address

You'll notice that I use the **Word** directive to cause the Stamp to store two bytes at the calculated pointer location. This is necessary since the string definitions require far more than 255 bytes of EEPROM, hence, will require two bytes for addressing. So the pointer location stores the EEPROM location of the first character in its respective string. Each string is terminated with a zero so we can find its end. The base address was set to $600 as this is the highest starting location we can use with a possible device number of $FF. This allows string storage all the way up to $599 (1,536 bytes).

A description is displayed by sending the device number to the subroutine called DisplayDeviceType. This code uses the math previously described to calculate the pointer to the device string. Two reads are required to get the starting address of the string. Once we have the starting address, we read a character, display it, and then increment the address until a zero is located. You'll probably recognize this technique as we've used it many times before. The difference here is the ability to use different program slots to store the strings. This is a great opportunity to create a multi-lingual application – with different languages being stored in different program slots. Change the slot number to read from and you can change the language of your displays.

Okay, that's enough for this month. Seemingly simple code, but lots of good stuff going on with it and a pretty good demonstration of the usefulness of the new STORE command. I suggest you spend some time studying what we've done here – there are a lot of good code bits. And you can see why I like the BS2p so

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Does This Make Any Sense?

I was thinking the other day and it occurred to me that this column has been around for a few years now. First, there was Scott, then me, then Lon – now back to me. Between the three of us, we've shared a lot of good tricks.

Don't worry, we're not going away, just considering what to do next to keep you interested and entertained. A friend recently suggested spending a bit of time on inexpensive sensors and how to integrate them into Stamp projects. So that's what we'll do – for a while, anyway.

My buddies at the DPRG (Dallas Personal Robotics Group) gave me a nifty little light sensor (light to frequency) from TAOS: the TSL230. The great news is that it's easy to use and will work with any Stamp 2. But that's not the only part we'll be working with next month, so come back and join me.

As always, I wish you Happy Stamping. **NV**

```
' Listing 1
' Nuts & Volts - Stamp Applications, April 2001

' {$STAMP BS2p,OWSEARCH.BSP,DSNAMES.BSP}

' -----[ Title ]-----------------------------------------------------------
'
' File..... SRCHDEMO.BSP
' Purpose... Demonstrates Dallas 1-Wire Search Algorithm
' Author.... Jon Williams
' E-mail.... jonwms@aol.com
' Started... 27 FEB 2001
' Updated... 05 MAR 2001


' -----[ Program Description ]---------------------------------------------
'
' The purpose of this program is to demonstrate the use of external
' program slots to hold code code or subroutines.  When first downloaded
' to the BS2p, the number of Dallas 1-Wire devices is unknown (flag value
' of $FF).  This program reads that flag and if it is $FF, the search
' program slot is called to conduct the search.  Search results are
' written directly to the this program's EE (thanks to the BS2p STORE
' function).
'
' When the search is complete, a list of all found devices is displayed
' in a DEBUG window.


' -----[ Revision History ]------------------------------------------------
'
' 28 FEB 2001 - Version 1 complete and tested


' -----[ I/O Definitions ]-------------------------------------------------
'
OWpin           CON     15              ' 1-Wire bus


' -----[ Constants ]-------------------------------------------------------
'
SearchPgm       CON     1               ' search program slot
NamesPgm        CON     2               ' DalSemi OW device names

' 1-Wire Support
'
OW_FERst        CON     %0001           ' Front-End Reset
OW_BERst        CON     %0010           ' Back-End Reset
OW_BitMode      CON     %0100
OW_HighSpd      CON     %1000

ReadROM                 CON     $33     ' read ID, serial num, CRC
MatchROM        CON     $55             ' look for specific device
SkipROM         CON     $CC             ' skip ROM (one device)
SearchROM       CON     $F0             ' search


' -----[ Variables ]-------------------------------------------------------
'
thisSlot        VAR     Nib             ' this program's slot (0 - 7)
devices         VAR     Byte            ' 1-Wire devices found
addr            VAR     Word            ' EE address of device SN
offset          VAR     Nib             ' offset byte of device SN
idx             VAR     Byte            ' loop counter
dByte           VAR     Byte            ' data byte
devType         VAR     Byte            ' device type (first byte of SN)
devName         VAR     Byte            ' device identifier
strPtr          VAR     Word            ' string pointer
char            VAR     Byte            ' string character to print
crcErrors       VAR     Byte            ' indicates problems with search

tempROM         VAR     Byte(8)         ' data from 1-Wire device
crcVal          VAR     Byte            ' CRC of returned data


' -----[ EEPROM Data ]-----------------------------------------------------
'
Num_OW DATA     $FF                     ' number of 1-Wire devices
OW_Data DATA    0(80)                   ' space for 10 1-Wire SN's


' -----[ Initialization ]--------------------------------------------------
'
Initialize:
  READ Num_OW,dByte             ' ROM codes present?
  IF (dByte < $FF) THEN Main    ' yes, run this program

  DEBUG CLS
  PAUSE 5
  DEBUG "Searching for 1-Wire devices...",CR

  GET 127,thisSlot              ' get this pgm slot #
  PUT 126,thisSlot              ' save it
  PUT 125,OWpin                 ' save OW I/O
  PUT 124,OW_Data               ' save data storage start
  PUT 123,0                     ' clear CRC errors

  RUN SearchPgm                 ' run the search program


' -----[ Main Code ]-------------------------------------------------------
'
Main:
  GET 123,crcErrors
  IF (crcErrors = 0) THEN ShowDevices
  DEBUG "Warning: CRC errors during search.",CR

ShowDevices:
  READ Num_OW,devices           ' get number of devices
  DEBUG CR,DEC devices," device"
  IF (devices = 1) THEN SkipEss
  DEBUG "s"

SkipEss:
  DEBUG " present.",CR
  IF devices = 0 THEN Done

  FOR idx = 1 TO devices        ' display each one
    DEBUG CR, DEC2 idx," : "
    addr = 8 * (idx - 1) + OW_Data      ' calculate device address
    STORE thisSlot              ' point to local EEPROM
    FOR offset = 0 TO 7         ' eight bytes per device
      READ (addr + offset),dByte        ' read it from EEPROM
      DEBUG HEX2 dByte          ' show it
    NEXT
    READ addr,devType           ' get device type
    GOSUB DisplayDeviceType     ' display it
  NEXT

Done:
  DEBUG CR
  END


' -----[ Subroutines ]-----------------------------------------------------
'
' This subroutine is used to display the part number and description of
' a connected device.  The text data and pointers to it are stored in the
' EE of a different program slot.

DisplayDeviceType:
  DEBUG " -> "
  addr = devType * 2 + $600     ' calulate string pointer addr
  STORE NamesPgm                ' point to names EEPROM
  READ addr,strPtr.LowByte      ' get the string location
  READ addr+1,strPtr.HighByte

ReadAChar:
  READ strPtr,char              ' read character from string
  IF (char = 0) THEN DevTypeDone        ' at end? (0 = Yes)
  DEBUG char                    ' no, print the char
  strPtr = strPtr + 1           ' point to next char
  GOTO ReadAChar

DevTypeDone:
  RETURN
```

Continued from page 60

BASIC STAMP 2 users: "Inside the BASIC Stamp II" tells how the PBASIC interpreter works, how code is stored in EEPROM, how to optimize code for space and speed. 160 pages, 50 illustrations, many examples. See http://members.aol.com/stamp2book Send $29.95 check or money order (US funds) to Brian Forbes, PMB 326, 19672 Stevens Creek Boulevard, Cupertino, CA 95014-2465.

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Continued on page 85

MINI MIDI MONITOR – Part 2

by Robert Lang

INTRODUCTION

Part 1 of this article covered the building of the hardware for the MINI MIDI MONITOR (MMM). In this article, I will cover the programming of the brain of the system – the 16F873 Programmable Interface Controller (PIC).

PROGRAMMING HARDWARE

In order to program the 16F873 chip, you must have some programming hardware. This hardware usually connects to the parallel port on a Windows-based personal computer. The hardware is available from a number of sources. One programmer that consists of a minimum of hardware is available from Source 1. There is freeware software that runs under DOS or WIN95/98 that comes with the hardware that can be used to program the first 1,024 bytes of 16F873 memory. It takes about 13 seconds to program and verify the 16F873 chip.

IN-CIRCUIT PROGRAMMING

The software went through a lot of revisions during the testing. For this reason, the in-circuit programmability of the Microchip PIC was very useful. I did not have to remove the chip from the circuit each time I needed to re-program it, which saved a lot of wear and tear on the chip's pins.

There are some things to consider for successful in-circuit programming. First, I found it very useful to disable the clock when attempting in-circuit programming. If this is not done, it is possible for the chip to actually start running its old program before you get a chance to start the new programming. It was also necessary to disconnect the +5V power supply on pin 20 from the rest of the hardware circuit, otherwise I got programming errors. The +5V connection on pin 1 had to be replaced with the +12 programming voltage from the programming hardware. The ground connection on pin 19 was connected to the ground from the programming hardware. Finally, the data clock and data signals from the programming hardware had to be connected to pins 27 and 28. These pins could be isolated from the LCD load by unplugging the LCD cable. In total, there are five wires from the programming hardware to the PIC as shown in Figure 1. Yes, there are a few wires to change for in-circuit programming, but it certainly beat digging a 28-pin chip out of the circuit.

THE PROGRAM

The program is written in Microchip assembly language. This language is available at no cost from Microchip and has only 35 commands. After the program is assembled and linked, it is downloaded to a PIC programmer through the PC parallel port. The PIC programmer programs the 16F873 chip.

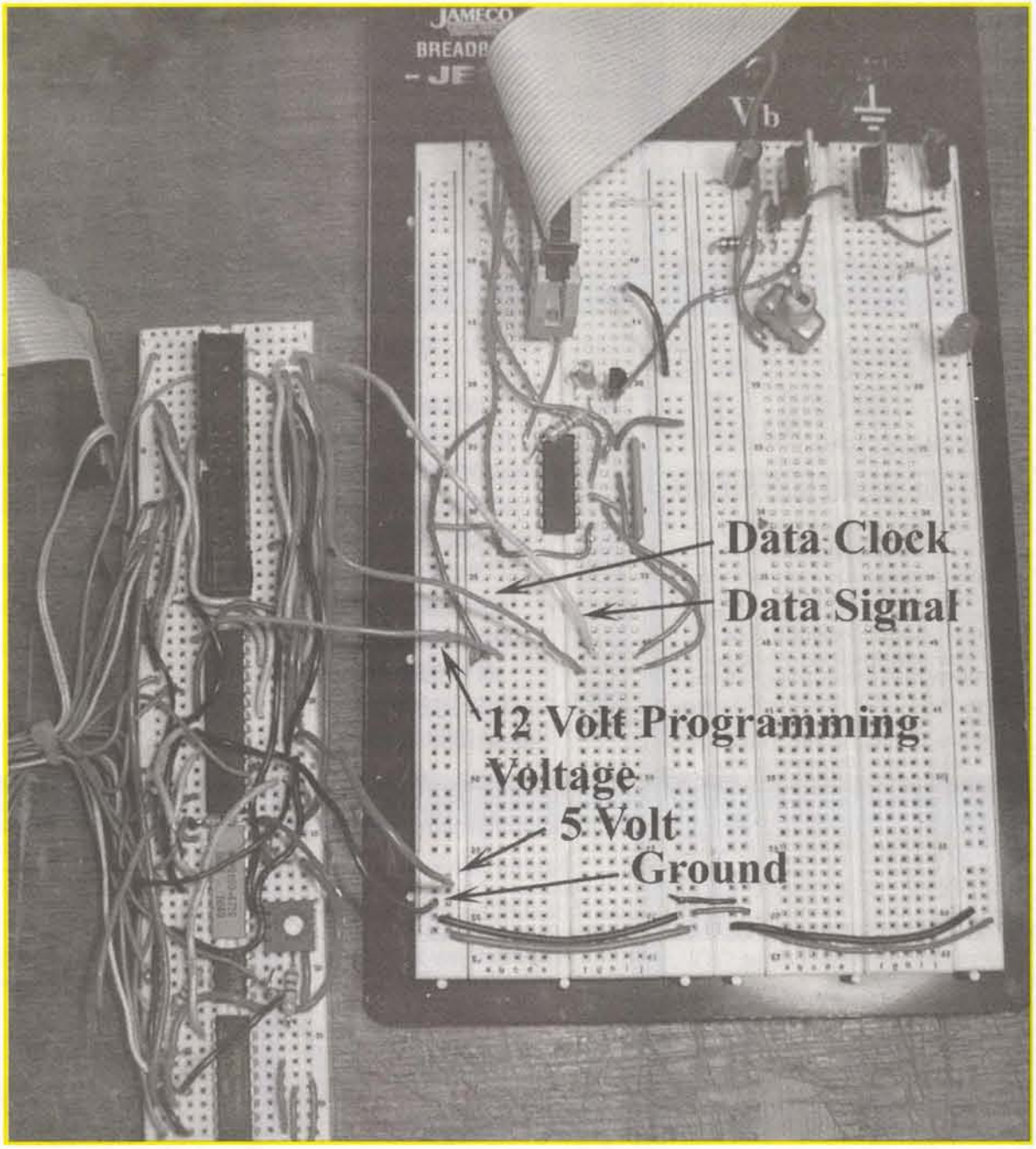

Figure 1. PIC Programming Set-up

Before I get into the details of the programming, let me briefly review what the software should do. The software will receive serial data on pin 18 (RC7). The baud rate will be selected by Switch 2: 31,250 baud for MIDI; 19,200 baud for RS-232 data. The switch settings are read on power-up or whenever the RESET switch is pressed. You cannot change a switch setting without pressing the RESET switch. An interrupt will cause the program to stop whatever it is doing and read the byte of data on the serial port. A framing or overflow error will cause D2 to light. The data will be put into a buffer and the program will return to what it was doing before the interrupt.

