

# Nuts & Volts

Exploring Electronics And Technology For The Hobbyist And Professional

*May 1999 Vol. 20 No. 5*

## Live Pictures From The MIRA Space Station

Amateur radio and MIRA  
combine to make history with  
an SSTV system.

## The Computer Controlled World

Watch 16 Video Sources  
Simultaneously in a  
Windows 98 Window.

- At Home With Computer Numerical Control
- Low-Earth-Orbit Handheld Communicators
- Switching Voltage Regulator Basics

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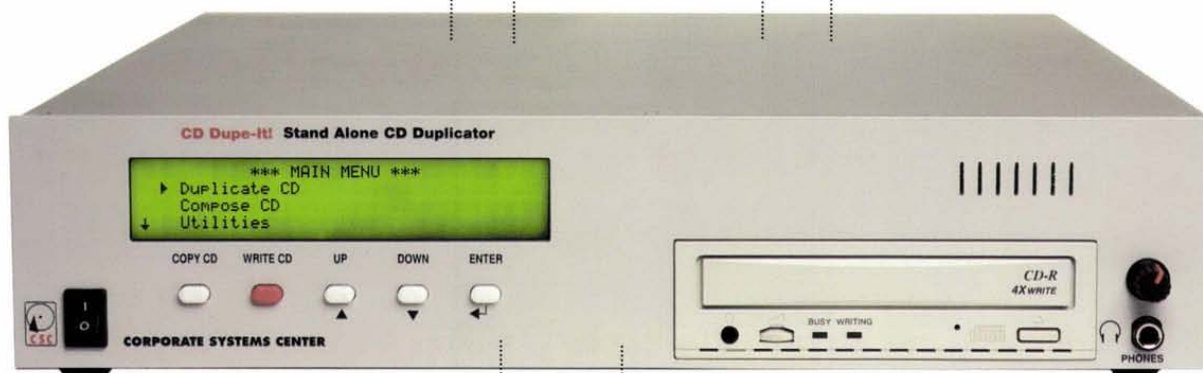


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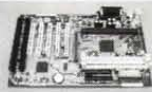


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## Pentium II Motherboard

- Microchips C300 Mini-ATX (7.5" x 12") Motherboard!
- For Intel Pentium II or Celeron 233 - 333 MHz CPU
- Intel 440LX PIII 4 chipset, 3-3.3v, unbuffered 168-pin DIMM sockets, up to 384MB, ECC memory support
- Dual channel PCI bus mastering Ultra DMA/33 EIDE
- 1-AGP slot, 4-PCI slots, 1-ISA slot (1-PCI/ISA shared)
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- IrDA compliant IR Header, SB-LINK header
- AMI PCI BIOS on 1MB Flash with Advanced Power Management 1.2
- New, 90-day warranty, with CPU retention post, FD/HD ribbon cables, Driver CD, instruction manual via Adobe Acrobat Reader (Note: CPU not included!)



HSC#17809

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## Ultimate Family Tree Deluxe Software

- Easiest and fastest software for cataloging and completing your family tree!
- Free professional genealogy family search
- Access to over 500,000,000 names and sources!
- Easy step-by-step instructions and tutorials included
- Lots of charts and reports!

HSC# 80471

\$9.95

## Video-hacker Dream!

- Logitech Videoman Video-conference camera & interface
- These units were sold with Hewlett Packard S-700 workstations for videoconferencing capability
- We do not have technical data, software or manuals
- All we have is cameras with stand, and SCSI-II interface
- The camera is on a weighted stand that extends from 13" tall to over 20" tall, and has a stereo microphone
- Color camera is digital output only (not NTSC) as far as we can tell -- but who knows?
- Interface box has two SCSI-II ports on back, and a DC power input (we do not have the adapter), and on the front it has a mic. out jack, composite video input (BNC), and the connector for the camera cable.
- Note: HP and Logitech will provide no information on these



HSC#17503

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## Superior Motherboards!

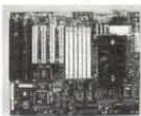
High-quality **Microchips** motherboards for top-level performance! Both boards feature:

- Built-in Pri. & Sec. Mode4 IDE controller, floppy controller
- 2-USB ports at 12Mbps rate, connect as many as 127 devices to host system
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- Full support for the 'Green PC' specification

- "**DUAL FORTRESS**" has dual Intel Slot 1 sockets for Intel Pentium II chip at 233/266/300 MHz (CPU's not included)
- ATX motherboard has 4 PCI, 2 ISA slots, (one shared)
- Intel 440FX PCIs, PIII 3, SMC FDC37C93X Ultra I/O
- Four 3.3V unbuffered 64-bit DIMM sockets, support for EDO, BEDO, Fast Page Mode (FPM) memory, ECC
- Yamaha OPL MIDI/sound on board w/ drivers
- New in box, 90-day warranty, with instruction book, CPU brackets, Win/DOS driver diskettes & cables

HSC#80469

\$99.00



- "**M6MI**" Pentium Pro ATX motherboard has 4 PCI, 3 ISA slots, Intel 440FX PCIs
- Comes with tested "Pentium Pro" 150 MHz CPU installed w/ heatsink, fan & VRM module
- Supports up to 384MB memory (6 x 72-pin SIMMs)
- Support for EDO, Fast Page Mode (FPM) memory, ECC
- New in box, 90-day warranty, with instruction book

HSC#17625

\$129.00

## External SCSI Drive Cases

- Bargain case for 5.25" drives, brand new!
- 7" x 4.5" x 10.5" overall size
- 50-pin SCSI connectors
- SCSI ID switch
- 65W Power supply (lots of power for hard drives, etc.)
- Fan-cooled, uses standard IEC Power cord (not included)



HSC# 17130

\$39.95

- High quality low profile case for 5.25" drives, brand new!
- 7" x 2.25" x 11" overall size
- 50-pin SCSI connectors, RCA Audio connectors
- SCSI ID switch, termination switch
- Tiny 12W Power Supply (5VDC @ 1.4A, 12VDC @ .4A, probably only good for CD-ROM's)
- Fan-cooled, uses standard IEC Power cord (not included)



HSC# 17357

\$29.95

## Compaq Docking Bay

- Compaq docking "Smartstation" for laptop computer (we don't know which!)
- Has two internal ISA slots
- SCSI port, network ports, serial, parallel, video, keyboard & mouse ports on back
- Used, 90-day warranty



HSC#17713

\$39.00

## CyberEye PC Camera!

- High-quality (nice looking too!) composite color camera
- 1/4 inch CCD sensor w/auto white balance control
- Resolution: NTSC video, 542 x 492
- Manual focus knob/ring, 5mm to infinity
- Power: 5.0 VDC @ 180 mA. Supply from PC or keyboard power...no external adapter needed!



HSC#17535

\$69.00

## Rechargeable Battery Buy!

Three types of rechargeable battery for a variety of uses!

Amazing power in a small package! **Nickel-Metal Hydride (Ni-MH)** batteries have the capacity of Nicads without the "memory" effect. These are factory-new, not pulsed!



- Toshiba 8TH-F5-F1-AIR, 9.6VDC at 600 mAh, measures 4.5" x 1.875" x .25" thick (8 cells in series)

Appears to have a thermal fuse for over-current protection

HSC#17871

\$17.50

...Or you can choose a NiCad battery pack in a similar form-factor. These are a flat array of cells, like the battery above, with handy solder tabs for connection.

- Thin NiCad pack, 8.4VDC at 450 mAh, measures 4.5 x 1.875 x .25" thick (7 cells in series)

HSC#17872

\$12.50

...Or you may need the power of a lead-acid battery. These are all new batteries by Tempest with tab terminals. Perfect for hobbies, security systems, battery back-up, etc.

- TR1-2-6, 6VDC at 1.2 AH, measures 3.75 x 1 x 2"

HSC#17589

\$3.95

- TR1-2-12, 12VDC at 1.2 AH, measures 3.75 x 1.875 x 2"

HSC#17197

\$4.95

- TR4-6, 6VDC at 4 AH, measures 2.75 x 1.75 x 4"

HSC#17588

\$4.95

## Home Alarm Stuff!

These items are dealer-returned inventory (shelf worn packaging but unused) of home security components that were made by Telko Inc. Mix and match to create your own bargain security system! All items have mounting screws or adhesive pads, instructions, and alarm units have window warning stickers. All parts have 30-day warranty.

- ST911 Automatic Phone dialer has screw terminals for sensor input, power adapter, and very long phone cord.
- Instantly contacts up to four pre-selected phone numbers with your own digitally recorded 16 second message.

HSC#17718 Phone Message Dialer

\$27.50

- S100M Magnetic entry sensors (mag-switch) have a reed-switch and magnet pair for door or window mounting, and approx. 50 feet of white hook-up wire.
- Use with PIR units or Entry Guard below for additional protection. Switches may be used in series for multiple door/window protection.

HSC#17723 Magnetic Entry Sensor

\$1.95

- S002M Digital Control Motion Alarm has wall-mount keypad, PIR infrared motion detector with 110° coverage to 60 feet, programmable security code, 10 - 15 second entry delay, extremely loud alarm.
- Uses 9V battery or AC Adapter (neither included)

HSC#17720 Digital Control Motion Alarm

\$15.00

- S008B Digital Control Motion Alarm with Safety Chime has wall-mount keypad, PIR infrared motion detector (same as S002M above) with very loud alarm OR safety chime alert.
- Uses 9V battery or AC Adapter (neither included)

HSC#17721 Digital Motion Alarm/Chime

\$17.50

- S082X Entry Guard Alarm has wall-mount keypad, mag-switch activation (one switch included), programmable security code, 10 - 15 second entry delay, extremely loud alarm or pleasant tone chime.
- Uses 3 AAA batteries (not included)

HSC#17722 Digital Entry Guard Alarm

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## Get the Right Touch with ALPS Input Devices!

Get name-brand quality at bargain-basement prices with these premium keyboards and mice -- all are new and have a 90-day HSC warranty. Some quantities limited!

### Alps Premium Keyboard

- 'AlpsTouch' (tm) Model: MCL-101
- Premium mechanical keyswitches
- Audible key clicks
- Industry-standard 101-key layout
- IBM AT, PS/2 and 100% compatible

HSC# 17828

\$14.95

### Alps PS/2 - Style Keyboard

- Alps 'WB' series PC compatible keyboard
- 101 key, Windows layout
- Small footprint, low profile, lightweight

HSC# 17829

\$12.50

### Alps Adjustable Mouse

- For Macintosh computers
- The first mouse that adjusts to you!
- Three programmable buttons!
- Sleek design for comfort, easy handling
- Chording -- Program multiple button combinations!
- Requires Mac OS 6.04 or later, available ADB port
- 400 dpi resolution, Made in U.S.A.

HSC# 17827

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### Alps 2-Button Mouse

- Two-button type with PS/2 plug
- Ergonomic shape for comfort, easy handling
- Ultima Driver software v1.3 diskette included
- 400 dpi resolution
- New, OEM package, 90-day warranty

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### Alps PS/2 Mouse

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- Designed for comfort, easy handling
- Alps 'professional' series mouse
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- New, OEM package, 90-day warranty

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### Alps Glidepoint Touchpad

- Desktop pointer...replaces your mouse or trackball
- Three programmable buttons
- 'Taps' for instant selection (highlighting, clicking...etc.)
- Large touchpad for comfort and accuracy
- DOS, Windows 3.x and 95 compatible
- Adjustable base for convenience and control

HSC# 17832

\$14.95

## PCI-Bus 56K Modem!

- Genica PCI-Bus 56K Modem at unheard-of price!
- Data, FAX, voice, full V.90 compatibility
- Voice from handset
- Windows 95/98 or NT only (Not Win 3.1 compatible)
- Uses latest Lucent chipset, comes with Lucent drivers
- New retail box, with Trio application software on CD
- 90-Day Warranty



HSC#17532

\$39.95

## Briefcase of Goodies!



- These handsome hardshell cases were used to carry a laptop-computer estimating system (laptop not included)
- They were used with a Compaq LTE laptop, and provided a SCSI port for a CD-ROM drive with battery back-up
- Large Nicad pack has 10 Sanyo Cadnics cells.
- Built-in 19VDC power supply for battery charging
- Tiny piggy-back PC board seems to be a SCSI interface
- Case measures 18" x 14" x 7", with several compartments
- SCSI II to CEN50 SCSI cable, many great parts inside!
- Buy either the whole assembly, or just the parts you want!
- Not guaranteed to function with laptops -- for parts only!

HSC#17180 Complete Laptop Case

\$29.95

HSC#17182 Empty Hardshell Case

\$15.00

HSC#17181 Nicad Pack, 12.5VDC, 5AH

\$17.50

HSC#17179 SCSI II Cable, 1 ft. long

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- Adobe .PDF files are available for download and viewing.
- Or drop on by and pick one up...we'd love to see you!

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The Optocom computer controlled receiver is no ordinary receiver. The Optocom provides solutions to applications that previously required multiple receivers, external decoders, and receiver modifications. Some features of the Optocom have never before been seen on a communications receiver. Ever! With an Optocom, you'll be poised to meet the changing scanning world.

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- Discriminator audio input and output
- Reaction Tune with Scout/Mini Scout/Super Scout
- Decode CTCSS, DCS, LTR and DTMF
- Motorola control channel monitoring with Trunker software and two Optocoms®
- Motorola control channel monitoring with Trunk Trac®
- Palm Pilot® support for frequency and tone display®
- Store and Scan 100 frequencies for use away from computer
- Supported by other third party scanning programs

\*Optocom includes: Trakkstar software, Palm Pilot software, Radio Manger for Windows, antenna, serial cable, and power supply



### PALM PILOT™

Interface the popular Palm Pilot™ Connected Organizer to display the frequency being scanned as well as decoding of CTCSS, DCS, and DTMF while in Store and Scan Mode. Software included. Ideal for mobile applications



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Using the supplied Trakkstar software the Optocom has the ability to scan conventional frequencies, as well as trunk follow both LTR and Motorola Trunk systems.

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\*Trunker, Trunk Trac, E-Trax, Scout, Computer, and Palm Pilot Connected Organizer not included.



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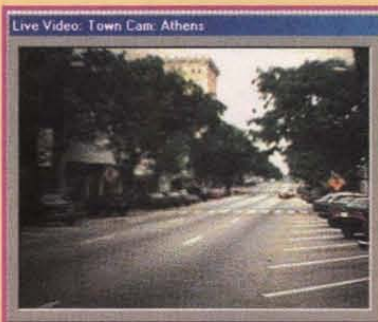
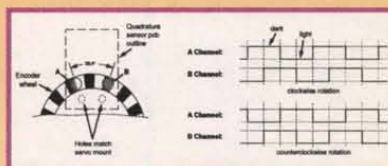
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# Live Pictures from the Mir Space Station

by Farrell Winder W8ZCF

The Mir Space Station is presently sending many superb and exciting pictures to earth via SSTV (Slow Scan Television, Note 1) as Mir orbits the earth at approximately 226 miles altitude. This has been achieved by amateur radio and is a first for Mir, as well as a historical event for both amateur radio and the Mir Space Station. Mir is presently transmitting pictures on a two days/week schedule.

The idea to put an SSTV system aboard Mir originated almost two years ago between Farrell Winder W8ZCF and Dr. Don Miller W9NTP. Through the assistance of Dr. Dave Larsen N6CO and Miles Mann WF1F, contact with Russia and eventual approval for a "GO" was given. This approval was made by Sergei Samburov RV3DR, Chief of the Cosmonaut Amateur Radio Department RSC (Rocket Space Corporation) "Energia" in Moscow.

No packaged equipment existed in suitable functional form to meet the Mir application. Neither were any funds available for equipment. Sponsors were contacted and those who generously supplied the necessary equipment were

Don, Farrell, and Hank assembled and tested the finalized packages. Four systems were produced for testing and spares. Two airborne tests were done by Chris Scott WB9NEQ, using his airplane, and Hank W4HTB as co-pilot. Both uplink and downlink tests were accomplished with excellent pictures both ways.

The equipment was delivered aboard Mir in Nov. '98 and commenced transmitting pictures to earth on Dec. 12th. The downlink frequency is presently 145.985 MHz FM. Mir is currently sending pictures, tentatively, two days per week, on Sunday and Monday depending on the crew schedule. It is expected at a later date to move to 437.975 MHz FM and run on a more continuous basis. Pictures are taken from within Mir containing images of the crew or outside. Outside shots usually show a portion of one of the Mir modules with the earth or space as a background. Many very interesting geographical images of the earth have been received, some of which are shown in this article.

Earth stations should now be able to become more closely acquainted with Mir.

## A Historical First for Amateur Radio and Mir!

Tasco Electronics, Kenwood Corp., PictureTel Corp., and Apple Computer.

To relieve the cosmonauts of constant attention to manually operate the equipment, an automated mode of operation was incorporated. Hank Cantrell W4HTB joined the group to design and fabricate an auto controller, which provides a CW tone ID, ROMIR (R Zero MIR), and an automatic sequencing of the equipment to provide a new picture in Robot 36 mode every two minutes, now yielding 720 pictures/day around the world!

This basic SSTV system is stand-alone, except for power and antenna. No computer is required to either transmit or receive pictures.

### Note 1.

While amateur radio is considered to be a hobby, there are many times that amateur radio has contributed to highly-advanced technical developments. One of these is SSTV which was conceived and developed entirely by amateur radio. The concept of SSTV was originated by Copthorne MacDonald — now with updated call VY2CM — who conceived a method for the transmission of video using a voice channel. Cop was joined by Don Miller W9NTP and they developed and experimented with SSTV over the air with the first radio transmissions in 1957.

The definition of SSTV as provided to the FCC by W9NTP is: "SSTV is the transmission of a 'live picture' over a voice communications channel in real time."

Don W9NTP was one of the key players in getting the Mir SSTV System engineered and completed successfully for the Mir Space Station, as is referenced in this article.

Educational facilities especially should benefit as scheduled contacts are made with schools whose students will also be able to present questions and at the same time "see" the cosmonauts who will be answering their questions and experience a greater learning of the Mir station and of space.

Besides the amateur and educational functions, this system aboard Mir could serve to provide pictures and voice transmissions should a critical need arise. It could easily supplement normal communications between the Mir and Moscow or other points on the earth or even to other space stations should such an event become a reality.

Experience gained with the Mir system and the basic equipment used will be made available to those working to provide an SSTV system aboard the International Space Station. NV

### Note 2.

Miles WF1F arranged for delivery of the SSTV systems to Russia and made a trip to train Cosmonauts Gennadiy Padalka and Sergei Avdeyev before they departed for the Mir Space Station. Details of this training and specifications for the Mir system, including test results during the development of the system, can be found on the MAREX-NA (Mir Amateur Radio Experiment — North America) web page at: [http://www.geocities.com/CapeCanaveral/Hangar/7355/sstv\\_proj.htm](http://www.geocities.com/CapeCanaveral/Hangar/7355/sstv_proj.htm).



Commander Gennadiy Padalka in front of the camera with SSTV equipment.

Commander Gennadiy Padalka and Flight Engineer Sergei Avdeyev. Sergei is holding the TM-V7 Instruction Manual.



JAN 31, 1999  
Bowling Green KY  
RCV: W4HTB



Soyuz with earth in background taken from the Piroda Module.



Sergei Avdeyev

Jean-Pierre Haignere

Mir SSTV Feb 22 99 11:33 UTC Rec by W8ZCF

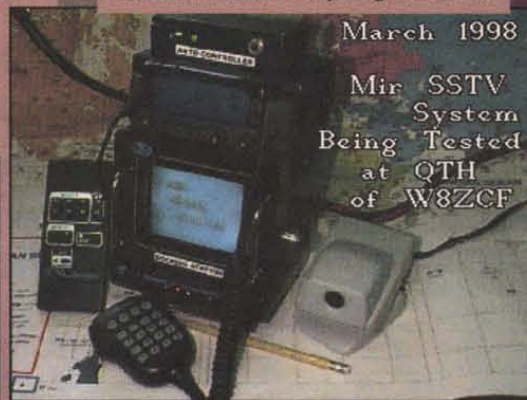
Sergei with French Astronaut Jean-Pierre who came aboard Feb. 20th for a six-month tour of duty.



Mir Space Stn  
Dec 12, '98  
18:59 UTC

Rx W8ZCF Cinti, O

The Amateur Radio SSTV package aboard Mir.



March 1998

Mir SSTV System  
Being Tested  
at QTH  
of W8ZCF



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**T**he Internet and, in particular, the easy access to home business/hobby web sites, has generated a need to automate the manufacturing of products made in home shops by hobbyists. From manufacturing identification tags for Fido, to machining parts for robots, to making molds for jewelry, there is a need to improve the rate and quality of products produced in the home shops.

This article will explain the concepts of CNC and will be the first step in automating the home workshop. It will detail many of the aspects of CNC, but this article should be considered to be a general discussion of the concepts of low-cost CNC.

(PCB) drilling machine. I intend to follow that same format, but will significantly update the rapid developments in this area and build several new projects.

This article will provide an updated explanation of CNC and how it all works together in the home shop. The next article will show you how to build a low-cost three axis chopper step motor controller. The third article will take an off-the-shelf low-cost milling machine and convert it to CNC.

## A Basic Overview of CNC

The parts that make up a CNC system are:

1. The personal computer (PC).
2. Programs that allow the users to design their products.

by Dan Mauch

controlled manner.

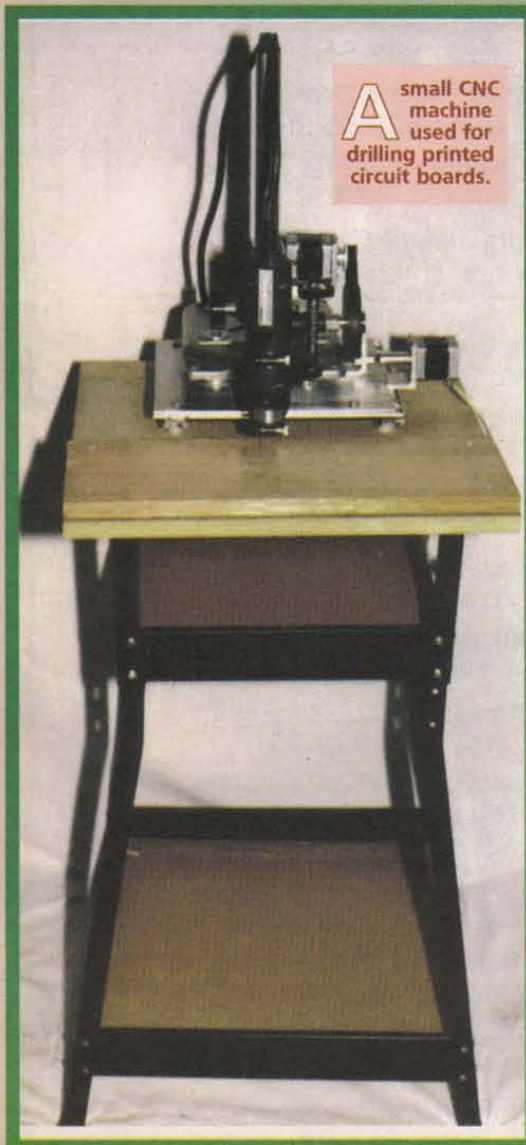
7. The stepper motors that move the axes of the machine to the requirement of the instruction sent to the controller.

8. The machine that moves each axis individually or simultaneously. Usually these are three-axis machines.

## CNC Explained

A detailed explanation of the above parts of the CNC system is as follows:

The PC is the brains that runs the various software programs that then send signals to the parallel port instructing the step motor con-



**A** small CNC machine used for drilling printed circuit boards.

# At Home with Computer Numerical Control (CNC) Part 1



**A**n inexpensive drill press converted to CNC. An old disk drive case and power supply houses the step motor controller.

## Background

Several years ago, I wrote three articles that were published in *Nuts & Volts Magazine*. The Oct. '94 article had a general overview of CNC and its various applications from drilling printed circuit boards to running a metal cutting power band saw. The Nov. '94 issue carried an article on how to build a low-cost three axis L/R stepper motor driver. Last, the Dec. '94 issue detailed the construction of a low-cost stepper-motor-driven CNC-operated printed circuit board

3. Programs that convert the designs into G code (see Glossary) instructions which are used by G code interpreter programs that, in turn, run the machine's controller.

4. Programs that interpret the instructions and operate the machine.

5. The PC parallel port that sends the signals to the machine's controller.

6. The controller that reads the signals generated by the PC via the program and the parallel port, which operates stepper motors in a

troller when and how much to move the stepper motor attached to each axis. The PC used for most of the design (Computer Aided Design [CAD]) and Computer Aided Manufacturing [CAM]) functions will be an 80486DX2-133 or faster computer. It should be a Windows or Windows95™ based machine.

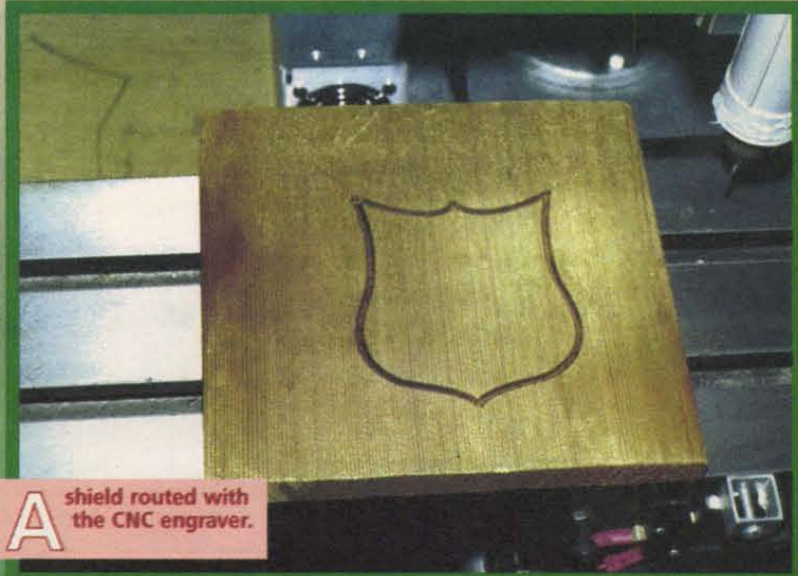
The PC used in the shop should be a DOS-based 486DX2-66 or better. The shop computer only needs a small hard drive of 100 MB and needs only four megs of RAM. The shop com-



# A n X-Y table converted to a CNC engraver.



# A shield routed with the CNC engraver.



puter must have a parallel port with standard parallel port addresses. A Pentium is probably overkill for the shop computer if it exceeds 133 MHz. SX type computers don't work well because they do not have the math co-processor. The software generally requires an SVGA monitor.

There are several programs that are used on a PC. The first is a design program generally called Computer Aided Design (CAD). This is the program where you design your part. There are numerous CAD programs for creating the part to be made. AutoCAD™, and TurboCAD™ are examples of the range of programs available to the users. When starting out, look for a low-cost program that will save your files as DXF files because there are other programs that will convert this file format to G Code which will be explained below.

The next piece of software, which may or may not be part of the CAD program is the Computer Aided Manufacturing (CAM) program. This program reads the DXF file and generates G code instructions, which are saved in a tool path file. A CAM program works with the user to generate the instructions for the machine. It allows the user to set the various

speeds, feed rates, and depth of cuts.

The level of user inputs with the CAM program varies with the particular software. An example of a CAM program is called Deskam. A demonstration copy may be downloaded from [www.deskam.com](http://www.deskam.com). This program reads the DXF file and the user sets various parameters. The program then creates a tool path file in G Code. The below listed file is an example of G code:

(Matl 1/4" alum Plate, use 3/8D end mill, set work .5" below Z=0") Setup instructions.

G90 — This instruction sets the absolute mode as opposed to G91 Incremental Mode.

G00 X1.000 Y1.000 Z0.4000 — This instruction will cause the machine to move in a rapid traverse mode to a location designated as X=1, Y=1 and will move the spindle down .4 inch on a milling machine.

G01 Z-.8 F10 will cause the end mill to be fed at a rate of 10 inches per minute through the material.

G01 X2.000 Y1.000 — This will command the machine to move from the above coordinate to X=2". (The parameters are modal which means that the feed rate will remain at 10 inches per minute until changed by the G code.

Thus, the machine has moved to the location X=2, Y=1, and Z=-.8.

G01 Y2.000 — This again moves only the Y axis 1" from the Y location of Y=1 to Y=2".

The last piece of software used by the computer is called G code interpreters. These programs read a configuration file where the numbers of steps-per-inch are declared, as well as various other parameters such as backlash compensation. With that information, the G code interpreter reads the G code file, calculates the number of steps for each axis to move, and then sends signals to the stepper motor controller which, in turn, moves the various axes.

DeskNC is an example of a low-cost G code interpreter program. A demo copy may be downloaded from [www.deskam.com](http://www.deskam.com). There are several other G code interpreters that are low cost and work fine. A free G code interpreter is available at [www.metalworking.com](http://www.metalworking.com).

The parallel port on most IBM compatible type computers has one of the following base addresses: 3BCH (956D), 378H (888D), or 278H (632D). Usually it is 378H (888D) for LPT1. This is the address that is set in the configuration file of the G code interpreter program. The stan-

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standard parallel port uses data bits 0-7 and pins 2-9. The G code interpreter sends the step and direction signals to these pins. The controller attached via a cable receives these signals and translates them into step sequences that move the motors.

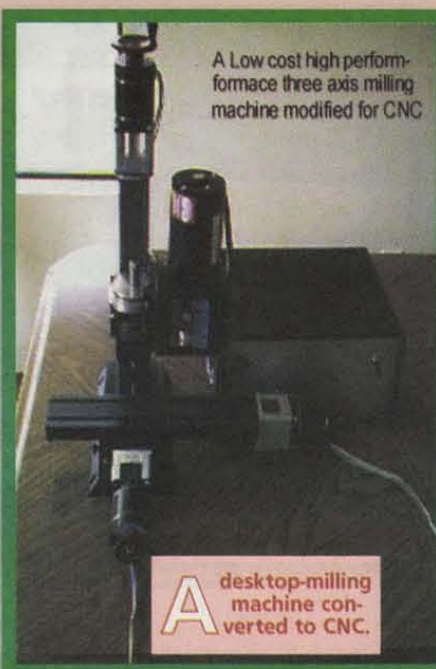
The stepper motor controller as described above receives the signals. Most modern controllers take step and direction signals. One of the data bits received is used as a pulse stream of information and a second data bit is used to determine the direction. This bit is either logic high or logic low. The other axes are similar.

For example, data bit 0 is usually pin 2 and this is normally connected to the X-axis step signal line. Data bit 1 is usually pin 3 of the parallel port and is connected via a cable to the direction line of the controller. Data bit 2 is usually the Y-axis step signal line and operates pin 4 of the parallel port. Some G code interpreters produce phase sequences, but that is inefficient, and step and direction type controllers are predominately used.

There are several types of controllers. L/R (Inductance over Resistance) types are simple, cheap, and inefficient. Chopper type step motor controllers are much more efficient, but are more expensive. They easily can handle much higher voltages than L/R types. A good chopper driver operates at several times the voltage rating of the motor. This allows the coils in the stepper motor to charge quicker and thus you get more speed efficiently.

An L/R type uses large dropping resistors to limit the current. Other features of a step motor controller are that they have various settings for full steps or half steps. The best controllers use microstepping. The problems with most low-cost controllers are that they are open loop. That means that if the stepper motor loses its position, then there is no feedback to correct the position and the part is ruined. On the other hand, a stepper motor system can operate without losing steps if the software, the controller, and the machine are set up correctly. In my next article, we will assemble and test a low-cost chopper step motor controller.

Stepper motors are incremental motion



**A** desktop-milling machine converted to CNC.



**M**y mill drill with one of my custom controllers.

devices. They are

different from brush type DC motors. The main types of stepper motors used for CNC are bipolar or unipolar.

They require 200 steps to make a full revolution. The software generates the pulses that the step motor controller translates into phase sequences. These phase sequences increment the rotation of the stepper motor. The torque of the motor is rated in ounce inches. The faster the motor turns, the less torque it has. The slower the motor turns, the more power it has.

Low inductance stepper motors, by their nature, will run faster than high inductance motors. Four wire stepper motors have two coils and are called bipolar. Unipolar stepper motors have two coils with center taps that create four coils. If the center tap is not used, then a unipolar motor can be used as a bipolar series stepper motor.

The machines that can be constructed or retrofitted to CNC are unlimited. I know of inventors and technicians that have built machines to accomplish tasks such as precision dispensing of glue to making butterballs. Don't ask me how!


In general, the home shop needs a milling



**A** part being machined under CNC. A one-inch hole is being circular interpolated using a 3/8-inch end mill.

machine, or a lathe, perhaps an engraving machine, a drill press, or even a plasma cutter. Most CNC machines use two axes. The X-axis moves from left and right, the Y-axis moves front to back. A third axis is used in a milling machine for moving the spindle up or down. Solid-state relays may be added for turning on or off coolant pumps, glue dispensers, plasma, or oxy-acetylene torches.

Addition of solid-state relays is software dependent and you need to check that out if you are purchasing a G code interpreter program. The most popular machines to retrofit



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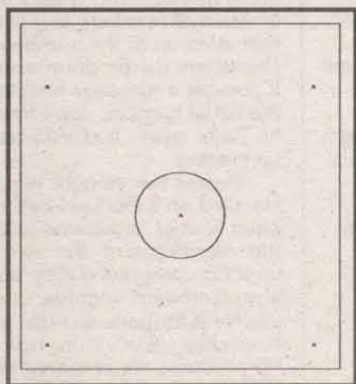
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are small desktop milling machines such as the Sherline (<http://www.sherline.com/sherline>). With a CNC retrofit kit, amazing work can be done with these machines.

## Wrapping it Up

In general, one can move from the design stage to manufacturing products in a matter of minutes once the design is completed and the G code is generated. For example, I designed a motor mount that required a  $1.000 \pm .001/-0.001$  hole and four 3/16-inch diameter holes. The design only took a few minutes using a CAD/CAM program (see [www.bobcad.com](http://www.bobcad.com)). My milling machine already had the mill vice set up so it only took a few minutes using an edge finder to locate the X=0, Y=0, Z=0 location.



**A**n example of a part drawn with CAD program and used in a CAM program.

The enter button was pressed and, in less than four minutes, the 3/16 end mill drilled the four holes and bored a .999 inch diameter hole. It was awesome to watch it make 11 more identical parts. It almost took more time to deburr each part, then load blank parts and unload finished parts in the machine than it took to make the part.

When you first start out using CNC-operated machines, there is a learning curve. It takes time to get the software and the hardware all working together, but once it is set up, then you are only limited by your imagination as to what you can accomplish. As a footnote, I was testing a raster to vector program that was machining an image of my granddaughter while

I was writing this article. How is that for productivity?

In my shop, I have CNC controls on my full size milling machine, a 13x25 metal cutting lathe, a mill/drill, two printed circuit drill machines, a desktop Sherline milling machine, a small vertical mill, and an eight-inch bench drill press. You will not need as many machines for your home shop, but I have found CNC at home to be very addictive!

## What's Next?

Look for my upcoming article on how to build a low-cost, high-performance, three axis bipolar chopper step motor controller. **NV**

## Glossary

G-Codes are industry standard commands used in CNC machines

### Common Used G-Code Commands

Assumes G90 (Absolute coordinates) and uses incremental I and J (K) only. Commands.	
G0	Rapid travel at maximum feed rate.
G01	Linear interpolation at current feed rate.
G02	Clockwise circular interpolation at current feed rate. X-Y plane only.
G03	Counter-Clockwise circular interpolation at current feed rate. X-Y plane only.
G04	Dwell in tenths of a second, e.g., G04 X10 will dwell for one second.
G81	Drill cycle.
G90	Absolute coordinates (Assumed).
G92	Sets Coordinates
M0	Program Stop.
M2	Program End.
M7	Coolant On.
M8	Coolant On.
M9	Coolant Off.
Txx	Tool change to tool xx.

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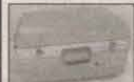
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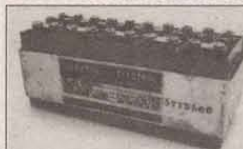


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## Modern computing and standard surge suppressors... a recipe for disaster.

Almost all surge protection devices use MOV's (metal oxide varistors) as their active element. MOV's are sacrificial/wear/limited life components. Surge suppressors based on this technology are doomed to failure. These surge "suppressors" also don't suppress a thing. They divert powerline surges equally to the ground and neutral wire. When you put current on the common ground wire of interconnected equipment some of that current will flow (through the inherent ground loops) to the data lines. This is a major cause of lock-ups and misoperations that plague today's computer environments. Another fact; all modern computers use switch mode power supplies. During surges the power supply capacitors must charge to the clamping level of the MOV before the MOV turns on. A recent study has shown that it takes a 3000A surge 15 microseconds (15,000 nanoseconds) to charge the typical capacitors of these power supplies to that level. The surge is virtually over before the MOV reacts. (See five things you probably don't know about your surge suppressor at [www.firethings.com](http://www.firethings.com).)