The basic background task of the system is to look in the buffer and display the data, depending on the setting of switches 2, 4, and 5. As mentioned before, Switch 2 controls the baud rate and data mode – MIDI or RS-232. Switch 4 selects hexadecimal or interpreted formatting. RS-232 interpreted is also referred to as ASCII mode. Switch 5 is only operational in MIDI mode and is used to control the filtering out of MIDI active sensing status bytes (FE). The MIDI active sensing status byte is used by some systems just to let the MIDI devices know that the cable is connected. Every 300 milliseconds a byte of data (FE) is sent if no other MIDI data is being sent. This lets the device at the other end know that there is an active MIDI device connected to the cable. Sometimes you may want to filter this information out or the display will be constantly filled with FEs.

MANAGING THE DATA BUFFER WITH FSR_PUT AND FSR_GET

There are two routines – FSR_PUT and FSR_GET – that handle putting data into and getting data out of the data buffer. The data buffer is simply a 170-byte area of memory from 34-7E and A0-FE where data is temporarily stored. The buffer is needed to hold data because the rate that data comes into the serial line is much faster than the data is displayed on the LCD. Fortunately, the MIDI data usually occurs in short bursts which will give the LCD time to catch up before the buffer overflows.

The interrupt routine uses FSR_PUT and the

IN_PTR pointer to load data into the buffer. The FSR_PUT flowchart is shown in Figure 2. The main program uses FSR_GET and the OUT_PTR to get a byte out of the buffer and transmit the byte out the serial port. The buffer is filled and emptied independently. With the IN_PTR and OUT_PTR changing independently, there are several possible conditions which can arise: Normally the input pointer, IN_PTR, will be larger than the output pointer, OUT_PTR, if input and output are being processed from the same pass through the buffer. If this is not true then the IN_PTR has started to write over the buffer. This is okay until it catches up to the OUT_PTR. If the IN_PTR passes the OUT_PTR, then a buffer overflow has occurred and the BUFFER OVERFLOW LED will be lit. The logic is explained in Table 1.

A warning is perhaps necessary here. There are other portions of memory where data can be stored. You may be tempted to use part of the large flash program memory as the buffer. There are (4,096 – your program size) bytes of flash program memory where data can be stored. There are also 128 bytes of EEPROM memory where data can be stored. I thought I could use the flash memory for a really big input buffer. I tried it and this is what I found. The flash program memory and the EEPROM data memory are too slow to be useful as a high speed buffer. This memory is perhaps a thousand times slower than the 192 bytes of RAM register memory. In addition, the flash program memory is only specified for 1,000 erase/write cycles. The EEPROM is specified for 100,000 erase/write cycles. The fastest memory on the chip is RAM data memory and I used 170 bytes of it for my buffer.

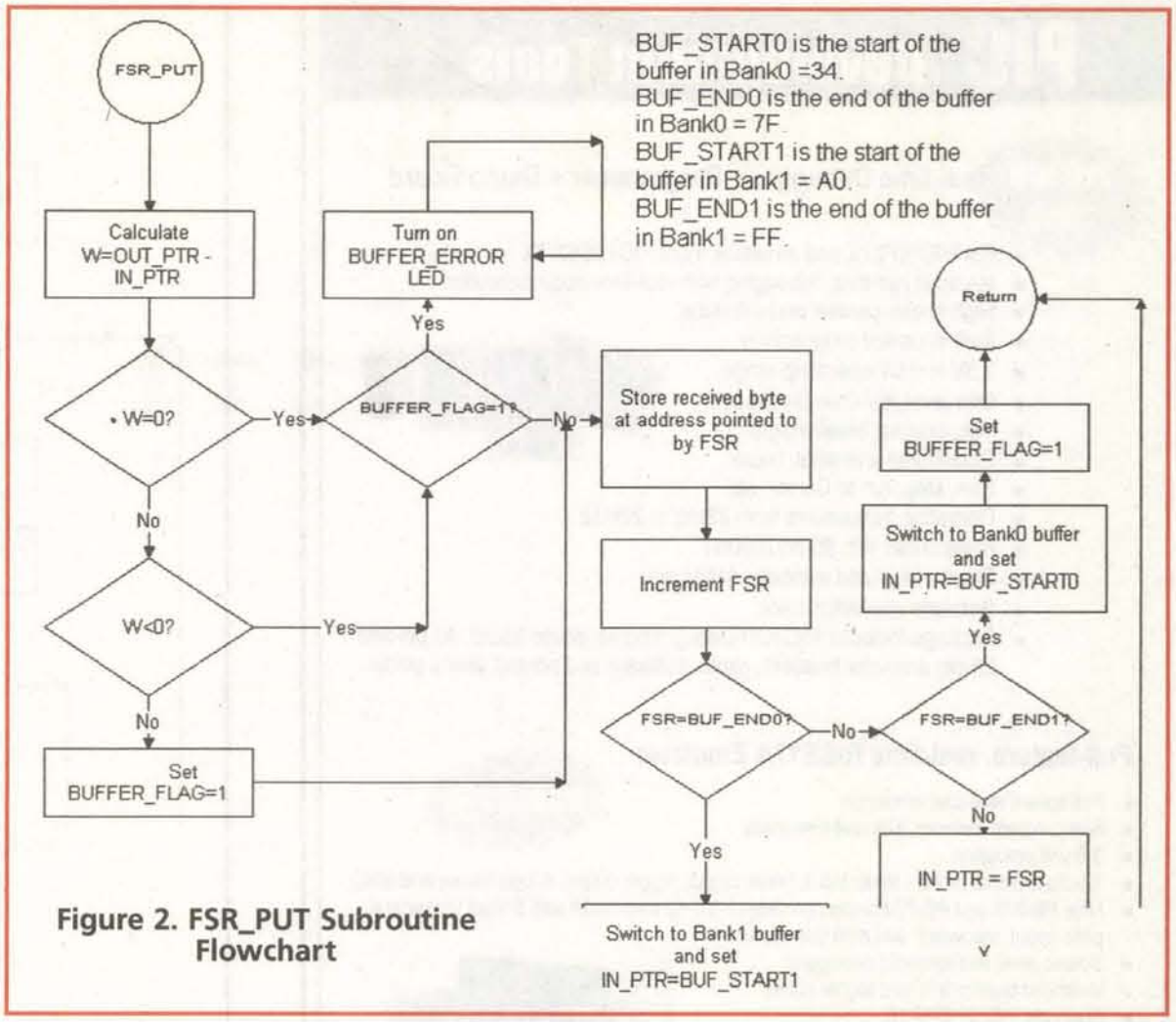

Figure 2. FSR_PUT Subroutine Flowchart

SETTING THE BAUD RATE

For MICROPIC peripheral interface controllers that contain a USART, the baud rate must be set properly by setting SPBRG register and the BRGH bit in software. I wanted to use two baud rates: 31,250 for MIDI data and 19,200 for non-MIDI data. The equation is:

SPBRG = (FREQ/BAUD_RATE/(64-(48*BRGH))-1

I set BRGH=1 and SPBRG=7 for a 31,250 baud rate using a 4,000,000 Hz crystal. For 19,200 baud, I set BRGH=1 and SPBRG=12 which gave a baud rate of 19,230.8.

THE INSIDEOUS INTERRUPT

Once the program was written, it was time to test. Debugging an interrupt service routine (ISR) is an art, but there is a simple rule you can use. The rule on ISRs is keep them short and simple. Don't try to do too much in the interrupt routine. The MMM interrupt routine will just save the processor status, get a byte from the serial port, save the byte in a buffer, and restore the processor status. The flowchart for the MMM interrupt service routine is shown in Figure 4.

After all the debugging, the program would not work outputting data in hexadecimal format. ASCII format worked fine. This problem required several days of cogitation. Reading the interrupt section of the Microchip specification for the 16F873 for the 10th time, I came across the sentence, "There are no status bits to indicate a stack overflow or underflow condition." The 16F873 has an eight-level stack where return addresses are pushed whenever a subroutine CALL or INTERRUPT occurs. Was it possible that I was exceeding this stack limit and the program was merrily returning to the wrong calling address? This would certainly explain the apparent unpredictability of the program.

I decided to map out what happened when I was seeing the error. Table 2 shows the point at which I was having the problem was right after an LCD erase when outputting data in hexadecimal format. If an interrupt occurred at that point, the stack limit of eight would be exceeded. I combined the multiple layers of delay subroutines and the problem went away.

THE SOFTWARE IN DETAIL

The complete commented program source for the MMM is available at no cost from Source 2. Most of the important subroutines are now discussed in detail:

MAIN ROUTINE

The main program reads the data switches, sets up all registers and baud rates, tests the FRAMING ERROR and BUFFER OVERFLOW LEDs, initializes the LCD, displays the messages describing the switch settings, and initializes the MIDI mode to NOTEON. The main routine also sets the buffer pointers to the start of the buffer, enables the interrupts, and goes into an endless loop of getting data out of the buffer, transmitting it, and displaying it.

INTERRUPT ROUTINE

The interrupt routine saves the PC, W, and STATUS registers, reads data from the serial port, and stores the byte in the data buffer by calling FSR_PUT. Error conditions are checked and FRAMING ERROR or BUFFER OVERFLOW LEDs are set, if necessary.

LCD_WRITE MACRO

The MMM uses a macro called LCD_WRITE. A macro is a way of reproducing specific coding at several locations in the program. The macro is inserted by name when preparing the assembly language source. The assembler then expands the coding when it is compiled. The nice thing is that I can pass an address by name to the macro. Using the LCD_WRITE macro shown in Figure 3, one can display the "MIDI" message on the LCD with one simple statement: LCD_WRITE MIDI.

LCD_ERASE

This subroutine waits until the LCD is not busy, then sends the LCD erase command B'00000001'

CONDITION	BUFFERFLAG	MEANING
IN_PTR >OUT_PTR	0	This is the normal condition. Data is coming in faster than it is being displayed
IN_PTR=OUT_PTR	0	Display has caught up with incoming data. Stop displaying data until more comes in.
IN_PTR=OUT_PTR	1	Incoming data is starting to write over data that has not been displayed yet. Set BUFFER OVERFLOW LED.
IN_PTR < OUT_PTR	1	New data is starting to write over the data that has been displayed in the buffer. OK until IN_PTR=OUT_PTR.

Table 1. Conditions for Buffer Pointers

STACK LEVEL	SUBROUTINE CALL
1	RS232_DISPLAY
2	OUTPUT_AS_HEX
3	SENDLCDDATA
4	LCD_ERASE
5	DELAY_1SEC
6	DODELAY200MS
7	DELAY
8	INTERRUPT
9	FSR_PUT

Table 2. Worst Case Stack Condition

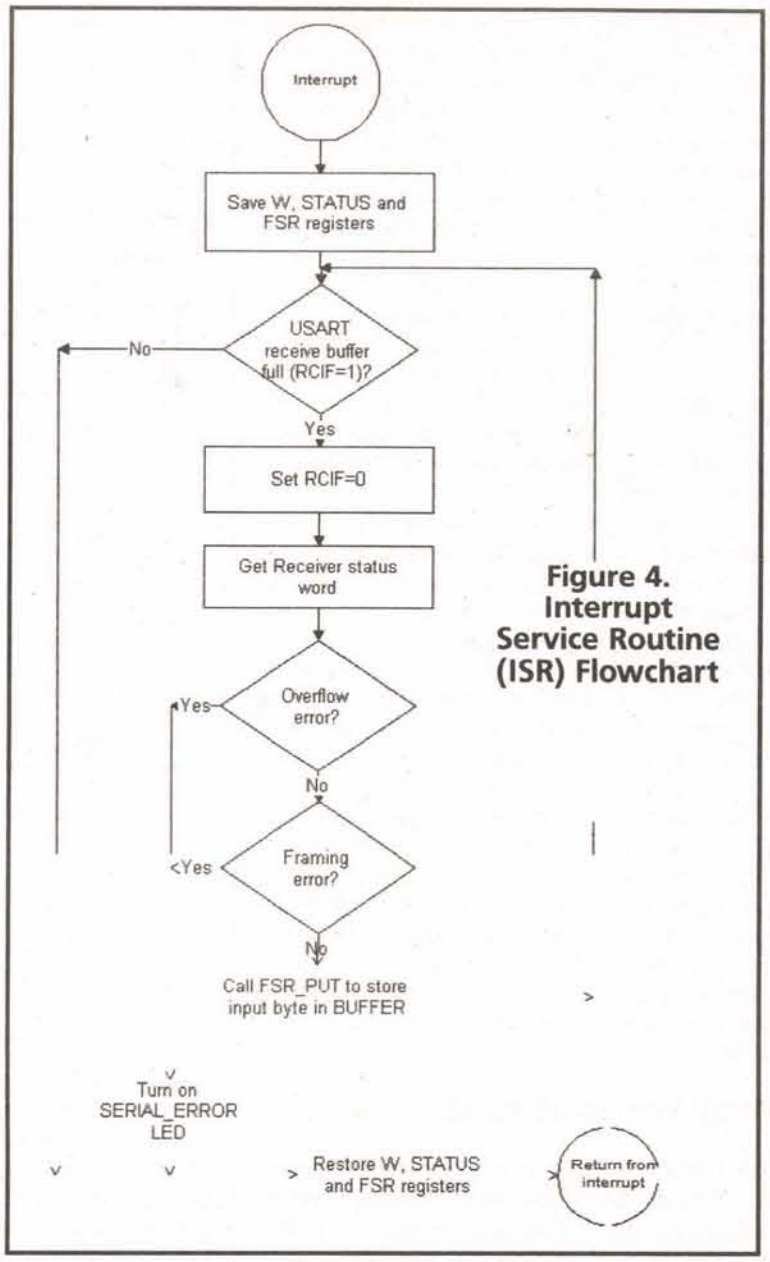

Figure 4. Interrupt Service Routine (ISR) Flowchart

to the LCD, then waits until the LCD is not busy before returning.

LCD_BUSY

Because the LCD is a slow output device compared to the PIC, it was necessary to insert delays after each write to the LCD. This resulted in wasted time in the program. In order to push the LCD to its limit, this subroutine was written to check the BUSY bit and loop until it was cleared. This complicated the program somewhat because now it was necessary not only to write to the LCD, but to read from the LCD. Reading and writing to the LCD involved changing the LCD_RW_BIT and changing PORTB from input to output. The program was noticeably speeded up by this change.

SENDLCDDATA

If the LCD display is full of characters, then this subroutine will call LCD_ERASE to erase the LCD. It will set the LCD_RS_BIT =1 and will then send the byte stored in ARG1 by pulsing the LCD enable bit, LCD_E_BIT. The remaining LCD character count will be reduced by one.

SENDLCDCOMMAND

This will send a byte to the LCD as a command. It will set the LCD_RS_BIT =0 and will send the byte stored in ARG3 by pulsing the LCD_E_BIT.

DELAY, DODELAY200MS, DELAY_1SEC

These routines implement 50 millisecond, 200 millisecond, and 1,000 millisecond delays. Eventually due to stack overflow problems, all of these routines were eliminated except DELAY, which became a one-second delay.

OUTPUT_AS_HEX

This routine will check and see if there are two spaces left in the LCD display. If there are not, it will call LCD_ERASE to erase the LCD. It then displays the byte in ARG1 as two characters by calling NO_SPACE_HEX.

NO_SPACE_HEX

Sends the byte stored in ARG1 to the LCD display as two hex digits. So if ARG1=1F, then the characters "1" and "F" will be displayed on the LCD.

HEX_TO_ASCII, NOTES, SHARPS

These routines are all very similar look-up table routines. A table index is passed to the subroutine in the W register. The argument is used to look up a value in a table. The table value is returned to the calling program in the W register. For example, if the HEX_TO_ASCII routine is called with W=8, then it returns with W="8".

MODESTORE

This routine is called whenever a MIDI byte has the high order bit set indicating a status byte to determine the type of status byte. The MODE_FLAG bits are set based on the high nibble of 8=NOTEOFF, 9=NOTEON, B=CONTROLLER_CHANGE, C=PATCH_CHANGE, E=PITCH_BEND, F=SYSTEM_MESSAGE. The low nibble is stored as the channel number.

WRITE_CHANNEL

This routine calls PRINT_SPACE to output a space to the LCD. Next, the LCD_WRITE macro is called with CH# argument to output "CH#" to the LCD. HEX_TO_ASCII is called to convert CHANNEL_NO to an ASCII character. SENDLCDDATA is then called to output the ASCII character to the LCD.

WRITE_NOTE

This routine calls PRINT_SPACE to output a space to the LCD. Next, the octave is calculated by repeatedly subtracting 12 until the result is negative or zero. The octave is output by calling HEX_TO_ASCII and SENDLCDDATA. The note offset

SOURCES

Source 1 Peter Anderson at http://www.phanderson.com

Source 2 MIDIMON homepage at http://www2.netdoor.com/~rlang/mmm/mmm.htm

(the remainder after all the octaves are subtracted) is passed to the NOTES subroutine which returns with the ASCII equivalent of the note. For example, if NOTES is called with 3, then "D" is returned. SENDLCDDATA outputs the note. Next SHARPS is called. If SHARPS is called with 3, then "#" is returned and SENDLCDDATA outputs the sharp. If zero is passed to the routines, a "C " is returned. The scale is (C ,C#,D ,D#,E ,F ,F#,G ,G#,A ,A#,B).

WRITE_VELOCITY

This routine calls PRINT_SPACE to output a space to the LCD. Next, a "V" is output to the LCD by calling SENDLCDDATA. Finally, the velocity is output as two hexadecimal digits by calling NO_SPACE_HEX.

LCD_INIT

The specification for the LCD indicates that a hexadecimal 30 be sent to the LCD as a command to initialize the LCD.

ENABLE_INTERRUPTS

This routine simply enables the global interrupt, the peripheral interrupt, and the USART receive interrupt.

MIDI_DISPLAY

This routine checks to see if the MIDI running status filter switch is set. If it is, then hexadecimal FEs that are received are ignored. If the display mode switch is set for INTERPRETED, then the subroutine MIDI_INTERPRETED is called. Otherwise, OUTPUT_AS_HEX and PRINT_SPACE are called to output two hexadecimal digits and a space.

MIDI_INTERPRETED

This is probably the most complicated subroutine. It first checks to see if the byte being processed is a MIDI status byte (high order bit =1). If it is, then MODESTORE is called to set the MODE_FLAGS. If it is a MIDI data byte, then the mode has already been set.

The program then branches based on which bit is set in the MODE_FLAGS register. For example, if bit NOTEON_FLAG is set, the subroutine branches to MSG_NOTEON. First, the LCD is erased by calling LCD_ERASE. Next, "NOTE ON" is output to the LCD by calling the LCD_WRITE macro with the NOTE_ON argument. Next, the channel number is output by calling WRITE_CHANNEL. FSR_GET is called to get the data byte containing the note. WRITE_NOTE is called to output the note to the LCD. FSR_GET is called again to get the data byte containing the note velocity. Finally, WRITE_VELOCITY is called to output the velocity to the LCD. At this point, the 20-character LCD should contain something like "NOTE ON CH#4 5A# V64."

RS232_DISPLAY

Depending on the setting of DISPLAY_MODE, this routine will either output a byte as a single ASCII character by calling SENDLCDDATA, or as two hex digits and a space by calling OUTPUT_AS_HEX followed by PRINT_SPACE. If data is being output as ASCII characters and a hexadecimal "0D" (carriage return) is received, then LCD_ERASE will be called to erase the LCD. Hexadecimal "0A" (line feeds) is ignored. This permits several words to be displayed on the screen at one time without exceeding the maximum number of 20.

Figure 5. MMM Displaying MIDI Interpreted Data

PRINT_SPACE

The PRINT_SPACE routine sends a single space to the LCD display.

CONCLUSION

The construction of a device that can receive and display MIDI or RS-232 data in hexadecimal or interpreted format has been described. Figure 5 shows the MMM receiving and interpreting MIDI data. The programming of the brain of the system has been covered including the interrupt processing and use of a circular buffer. This project is a great way to get familiar with the Microchip 16F873 peripheral interface controller hardware and software, and build a useful tool in the bargain. **NV**

```
MIDI  ADDWF  PCL, F          ;JUMP TO CHAR POINTED TO IN W REG
    RETLW  'M'
    RETLW  'I'
    RETLW  'D'
    RETLW  'I'
    RETLW  0
LCD_WRITE MACRO MYMESSAGE
    LOCAL NEXT_CHAR          ;THESE ARE LOCAL BRANCH POINTS
    LOCAL FINISHED           ;OF USE ONLY IN THE MACRO
    MOVLW  0                 ;INDEX IN TABLE OF START OF MESSAGE
NEXT_CHAR MOVWF  TEMP  ;TEMP HOLDS START OF MESSAGE INDEX
    CALL  MYMESSAGE
    MOVWF  ARG1              ;PUT CHARACTER IN ARG1
    ANDLW  0FFH              ;CHECK IF AT END OF MESSAGE (ZERO
    BTFSC  STATUS,Z          ;RETURNED AT END)
    GOTO  FINISHED
    CALL  SENDLCDDATA
    MOVF  TEMP,W             ;POINT TO NEXT CHARACTER
    ADDLW  1
    GOTO  NEXT_CHAR
FINISHED NOP
     ENDM
```

Figure 3. LCD_WRITE Macro Listing

BIOGRAPHY

Robert Lang is a professional electrical engineer interested in Robots, MIDI, and music. He has written several articles for computer, electronics, and synthesizer magazines. He can be reached at rlang@netdoor.com.

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Don't forget to check out the new online electronics forums at the *Nuts & Volts* website. There are currently boards for discussing Robotics, Microcontrollers, Radio, Computers, and a General forum for discussing any electronic topic at all. We'll even add new dedicated boards for hot topics. Just let us know!

Want to get a jump on things before the magazine arrives? The Tech Forum questions are posted on our website on or before the first of each month. Unanswered questions from recent issues are there also.

I've been looking for a digital display readout indicator, conversion kit EPROM for Dak Mark-10 with an IC-1PLL.02 board chip.

4011 **Anonymous**

I'm looking for some Visual Basic codes which would allow me to use a computer's sound card to decode DTMF for incorporation in a computer-based amateur radio repeater controller program.

The program will be made available as freeware when completed.

Note that I'm looking to do the decoding with the computer itself rather than an outboard decoder such as a Stamp.

4012 **Dan Rapak**
via Internet

I have an Arrick Robotics stepper motor (two motor) controller for #23 steppers. I would like to adapt it for use with steppers of different voltage and current. Can an outboard circuit be devised to do this with minimal complexity? I would appreciate any help. I have found NO INFO in any source for this.

4013 **Nicholas I. Oshana, Jr.**
via Internet

What is needed to display simple line graphs and data on a Sharp LM64194F LDC using a PIC and a Basic compiler.

4014 **Anonymous**
via Internet

I have a Hewlett Packard 5342A frequency counter. I need what used to be an off-the-shelf IC, the LF13333N quad JFET switch.

Does anyone know of a source for these, since they are no longer being manufactured by National Semiconductor?

I've already tried most of the major IC distributors, such as Digi-Key, Arrow, Avnet, etc.

4015 **E. Kirk Ellis**
Pikeville, NC

I would like to put a smoke detector in my garage. I want to know if I can extend the wires to put the buzzer inside my house to hear if there's a fire.

I want to take out the buzzer or piezo element and run wires from it to the detector about 25 feet away.

Would the smoke detector put out enough current to drive the buzzer at that distance or do I need some kind of transistor build-up to make the signal reach me and how far could one make it go? Fifty feet, 100 feet?

This is a battery-operated unit, not using the AC house wiring for power.

4016 **Dan Smith**
via Internet

I need to purchase a 400MHz AMD-K6R-2 with 3D now processor. This is the highest I can go with Trogon E-22 notebook that has been discontinued. Also, understand that AMD discontinued the 400MHz mobile processor a couple of years ago.

I have been attempting to locate the mobile processor without any results.

4017 **Robert Higgins, Sr.**
via Internet

Where can I find addresses of companies that supply super conducting wire?

4018 **Curtis Singleton**
Augusta, GA

I have built a simple Dac system using a PIC, modem, and a Motorola bag phone. The cell converter for the bag phone is $200.00. Is there a way to directy interface with the bag phone or a cheaper version of the cell converter?