**THE POINT:** Standard surge suppressors allow too much current to hit the computer. Standard surge suppressors divert surge current to the ground wire and disrupt data transfer. Standard surge suppressors eventually fail without warning. Modern computers have logic voltage levels (the signals that transmit the data) and power supply voltages that are dramatically lower than that of their recent predecessors. Modern computers use integrated circuits with transistors of ever decreasing physical geometries. Modern computers are virtually always interconnected to other computers or peripheral equipment. The bottom line; **modern computers are much more sensitive and susceptible to powerline anomalies.**

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# reader FeedBack

Dear Nuts & Volts:

I have just read "Some Practical Light Meters" by Evert Fruitman in the March '99 issue of *Nuts & Volts*. I have a couple of suggestions regarding power for these circuits.

In the discussion of the analog system (Figure 11), Mr. Fruitman mentions using "AAA" batteries for the 12-volt power source. Eight "AAA" batteries are going to occupy a fairly large space in a portable unit.

I have recently begun using a small 12-volt battery for projects with low current drain, and I think it would work well in this circuit. This is an alkaline photo battery, Energizer A23 or Duracell MN21, which sells for about a dollar. These batteries will fit a RadioShack 270-405 holder (for a single "N" cell), which costs less than a dollar.

The current drain of Figure 11 includes almost six mA through R1 and R2. This six mA current can be eliminated by using a 7809 regulator instead of the LM317. Also, the 7809 (or the 7805 in some of the other circuits in the article), can be replaced with the "L" versions (78L09 or 78L05), which are in a smaller T92 case. Not all distributors carry these regulators, but all three (7809, 78L09, and 78L05) are listed in the catalog of both Dalbani Corp. and Mouser Electronics.

**Bill Stiles  
Hillsboro, MO**

Dear Nuts & Volts:

I love your magazine. Your articles are fresh and different every month.

The monitor repair article a few months ago has helped me several times already. How about an article on Switch Mode P/S with some flow charts, these are constantly giving me problems. Keep up the great work !!!

**James Rock  
Via Internet**

Dear Nuts & Volts:

I recently had a problem similar to another reader, loading Packard Bell Win 95 onto a PC.

After I salvaged what I could of a friends PB to build him a PC, I encountered the BIOS situation. I put the Packard Bell CD in my PC and ran XTREE so that I could have a look see at the files. I found that PBSETUP was a batch file that called a program which looks for a PB BIOS. If it doesn't find the file, it won't

load. If it does find a PB BIOS routine, it runs a program called SETUP. Upon a hunch, I typed in SETUP instead of PBSETUP at the start, and Win 95 loaded easily.

The only problem you might have is when the CD asks for the serial number. You enter a combination of numbers and letters that adds up to the number of characters the program asks for. If you get a message rejecting the serial number, don't fret. Just hit Enter again. It should continue loading.

People that bought Win 95 installed on a Packard Bell computer should be allowed to use their legal copy of Win 95 on their PB computer if they put in a motherboard upgrade, or dismantle it for parts to build a real computer. I don't know how well PB products are prepared for Y2K, but this info will allow some individuals and business to have their PBs upgraded, if needed, without having to upgrade to Win 98 or buy another copy of Win 95.

**Shawn K.  
walt@klondyke.net**

Dear Nuts & Volts:

I enjoy the Q & A column, by TJ Byers, very much. I would like to add this information to it.

Because of its totem-pole (Stacked) output design, the bipolar editions of the LM555, .6, .8 parts are infamous for creating power supply glitches. In stand-alone operation, this is usually not a problem. In designs with other logic devices, mysterious erratic operation often occurs. To avoid this, the LMC... parts can be used. Or use an 'LS123A part, if the frequency range, etc. is compatible. It does everything that a 555 does, except at long intervals. At least, double bypass it with a large electrolytic and a standard monolithic bypass cap.

This family also needs a bypass on the CV pin(s) if reliable operation is desired. Pin 5 on the '555 and pins 3 & 11 on the '558 should be connected to ground through a cap in the range of 0.01-0.47 mF.

Byers makes reference to the Max038. It is a redesign of the venerable Intersil/GE/RCA/Harris ICL8038. It has a much wider operating frequency range and other improved characteristics. The chip also carries a price tag several times higher than the 8038.

**Phillip Milks**



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# Open Channel

## That Upcoming Science Fair

by Joseph J. Carr

Every year in most localities, there is a round of science fairs that progress from the school level, to an area science fair, a regional or state science fair, up to the international fair. Because my readers are involved in science and technology, with a special emphasis on electronics, many of them will wind up somehow involved with science fairs ... especially if they have an interest in, or a part of, the next generation of techies.

The same scenario is found over most of the country. At each level, there is a sorting out process in which some students are selected to go forward and others are not (we never say "lose" because that's not the issue). Let's address these fairs. Whether you are a student who will enter a fair, a parent whose kid will do a project, a teacher, a mentor who might counsel a student, or a potential judge, there are some things that might be helpful. More information is found in my book *The Art of Science* (LLH Technology Publishing, available from Amazon Books, and from 1-800-247-6553).

First, though, let me put in a pitch for science fair judge volunteers. Some years, I will judge three to six fairs depending on my time. If

you have any technical ability (which includes the vast majority of *Nuts & Volts* readers), or if you are trained in any of the sciences or mathematics, then I recommend that you get involved in science fair judging. It's really quite rewarding to see kids who work in a disciplined manner to ferret out some bit of truth about nature. While few of them will ever earn a Nobel prize, or even take up science as a career, there is a distinct learning process going on. Students who negotiate the rigors of even high school science learn to think critically, and to organize facts and data ... and that is a prerequisite for good citizenship.

Science fairs are not only personally rewarding, but they can also steer youngsters into amateur radio, radioscience observing, and other technical hobbies. If you are a member of a local special interest club, or a local chapter of a professional society, then perhaps your group could sponsor a special prize, a scholarship, or even just a certificate for the "best of fair."

For example, I am a member of the American Society for Quality (ASQ, formerly ASQC). Our local chapter provides judges, as well as a prize. I sometimes contribute one of my books to the local middle and high school's fair to serve as a prize (I don't have enough books to do that for others, however!). It would certainly get some publicity for your hobby. Most science fairs have a time for special judging by

professional societies and other interest groups. The local school board science fair coordinator can get you the information.

### Winning a Science Fair

Science fairs are about science, so scientific method counts for a great deal. When I wrote about this subject one time before, a reader (of a different magazine) wrote me a harsh letter and complained that a young friend had been rejected at a science fair because she did not have a stated hypothesis. The claim was made for her that the project was a perfectly valid environmental project and was based on good data. It probably was, but if it did not have some hypothesis at risk, then it is doubtful science at best.

The lesson: Form a hypothesis that can be tested by observations in nature or in a controlled experiment. The experiment or systematic observation is a way of filtering out the signal nature might be whispering in your ear from the noise in which it is embedded (Figure 1).

A hypothesis is a falsifiable statement of what you are looking for. The term "falsifiable" means that it is capable of being proven false. If you work on a question that cannot be falsified, then you are wasting a lot of time and money. Indeed, it is often easier to falsify a null hypothesis, i.e., the statement that something cannot occur, than it is to falsify the hypothesis itself. One example: Suppose the hypothesis is that "... all cats are gray in color." You can inspect 10,000 gray cats and still not be sure that all cats are gray. Even a single not-gray cat (Figure 2) disproves the "all-cats-are-gray" hypothesis. The example is trivial, and a bit weak, but you get the idea.

Another example ... but please, please, please don't try this experiment at home. Suppose the hypothesis is: "Kerosene in an open dish cannot be ignited by tossing a lighted cigarette into it." You can toss a thousand lighted weed butts into it and see them doused without knowing for sure that the hypothesis is correct. But, if a single time it lights off the kerosene, then the original hypothesis ("cannot") is falsified.

The hypothesis should be formally written out before the experiment is designed and conducted, not merely kept in your head. It is

amazing how the experiment plan will evolve in your head as you progress, so that the data at the end of the process is not the same stuff as the data collected at the beginning. There is a natural tendency to change how we do the experiment as it evolves.

If data collection involves some ambiguity, make a prior decision on how to count each datum. For example, if the relevant data are voltages, you classify "above 5 volts" and "below 5 volts" and place the data into different mental buckets (Figure 3). Some people will place all of the "exactly 5.00 volt" readings in one bucket or the other, while others alternate back and forth (i.e., the first 5.00 volt reading goes in one bucket, the next in the opposite bucket). Still others randomly assign the data point to one bucket or the other.

Without some scheme, there is a natural and lamentable tendency to place ambiguous data in the bucket that does your preconceived mental model the most good. A certain amount of "leveling" and "sharpening" naturally takes place. The former is discounting disconfirming data and the latter is over-emphasizing confirming data. Thus, if your preconceived notion needs more "5 volts" readings, they seem to wind up in the preferred bucket!

### The One-Sided Evidence Mistake

This type of mistake emerges from situations where only one class of evidence is abundantly available. I've seen grown men — professional engineers — seriously claim that more elevators in our office building go up than go down. The reason for the misperception is that they were going down, and while they waited, several "up" elevators went past their floor. Because they got on the first "down" elevator to arrive, they could only count one. Because elevators are cyclic, the only logical way their observation could be true is for elevators to be assembled in the basement and then either disassembled or stored on the roof. Or perhaps they return to the basement by another route that is hidden from view. By now, the building should be showing a distinct list to starboard from all those elevators on the roof! Data collection schemes in which only one of two (or more) possible

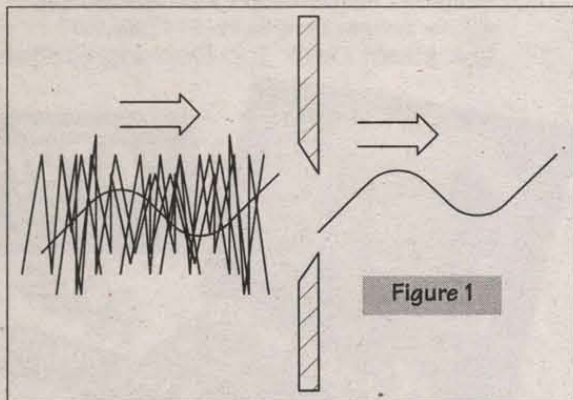


Figure 1

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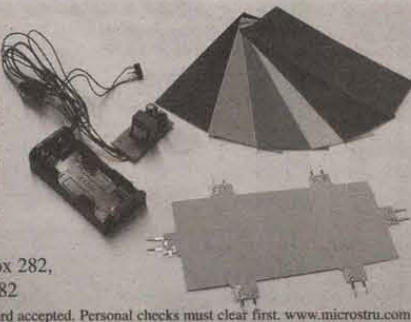
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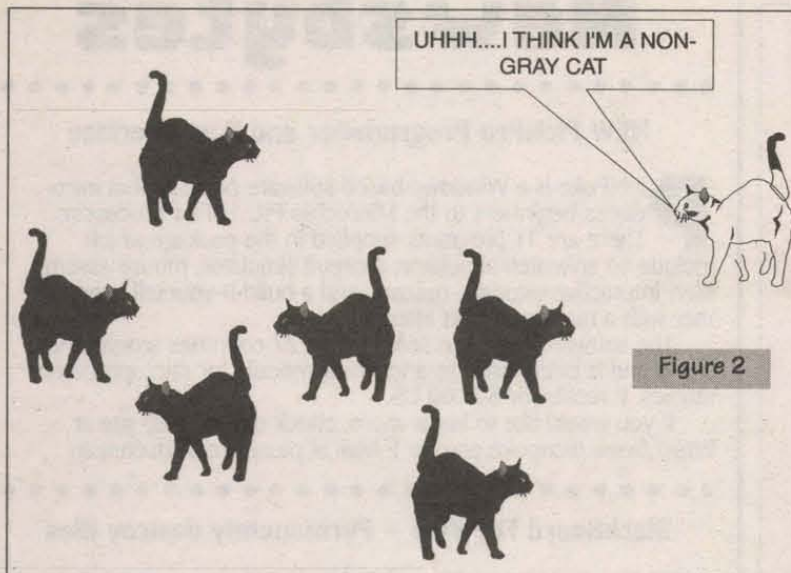


Figure 2

outcomes can easily be captured are inherently flawed.

The way that an experiment hypothesis is framed can have a profound effect on outcomes. If we ask "what evidence supports this view ...," then we tend to pre-bias ourselves to look for confirming evidence rather than all of the evidence. We may overlook valid disconfirming evidence because we either did not look for it, or failed to recognize it when it surfaced. We also see this effect when asking about similarities or dissimilarities between two classes of event, or when comparing evidence against some pre-existing model.

Furthermore, when planning the experiment, decide what data constitutes sufficient proof of the hypothesis and null hypothesis. Just because a bit of data supports a hypothesis does not mean that it proves it. Even if the evidence is totally necessary for the proof, it may not be sufficient for the proof. More elements of evidence may be needed to prove the case.

This form of error often comes from expecting too much information from too little data. It is especially likely to occur when, early in an experiment or study, a rather high number of confirming data points are noted. If there is a fair number of these confirming data points, then we may take a logical leap of faith and assert that those data prove that the hypothesis is true.

Do enough trials of the experiment to ensure that the results are significant. Doing three or four trials is probably not sufficient. Perhaps 20 or 30 is better. No one expects high school students to have the resources and time to do some more complex experiments with a number of repetitions that statisticians would like — or that professional scientists would use — but "only a few" is clearly suspect.

It is also critical that students do their own work. While that should go without saying, there are always those who have someone else do their work and submit it as their own. Sighhh. Of course, sometimes judges make errors. I recall one

youngster, whom I knew personally, who built an electronic project too well. Some judges claimed that he had to have had his father do it for him, because the quality of construction was too good. But I knew the kid had done a lot of projects other than the science fair project, so I intervened and convinced them that his father did not do it. Indeed, he probably didn't know how ... he was an accountant with no amateur radio or hobbyist electronics background. The kid's project might as well have been in Greek for all the father knew about it (same with the mother).

Another good trick is to keep a complete notebook on the project. Professional scientific or engineering notebooks are available, but are too costly for most high school projectors. A simple bound composition notebook is sufficient. The standard in science is to use a bound notebook so that other people can tell if pages — perhaps embarrassing pages — were removed. One of those speckled black and white "composition notebooks" are just fine at the high school level.

Make all entries in the notebook in ink. Do not attempt to erase erroneous entries. Cross them out, in ink, note the date of the correction, and place your initials by the correction. Close to the same spot write in the correct data, if available. I had a freshman physics professor in college who would seriously deface the book if a student violated these little rules ... and mark an "F" for the lab period in his own book.

Make good use of statistics. If you don't know anything about statistics, then get an introductory book. I can immediately recommend my own book *The Art of Science*. It has a lot of very good information for the budding scientist, and is well within the intellectual reach of even average high school students. That old trash about "you can prove anything with statistics," meaning that you can propagate rubbish, or "there are liars, damn liars, and statistics," is essentially hogwash. There is only good use of statistics and bad use.

Also learn what "significant figures" means. If you measure a poten-

tial of one volt, and a current of three amperes, with the usual measuring instruments the answer  $R = E/I = 1/3$  is not "0.333333333" (or however many digits your calculator can carry), but "0.33" or "0.333" at most; in some cases it might even be "0.3." The judges are not only not impressed with such seeming precision as "0.333333333," but will be sufficiently disimpressed as to count off significant points for such sloppiness.

The display that you prepare should be as nice as possible. If you have the resources, use your computer graphics and word processor programs. Mount everything on styrofoam backed poster paper (or even use one of those three panel "science fair" displays made from foam-backed poster paper. If

you don't have the resources, then hand write ... or print ... everything as neatly as humanly possible. Judges are generally not impressed enough with the display to award a higher place for bad science, or reduce the place for good science, but in borderline cases, the display can make the difference. And if you are good enough to go to the regional or state science fair, appearance becomes a lot more significant. At that level, all of the competition is good.

Above all, the students should know the subject and be prepared to answer some questions. If you don't know the answer, then don't try to scam the judge ... it won't work. "I don't know" is an acceptable answer if it is the truth, especially when followed by "... but I intend to find out." The essence of good science is the Confession of Ignorance, coupled with the integrity to admit it out loud, and the energy to go find the answer. After all, the professional scientist spends most of her time out on the frontiers of knowledge, and out there, nature is very unforgiving of a "know-it-all" attitude. "Y gwin erbyn y byd" ("Truth prevails against the whole world"), the war cry of the Iceni (Briton) Queen Boudica (ca. AD 61), applies to science ... but only for those who have the integrity to seek it out.

## A Lesson Learned

The science fair coordinator for our local middle school called me and asked me to contact one of the two teachers. It seems that they had a problem student (I'll call him an anonymous "John"). One teacher contemptuously referred to the eighth grader as a "moron," but the other wasn't sure. John had done a science fair project based on an electronic circuit, and wanted to enter it. The "moron" teacher wanted to prohibit him from entering the fair ("for his own good," no doubt), while the other sought outside help to evaluate the quality of the project. The teacher asked me to make an appointment with the parents and go look at the project. I could then advise them whether or not the kid

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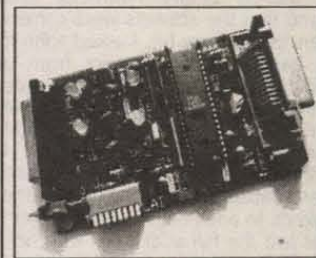
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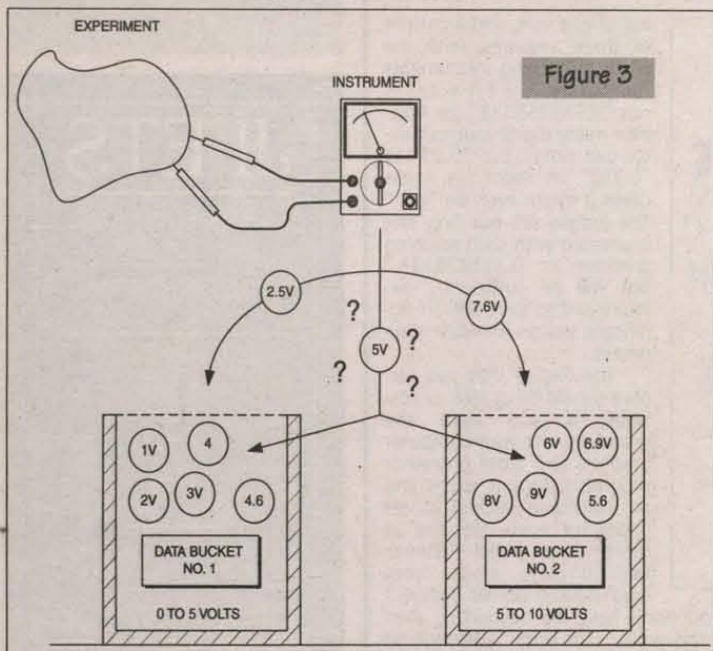


Figure 3

should "be allowed to participate."

The project was typical of many middle school kids' projects: rat's nest wiring, but it somehow managed to work. What the lad had done was build a binary circuit that could correctly add or subtract two binary numbers. The numbers were entered via toggle switches (one position for "1" and the other for "0"), and a push-button switch made the calculation. No chips were used, so the full-adder digital circuits were made from transistors.

After I entered all combinations of two-bit binary numbers, and found that the answers were correct even to the carry bit, I asked John if he had made the project from a book (often the case of eighth grade science fair electronics projects). He told me "yes" and got out an old RadioShack book. Immediately, I noticed that the book version had more transistors than the one on the project. In addition, the book project was just the full adder, not the combination needed for the addition and subtraction function performed

(including two's complementing for subtraction). When I pointed out the discrepancy, John told me that he didn't have enough left from his small allowance to buy all those transistors "... so I re-designed the circuit to fit how much dollars I had."

I related this story in a letter to the science teacher who supported him, and the lad was allowed to enter. He eventually won a second place certificate in the local area fair. The kid was supposedly semi-autistic, but in terms I understand: it wasn't the central processing unit that was defective (he re-designed an electronic circuit), but the I/O channel. One merely had to have the patience to communicate with this "moronic" student.

I don't use the word "moron" much anymore. **NV**

### Connections ...

I can be reached by snail mail at P.O. Box 1099, Falls Church, VA 22041, or via E-Mail at [CARRJJ@AOL.COM](mailto:CARRJJ@AOL.COM).

# Newsbytes

## NEW PicNPro Programmer and Port Interface

**P**icNPro is a Windows-based software package that introduces beginners to the Microchip PIC 16F84 processor. There are 11 programs supplied in the package which include an animated simulator, a circuit simulator, mouse assembler, interactive tutorials, quizzes, and a build-it-yourself programmer with a real-world port interface.

The software has been sold in over 27 countries around the world and is being used as a teaching module for microprocessor studies. It retails for \$27.00 US.

If you would like to know more, check out the web site at <http://www.picnpoke.com> or E-Mail at [picnpoke@cdi.com.au](mailto:picnpoke@cdi.com.au)

## BlackBoard FileWipe – Permanently destroy files

**A**lbert's Ambry presents BlackBoard FileWipe – a 32-bit utility which overwrites files up to 10 times with random data. In this world, it grows ever more difficult to maintain your privacy. Where you could once leave your door open, you now double lock it. Where you could once simply throw away documents, you now feed them through the shredder. Where you once only deleted files, you can now FileWipe them.

BlackBoard FileWipe can prevent data recovery from deleted files. Tests have shown that file data can be recovered when overwritten up to nine times. For maximum security, BlackBoard FileWipe allows you to overwrite up to 10 times. Just select the files you want to destroy and drag them into the selection box. Then press Wipe. Also, a file can be wiped by using right-click in Windows Explorer.

The latest version has improved security, a stronger overwriting mechanism, and handles multiple file deletions with ease.

Rick Maybury of "The Electronic Telegraph" considers BlackBoard FileWipe to be one of the "10 popular titles that no Windows 95 PC should be without."

The latest version, 4.3, is free for a 30-day trial period and available at <http://www.blackboardsoftware.com> for \$17.95.

**E**-Tech Canada Ltd., a Markham, Ontario-based high-tech company has successfully developed a state-of-the-art Internet Telephony solution allowing users a FREE alternative to traditional long distance carriers.

This revolutionary product is available to consumers worldwide through e-commerce, with over 2500 Web-stores carrying the product.

The global war on long distance telephone charges is long from being over! International long distance carriers now have a new enemy on their hands – Internet Telephony. This latest innovation allows for the use of the Internet as a vehicle for free communication with users anywhere in the world! Unlike conventional telephone communication, Internet Telephony allows users the ability to transmit and receive voice E-Mail, full live-motion video, as well as data information, along with excellent – quality audio-telephone communication – absolutely free!

Future trends predict that within a few short years, Internet Telephony will occupy as much as 20% of the long distance telecommunications market. Prior constraints to this technology involved slower modem speeds, inadequate processing abilities, and high-traffic Internet Service Providers. With today's high-speed modems and cable connections to superior ISPs, technology has finally allowed Internet Telephony to become incredibly functional. Since it is presumed that a PC occupies space in almost every



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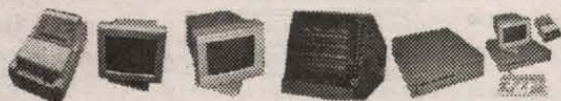
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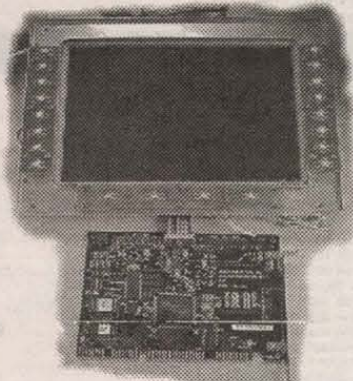


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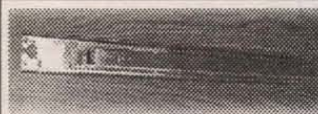


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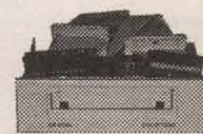


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HP 6281A 0-7.5 V 0-5 A CV/CC Power Supply	\$150.00
HP 6299A 0-100 V 0-750 mA CV/CC Power Supply	\$200.00
HP 6384A 0-0.5 V 0-8 A CV/CC Power Supply	\$125.00
HP 6443B 0-120 V 0-2.5 A CV/CC Power Supply	\$450.00
KEPCO ABC-1500M 0-1500 V 10 mA CV/CC Power Supply	\$125.00
KEPCO ATE 36-30M 0-36 V 0-30 A CV/CC Power Supply	\$900.00
KEPCO ATE 36-8M 0-36 V 0-8 A CV/CC Power Supply	\$375.00
LAMBDA LX-352-FM 0-60 V 0-15 A CV/CC Power Supply	\$600.00

SORENSEN DCR 20-25B2 0-20 V 0-25 A CV/CC Power Supply	\$550.00
SORENSEN DCR 600-0.75B2 0-600 V 0-750 mA CV/CC Power Supply	\$550.00
SORENSEN DCR 600-1.5B 0-600 V 0-1.5 A CV/CC Power Supply	\$700.00
SORENSEN SRL 20-12 0-20 V 0-12 A CV/CC Power Supply	\$400.00
SORENSEN SRL 60-8 0-60 V 0-8 A CV/CC Power Supply	\$600.00
TEK PSS01-1 Power Supply, 0-20 V, 2 mV res., 400 mA, TM500 series	\$175.00

#### MULTIPLE OUTPUT

HP 6205C Dual Output Supply, 0-40 V 300 mA or 0-20 V 600 mA	\$300.00
HP 6228B Dual 0-50 V 0-1 A CV/CC Power Supply	\$450.00
HP 6236B Triple Output Supply, to +/-20 V 0.5 A & 0-6 V 2.5 A	\$375.00
HP 6253A Dual 0-20 V 0-3 A CV/CC Power Supply	\$450.00
HP 6255A Dual 0-40 V 0-1.5 A CV/CC Power Supply	\$450.00
KEPCO MPS-620M Triple Output Supply, dual 0-20V 1A tracking & 0-6V 5A	\$250.00
LAMBDA LPD-422-FM Dual 0-40 V 0-1 A CV/CC Power Supply	\$300.00
LAMBDA LPT-7202-FM Triple Output Power Supply	\$450.00
TEK PSS01A Programmable Triple Power Supply, TM5000 series	\$650.00
TEK PSS03A Dual Power Supply, TM500 series	\$200.00

#### MISCELLANEOUS

ACME PS2L-500 Programmable Load, 0-75 V / 0-75 A / 500 Watts max.	\$350.00
HP 59501B HP1B Isolated DAC/Power Supply Programmer	\$175.00
HP 6825A Bipolar Power Supply/Amplifier, +/-20 V 2 A	\$800.00
KEPCO BOP 20-20M Bipolar Op Amp/Power Supply, to 20 V 20 A	\$675.00
KEPCO BOP 36-5M Bipolar Op Amp/Power Supply, to 36 V 5 A	\$400.00
KEPCO BOP 50-2M Bipolar Op Amp/Power Supply, to 50 V 2 A	\$400.00
TRANSISTOR DEV DAL-50-15-100 Programmable Load, 0-50 V, 0-15 A, 100 Watts max.	\$200.00

### TIME & FREQUENCY

#### UNIVERSAL COUNTERS

HP 5314A-001 100 MHz/100 nS Universal Counter; TCXO reference option	\$275.00
HP 5315A-001 100 MHz/100 nS Universal Counter; TCXO reference option	\$450.00
HP 5315A-002,003 100 MHz/100 nS Univ. Counter; batt. power & 1 GHz C-ch.	\$650.00
HP 5315A-003 100 MHz/100 nS Univ. Counter, 1 GHz C-channel option	\$550.00
HP 5315B 100 MHz/100 nS Universal Counter	\$500.00
HP 5316A 100 MHz/100 nS Universal Counter, HP1B	\$600.00
HP 5316A-001,003 100 MHz/100 nS Univ. Counter, HP1B, TCXO, 1 GHz C-ch.	\$750.00
HP 5316B 100 MHz/100 nS Universal Counter, HP1B	\$750.00
HP 5335A 200 MHz Universal / Statistical Counter	\$500.00
HP 5364A Microwave Mixer / Detector, for modulation domain an.	\$3,000.00
TEK DC5004 Programmable 100 MHz/100nS Counter/Timer, TM5000 series	\$250.00
TEK DC5009 Programmable 135 MHz Univ. Counter/Timer, TM5000 series	\$400.00
TEK DC5010 350 MHz/ 3.125 nS Universal Counter, TM5000 series	\$950.00
TEK DC503A 125 MHz/100 nS Universal Counter, TM500 series	\$275.00
TEK DC509 135 MHz/ 10 nS Universal Counter, TM500 series	\$275.00

#### FREQUENCY COUNTERS

EIP 575 18 GHz Source Locking Counter, GPIB	\$1,250.00
FLUKE 7220A-010,131,351 1.3 GHz Counter; battery power, OCXO, and res. mult.	\$500.00
HP 5340A 18 GHz Frequency Counter	\$450.00
HP 5343A-001 26.5 GHz Frequency Counter, OCXO reference	\$3,500.00
HP 5345A/5355A/5356B 26.5 GHz CW/Pulse Frequency Counter	\$3,500.00
TEK DP501 1.3 GHz Prescaler, divide by 16, TM500 series	\$225.00

#### STANDARDS

HP 105B Quartz Oscillator, 0.1/1.0/5.0 MHz, battery power	\$1,500.00
HP 5061A Cesium Frequency Standard, 0.1/1.0/5.0/10.0 MHz outputs	\$6,500.00
HP 5065A-002 Rubidium Frequency Standard, 0.1/1.0/5.0/10.0 MHz out	\$3,500.00
HP 5087A Distribution Amplifier, 12 outputs at 1 MHz	\$1,500.00
HP 5087A-opt.032 Distribution Amplifier, 12 outputs at 5 MHz	\$1,750.00
HP 5087A-opt.033 Distribution Amplifier, 12 outputs at 10 MHz	\$1,750.00

### AUDIO & BASEBAND

#### SPECTRUM ANALYSIS

HP 3586C Selective Level Meter, 50 Hz-32.5 MHz, 50 & 75 ohms	\$1,500.00
TEK 7L5/L3/R7603 Spectrum Analyzer, 20 Hz-5 MHz, 10 Hz min. res., w/frame	\$1,500.00

#### DISTORTION ANALYZERS

HP 339A Distortion Analyzer, built-in low distortion osc.	\$750.00
HP 8903A-001 Audio Analyzer, 20 Hz-100 kHz; rear panel input	\$1,500.00
TEK DA0484 Programmable Distortion Analyzer	\$750.00





### RMS VOLTMETERS

FLUKE 8922A True RMS Voltmeter, 180 uV-700 V, 2 Hz-11 MHz	\$450.00
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### OSCILLATORS

HP 209A Sine/Square Wave Generator, 4 Hz-2 MHz, 5 VRMS max.	\$225.00
HP 3336C Synthesizer / Level Generator, 10 Hz-21 MHz	\$1,400.00
TEK SG5010 Programmable Oscillator, 10 Hz-163.8 kHz	\$2,750.00
TEK SG502 Sine/Square Osc., 5 Hz-500 kHz, 70 dB step atten., TM500	\$200.00

### MISCELLANEOUS

KROHN-HITE 3103 High/Low Pass Filter, 10 Hz-3 MHz, 24 dB/octave	\$350.00
KROHN-HITE 3202 Dual HP/LP/BP/BR Filter, 20 Hz-2 MHz, 24 dB/octave	\$450.00
KROHN-HITE 3342R Dual HP/LP Filter, 0.001 Hz-99.9 kHz, 48 dB/octave	\$900.00
KROHN-HITE 3750 LP/HP/BP/BR Filter, 0.02 Hz-20 kHz, 6/12/18/24 dB/oct.	\$600.00
KROHN-HITE DCA-10R 10 Watt Amplifier, 20 dB gain, DC-1 MHz, 600-1000 Ohms	\$450.00
ROCKLAND 852 Dual Highpass/Lowpass Filter, 0.1 Hz-111 kHz	\$900.00
TEK AM502 Differential Amplifier, 0.1 Hz-1 MHz, TM500 series	\$475.00

### RF & MICROWAVE

#### SPECTRUM ANALYZERS

HP 11517A/18A/19A/20A Mixer Set, 12.4-40.0 GHz, for HP 8555A/8569A	\$600.00
HP 11970A WR28 Harmonic Mixer, 26.5-40 GHz	\$1,100.00
HP 11970K WR42 Harmonic Mixer, 18.0-26.5 GHz	\$1,100.00
HP 11970Q WR22 Harmonic Mixer, 33-50 GHz	\$1,400.00
K2 3585A Spectrum Analyzer, 20 Hz-40 MHz, 3 Hz min. res. bw.	\$4,500.00
HP 8559A/853A-001 Spectrum An., 0.01-21 MHz, 1 kHz res., w/rackmount frame	\$3,750.00
HP 8565A-100 Spectrum Analyzer, 10 MHz-22 GHz, 100 Hz min. res.	\$4,500.00
HP 8569B Spectrum Analyzer, 10 MHz-22 GHz, 100 Hz min. res. bw.	\$7,500.00
TEK TR502 Tracking Generator, 0.1-1800 MHz, for 7L13/7L14	\$950.00
TEK WM782V WR15 Harmonic Mixer, 50-75 GHz	\$1,500.00

#### NETWORK ANALYZERS

HP 11650A Network Analyzer Accessory Kit, APC7	\$600.00
HP 35676A Reflection/Transmission Test Kit, 5 Hz-200 MHz	\$1,000.00
HP 4195A Network / Spectrum Analyzer, 10 Hz-500 MHz	\$15,000.00
HP 8405A Vector Voltmeter, 1-1000 MHz	\$450.00
HP 85020A Directional Bndge, 10-4300 MHz, N(f) test port	\$650.00
HP 85027C Directional Bndge, 0.01-18 GHz, N(f) test port	\$1,750.00
HP 85044A Reflection/Transmission Test Set, 300 kHz-3 GHz	\$1,500.00
HP 8756A Scalar Network Analyzer	\$2,500.00
HP 85026A 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., GPIB	\$1,900.00
FLUKE 6060A/AN Synthesized Signal Gen., 10 kHz-520 MHz, 10 Hz res., GPIB	\$1,500.00
FLUKE 6060B/AB Synthesized Signal Gen., 0.1-1050 MHz, 10 Hz res.	\$2,250.00
GIGATRONICS 1018 Synthesized Signal Gen., 50 MHz-18 GHz, 1 MHz res.	\$4,500.00
GIGATRONICS 600/10-18 Synthesized Source, 10-18 GHz, 1 MHz res., GPIB	\$2,500.00
GIGATRONICS 600/6-12 Synthesized Source, 6-12 GHz, 1 kHz res., GPIB	\$2,500.00
GIGATRONICS 875/50 Levelled Multiplier, x4, 50.0-75.0 GHz output, -3 dBm	\$3,750.00
GIGATRONICS 875/86 Levelled Multiplier, 26.5-40.0 & 50.0-75.0 GHz outputs	\$2,500.00
GIGATRONICS 900/28 Synthesized Signal/Sweep Gen., 2-8 GHz, 1 MHz res., GPIB	\$2,500.00
HP 11720A Pulse Modulator, 2-18 GHz, 80 dB on/off ratio	\$450.00
HP 3335A Synthesizer / Level Generator, 200 Hz-81 MHz	\$4,500.00
HP 85100V Frequency Mult., 10-15 GHz in / 50-75 GHz out >0 dBm	\$3,750.00
HP 8640B Signal Generator, 0.5-512 MHz, AM, FM, pulse modulation	\$1,000.00
HP 8656B-001 Synth. Signal Gen., 0.1-990 MHz, 10 Hz res., OCXO ref.	\$2,500.00
HP 8657A-002 Signal Generator, 0.1-1040 MHz, 10 Hz res., HP1B	\$3,250.00
HP 8660C/8660B-002 Synth. Sig. Gen., 1-1300 MHz, FM / Phase mod. w/86635A	\$2,750.00
HP 8660C/86603A Synthesizer, 1-2600 MHz, AM / FM, w/86633B	\$3,250.00
HP 8673C Synthesized Signal Generator, 50 MHz-18.6 GHz	\$16,500.00
HP 8673C-004.008 Synth. CW Signal Generator, 2-26 GHz, >+8 dBm output	\$12,500.00