4019 **Anonymous**
via Internet

I want to be able to call my home and not have my FAX card and/or machine answer when a voice call is being initiated.

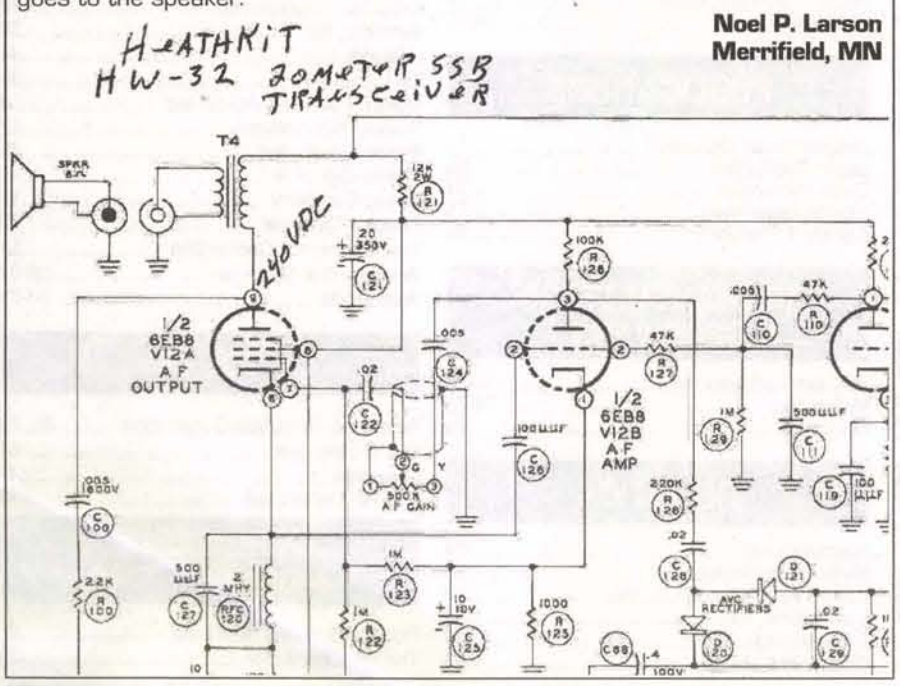
I had one such device, but it vanished and I can't remember how it was made.

Is there a simple kit I could construct to accomplish the desired results?

40110 **Rocky Misner**
via Internet

I'm restoring a number of Heathkit monobanders (HW-12, HW-22, and HW-32). What I need is a replacement for the output transformer T4 that goes to the speaker.

Noel P. Larson
Merrifield, MN



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- Write legibly (or type). If we can't read it, we'll throw it away.
- Include your Name, Address, Phone Number, and email. Only your name, city, and state will be published with the question, but we may need to contact you.

ANSWERS

TECH FORUM

ANSWER TO #3016 - MAR. 2001

I've had much difficulty finding an AC adapter for Altima LSX laptop. I was wondering if you could help me find the pinout for this old machine. I thought I might be able to use a standard AC adapter in place of the battery charger, or perhaps build a custom charger for it once the pinouts are known. Any thoughts?

I had someone give me a Altima "NSX" circa 1990's model that also had the transformer missing. I contacted everybody including Taiwan, the manufacturer, and they told me that it was too far out of date to even give me the specs. I played with it and got it running despite the fact that the battery pack was also long dead. What I found out about this computer was:

1. The current requirements for the computer is almost two full amps.

2. A battery replacement pack (1.9 amp hour), if you could find one, is $80.00. to $130.00. (The NiCad batteries are not standard "D" type or other.)

3. When choosing a transformer, make sure that under load it can provide at least 2-1/2 amps while running at 12.5 volts, and not exceed 14 volts. Any less amperage or voltage and the screen will dim when the hard drive kicks in or if you set the brightness control too high. This can cause a corruption by momentarily dropping the power supply below critical voltage which tends to restart the computer.

4. The power pin has a (+) center and a (-) outer ring.

However, because your computer is an LSX (not the NSX), you can quickly check the power pin configuration by connecting a low-voltage power supply running at 3V DC with less than 500 milliamps output, and a swapable pin tip that allows you to reverse the power plug to have a positive or negative tip. Using this small transformer will protect any reverse-voltage (blocking) diodes from being stressed in the event you start the lead check with the power plugged in backwards.

After plugging in this power supply, check the battery plug inside the

ANSWERS TO #3012 - MAR. 2001

I have a 2.4GHz parabolic dish antenna that I use for wireless video. I have installed a 12VDC winch motor with a 50 amp draw to remotely raise and lower it. The problem is that it goes up and down way too fast. I need to figure out a way of varying the speed of the motor.

#1 I'm assuming that the winch motor you are using is originally from an automotive application. To reduce the motors RPM's by about 25% use a 3.3V zener diode (most automotive parts must operate @ 9.00VDC). I have looked up a Digi-Key part# 1N5333BMSTR-ND, however, because of the wattage limitations you would need about 35 of these in parallel to be able to dissipate the power safely. I suggest that maybe you should look for a higher wattage zener before going with these.

Robert D. Miller
Westland, MI

#2 D2, D3 are 1N4148 or equivalent. D1 is any large amperage diode. (10A or larger). Q1 is a 50 amp N channel FET. R2 is 100K ohm resistor 1/4 watt. R1 is 1M ohm potentiometer. C1 can be .01 to .001 microfarads.

You can modify the circuit slightly and substitute a 555 timer or a comparator IC for the 74C14.

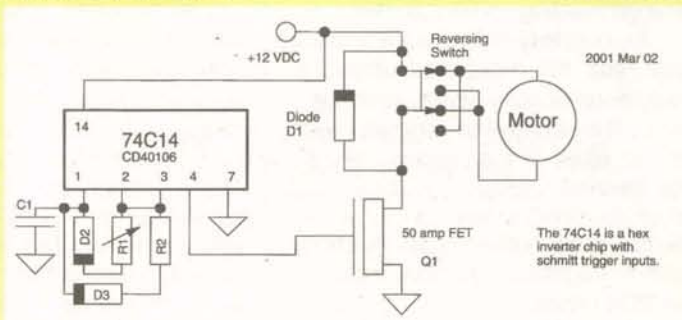
Adjust R1 until the motor speed desired is obtained. The output of the 74C14 (pin 4) is a variable duty-cycle squarewave. R1 controls the duty-cycle. A smaller value C1 means a higher frequency for the squarewave.

A higher frequency means more switching losses in the FET. A lower frequency may lead to motor vibration. Without knowing more about the motor it is difficult to choose a value for C1.

The output of the 74C14 drives the FET (Q1) off and on. If the FET is always on, the motor has full power. As the duty cycle begins to leave the FET off more of the time, the power and speed of the motor drops off.

Places to get parts include: **Digi-Key www.digikey.com; RadioShack www.radioshack.com**; and **Gateway www.gatewayelex.com**.

Gus S. Calabrese
via Internet



computer's battery box with the battery disconnected for a positive reading at the red wire and a negative voltage at the black lead.

If your computer is different than mine you won't get a reading at these pins with zero volts at either lead, and using the small transformer won't hurt any of the components with the voltage reversed. If you get zero volts, reverse the tip input and re-check for a voltage and it should give you a reading. If not, you may have damage to the battery charging circuit.

If you choose to use a ohmmeter or diode checker, it may give you strange readings similar to this.

A negative-to-negative check may read 5K resistance while the positive to positive leads read zero ohms. The negative-to-negative reads 5K because of the blocking diodes, the internal voltage regulator and other possible safety circuits within the computer. Other cross readings such as negative to positive reads in the 20K range.

As to making a battery for a lot less, I plan to strip some Ni-Metal hydride battery packs and use them to make up a large two-amp hour battery with room to spare.

Chris
via Internet

ANSWER TO #10002 - OCT. 2000

I have an IR imaging tube with power supply I picked up from a salvage yard. Unfortunately, the wires from the power supply were broken loose from the IR tube.

It looks to be in good shape, but I need help on the wiring part.

Infrared converter tubes typically have only two wires going to them, high voltage positive or negative, and a ground wire. Early tubes had a third wire for focus, but what it sounds like is that you have the later version of the "night scope," possibly the Varo, ITT, or AEG brand, not specifically sensitive to the infrared spectrum, with a gated or non-gated microchannel plate.

Night scopes or "image intensifiers" as they are called, come in a variety of flavors which are sensitive to many different applications from the ultraviolet all the way to the lower infrared, usually cutting off at the 1,100 nm range.

Almost all of the tubes except for the ultraviolet models are sensitive enough to detect infrared from 800 nm to 1,100 nm, but drastically cut off thereafter. Not all models are strong at these frequencies and so, they might be specific or strong at a single spectral point for scientific purposes such as astronomy or spectroscopy.

In order to connect your tube back up to the power supply you need to first locate the broken solder joints on the tube so that you can clean them up for re-soldering, and then test the power supply for operation. These broken connections may be buried under a 1/4" layer of pure potting silicone. If so, you have to trim back the silicone and clean the solder joints, before and after, with a non-polluting solvent such as TCE-111 "Brake Kleen" or isopropyl alcohol and let dry.

Most standard hydrocarbon cleaning agents such as gasoline, turpentine, or others will deteriorate the surrounding material and contaminate the potting material with left over oils which will lead to a shorting out or tracing of the material, and thus the power supply will not operate. Cleanliness is everything.

When reassembling and sealing the high-voltage joints, ***do not*** use RTV or any standard silicone that smells like vinegar because the acetic acid (vinegar) will conduct, will remain in trace amounts in the cured silicone, and will short out the power supply. Use high-voltage putty instead, available at TV repair shops, and use gloves when applying because body oils can also cause a high-voltage trace.

As to the standard colors of the power supply, I have several units that vary slightly and so I would not recommend just hooking them up by color or code unless you have the exact spec sheet from the actual manufacturer. Instead, you will need to make a voltage divider in order to use a standard voltmeter to measure the output of your power supply. Your power supply, although it doesn't produce a lethal amount of power, will produce a small amount of current with a voltage rated as high as 10,000 volts, typically 8 or 9 kV, and thus when applied to the standard voltmeter, exceeds its input value by at least 10 times.

The different sections of your tube are as follows. The first section or viewing screen consists of the high-voltage section (usually one of the red wires) which will typically run around 4 kV all the way as high as 12 kV or more depending upon the brand and model.

The next section is called the MCP or micro channel plate and it typically runs from 500 to 1,000 volts. Note that the micro channel plate always has a positive input wire; violet, blue etc, and ground wire out (black) which forms the main ground wire for the tube assembly. This ground wire serves as a central ground with most phosphor screens having a positive input, as well as the photo cathode at the other end of the tube also have a positive input, and both positive voltages share the black wire to return to ground.

Some micro channel plates have a potentiometer placed in parallel for gain or brightness and so you'll have to check for a two wire configuration which has a high-value resistor or potentiometer in the circuit, or possibly a remote transistor control circuit such as a light sensor which will probably be in the 500K range if it is a direct CD sensor, or higher in the 10 meg plus range if it is transistorized. This resistance basically shorts out the path way through the MCP, bypassing some of the current necessary to operate it and allows a gain function which acts like a brightness and/or sensitivity control.

The third section is called the photo cathode which is the entrance point of light and it typically uses around 100 to 200 volts. These wires may be yellow, green, or some light color that indicates the input of light. Again, the colors vary from make and model, as well as brand.

With this in mind, it is easy to determine which is which simply by measuring each output to determine where the leads go.

Before you start with the high-voltage section, you need to know about the low-voltage input section. It will be separate from the other wires, usually on the other side of the power supply as far as possible away from the high voltage section and it will always contain one black wire for a ground, and unfortunately, usually another red wire which can confuse the situation.

You should note that all black wires are almost always a common ground wire no matter what brand or model, and this includes a common hook up to the high voltage section as its return or ground zero connection.

Orange wires from my experience (not always) are for AFG, adjust, or sensor cut off which act to protect the unit by shorting or shutting down the power supply when bright light is present.

A red wire (mostly) on the low voltage section accompanies the black wire and can be checked as the positive input wire simply by applying a low voltage (two to three volts) input to it with an ammeter in series to check for a current draw. If the red wire is a positive output such as the 100V, 1000V, or the 10 kV, it is diode checked and will not accept the voltage back into the unit and thus no current draw (above one milliamp) will be present.

The typical current draw on a power supply can be any thing from 20 milliamps to as high as 60 or 80 milliamps.

Most of the single tube units such as the ultraviolet image intensifier or the second-generation image intensifier units that I have set up, run in the 40 to 60 milliamp range. But these units are much larger in size (3" x 1") and aren't designed for

goggles, which probably use less power per tube.