#### SWEEP GENERATORS

HP 8350A/83545A-002 Sweep Oscillator, 5.9-12.4 GHz, 70 dB step attenuator	\$4,000.00
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 levelled, 70 dB atten.	\$1,250.00
HP 86230B RF Plug-in, 1.8-4.2 GHz, +10 dBm levelled	\$400.00
HP 86240C RF Plug-in, 3.6-8.5 GHz, +16 dBm levelled	\$700.00
HP 86241A-001 RF Plug-in, 3.2-6.5 GHz, +8 dBm levelled	\$300.00
HP 86242D-004.008 RF Plug-in, 5.9-9.0 GHz, +10 dBm levelled	\$300.00
HP 86250D RF Plug-in, 8.0-12.4 GHz, +10 dBm levelled	\$500.00
HP 86260A RF Plug-in, 12.0-18.0 GHz, +10 dBm levelled	\$500.00
HP 86260A-H04 RF Plug-in, 10.0-15.0 GHz, +10 dBm levelled	\$500.00
HP 86290A RF Plug-in, 2.0-18.0 GHz, +7 dBm levelled	\$1,750.00

WAVETEK 962 Sweep Generator, 1.0-4.0 GHz, markers, +12 dBm univld.	\$1,250.00
WILTRON 6619A Sweep Generator, 2-8 GHz, +10 dBm levelled	\$1,500.00
WILTRON 6647M Sweep Generator, 10 MHz-20 GHz, +10 dBm levelled	\$4,500.00

#### POWER METERS

ANRITSU MP-81B/ML-83A Power Meter, 75-110 GHz (WR10), -20 to +20 dBm	\$2,500.00
BOONTON 4200-01A.03/8-4A x2 Dual Channel Microwattmeter, w/(2) 1 MHz-7 GHz sensors	\$950.00
BOONTON 42B/41-4B Analog Power Meter, with 1 MHz-12 GHz sensor	\$375.00
BOONTON 42B/41-4E Analog Power Meter, with 1 MHz-18 GHz sensor	\$500.00
GENERAL MICROW 476/4240A Power Meter & Sensor, 0.01-18 GHz, -35 to +10 dBm	\$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	\$1,750.00
HP 435B/8482B Power Meter, -10 to +34 dBm, 100 kHz-4.2 GHz	\$900.00
HP 436A/8481A Power Meter, -30 to +20 dBm, 10 MHz-18 GHz	\$1,400.00
HP 8477A Power Meter Calibrator, for HP 432 series	\$500.00
HP K486A WR42 Thermistor Mount, 18.0-26.5 GHz, for 432 series	\$350.00
HP Q8486A Power Sensor, 33.0-50.0 GHz, WR22, for 435/6/7/8	\$1,500.00
HP R486A WR28 Thermistor Mount, 26.5-40 GHz, for 432 series	\$350.00
HP R8486A WR28 Power Sensor, 26.5-40 GHz, for HP 435/6/7/8	\$1,500.00

#### RF MILLIVOLTMETERS

BOONTON 92B-005 RF Millivoltmeter, 10 kHz-1.2 GHz, 75 Ohms scale	\$500.00
RACAL 9303 TRMS Level Meter, 10 kHz-2 GHz, -77 to +23 dBm, GPIB	\$875.00

#### AMPLIFIERS, MISCELLANEOUS

AMPLIFIER RESE IW1000 Amplifier, 30 dB gain, 1-1000 MHz, 1 Watt output	\$650.00
BOONTON 82AD-001.01A Modulation Meter, AM, FM, 10-1200 MHz, GPIB	\$750.00
HP 11945A-E51 HP 11940A & 11941A Close-Field Probes, w/8447F-H64 amp	\$1,600.00
HP 415E SWR Meter	\$200.00
HP 465A Amplifier, 20/40 dB, 5 Hz-1 MHz, 1/2 Watt/50 Ohms	\$125.00
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 8901A Modulation Analyzer, 150 kHz-1300 MHz	\$2,500.00
HP 8901B-1.2.3 Modulation An., 0.15-1300 MHz, rear input, OCXO, ext. LO	\$3,000.00
HP 8970A Noise Figure Meter	\$4,000.00
HUGHES 1177H02F000 TWT Amplifier, 4.0-8.0 GHz, 10 Watts output	\$1,500.00
ROHDE & SCHWARZ ESH2 Test Receiver, 9 kHz-30 MHz	\$5,000.00

### COAXIAL & WAVEGUIDE

AMERICAN NUCLEONICS AM-432 Cavity Backed Spiral Antenna, LHC, 2-18 GHz, TNC(f) "NEW"	\$95.00
AVANTEK AMT-400X2 WR28 Active Doubler, 13-20 GHz +10 dBm in, +10 dBm out	\$450.00
BAYTRON 3-28-300/10 WR28 Directional Coupler, 10 dB, 26.5-40 GHz	\$300.00
BIRD 6735-300 1 kW Load, 25-1000 MHz, LC(f), with wattmeter	\$650.00
CONTINENTAL MW RA2E8-K-M WR28 x K(m) Endfire Adapter	\$225.00
FXR/MICROLAB S3-02N Triple Stub Tuner, 200-1000 MHz, 100 Watts max., N(m/f)	\$125.00
GR 874-LTL Constant Impedance Trombone Line, 0-44 cm, DC-2 GHz	\$400.00
GR 900-Q GR900 14mm Interseries Adapters	\$125.00
HP 11590A-001 Bias Network, 1.0-18.0 GHz, APC7	\$450.00
HP 11636A 2-Way Power Divider, DC-18 GHz, N(m/f)	\$300.00
HP 11692D Dual Directional Coupler, 22 dB, 2-18 GHz	\$800.00
HP 11966C Biconical Antenna, 30-300 MHz	\$900.00
HP 11966D Log Periodic Antenna, 200-1000 MHz	\$1,000.00
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	\$1,200.00
HP 774D Dual Directional Coupler, 20 dB, 215-450 MHz	\$275.00
HP 777D Dual Directional Coupler, 20 dB, 1.9-4.1 GHz	\$275.00
HP 778D Dual Dir. Coupler, 20 dB, 100-2000 MHz, N test port	\$450.00
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 8495H-002 Programmable Step Attenuator, 0-70 dB, DC-18 GHz, SMA	\$400.00
HP 8497K-004 Programmable Step Attenuator, 0-90 dB, DC-26.5 GHz	\$750.00
HP K281C-012 WR42 x APC3.5(m) Adapter	\$300.00
HP K382A WR42 Direct Reading Attenuator, 0-50 dB, 18-26.5 GHz	\$2,900.00
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 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 R382A WR28 Direct Reading Attenuator, 0-50 dB, 26.5-40 GHz	\$2,000.00
HP R422A WR28 Crystal Detector, 26.5-40 GHz	\$400.00

HP R532A WR28 Frequency Meter, 26.5-40 GHz	\$500.00
HP R752A WR28 Directional Coupler, 3 dB, 26.5-40 GHz	\$450.00
HP R752C WR28 Directional Coupler, 10 dB, 26.5-40 GHz	\$450.00
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 45712H-1000 WR22 Frequency Meter, 33-50 GHz	\$900.00
HUGHES 45714H-1000 WR15 Frequency Meter, 50-75 GHz	\$900.00
HUGHES 45721H-1000 WR10 Frequency Meter, 75-110 GHz	\$900.00
HUGHES 45721H-1000 WR28 Direct Reading Attenuator, 0-50 dB, 26.5-40 GHz	\$1,000.00
HUGHES 45724H-1000 WR15 Direct Reading Attenuator, 0-50 dB, 50-75 GHz	\$250.00
HUGHES 45732H-1200 WR22 Level Set Attenuator, 0-25 dB, 33-50 GHz	\$400.00
HUGHES 45772H-1100 WR22 Thermistor Mount, -20 to +10 dBm, 33-50 GHz	\$800.00
HUGHES 45775H-1100 WR12 Thermistor Mount, -20 to +10 dBm, 60-90 GHz	\$600.00
HUGHES 47316H-1111 WR10 Tunable Detector, 75-110 GHz, positive polarity	\$375.00
HUGHES 47974H-1000 WR15 SPST PIN Switch, 250 MHz speed, 60-62 GHz response	\$200.00
KRYTAR 2616S Directional Detector, 1.7-26.5 GHz, K(f)/m/SMC	\$450.00
M/A-COM 3-19-300/10 WR19 Directional Coupler, 10 dB, 40-60 GHz	\$40.00
MIDWEST MICROW 3537 DC Block, 0.1-12.4 GHz, SMA(m/f) "NEW"	\$25.00
MINI-CIRCUITS ZFDC-20-4 Directional Coupler, 19.5 dB, 1-1000 MHz, SMA(f)	\$400.00
MINI-CIRCUITS ZHL-42 Amplifier, 30 dB gain, 0.7-4.2 GHz, +28 dBm, 15V, SMA	\$150.00
NARDA 3000-SERIES Directional Couplers	\$300.00
NARDA 3024 Bi-Directional Coupler, 20 dB, 4-8 GHz	\$225.00
NARDA 3090-SERIES Precision High Directivity Couplers	\$500.00
NARDA 368BNM Coaxial High Power Load, 500 Watts, 2.0-18 GHz, N(m)	\$1,000.00
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	\$75.00
NARDA 4000-SERIES SMA Miniature Directional Couplers	\$275.00
NARDA 4226-10 Directional Coupler, 10 dB, 0.5-18.0 GHz, SMA(f)	\$325.00
NARDA 4227-16 Directional Coupler, 16 dB, 1.7-26.5 GHz, 3.5mm(f)	\$200.00
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)	\$135.00
NARDA 4799 Level Set Attenuator, 0-15 dB, 4-18 GHz, SMA(f)	\$300.00
NARDA 5070-SERIES Precision Reflectometer Couplers	\$165.00
NARDA 765-10 10 dB Attenuator, 50 Watts, DC-5 GHz, N(m/f)	\$275.00
NARDA 769-30 30 dB Attenuator, 150 Watts, DC-6 GHz, N	\$375.00
NARDA 792FF Variable Attenuator, 0-20 dB, 2.0-12.4 GHz	\$375.00
NARDA 794FM Direct Reading Variable Attenuator, 0-40 dB, 4-8 GHz	\$50.00
OMNI-SPECTRA 2085-6010-00 Crystal Detector, 1-18 GHz, negative polarity, SMA(m/f)	\$250.00
PAMTECH KYG1014 WR42 Junction Circulator, 18.0-26.5 GHz	\$75.00
SONOMA SCIENTI 21A3 WR42 Circulator, 20 dB, 20.6-24.8 GHz	\$350.00
SPACEK LABS K-2X Frequency Doubler, 9.0-13.25 GHz in / 18.0-26.5 GHz out	\$1,000.00
TRG B510 WR22 Direct Reading Attenuator, 0-50 dB, 33-50 GHz	\$1,250.00
TRG B528 WR22 Direct Reading Phase Shifter, 0-360 deg., 33-50 GHz	\$600.00
TRG V551 WR15 Frequency Meter, 50-75 GHz	\$750.00
TRG W551 WR10 Frequency Meter, 75-110 GHz	\$200.00
WAVELINE 100080 WR28 Terminated Crossguide Coupler, 30 dB	\$150.00
WEINSCHEID DS109 Double Stub Tuner, 1-13 GHz, N(m/f)	\$150.00
WEINSCHEID DS109LL Double Stub Tuner, 0.2-2.0 GHz, N(m/f)	

### COMMUNICATIONS

HP 4935A-001 Transmission Test Set, 20 Hz-110 kHz, battery option	\$700.00
HP 59401A HP1B Bus Analyzer	\$700.00
TEK 1410R NTSC Gen., w/SPG2 sync. generator, TSG7 color bars	\$800.00
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, TSG13, TSG15, TSG16	\$1,100.00
TEK 1411R opt-04 PAL Test Gen., w/SPG12, TSG11, 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

P.A.R. 5206-95, 98 Two-Phase Lock-in Amp., 2 Hz-100 kHz, GPIB	\$1,500.00
P.A.R. 5209 Lock-in Amp., 0.5 Hz-120 kHz, 130 dB dynamic reserve	\$2,000.00
TEK TM5006 5000-series 6-slit Programmable Power Module	\$600.00
TEK TM504 500-series 4-slit Power Module	\$175.00
TEK TM506 500-series 6-slit Power Module	\$250.00
TEK TM515 500-series 5-slit Traveller Power Module	\$275.00



# Events

MAY 1999

MAY 1

**AL - MOULTON** - Hamfest. Bankhead ARC, Rex Free K4ACI, 256-905-0822. Ed Weatherford K4EKW, 256-974-0436.  
Web: <http://www.symmetric-inc.com/N4IDX>

**AZ - SIERRA VISTA** - Hamfest. Cochise ARA, Ray Berger W1LYT, 520-378-4214

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

**CANADA - ONTARIO - STITTVILLE** - Hamfest. Ottawa Valley Mobile RC, John Barnhardt VE3ZOV, 613-521-8910. Fax: 613-523-7889.  
E-Mail: [ve3zov@rac.ca](mailto:ve3zov@rac.ca)

**CO - MOUNGMENT** - Hamfest. Pikes Peak RAA, Robert Ryals K10GF, 719-265-9950.  
E-Mail: [rryals@pcisys.net](mailto:rryals@pcisys.net)  
Web: <http://www.qsl.net/ppraa/swapfest.html>

**KY - FALLSBURG** - Swapmeet. Fallsburg Community Center, 5 mi N of Louisa, take Rt. 3 toward Yatesville Lake. 9am-4pm. Talk-in: 147.390 (+) (K4PGA). Big Sandy ARC, Fred Jones WA4SWF, 606-638-9049  
E-Mail: [wa4swf@foothills.net](mailto:wa4swf@foothills.net)

**MD - GRAYSONVILLE** - Hamfest. Kent Island & Anne Arundel ARCs, Tony Young WA3YLO, 301-262-1917. E-Mail: [tonyy@juno.com](mailto:tonyy@juno.com)  
Web: <http://home.att.net/~n3szw/aarc.html>

**MI - CADILLAC** - Swapmeet. Cadillac Middle School. 8am-1pm. VE Exams. Talk-in: 146.98. Wexauke ARC, Dan KE8KU, 616-775-0998.  
E-Mail: [ke8kudan@juno.com](mailto:ke8kudan@juno.com)  
E-Mail: [n8njawrk@juno.com](mailto:n8njawrk@juno.com)

**SC - WINDSOR** - Hamfest. Salkehatchie ARS, Ray Thomas WA4OMM, 803-266-4759.  
E-Mail: [rose2@sc.tds.net](mailto:rose2@sc.tds.net)

**TN - NASHVILLE** - Hamfest. Vaughn Bldg., TN State Fairgrounds, Nashville ARC, Bob Malone WB5ZDS, 615-865-6225.  
E-Mail: [WB5ZDS@juno.com](mailto:WB5ZDS@juno.com)

**WI - CEDARBURG** - Hamfest. Ozaukee RC, Joe Holly AA9HR, 414-377-2137.  
E-Mail: [aa9hr@execpc.com](mailto:aa9hr@execpc.com)

**WI - SUPERIOR** - Hamfest. Arrowhead RAC, Jeff Daniels N0VQF, 218-485-8131.  
E-Mail: [jdaniels@CP.Duluth,MN.US](mailto:jdaniels@CP.Duluth,MN.US)

MAY 1-2

**AL - BIRMINGHAM** - Convention. Zamora Temple, off I-459 E. Birmingham ARC, Glenn Glass, 205-681-5019. Don Morgan KB4MDI, 205-822-5242. E-Mail: [kb4mdi@scott.net](mailto:kb4mdi@scott.net)  
Web: <http://bro.net/barc/fest.html>

**IL - ELGIN** - CoFest. Elgin Plaza Hotel, 345 W. River Rd. The Glenside County Computer Club, Tony Podraza, 847-428-3576.  
E-Mail: [tonypodraza@juno.com](mailto:tonypodraza@juno.com)  
Web: <http://members.aol.com/clubbbs/glenside>

**NJ - EDISON** - Trenton Computer Festival. NJ Convention Center, Raritan Center, Sat: 9am-5pm, Sun: 9am-4pm. KGP Productions, Inc., Marlin Light, 1-800-631-0062. E-Mail: [kpg@mail.com](mailto:kpg@mail.com)  
Web: [www.tcf-nj.org](http://www.tcf-nj.org)

**TX - ABILENE** - West Texas Section Convention. Key City ARC, Peggy Richard KA4UPA, 915-672-8889. E-Mail: [jimr@swconnect.net](mailto:jimr@swconnect.net)  
Web: <http://www.westex.net/kcarr/hamfest.html>

MAY 2

**IL - DECATUR** - Hamfest. Cenois ARC, Tracy Ruble N9VIM, 217-423-0314.  
E-Mail: [n9vim@springnet1.com](mailto:n9vim@springnet1.com)  
Web: <http://members.tripod.com/StormBlazer/>

**IL - SANDWICH** - Hamfest. Kishwaukee ARC, Bob Yurs W9ICU, 815-895-3219.  
E-Mail: [w9icu@tbcnet.com](mailto:w9icu@tbcnet.com)  
Web: <http://tbcnet.com/~jleonard/hamfest.htm>

**MD - HAGERSTOWN** - Hamfest. Community College, Athletic and Recreation Bldg. 8am-3pm. Talk-in: 147.090+. The Antietam Radio Assn., Tina Jones KB8ZQM, 304-728-7769. Fax: 304-728-3024. E-Mail: [kb8zqm@intrepid.net](mailto:kb8zqm@intrepid.net)  
Web: <http://www.erols.com/njlong61/ara>

**NY - YONKERS** - Flea Market. Lincoln High School, Kneeland Ave. 9am-3pm. VE Exams. Talk-in: 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

**PA - WASHINGTON** - WACOM "Swap 'N Shop." Washington County Fairgrounds, 4H Bldg. 8am-1pm. VE Exams. Talk-in: 145.490. Washington Amateur Communications, Jim Burtoft KC3HW, 724-228-0546

**PA - WRIGHTSTOWN** - Hamfest. Middletown Grange Fairgrounds, Penns Park Rd. 7am. VE Exams. Talk-in: 147.69/09 repeater & 146.52 simplex. Warmister ARC, John D'Onofrio 215-675-9165. Tony Simek N3YNH, 215-674-5218.  
E-Mail: [tsimek@aol.com](mailto:tsimek@aol.com)

# 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 Princland Court  
Corona, CA 91719  
Phone 909-371-8497  
Fax 909-371-3052  
E-mail [events@nutsvolts.com](mailto:events@nutsvolts.com)

**WV - RIPLEY** - Hamfest. Jackson County ARC, Gary Casto AQBRY, 304-372-2849

MAY 7-8

**NH - ROCHESTER** - Hamfest. Hosstraders, Joe Demaso K1RQG, 207-469-3492

MAY 8

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

**CA - KINGSBURG** - Hamfest. Fresno ARC, Pat Pennacy W6YEP, 559-222-3105

**CO - GRAND JUNCTION** - Hamfest. Western Colorado ARC, David Hagopian KD6RA, 970-256-0096. E-Mail: [dwhag@it2.net](mailto:dwhag@it2.net)

**KY - DAWSON SPRINGS** - Hamfest. Curt Beshear KE4UZE, 502-797-9117.  
E-Mail: [ke4uze@juno.com](mailto:ke4uze@juno.com)

**OK - MCALESTER** - Lake Eufaula Hamfest. John Petersen KM5ES, 918-452-2279.  
E-Mail: [km5es@cwis.net](mailto:km5es@cwis.net)

**SC - ANDERSON** - Hamfest. Anderson County Fairgrounds, Hwy. 29 Business. Talk-in: 146.610. Blue Ridge ARS, Robert G. Watson W4RGW, E-Mail: [w4rgw@backroads.net](mailto:w4rgw@backroads.net)  
Web: <http://www.brars.org>

**TX - CHICOTA** - Hamfest. Red River Valley ARC, & ARS of Lamar County, Don Honsinger KB5MJS, 903-732-3290.  
E-Mail: [honsinger@neto.com](mailto:honsinger@neto.com)

**WA - STANWOOD** - Hamfest. Stanwood-Camano ARC, John McCann N7MZ, 360-629-2921. E-Mail: [huppert@whidbey.net](mailto:huppert@whidbey.net)

**WI - MANTOWOC** - Hamfest. County Expo Center, County Hwy. R. 8am-12pm. VE Exams. Talk-in: 146.01/61. Mancorad RC, Red 920-684-3733, Fred 920-682-9312

MAY 10

**MA - GREENFIELD** - Hamfest. Franklin County ARC, Richard Strycharz KD1XP, 413-665-2211.  
E-Mail: [kd1xp@ar1.net](mailto:kd1xp@ar1.net)  
Web: <http://www.shaysnet.com/~fcarc>

MAY 14-15-16

**OH - DAYTON** - Hamfest. Hara Arena. Dayton ARA, Dick Miller N8CBQ, 937-427-3109.  
E-Mail: [chair@hamvention.org](mailto:chair@hamvention.org)  
Web: <http://www.hamvention.org>

MAY 15

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

**CANADA - ONTARIO - ETOBICOKE** - Hamfest. Skywide ARC, Murray Smith VA3KTL, 416-621-1233. E-Mail: [murray.smith3@sympatico.ca](mailto:murray.smith3@sympatico.ca)

**GA - STATESBORO** - Hamfest. Statesboro ARS, Martin Holzman WB4MOG, 912-764-5959.  
E-Mail: [mart@bulloch.edu](mailto:mart@bulloch.edu)

**ID - CALDWELL** - Hamfest. Snake River ARC, Don Ingram KB7UJK, 208-459-2459.  
E-Mail: [ingramde@cyberhighway.net](mailto:ingramde@cyberhighway.net)

**NC - GREENVILLE** - Hamfest. East Carolina Antique Radio Club, Herman Schnur K4CTG, 252-752-2264

**RI - FORESTDALE** - Hamfest, Flea Market, and Auction. VFW, Rt. 146. Rhode Island Amateur FM Repeater Service, Rick Fairweather K1KYL, 401-725-7507. E-Mail: [sk1kyl@juno.com](mailto:sk1kyl@juno.com)

**TN - CLARKSVILLE** - Hamfest. Clarksville Amateur Transmitting Society, Hank Koebler N3ORX, 931-645-5206. E-Mail: [n3orx@ar1.net](mailto:n3orx@ar1.net)

MAY 16

**MA - CAMBRIDGE** - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XMR PL 114.8 (2A), Nick

## COMPUTER SHOWS

**AGI Shows**, 317-299-8827.  
E-Mail: [info@agishows.com](mailto:info@agishows.com)  
<http://www.agishows.com>

**Blue Star Productions**  
612-838-1901  
<http://www.supercomputersale.com>

**Computers And You**, 734-283-1754.  
[www.a1-supercomputersales.com](http://www.a1-supercomputersales.com)

**Computer Central Shows**  
847-412-1900 & 1-888-296-6066.  
E-Mail: [compcent@megsnet.net](mailto:compcent@megsnet.net)  
[www.computercentralshows.com](http://www.computercentralshows.com)

**Five Star Productions**  
810-890-0988. E-Mail: [jeff@fivestar.com](mailto:jeff@fivestar.com)  
[www.fivestars.com](http://www.fivestars.com)

**Georgia Mountain Productions**  
706-838-4827.  
E-Mail: [gamtinfo@blrg.tds.net](mailto:gamtinfo@blrg.tds.net)  
[georgiamountain.com](http://georgiamountain.com)

**Gibraltar Trade Center, Inc.**  
734-287-2000. Taylor, MI.

Altenbernd KA1MQX, 617-253-3776 (9-5). Web: <http://web.mit.edu/w1mx/www/swapfest.html>

MAY 22

**NH - LONDONDERRY** - Hamfest. Londonderry Lions Club, Mammoth Rd. Rt. 128. 8am-1pm. The Interstate Repeater Society ARC, Paul KILL 603-432-1538. E-Mail: [k1llx@juno.com](mailto:k1llx@juno.com)

**PA - WINFIELD** - Hamfest. Milton ARC, Ray Grant K3COD, 570-568-1727. E-Mail: [rgrant@csrlink.net](mailto:rgrant@csrlink.net)

MAY 22-23

**WA - YAKIMA** - WA State Convention. Yakima ARC, C. Jo Whitney KA7LJQ, 509-965-3379.  
E-Mail: [kb7hdx@telestar.com](mailto:kb7hdx@telestar.com)  
Web: <http://eagle.ykm.com/~w7aq/hamfest.html>

MAY 23

**CA - SACRAMENTO** - Hamfest. North Hills RC, Earl Mead K6ESM, 916-331-1115.  
E-Mail: [nhrcc@k6is.org](mailto:nhrcc@k6is.org) Web: <http://www.k6is.org>

MAY 29

**CANADA - MANITOBA - WINNIPEG** - Hamfest. Winnipeg ARC, Ed Henderson VE4YU, 204-694-0667. E-Mail: [edve4yu@pangea.ca](mailto:edve4yu@pangea.ca)

**CT - VERNON** - Hamfest. Natchaug ARC, Wayne Ryehling N1GUS, 860-487-1921.  
E-Mail: [warych@neca.com](mailto:warych@neca.com)

**NC - DURHAM** - Hamfest. Durham FM Assn., Joseph Fields KF4QYV, 919-596-3738.  
E-Mail: [dfma@vramp.net](mailto:dfma@vramp.net)

**NY - PLATTSBURGH** - Hamfest. Champlain Valley ARC, Bernhard Jakobetz KC2ALG, 518-643-9657

MAY 29-30

**WY - CASPER** - State Convention. Casper ARC, Warren "Rev" Morton W5TW, 307-235-2799 (H), 307-237-9301 (W). E-Mail: [mortonwg@aol.com](mailto:mortonwg@aol.com)  
Web: <http://w3.trib.com/~carc/hamfest.html>

MAY 30

**CA - SANTA ANA** - Swapmeet. ACP parking lot. Marry Russo 714-558-8813  
**CANADA - QUEBEC - SOREL-TRACY** -

**Gibraltar Trade Center, Inc.**  
810-465-6440. Mt. Clemens, MI.

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1-800-631-0062, 732-297-2526.  
E-Mail: [kpg@mail.com](mailto:kpg@mail.com)

**MarketPro, Inc.**, 201-825-2229  
<http://www.marketpro.com>

**MarketPro, Inc.**, 301-984-0880.  
E-Mail: [md@marketpro.com](mailto:md@marketpro.com)  
<http://marketpro.com>

**Narisaam Computer Show**  
770-663-0983.  
E-Mail: [narisaam@aol.com](mailto:narisaam@aol.com)  
Web: <http://www.showsale.com>

**Northern Computer Shows**  
978-744-8440  
E-Mail: [inquiries@ncshows.com](mailto:inquiries@ncshows.com)  
Web: [ncshows.com](http://ncshows.com)

**Peter Trapp Computer Shows**, 603-272-5008. Web: [www.petertrapp.com](http://www.petertrapp.com)

Hamfest. Le Club RA, Jean Gadoury VE2UL, 450-836-3072. Fax: 450-836-6252.  
E-Mail: [alaing@autray.net](mailto:alaing@autray.net)

**OH - HILLIARD** - Franklin County Hamfest. Franklin County Fairgrounds. 8am. Chris Lind KC8BUO, 614-267-7779. Fax: 614-263-7934.  
E-Mail: [FKLN-CNTY-HFST@prodigy.com](mailto:FKLN-CNTY-HFST@prodigy.com)

**MD - WEST FRIENDSHIP** - Memorial Day Hamfest. Howard County Fairgrounds, Rt. 144 (1 mi W of Rt. 32, S of I-70). 8am-2:30pm. Talk-in: 146.76 & 224.76 & 444.00. Maryland FM Assn., Craig WA3TID, 410-987-6042.  
E-Mail: [K3HH@compuserve.com](mailto:K3HH@compuserve.com)

## JUNE 1999

JUNE 3-4-5

**IN - INDIANAPOLIS** - Antique Radio Swapmeet, Auction, Seminar. Indiana Historical Radio Society & Antique Wireless Assn., Herman Gross, 765-459-8308. E-Mail: [w9itt@juno.com](mailto:w9itt@juno.com)

JUNE 4-5

**NE - SOUTH SIOUX CITY** - Iowa State Convention. 3900 Club & Sooland ARA, Mike Nickolaus NF0N, 402-494-6070.  
E-Mail: [nf0n@avalon.net](mailto:nf0n@avalon.net)  
Web: <http://www.pionet.net/~k0brd/hamboree/>

JUNE 4-5-6

**NY - ROCHESTER** - Atlantic Division & NY State Convention. Monroe County Fairgrounds. Fri: 12pm-5:30pm, Sat: 8:30am-5:30pm, Sun: 8:30am-1:30pm. Harold Smith K2HC, 716-424-7184. Fax: 716-424-7130. E-Mail: [rochfst@frontier.net](mailto:rochfst@frontier.net) Web: <http://www.rochesterhamfest.org>

JUNE 5

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

**IL - SPRINGFIELD** - Hamfest. Illinois State Fairgrounds. 8am-1pm (Flea 6am). VE Exams. Talk-in: 146.685 (-). Sangamon Valley RC, Ed Gaffney KA9ETP, 217-628-3697. E-Mail: [egaffney@fgi.net](mailto:egaffney@fgi.net) Web: <http://www.skylight1.com/svrc/>



# Events CALENDAR

**ME - HERMON** - Hamfest. Hermon High School. 8am-1pm. VE Exams. Talk-in: 146.34/94, 146.52. Pine State ARC, Roger Dole KA1TKS, 207-848-3846. E-Mail: dolerw@juno.com

**MI - GRAND RAPIDS** - Hamfest. Hudsonville Fairgrounds. VE Exams. Talk-in: 147.160 link repeater system. Independent Repeater Assn., Kathy KB8KZH, 616-698-6627 4-7pm.

**MN - ST. PAUL** - Hamfest. TwinsLan ARC, Ann Foster NOLL, 612-706-1761. E-Mail: tailgate@twinslan.org

**Web: http://www.twinslan.org/tailgate.html**

**MO - HOUSTON** - Hamfest. Ozark Mountain Repeater Group, Bob Simpson N0NTC, 417-967-3535. E-Mail: n0ntc@train.missouri.org

**NJ - TEANECK** - Hamfest. Bergen ARA, Jim Joyce K2ZO, 201-664-6725. E-Mail: jjoyce@cybernet.net

**Web: http://www.bara.org**

## JUNE 5-6

**GA - MARIETTA** - Hamfest. Jim Miller Park. Atlanta Radio Club, Ben Dasher KE4YXZ, 404-869-6959. E-Mail: bendasher@mindspring.com

**Charles Golsen N4TZM, 404-252-3303 or 404-688-6278.**

**E-Mail: cgolsen@atlanta.com**

**Web: http://www.saf.com/arc**

**NE - CHADRON** - Hamfest. Hamfest. Ridge ARC, Lynn Bilyeu K0ODF, 308-432-2297. E-Mail: lynnbb@bbc.net

**OR - SEASIDE** - SEAPAC NW Division Ham Convention, Seaside Convention Center, 1st St. VE Exams. Talk-in: 146.66 (-). Oregon Tualatin Valley ARC, Al Berg W7SIC, 503-640-5456; Randy Stinson K2ZT, 503-297-1175.

**E-Mail: rastinson@att.net**

**Web: http://www.otvarc.org/events/hamfairs/seapac/index.htm**

## JUNE 6

**CT - NEWINGTON** - Flea Market. Newington High School, Willard Ave. (Rt. 173), 9am-1pm. FCC Exams. Talk-in: 145.45 & 146.52 simplex & 224.84, 443.05. Newington AR League, John Disarro KA1HQK, 860-666-8569; Joe Bottiglieri AA1GW, 860-666-9692. E-Mail: aalgw@aol.net

**IL - PRINCETON** - Hamfest. Starved Rock RC, Frank Carraro KF9NZ, 815-856-3773. E-Mail: w9mks@qsl.net

**Web: http://www.qsl.net/w9mks/**

**IN - WABASH** - Hamfest. Wabash County 4-H Fairgrounds, SR 13N, 6am. Talk-in: 147.03/147.63 & 442.325/447.325. Wabash County ARC, Ralph Frank, 219-563-8487 (O), 219-563-8489 (Fax), 765-833-7372 (H). E-Mail: wial@netusa.net

**Web: www.netusa.net/~qrziota/**

**NY - QUEENS** - Hamfest. Hall of Science parking lot, Flushing Meadow Park, Corona, 47-01 11th St. 9am-3pm. Talk-in: 444.200 repeat, PL 136.5, 146.52 simplex. Hall of Science ARC, Stephen Greenbaum WB2KDG, 718-898-5599.

**E-Mail: WB2KDG@Bigfoot.com**

**OH - MEDINA** - Hamfest. County Fairgrounds, Community Center, 735 Lafayette Rd. 8am-3pm. Talk-in: 147.630 in, 147.030 out. Medina 2 Meter Group, Mike Rubaszewski N8TZY, 330-273-1519.

**E-Mail: m2mgroupp@aol.com**

**Web: http://members.aol.com/m2mgroupp**

**PA - BUTLER** - BreezeShooters Hamfest. Butler Farm Show Grounds, Rt. 68. 8am-4pm. Talk-in: 147.96/36. BreezeShooters ARC, H. Rey Whanger W3BIS, 412-828-9383.

**E-Mail: w3bis@freeweb.com**

**Web: http://breezeShooters.net**

**VA - MANASSAS** - Hamfest. Prince William County Fairgrounds, 1/2 mi S on Rt. 234. Talk-in: 146.97 (-) & 224.660 (-). Ole Virginia Hams ARC, Jack N4YIC, 703-335-9139. E-Mail: patnjack@erols.com; Mary Lu Blasdel KB4EFP, 703-369-2877.

**E-Mail: mblasdel1638@aol.com**

## JUNE 11-12

**GA - ALBANY** - Convention. Albany ARC, Ricky McCrary KD4OZR, 912-438-9714.

**E-Mail: mccrary@plantel.net**

**Web: http://www.isoc.net/aarc**

**TX - ARLINGTON** - Convention. HAMCOM, Jim Haynie W5JPB, 214-351-3271.

E-Mail: jimhaynie@aol.com

## JUNE 11-12-13

**WA - DRYDEN** - Wenatchee Hamfest. Apple City ARC, Roger Eckhardt WB7SHL, 509-782-4977. E-Mail: dmekhardt@juno.com

**Web: http://www.qsl.net/w7td**

## JUNE 12

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

**CANADA - ONTARIO - FERGUS** - Hamfest. Guelph & Kitchener-Waterloo ARCs, Bill Smith VE3WHS, 519-821-6642.

**E-Mail: smith.ve3whs@sympatico.ca**

Web: http://www.kwarc.org/fleamarket

**CT - GOSHEN** - Hamfest. Fairgrounds, Rt. 63. Southern Berkshire ARC, Lee Collins K1LEE, 860-435-0051. E-Mail: collins@li.com

**ID - COEUR D'ALENE** - Hamfest. Kootenai ARS, Jim Monroe, 208-667-4915. E-Mail: jimmonroe@dm.net

**MA - FALMOUTH** - Hamfest. Falmouth ARA, Ralph Swenson N1YHS, 508-548-6405. E-Mail: depsher911@aol.com

**Web: http://www.falara.org**

**MO - MACON** - North Central MO Hamfest. Macon County ARC, Dale Bagley K0KY, 660-385-3629. E-Mail: dbagley1@istmacon.net or kfoster@istmacon.net

**Web: http://www.istmacon.net/~kfoster/hamfest.htm**

**NC - WINSTON-SALEM** - Winston-Salem Classic

Hamfest. Dixie Classic Fairgrounds. 7am-1pm. Talk-in: 146.64 (-) & 145.47 (-). Forsyth ARC, Tom Gallagher N4IOZ, 336-723-7388.

**E-Mail: n4ioz@ibm.net**

**Web: http://members.xoom.com/w4nc/Hamfest.htm**

**PA - BLOOMSBURG** - Convention. Columbia-Montour ARC, Dave Schack WC3A, 717-752-6851. E-Mail: kev17815@epix.net

**Web: http://www.bafn.org/~cmarc**

## JUNE 12-13

**NH - LANCASTER** - Hamfest. Lancaster Fairgrounds, Rt. 3 North. 9am. VE Exams. Talk-in: 145.430 & 145.150 & 147.315. Moose Swappers, Russ Boyce N1YZE, 603-922-5514.