To make a high-volt probe for checking the output of each wire, you attach two resistors in series to make up a voltage divider which controls the voltage going R1 down to a measurable level so that your voltmeter won't be damaged. Most meters can only handle 1,000 volts DC and so with these two resistors in line and going to ground, they will act as dummy load and thus control the voltage across R1 to manageable level of 1,000 volts or less. (Most meters can handle some over voltage, but not too extreme.)

By forming a 10:1 divider, the maximum voltage at the high-voltage section on the smaller of the two resistors (R1) will read 900 volts assuming that there is a 9 kV potential. Even if your choice of resistors is set too low (less than 10 megs over all) dragging down the over all output potential of each lead, you will still be able to determine which leads are which because of the approximate 10:1 ratio or difference of each output lead.

For example, if the photo cathode runs at 100 volts, the MCP at 1,000 volts, and the phosphor screen at 10 kV, then all of your readings even if lower and clamped by your voltage divider, will still have approximately a 10:1 difference between them making it possible to tell which lead is which, and also determine if the power supply is working.

Because the high-voltage lead has a amperage output that is extremely low, typically in the pico amp range, I suggest using a 10-meg resistor (R1) in line with a 90-meg resistor (R2), and bridge the 10-meg resistor with your test leads for measuring purposes.

Place the voltmeter across points #1 and #2 on the (R1) resistor for measuring a low voltage that is manageable for your meter. Assuming you have 9 kV potential at the positive input, you will have a 900-volt drop across R1, and the remaining 8,100 volts dropping across R2. With this 10:1 ratio of resistors, you measure the voltage at resistor 1 and multiply its value by 10 for the correct operating voltage of your power supply. These resistor values, however, may still be too small and may load the power supply down beyond its capability to produce a proper high voltage, and so the readings may be lower than normal. As long as the readings are proportional to each other, as in a 10:1 ratio from each other, you should be able to judge if the power supply is working and which lead is which.

The ideal resistor network for measuring a power supply is at least a 100-megohm resistor combined with a 900-megohm resistor, but finding single resistors with these values is not that easy or cheap.

Chris
Bieber CA

Continued from page 73

Refilling Inkjet Cartridges

by AJ Saferstein

Tired of Expensive Inkjet Cartridges?

With the high price of today's inkjet cartridges and no relief in sight, consumers are currently paying between 3.5 to 8 cents per page for black ink, and between 6 to 18 cents per page for color ink. Hewlett Packard has recently started filling many of their inkjet cartridges with one-half as much ink as their full-size cartridge counterparts. Cartridges that end with the letter A contain a full charge of ink, while cartridges ending with the letter G contain half as much ink. G-size cartridges, however, are far more than half the price of full-size cartridges.

As consumers, we do have options to cut the cost of running our printers, which the manufacturers don't want to acknowledge. With Hewlett Packard and Lexmark cartridges, you currently have three options:

1. Buy the original HP or Lexmark cartridges.
2. Buy a remanufactured HP or Lexmark cartridge, and save 30 to 50 percent.
3. Refill the cartridge yourself and save 50 to 90 percent.

Remanufactured cartridges are once used cartridges which have been professionally cleaned, filled, tested, and sealed. Most companies, which sell these cartridges, will guarantee them to perform as the original. Most HP black cartridges and Lexmark black and Lexmark color cartridges can be easily refilled between four to 10 times before the cartridges wear out. HP color cartridges can generally be refilled two to five times before they quit working. Although refilling has received a lot of bad press from self-interest OEMs (Original Equipment Manufacturers), the fact is most cartridges can be easily refilled and deliver the same quality as new cartridges providing the following:

1. Use an ink that is made specifically for your cartridge (avoid Universal inks which may harm your cartridges or printer).
2. Refill your cartridge AS SOON AS it goes empty or better yet, when it gets low. (Refill the one you are using.)
3. Follow the directions!

Your options to use remanufactured cartridges, or to refill your cartridges are protected by federal law under the Magnusson Moss Warranty Protection Act, which prohibits manufacturers from voiding your printer's warranty. The exception is if the manufacturer can prove that the cartridge actually damaged the printer. Make the manufacturer aware that you know your consumer rights; refilling alone does not void your printer's warranty. If this were the case, HP and Lexmark would have a monopoly on their printer supply market, which would allow them to raise cartridge prices at will.

Inkjet inks vary in several chemical properties such as viscosity, surface tension, and composition. Additionally, the color dyes from any manufacturer may vary from one cartridge model to another. Universal inks may clog the small cartridge inkjet nozzles, or may cause the ink to run on the paper if the ink is thinner than required.

The idea behind refilling as soon as the cartridge goes empty is to keep your cartridge working rather than allowing the cartridge inkjet nozzles to dry up and clog, or prevent the cartridge's sponge from drying up and getting hard. Keep the patient alive rather than trying to revive it from the dead! Therefore, refill the cartridge you are currently using and continue to refill it until it eventually fails. At that time, you should replace it with a new cartridge. The savings from refilling can be up to 90 percent over buying new cartridges. That's $2.50 per fill versus $25.00 for a new cartridge, cutting your ink cost to well under a penny per printed page!

Most Canon and Epson inkjet cartridges are not patented and hence your three options are:

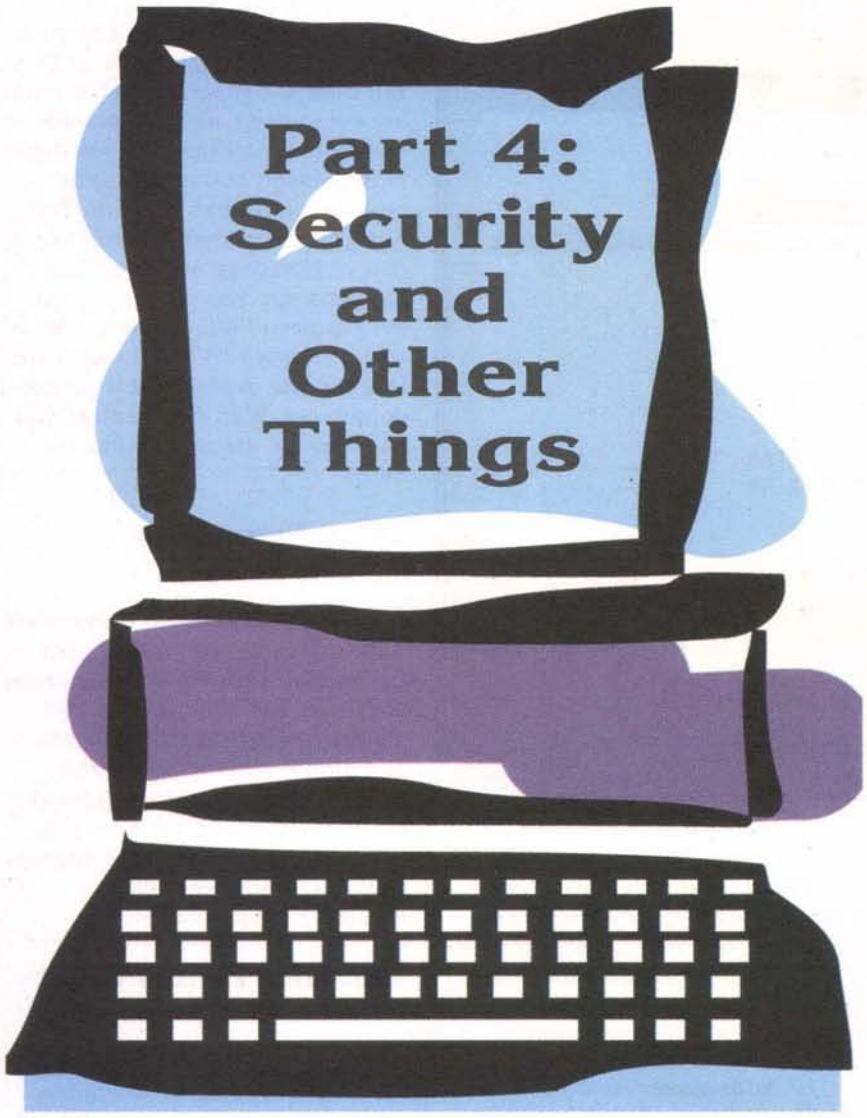
1. Buy the original Canon or Epson cartridge.
2. Buy a new factory-compatible cartridge at a 40 to 60 percent savings.
3. Refill the cartridge for a 50 to 90 percent savings.

Factory-compatible cartridges unlike remanufactured cartridges are brand new. They will have a different label to denote that they are not the OEM brand. Most companies will guarantee their cartridges, although the quality may vary among the numerous "generic" brands available. Epson cartridges tend to be a little more involved to refill due to the design of the cartridge's internal sponge. It is best to refill these cartridges well before they go empty. They may generally be refilled four to six times before they should be replaced. Canon cartridges tend to be the easiest to refill and may be filled 10 to 30 times depending on the cartridge type. A factory-compatible cartridge may also be refilled with the same quality results.

Additional tips on refilling and a variety of inkjet products are available from Inkjet Southwest (see their ad on page 56). They can be contacted at **1-800-447-3469** or on the Internet at **www.inkjetsw.com. NV**

Cyber-Street Survival

by M L Shannon



Welcome back to Cyber-Street.

In Part 3, we continued with some privacy issues, focusing on Email and spam. In this article, we will look at CyberStalking and CyberPorn – Internet pornography. And, once again, we'll start off with a learning exercise; something you can do. This will be a program called CommView, a Packet Sniffer which is similar in operation to the programs used by Federal agents in Carnivore, described in Part 2.

Now, you may have read that a packet sniffer is a "Hacker" tool; the implication being that it is for unlawful or unethical purposes. It can be. And, it can be used for legitimate reasons, just as a hammer can be used to pound nails and build a house, as well as to smash a window in a jewelry store. But regardless of perspective, regardless of the government's plan to start making such tools illegal, you bought and paid for your computer and you have the right to know what information is entering and leaving it.

CommView will tell you just that. It will display every single packet of information coming in and going out, and may reveal things that others would rather you didn't see. Such as the serial number hidden in the CueCat you read about last issue. And other things ...

The trial version of CommView displays only every other packet, but you will be able to use and understand it from this and decide if you want to register it. The cost is $49.00 for the personal version.

About Packets

Keep in mind that everything that is transmitted over the Internet is in these small groups: packets. Reading the news on Yahoo, downloading a new program, sending Email to your Granny, everything is sent in packets.

Now, if you read the articles at Gibson Research (www.grc.com), you will remember that there are programs – hundreds of them – called 'Spy-Ware' or "Ad-Ware" that place graphics on your computer without you necessarily knowing about it. These applications include word processing and text editing, web site building, utilities and IP tools, programs that search for music files, graphic editors, and games. The people who write these programs have cut a deal with certain marketing companies to place banner ads on them. You want to use the program, you have to see the banner ads on the screen. Okay, that in itself isn't such a bad idea. The programmers get paid by the marketing companies and you get the software for free. For a list of these programs, see http://www.infoforce.qc.ca/spyware/enknownlistfrm.html.

When you first install the program, you are asked to fill in a questionnaire, sometimes a very long one, where they want to know a lot about you. Then, when you use the program, the marketing company starts sending you banner ads that are tailored to your lifestyle and purchasing habits. But this is not just while you are online. These banner ads have been stored on your computer so you always see them when using the programs, even while off-line.

They are trying to sell things to you because of the questions you answered. They have a good idea what you are likely to buy based upon income bracket, age, gender, etc. Okay, you may not like this, but figure that it is no big deal, since no one is forcing you to buy anything. Unfortunately, it doesn't end there.

Steve Gibson of Gibson Research uncovered evidence that a company called Aureate (who has since changed their name to Radiate) was not only placing these graphic banner ads on his computer, they also obtained his real name and real Email address. Through his web browser.

And, if that isn't bad enough, some of these 'spy ware' programs like "Netscape SmartDownload," "RealDownload," and "NetZip Download Demon" will, as detailed by Gibson, even make a list of every program you download from the Internet. This information is then automatically sent to certain web sites. The details are at http://grc.com/downloaders.htm.

Steve used CommView to discover this, and so can you. Who knows, you just might find a new Spy Ware program. If so, please let Steve know. And, also at Gibson, you can get the free Opt Out program which will delete the files Aureate has smuggled onto your hard disk drive.

So all right already, let's get on with it. Go to www.tamosoft.com and download the file CommView 2.3. Close any Windows programs that are running and install it the same as any other program.

Start it and you will see the screen shown in Figure 1.

There are a number of options available. For details, please see the Help file. For now, go to Settings, Options, and Autostart Capturing. You want this selected so that CommView starts logging packets automatically. And, if you have Zone Alarm installed, configure it to give CommView Internet access. That way, you won't miss anything and the most important information may well be at the very beginning of the transmission.