**E-Mail: cusvt@together.net**



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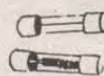
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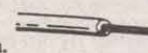
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# Events CALENDAR

JUNE 13

**IL - WHEATON** - Hamfest. DuPage County Fairgrounds, 2015 Manchester Rd. (N of Roosevelt Rd. (Rt. 38), E of County Farm Rd.). VE Exams. Talk-in: 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. E-Mail: WA9RIJ@MC.NET  
Web: <http://cyberconnect.com/orion/smc.html>  
**KY - INDEPENDENCE** - Ham-O-Rama '99. Summit View Middle School, 5002 Madison Pike (KY 17) 8am-3pm. Talk-in: 147.255+ or 147.375+ repeaters. Northern KY ARC, Robert Blocher N8JMV, 513-797-7252. E-Mail: nkarc@juno.com  
**NY - BETHPAGE** - Long Island Hamfair.

Briarcliffe College, 1055 Stewart Ave. 8:30am-2pm. VE Exams. Talk-in: W2VL 146.85 repeater (136.5PL). Long Island Mobile ARC, Rich N2WJL, 516-520-9311. E-Mail: hamfest@limarc.org  
Web: <http://www.limarc.org>  
**OH - AKRON** - Hamfest. Goodyear ARC, Robert J. Taylor KB8ZEC, 330-836-3282. E-Mail: rtaylor@akron.rr.net  
**TN - KNOXVILLE** - Hamfest & TN State Convention. National Guard Armory, 3330 Sutherland Ave. 9am-4pm. VE Exams. Talk-in: W4BBB 147.30 (+) & 224.50 (-) & 444.575 (+). Radio Amateur Club of Knoxville, David Bower K4PZT, 423-974-5064 (W), 423-670-1503 (H). E-Mail: rack@kornet.org or d.bower@ieee.org  
Web: <http://www.kornet.org/rack>

JUNE 19

**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052  
**CANADA - BC - KELOWNA** - Hamfest. Orchard City ARC, 250-766-2179. E-Mail: ve7kng@rac.ca  
Web: <http://www.okanagan.net/ocarc>  
**CANADA - ONTARIO - MARMORA** - Hamfest. Tri-County ARC, Paul Davidson VE3UJM, 613-472-3449. Pete Blakely VA3PGB, 613-473-1171. E-Mail: rhobson@bvl.igs.net  
Web: <http://www.redden.on.ca/~tcarc/tricity.htm>  
**MI - MIDLAND** - Hamfest. Midland County Fairgrounds, Gerstaecker Fair Center. 8am-1pm. VE Exams. Talk-in: 147.00 (+) (WBKEA repeater). Midland ARC, Del Lafavor WB8FYR, 517-636-

5097 (w), 517-689-3477 (h).  
E-Mail: lafaveord@aol.com Web: <http://www.qsl.net/w8kea/MARC5WAP.htm>  
**NJ - DUNELLEN** - Hamfest. Columbia Park, near Rt. 529 & Rt. 28 intersection. 7am-2pm. Talk-in: 146.025/625 & 146.52 simplex. Raritan Valley RAC, Bob Pearson WB2CVL, 732-846-2056 or Fred Werner KB2HZO, 732-968-7789 before 8pm. Web: <http://www.w2qgw.org>  
**OH - MILFORD** - Hamfest. Milford ARC, Chris Reinfelder KB8SNH, 513-753-5066. E-Mail: RAC.Reinfelder@FUSE.NET  
**WV - BLUEFIELD** - Hamfest. Brushfork Arm. East River ARC, Don Williams WA4K, 540-326-3338

JUNE 20

**CA - ORCUTT** - Santa Maria Hamfest. Satellite ARC, Eric Lemmon WB6FLY, 805-733-4416. E-Mail: wb6fly@impulse.net  
**IN - CROWN POINT** - Dad's Day Hamfest. Lake County Fairgrounds. 8am. VE Exams. Talk-in: 147.00, 146.52 & 442.075. Lake County ARC, Malcolm Lunsford W9MAL, 219-769-3925 (ph) or 815-361-1913 (fax). E-Mail: w9mal@cris.com  
**MA - CAMBRIDGE** - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: <http://web.mit.edu/w1xm/www/swapfest.html>  
**MD - FREDERICK** - Father's Day Hamfest. Frederick County Fairgrounds, 797 E. Patrick St. 8am-3pm. VE Exams. Talk-in: K3ERM 146.640 (-) & 147.060 (+) & 146.52 simplex. Frederick ARC, 301-695-2633 code: 6393  
**MI - MONROE** - Hamfest. Monroe County Fairgrounds, Monroe County Radio Communications Assn., Fred VanDaele KA8EBI, 734-587-7165 days or 734-242-9487 eves.  
**OH - MACEDONIA** - Hamfest. Cuyahoga ARS, Rich James N8FIL, 1-800-404-2282. Web: <http://www.cars.org>

JULY 1999

JULY 3

**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052  
**KY - TOMPKINSVILLE** - Hamfest. Monroe County ARC, David Welch KA4PL, 502-678-5784. Web: <http://monroecar.hypermart.net>  
**NC - SALISBURY** - Hamfest. Firecracker Hamfest. Civic Center. Rowan ARS, Ralph Brown WB4AQK, 704-636-5902. E-Mail: rbrown@salisbury.net  
Web: <http://home.interpath.net/kk4lh/hamfest>  
**PA - LEHMAN** - Wilkes-Barre Hamfest. Luzerne County Fairgrounds, Rte. 118 (I-81 Exit 47B to Rt. 309 to Rt. 415 to Rt. 118). 8am. FCC Exams. Talk-in: 146.52 & 146.61. Murgas ARC, Stan Perry KE3TC, 570-735-2385. E-Mail: slperry@epix.net - Bob N3FA, 570-288-3532

JULY 4

**PA - BRESSLER** - Firecracker Hamfest. Emerick Cibort Park, Penn St. 8am. VE Exams. Talk-in: 146.16/76 & 146.52 simplex. Harrisburg RAC, Richard Bordner W3NJB, 717-939-4825. E-Mail: n3njb@aol.com

JULY 9-10-11

**CANADA - MANITOBA - BRANDON** - Hamfest. International Peace Garden, Dave Synal VE4XN, 204-728-2463. E-Mail: dsynal@mb.sympatico.ca

JULY 10

**CA - FONTANA** - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves  
**CANADA - ONTARIO - BURLINGTON** - Hamfest. Burlington ARC.  
**GA - GAINESVILLE** - Hamfest. Lanierland ARC, Ken Parrish KN4UQ, 770-867-9833. E-Mail: kn4uq@mindspring.com  
Web: <http://www.qsl.net/kc4oxp/index.htm>  
**IN - INDIANAPOLIS** - ARRL Central Division Convention, Rick Ogan N9LRR, 317-251-4407. E-Mail: ogan@in.net  
Web: <http://www.indyhamfest.com>  
**ME - UNION** - Hamfest. Fairgrounds, Pen-Bay ARC, Will Chadwick WC1W, 207-785-2739. E-Mail: wilchad@tidewater.net  
**MI - PETOSKEY** - Swap & Shop. Emmet County Fairgrounds, US 31, 2 blks W of 131. 8am-1pm. VE Exams. Talk-in: 146.68 (-). Straits Area RAC, Tom WB2LS, 616-539-8459; Dirk KG8JK, 616-348-5043. E-Mail: kg8jk@qsl.net  
**MO - KANSAS CITY** - Midwest Division Convention, Bob Roske WA0CLR, 816-436-0069. E-Mail: wa0clr@worldnet.att.net  
Web: <http://members.tripod.com/~PHDARA/>  
**NY - BATAVIA** - Hamfest. Genesee fairgrounds. 6am-3pm. Talk-in: W2RCX 147.285+. "Gram", Harold Hay, 716-343-2844. E-Mail: wa2baq@aol.com

Continued on page 61



## LEVITRON

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### ANIMAL SOUNDS PIANO KIT \$29.95

This project kit has ten keys for playing notes of the scale and eight buttons to select the sounds associated with each note. Select the piano mode and the kit will synthesize piano sounds for each key. OR select one of seven different animal voices including cat, dog, pig, bird, chicken, duck, and sheep. Old MacDonald never had a choir like this! The circuit features an auto power-off function, a demo mode, and easy step-by-step instructions. Requires 2 AA batteries not included.



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### BE A FLY ON THE WALL!!!

Well, actually, those little wings would look pretty stupid on you, but you can build a miniature "bug". Surface mount technology is the latest techno-buzz word, and a challenging new frontier for kit builders. The manufacturer understood that the first try might be a bit rough, so they included enough components to assemble two units. (so it is o.k. to lose or damage a SMT component!) With the entire FM broadcast band (from 88 - 108 MHz) for your receiver, and a transmit range of 300 feet, even James Bond would like this kit! This unit is powered by a 1.5 volt watch battery (included) and features an electret type high gain microphone for superior audio quality and extended pick up range - hear a whisper of 10 feet. A lot of fun in less than a square inch!!! Micro Size FM Wireless Transmitter Kit \$19.95

### PHOTON II MICROLIGHT

The popular photon microlight has been improved. These super-bright (better than 8 candellas!) LED lights are visible over a mile away. The LED is secured in a tough ABS case and offers a squeeze button for quick use, and a constant on slide switch for prolonged lighting needs. The lithium batteries last a very long time (10 year shelf life!) and are included. The light won't burn out because it is an LED! Specify your choice of five incredible bright colors. Great for home or office use, popular with fire and rescue professionals, pyrotechnicians, stage performers, and dimly lit restaurant patrons. PHOTON II microlights include a keyring and come in ruby red (\$13.50), amber yellow (\$13.50), orange (\$13.50), sapphire blue (\$17.50), turquoise (\$17.50), diamond white (\$17.50), and emerald green (\$17.50). Includes two replaceable 2016 lithium batteries.

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## Geophone

vibration sensing kit

Detect a fly stomping across the desk! Well maybe not that sensitive, but almost.

These vibration sensors made by Geosensor® were used in oil exploration to determine geological statistics. They are made with a magnet suspended in a coil and are very sensitive to vibration. Compact size, the unit measures approx. 1.6" high and 1.2" dia. The kit includes a geophone vibration sensor along with parts to build a basic detector that will light an LED. In addition we include a schematic that will show you how to operate a relay. The sensitivity is adjustable, so you can set it to detect elephants and other small creatures. Similar units were used by our armed forces to detect enemy troop movements...the perfect device to alert you to the pitter patter of little Leroy's feet! Unit sensitivity can be set high enough to detect a business card dropped on a table, and we've made it work with vibrations up to 40 feet away! Earthquake or Aunt Agatha...you decide! It's a fun gadget with many uses.

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### AMAZING MINI MICRO FM RADIO! \$7.50

Much lighter than a heavy jam box with really good sound! This tiny radio (1.5"x1.06"x0.38") has a seek button, reset control, and an on/off switch. Personal listening has never sounded better! Ideal for ballgames, studyhall, and workouts. Battery and nugget style earphones included.

### WALKING TRICERATOPS ROBOT KIT

Tyrannosaurus Rex never looked this cute! Triceratops toddles along powered by a small motor. The kit includes, motor, pre-cut wooden parts, assembled gear unit, hardware and instructions. Easy to assemble with ordinary tools. Only a hammer, screwdriver and long-nose pliers are needed.

Great fun for kids or grown-ups! \$ 12.95

### Lighted Screwdriver Supertool \$9.95

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# THE 'OPTO' IN OPTOELECTRONICS (Part 3)

The first two episodes of this mini-series described the basic nature and behavior of light and light-beam manipulators such as mirrors, prisms, and lenses, with particular regard to their use in modern optoelectronic systems.

This month's episode continues the 'light-beam manipulator' theme by describing the basic nature and behavior of modern fiber optic cables and systems.

## FIBER OPTICS

### INTRODUCTION

A fiber optic cable can, in very simple terms, be regarded as a hair-thin flexible light pipe or *optical waveguide* that can efficiently carry modulated or unmodulated light signals from one point to another (even if the journey involves bends and loops) with complete immunity from electromagnetic interference.

In most practical applications, the cable must be linked to the light source and destination points via special connectors, to minimize signal losses.

Figure 1 shows the basic elements of a simple one-channel, one-way fiber optic communication system, in which the output of the optogenerator LED is pulse-modulated and is coupled to the input of optosensor Q1 and its pulse-detecting unit via a length of sheathed fiber optic cable.

The Figure 1 circuit can send data from point A to point B, but not the other way around. Figure 2 shows a two-way (bidirectional) version of the above circuit. Here, signals can be sent from A to B via Tx unit 1, cable 1, and Rx unit 1, and from point B to point A via Tx unit 2, cable 2, and Rx unit 2. In practice, special two-core 'duplex' fiber optic cables are available for use in this type of application.

The Figure 1 and 2 circuits are designed for use in applications in which each fiber optic cable carries only a single data channel. If multi-channel operation is needed, the channels can be electronically multiplexed, or each channel can be superimposed in a high-frequency carrier wave in the manner of a normal radio or TV channel.

When the commercial possibilities of fiber optic cables were first postulated in the early 1960s, there was much speculation regarding the probable performance capabilities of such cables.

Visible light has, for example, a frequency spectrum ranging from 430,000MHz (700nm wavelength) to 750,000MHz (400nm wavelength), and it was presumed that fiber optic cables would have bandwidths that would easily cover this 320,000MHz spectrum, thus enabling them to handle up to 64,000 5MHz data channels.

In practice, modern fiber optic cables fall well short of this imagined ideal; many have real-life bandwidths of only a few hundred MHz, and can handle only a few dozen 5MHz data channels.

In spite of their limitations, fiber optic communication systems outperform conventional wire-connected systems in many important respects. They are immune to electromagnetic interference, are electrically fully isolated, are low in weight, offer high security, and (unlike copper wires) are made

from a cheap and very abundant raw material (silica).

### FIBER OPTIC PRINCIPLES

An optical fiber is a wire-like strand of high-purity glass or plastic in which the refractive index of the outer layer is lower than that of the inner core, thus endowing the fiber with the optical phenomenon of total internal reflection (as described in Part 2 of this series).

Figure 3 illustrates some elementary fiber optic operating principles and helps explain some basic fiber optic jargon. The main (a) part of the diagram shows a simple glass rod or 'light pipe' in which the glass has a refractive index of 1.5; light rays travel through this glass at a speed of 200 meters/ $\mu$ S.

Imagine in Figure 3 that a series of light-beam

**Ray Marston describes the basic nature and behavior of fiber optic cables and communication systems in this penultimate episode of the series.**

pulses are fed into the butt-end input of the glass rod via a focusing lens. The beam is made up of a vast number of photonic rays, which enter the butt-end input at a variety of angles of incidence. The diagram depicts the paths of four such rays, which travel in the following individual ways.

Ray A strikes the butt-end input of the glass rod at an angle of incidence of zero degrees, passes cleanly through the glass rod via the shortest possible route, and emerges from the rod's butt-end output after traveling through the

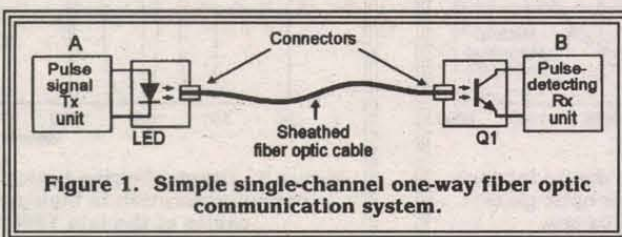


Figure 1. Simple single-channel one-way fiber optic communication system.

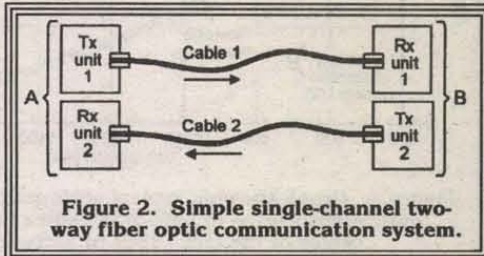
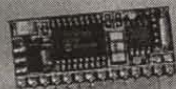


Figure 2. Simple single-channel two-way fiber optic communication system.

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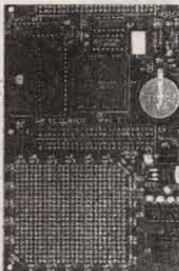
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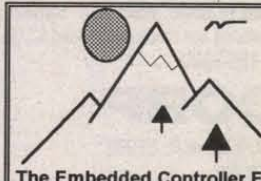
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rod at a mean speed of 200 meters/ $\mu$ S.

Ray B strikes the butt-end

input at a moderately sharp angle of incidence, is refracted to an angle of  $12^\circ$  on entering the glass

and, after traveling a fairly short distance, strikes the rod's upper glass-to-air boundary, where (because it arrives at a fairly shallow angle) it is subjected to the phenomena of total internal reflection (see Part 2 of this series), which reflects the ray downwards at an identical angle until it strikes the rod's lower glass-to-air boundary, from which it is reflected upwards again, and so on as the ray propagates its way along the rod until it eventually leaves its butt-end output.

The ray thus follows the repeatedly-reflected zig-zag course shown in the diagram; this beam travels a greater distance than ray A in its journey through the

glass rod, actually traveling through it at a mean horizontal speed of 195 meters/ $\mu$ S.

Ray C, on entering the rod, is refracted to an angle of  $22^\circ$  on entering the glass and then propagates its way along the tube in the same basic way as ray B, but does so at sharper reflective angles and thus takes even longer than ray B to complete its journey through the glass rod, actually traveling through it at a mean speed of 185 meters/ $\mu$ S.

Ray D strikes the butt-end input at a very sharp angle of incidence, is refracted to an angle of about  $60^\circ$  on entering the glass and, after traveling a short distance, strikes the rod's upper glass-to-air boundary, where (because it arrives at an angle greater than the critical angle of the boundary) it

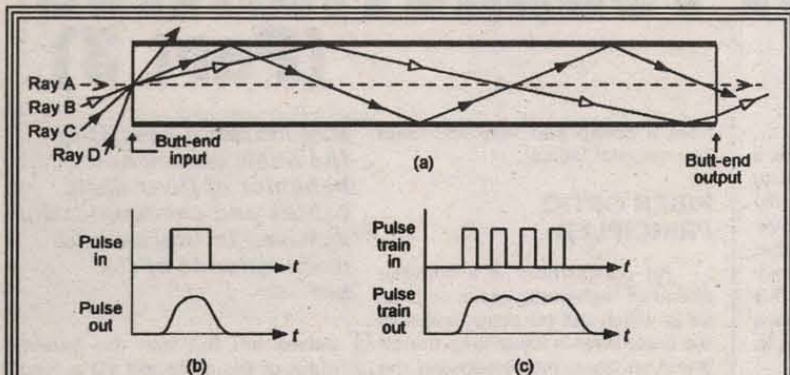


Figure 3. Diagram illustrating basic 'step index' fiber optic operating principles.

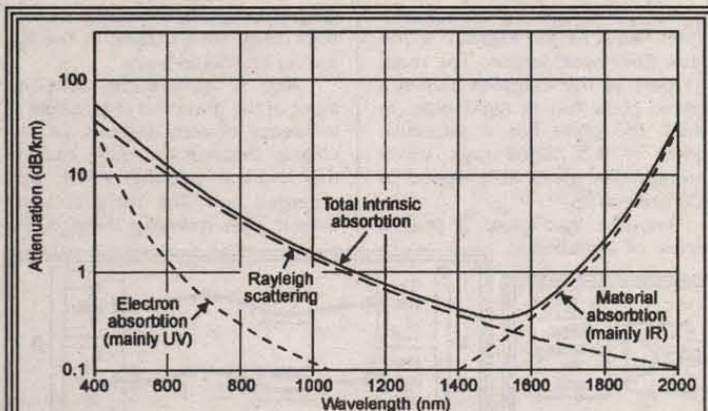


Figure 4. Graph showing typical attenuation due to intrinsic optical absorption in high-grade silica fiber optic glass cables of the late 1980s to early 1990s era.

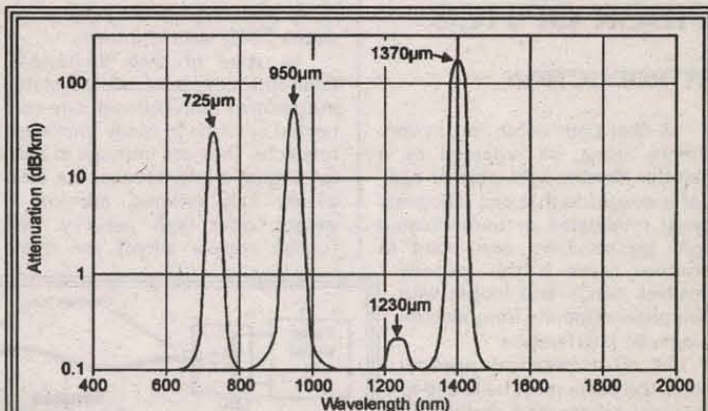
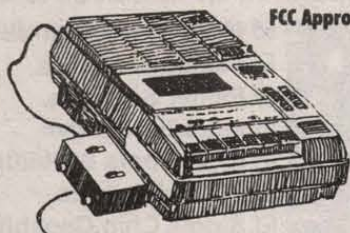


Figure 5. Graph showing typical attenuation due to extrinsic optical absorption in high-grade silica fiber optic glass cables of the late 1980s to early 1990s era.

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simply passes through the boundary and is dissipated into the air. This ray thus fails to propagate along the glass rod.

Note that Figure 3 depicts the fiber optic rod's operation in a simplified two-dimensional style, in which the rays simply bounce off of the internal top and bottom faces of the rod. In reality, rays travel three-dimensionally, bouncing off of the rod's top, side, and bottom faces, and thus tend to spin or skew as they travel along the rod.

### FIBER OPTIC JARGON

Various 'jargon' words and phrases are widely used in fiber optics and have meanings that can be explained with the aid of Figure 3, as follows.

**Step Index.** Fiber optic cable operation depends on the total internal reflection phenomenon that can occur at the points where a transparent material meets a material or substance with a refractive index lower than its own. In the Figure 3 example, the glass rod has a refractive index of 1.5, and the surrounding air has a refractive



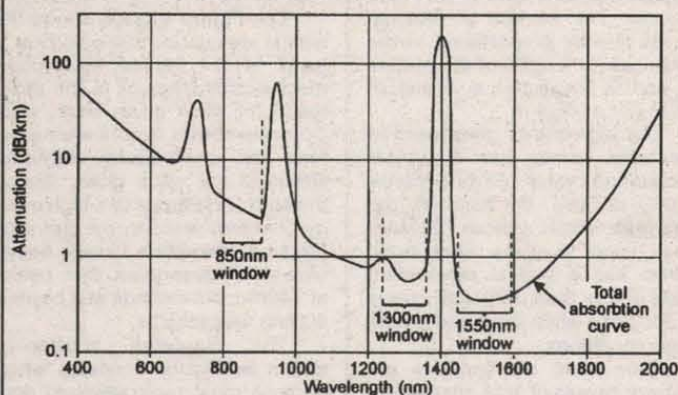


Figure 6. Graph showing typical attenuation due to all forms of optical absorption in high-grade silica fiber optic glass cables of the late 1980s to early 1990s era.

index of 1.0, and reflection can occur at the precise point where the ray meets the abrupt or *step* reduction of the refractive index. Cables of this type are called *step index* fiber optic cables. *Graded index* cables are also available, and are described later in this article.

**Maximum Acceptance Angle and Numerical Aperture.** Light rays will only propagate through a fiber optic cable if the input ray applied to the cable's butt-end input falls within a certain angular range.

In Figure 3, for example, rays A (arrival angle = 0°), B (24°), and C (45°) all propagate, but ray D (75°) does not propagate. The maximum input angle at which propagation will occur is called the cable's *maximum acceptance angle*, and is denoted by the symbol  $\alpha_M$ . This basic parameter is often expressed in sine form, in which case, it is called the cable's *numerical aperture (NA)*, and equals  $\sin \alpha_M$ . Thus, a cable with a maximum acceptance angle of 32° has a numerical aperture of 0.53.

**Operating mode.** In Figure 3, light rays can propagate along the glass rod at a variety of angles or 'operating modes.' Rays that propagate at steep reflective angles travel in *high-order mode*, and ones that propagate at shallow angles travel in *low-order mode*. Since the rays can travel in a variety of modes in this particular fiber optic rod, it is called a *multi-mode* or *MM* device. Some fiber optic cables can operate in only a single mode, and are called *single mode* (SM) or *monomode* devices.

**Modal Dispersion.** When light rays propagate through a step index multi-mode fiber optic cable or rod, their speed of linear travel depends on their angular operating mode. High-order mode rays travel at lower linear speeds than

low-order ones. In the Figure 3 diagram, for example, ray A travels at a linear speed of 200 meters/ $\mu$ S and takes 5nS to travel one-meter; the slowest (highest-order) ray that can propagate through this particular rod travels at 141 meters/ $\mu$ S and takes 7.1nS to travel one-meter. Consequently, if a very fast sharp-edged light pulse is fed to the input of the Figure 3 fiber optic rod, the individual photonic rays representing its leading or trailing edge at the rod's output are spread over a 2.1nS time spread in a one-meter rod, or 21nS in a 10-meter rod, and so on.

This 'spreading' is called *modal dispersion* and produces a degraded (blurred) output pulse, as shown in Figure 3(b). Similarly, if a train of ultra-fast pulses are fed through the rod, modal dispersion

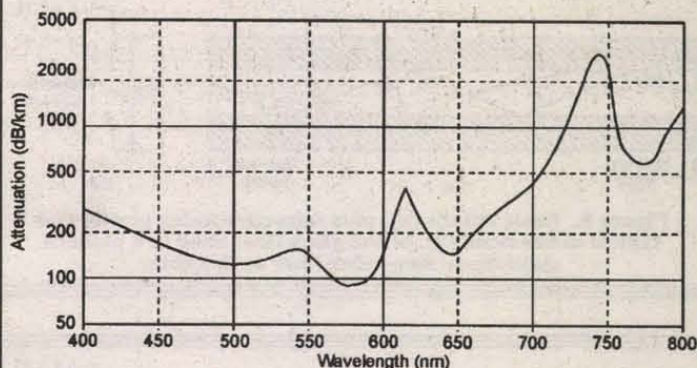


Figure 7. Graph showing typical attenuation due to all forms of optical absorption in modern plastic polymer fiber optic cable.

may degrade them into the form of a single pulse, as shown in Figure 3(c).

Modal dispersion is the major factor that limits the maximum pulse-operating rates (frequencies) of fiber optic cable, and is determined both by the design and the length of the cable. Cables with low modal dispersion figures offer higher maximum pulse operating rates than ones with high modal dispersion figures.

**Material Dispersion.** The speed at which light travels through a fiber optic material depends upon the material's refractive index, and this varies with the light's wavelength. All real-life light sources have finite spectral bandwidths, and their different component wavelengths thus trav-

el through the material at different speeds; such light thus undergoes spectral dispersion (spreading) as it travels through the fiber.

This phenomenon is known as *material dispersion*, and — like modal dispersion — limits the maximum pulse-operating rates of fiber optic cable. Its degrading effects are directly proportional to the light source's spectral bandwidth, but are normally small compared to those caused by modal dispersion. Material dispersion can typically be reduced by a factor of about 200 by using a laser diode, rather than a normal LED, as the light source that feeds signals into the fiber optic cable.

**Attenuation.** When light passes through any translucent glass or plastic material, its power is

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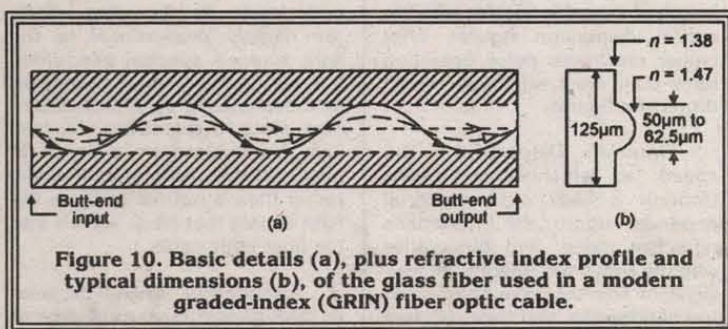
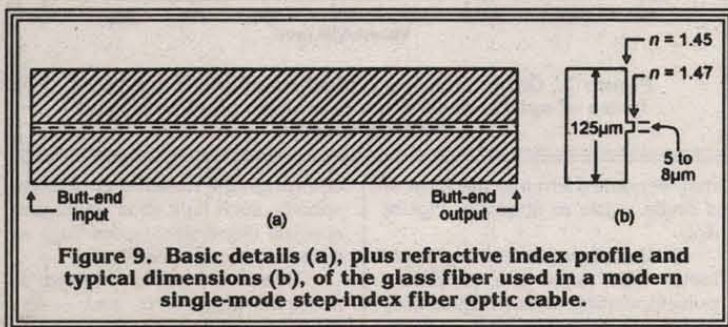
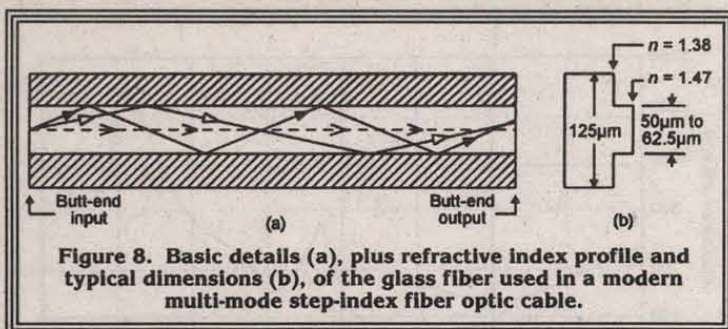
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inevitably attenuated in the process. The amount of attenuation is directly proportional to the thickness (or length) of the material, and is measured in terms of dB/meter or dB/km.

The high-quality glass used in spectacle lenses has a typical attenuation value of 6dB/meter (6,000 dB/km). By contrast, the ultra-pure silica (silicon dioxide) glass used in glass fiber optic cables has a typical attenuation value of less than 0.0013dB/meter (1.3dB/km) when used under optimum conditions.

Four basic mechanisms are primary causes of light attenuation in glass. Three of these (electron absorption, Rayleigh scattering, and material absorption) are *intrinsic absorption mechanisms* inherent in the basic nature of glass; the fourth mechanism (impurity absorption) is an *extrinsic absorption mechanism* caused by contamination (impurity) within the manufactured glass.

In ordinary glass, the extrinsic (impurity) absorption is the dominant mechanism in the basic attenuation process. In modern fiber optic cables, the impurities in the silica glass are reduced to the lowest commercially-viable levels, and this results in the type of attenuation graph shown in Figure 6 which, in turn, is derived by combining the intrinsic and extrinsic absorption graphs shown in Figures 4 and 5. Note that these particular graphs are based on typical cable of the late 1980s to early 1990s era, and that most modern cables give attenuation figures that are somewhat lower than those

shown.

The Figure 4 graph shows the typical attenuation that occurs as a result of the intrinsic absorption mechanisms inherent in the basic nature of silica glass. Here, *electron absorption* occurs when photons are absorbed by individual atoms in the silica glass, raising the atom's electrons to a high energy (excited) state in the process. Electron absorption causes heavy ultra-violet absorption that peaks at 140nm, but extends well beyond 400nm wavelengths.

The *Rayleigh scattering* shown in Figure 4 occurs when photons meet molecule-sized density irregularities in the glass and undergo shifts in their refraction angles. The consequent attenuation effects are severe when the photon's wavelength is similar to the dimension of the irregularity, but decline steadily as wavelength increases above 400nm.

The *material absorption* shown in Figure 4 occurs when photon energy is absorbed by the atomic/molecular bonds associated with the basic glass material, and causes heavy attenuation of infrared at wavelengths greater than 2000nm. The net result of the effects of the three intrinsic absorption mechanisms is that the optical attenuation of the glass is high (70dB/km) at 400nm, falls smoothly to a minimum value of about 0.4dB/km at 1500nm, and then rises rapidly again (because of material absorption) at longer wavelengths.

The Figure 5 graph shows the basic form of the attenuation that occurs as a result of extrinsic absorption mechanisms in most high-grade normal-quality silica fiber optic glass. These losses are caused primarily by the presence of hydroxyl (OH) ions in the glass, which result in three large peaks of absorption within the 400nm to 2000nm spectrum. The largest peak occurs at 1370nm, and the other two occur at 950nm and 725nm; a very minor additional peak occurs at 1230nm.

The Figure 6 graph shows the typical attenuation that occurs as a result of all intrinsic and extrinsic absorption mechanisms in high-grade normal-quality silica fiber optic glass. Important points to note from this particular graph are that attenuation is very high (greater than 10dB/km) over most of the visible-light (400nm to 700nm) spectrum and in various other areas, and that there are three 'window' areas in the infrared range (at 850nm, 1300nm, and 1550nm) at which attenuation figures attain local 'low' values. Practical glass fiber optic communication systems are nearly always operated within one or the other of these 'window' ranges.

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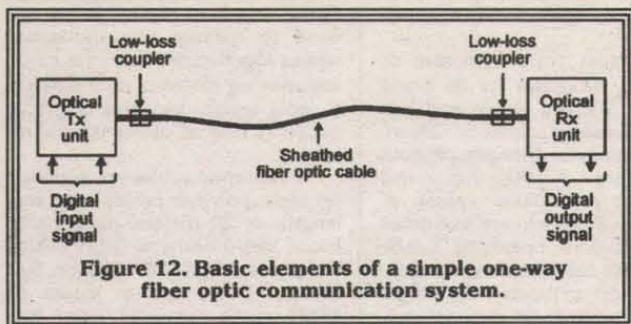


Figure 12. Basic elements of a simple one-way fiber optic communication system.

widely used type of fiber optic cable is made from silica glass and can only be correctly cut with a special tool. This type of cable is meant for use with IR light, primarily in medium- to long-haul (greater than 250 meters) communication and data-transfer systems. There is, however, an alternative and cheaper type of fiber optic cable; it is made from plastic polymer and can easily be cleanly cut with a sharp blade, and is best suited to use with visible red (rather than IR) light, in very-short-haul (up to 50 meters maximum) applications.

Figure 7 shows the typical attenuation graph of a modern polymer fiber optic cable. This particular cable gives a mean attenuation of about 200 dB/km (0.2dB/meter) when averaged over the full visible light spectrum, but about 1500 dB/km (1.5dB/meter) when used in the low infrared ranges.

## PRACTICAL FIBER OPTIC CABLE TYPES

The simple glass type of fiber optic rod or cable shown in Figure 3 is too crude to be of real practical value, since its internally-reflective glass-to-air junction is highly susceptible to external damage from scratches and contamination, and the very large differences between the refractive index values of its two media (about 1.5 for glass, 1.0 for air) give excessively large modal dispersion values.

All practical, modern, fiber optic cables are designed to give low values of modal dispersion, and use either a multi-mode or single-mode step-index form of construction, or a graded-index (GRIN) form of construction, as shown in Figures 8 to 10, which also show the basic refractive index ( $n$ ) profiles and typical dimensions of their 'glass type' fibers.

Each of these fibers has a solid core that is surrounded by a solid cladding with a refractive index value lower than that of the core; this cladding makes the cable's modal dispersion value immune to the effects of external surface scratches, etc. The outer core is further enclosed in an opaque primary outer sheath that provides further physical protection and immunity to optical interference.

Descriptions of the three basic cable types are given below; when reading these descriptions, remember that a human hair has a typical thickness of about 50 $\mu$ m, and note that fiber optic cable basic dimensions are conventionally notated in an 'a/b/c' or 'a/b' form, in which 'a' is the outside diameter of the fiber core in  $\mu$ m, 'b' is the outside diameter of the fiber cladding in  $\mu$ m, and 'c' is the outside diameter of the cable's primary outer sheath in  $\mu$ m. Thus, a 50/125/250 $\mu$ m cable uses a 50/125 $\mu$ m fiber that is protected by a 250 $\mu$ m-diameter primary sheath.

## MULTI-MODE STEP-INDEX CABLES

Figure 8 shows basic details of this type of fiber optic cable, in which a relatively thick core (typically 50 $\mu$ m or 62.5 $\mu$ m in glass fibers) is covered by a layer of cladding with a refractive index

value that is only a few percent lower than that of the core, thus giving the fiber's butt-end input a fairly narrow (typically 11° to 24° maximum) acceptance angle and

thus endowing the fiber with fairly low values of modal dispersion.

These characteristics and dimensions make it easy to couple optical signals into and out of this

Fiber Optic Cable Type	Fiber Dimensions	Operating Wavelengths	Maximum Operating Bandwidth	Maximum Data Rate (bits/sec/km)	Basic Description
Polymer multi-mode 'light pipe' cable	1mm/2.2mm	400 to 700nm (visible light range)	1MHz/km	500kb/s/km	Easy-to-use cable, for use in very-short-haul very-low-data-rate applications
Multi-mode step index, glass	50/125 $\mu$ m or 62.5/125 $\mu$ m	850nm 1300nm 1550nm	33MHz/km	16Mb/s/km	Used mainly in short-to medium-haul low-data-rate applications.
Graded-index (GRIN), glass	50/125 $\mu$ m or 62.5/125 $\mu$ m	850nm 1300nm 1550nm	0.5 to 1.0GHz/km	250Mb/s/km to 500Mb/s/km	Used mainly in short-to medium-haul high-data-rate applications.
Single-mode step index, glass	50/125 $\mu$ m or 62.5/125 $\mu$ m	850nm 1300nm 1550nm	Up to 10GHz/km	Up to 5Gb/s/km	Used mainly in medium- to long-haul very-high-data-rate applications

Figure 11. Table listing the main features of the four major types of fiber optic cable.