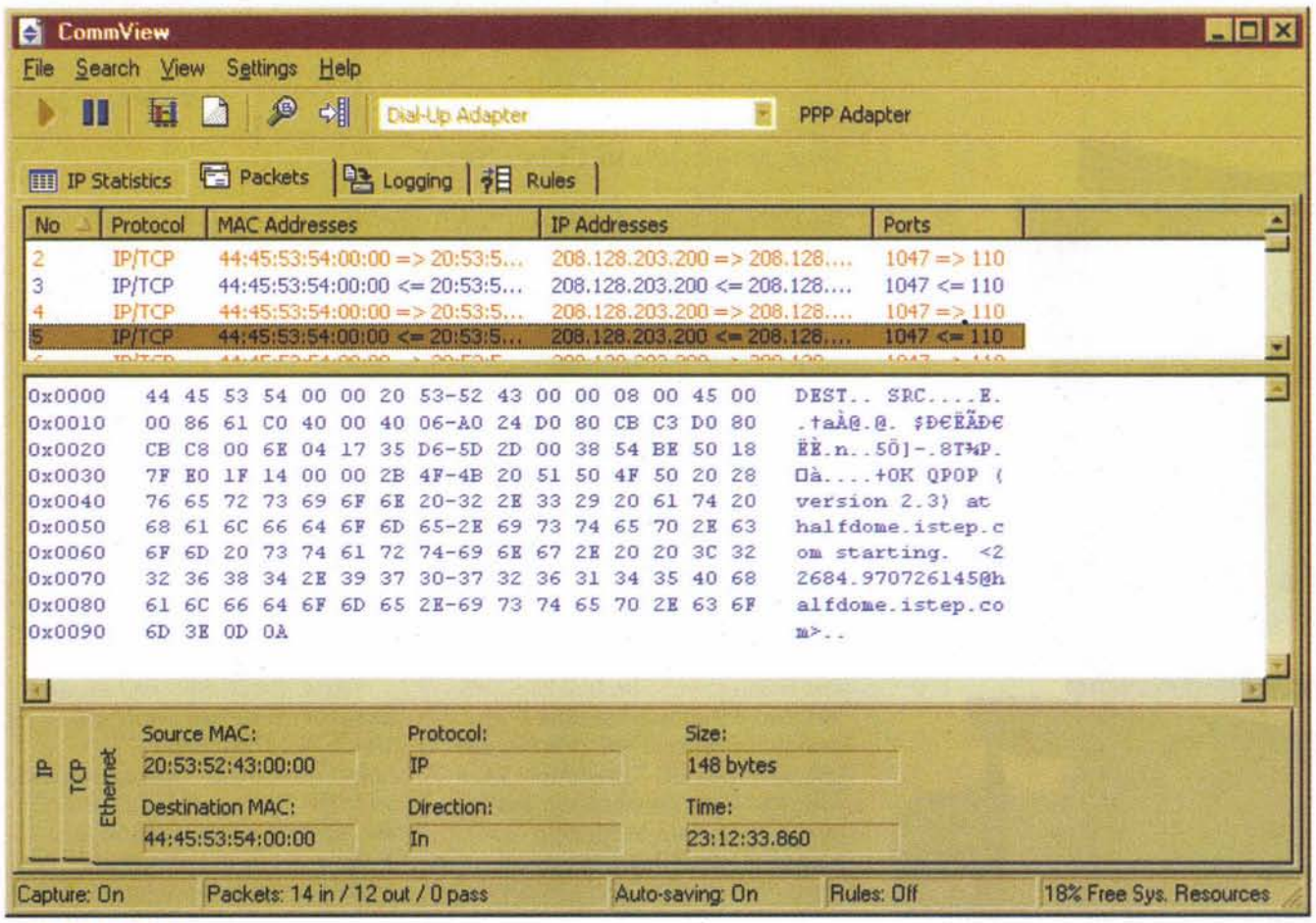


FIGURE 1

At the top is a small window that should say Dial-Up Adapter if you have a Dial-up account, DSL, or cable, whichever you are using. If it doesn't show your connection, go to Settings and Options and select the correct one. While you are there, you can change the color of the text in the two display windows. You could use, for example, INdigo (purple) for INcoming and Orange for Outgoing packets. Makes it a little easier to keep track.

Now, get connected, then click the right-pointing arrow in the extreme top left corner (this starts it capturing and you have to do this only once) and then the Packets tab that has the two little envelopes. Remember, in Part 2, comparing packets to envelopes?

Then you have to do something to cause data to start transferring. Log onto a web site or check your Email, switch back to CommView and you'll see lines of ... well something ... in the windows. Click on any line (packet) in the top window and the contents of that packet are displayed in the lower window. More on this weird looking stuff coming up.

Across the top window you see:

No: Protocol: MAC Address: IP Addresses: Ports:

No: is the packet sequence number. Every time you clear the screen, it starts over at 1.

Protocol: It says IP/TCP which is usually expressed the other way; TCP/IP which means Transmission Control Protocol/Internet Protocol. This refers to a set of standards used so that data — such as Email to your Granny in Iowa — can be sent through the Internet even though it goes through different machines that use different operating systems. That, basically, is IP. TCP has to do with re-assembling all those packets in order; reconstructing them into the order in which they were sent.

It is not necessary to understand this to apply what you learn here, but if you would like to read the technical details of TCP/IP, get *Hacker Proof* by Lars Klander. Published by Jamsa Press, this 700-page book is available at most computer book stores for about $55.00. The ISBN is 1-884133-55-X.

MAC Address: This MAC stands for Media Access Control and is the unique identifier of a Network Interface Card, which is a plug-in circuit board used with computers that are part of a network. If you don't have an NIC, you will see 44-45-53-54-00-00 which is the same (default) for all computers without the card. For now, just ignore it.

IP Addresses: Here you see the IP addresses of your computer and the one you were connected to for that packet. By now, you should be familiar with your own IP, by using IP Agent from Gibson Research.

Ports: A port is a 'doorway,' an opening through which data flows in and out of a computer. Different ports are used for different purposes. When you log on to a web site, your computer uses port 80. Check your mail and port 110 is used. You will also see port 53 which is used for DNS; Name Servers. Remember from Part 1 how Name Servers convert plain English site names to their numeric IP address? This is your computer accessing a DNS server to look up an IP address.

For now, those are probably the only ports you will see on CommView, unless someone attempts to gain access to your computer, in which case, you might see any port number all the way up to 65,535. But most likely the ones you'll see will be 137, 138, and 139. If you disabled File and Printer Sharing back in Part 1, there is little need to worry about these three ports.

With Windows 95 or 98, you have an icon at the bottom right corner of the screen (two little monitors) that tells you when data is being transferred. And, if you have Zone Alarm, you will see the little bar graphs light up. When you see them blink, you can click the CommView task bar icon to see what is happening. What ports are being used, what IP you are connected to. When you see these IP addresses, you may well be curious as to what they are. Try typing them in the Location window of Netscape and see what happens. Or, you can download the program I will review in Part 5 which is about IP Tools, called Net Demon and available at www.net-demon.net. With Net Demon, you can look up these IPs and a lot more.

Other CommView Settings

After you have used CommView for a while, you might want to experiment with the settings under the Rules tab. Here you can set CommView to log certain ports and ignore others, and do the same with IP addresses and text strings. You could, for example, set it up to log only the IP addresses that companies such as Radiate/Aureate use.

Gibberish By Any Other Name

What you are seeing in the main window is, of course, the actual data flowing in and out. In the center, you see it in Hexadecimal form. Hex is a method of counting based on 16 rather than 10, and uses 0 through 9 and the letters A to F. On the right is the same data in part plain English and part more gibberish. Actually, these are control characters and binary data such as graphics. But if you scroll through the lines, you'll soon start

You Have Mail. Spy Mail

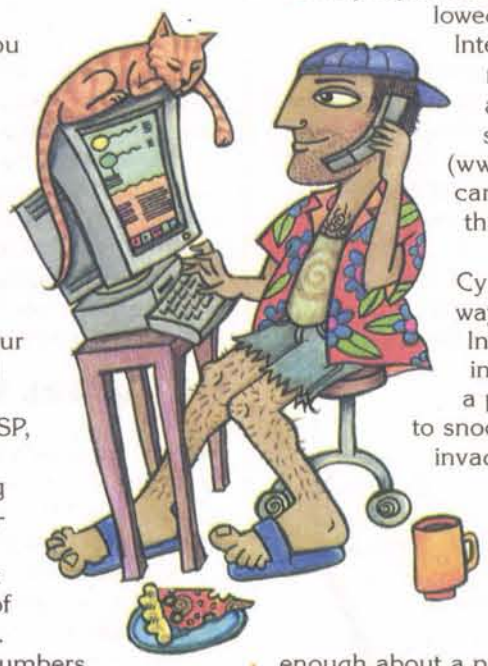
A program was developed, several years ago, with which someone can send mail that has a few lines of 'invisible' text added. This code will send back comments that are added to the original mail when it is forwarded, as well as a list of people whom it has been sent to.

Although this technique is not new, only recently has there been anything published about it.

I will have more on this trick in Part 5. Meanwhile, to defeat it, just use Pegasus or Eudora for Email and not a web browser or Outlook Express.

to recognize things. You'll see parts of Email you received, and parts of the text that are on web sites you visited.

What You Are Looking For ...



The name you used when you set up your browser, assuming that it is something-other than your real moniker, which shouldn't be there. Your real name, real Email address, name of your ISP, your computer name, anything that could identify you to whomever is at the other end of the connection. Unusual port numbers that could be used in attacking your computer. Just like Steve at Gibson Research.

The possibilities are limitless with CommView. I spent quite a few hours searching for other such programs, downloading them, trying them out, and nothing I was able to find even comes close. An excellent versatile program, easy-to-use, and the only one that is affordable. The other program that Steve used — Iris — is $1,745.00. A little steep for a starving writer, and also, Iris requires Microsoft Internet Explorer. CommView does not.

The CommView Help files are useful, and it is a good idea to take the time to read everything at Gibson Research; at least what you can understand (some of it is rather technical) and, as I expect this program to elicit some questions, I have set up a Reader's Forum at my web site, www.fusionsites.com.

CyberStalkers

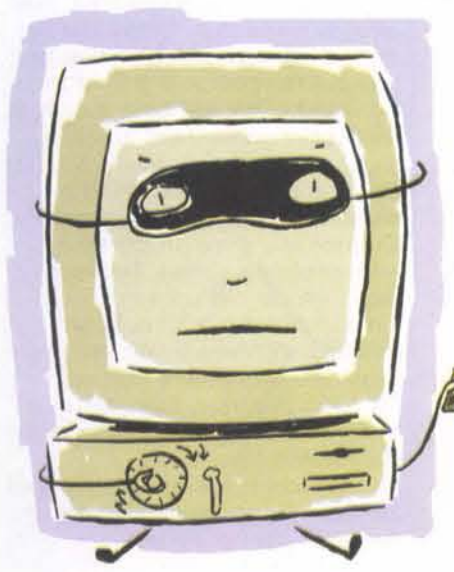
There have been many stories of people being stalked, 'followed' on the Internet. The media runs them now and then, and a search at Google (www.google.com) came up with more than 5,000 listings.

So what is CyberStalking, anyway? Using the Internet to obtain information about a person in order to snoop. Perhaps invade their privacy, to harass, threaten, or intimidate. Or even physically attack.

To learn enough about a person to be able to impersonate them. Use their identity to commit crimes, get their credit card information and go on a spree, charging merchandise and services.

To entice unsuspecting people into personal meetings such as pedophiles who prey on the inhabitants of some IRC Chat Rooms. Sometimes with tragic results. Tragic, but preventable. While Cyberstalking is becoming a very big problem, there is a great deal you can do to protect yourself and your family. The most important is to not get yourself into a position where you may be stalked, threatened, or harassed. Just like trying to avoid spam in Part 2.

Prevention



Once again, it isn't a great idea to use a web browser for Email, but if you do, make up a name and don't include an Email address, or just make one up; a phoney address. There is nothing illegal about this.

Consider Eudora or Pegasus for your personal Email and set up a temporary second Email account at one of the many free sites available. Yahoo, for example. Use this second account for surfing on sites where you are asked for a name and Email address. Such as banner ads that ask a lot of questions. Once you start getting a lot of spam (and you will!), you can close the account and open another.

Avoid clicking on banner ads, and don't answer the questions they may ask, or use the temporary mail account.

Whenever possible, avoid using browser response forms at sites you visit such as when requesting more information on a product or service. Use your temporary Email program to send the information to. Many such sites offer this option.

Never use your Social Security number online unless it is absolutely necessary, such as electronic tax return filing. To learn more about your SS number, check out an excellent article by Chris Hibbert at http://courses.cs.vt.edu/~cs3604/lib/Impact/SSN.html.

Think about it before you make online credit card purchases. First, do you really know for sure that the company you place an order with is legit; a real business rather than a 'fly-by-night' operation? Will you get what you end up paying for? And, there is always the chance that your credit card information will be leaked by the sites where you have shopped. Incidentally, in spite of what the media reports, the chances of this happening — your credit card info being 'leaked' — is much more likely to be caused by errors by the site administrators than from hackers.

Like the airline ticket reservations site where a programmer forgot to engage security measures, leaving thousands of these records open to anyone who connected to the site. Or on Netcom, where thousands of credit card files had been filched, apparently for the same reason, and had floated around for years. The same error.

Just doing, or avoiding these few basic things can make the Internet a much safer place to be. But there are some things over which you have little control, and which CyberStalkers can use.

Sources

Information about people, some of which may be considered 'personal,' has always been available to those who knew how to find it.

For decades, most people had to rely on private investigators and 'information brokers,' both of whom might provide this information for a fee. But even to those with 'inside' knowledge, obtaining

this public information was not usually that easy. Before the Internet was available to the general public, clients used to consult me from my Yellow Pages ad, and ask for various things, sometimes even "everything you can find about this person."

This meant many hours in libraries, court house basements amid boxes containing musty files, moving from one government office to another. Endless hours working the phone, pounding the streets, and wearing out shoes. Birth and death, marriage and divorce, motor vehicles, civil, criminal, probate courts, business licenses, and DBAs, voter registration ... All available to those who knew how to get it.

Today, much of that data is available through the Internet. Some of it directly, at sites anyone can connect to, and some of it through brokers.

One example is the 'FREE public records sites directory' at http://www.brbpub.com/pubrecsites.asp.

This is far from complete; it has only some agencies in some counties, but it is an example. And, more government agencies will be added in the future to this, and many other similar sites. Check it out if you like. You just might find yourself listed there. Particularly if you happen to live in Florida.

Go to US Search at www.1800ussearch.com and you'll see a long list of information that may (or may not) be available for a fee. Now you might be thinking that, heck, this is all public domain stuff, isn't it? Not necessarily. Your Social Security number is not public domain and, in many states, neither is your driver's license number, which is sometimes the same. But you might get them from this US Search site.

An old 17-page sample report included both of these numbers, a physical description, list of known addresses, business affiliations, vehicles owned ... a fair amount of information delivered in a matter of hours. So, starting with little more than a name, it may be possible to obtain all of this.

Another site that has useful information about obtaining Social Security numbers online is Full Disclosure at www.glr.com.

Additional information may be obtained from some private investigators who, in most states, are required to be licensed, or an information broker who is usually not. Some are very strict in complying with privacy laws and others are not. If you have the funds, you will probably be able to find someone who will get you, for example, unlisted phone numbers.

Now, so far, we haven't got to really personal data such as one's sex life and preferences, likes and dislikes ... Remember Dejanews (www.dejanews.com) from Part 2? A massive archive of posts from Usenet? People sometimes reveal a great deal about themselves on Usenet.

Deja, at least the Usenet archives, is being taken over by Google, the search engine (and one of the better ones, incidentally) at http://groups.google.com/. Their massive databases contain some 500 million messages, going back several years. You better hope your granny doesn't read about how you flamed her after last Thanksgiving or you are in trouble!

IRC and Chat Rooms

I mentioned IRC in Part 2, as being a way that spammers can get your Email address and that you might consider visiting the CyberAngels site (www.cyberangels.org) to learn more about it.

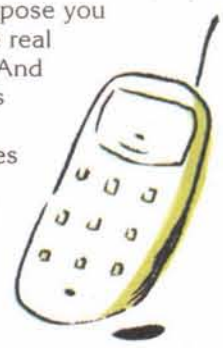
Here, on the Internet Relay Chat, is where some very personal, very intimate information is often shared. Between people who are initially total strangers.

Now, this is not, in itself, the problem — people should be able to share whatever they want with others. But they should also know that the IRC is where CyberStalkers have been known to hang out. Some of them are pedophiles who prey on unsuspecting children. There have been media stories (some of them tragic) of personal meetings between these creeps and their victims, kids leaving home, running away, to get together with pseudonamed entities they are dying to meet. Sometimes literally.

There are other dangers on IRC. It is possible to contract viruses and Trojans that can wipe out or take control of your computer, as well as minor irritants such as temporary denial of service (DoS) attacks which don't cause any damage, but require that you restart your computer.

If you are anxious to try IRC, you can go to www.irc.net where there are free programs to download, and excellent instructions. Also, you are offered the chance to create an online profile.

You may be asked to enter things such as a name, city, state, and zip, Email address, age, sex, and phone number. The choice is yours, but for your own protection, please consider using a fake name, as well as the other information. Again, for Email, you can open a temporary account at Hotmail or any of dozens of others.



Now, suppose you decide to use real information. And your profile is such that a stalker decides to make you a target. You start getting phone calls. That you likely would rather not receive.

So, you don't include a phone number but everything else is true. And you still start getting phone calls. The stalker has gone to one of the lookup services such as www.whitepages.com, punched in your name and city, and gets your number. "But it is unlisted."

These services are not supposed to include unlisted numbers but sometimes they accidentally do. If the stalker strikes out, then they can search for people who live near you, by street number, and call the listings they find, and possibly get your number.

Perhaps by claiming some sort of emergency, or other ruse. And believe me, this often works. I used it with much success for a legit purpose, when I worked as an enumerator for Census 2000.

Or, maybe CyberStalkers will hire an information broker to get your number.

If they can't get a phone number, then they bug you by Email, and if you used your real address, then you have another problem. Maybe you can trace them, but by using a temporary Email server, you can avoid the problem in the first place. It is even possible to find you from nothing more than your IP address. More on this in Part 5.

So, when using IRC, the less you reveal about yourself, the safer you are against CyberStalkers.

ICQ

This is an acronym for I Seek You; a tool with which you can let others know when you are online. They will be able to make direct contact with you, and you can, apparently, share things. Text files. Programs. Unfortunately, people can also send you viruses. And Trojans. Your IP will also probably be visible to others.

Personally, I have never used ICQ. If you do, I hope you will make sure you understand it before you install the program. At this site http://www.icq.com/features/security/security-note.html is a tutorial which will be useful.

Dealing With Stalkers

Now, suppose the worst happens. Someone is seriously stalking you? How will you deal with it? What will you do?

The first and most important thing is to not get rattled, freaked out. Remain as calm as you possibly can. It is very important that you not let the stalker think that you are taking them seriously. Some stalkers are only encouraged when they discover that they are getting to you, frightening you. If ignored, they are more likely to go away and find someone else.

The next thing is to start a log, a journal, as soon as this harassment begins. Dates and times and the IP you were using at the time. Remember IP Agent from Gibson Research? Make copies of any communications you have, whether it is on IRC or Email that you are receiving. And also be sure that the message headers are included, like you already learned about in Part 2. This is important. Copy all of this to a floppy disk, and update it whenever anything significant happens.

Email can be monitored. You already know that. Email can be encrypted, scrambled so that no one but the person it is sent to can read it. We will have a look at encryption in the next article.

Meanwhile, you might find this of interest: Tamosoft, the same company that produced CommView, once produced a nifty program, called "Between Us," that can set up a private Email system — a Chat Room actually, with which you can communicate with others who also have the program. Everything is encrypted using well-known and time-tested algorithms.

Tamosoft has apparently sold Between Us to another company. See their site for details.

Then, write down a description of the incident. What you were doing before the contact, how it affected you, what you did after it ended. If the stalker is caught and prosecuted, this information may be useful to the agency handling the case, and also to your attorney in the event of a civil suit.

Witnesses

It is also a good idea to have a witness to back you up. Someone who sees offensive Email coming in, listens in on an extension phone, or observes you opening paper mail from a stalker.

Support

A person being stalked often needs support from people who have experience in dealing with these things. Fortunately, there is help available from the site listed above (CyberAngels). Here, you may also get some more ideas on tracking the stalker.

Get a Different ISP

Changing ISPs isn't a big deal, and although it is an inconvenience, it is one easy way to make it difficult for stalkers to find you again through your IP address. Each ISP has a block of these addresses, and once your server is known to a stalker, it is easy for them to get the entire list of their IPs. This is explained in Part 6, but for now, if you like, download Net Demon from www.netdemon.net and read about IP blocks in the help files.

If you are being harassed by telephone, may I make a shameless plug for one of my books — *The Phone Book* —which has a detailed chapter on how to end telephone harassment. Permanently. You can check it out at http://www.fusionsites.com/Lysias/My_Books/my_books.html.

Law Enforcement?

Don't count on the local police, as they have no way of dealing with CyberStalkers, unless the telephone is being used. But that comes later. First thing, call the phone company Annoyance Bureau and request their services. You may need to be very insistent, but if you are convincing, they will set up a system where the number of anyone who calls you is logged. Later, this may be forwarded to the police and used as evidence.

Again, Cyber-Street Survival is about being self-sufficient. The idea is to not get yourself into the position where you need help. But if you do, then help is available.

CyberPorn: Internet Pornography

The Internet is an extension of the real world. It is an electronic reflection of all that people say and do and what they are. The real world includes 'adult' material. Pornography. Art. Smut. Creative self-expression. Whatever you want to call it. There are adult 'sex toy' stores, bookshops, and video rentals in most cities, and naturally, there are the same things on the Internet.

Beauty, it is written, is in the eye of the beholder. And so is evil. What one person calls art is to another obscene. Who is right? Who is wrong? Where does one draw the line? There are those who say there should be no restrictions on Internet pornography. That is one extreme. Others say that nothing that — in their opinion is pornography — should be allowed. So, who has the right to make decisions for others? Shouldn't this be a matter or personal choice? Some people don't want you to have that choice. They want to take away your right to choose for yourself. Force their own beliefs upon you against your will. People who are very rich and very powerful.

Onward Christian Soldiers

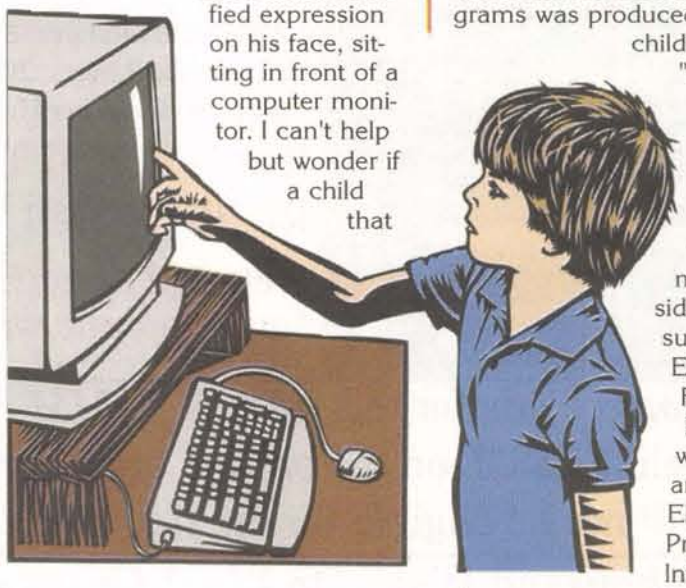
In February 1995, Senator Jim Exon introduced Senate Bill S314, the so-called Communications Decency Act. This was an amendment to the Communications Act of 1934 which prohibits any "comment, request, suggestion, proposal, image, or communication which is obscene, lewd, lascivious, filthy, or indecent." This is so vague, so broad, that if the same restrictions in the CDA applied to the rest of the world, virtually every theater, bookstore, library, and museum would have their doors chained shut by the government.

This bill could have made all ISPs and other Internet facilities liable for the content of anything sent over their networks. Liable for prosecution. Tens of thousands of dollars in fines. Confiscation of equipment. Up to two years in jail. They — the Internet service providers — would have to view every graphic file received, and become the judge of whether or not it was "evil" and delete what is. They, the ISPs, don't have the time or the personnel to do this. So, graphics would start to disappear from the Internet. The great works of art. "Disgusting" pictures showing how to examine a breast for lumps. Scanned photos of missing children. Photos showing people how to identify skin diseases.

On June 12, 1996, a court in Philadelphia ruled that the Communications Decency Act is an unconstitutional abridgment of rights protected by the First and Fifth Amendments. The Department of Justice filed an appeal with the Supreme Court, now known as Reno v. American Civil Liberties Union. In a 7-2 decision on June 26, the Supreme Court affirmed the lower court decision and held that the Communications Decency Act violates the First Amendment's guarantee of freedom of speech.

Time Magazine and The Great Cyberporn Hoax of 1995

Shortly (and conveniently) after the CDA, in July '95, *Time Magazine* published a feature article "Cyberporn," with a photo of a small child, horrified expression on his face, sitting in front of a computer monitor. I can't help but wonder if a child that young could comprehend whatever it was the little tyke was "seeing," but the picture had the effect *Time* wanted. It sold one helluva lot of copies. And keep in mind that *Time* is not in business to bring you the news. *Time* is in business to make money.