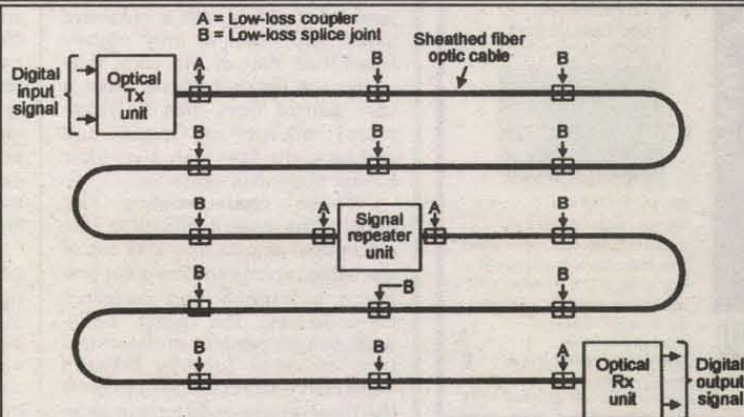
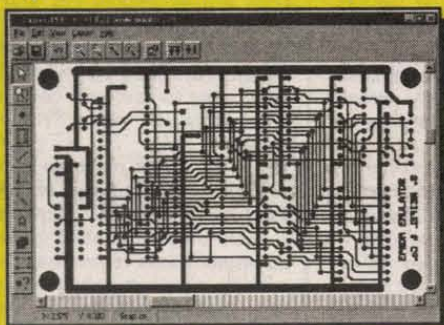


Figure 13. Basic elements of a long one-way fiber optic communication system using splice joints and signal repeaters.

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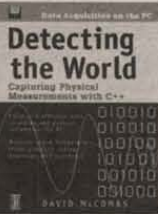
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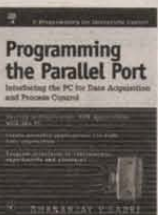
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type of cable. The most popular 'glass' versions of this cable have basic fiber dimensions of 50/125µm or 62.5/125µm. Typical bandwidth/length product values vary from 1MHz/km for plastic cables to 33MHz/km for glass types; these cables are thus used mainly in short- to medium-haul low-data-rate applications.

### SINGLE-MODE STEP-INDEX CABLES

Figure 9 shows basic details of a typical single-mode step-index fiber optic cable, in which a very thin (typically 5 to 8µm) glass core is covered by a relatively thick layer of cladding with a refractive index value that is only slightly lower than that of the core, thus giving the fiber's butt-end input a very narrow (less than 6° maximum) acceptance angle and endowing the fiber with a very low modal dispersion value.

These characteristics and dimensions make it difficult to couple optical signals into and out of the cable, which requires great precision in cutting and coupling. Nevertheless, the great bandwidth/length product values of this type of cable (usually between 1GHz/km and 10GHz/km) make it the most widely used type in long-haul high-data-rate applications.

### GRADED-INDEX (GRIN) CABLES

Figure 10 shows basic details of a 'GRIN' type of fiber optic cable. Here, the core has a refractive index value of about 1.47 along its central axis, but the value gradually diminishes (in 'graded' form) as the distance away from the central axis increases, until it falls to a minimum value of (say) 1.38. Photonic rays that arrive at the cable's butt-end input at fairly sharp angles of incidence are progressively refracted downwards and speeded up as they pass through successively-lower refractive index values, until they eventually arrive at a point where their angle of incidence is so shallow that total internal reflection occurs and the ray starts to travel back downwards again at ever increasing refractive angles and decreasing speeds, thus following the waveform pattern of a sinewave. This process continuously repeats as the ray propagates through the length of the cable.

The big point to note about the type of photonic wave-travel action described above is that it makes all photons travel through the cable at virtually identical mean linear speeds, irrespective of their angles of incidence at the cable's butt-end input. Thus, GRIN cable offers a very low modal dispersion value (typically 0.5nS/km), combined with fairly wide butt-end input

acceptance angles and great ease of use.

The most popular version of the cable is known by its trade name of 'Widoshii' cable and has fiber dimensions of 62.5/125µm. Typical bandwidth/length product values are 500MHz/km and 1GHz/km; attenuation values of less than 0.22dB/km are attainable under optimum operating conditions. GRIN cables are now widely used in short- to medium-haul high-data-rate commercial applications.

### FIBER OPTIC CABLE SUMMARY

The table shown in Figure 11 summarizes all of the above data. Note that polymer 'light pipe' cables are relatively 'big' multi-mode step-index devices that are quite easy to use and are thus popular with amateurs, experimenters, and occasional users of fiber optic cables, but have very severe operational (bandwidth and attenuation) limitations.

For most high-performance professional uses, glass multi-mode step-index or graded-index (GRIN) cables should be used. Single-mode step-index glass cables are very specialized devices, intended mainly for use in commercial very-high-performance medium- to long-haul applications.

### USING FIBER OPTIC CABLE

Figure 12 shows the basic elements that are used in a simple one-way fiber optic communication system. The transmitter (Tx) unit houses a pulse-driven light generator such as a LED or laser diode, which has its output fed into the butt-end input of the cable via a dedicated low-loss coupler.

At the other end of the cable, another low-loss coupler feeds the optical signal into a receiver (Rx) unit that houses a light sensor such as a PIN diode or phototransistor, plus appropriate signal conditioning circuitry.

It is important to note that the fiber optic communication system will only work efficiently if its cable ends are accurately cut and polished, to minimize attenuation losses, and if special low-loss signal couplers are used. Polymer cable is fairly easy to use, and can be cut reasonably well with a very sharp blade.

Glass cable must be cut and polished with the aid of special (and fairly expensive) equipment. A well made coupling gives an attenuation loss of less than 0.5dB; a badly made coupling may give very high attenuation or a complete failure to pass optical signals.

Figure 13 shows a long and more complex one-way fiber optic system that uses splice joints and

signal repeaters. Splice joints are used to cleanly join individual cables together, either in the initial cable-laying stages or after making a cable repair, and give a typical coupling loss of about 0.5dB per joint.

Fiber optic cables are supplied on reels; polymer cables have reel lengths of 20 meters; glass multi-mode step-index and GRIN cables have reel lengths of 100 or 500 meters. Thus, a 5km length of GRIN cable typically uses two input/output couplers plus nine splice joints, which give a combined total attenuation loss of 10.5dB, plus that of the actual cable.

Optical signal repeaters are DC-powered and contain an optical Rx input stage, a signal conditioner, and an optical Tx output stage. When inserted into a fiber optic cable system, they can boost a weak and degraded input signal and convert it into a fully-restored strong and clean output signal. Signal repeaters can be used purely as signal boosters, or as signal data-rate (or frequency bandwidth) expanders.

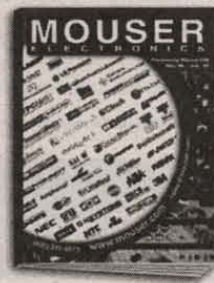
Most fiber optic cable systems are driven by LED or laser diode inputs at power levels in the typical range 0.5mW to 5mW, and when repeaters are used purely as signal boosters in such systems they should be spaced at source-to-repeater 'attenuation' intervals of 30dB maximum. In the case of a GRIN system made from 500 meter lengths of cable with an attenuation value of 1.5dB/km, for example, repeaters should be placed at maximum intervals of 10km (25.5dB attenuation) to 12km (30.5dB attenuation).

Note in the above example that if the GRIN cable has a maximum operating data rate of 250 Mbits/sec/km, it will be able to operate at a maximum data rate of 500 Mbits/sec in a 0.5km cable, but at only 25 Mbits/sec in a 10km cable, and so on.

This length-related loss of data rate (and signal bandwidth) can be minimized with the aid of signal repeaters. If these are spaced at 1km intervals along the cable, the data rate will (in this example) not fall below 250 Mbits/sec.

Finally, note that the types of fiber optic cable used in most modern commercial long-haul bi-directional telephone systems are armored and accommodate up to 35 fiber pairs. Each digitized telephonic speech channel operates at a 70-80 kbits/sec data rate, and a cable with a total bit-rate capacity (divided amongst a number of fiber pairs) of 650 Mbits/sec can thus accommodate a total of 8,000 individual speech channels.

Next month's concluding episode of this series will describe the basic operating principles of LEDs and low-power lasers. NV



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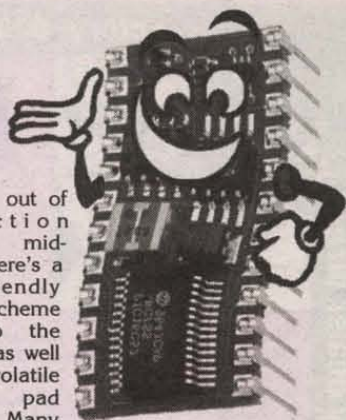
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# STAMP APPLICATIONS

by Lon Glazner



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

### Dual Digital Power Supply — Part 1

#### Overview

Just a few days ago, I was back in the lab, rummaging around for parts for this Stamp Applications article. By delving deep into our company's hoard of electronic parts, I can usually drum up some cool stuff to work with. So, with a box full of components, I went to work laying out my schematic for the design. Since there was one component in particular I hadn't worked with before, I decided that it would be prudent to do a few tests on the component in question to get a feel for how it worked.

So I strolled off into the lab looking for a place to work. Now I should say that we're quite well-equipped for electronic design. But each lab station that I went to was either being used for test or verification of various projects. It seemed that the only thing I really needed was a power supply for my design. I could have made use of the 10 or 20 wall plugs that we have stashed away. But what I really wanted was a dual regulated power supply with a display. That's when the gears started turning in my head.

Component names and descriptions were flashing down the myriad of synapses in my slightly twisted engineer's brain. It's great when you stumble upon a project that you really want to build.

After pulling out some old data sheets, and looking over last month's Stamp Applications article, I felt like I had a handle on a digitally controlled, BASIC Stamp based, solution to my power supply woes. With reckless abandon, I deemed it necessary to mercilessly throttle two birds with one stone, or hand, or whatever. In other words, I would write my Stamp application about a power supply that I could use for other Stamp projects.

#### Defining the Design

Quite often, a design can be chopped up into smaller pieces. I find it easier to stay focused on a design when I can see portions of the design completed. Dividing your designs up into segments also allows you to work on multiple projects without getting too bogged down. For this

particular project, I'm going to break up the two major design blocks over a couple of articles. This month, I'll focus on designing a user interface with a minimal number of I/O lines. Next month, I'll define the power supply parameters and control circuitry.

For ease of use, I want the dual power supply to have a sophisticated user interface. Power supply settings should also be stored in non-volatile memory. Furthermore, I want the power supply settings to be entered with a keypad and not via a potentiometer. I'll use the Solutions Cubed product — the MEMKey serial keypad encoder — for the keypad to BS2 interface. This requires about the same number of I/O lines as a couple of potentiometers, and allows a significant increase in functionality. Both voltage levels will be displayed via a 2x8 LCD display utilizing a four-bit interface protocol.

This LCD interface has been covered extensively in previous Stamp Application articles. In fact, the code I'm using here was taken directly out of a previous author's Stamp Application (Jon Williams — Volume 18, Number 9, 9/97, pg. 41).

For this project, I'm going to concentrate on the actual user-interface rather than the mechanics of LCD communication. It looks as though the four-bit LCD interface and the serial MEMKey interface will allow enough I/O lines for the power supply controls as I have them envisioned. But if I run short of I/O lines, I can always opt for a Scott Edwards Electronics serial LCD backpack. I don't think I'll need one this time around, but it's nice to know it's there if I do.

#### Connecting the Parts

Interfacing a Stamp to a keypad can require quite a few resources. Sometimes, you can multiplex some of the I/O lines between your keypad and other electronics. But implementing typematic rates and key debounce can tie up your Stamp and use memory that might be necessary to complete the design.

To reduce the amount of resources that the Stamp needs to interface to a keypad, I'm going to use the Solutions Cubed MEMKey. This is a product that

just rolled out of production around mid-March. There's a Stamp-friendly interface scheme built into the MEMKey, as well as non-volatile scratch pad memory. Many

of the settings — including the row and column locations — are programmable via a 2400 baud 8N1 serial interface. The MEMKey's row and column configuration defaults to the low-cost Grayhill 96 series keypads, which are available from both Parallax and Digi-Key. The 2x8 LCD screen (Optrex DMC-50448N) that I will use is also available from Digi-Key.

The MEMKey, keypad, and LCD screen will be connected as shown in Figure 1. Notice that I left six I/O lines open on my schematic for the power supply controls. At this point in the project, I have a complete schematic of the design, but it is only hand drawn. I didn't want to commit to the power supply portion of this circuit until I have spent a little more time doing design and testing. It's also easier to read the schematic for the user interface components when the power supply portion has been omitted.

As you can see from Figure 1, I have included a programming port for the Stamp, and have selected the BASIC Stamp 2 (BS2) for this design. The programming port makes good sense, and I try to include it on all of my Stamp designs that migrate to a printed circuit board

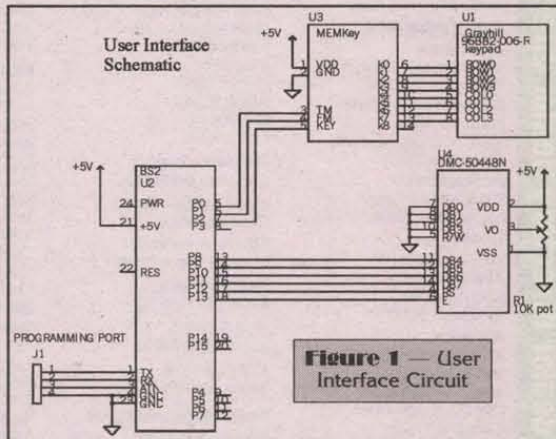


Figure 1 — User Interface Circuit

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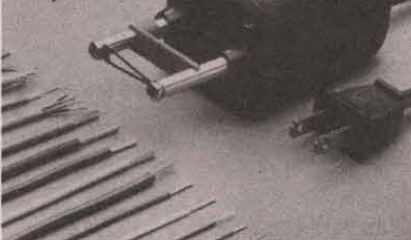
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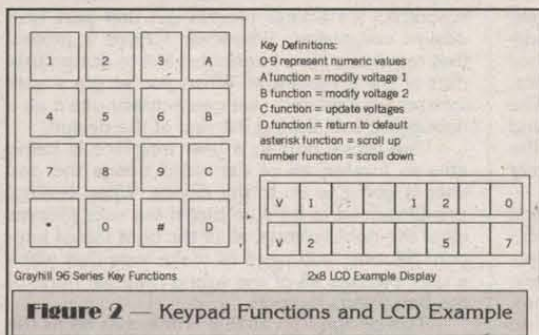
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# STAMP APPLICATIONS



(PCB).

One of the real strengths of the BASIC Stamp is the ability to be programmed over and over again. This coupled with the fact that BASIC Stamps have DEBUG commands built into them means that after-market modifications can be implemented quickly. A programming port for this design has other ramifications.

For instance, I may wish to have a power supply that can be controlled by a PC, or one that varies its output over set periods of time. If those needs arise, I can reprogram this hardware to do just that, because the programming port will be available.

## Keypad and LCD Setup

One of the first things you should do when designing a user interface is define the functionality you expect to implement. A good way to get this started is to label your keypad keys with values and functions. Next, you can actually diagram your LCD display. Figure 2 is an example of the what I'm talking about.

In my mind's eye, I see a couple of functions that I would like to implement in this dual supply. For example, if a user wished to modify voltage 1 so that it was equal to 12.0V, they could do it in one of two ways. To select a numeric value, they would press the key marked A. Next, they could press key 1, 2, and 0. Then by pressing key C the display would be updated, and the power supply would output 12V at the voltage 1 terminal.

A second method of modifying the voltage would be to press the key marked A, and then scroll the voltage value up or down using the asterisk or pound key. When the correct voltage level was reached, the C key would update the voltage output. To modify the second voltage available in this dual supply, the key marked B would be used in place of the key marked A in both of the previous examples.

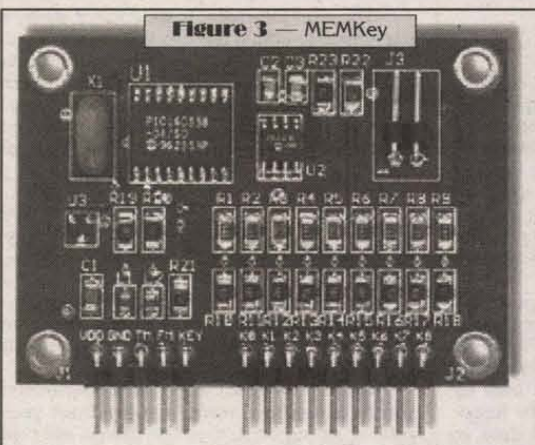
As far as the 2x8 LCD screen is concerned, there are three digits allotted for the voltage values. Leading zeros will not be displayed. There is room on the LCD to display the voltage with a resolution of 10mV. However, it's unlikely that a resolution greater than 100's of millivolts will be useful since this design will make use of eight bit A/Ds with an input range of zero to five volts.

You'll see as this process goes on that user interfaces are pretty code intensive. If we start running out of program room, we can always upgrade from the BS2 to the BS2SX which has quite a bit more program memory, as well as more program RAM.

One thing I want to be sure to do is to keep the code as simple as possible. I hate to read an application note where the writer implements cryptic programming techniques. Unless the application note is specifically about programming techniques, I think it's best to implement everything in the simplest code possible. As this project goes on, we may be forced to get tricky to make everything fit. If that's the case, I'll be sure to provide notes in the source code if not in the text of the article.

## Using the MEMKey

The MEMKey serial keypad encoder can be used with keypad matrices up to 4x5 in size. The Grayhill 96BB2-006-R that I'm using here is an example of a 4x4 keypad. The MEMKey has two forms of serial interfaces. The first is PC/AT, which is one of the protocols that IBM style PCs use to communicate with keyboards. The PC/AT protocol is selected by removing the jumper J1



on the MEMKey. BASIC Stamp users will not want to make use of the PC/AT interface. That function is included for use by original equipment manufacturers (OEMs) of electronic devices and keypad suppliers.

The second interface is selected by leaving the jumper J1 in place (as the product is shipped). This jumper selects a serial communication protocol consisting of a 2400 baud data rate, eight data bits, no parity, and one stop bit (8N1). Like all Solutions Cubed Miniature Engineering Modules (Mini-Mods), this device can make use of a one- or two-wire serial interface. I'll stick with the two wire serial interface for simplicity.

The complete data sheet for the MEMKey can be downloaded in PDF format from [www.solutions-cubed.com](http://www.solutions-cubed.com). As with all Mini-Mods, a Master is defined as the device accessing the Mini-Mod, in this case, the MEMKey. Our Master unit will be the BS2.

The MEMKey, when using its serial interface, can be configured for Automatic Mode, or Polled Mode. In Automatic Mode, the MEMKey sends key press data to the Master unit automatically. This can be useful when your Master unit is a PC or microcontroller with interrupt driven serial communication hardware built into it.

For a BS2, we should concentrate on Polled Mode. Polled Mode doesn't send key press data until the Master unit reads the keypad buffer. The MEMKey stores the key presses in an eight key FIFO (first-in first-out) buffer, for later retrieval by the Master. In both modes, the MEMKey KEY pin is set to a logic high when any key is pressed. For ease of use, the BS2 can simply check the KEY pin every now and again and, if it's high, it can perform a Read Key Buffer, and act on the data received.

## RESOURCES

For more information on the BASIC Stamp, contact:

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## User Interface Description

For this particular design, my BS2 doesn't have to be doing much other than waiting for key presses. Next month, when I add the power supply control circuitry, that will probably change. If you have a particular design that can't be waiting around for keys to be pressed you can periodically poll the KEY pin of the MEMKey for a logic high. Using this method, the key press buffer may be read at the convenience of the Master unit.

My user interface stores and displays ASCII characters. Next month, when the power circuitry is defined, there will have to be an ASCII-to-binary conversion. It's not likely to be a straight conversion. For that reason, I think it's best to save a little code space and headache by keeping the user interface simple. All ASCII data is stored in the MEMKey's user EEPROM. Of the 64 bytes of EEPROM available, only 16 were consumed by this program. The user can modify the voltage portions the LCD display. I haven't implemented the voltage scroll-up or scroll-down commands yet (asterisk and pound keys). I wanted to wait until the power supply is better defined before tackling those functions.

The user interface, in its current state, allows user input to adjust the two voltage displays independently. The voltage range is currently limited to between 3.0 and 20.0, in 100mV increments. This can be easily modified in software. The reset function has also been implemented and resets both voltage displays to 5.0. All in all, the keypad and LCD interface appears to be pretty robust.

Believe it or not, one of the best ways to test a keypad based design is to press as many keys as you can as fast as possible. Press multiple keys at once, and be sure to press the numeric and function keys. If there's a hole in your programming, it's bound to turn up when you do this. A solid user interface will not be affected by this kind of mistreatment.

If you provide for worst case possibilities, like someone laying a heavy book across your keypad, or sitting on it, then the design will probably survive the real world. And if you're not sure you can account for everything the world is going to throw at you, you can always include a reset button just for good measure.

## In Closing

The user interface went together pretty

smoothly. It's always nice to get that part of a design completed. Whenever I have a project that requires a user interface, I like to design that part of the project first. When you've got a user interface completed, you can actually use it as a debugging tool during the rest of the design.

The tricky part to a user interface is being able to foresee all of the weird things the end user is going to do to the device. When testing, you first need to be sure that if the user presses all of the right buttons, all of the right things happen. Second, you need to make sure that when a user presses all of the wrong buttons, none of the bad things happen.

This design isn't all that efficient as far as the code is concerned. There are a few big chunks of code that differ only with respect to the MEMKey user EEPROM that is accessed. These code blocks could be combined. I think the code itself is somewhat self-explanatory. This program took up about half of the BS2's EEPROM, and RAM. Since the display characters are stored in the MEMKey's EEPROM you could probably hone the RAM requirements down to just a few bytes.

I guess it's time to get back into the lab and figure out the power specifications for the power supply. I hope you found something useful in this article, and I'll see you again next month. **NV**

\* MAY99.BS2 - User interface code listing. This source code implements a user interface consisting of a 2x8 LCD screen operating in four bit mode, and a 4x4 keypad. The LCD is driven directly with a BASIC Stamp 2 while the keypad is encoded by a MEMKey serial keypad encoder. LCD display data is stored in the MEMKey's user accessible EEPROM. This code is phase one of a BS2 based power supply. Many of the limits imposed on the display values can be modified during the second phase of the project which will define the regulated DC output of the system.

\* LCD constants  
RS CON 12 \* Register Select (1 = char)  
E CON 13 \* LCD Enable pin (1 = enabled)

\* LCD control characters  
ClrLCD CON \$01 \* clear the LCD  
CrsrHm CON \$02 \* move cursor to home position  
CrsrLf CON \$10 \* move cursor left  
CrsrRt CON \$14 \* move cursor right  
DispLf CON \$18 \* shift displayed chars left  
DispRt CON \$1C \* shift displayed chars right  
DDRam CON \$80 \* Display Data RAM control

\* LCD Variables  
Char VAR Byte \* Character sent to LCD

\* MEMKey pin assignments  
TM CON 0 \* To Master  
FM CON 1 \* From Master  
KEY CON 2 \* Key press notification pin

\* MEMKey variables  
Index VAR Byte \* For next loop variable  
KeyVal VAR Byte \* Storage for key values  
B\_1 VAR Byte \* Variable storage byte  
B\_2 VAR Byte \* Variable storage byte  
B\_3 VAR Byte \* Variable storage byte  
B\_4 VAR Byte \* Variable storage byte  
B\_5 VAR Byte \* Variable storage byte  
B\_6 VAR Byte \* Variable storage byte  
B\_7 VAR Byte \* Variable storage byte  
B\_8 VAR Byte \* Variable storage byte  
B\_9 VAR Byte \* Variable storage byte

\* MEMKey constants  
Baud CON 396 \* Baud rate = 2400  
PConfig CON \$0E \* Program configuration command  
Config CON \$00 \* Disable typematic, disable auto  
PDBounce CON \$04 \* Program debounce command  
DBounce CON \$0A \* Set debounce for 25ms  
Peeprom CON \$08 \* Program user EEPROM command  
Reeprom CON \$09 \* Read user EEPROM command  
Pkeyval CON \$0A \* Program key value command  
Rkeyval CON \$0B \* Read key value command  
Default CON \$11 \* Resets MEMKey to default values  
Rbuffer CON \$00 \* Read key in buffer

\* This routine initializes the BASIC Stamp, LCD, and MEMKey.

\* Initialize the BS2  
BS2\_ini:

DirH = %01111111 \* set pins 8-15 direction  
OutH = %00000000 \* clear the pins  
DirL = %00000010 \* set pins 0-7 direction

OutL = %00000010

\* Initialize the LCD (Hitachi HD44780 controller)

LCD\_ini: OutC = %0011 \* 8-bit mode  
PULSOUT E, 1  
PAUSE 5  
PULSOUT E, 1  
PULSOUT E, 1  
OutC = %0010 \* 4-bit mode  
PULSOUT E, 1  
Char = 40 \* Set for 2 line operation  
GOSUB LCDcmd  
Char = 12 \* Shift cursor right  
GOSUB LCDcmd  
Char = 6 \* Increment DDRAM after write  
GOSUB LCDcmd  
Char = 1 \* Clear LCD screen  
GOSUB LCDcmd

\* Initialize the MEMKey  
MEMKey\_ini:

HIGH FM \* Make sure FM is high  
PAUSE 2000 \* Let the system power settle  
SEROUT FM,Baud,[PConfig,Config] \* Configure MEMKey for Polled Mode  
PAUSE 15 \* Pause 15ms for EEPROM access  
SEROUT FM,Baud,[PDBounce,DBounce] \* Program debounce value  
PAUSE 15 \* Pause 15ms for EEPROM access

GOSUB DisplayLCD

MainProgram:

GOSUB KeyFind \* Poll for a key press  
GOSUB ModeSelect \* If key is pressed start user interface interaction  
GOTO MainProgram

\*-----[ Subroutines ]-----

\* LCD commands, such as address pointer, are sent via LCDcmd, characters are sent with the LCDwr routine. This routine and LCD initialization routines taken from a previous author's Stamp Applications code listing. It was Jon Williams who wrote the original code in Nuts & Volts Volume 18, Number 9 (September 1997 pg. 41).

LCDcmd:

LOW RS \* Enter command mode  
\* then write the character

LCDwr:

OutC = Char.HIGHNIB \* Output high nibble  
PULSOUT E, 1 \* Strobe the Enable line  
OutC = Char.LOWNIB \* Output low nibble  
PULSOUT E, 1  
HIGH RS \* Return to character mode  
RETURN

\* All display data including voltage levels are stored in the MEMKey's EEPROM in locations \$00-\$0F. Whenever the display is updated each character is read from EEPROM and then sent to the LCD. The leading zeros for the voltage levels on both line one and line two are displayed as ASCII " " (space). This makes the display look a little nicer. If this display update routine is too slow for your design you can just update the voltage levels.



## Display CD:

```

If KeyVal = "C" then AdjV2Done
If KeyVal > "9" then AdjV2Over
If KeyVal = "#" then AdjV2Over
If KeyVal = "*" then AdjV2Over
SEROUT FM,Baud,[Peeprom,B_2,KeyVal]
PAUSE 15
GOTO AdjV2Again

```

AdjV2Over: SEROUT FM,Baud,[Peeprom,B\_2,"0"]  
PAUSE 15

```
AdjV2Again:
                GOSUB DisplayLCD
B_2 = B_2 + 1
If B_2 = $0E then AdjV2Again
If B_2 = $10 then AdjV2
GOTO AdjV2Continue
```

AdjV2Done: GOSUB Limits  
RETURN

```

ResetSupply:
    GOSUB Reset           ' Implement reset command
    GOSUB DisplayLCD      ' Update display
    RETURN

```

\* Keyfind looks for a logic high on the KEY pin(IN2). If one is present then the Read Key Buffer command for the MEMKey is implemented. There is enough RAM allotted in the SERIN command to read a maximum buffer size of 8 bytes. It is likely that only one key value will be returned. The SERIN "escape clause" has been set to 50ms to ensure that the serial communication does not hang up the program. Once this subroutine is entered it will not exit until a key has been pressed. When it does exit the key value will be loaded into the KeyVal variable.

```
KeyFind: IF IN2 <> 1 Then KeyFind ' Check the KEY pin for a logic high
SEROUT FM,Baud,[Rbuffer] ' Read buffer command
SERIN TM,Baud,50,DoneBuffer,[KeyVal,B 3,B 4,B 5,B 6,B 7,B 8,B 9]
```

```

DoneBuffer:
  SEROUT FM,Baud,[Rbuffer]      ' If there is a fast key press don't accept it
  PAUSE 40
  IF IN2 <> 0 then DoneBuffer    ' Wait for KEY pin to go to logic low
  RETURN

```

<sup>1</sup> The Limits subroutine checks entered values for out of range or mis-keyed entries. If either voltage input is greater than 20.0 or less than 03.0 then the values are forced to either the minimum or maximum values accepted. Prior to this routine being exited the ">" character that was loaded next to the adjusted voltage is replaced with a space character.

Limits: SEROUT FM,Baud,[Reeprom,\$04] ' Read tens character of voltage on line 1  
SERIN TM,Baud,[B\_1]  
If B\_1 > "1" then ZeroOnesV1 ' Check to see if tens is greater than "1"  
If B\_1 = "0" then TestOnesV1 ' Check to see if tens is a zero

ZeroOnesV1:  
SEROUT FM,Baud,[Peeprom,\$04,"2"]  
PAUSE 15

```

      GOTO 15
SEROUT FM,Baud,[Peeprom,$05,"0"]
PAUSE 15
SEROUT FM,Baud,[Peeprom,$07,"0"]
PAUSE 15
GOTO NextLimit

```

```
TestOnesV1:
    SEROUT FM,Baud,[Reeprom,$05]
    SERIN TM,Baud,[B_1]
    IF B_1 > "2" then NextLimit
    SEROUT FM,Baud,[Reeprom,$05 *3]
```

SEROUT FM,Baud,[Peeprom,\$05,"0"]  
PAUSE 15  
SEROUT FM,Baud,[Peeprom,\$07,"0"]  
PAUSE 15

Next Limit: SEROUT FM, Baud, (Reeprom, \$0C) ' Test voltage on line 2 as line one was tested  
SERIN TM Baud (R 1)

```

      If B_1 > "1" then ZeroOnesV2
      If B_1 = "0" then TestOnesV2
      GOTO      Done1 limit

```

```

ZeroOnesV2: SEROUT FM,Baud,[Peeprom,$0C,"2"
PAUSE 15
SEROUT FM,Baud,[Peeprom,$0D,"0"
PAUSE 15
SEROUT FM,Baud,[Peeprom,$0F,"0"
PAUSE 15
GOTO DoneLimit

```

```
TestOnesV2:
SEROUT FM,Baud,[Peeprom,$0D]
SERIN TM,Baud,[B_1]
If B_1 > "2" then DoneLimit
SEROUT FM,Baud,[Peeprom,$0D,"3"]
PAUSE 15
SEROUT FM,Baud,[Peeprom,$0F,"0"]
PAUSE 15
```

```
DoneLimit: SEROUT FM,Baud,[Peeprom,$03,* "] ' Make sure to replace either ">" with a " "(space)
           PAUSE 15
           SEROUT FM,Baud,[Peeprom,$0B,* "]
           PAUSE 15
           GOSUB DisplayLCD
           RETI RN
```

END:

## Nuts &amp; Volts Magazine/May 1999 33



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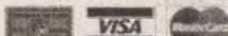
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There are GEOs, MEOs, and LEOs in space, and each satellite system has unique capabilities for keeping us in touch with land lines and the Internet anywhere in the world. Some of these satellites can also tell us our position, too.

## GEOs

The GEOs are geosynchronous, and they appear motionless in space because THEY revolve at the same rate as WE revolve. Out at 22,500 miles, the geostationary satellites parked in their very crowded orbits can bring us entertainment, such as direct satellite broadcast, plus communications through INMARSAT. But it takes satellite spot beams and dish antennas to get voice signals up and back, and because of the distance to these distant GEOs, there is always a slight delay in the voice circuits. Improvement in satellite antennas can give us good data exchanges through the INMARSAT GEOs, using a relatively small football-sized antenna from fixed-mount equipment. This is INMARSAT-C.

American Mobile Satellite Corporation (AMSC) also has great spot beam coverage of the United States, and this allows relatively small fixed-mount and briefcase-sized transceivers to work signals through the satellite when driving or boating within their spot beam coverage area.

## MEOs

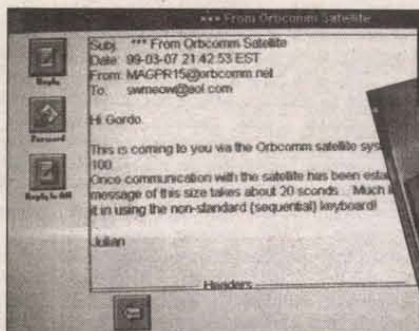
The global positioning system is in mid-earth orbit at 10,800 miles up. These are not geostationary satellites, but satellites in six orbital planes inclined 55 degrees apart with powerful spread-

spectrum signals blanketing the earth with sufficient power to be received with a tiny handheld GPS receiver. Position is determined by a process called trilateration, and this involves measuring the time delays from three or more GPS satellites. Position accuracy is within 300 feet almost all of the time, and usually better than 100 feet half the time. Terrestrial low-frequency reference stations transmitting correction signals can bring GPS accuracy all the way down to six feet.

## LEOs

Low-earth-orbit satellites have been around for many years, and the most popular are the polar-orbiting weather satellites up around 500 miles. This is near the altitude that the space shuttle flies, and the views from the shuttle are those that most weather satellites are able to downlink at 137.500 MHz. At 500 miles, it doesn't take much to pick up the twice-a-day signals from low-earth-orbit weather satellites making an overhead pass. If you have a scanner or a ham set that will tune below the two-meter band, try 137.500 MHz on FM or AM, and see what you might pick up. Listen for a twice-a-second sweeping sound coming from the weather satellites.

But new to low-earth-orbit planes are the recently launched 66 Motorola Iridium low-earth-orbit satellites for voice communications, and 28 ORBCOMM low-earth-orbit satellites for data communications. Because the satellites are relatively close, it's easy to get a few watts of power from a completely portable handheld transceiver up to the satellite for voice or data communications.



An ORBCOMM message seen on regular E-Mail and then on the satellite communicator.

Keep in mind that ham radio operators routinely communicate to the space shuttle where all the astronauts are using is a little handheld transceiver into a unity-gain loop in the window. We always hear reports from hams in remote regions being able to talk from handheld on earth to handheld in space with complete clarity, both stations running under a couple watts of power using traditional frequency modulation techniques.

Both Iridium, as well as ORBCOMM, began testing their handheld battery-operated communicators at about the same time last year, but it wasn't until the first of this year that both companies made their equipment readily available to the general public. And I was able to secure, for a 30-day trial, one Iridium phone, as well as one ORBCOMM data communicator to use offshore in international waters, as well as in a remote area of Mexico.

The present Motorola Iridium phone does principally voice at this time, and is not designed for text messaging directly on the handheld. The ORBCOMM Magellan data communicator is specifically designed for data E-Mail, and won't handle voice without the assistance of an ORBCOMM operator. So it wasn't like I was comparing each handheld communicator to the other, but rather seeing how each system had its benefits out on the ocean or in remote areas to keep us in touch.

## THE ORBCOMM DATA COMMUNICATOR

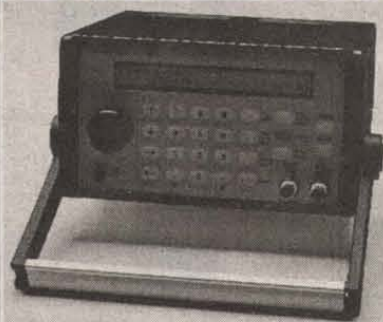
The actual product model number is Magellan GSC 100, which is a completely

Once the Magellan data-grammer makes contact with an ORBCOMM satellite, you get a message check!

We once had five E-Mails waiting for us out at sea.

# LOW-EARTH-ORBIT HANDHELD COMMUNICATORS

by Gordon West



Telulex Inc. model SG-100A

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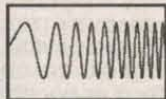
**Telulex Inc.**

## ● Synthesized Signal Generator

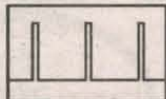
Clean sinewaves DC-21.5 MHz with .001% accuracy! .01 Hz steps. DC Offset. RS232 remote control.

## ● Arbitrary Waveform Generator

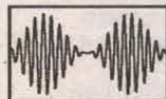
40 Megasamples/Second. 32,768 points. 12 bit DAC



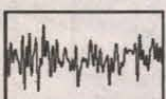
DC to 21.5 MHz linear and log sweeps



Pulse Generator



Int/Ext AM, SSB, Dualtone Gen.



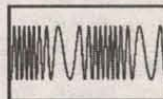
Noise

## ● Function Generator

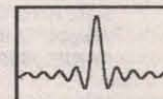
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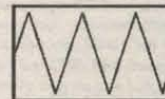
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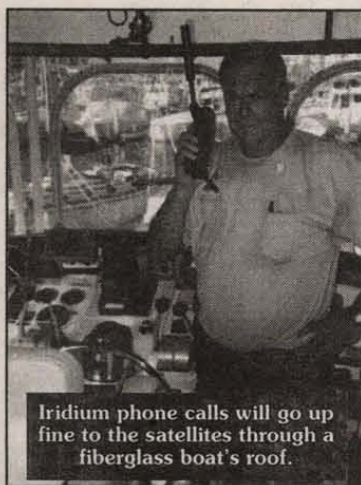
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Iridium phone calls will go up fine to the satellites through a fiberglass boat's roof.

portable battery-operated, pull-up-antenna, data communicator designed to work anywhere in the world and put mail onto the E-Mail system, or send a message to an operator that will read it over the phone lines, or take a message from someone on E-Mail or phone lines, and send it to you. The unit weighs two pounds including its rechargeable battery pack. It plays for about six hours in between charges if you do a lot of E-Mail sending and receiving. It has a built-in, two-channel GPS, too.

The GSC 100 data communicator operates in the satellite spectrum of the VHF band, transmitting at approximately 149 MHz, and receiving at 137 MHz. Transmit data rate is 2.4 KB, and 4.8 KB receive. This works out to be around 20 or 30 seconds of transmitting time for three

or four lines of text, and half that time for receiving three or four lines of text.

The little handheld data communicator with its telescopic whip is not designed for lengthy E-Mail contacts. Rather, Magellan calls the communications "global gramming," much like the old telegram where you are charged for every character sent and received. Although we could compose a 2,000 character message, it would take quite some time to compose it on the A to Z tiny keyboard. I think they purposely designed the equipment this way to keep your outgoing message short to set the example for the received party.

We found that we could easily uplink to a satellite that had mutual contact to one of four USA ground stations. This could allow us to generate a lengthy message, although we stayed with a short one. If we were thousands of miles out at sea we would limit our message to less than 250 characters because satellite relay cannot accommodate long messages.

The handheld data communicator worked great at sea. After all, there was nothing to block its shot at any of the satellites coming into view. If you composed a global gram on the screen, and tried to send it with no satellite in view, the unit will automatically store your message in the buffer, listen for another satellite pass, and then automatically upload the data gram. And to receive a message, simply turn the equipment on, poll the next available satellite for any mail to you, and the equipment will automatically download it and put it in a buffer for later retrieval.

For boaters, they would regularly send their latitude and longitude to loved ones, along with a brief message of how

the weather was, and how they were doing. Since the Magellan GSC 100 has its own built-in GPS, it takes only two additional keystrokes to list your position.

If your outgoing message is going to someone without a FAX machine or an E-Mail address, you can send the message to ORBCOMM central and they will — for about a buck more — read the message to the phone number you put on the screen. And the same thing can work in reverse, too — you can give your Mom or Dad a single phone number, and an operator will take down their brief message and upload it to you in a text message for your GSC 100 to read when you next look for mail.

The GSC 100 costs under \$999.00. There is a one-time \$50.00 activation fee, plus an every month use fee of \$29.95, whether you use the equipment or not. But that \$29.95 includes 10 global gram messages per month, up to 500 characters per message, plus an everyday satellite check-in to see if you have any messages holding. If you exceed your 5,000 monthly allotment of characters, it is \$.01 per character plus \$.20 per message check beyond the 30 message checks you get for free per month. It's also \$1.00 extra for any message from the operator to you, and \$3.00 for any message you want read to someone back home. There is also a \$4.00 per month additional weather charge if you would like to receive up-to-date weather reports delivered to your handheld communicator.

On shore, we found that we needed to be in a quiet RF environment for the Magellan GSC 100 to work well. This means away from power lines and away from strong paging transmitters at 150 MHz. We also found that we could

improve our signal by placing the unit on the roof of a vehicle or over any large amount of metal on a boat. Soon we may see an external antenna specifically for this product, for both vehicle as well as boat use. No, it doesn't do voice — just data. But data it does well, and our tests were extremely favorable on everything this little Magellan handheld data communicator could do. For more information, go to the web at [www.orbcomm.com/globalgram](http://www.orbcomm.com/globalgram).

## MOTOROLA IRIIDIUM

The Motorola Iridium system operates GSM, frequency-division, time-division modulation at 2.4 KB per second, giving us excellent voice recognition, but some rather strange sounds when it comes to dial tones, busy signals, and wrong numbers. The handheld is slightly larger than a big cellular phone, and operates on L-band — 1616 MHz to 1626.5 MHz — with about one watt output to a very strange-looking satellite omnidirectional antenna that is positioned well above your head for safety.

The Iridium phone sells for around \$3,000.00, and you need to add about \$400.00 if you want to add local cellular capabilities, too. With the added cellular module inside, the Iridium phone will first try to make a cellular connection, and save you big bucks when talking locally around the states, or in a cellular area you designate in a foreign country. If the cellular module cannot find a compatible cell site, it will then switch over to the built-in satellite capabilities, and your phone now goes extra-terrestrial.

We operated the Iridium Model 9500 portable phone WITHOUT the local cellular

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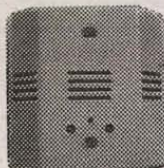
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lar module inside. Since we were going to be the only one using the phone, we also did not purchase the optional SIM card that has the billing information for anyone else you want to loan the phone to. We were offered an exceptional deal on a demonstration phone through a Motorola satellite specialist from the West Coast — Ms. Debra Sortino at 760-967-8800. While Motorola has hundreds of Iridium phone dealers throughout the country, and hundreds of service providers, Sortino was the only one that could give us some precise information on what it was going to cost us to make phone calls down south in international waters, as well as within Mexico jurisdiction. We just received our phone bill, and she was pretty close on how much it costs to make a satellite phone call.

For one thing, the \$3,000.00 phone requires an additional \$100.00 to get activated for service, plus the assignment of your unique four-digit PIN number. The monthly fee, whether you actually use the equipment or not, is \$70.00, and unfortunately, no free ride when you make a phone call through the traditional land-line system. However, for that \$70.00 a month, you can call another Iridium phone through the Iridium satellites, and you can talk up a storm, from what I've been told, for FREE. Now I don't know if there is a time limit on this, but here's something you get in addition to the capabilities of getting connected over to the land lines. We also hear of capabilities for someone on the Internet to dial into the Iridium web page and possibly leave you a message on the phone for next to nothing. I am still getting this story, so best check with the local Iridium service provider on how this works.

"Motorola built the Iridium network, and manufactures the Iridium phone. It is the Iridium consortium that owns the network, and the service provider may determine certain rates for how the phone call is completed. The consortium develops its own on-air-time costs, and the service providers sell the air time — so pricing is relatively uniform from any service provider," comments Debra Sortino, the Motorola satellite specialist.

"It's going through the public switched network that begins to cost some real minute money," adds Sortino, indicating that Iridium has to pay for that interconnect capability, and this is where pricing gets confusing.

"AT&T, Sprint, MCI, and other domestic carriers charge for this interconnect service," comments Sortino. "... Maybe \$4.00 a minute, maybe \$5.00 a minute — but it's pretty steep, and this is one of the big reasons why it took the Iridium system so long to get going because it had to negotiate with every phone company in the world these interconnect by-minute rates," adds Sortino.

We found that our phone calls from ship and shore varied from \$3.00 a minute to \$5.50 a minute. The land-line charges were part of these minute charges, so no additional fees to call any part of the country. I suspect that these rates will begin to drop as soon as there are more subscribers, but for right now, a monthly phone bill including your monthly service fee is going to be well over \$100.00 if you regularly make phone calls from afar through satellites.

And don't look for competition soon to drive down the rates — it takes a long time to get low-earth-orbit satellites up there and operating.

And how well did the Iridium phone work? SUPERBLY! Out on the boat, people would call us and think we were driving down the freeway with a little handheld cellular phone. They had no idea we were hundreds of miles out at sea, and operating through satellites.

When we were ashore in Mexico, the Iridium phone was sensitive to calls getting dropped if we were too close to the side of a building. This is completely understandable — at 1600 MHz, the Iridium phone needs a clear shot at the sky. In fact, using the Iridium phone is almost identical to receiving GPS satellite signals for navigation — if you have a relatively unobstructed view of the sky, no problem.

Same thing when hiking up in the back hills of Mexico — as soon as we would get under big trees, reception would drop out. But as soon as we would get into a clearing, we would immediately see the phone access the satellite and tell us it was ready for receiving calls or sending calls.

Receiving calls was easy — just push the talk button, and we were connected. But we advised everybody calling us that THEY were paying for the phone call at about \$5.00 a minute, so needless to say the calling party kept it quick and to the point. The calling party always pays on Iridium. On outgoing phone calls, we needed to add a couple of additional country codes — but once we got the swing of things, and once we put all of this info in our rapid-dial memory, there was nothing to it. On initial phone turn-on, we needed to enter our PIN number, and this we would do once a day each time we turned the phone from completely off to operate.

There is almost no signal delay from low-earth-orbit satellites, unlike the noticeable signal delay when working bigger satellite phones through the geosynchronous INMARSAT or AMSC satellites. However, somewhere in the analog-to-digital-to-analog circuit, a sizeable processing time was introduced, and this gave us that customary satellite delay that makes a fast-paced conversation almost impossible. I would instruct everybody on the phone to say "over" when they were finished talking and were expecting a reply. This way there would be no attempt to interrupt a conversation, and the communications went well. This was about the only "surprise" encountered with the Iridium phone — this noticeable time delay between when I stopped talking, and they would start talking. But even the new PCS phones have this delay, so I guess everyone is getting used to that fraction of a second pause between when you stop talking, and they respond to your answers.

The Iridium phone works anywhere in the world. But depending on where you are, and where your signal comes down from, your calls may cost as little as \$2.50 a minute, or more than \$5.00 a minute.

But if you look at the price of making a phone call from a foreign hotel room, or getting a phone call in the middle of the desert or ocean that is an important one that just can't wait, you sure can't beat the little hip-pocket Iridium communicator that isn't much larger than a regular analog cellular telephone. Although that strange-looking antenna is a dead give-away you are talking off of satellites, everything else looks like cellular (www.Iridium.com).

So, if you are going a long way away and just can't stay out of touch, you can stay in voice contact 24 hours a day through Motorola Iridium, or work E-Mail from the ORCOMM Magellan data gram sender. Both systems work well! NV

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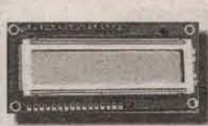


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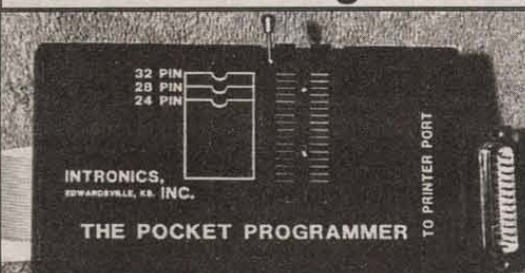
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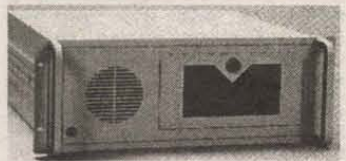
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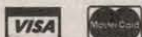
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**WANTED: TERMINALS + PRINTERS:** DEC, Wyse, IBM, ADDS, Okidata, Data South, Epson, C.I.T.O.H., etc. Call for quote on any surplus computer equipment. Call Jeremy, 603-673-8077.

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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 low enforcement models that cost hundreds more!



Basic 20 mW model transmits up to 300' while the high power 100 mW unit goes up to 1 1/4 mile. Audio units include sound using a sensitive built-in mike that will hear a whisper 15 feet away! Units run on 9 volts and hook-up to most any CCD camera. Any 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!

C-2000, Basic Video Transmitter Cube.....	\$89.95
C-3000, Basic Video & Audio Transmitter Cube.....	\$149.95
C-2001, High Power Video Transmitter Cube.....	\$179.95
C-3001, High Power Video & Audio Transmitter Cube.....	\$229.95

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Top quality Japanese Class 'A' CCD array, over 440 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 (Infrared) 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 audio sound pick-up and 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
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## Mini Radio Receivers

Imagine the fun of tuning into aircraft a hundred miles away, the local police/fire department, ham operators, or how about 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 short-wave and FM broadcast which has handy SCA output. Add our snazzy matching case and knob set for that smart finished look.

AR-1, Aircraft 108-136 MHz Kit.....	\$29.95
HRFC-1, WWV 10 MHz (crystal controlled) Kit.....	\$34.95
FR-1, FM Broadcast Band 88-108 MHz Kit.....	\$24.95
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
SR-1, Shortwave 4-11 MHz Band Kit.....	\$29.95
Matching Case Set (specify for which kit).....	\$14.95

## Tiny FM Transmitters



Gosh, these babies are tiny - that's a quarter in the picture! Choose the unit that's best for you. FM-5 is the smallest tunable FM transmitter in the world, picks up a whisper 10' away and transmits up to 300'. Runs on tiny included watch battery, uses SMT parts. FM-4 is larger, more powerful, runs on 5-12 volts, goes up to a mile. FM-5 operate in standard FM band 88-108 MHz. FM-6 is crystal controlled in 2 meter ham band, 146.535 MHz, easily picked up on scanner or 2 meter rig, runs on 2 included watch batteries. SMT (surface mount) kits include extra parts in case you sneeze & lose a part!

FM-4MC, High Power FM Transmitter Kit.....	\$17.95
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FM-100, Pro FM Stereo Transmitter Kit.....	\$249.95
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## FM Stereo Radio Transmitters

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

FM-25, Synthesized FM Stereo Transmitter Kit.....	\$129.95
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Lower cost alternative to our high performance transmitters. Great value, tunable over FM band, plenty of power and manual goes into great detail about antennas, range and FCC rules. Handy kit 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 power from 5 to 15 VDC. Add our matching case and whip antenna set for a nice 'pro' look.

FM-10A, Tunable FM Stereo Transmitter Kit.....	\$34.95
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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.

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

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TM-100, Tri-Match FM Station Antenna Kit.....	\$39.95
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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

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Everyone who sees one of these babies says they just gotta have one! Super cute tiny FM radios have automatic scan/search tuning, comfortable ear bud earphones and we even include the battery. The pager style unit looks like a shrunken pager and even has an LCD clock built-in. You will be amazed at the crystal clear amazing sound! That's a quarter in the picture for size comparison - pretty tiny, huh?

MFMT-1, World's Smallest FM Radio.....	\$11.95
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## MILLIOMETER

HEWLETT PACKARD, Model 4328A. Designed to measure very low resistances. Measurement range 1m ohm to 100 ohms. Resolution 20 u ohms. Analog meter readout. Ideal for measuring contact resistance of switches or relays. This unit is also useful for measuring the resistivity of semiconductor devices. (Requires special 4 terminal probes which are not supplied, but probably are available from Hewlett Packard.) Power input: 115-230 VAC 48-66 Hz, 5 VA max. Dimensions: 5-1/8" wide x 11-1/2" deep x 6-1/2" high.

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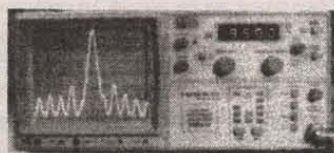
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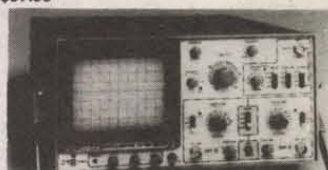
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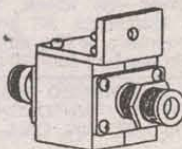
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**GENUINE UNMODIFIED JERROLD DPBB7312 FOR SALE 10 LOT MIN. CALL 708-715-6118.**

## TELEPHONE/FAX

**TELEPHONE CATALOG** 160 pages including office automation, voice mail, and all phone accessories. Send \$10 to HES Electronics, POB 183, Brick, NJ 08723. A 10% off certificate will be included! Visit [www.heselectronics.com](http://www.heselectronics.com)

**PHONE SYSTEMS WANTED!!!** We buy AT&T MERLIN, SYSTEM 25/75/85 and other AT&T phone systems. Please call for a quote or fax us your equipment list. KEYWAYS, INC., 937-847-2300 or FAX 937-847-2350.

**CELLULAR CLONING COLLECTION.** 1999 CELLULAR CLONING INFO BIBLE \$22, 1999 CELLULAR CLONING SOFTWARE COLLECTION \$33, 1999 CELLULAR SECRETS & PROGRAMMING MANUAL \$11. ALL 3 FOR \$44, WOW!! (SAVE \$22). FOR EDUCATIONAL/TECHNICIAN TESTING USE ONLY. (VISA/MC/AMEX/COD). OPEN 24 HOURS! 352-429-5496. BRINKER ENGINEERING LABS, USA.

## COMPONENTS

**RF TRANSISTORS, TUBES, 2SC2879, SD1446, MRF455, MRF454, 3SC1969, 2SC2166, 2SB754, TA7222AP, 2SC1419, 2SC1947, 2SB688, 2SD880, MRF422, MRF448, MRF247, MRF317, SAV7, SAV17, 3-500ZG 4CX250B, 572B, 3CX3000A7, 4CX400A** silver mica caps, resistors, electrolytics, etc. Westgate 1-800-213-4563.



**AMAZING! 35¢ ALL TOGGLE SWITCHES.** Brand new. Rated 6A/125V. Hardware included. 1/4" panel hole. SPDT or DPDT on-on, or on-off-on. Minimum 100pcs/package. Add \$6 freight. Gateway Products Corporation, PO Box 936397, Margate, FL 33093, 954-974-6864, Fax: 954-974-6818, VISA/MC, no COD.

## Miniature Transmitters and Receivers

### 2 Button / 3 Channel Transmitter

<b>RF300T</b>	1....\$22.95
	5....\$19.95 ea
	10....\$16.95 ea
<b>RF300XT</b>	1....\$25.95
	5....\$22.95 ea
	10....\$19.95 ea

- 300' (XT), 150' (T) Range
- Frequency: 318 MHz
- 59,049 Settable Security Codes
- 12 Volt Battery and Keychain Included
- Current Draw: 4.8 ma
- Fully Assembled in Case
- Dimensions: 1.25" x 2.0" x .5"
- Push both buttons for the 3rd Channel
- Slide Button Cover Included

- Alarm Systems
- Garage / Gate Openers
- Lighting Control

### 4 Button / 15 Channel Transmitter

<b>RF304XT</b>	1....\$27.95
	5....\$24.95 ea
	10....\$21.95 ea

- 250' Range
- Frequency: 318 MHz
- 6,561 Settable Security Codes
- 12 Volt Battery and Keychain Included
- Current Draw: 4.6 ma
- Fully Assembled in Case
- Dimensions: 1.35" x 2.25" x .5"
- Push combination of buttons to achieve up to 15 channels

- Magic Props
- Medical Alert
- Monitoring Systems
- Industrial Controls
- Surveillance Control
- Motor Control

### 2-4 Data / 3-15 Channel Receivers

<b>RF300RL</b>	1....\$27.95
<b>RF300RM</b>	5....\$24.95 ea
	10....\$22.95 ea
<b>RF304RL</b>	1....\$29.95
<b>RF304RM</b>	5....\$26.95 ea
	10....\$23.95 ea

- Compatible with 300/4 Transmitters
- 11-24 volts DC Operating Voltage
- 13 ma. Current Draw
- Latching (L) or Momentary (M) Output
- Kits Available (subtract \$5.00 ea.)
- Dimensions: 1.25" x 3.75" x .5"
- 2 (300) / 4 (304) Output Data Lines
- Binary to Dec / Hex Converter can achieve up to 15 channels

- Schematics Available
- Receiver Board Layout Available
- Custom Design Consulting Available

**Visitect Inc.**

(510) 651-1425 Fax: (510) 651-8454 Email: [Support@Visitect.Com](mailto:Support@Visitect.Com)  
P.O. Box 14156, Fremont, CA 94539 Visa / Mastercard, COD



## NEW, WinCam.live DIAL-UP, WEB CAM, for any INTERNET CONNECTED PC!

Webcam live images can be seen by anybody with a WEB browser. There are no plug-ins or operating system restrictions.

Perfect for sending live video from:

- DAY CARE CENTERS • TOURISM • VETERINARY • TRAFFIC • WEATHER
- HOME • OFFICE • CONSTRUCTION • AIRPORT • MARINA • SECURITY

Webcam live, a 100% digital device. No capture card is req'd. Can be up to 5000ft. from your PC and operated via modem.

Power is supplied via the serial cable. No AC power is required at the remote camera sight. Complete with Capture Box, automated, dedicated, webcam software specifically for WinCam.live. Operating in the background it auto dials the Internet to upload live images. You set the hours of operation & the update frequency. You can run other software & even surf the net at the same time!

**CAMERA SPECIFICATIONS AND GENERAL SYSTEM FEATURES:**

- Sharp CCD Sensor, captures crisp 24-bit color images up to 640x480
- 8.0mm f/2.0, 3-Element Glass Lens, high quality & focusable.
- Electronic exposure: 1/100,000 to 1.3 sec. software controlled.
- RS-232 Based Serial protocol, auto baud up to 230Kb max.
- Size: 4.1W x 3.1H x 5D
- RS232, expandable for multiplexing, long cables, even wireless.
- Host PC is not restricted to the same location as the cameras.
- 32-bit software optimized for multiple cameras & min. processor power.
- Customizable options: Customize auto color bal., contrast, text/time/date stamp, image overlay, hands-free, scheduling & JPEG compression.
- Optional lenses: ultra wide angle to telephoto
- Multiplexing Box, up to six cameras on one serial port or modem. Mux boxes can be daisy chained for unlimited cameras.
- Cable Extender Kit, break the 200 ft. barrier. Extend camera or Mux up to one mile from the host PC while maintaining a speed of 115.2Kb!
- Outdoor Enclosure, weatherproof housing with high quality window and heavy duty steel mounting bracket.

WinCam.live complete package.....\$499ea.

## LASERWATCH, Never be your laser again! Combination sport watch & laser pointer!

Two models available, analog Titanium, or Black digital.

Common features:

- Space-age look.
- Integrated 650nm class IIIa Laser visible to 500 meters.
- Water resist to 3 Bar (30m or 97 ft).
- Shock resistant. Antimagnetic. Scratch resistant.
- Quartz controlled accuracy.
- 3 x LR44 or SR44 battery for laser, 20 min. constant on.
- x SR6265 battery for watch (2 Year).
- Watch spanner (to open back) included.
- Handsome gift packaging. Perfect for the person who has everything.

**LCD MODEL:**

Black chrome plated case. Chronograph with 1/100th sec. lap, up to 24 hours. Displays hour, minutes, second, month, date, weekday. 1 min. snooze alarm, hourly chime and 12/24 hours select. Electroluminescent backlight. Detachable compass. Dimension: 55mm(L) x 48mm(W) x 19mm(H) Weight: 110 Grams (incl. batteries.)

LCD LASERWATCH.....\$69ea.

**ANALOG MODEL:**

Unidirectional rotating bezel. Black dial, luminous hour markers. Sweep seconds with tritium luminous hands. Titanium-plated bracelet with stainless buckle. Extremely rugged construction. Size: 55mm(L) x 48mm(W) x 19mm(H) Weight: 180 Grams (incl. batteries.)

TITANIUM LASERWATCH.....\$79ea.

## NEW, GEN II, INTENSIFIED GOGGLES, AFFORDABLE AND U.S. MADE.

The NQ5001-2; the world's most rugged and reliable, high performance night vision goggles for ground operations. Extensively used by the U.S. Army, it is the State-of-the-Art in mono-tube Night Vision Goggles. It can be used under extreme conditions, headstrap mounted or handheld. Engineered for maximum comfort and simple to use. The system contains an IR illuminator, low battery indicator & high light sensor for automatic power off to image tube.

**Specifications:**

- Generation: Two
- Photocathode: Multi Alkali
- Resolution: 28 lp/mm
- Photo Response: 450 Ma/lux
- Tube Gain: 25,000x
- System Gain: 2,200x
- Signal To Noise: 11:1
- Battery Type: 2 'AA'
- Battery Life: 20 Hours
- Magnification: 1x
- Objective Lens: 25mm F/1.2
- Field Of View: 40°
- Focus Distance: 2.5m To Infinity
- Size: 14.9 x 14.9 x 9.1 cm
- Weight: 680 gm

Special.....2195ea.

## MOTORIZED, INDOOR PAN & TILT WITH CONTROLLER NEW, PT100-C provides dependable motion control.

**SPECIFICATIONS:**

- Movement range: 350° Pan, +/-60° Tilt
- Pan: 4°/sec., Tilt: 3°/sec
- Load rating: Pan: 7kg, 15lbs., Tilt: 4kg, 8lbs.
- Pan: continuous, Tilt: intermittent
- Cable req'd.: 6-conductor, unshielded
- Finish: light gray textured
- Input voltage: 117VAC @ 0.02A, 6 watts
- Operating temperature: -25°C to +60°C
- Construction: aluminum and plastic
- Dimensions: 184H x 115mm diam.
- Weight: 1.9kg

SPECIAL.....\$299 set

## NEW, KEITHLEY/ACCULEX, DP-2000, 4 1/2 DIGIT, LCD, Digital Panel Meter

Industrial quality 5VDC powered, 19,999 count DPM with 1/2" digits. Requires only 15mW and only 0.73" space behind panel. Perfect for any application requiring precision and portability. User selectable range control provides +/-200mVDC and +/-2VDC option. Auto polarity, overrange, selectable decimal point and display hold functions. Full differential inputs, 100M Ohm input imped. on 200mV range. 1M Ohm on 2V range. Snap in mounting. Stability 100ppm/deg C.

Regular price.....\$99ea. SPECIAL.....\$39.00ea. 2 for \$69

## NEW, MINI LASER PATTERN PROJECTOR and IT'S PORTABLE TOO!

**PRODUCT FEATURES:**

- Built-in microprocessor control.
- Approximately 40 patterns.
- Spinning and geometric laser displays.
- Pattern modes: Auto, Manual, & sound control.
- Wireless remote control.
- Laser patterns can be easily projected in any direction.
- Battery or AC powered.
- 4 x "AA" batteries & AC adapter incl.



- 635nm 635nm Class II laser for excellent visibility.
- Laser patterns change rhythmically to sound input.
- External sensitivity control for sound mode.
- Dimension: 16.0cm(L) x 15.0cm(W) x 9.0cm(H)
- Weight: 600Grams (incl. batteries.)
- Range: 12meters
- Approximately 4 hours run time from batteries.
- 1yr. Warranty for 1 year.

MINI Laser Projector, Special.....\$89ea.

## NEW, 9" SECURITY MONITORS

We were fortunate to obtain these Hi-res 700 Line. B&W units. Original manufacturers boxes, 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.....\$129.00ea. 2 for \$238.00

## IS ANYBODY OUT THERE?

# RESOURCES UN-LTD.

VISA, MC, AMEX, DISCOVER, C.O.D.

ORDER: 800-810-4070 TECH: 603-668-2499

FAX: 603-644-7825 E-MAIL unltd4u@rac.net

300 BEDFORD STREET, MANCHESTER, NH 03101

## NEW! SecureCam Pro DIGITAL SURVEILLANCE SYSTEM PHONE LINE IMAGE ACCESS, MOTION DETECTION & STORAGE AND MORE!

A complete, remote, security camera system for automatic capture of high resolution color images for later download, or as a remote access slow scan CCTV camera. Access unlimited cameras from anywhere there is a PC and a modem. Everything is included... camera, cable, mount, modem, power supply & software.



- Can SecureCam Pro connect to a standard VCR or Monitor? SecureCam Pro is 100% digital, and cannot connect to standard video equipment.
- Is the software customizable? Everything from the name of the camera to the exact areas that you want the motion detection to look at.
- How far from the modem can I place the camera? From the modem, or PC serial port, the SecureCam Pro camera can be up to 200 feet away (over a mile with the cable extender kit). The modem, of course, can be anywhere there is a phone line.
- Is it possible to have more than one SecureCam Pro camera connected to the same computer? With the optional digital camera multiplexer, up to six SecureCam Pro cameras can be connected to one modem or PC serial port. The camera multiplexer is also chainable to additional camera multiplexers allowing for a virtually infinite number of cameras on one serial port or modem.
- With multiple serial ports, you can connect one camera or multiplexer to each serial port on your computer.
- If I have more than one camera, do I need more than one phone line? No. They all can share a single phone line and modem.
- What else do I need? A PC running Windows 95, 98 or NT with modem or serial port. A telephone line to connect to SecureCam Pro.

- What can SecureCam Pro do for me? The built in motion detector & computer interface, and the ability to connect to std. alarm sensors, can provide a total alarm verification, employee monitoring or home surveillance solution. It can work alone to watch for signs of trouble & notify you, all while keeping a visual record of events.
- What makes SecureCam Pro different than other security camera systems? With 100% digital image, interface, dial up accessibility & internal image storage, there is nothing that can compete. As a "CCTV" camera, it displays real-time images directly on your computer screen from anywhere. Using the internal motion detection, your computer becomes a motion detection VCR, recording directly to disk. A wide range of lenses, cable lengths up to 5000 feet, multiple camera support, remote dial-up & outdoor enclosure are available.
- Where are the pictures stored? Inside the camera using FLASH memory which will hold information even if the camera is disconnected. To view the pictures, they are downloaded from the camera, where they can be archived or printed.
- How many cameras can I have at one location? As many as you need... There are no hardware or software limits.
- What is SecureCam Pro's frame rate? Connected to a PC over a modem, typical frame black & white frame rate is one frame every 3 to 4 sec. Connected directly to a PC serial port, the frame rate is much higher. For high resolution color images, over modem it can take between 15 sec to 1 minute per image.

SecureCam pro Standard .....\$649  
SecureCam pro Local (no modem) \$599  
SecureCam pro 6-Camera MUX.....\$389  
SecureCam pro Slave camera.....\$549  
Weather resistant enclosure.....\$99

## EXPLOSIVE LABEL? CLASS 1.1E 1

Completely assembled and tested! Nice size, about 4" x 4" square.

Very attention getting!

Special..... 5 for \$5.00



## COVERT, INFRA RED TRANSMITTER FOB Perfect as a "FRIEND or FOE" signal system.

New, Key FOB style IR transmitter from Polaroid, becomes the perfect companion to any CCD camera or night vision device. The high output IR LED is completely invisible to the naked eye, but what a blast to a CCD camera or starlight scope! IR FOB.....\$5 for \$10 or 30 for \$49

## FOOD for THOUGHT: MERCEDES or HYUNDAI?

We always strive to bring you the best products at the best price. Every product is tested for performance. If it doesn't work to specification we simply won't buy it and offer it to you. You can pay for their CEO's Mercedes or my Hyundai. Your money, Your choice.

## NEW! DAYLIGHT to LOW LIGHT MINI CAM, with AUTO IRIS LENS!

For those applications that must work from dawn 'til dusk, this is it. Rugged aluminum housing with dual mounting sockets. Specs: 1/3" CCD, 420 lines resolution, 0.1 lux sens., AGC, Auto shutter, 12VDC @120mA. Take full advantage of camera sensitivity with the super, 4mm, f1.4, 78° FOV Auto Iris lens included. Video out on BNC. Size: 50mm sq. X 65mm long. Power adapter included. Ready to go!

SPECIAL, GM-510-A/1.....\$199ea. or 2 for \$369

## ARMY TELEPHONE SET, TA-1/PT For Secure Y2K Communications

Like new, direct from depot storage in original boxes. Each portable and lightweight handset phone is sound powered, has a built in push to talk ring generator, buzzer volume, and visual indicator for silent call signal. NO BATTERIES or EXTERNAL POWER REQUIRED. Any two conductor wire is all that is needed for interconnection & communication between two phones. Voice transmission range is up to 4 Miles. Freq. Response: 300 Hz to 4000Hz, Signal voltage: 65-80VAC @ 20Hz, Operating temp. -40 to +131F. Complete with hard field case and complete manual. An excellent collectors item.

## WE JUST HAPPEN TO HAVE..... 1000 foot SPOOLS of 4 CONDUCTOR Standard Modular Phone Cable.

Standard 484U-CU26-SS, silver gray color. Use it as intended with crimp RJ style connectors or as a low cost cable for your ARMY Field Phone (above) New spools. First quality U.S. made. Special.....1000ft. Spool for \$25 or 2 for \$49

## G2P, GEN II, NIGHT VISION WEAPON SIGHT

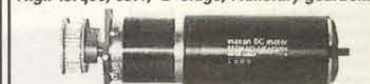
The G2P, genII, night vision weapon sight represents an unbelievable combination of price, performance, & features. U.S. made, three power, mini-illuminator provides a detachable long range infrared illuminator and a new quick dot reticle for easy target acquisition. The G2P is water & shock resistant, suitable for any application. Mil-Spec Ekan® weapon mount makes sighting a simple task and allows the sight to be removed and reattached without losing zero. Easy to operate & light weight. A 12" FOV. Great light gain & excellent resolution. Specifications:

**Generation Two**  
Photocathode Multi Alkali  
Resolution 28 lp/mm  
Photo Response 450 Ma/lux  
Tube Gain 25,000x  
System Gain 2,200x  
Signal To Noise 11:1  
Battery Type 3V Lithium  
Standard Accessories Hard Case, Operators Manual  
Optional Accessories Infrared illuminator, softsided field bag

**Battery Life 40 Hours**  
Magnification 3x  
Objective Lens 75mm F/1.4  
Field Of View 12°  
Focus Distance 9m To Infinity  
Size 5.5" x 2.9" x 2.1"  
Weight 1.8 lbs  
Reticle Quick Dot

G2P, WEAPON SIGHT.....\$1449ea.

## MAXON, Rare Earth Magnet, PRECISION DC GEARMOTOR High Torque, 35:1, 2- stage, Planetary gearbox.



Maxon P/N: RE035-071-34EAC200A. All metal construction with mounting ears. Approximately 1000RPM at the gearbox output and 4000RPM at the direct output. (dual shaft design) Direct shaft is 3.9mm diam. X 18mm long. Geared Shaft size: 6mm diam. x 18mm long. Overall size: 35mmO.D. x 109.1" not including shafts. Ball bearing outputs. Torque 2.25Nm continuous. Nominal operating voltage: 24VDC @ 40W. No load current 45.7mA. Max. Cont Current: 1.5A. A fantastic motor and always a sellout! Maxon, Special.....\$39ea.



## ULTRA MINI and WEATHERPROOF,

"SLIPSTICK" CAMERA Sleek black anodized, aluminum 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. <1 ounce! IR SENSITIVE. 3mmx50mm, 36" cable with BNC video & DC barrel jack.

**GM-200K-STD.....\$99**

**GM-200K-PH lens.....\$99**  
PINHOLE Model. So tiny you can install it directly into a door. Only 0.9" diameter hole! Specs as above. 90° FOV Pinhole lens. 1/2" on! Size only 23mm d.x35mm long. Think of the places you could put this little jewel.

## MICRO CAMERA, with

### MIRROR IMAGE

Perfect for "rear view." 1/3" CCD, with 266K Pixels, 410 Lines Res., 0.3 Lux sens. AGC and Auto/Man Shutter. Low Power 12VDC @100mA. 3.6mm, 92° FOV, focus from 10mm to infinity. A real glass lens! WHY BUY DISCONTINUED OR SURPLUS? New first quality. Standard NTSC video out. 1/2" on! IR SENSITIVE! Mating connector w/ cable included.