In that article, *Time* reported that "83.5 percent of the pictures in Internet Usenet newsgroups were pornographic."

Actually, when the truth came out, it was discovered that the source of most of this "lewdness" was actually a series of private BBSs, bulletin board systems that are similar to the Chat Rooms. But these BBSs were not the Internet. They were not part of the Internet, and were not connected to or accessible from the Internet.

There was no truth to this article; it was yellow journalism at its worst. But, the media isn't likely to let the truth get in the way of a sensationalized story ...

Marching As To War ...

The people behind the so-called Decency Act will be back. They will try again and again to make the entire Internet conform to what they approve of. They will continue to try and dictate to hundreds of millions of users what they may or may not see and say and hear and do.

What You Can Do

If you are not interested in "porn" then don't view it. Don't log on to sites that have material that you consider "indecent." And take the responsibility for protecting your children. If you do not, the government will. But, you may not know what to do. Your kids probably know more about computers than you do. So, a good place to start is http://www.netnanny.com/ where one of the original programs was produced to protect children from "adult" web sites.

Take the responsibility, please. Don't leave it up to the government. And consider visiting sites such as the Electronic Frontier Foundation at www.eff.org and the Electronic Privacy Information Center at www.epic.org. **NV**

Next Month

Hackers. An excursion into the murky and media distorted world. What's it really all about? What is, and isn't, a "Hacker?" Tools that hackers use. And why you — as an individual — not only have little to fear from hackers, but should be damn glad they exist.

Also data encryption. Programs with which you can 'scramble' your Email so that no one but the person it is sent to can read it. Not even the NSA. Specifically, Pretty Good Privacy (PGP) made available by programmer and cipher expert Phil Zimmerman.

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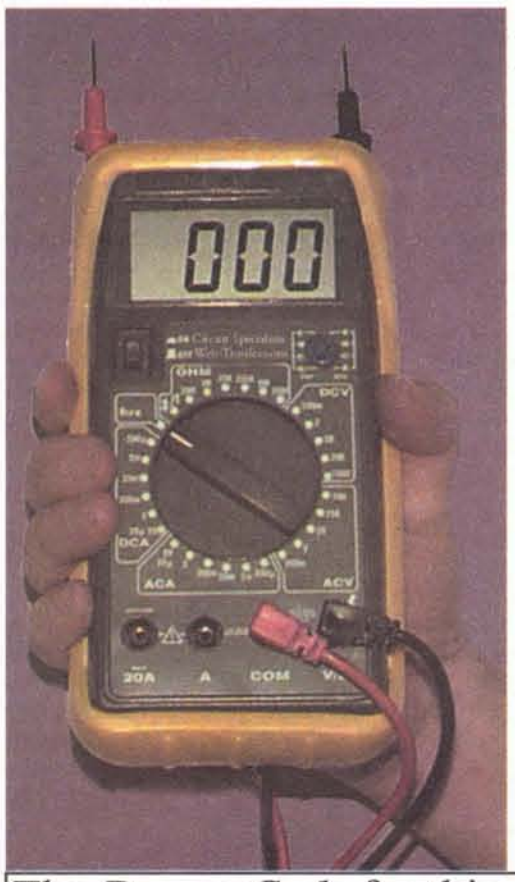

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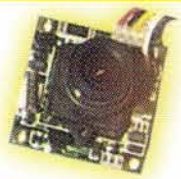

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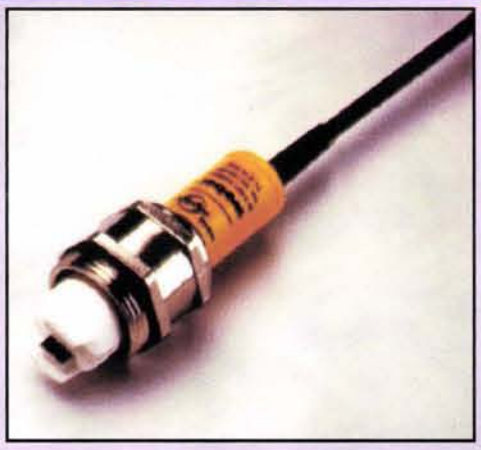

The new vent-captor from weber Sensors, Inc., measures flow of air or gaseous media, utilizing an advanced calorimetric principle that was pioneered by weber. Unlike other air flow monitors, the vent-captor has no moving parts, can measure low flow rates (0-1 meter/second), as well as high (0-30 meters/second), can operate as a single or dual set point alarm or control or provide a linearized, 4-20mA analog output for metering.

The unit is compact (only three inches long), self-contained requiring no added circuitry. Unique features include field adjustable span and set point with LED indication of flow and optional stainless steel housing. The vent-captor provides measurement capabilities previously unattainable.

For more information, contact:

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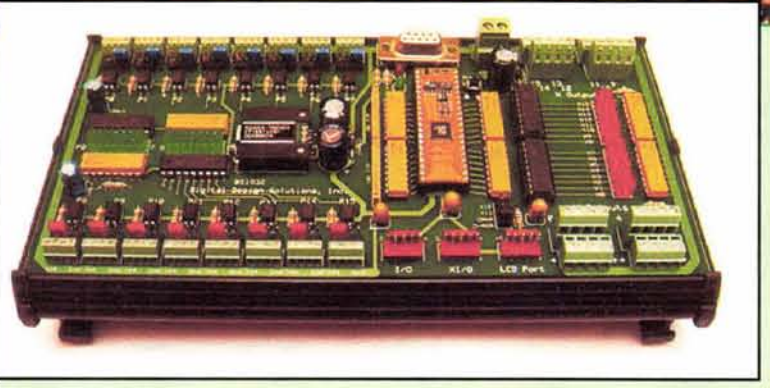

For those desiring more I/O in the industrial environment, Digital Design Solutions, Inc., annouces the release of a Programmable Industrial Controller which interfaces with 24-volt input and output devices using the new 40-pin BSII40p Basic Stamp module for increased I/O count.

All inputs are opto-isolated allowing for a good deal of flexibility. The 16 inputs are easily configured to use with both flavors of industrial 24-volt sensors both PNP and NPN optical photo sensors or proximity sensors. The inputs will also accept switches or contacts, various phototransistors, and Hall-Effect sensors with open collectors. Input sensors derive their power from the four-terminal input connections. Thus, there is no need to assemble a large section of DIN rail terminal blocks to distribute power to sensors. A DIN rail fuse block is recommended to power up this module.

A ULN2803 Darlington array is used to drive the 16 outputs using open collector drivers. This chip includes internal flyback diodes for protection against inductive spikes when driving pneumatic solenoids, relays, or motors.

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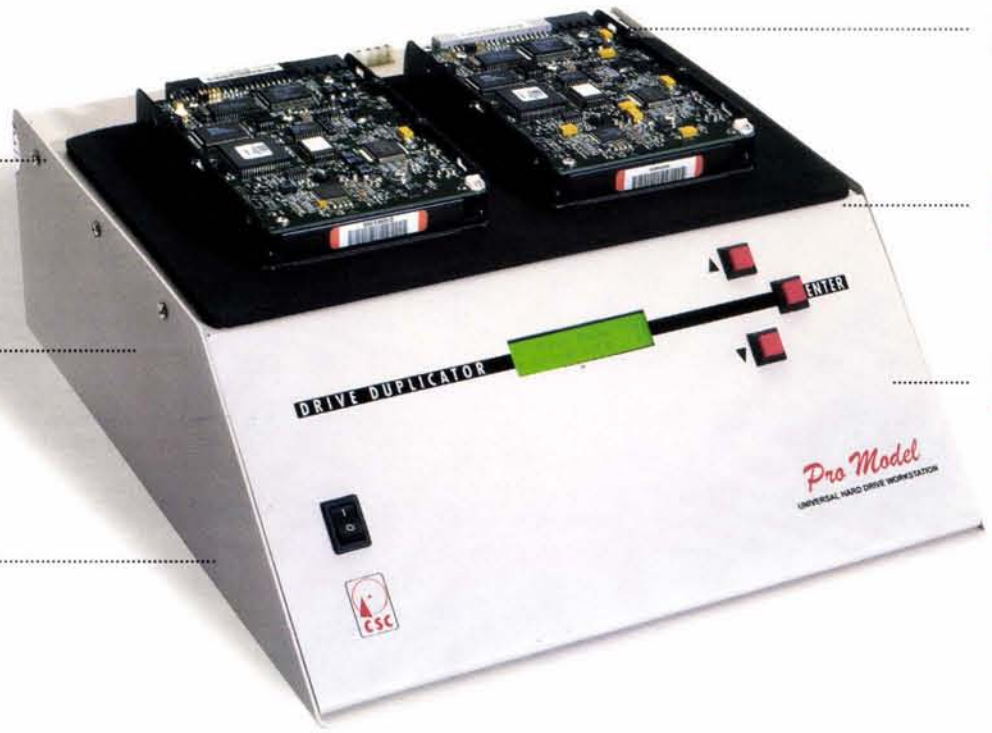
This 16 x 16 controller comes with DIN rail mountable plastic holder ready for your application. Just add power, a BSII40p, your sensors, controls, and some programming to have your industrial solution up and running for a lot less money than an equivalent mini PLC.

Two direct I/O ports are also available for controlling specialty chips such as ADCs, DACs, EEPROMs, clocks, etc.

The fully assembled controller with DIN rail mounting is available for $389.00.

For more information, contact:

DIGITAL DESIGN SOLUTIONS, INC.
1937 HYDE DR., DEPT. NV
LOVELAND, CO 80538
970-667-4239
EMAIL: ronaldsa@earthlink.net



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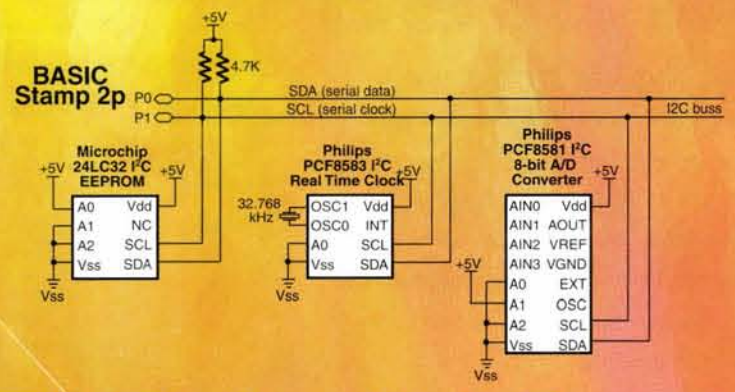
The newest in BASIC Stamp technology is our BS2p24-IC and BS2p40-IC, due out in the first quarter of 2001. Marked by their distinct gold printed circuit boards, these BASIC Stamps have several new commands for Dallas Semiconductor 1-Wire and iButton parts, I²C, and Hitachi-compatible LCDs. Similar to other PBASIC commands, it only takes a couple of lines of code to control these parts.

Package	24-pin DIP or 40-pin DIP
Environment	0° - 70° C (32° - 158° F)
Microcontroller	Scenix SX48AC
Processor Speed	20 MHz Turbo
Program Execution Speed	~12,000 instructions/sec.
RAM Size	38 Bytes (12 I/O, 26 Variable)
Scratch Pad RAM	128 Bytes
EEPROM (Program) Size	8 x 2K Bytes, ~4,000 inst.
Number of I/O pins	16 (or 32) + 2 Dedicated Serial
Voltage Requirements	5-9 VDC
Current Draw @ 5V	40 mA Run / 400 µA Sleep
Source / Sink Current per I/O	30 mA / 30 mA
Source / Sink Current per unit	60 mA / 60 mA per 8 I/O pins
PBASIC Commands	55
PC Programming Interface	Serial Port
DOS Text Editor	STAMP2P.EXE
Windows Text Editor	Stampw.exe (v1.1 and up)

The I²C protocol is a form of synchronous serial communication that requires only two BS2p I/O pins. Both pins can be shared between multiple I²C devices. A PBASIC code example is shown below:

```
I2COUT 0, $A0, 5, [100]
```

This code will write a byte of data (the number 100) to location 5 of a Microchip 24LC32 EEPROM connected to I/O pins 0 and 1 of a BS2p.



BS2P24-IC MODULE $79

Writing assembly language code to interface your microcontroller to I²C, 1-Wire, and LCDs can be tedious. The BS2p makes it easy. If time matters, or you just need to get the job done, try the BS2p. We've taken everything neat about the BS2SX-IC and added features you've been requesting.

Jump right in learning about the BS2p by downloading the new BASIC Stamp Manual V. 2.0 from www.parallaxinc.com.

The BS2p24-IC is pin compatible to other BASIC Stamp 24-pin DIP modules.

BS2P40-IC MODULE $99

Ever been short on I/O pins? The BS2p40-IC provides 32 pins for your projects.

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