**GM-251, w/AC PWR. adapter.....\$79ea.**

## PRICE BUSTER, DSP, COLOR CAMERA,

Brand New, model GM550. Size: 1.6" x 1.6" x 1.5". 1/3" CCD with SONY CCD & DSP technology. 4mm, f1.8 glass lens, 80° FOV. Resolution >350 lines, sensitivity, 0.3lux, AWB, AGC & auto electronic shutter 1/60 to 1/10,000 sec. Pwr. 12VDC @160mA. NTSC out. Budget color surveillance. Standard / Pinhole.

**GM550-STD.....\$129ea. GM550-PH.....\$129ea.**

## CO-AXIAL VIDEO CABLES, New!

**100' RG-6, low loss, or 10' RG-59/U, both are 75 ohm,** terminated with a BNC plugs, both ends. RG-6 is Belden 9114, RG-59 is L-COM. **Special RG-6.....\$15ea. or RG-59/U.....\$5ea.**

## ULTRA RESOLUTION & SENSITIVITY, SCIENTIFIC QUALITY for demanding applications

Type GM-600, offers 425K pixels, 600 Lines resolution < 0.02LUX sensitivity. Access to all operating parameters from outside the camera! Adjustable shutter speed, gain, auto/man. gain, external/internal sync and gamma. 12VDC powered. Dual mounts. Sony CCD! Just the thing for astronomy, scientific or extreme low light.

**SPECIAL, GM600.....\$359ea.**

## NEW GM182, 580 LINE, CCD CAMERA,

1/3" CCD, 580 Lines Res., 0.1 Lux sens., AGC, Auto Shutter. Pwr. 12VDC @120mA, 3.6mm, 71° FOV. Real glass lens. Focus from 10mm to infinity. Standard NTSC video out. 1/2" on! SENSITIVE to IR. Size: 1.7" sq. x 1.7" with 6' leads. Superior quality for demanding applications. **GM182.....\$179ea.**

Please fax us your list of unique surplus material.

## 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". 250,000 Pixels, 380 Lines Resolution, Sensitivity 0.3 Lux, The GM410 specs: size only 1.5" sq. x 1.6". >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.....\$119. GM410, less lens.....\$169**

## SONY, COLOR CONFERENCE CAMERA, 450Line, 8X, NTSC & Y/C OUT, Serial Control, Pan, Tilt, Zoom, Auto Iris and Auto Focus!

Like having your own R2D2. Intended for use in fortune 500 board rooms. The video performance is stunning. Superior to almost anything we have seen. Camera and lens is an integral assembly. Excellent Condition. Rugged black ABS enclosure. 8 pin mini-DIN & Std. 5VHS jack. Size: 8"Dx6.5"H. Sorry, we have no data on using the serial port. The units sell test on power up and the video is active. Reg price over \$4K. **SPECIAL PRICE.....\$279ea.**

## NOW YOU CAN SEE WHAT the "FISHES ARE DOIN" GO UNDERWATER (down to 60 ft.)

### Waterproof B&W CAMERA

#### with INTERNAL, INFRA-RED ILLUMINATOR!

Sleek black anodized, BRASS, housing is O-Ring sealed & RAINPROOF. Adjustable mount included. Specs: 1/3" CCD, 400 Lines resolution, 0.05 Lux sensitivity, AGC, Auto Shutter. Operates on 12VDC @225mA, 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. Great for general outdoor use also. **SPECIAL GM-300KIR.....\$199**

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

The sleek aluminum housing fits like a glove! Removable mounting bracket and a 1.3M cable with BNC vid., RCA aud., (internal mic) & DC barrel jack for, no sweat hook up. Why fool around with an open PC board? Now you can have the "STEALTH CAM". 1/3" CCD, 410 Lines, 0.3 Lux, AGC, Auto Shutter. Pwr. from 9 to 12VDC @110mA, 250k pixels, Std. model, 4mm, 78° FOV lens, Pinhole model, 90° FOV. A real glass lens. Focus from 10mm to infinity. NTSC video out. Only 1.7 ounce! SENSITIVE to IR. Size Std: 30mm sq. x 29mm d. PH is 16mm d. **WARNING: Don't confuse these models with LOW RESOLUTION, HIGH LUX C-MOS CAMERAS**

**GM-2000S-STD, w/audio.....\$79.00**

**GM-2000S-PH, w/audio.....\$79.00**

## MINI, WEATHERPROOF, COLOR BULLET CAM!

For those applications that must be color, this is it. Black anodized, aluminum, housing is O-Ring sealed & RAINPROOF. Adjustable tilting mount included. Specs: 1/3" CCD, 400 Lines resolution, <1 Lux sensitivity, AGC, Auto Shutter. 12VDC @180mA, 4.3mm, 78° FOV lens, A real glass lens. Std. video out. Size: 32mm diam. X 65mm long. 24" leads with RCA jack and DC jack with AC power. adapter. Ready to go!

**SPECIAL, GM-400K.....\$199ea.**

## COVERT VIDEO SUNGLASSES, For those who need to know!

The ultimate undercover wear! This is the camera that sees what you see, hears what you hear and does it with stealth and style! Popular with TV expose' shows. Provides undetectable, low light color video. Specifications include: 1/3" CCD, >350 lines, 510 x 492 pixels, <1.5lux, external 12VDC powered. Includes carry case. Tinted lenses in black aviator style frame. Photo sensitive lenses available. Please allow 3-4 weeks for delivery. **Regular Price.....\$2895.00 Special Price.....\$2295.00**

## IS ANYBODY OUT THERE?



# RESOURCES UN-LTD.

VISA, MC, AMEX, DISCOVER, COD.  
ORDER: 800-810-4070 TECH: 603-668-2499  
FAX: 603-644-7825 E-MAIL unltd4u@riac.net  
300 BEDFORD STREET, MANCHESTER, NH 03101

low cost MICRO BOARD CAMERA, w/audio 1/3" CCD, 410 Lines Res., 0.3 Lux sens., AGC, Auto Shutter. Pwr. from 9 to 12VDC @100mA, 250K PIXELS, Std. model, 4mm, 78° FOV lens, Pinhole, 90° FOV. A real glass lens. Both focus from 10mm to infinity. Std. NTSC video out. 1/2" on! SENSITIVE to IR. Size Std: 1.25" sq. x 1.7" d. PH is 0.6" d. 1.6M long wiring harness with connectors included. **WARNING: Don't confuse these models with LOW RESOLUTION, HIGH LUX C-MOS CAMERAS. Six models to choose from.**

**GM-1000A-STD.....\$60 GM-1000A-STD/Aud.....\$65**  
**GM-1000A-PH.....\$60 GM-1000A-PH/Aud.....\$65**  
**GM-1000A-CMNT.....\$60 GM-1000A-CMNT/Aud.....\$65**

**Micro Lenses for GM1000 series**  
2.5mm, 150°.....\$22 8.0mm, 40° f2.0.....\$22  
4.3mm, 78° f1.8.....\$22 12.0mm, 28° f2.0.....\$22  
6.0mm, 60° f2.0.....\$22 5mm, 70°PH.....\$22

## C-MOUNT, CCD IMAGE INTENSIFIER,

### NOW a MINI HAND HELD VIEWER ALSO.

Our EXCLUSIVE GM-15K, U.S. made 2nd GEN. IP system provides up to 15,000X gain. Add true night vision and super IR capability to any quality CCD camera. Installs between camera & your C-mount lens! Useful as a hand held viewer with our eyepiece & battery holder. Makes your intensifier twice as useful. One of the smallest viewers available! Truly fits in the palm of your hand. Size: 2" d x 3.4" l.

**GM-15K INTENSIFIER.....\$995. GM-15K with GM600 CCD CAMERA.....\$1200**

25mm, f1.4 Lens for use as a pocket scope.....\$125

6mm, f1.3, 1/2" lens for GM600.....\$69

## NEW! 0.008lux, COLOR NIGHT VISION CAMERA!

### UNBELIEVABLE LOW LIGHT PERFORMANCE.

#### Our GMV-2K, DOES it in COLOR TOO!

For covert, military and scientific applications that must be color, this is it. Performance is enhanced through low speed electronic shuttering and digital frame memory. With an auto iris lens, 24 hour monitoring is possible. Auto sensitivity mode starts as it becomes dark. Eight Gain/Shutter modes are user selectable. Normal, X4, X8, X16, X24, X32, X64, X128. These provide frame rates of 60, 15, 8, 4, 3, 2, 1, and 0.5 frames per second. Auto/Manual white balance. Aluminum housing with dual 1/4" 4x20 mounts. Specs: 1/3" CCD, with 291K pixels, 320 Lines, <1 Lux std. mode sens., 12VDC @200mA, Std. video out on BNC. Size: 54mmx50mmx94mm long. With pwr. adapter. All functions can be externally controlled via an 8 pin mini DIN. Uses std. c-mount lens not included.

**New Item, GMV2K.....\$589ea.**

For day to night observation use 4mm, f1.4 A/I lens with custom cable.....\$ 99ea.

## NEW! DAYLIGHT to LOW LIGHT MINI CAM, with AUTO IRIS LENS!

For those applications that must work from dawn 'till dusk, this is it. Rugged aluminum housing with dual mounting sockets. Specs: 1/3" CCD, 420 lines resolution, 0.1 Lux sens., AGC, Auto shutter, 12VDC @120mA. Take full advantage of camera sensitivity with the super, 4mm, f1.4, 78° FOV Auto Iris lens included. Video out on BNC. Size: 50mm sq. X 65mm long. Power adapter included. Ready to go!

**SPECIAL, GM-510-A/I.....\$199ea. or 2 for \$369**

## PRICE BUSTER, DSP, COLOR, MINI C-MOUNT

New, model GM859. Size only: 2" x 2" x 2.5". Latest 1/4" CCD technology. Res. 350 lines, sens., <3lux, auto white balance, AGC. Auto iris connector. 9-12VDC @150mA power. BNC video out. Switchable gain. Superior cast aluminum housing with top and bottom mounting. Perfect for general surveillance. Less lens. LESS sens. See options below. **Special, GM859.....\$179ea.**

## WOW! SUPER COVERT

### "BODY CAM" PINHOLE CAMERA

Now available in WIRED or WIRELESS version! Super stealth, Super small, Super lightweight. Operates from 9VDC. Wireless model transmits on channel 59 cable with 100mW of power! Provides a range of up to 1500 feet or more with a good receiving antenna. Bow tie antenna with balun and "F" connector included. Size: 1.5" W x 2" H x 1" D. Commercially made and BRAND NEW! The best "plug and play" unit available. Both models include the excellent GM1000-PH camera shown left.

**BCIKW, Wired.....\$169 Wireless.....\$299**

## Items we are looking for:

- Esoteric electronics/electro-optics.
- Detectors, Stirling coolers etc.
- What you would like in our next ad?
- Small precision gearmotors.
- Thermal imaging systems.
- Optical mounts

## END FIELD OF VIEW GUESSWORK!

### 3.5 to 8mm VARI-FOCAL LENS

Brand New, super f1.8 lens allows you to smoothly adjust from a 97° FOV @ 3.5mm to a 44° FOV @ 8mm. Now you can frame your area of interest just the way you want it! Standard CS-Mount with adjustable focus and iris.

**SPECIAL.....\$99ea. or 2 for \$189**

## C-MOUNT LENSES

### STANDARD

4mm, 80° FOV.....\$24

6mm, 60° FOV.....\$24

8mm, 40° FOV.....\$24

12mm, 28° FOV.....\$24

### LOW LIGHT

16mm, f1.6, 15° FOV.....\$39

8mm, f1.3, 40° FOV.....\$49

4mm, f1.4, 78° FOV.....\$49

2.8mm, f1.3, 90° FOV.....\$69

### AUTO IRIS, LOW LIGHT

4mm, f1.4, 78° FOV.....\$99

2.8mm, f1.3, 90° FOV.....\$129

Custom cable.....\$12

## SUPER, HIGH SPEED f1.2, 6X, 8.5 to 51MM, MOTORIZED ZOOM,

3 motors, zoom, focus and iris, standard c-mount lens. Compact & lightweight. New Computer type: H6Z-8512M3 Operates from 6-12V dc power. New.

**REG. PRICE \$350**

**Now.....\$199**

New ZOOM LENS CONTROLLER w internal Iris motor control signal, makes ANY motorized lens an Auto Iris lens as well! Super deal with lens.....\$349

## MOTORIZED ZOOM LENS SPECIAL,

### 6X Magnification and Auto Iris too!

#### 12.5 to 75mm & Super Fast f1.2

New, fabulous hi-res. optics with std. C-Mount. Superior Fujinon and Vicon lenses. Normally cost from \$600 to \$1500. There is no substitute for a good lens! All drive motors will operate from 6-12VDC. The Auto Iris has a built in amp which works with any camera video output. No special connectors or A/I plug required. Model B-6XENC has HP optical encoders for position feedback of focus and zoom as well.

**Special, Type B-6X.....\$179ea. or 2 for \$349**

**Special, Type B-6XENC.....\$229ea. or 2 for \$399**

**New ZOOM LENS CONTROLLER.....\$169**

## MOTORIZED 10X ZOOM, SURVEILLANCE LENS

New, 11mm to 110mm, f1.8, C-Mount, Fujinon, industrial quality optics paired with precision drive enable smooth remote operation of FOCUS, ZOOM and IRIS. Unit is open frame, black anodized alum. structure supports the sophisticated drive. Two models: Mod Z5 std, or Mod Z10 has HP optical encoders for position feedback (128ppl on zoom & focus Edmunds sells the lens w/o drive for \$869ea. Motorized unit sells for >\$2000. Very limited quantity. Don't cry when these are gone! **SPECIAL PRICE. Model Z5.....\$349ea. Model Z10.....\$399ea. New ZOOM LENS CONTROLLER.....\$169ea.**



**Brand New, Video Motion Sensor.** Model VM10. Attach to any standard video signal and you've got an electronic "watchman" diligently watching the entire scene. Or any adjustable sized area within the scene. Such as a doorway or even a drawer or cabinet. A state of the art security aid. The unit will close a contact when it senses a change. Use it to turn on a VCR or call the hounds. Auto or manual reset. Compact, ac powered. Adjustable sensitivity. Video loop through jack. **NEW VM-10.....\$189.**

**DIGITAL VIDEO CHANNEL MODULATOR, WORLD'S SMALLEST**  
Make your own TV Channels! Your in-house cable TV network! Now you can take standard video & audio from any source: camera, camcorder, laser disk, VCR, game etc. and create your own cable TV channel. You could have channel 72 for the front door, 73 for the VCR and 75 for the baby's room. Units have a built in sequencer for cascading multiple units, allowing multiple sources on the same channel. Sensor inputs allow security contact closures to generate audio alerts and automatic channel switching. Built-in video amplifier allows the MOD-70 to be mounted at the video camera without signal loss. Combined stereo inputs, AV cables included. Internal test bars and audio tones for system setup without live video. Covers UHF 14-69 and Cable 70-125 with Crystal controlled +/- 5KHz stability. E-Prom channel memory. Specs: Out level +22dBmV, Vid. Freq. Resp. +/- 1dB, 75 Ohm I/O, Vid. S/N 52dB, Aud. S/N 50dB, 12VDC pwr. DC adapter supplied. Size: 3.4" x 2.2" x 0.9", extruded aluminum pkg. with black powder coat finish. 5 year ltd. warranty. Two models, single channel or three channels.  
**MOD70, One channel.....\$99ea.**  
**MOD70/3, Three channel.....\$199ea.**

**CO-AXIAL VIDEO CABLES, New!**  
**100' RG-6, low loss, or 10' RG-59B/U**, both are 75 ohm & BNC terminated, both ends. RG-6 = Belden 9114. RG-59 = L-COM  
**Special RG-6...\$15ea. or RG-59B/U...\$5ea.**

**New GME-1000, 2.4GHz FM Wireless Video FCC Approved, Range to 3 Miles\* Line of Sight!**  
Superior commercial quality and functionality with features not available elsewhere! Transmits color or B&W, NTSC or PAL up to 460 lines resolution, plus audio channel and two alarm contact closures. The ultra high sensitivity receiver provides superior Line of Sight range \*outdoors with gain antenna. The video signal is protected by a video loss alarm as well as a 24-bit identification code. Stand by mode reduces transmitter power draw to 10mA when no video is present. Four user selectable channels. Rugged all steel construction. Size: 3.4"W x 4.3"H x 1.2"D. Both units powered by 12VDC. 200mA TX, 350mA RX. Via simple screw terminal connection. System incl: Transmitter with omni antenna. Receiver with 8dB patch antenna, 2 AC power adapters and manual. 14dB patch and 24dB parabolic 30" x 24" antenna also available.  
**Complete system..... \$595, less recv. antenna.**

**NEW! HIGH RESOLUTION DUAL PAGE QUAD FULLY LOADED with FEATURES not PRICE!**

The GM8-BQ B&W quad processor, is an unbeatable value. The system offers 4 or 8 camera inputs. Full screen image, single or dual-page REAL TIME quad display, **super high resolution: 960 x480**, Independent brightness adj. for each channel. Alarm time (1-20 sec.) 8 alarm inputs. Auto Sequencing mode w/ith adj. dwell: 1-4 sec. User-friendly panel. Real quality video processing and a truly remarkable price. Specs: • 8 video inputs. • Video output: 1 monitor out and 1 quad out. • Quad Display: Single page or dual page switch. • Alarm input: 8 alarm inputs • Buzzer: Yes • Alarm output: 2 Alarm out • Dim: 239 x166 x55 mm. • Pwr: AC 24V.

**SPECIAL! PRICE BUSTER, GM8-BQ.....\$225ea.**

**MITSUBISHI COLOR VIDEO COPY PROCESSOR**

**MODEL CP100U**, Thermal transfer, dye sub. process. 640 X 480 resolution. NTSC, Y/C, SVHS, RGB TTL and analog inputs. Parallel port as well. Prints @ 70 seconds per sheet color and 35 sec. per sheet mono. Internal page memory freezes image for multiple prints. Includes manual and supplies for 100 prints. Additional available. Used in good condition. Perfect for screen grabs from VCR or computer. Original cost \$1500ea. **CP100U, Special.....\$249ea.**

**NEW! 4 CHANNEL VIDEO AUTO SWITCHER**  
Model GM34. Connect to any four standard video signals and they will be sequentially output to the dual rear panel BNC outputs. Front panel user adjustable, variable dwell 1 to 15 sec per channel. Auto or manual switching with channel bypass. Compact only 8.6"W x 3.7"D x 1.75"H, ac powered. Video loop through.  
**GM-34, Special.....\$79**

**NEW, 2.4GHz VIDEO + STEREO AUDIO TRANSMITTER with SONY, CCM-PCS COLOR CAMERA.**  
Originally sold for \$500! Now available for a fraction of that price. Great looking styling. Camera has a very stable, adjustable tilting base, front panel LED pwr. indicator and sensitive built in electret mic, providing excellent audio and video performance from one compact package. Simply connect camera to the completely self contained 2.4GHz transmitter. All cables supplied. You can transmit up to 700 feet clear line of sight! Companion matching receiver works with any TV or VCR. Internal patch antennas. Camera has adjustable focus 6mm lens. (1" to infinity, macro capable) Auto power off when the privacy shutter is closed. Power is 7-13VDC. (all pwr. adapters and cables included) 1/3" CCD, 330Lines res. 35% better than standard VHS! Can also be used to transmit VCR or camcorder output to another TV for remote viewing.

**SPECIAL, 2.4GHz SONY-ASTROVIEW \$189, complete 3pc system or 2 for \$339**  
**Order additional 2.4GHz TRANSMITTER/RECEIVER pair less camera...\$129 set.**

**COMPLETE SELECTION OF COVERT CAMERAS, all available with audio.**  
Specification for all models include: 1/3" CCD, 410 Lines Res., 0.3 Lux sensitivity, Power from 9 to 12VDC @100mA, 90° FOV lens except dome and PIR which are 80°. All focus from 2 ft. to infinity. Standard NTSC video out. SENSITIVE to IR. note: Smoke & Motion detectors not functional, Clock & Exit operate normally. Dome is 3.5"H x 5.5"Diam. Don't see what you want? We can put a camera in anything you desire. Call tech. support for quote.

**Smoke Detector, Motion Dector (PIR, Clock) or Dome Camera, Special.....\$99ea.**  
**Exit Sign, Special.....\$119ea. Please add \$10 for audio. (any model)**

**16 CHANNEL DIGITAL VIDEO MULTIPLEXER, allows real time, multi-camera recording to tape.**  
NEW! American Dynamics, 1484SL-16. Allows recording of up to 16 cameras on one video tape. Video loss detection and pre-loss frame memory. Manual/auto camera selection. Can be rack mounted. A commercial quality unit. Very limited quantity available. **AD1484SL-16, Special.....\$499ea.**

**IS ANYBODY OUT THERE?**

**RESOURCES UN-LTD.**

VISA, MC, AMEX, DISCOVER, COD.  
ORDER: 800-810-4070 TECH: 603-668-2499  
FAX: 603-644-7825 E-MAIL unltd4u@rac.net  
300 BEDFORD STREET, MANCHESTER, NH 03101

**\$5000 HI-TECH SURVEILLANCE SYSTEM, NOW 82% OFF!**

**THIS SUPER SYSTEM INCLUDES:**

- **MOTORIZED, 6X ZOOM LENS**
- **MOTORIZED, 360° CONTINUOUS PAN**
- **MOTORIZED, TILT up to 90°**
- **PHILIPS HIGH RES. 1/2" CCD CAMERA**
- **OPAQUE BLACK INNER DOME**
- **CLEAR ACRYLIC OUTER DOME**
- **ZOOM LENS CONTROLLER with A/I**
- **PAN and TILT CONTROLLER**

Walk into any major department store and you will see these fully integrated systems. Manufactured by Sensormatic, the same company who supplied the Atlanta Olympics! These are late model, new in the box systems. Virtually ready to use. All you add is power and cable. A quality Philips, 1/2", B&W CCD camera provides 450 lines resolution and 0.5 Lux sensitivity! Their best grade CCD. Anodized aluminum construction. Camera plus Pan & Tilt are powered by external 24VAC via the included Pan & Tilt controller. Super 6X, ft.2 motorized, Zoom, Focus, and Iris lens provides the capability of "close up" inspections. Zoom lens controller with auto iris control included. Size of dome: 14" diam. Includes mounting kit for drop ceiling installation. Sensormatic price \$5000ea.

**COMPLETE SYSTEM SPECIAL.....\$895ea. or 2 for \$1699**

**PANASONIC DIGITAL, PROFESSIONAL, COLOR CCD CAMERA**

- **Auto/Man White Bal.**
- **8X f1.4 Zoom Lens**
- **10.5 to 84mm / Macro**
- **Manual Zoom**
- **Stereo Mic Inputs**
- **NTSC Output**
- **Auto/Manual Iris**
- **Auto Focus**
- **3 Step AGC**
- **Earphone Output**

They are used in excellent condition. Specs: Res.380 Lines, S/N: 46dB, Sens. 7 lux. Size with lens: 10.75L x 4.5"W x 4.5"H. 1/1000 sec. electronic shutter for clear fast moving imagery. Supplied with users manual. New CA-10 cable. New Panasonic WV-3203B power supply with video and audio RCA outputs as well! A \$2800 package, very impressive. **WV-D5000 SYSTEM, Special.....\$299ea. Complete**

**MOTORIZED PAN and MOTORIZED TILT with Pan and Tilt Controller.**  
Now you can remotely PAN and TILT your video cams. Vicon model 3030 indoor units are NEW and operate on 24VAC provided. The complete system includes Pan & Tilt controller with internal power supply Easy hookup, info included. Max load 7.5lbs. Size: 5.25"W x 5.25"L x 5.25"H Approx. -10, 10, +50 deg. of tilt. Commercial quality unit. **VICON 3030PT.....\$249**

**WORLD'S SMALLEST ... 100mW ... VIDEO TRANSMITTER,**  
Incredibly only 0.98" x 0.8" x 0.037" in size. Transmits crystal controlled hi-res. images with 100mW output! The transmitter you've been waiting for. **Shown actual size. Smaller than the 9V battery which powers it.**  
Draws only 35mA! Factory tuned. Receive on cable channel 59. Will work with color or B&W cameras. UHF Bow tie antenna with balun and 3' F cable for TV included. Perfect with our GM1000A. Both will fit in a cig. pack with battery!  
**TVX-100.\$179. with GM1000A-PH CAM.....\$249.**

**4 HEAD TIME LAPSE VCR, Records 24 HOURS!**

**VICON 424, Special.....\$399ea.**

Used, refurbished, late model VICON model 424's, at only 2/3 off the regular price. On screen programming, time/date stamp, audio, index search, power loss recovery and alarm inputs. Excellent, with manual.

**SCIENTIFIC, 1/2" COLOR CCD CAMERA**

- **YC/SVHS out**
- **380K Pixels**
- **460 Lines**
- **<1 lux sens.**

All parameters adjustable from outside camera! Perfect for microscopy, inspection or surveillance. Internal or external sync, interlaced or N/A, Adj. shutter, 1/60 to 1/10000 Sec. Three step Auto White Bal. Auto iris output, C or CS mount, Manual/ auto gain or ext. variable gain. BNC video out, 12V @ 250mA pwr., via std. barrel jack. The GM470-C has it all! Aluminum housing. Size: 50mm W x 50mm H x 145mm L.  
**SPECIAL GM470C, less lens.....\$459ea.**

**SEE in TOTAL DARKNESS! WEATHERPROOF IR FLOOD,**  
48 powerful LED's project a 40 deg. FOV beam up to 45 feet. Automatic on at dusk off at dawn! 110VAC power. Rugged anodized aluminum, housing with adjustable mtg. bracket. Size: 4"x5"x6.3". Commercially made. Brand New!  
**WPIR.....\$179ea.**

**WEATHER RESISTANT Camera Enclosure,**  
Solid, extruded aircraft aluminum. Glass window. Strain reliefs for cables. Size: 3.5"W x 3.7"H x 1.4"L.  
**Special.....\$59ea. w/110V heater.....\$69ea.**

**CLOCK RADIO COVERT CAMERA**  
New, Magnavox clock radio with covert low light video camera. Specifications per our GM1000A shown on page two. Connect the output to anything with a "video input" jack via RCA style output plug.  
**CRC-1STD, Special.....\$129ea.**

**NEW, SONY, CCM-PCS COMMUNICATIONS CAMERA**

**HIGHLY RATED, TELE-CONFERENCE CAMERA**  
Originally sold for \$400! Now available for a fraction of that price. Great looking styling (doesn't look like a toy camera!) Very stable, adjustable tilting base, front panel LED pwr. indicator and sensitive built in electret mic, combine to provide excellent audio and video performance from one compact package. Designed to fit unobtrusively on top of your monitor. Adj. focus 6mm lens. (1" to infinity, macro capable) Auto power off when the privacy shutter is closed. Powered by 7-13VDC. (adapter included) RCA out for video & audio. 1/3" CCD, 330Lines res. 35% better than standard VHS! Size mm: 119 W x 95 D x 60 H. Sony quality.  
**SPECIAL CCM-PCS.....\$89ea. or 2 for \$169**

**ASTRO-CAM, SCIENTIFIC, CCD CAMERA with THERMO ELECTRICALLY COOLED HEAD**

Model TE3N/A with KODAK KAF 0400-CI CCD. Manufactured in 1994 these cameras were over bought by a large analytical instrument company. They are in like new condition. We have no data at press time except for the KODAK 768 x 512 CCD specs. Wavelength sensitivity is from 400 to 1080nm. Less than 1.5% non linearity. Fan cooled Pellier operating at -40° temp. Bayonet lens mount for 35mm objective. (lens not included) These heads are used in the Capella and Antares systems from Astromed/Astrocam. With readout rates of 500KHz to 8 MHz, 12-14bit dynamic range, No image retention lag or distortion, high tolerance to overexposure. Size: 4" sq. x 6" Long. Any info would be helpful. Sorry, we do not have the interface. **TE3N/A, Special.....\$399ea.**



## NEWPORT, PRECISION TRANSLATION STAGES. for those with a NEED to PERFORM!

### MODEL 400 or 406 X-Y PLATFORM

Two orthogonal positioners in one low profile unit. Super stable pre-loaded linear bearings can support up to 100 lbs. Provides 1/2" travel. <200 urod deviation. Model 400 has solid top plate. The model 406 (shown left) has a 2.25" diam. clear aperture though the unit. Both include Zeo, SM-13 vernier micrometers with 0.001mm resolution. Size: 5.5" x 5.5".  
**NEWPORT price \$600, Special.....\$249ea.**

### MODEL 436 TRANSLATION STAGE

Crossed roller bearing design for precision movement and load capacity. Lockable, stackable, reversible for left or right hand operation. Hardened carbide actuator insert. Pre-loaded against backlash. An array of 1/4-20 and M6 tapped holes provided. <125 urod deviation Supplied with the SM-13 vernier micrometer actuator with 1/2" travel and 0.001mm resolution. Max. stage travel: 1". Max load 125lbs. Size: 3.5" x 6".  
**NEWPORT PRICE, \$600, Special.....\$249ea.**

### NEWPORT OPTICAL MOUNT

Super quality brand new type MM-2 mirror mount, with 1" riser block and base. precision 80-pitch stainless steel adjustment screws with hardened ball tips and brass threaded inserts. 7.5° adjustment range and 5 arc/sec resolution. Black anodized aluminum construction.  
**OUR PRICE.....\$39.00ea.**

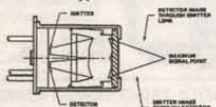
### BURLE PHOTOMULTIPLIER TUBE, 931B

New. Boxed. (shown LEFT) Side window type, 300-600nm. Data sheet supplied. Data avail. on Burle website. Reg. price \$85ea. **SPECIAL.....\$29ea.**

### LASER SIGHTS, 650nm and 635nm Rugged and Dependable.

Windage and Elevation are easily adjustable using internal adj. screws. Custom mount, alkaline battery and remote switch included. Simply specify your make and model.  
**LASER SIGHT, Super 650nm.....\$69**  
**LASER SIGHT, Ultra 635nm.....\$99**

### HIGH RESOLUTION, OPTICAL REFLECTIVE SENSOR IC, HP type HBSC-1100



The HBSC-1100 is an integrated device for reflective optical sensing. The modified, 8 pin, TO-5 pkg. contains a .007" diam., 700nm visible LED emitter and a matched IC photodetector. A bifurcated aspheric lens images the active areas to a single spot 4.27mm in front of the package. Applications include: pattern recognition and verification, object sizing, textile thread counting, defect detection, line locating, edge detection and bar code scanning. HP price \$27ea. **\$4.95ea. or 5 for \$20**

## MORE, NEWPORT TRANSLATION STAGES. for those with a NEED to PERFORM! also a few other goodies too!

MODEL:	DESCRIPTION:	EACH
270	LAB JACK	\$249
RSA-2T	360 deg. Rotary Stage with Clear Aperture.	\$129
625A-4	Laser Holder	\$149
481A	Rotary Stage	\$189
M36	Translation Stage	\$249
460A-XY	X-Y Translation Stage	\$189
M37	3 Axis Translation Stage	\$289
415	Vertical Translation Stage	\$129
M360-90	Mounting Plate 90deg.	\$29
M436	Translation Stage	\$199
M150	Magnetic Mfg. Base	\$129
420	Linear Translation Stage	\$119

### MISC. OPTICAL COMPONENTS:

HP10706A	INTERFEROMETER	\$129
HP10703A	INTERFEROMETER	\$129
HP10702A	INTERFEROMETER	\$129
HP10780A	RECEIVER	\$199
MELLES GRIOT	SHEAR PLATE	\$119
RUCKER & KOLLS 222	X-Y-Z MICRO POSITIONER	\$50.

## MANY MORE, LINEAR STAGES AND RELATED MOTION CONTROL ITEMS in STOCK

CALL FOR THE LATEST INFO IN ITEMS FROM:

- DAEDAL
- COMPUMOTOR
- AEROTECH
- LINE TOOL
- STEINBERGER
- KLINGER
- ORIEL
- VEXTA
- And Others



## 75mW ARGON LASER. Brilliant Turquoise beam, Uniphase Model 2213-75 w/2113 power supply.

The 488nm, TEMoo mode is something to see! Power for a "serious" display. Excellent plug and play condition. Power supply (used) can be controlled remotely with optional interfaces. Standard 220VAC operation. Compact power supply and fan cooled head. Less than one third the regular price. Unused heads. **Reg. \$6000, Our price.....\$1995**  
**Basic remote.....\$175, Remote w/LCD display.....\$595**



**COMPACT 3mW ARGON LASER, New, Uniphase 2202-3 with power supply.**  
**Brilliant Turquoise beam. Looks as bright as a 20mW HeNe!** The 488nm, TEMoo mode is something to see! The power is in the wavelength. This highly visible beam operates where the eye is most sensitive. Very impressive for its size. Head only 2.5" diam. and 13" long. Plug and play operation. Standard 110VAC operation. Compact power supply and fan cooled head. Less than 1/4 the price of a new one. Looks like a scaled down 2213 shown above. **Reg. \$2900 Our price.....\$695ea.**

### FREE ARGON LASER with POWER SUPPLY?

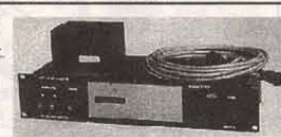
**16mW Brilliant Turquoise Blue.**  
Our low price is like paying for the power supply and getting the laser FREE! The 488nm, TEMoo mode is nearly 10X brighter than a 16mW HeNe! This is the laser you always wanted but couldn't afford. Perfect for that kick butt light show! All are in good, plug and play condition. Standard 115VAC operation. Integral fan cooling. We priced the whole system for less than others charge for the power supply alone. Why spend more? Always in demand. Limited Quantity.

**New Price...\$5K+ SALE.... THIS MONTH ONLY.....\$799 Complete**

### FANTASTIC LASER LIGHT SHOW SYSTEM,

**Operates with Internal or External Laser!**

The versatile Beamscan system requires no external PC. The processor is built-in. The beam scan is controlled using an integral twenty key touchpad and backlit 2X16 LCD display. The user can create simple or complex patterns with a few keystrokes. Beam effect sequences are played back for a user programmable position and duration. Events may be triggered by external audio. Over 80 patterns and 15 beam effects are pre-programmed. Three line level inputs, 4 oscillators, envelope generator, user name for custom input sequences, 8K NV-EEPROM. Virtually plug and play operation. One year warranty.



Three model from which to choose:  
**Model GM-XYPN without laser.....\$call**  
**Model GM-XYYP, w/5mW HeNe.....\$849**  
**Model GM-SHXP 2nd Scanner.....\$229**

## IS ANYBODY OUT THERE?



VISA, MC, AMEX, DISCOVER, COD.  
**ORDER: 800-810-4070 TECH: 603-668-2499**  
**FAX: 603-644-7825 E-MAIL unltd4u@iac.net**  
**300 BEDFORD STREET, MANCHESTER, NH 03101**

### Exclusive LAB STYLE, class 3A, LASERS.

Available in 650nm or 635nm wavelength.  
Rugged & dependable. with a 1 year warranty.

Adjustable X & Y beam position. Aircraft aluminum housing. Internal battery (included) rear push on, push off switch. AR coated end window. Shock protected. 75dium, x 2.75"



650nm \$69 or 635nm \$99

### SPECIFICATIONS:

DC Power: 4.5 - 9V, @65mA  
Power out: 4.5mW max.  
Range: 400-800 Meters  
Glass Collimator  
Size: 0.41" diam. x 0.71"

### NEW, LASER DIODE MODULES



650nm 5X Brighter...\$29  
635nm 10X Brighter...\$69  
\*635F 10X adj. focus. \$89

The best value for commercial, Subminiature, laser modules. Glass collimating lens provides 1.5mRad performance. (divergence comparable to HeNe lasers.) Wide input, internal surface mount, 4.5 to 9VDC power supply. Machined brass for excellent thermal characteristics.

### IR LASER DIODE, 5mW, SHARP LT022MD, Brand new!

Popular 5mW, 780nm laser diode. Excellent for laser communications, alarm systems, covert illuminators etc. Highly visible to CCD cameras. These must be protected from excess current and static electricity. Individually tested.  
**Special.....\$7.95ea., 3/\$20**



### NEW, MINI LASER PATTERN PROJECTOR and IT'S PORTABLE TOO!

- Built-in microprocessor control.
- Approximately 40 patterns.
- Spinning and geometric laser displays
- Pattern modes: Auto, Manual, & sound control.
- Wireless remote control.
- Laser patterns can be easily projected in any direction.
- Battery or AC powered.
- 4 x "AA" batteries & AC adapter incl.
- 635nm 635nm Class II laser for excellent visibility.
- Laser patterns change rhythmically to sound input.
- External sensitivity control for sound mode.
- Dimension: 16.0cm(L) x 15.0cm(W) x 9.0cm(H)
- Weight: 600Grams (incl. batteries.)
- Range: 12meters
- Approximately 4 hours run time from batteries.
- Mfg. Warranty for 1 year.



MINI Laser Projector, Special.....\$

## ARGON LASER POWER SUPPLY. INDUSTRY STANDARD, AMERICAN LASER 60X



We were fortunate to obtain these unused and factory refurbished ALC 60X power supplies. Always in demand but hard to find. They can power most Argon heads up to 12AMPS. We have no manuals at press time. If you have a 60X series head or similar this is the unit for you. 110VAC power. Rugged anodized aluminum, housing with internal fan. Size: 8"x8"x11", 22 lbs. Don't miss out. Very Ltd. Qty. **ALC60X...\$399ea. or 2 for \$695**

### OPTICAL BANDPASS FILTERS

Each kit includes three filters. One 420nm +/-2, one 520 +/-22, ONE 600 +/-18. Mfg. by CIBA-Corning. In original sealed packages. Each multilayer dielectric filter is 0.5"W x .75"L x .175" thick. Beautiful to look at even if you don't need one. **Reg. \$80 each. Now...\$20 per set**

### ESOTERIC OPTOELECTRONICS

Toshiba LINEAR COLOR CCD type TCD2301 C (shown RIGHT) Features a 3648 X3 element 3 line image sensor. Designed for high end page scanner. No data on driver board. Complete specs. for chip included.  
**SPECIAL.....\$19ea. or 2 for \$29**

### MIRROR GALVOS, Open Loop, X/Y

With 40mm, first surface mirrors. Galvos are General scanning model Z1483. Both are pre mounted on a black anodized aluminum plate and pre aligned for operation.  
**Limited Quantity.....\$249 set**



### CROSS-HAIR RETICLES, New precision ruled glass. 1.8" diam.

x .125" thick. Give your projects a professional touch. Usually quite pricey.  
**Special.....\$5 for \$10**

### VARI-DENSITY BEAM SPLITTER IS MOTORIZED!

50mm diameter wheel mounted to 3VDC Canon precision gear-motor. Includes a 5mm photo-voltaic cell for optical feedback. Riser & base machined from a single block of aluminum, black anodized. Optical center 46mm high. Overall size: W63mm x H92mm x D69mm. Removed from equipment.  
**SPECIAL.....\$129ea.**

### LASER EXPERIMENTERS BONANZA,

Computer Identics barcode reader with 670 nm laser diode scanning head. Late model system with remote laser head in extruded alum. housing, 4" x 3" W x 2" H. Head includes laser, collimator, 1" front surf. mirror mounted on resonant scanner, 1" obj. lens, bandpass filter, and receiver board with photo diode. Control module contains microprocessor, alphanumeric display, 15W triple output power supply. A super parts value or use as intended. With ops. manual. **\$39ea. 2 for \$69**

We appreciate your business. You have made it possible for us to offer unique items for the last nine years. What would you like to see in upcoming ads. Our Web page will be ready for product searches in about 45 days if we are lucky. We thank everyone for their kindness and hope to hear from you soon. Best Regards, Bill Domenico

### MOUNTED, FRONT SURFACE MIRRORS, adjustable. 1.5"

diam adj. mirror cell holds 14mm FSM. Mounts are easily removed from sturdy solid aluminum base. Four allen screws for adj. Single mirror base unit is: 5.25"H x 3"W x 1.6"D. Dual mirror base unit is: 4"W x 3"D x 2.75"H Perfect for home holography. Removed from laser system. Excellent condition.  
**Single.....\$14.95 Double.....\$19.95**

### CUBE BEAM SPLITTER, 13mm x 13mm.

Two precision right angle prisms, flat to two waves, Bonded and AR coated. Permanently mounted on alum. plate. Split approx: 88% thru, 6% split. **Special.....\$5ea.**

### MERCURY SHORT ARC LAMPS

Provide intense UV and visible illumination. Two, new types available:  
OSRAM HBO 1003/P, 1000W.....\$139ea.  
OSRAM HBO 1500W/P, 1500W.....\$179ea.  
One used model available:  
ILC MSH 10003GI, 1000W.....\$39ea.

### INFRA RED TRANSMITTER and RECEIVER MODULE.

Perfect for remote control or covert signal system.

New, Key FOB style IR transmitter from Polaroid, becomes the perfect companion to the tiny SHARP GP1U581Y integrated, high sensitivity receiver module. Size: 0.6"x0.6"x0.5h" Typical range of 25 to 40 feet. With data. Rcvr. has only three connections! Excellent classroom project. Package includes 4 IR transmitters and 2 IR receivers. **SPECIAL.....\$10 set or 6 sets for \$50**

Items we are looking for:  
• Esoteric electronics/electro-optics.  
• Detectors, Stirling coolers etc.  
• What you would like in our next ad?  
• Small precision gearmotors.  
• Thermal imaging systems.  
• Optical mounts



**DOVER AIR BEARING X/Y TABLES, ULTRA PRECISE,**  
Like New. The ultimate in precision motion control.  
Lead screw operated air bearing tables with  
1-20 Microns typical repeatability.  
Straightness, <1 micron each axis, angular  
error, <1 arc/sec. Squareness, <5 arc/sec.  
Three types: Model "A" has 6"x6" travel with 2  
type 238LS-021-02, 4.85A 24V Rapidsyn  
stepper/encoders. Type "B" is as above without  
motors. Type "C" has 4"x5" travel with two Compumotor LE57-S1-MTR  
steppers. Type "A".....\$1200, Type "B".....\$949, Type "C".....\$849



**MINI ROTARY DRIVE with on board LINEAR SLIDE,**  
Provides 300° rotation between removable  
stop. Rotates continuously with-out stop. 2  
optical position sensors for start & end. Same  
stepper as above. Each full step = -0.25° of  
rotation. Made from cast & machined resin &  
alum. Attached slide provides 3" travel.  
Construction similar to slide above. Moves 0.008"  
per step. Dual optical end of travel sensors. Overall 7.5"L x 5.25"W  
x 4.5"H. Special.....\$49ea or 2 for \$89



**UNIQUE LINEAR MOTION BASE,**  
Originally intended as the motion drive for a high end, desktop, flat bed  
scanner. These are new units  
removed from a discontinued model.  
Movement is via a stepper motor and  
toothed belt drive, which moves the  
carriage 12" across two polished  
stainless steel rails. (the same action  
that moves the lamp across the  
page.) The assembly is mounted to  
the scanner cover. We recommend removing it and mounting it on your  
base. Includes optical end of travel detector. Overall size: 16.1" x 13" w x  
2"H. Nicely made. LMB-2.....\$29ea, or 2 for \$49



**BRUSHLESS DC SERVOMOTOR**  
with Hall Effect position sensors. BEI Type:  
DH23-25-013Z, 2.25" diam. X 2.5" deep with a 1/4" ball  
bearing shaft. A beautiful precision motor. Sorry no  
specs. at press time. SPECIAL \$29ea, or 2 \$49



**TINY, PRECISE, PORTESCAP, SWISS, GEARMOTORS.**  
State of the art "ironless" type, mini motors. Mod. A (left) 1219E-012-G-400  
has 1044:1 Planetary gearbox. Size: 12mm dx 44mm l. Model B (right):  
M11-210-54-0 with approx: 40:1 spur gearbox. Size: 16mm d. x 43mm l.  
Both have 2mm d x 6mm l. flatted shaft, solder terminals.  
V<sub>dc</sub> I<sub>dc</sub> RPM  
A: 6V 5mA 68  
12V 5mA 145  
B: 6V 8mA 141  
12V 12mA 290



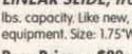
**MOTORIZED, ROTARY STAGE, Newport**  
model 495A, Extreme precision, bidirectional, 360°  
continuous rotation with 0.001° res. Integral DC  
motor & encoder. Load independent velocity  
servo. Mount in any orientation. Capacity:  
55lbs. Size: 4.75"x5"x1.35" 2" clear aperture.  
Reg. price >\$2000, Special.....\$695



**AIR BEARING SPINDLE from DOVER INSTRUMENTS**  
Super accurate motorized air bearing  
spindle & servo motor controller. Similar to  
534-RF-BDC/MFM. Face plate 4.8" d. Max.  
RPM 7200. Load to 65lbs., axial stiffness:  
1,500,000 lb/in., axial rotational error <2 micro-inches, radial  
rotational error <2 microinches. Operates with 90PSI @  
1.35cfm. Controller provides <0.01% speed accy. Good cond.  
Dover price >\$15K SPECIAL.....\$895



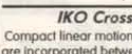
**LINEAR SLIDE, from PARKER, Anodized alum. Ball bearing, 50**  
lbs. capacity. Like new, removed from lab  
equipment. Size: 1.75"Wx4"Lx.75"H with 3.4" travel.  
Reg. Price.....\$80ea. Our Price.....\$29ea. 3/\$79




**LINEAR SLIDE, from THK,**  
Type: RSR 12WVM, with 15" RAIL  
Recirculating, miniature UM series guide. Like new, removed from lab  
equipment. Load bearing in all  
directions. Wide block design.  
Accurate to +/-0.04 mm or better.



**IKO Crossed Roller Ways, Type CRW-250**  
Compact linear motion rolling guides. Super-precise cylindrical rollers  
are incorporated between V-shaped, steel raceways. The CRW type, can  
be easily adapted to fit a variety of mounting arrangements. These  
crossed roller units have extremely high accuracy and high rigidity as  
well as very low frictional resistance. High reliability. Rail size: 9.8"L x  
0.54"H x 0.58"W. 2 rails plus the captive bearing unit make up one  
moving slide. Two sets would be required for most applications.  
Special.....2 for \$39



**RELIANCE ELECTRIC/ELECTRO-CRAFT**  
BRUSHLESS SERVOMOTOR  
BRU-Series, Electrocraft Series,  
Universal drive with power & reliability.  
Feature-rich, high-performance drives  
offer flexibility & versatility for a wide  
range of applications. In fact, the unit is  
capable of serving as an analog input  
velocity servo, variable speed drive,  
stepper drive replacement or master  
encoder follower with electronic gearing.  
The BRU-200, Drives Electro-Craft  
brushless servo motors over a wide range of torque and speed.  
DRIVER INFO: MODEL: DM-30, PN 9101-1133-G  
INPUT: 120/240 VAC, 1PH  
OUTPUT: 120/240, 0-4000Hz @ 15A Cont.  
MOTOR SPEC: MODEL: S-4030 P H00AA  
P/N: 6042-03-802-4/94  
STALL TORQUE: 3.3Nm, 30lb-in  
MAX. RPM: 4000



**BRU-Series, Electrocraft Series,**  
Universal drive with power & reliability.  
Feature-rich, high-performance drives  
offer flexibility & versatility for a wide  
range of applications. In fact, the unit is  
capable of serving as an analog input  
velocity servo, variable speed drive,  
stepper drive replacement or master  
encoder follower with electronic gearing.  
The BRU-200, Drives Electro-Craft  
brushless servo motors over a wide range of torque and speed.  
DRIVER INFO: MODEL: DM-30, PN 9101-1133-G  
INPUT: 120/240 VAC, 1PH  
OUTPUT: 120/240, 0-4000Hz @ 15A Cont.  
MOTOR SPEC: MODEL: S-4030 P H00AA  
P/N: 6042-03-802-4/94  
STALL TORQUE: 3.3Nm, 30lb-in  
MAX. RPM: 4000  
New, BRU-200, Special.....\$389ea.


**ULTRA PRECISE, KENSINGTON LABS, XY STAGE.**  
Model 8500-6X, 6"x6" of high performance travel.  
One of the best linear stages available. Highly  
repeatable, ultra-precise. Precision ground surfaces  
result in unmatched laboratory-grade performance.  
Linear glass scale, internally attached to the table,  
eliminates all drivetrain errors not measurable when an  
encoder is attached to the motor. System provides up to 0.025um res.  
over 100 mm. Built from stress relieved 7075 aluminum. Crossed roller  
bearings for excellent stiffness, load capacity and lifetime. Combined with a very  
low friction preloaded leadscrew and DC servo motor drive provides 20,000 hour MTBF. 100 mm/sec  
maximum speed and >50kg load capacity. Size: 15.1" x 9"W x 2.75"H Regular price >\$4Kea. X&Y stage  
with motors no drivers. USED, Very good condition.  
MODEL 8500-6, XY LINEAR STAGE.....\$1795



**COMPUMOTOR SX series, MOTION CONTROL**  
The SX is a bipolar, microstepping drive with built-in  
indexing. Drives two-phase permanent magnet step motors. MOSFET technology gives  
high performance in a small package while providing protection against short-circuit,  
brownout and over-temp. Built-in power supply. Indexer can store 99 multiple move  
motion programs in battery backed RAM. Programs can be selected via BCD inputs,  
programmable controllers or a computer via RS-232C interface. The SX also provides  
the following features:  
• 16 selectable resolutions (200 - 50,800 steps/rev)  
• Smooth microprocessor controlled, wide range microstepping.  
• Closed-loop positioning interfaces to incremental or absolute encoder.  
• Motion profiling allows distance based velocity change without stopping.  
• 90VAC - 132VAC, 50/60Hz power input.  
Many features too numerous to include here. Used, excellent condition. w/manual.  
SX model \$199 or 2 for \$349 also S model \$189 or 2 for \$329



**ROTARY TABLE with PRECISE .002" RESOLUTION**  
Hard to find rotary motion base. This 13lb. unit includes a 9.25" diameter  
anodized aluminum platter with a toothed outside diameter. A toothed  
belt surrounds the O.D. and is driven by a 1/2" diam. toothed pulley  
attached to the output of a Bayside 5:1 ratio, right angle drive, powered by a  
Slosyn, M061-IF-504, 1.25V, 3.8A, 200 step per rev., 60 oz/in. stepper  
motor. By our estimate this should equate to about an 18500:1 final drive  
ratio or about 0.0195 deg. per full step! Overall size is: 14.5"W x 17"L x  
4.75"H Construction is of anodized aluminum with a cast structural resin  
outer chassis. Removed from precision optical device.  
SPECIAL.....\$99ea. 2 for \$189.



**IS ANYBODY OUT THERE?**  
**RESOURCES UN-LTD.**  
VISA, MC, AMEX, DISCOVER, C.O.D.  
ORDER: 800-810-4070 TECH: 603-668-2499  
FAX: 603-644-7825 E-MAIL unltd4u@rac.net  
300 BEDFORD STREET, MANCHESTER, NH 03101

**STEPPER DRIVEN LINEAR SLIDE is STURDY and COMPACT**  
Based on a heavy duty 1.5" wide, aluminum and steel, dual rail. Drive is  
via a toothed belt, powered by a SLO-SYN M061-IF-504, 1.25V @3.8A  
stepper motor with 200 steps per rev and 60 oz. in. hold. The slide  
incorporates superior quality, recirculating ball bearings. Size of slider is  
3" x 3" x 1/2" thick with mounting plate. Limited quantity. Unit is mounted  
on a 1/4" thick, black anodized alum. plate. All have been carefully  
removed for precision optical equipment.  
Model Travel Rail L" Weight Overall Size Price  
Short rail: 11.5" 16" 7lbs. 16"L x 4"W x 6.5"H \$69ea. or \$119 for pair.



**BAYSIDE, RIGHT ANGLE, GEARHEAD DRIVE**  
PERFORMANCE SPECS:  
Gearhead Torque Peak Torque Input Speed Backlash Eff.  
Model in-lb (Nm) in-lb (Nm) RPM arcmin %  
NR 23 50 (6) 110 (11) 4,000 3 92  
Moment of Inertia Max. Radial Axial  
Weight Load Load Load  
kg-m2 (oz-in-sec2) lb kg lb in lb N  
8x10-5 (6x10-7) 3 (1.4) 150 (670) 100 (440)  
SPECIAL.....\$89ea. or 2 for \$169



**MAXON, Rare Earth Magnet, PRECISION DC GEARMOTOR**  
High Torque, 35:1, 2- stage, Planetary gearbox.  
Maxon P/N: RE035-071-34EAC200A. All metal  
construction with mounting ears. Approximately  
100RPM. at the gearbox output and 4000RPM at the  
direct output. 1 dual shaft design! Direct shaft is  
3.9mm diam. X 18mm long. Gearing: Shaft size:  
6mm diam. x 18mm long. Overall size: 35mm O.D. x  
109"L not including shafts. Ball bearing outputs.  
Torque 2.25Nm continuous. Nominal operating voltage: 24VDC @ 40W. No load current 45.7mA. Max.  
Cont Current: 1.5A. A fantastic motor and always a sellout! Maxon, Special.....\$39ea.



**EXTREMELY UNUSUAL, PITTMAN MOTOR with OPTICAL ENCODER**  
and Flex Coupled, Air Bearing Output Shaft.  
Pittman P/N: 14204C223. All metal construction with  
replaceable brushes. Approximately 4087RPM no load  
speed. Shaft is 0.37" diam. X 1.75" long. Overall size:  
2.8" max. O.D. x 9.1" not including shafts. Ball bearing  
outputs. Torque 14 oz. in. continuous. Peak torque, 107  
oz-in. Nominal operating voltage: 30.3 VDC. No load  
current 190mA. Stall Current: 19.9A. Encoder is BEI, MX-21 series. P/N: MX-213-25-100048. Quadrature with  
index. 1000ppr, 4000ppr quadrature. 5VDC @ 80mA powered. Square wave output TTL compatible.  
Pittman Precision, Special.....\$59ea.



**MINI, LINEAR MOTORIZED MOUNT,** This high  
quality mini slide provides 2.4" of travel for its 1" x 1" alum.  
plate riding on two 0.18" diam steel rods. Motion is via a  
toothed belt drive from a 1.8" per  
step, 8 ohm stepper motor. 1 full  
step = about 0.008" of travel.  
Overall size: 6.1" x 3.5"W x 2.5"H.  
Dual optical end of travel sensors. Alum. construction.  
SPECIAL.....\$24ea. or 5/\$99



**NEW STEPPER MOTOR**  
with Belt Drive Pulley. Assembly consists  
of a steel angle bracket 4.7" L x 2.6"H on which  
is mounted a 12V@4A stepper motor with a 1/2"  
removable toothed pulley. This drives a belt  
which rotates a larger 1.8" diam. toothed pulley  
Thus providing about a 3.6:1 drive reduction.  
There is also a take off pulley as part of the hub  
of the larger pulley. Very useful as a general  
purpose drive in many applications. New and priced for  
experimenting. BELT DRIVE.....\$8ea. or 4 for \$25



**RUGGED DC MOTORS,**  
High power or mini size.  
A. Shown right, is a Johnson 7500  
series, 12 to 36V, 1/40HP/1 6800 RPM @  
36VDC, 510mA @31 oz. in. torque. 1/8" d  
x 3/4" hardened, knurled shaft. Zinc  
plated steel body. Wt. 8oz. Size: 1.4"D x  
2.5"L. Fast-on terminals for power input.  
Type A: 4 for \$12 or 20 for \$49 or 100 for \$199  
B. Shown left, 1.5to 6VDC, approx. 3000RPM, @ 3V, 150 mA.  
Size: .635" d x 1.3"L, 11 tooth, 15' d gear on shaft. Two mounting  
holes on face. Type B: 5 for \$5 or 20 for \$15



**NEW! AIRPAX, 12V STEPPER,**  
Size: 2.25" diam x 1 deep 1/4" dx 5/8" shaft  
1.8deg. per step.  
Special 2 for \$5 or 10 for \$20



**PIEZO ELECTRIC, 2-AXIS, TRANSLATOR**  
Physik Instrumente, P267 Like New. The ultimate in precision  
motion control. Includes two P178.37, 1/2" diameter PZT mounts.  
Each providing up to 40 microns of ultra precise movement.  
Motion can be controlled from the front panel or via an external  
control voltage. Rack mountable. SPECIAL.....\$849



**120VAC, GEAR MOTOR NEW!**  
Autotrol model 7000  
All metal construction with mounting ears.  
4 RPM, CCW rotation. Shaft size: 1/2" d x  
8"L, 5" leads. Size: 2" O.D. x 2.6"L x 1.3"H  
Special \$3ea or 4 for \$10



**OPTICAL ENCODER, 4000ppr Quadrature**  
1000ppr Direct.  
SUMTAK, IBL-004-1000, 5VDC @ 80mA, 6mm  
diam. ball bearing shaft. 38mm diameter X  
32mm deep. 1000Hz max. rate. A, B and Z  
outputs on color coded leads. Removed from  
equipment, excellent condition. Special.....\$29ea.



**HIGH RESOLUTION OPTICAL ENCODERS**  
2500ppr, 10,000ppr Quadrature!  
DRC MODEL 25-5351-816-2500. Diff. line  
driver output. Size: 2.5" d, 1/4" ball bearing  
with shaft seal. Continuous rotation, 3000  
RPM max. Alum. housing. 5V powered with  
zero reference out, 18" cable. USED.....\$39ea.



**HP OPTICAL ENCODER, HEDS-7500,**  
NEW, 1000ppr quadrature, 256ppr direct  
TTL compatible. A & B output for count  
and direction, 5VDC @20mA. power. With  
Data. Perfect for do it yourself motion  
control. Size: 1.13" diam x 87'd  
HEDS1000.....\$15ea. or 2 for \$25



**OPTICAL ENCODER, 1000ppr, 4000ppr Quad.**  
NEW, from Inductive Components, series  
M21-DM-1000-SLD-25AS, modular, shaftless  
design. Uses the shaft of the monitored  
device. TTL A & B & C, count, direction,  
index. 5VDC @20mA. With Data.  
Size: 2" diam x 0.9" H  
M21-1000.....\$20ea. or 2 for \$35



**NEW, MITOTOYO MICROMETER,**  
Beautiful, large diameter, ultra precision.  
Travel: 25mm,  
Resolution: 0.002mm  
that's 0.00007" Bowed.  
Please don't confuse  
these with a standard  
micrometer. These  
babies are 2" in  
diameter. Ultra precise feel.  
Mitotoyo mic, Special.....\$69ea.



**NEW! COLEMAN DC MOTOR**  
Good for general purpose applications.  
Size: 1" diam x 2.5" long. Small 5/  
16" diam belt drive pulley attached.  
12VDC power, 200mA, No Load  
6000 RPM Rugged construction.  
Tach output.  
Special, \$4ea. 6 for \$20






# FEATURED FLYER SECTION

Please detach and save.

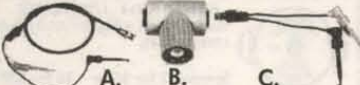
**KIK PLZ-150W, ELECTRONIC LOAD**  
Industry workhorse, can handle loads up to 150Watts. The front panel controls allow selection of all voltage and current parameters. Current up to 30A and Voltage up to 60V can be accommodated. LED readout. Good condition.  
**KIK-EL.....\$429ea.**




**HP5335A, UNIVERSAL SYSTEMS COUNTER**  
Providing true automatic measurement functionality. This system has 16 built-in front panel accessible measurement functions, all available via the HP-IB or manually. One of the most powerful universal counters available. Math and statistics include averaging, mean, sample size, standard deviation, engineering units display offset scale and normalization. Matched dual inputs provide 200MHz on chan. A and 100MHz on chan. B. Nine digit resolution from 30Hz to 200MHz. 1meg. and 50 Ohm inputs. Auto trigger and much more. All the toys in one package! Excellent condition.  
**New.....\$3900 Now.....\$395**



**LAB NECESSITIES, Quality E.Johnson test leads.**  
Always handy, especially at 75% off!  
A. 18" BNC to red and black hooks .....\$3.00ea.  
B. 6" BNC female to red & black hooks. For use with .....\$2.50ea.  
C. NEW BNC male to Dual BNC female "T" adapter. Deluxe model, with insulated outer shroud. .....8 for \$5 or 20 for \$10



**HP8152A, OPTICAL AVERAGE PWR. METER**  
Fully HP-IB programmable, dual channel, designed for those applications in the wavelengths from 100 to 1999nm. Each channel can be operated independently at different wavelengths and power levels, as in time division multiplexing or in combination for ratio measurements. System is autoranging with setup through menu driven options. 4 1/2 digit LED Displays relative or absolute values in dB, dBm, mW, uW, nW, pW, nm, HP-IB address, error messages, and status. Specs: 0.01pW, 0.01dBm/dB, 1nm resolution. Measurement range, +30dBm (1000mW) to -80dBm (10pW). Include four type HP81521B optical heads for 900-1700nm and operation/programming manual. Excellent condition. **Special.....\$895**



**BERTAN, HIGH VOLTAGE POWER SUPPLY MODEL 315, 0-500VDC @ 0-5mA**  
Automatic current limiting & arc protection assures reliable operation. Remote output high voltage programming & high voltage operation interlock are available. Specs: Reg:  $\pm 0.001\%$  line,  $0.002\%$  load. Tempco (0 to 50°C): 50ppm per °C. Stability (after 1 hr warm-up) 0.01%. Ripple: 25mV p-p. Calibrated front panel 10-turn potentiometer with 3 digit counter with resolution 0.25% of max. Programmable input for remote control of the output high voltage. 115 Vac  $\pm 10\%$  @ 0.5A powered. Size: 11.35" W x 8.7" H x 9.7" D, weight 11 lbs  
**Special.....\$325ea.**



**BERTAN HIGH VOLTAGE POWER SUPPLY MODEL 230-03R, 0-3KVDC @ 0-5mA**  
A single precision dial sets the high voltage output. Automatic current limiting & arc protection assures reliable operation. Remote output voltage & current monitoring, remote output high voltage programming & high voltage operation interlock are also included. Specs: Regulation:  $\pm 0.002\%$  line,  $0.005\%$  load. Tempco (0 to 50°C): 100ppm of maximum per °C. Stability (after 1 hr warm-up) 0.01%. 10mV p-p ripple. Front panel 3 1/2 digit LCD meter, switch selectable for reading output voltage or current. Calibrated front panel 10-turn potentiometer. Control resolution is 0.2% of max. A 0 to +5 Volt programming input can be used to control the output high voltage. Two analog outputs, 0 to +5 Volts proportional to output voltage & current are available. Short circuit current is limited. Arc protected & self-restoring. Polarity reversal is provided. 115 Vac  $\pm 10\%$  @ 0.5A powered. Size: 7-5/8" W x 7 1/2" D x 5-1/32" H, 10 lbs  
**Special.....\$395ea.**




**BERTAN HIGH VOLTAGE POWER SUPPLY MODEL 225-01R, 0-1KVDC @ 0-30mA**  
The 225 high voltage power supply offers advanced control and monitoring features via an internal IEEE-488 interface or from the front panel. Overload values for output voltage & current can be set from 0 to 101% of the units' max. rating. The unit can be programmed to turn off with a voltage and/or current overload. Selectable the high voltage output polarity. Remote analog high voltage programming, remote analog output voltage and current monitoring capability via a rear panel connector. Programming resolution 100mV & 1uA, ripple 10mV. LED digital display provides 5 digit resolution for voltage & current readings. It is also used to display errors, SRQ mode, overload response mode, model number, IEEE-488 address, and turn-on self-test conditions. A self-test routine is automatically run on power-up. Very compact for benchtop or dedicated ATE applications. Size: 19"W x 3 1/2"H x 9 5/8" D. Weight: 20lbs. 110VAC powered.  
**Special.....\$595ea.**



**TEKTRONIX 495P SPECTRUM ANALYZER, 30Hz to 1.8GHz**  
TEK 495P. No compromise performance. Optimized for use in baseband through UHF measurements. Covers 100Hz to 1.8GHz with -130dBm Sensitivity and +/- 1dB Frequency Response. Minimum resolution 30Hz, as well as 10- $\mu$  Marker and center frequency accuracy. Built-in signal counter can determine the frequency of marked signals only 30Hz apart, or count the exact delta frequency between two marked signals regardless of amplitude. External reference input. 10- $\mu$  Frequency accuracy. Intelligent markers with signal processing functions. Direct keypad entry of control parameters. Nonvolatile memory allows storage of up to nine front panel settings and nine waveforms. A permanent record of CRT display is available from the direct plot capability. Unit is fully GPIB programmable. Help menu explains front panel controls and signal processing functions. Now is your chance to obtain a top notch spectrum analyzer at an excellent price. This unit is in mint condition and includes option 05.  
**New.....\$30K Now.....\$2995**



**TEKTRONIX 335, MINI SCOPE, can be AC or DC powered.**  
The 35MHz bandwidth and 1mv/Division vertical sensitivity combine to make this compact dual trace scope a true field service performer. Size: 13.6" L x 9.3" W x 4.4" H. Weight: 10.5 lbs. Can be operated from 90 to 264VAC, 48 to 440Hz or 11 to 28VDC. External jack for DC input. Package includes probe, manual, calibration and 6 month warranty.  
**New.....\$3000 Now.....\$549**



**TEKTRONIX 2465ADM, 4 Channels and 300MHz, O'Scope on screen waveform stats, DMM readout.**  
One of the most popular & powerful scopes available at a reasonable cost. Features: 500ps/Div sweep, 2mV/Div. vertical sensitivity, 1Mohm / 50-ohm input, 500MHz trigger bandwidth, four channels. On-screen waveform cursors provide vert. & horiz. scale factors, trigger level, voltage, time, freq., phase, ratio values and mode indication. Plus complete DMM! Complete with 2 probes, pouch, and manual. Mint condition. 90 day warranty. **TEK 2465A/DM.....\$2695ea.**  
Also available TEK2465A.....\$2495ea.



**IS ANYBODY OUT THERE?**



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FAX: 603-644-7825 E-MAIL unltd4u@rac.net  
300 BEDFORD STREET, MANCHESTER, NH 03101

**MORE OSCILLOSCOPE SPECIALS**  
TEK 7834, 400 MHz Storage with two 7A18 dual trace vert., 2/ 7B53 T/B.....\$795  
TEK 475, 200 MHz portable, Dual trace, Delayed sweep.....\$649  
TEK 475A, 250 MHz portable, Dual trace, Delayed sweep.....\$749  
ALL PORTABLE SCOPES INCLUDE PROBE, MANUAL AND COVER, MAINFRAMES NO COVERS.  
TEST EQUIPMENT RECONDITIONED & CALIBRATED WITH 6 MONTH WARRANTY

**O'SCOPE PROBES, 100MHz w/READOUT!**  
If you have a TEKTRONIX scope with an auto switching attenuator, you need a probe with the readout option. Don't be fooled by cheap, low priced low bandwidth probes without readout. This one works the way your scope was intended. Complete with all accessories.  
**New \$39ea. w/o readout \$34ea.**



**350MHz, TEKTRONIX 2467, MICRO CHANNEL PLATE CRT! 4 Channels, 500ps per division 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 of 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 condition. 90 day warranty.  
**New.....\$12K Now TEK2467.....\$3975ea.**



**IWATSU 200 MHz, MODEL SS-5712335, LAB QUALITY SCOPE**  
The 200MHz, bandwidth and 1mv/division vertical sensitivity combine to make this Portable dual trace scope a true performer. 10ms max horizontal sweep rate. Delayed sweep, adn did we mention FOUR CHANNELS? Includes 2 probes, 6 month warranty.  
**Special.....\$549**



**SLEEK, 100MHz, TEK 2337, PORTABLE, FIELD SERVICE O'SCOPE with DMM**  
Dual trace, Delayed Sweep, 50ns/div. Sweep Rate, 5mV Vert. Sensitivity. Differential Time meas. on LCD display plus DMM for AC/DC volts plus Ohms. Extra rugged, perfect for field service work. Package includes two probes and manual. Mint condition. Six month warranty. Similar to photo.  
**New.....\$4850 Now.....\$895**




**TEKTRONIX 485, 350MHz,**  
Probably the fastest and lowest cost scope available today. Superior performance at low cost! Dual Trace, Delayed sweep 1 ns/div Sweep rate, 5mV Vert. Sensitivity. Switchable input imped. 50 ohm / 1meg. Package includes 2 probes, cover and operation manual. Six month warranty. Excellent shape. **New.....\$9100 Now.....\$749**




**TEK 7104, 1GHz with MICRO CHANNEL PLATE, CRT**  
Tektronix' highest bandwidth & highest writing speed model. Unsurpassed single shot capability, 1000x brighter than conventional CRT at maximum sweep speed. 350ps risetime! 200 ps per division fastest calibrated sweep rate. Includes two 7A29 1GHz vertical amplifiers, one 7B10 & one 7B15 horizontal amp. Complete operating manual, 90 day warranty.  
**New.....\$45K Now.....\$2495**




**LAMBDA 0-120VDC @ 0.5A POWER SUPPLY**  
Model: LGS24, operates in constant current or constant voltage mode. LED digital readout displays Volts or Amps. (switchable) Front panel 5-way binding posts. Compact, excellent condition.  
**Ltd. Qty. Special.....\$179ea.**



**HP3312A, SWEEP FUNCTION GENERATOR**  
The HP3312A combines two separate, independent function generators in one instrument. The main generator can be triggered by the modulation generator to provide sweep, trigger functions, AM, FM, gate or tone burst. Up to 10V p-p into 50 Ohms. 10,000:1 output attenuator and up to 10V of DC offset are available. Freq: 0.1Hz to 13MHz. R: <20ns. Low distortion. Excellent condition.  
**New.....\$1450 Now.....\$325ea.**



**TEKTRONIX AM503, CURRENT PROBE AMPLIFIER**  
Allows the display of current on any oscilloscope which has 10mV/div sensitivity. Capable of measuring currents from 1mA to 100Amps of DC to 50MHz bandwidth. Must be used with A6302 or A6303 current probe. Excellent condition, with operating manual, less current probe.  
**Special.....\$199ea.**




**SCOPEMOBILE, 200C,**  
from TEKTRONIX. Now you can afford the convenience of taking your 400 series scope anywhere. How many times have you wished your scope was easy to move or just at the other end of the bench? Put your scope on this sharp looking cart and away you go! Locking front wheels. Heavy duty aluminum construction. New \$380  
**OUR PRICE...\$79**




**DUAL, 20VDC @ 3A, LAB POWER SUPPLY, HP 6253A**  
Two independent outputs of 0-20 volts @3 amps. Extremely low ripple @ only 1mV. Each with constant current & constant voltage mode, as well as tracking & OVP. Front and rear floating outputs, rack mountable.  
**New.....\$1350 Now.....\$249ea.**



**DIGITAL THERMOMETER, from ANRITSU**  
New, Model HT600. Palm sized, with large LCD with EL backlight. Displays: Actual, Min. and Max. at the same time. Other functions include: Averaging, C or F and 0.1 or 1 degree resolution. Includes type K thermocouple, manual, Cal certificate. Requires 4AA batteries.  
**New, Boxed.....\$79ea.**



**CLAMP-ON CURRENT PROBE, AEMC Industrial # 100.101, for any DVM.**  
The 1000:1 ratio provides measurements up to 1000 Amps with 1% accuracy! Frequency range 50Hz to 5000Hz. This is an industrial quality current transformer rated for use on cables up to 2000V. Two inch diameter opening for cable. Overall size 8" long. Banana jacks for output. **New.....\$39ea.**



**OPTICAL X-Y DISPLACEMENT MEASUREMENT ANALOGIC 7000C, provides resolution to .005" of lens displacement down to 0.00001"**  
Full scale range of 0.225". Comprised of PMT based optical camera and control unit. Capable of measuring displacement, motion and elongation. Measurement is non contact thus eliminating any change in the target dynamics. Operation is achieved by locking onto a target area which has a contrasting property. LIKE NEW condition. Includes heavy duty wheeled transit case for system. Analog outputs for waveform analysis and direct digital display. **New.....\$50K Now.....\$749**





# FEATURED FLYER SECTION

Please detach and save.

PAGE SEVEN MILITARY & POWER

## RADIOLOGICAL SURVEY METER, Civil Defense type.

Designed to determine contamination levels in the event of a nuclear disaster. Hermetically sealed ionization chamber type sensor. Simple transistorized circuitry will operate up to 150 hours from one "D" cell. (not incl.) Measurement range 0.1R to 500R per hour in four ranges. Accy is 20% over -20% to +125%. R4 to 100%, dlt. to 25,000f. Indication on meter. 0.5 Sibs. Size: 8.5" x 4.5" x 6.5". Bright yellow aluminum case w/red and blue "CD" logo. Manual w/schematic included. **UNTESTED .....2/\$49**



## SEE IN TOTAL DARKNESS! 6914 IR image converter tube & VARIO 3093A 15KV power module.

Converts IR radiation to visible light. The NEW 6914 is the finest IR tube available at reasonable cost. 50 lp/mm resolution & self focusing, only one operating voltage req'd. Hermetically sealed mil spec. VARIO power supply requires only 1.5V DC @ 30mA! You add an objective lens (35mm or 1" C-mount), eyepiece & housing, for a complete viewer. Please note: This is not a "thermal imager" an external source of IR illumination is req'd. Tube Size: 2.9" x 1.9". **Special.....\$239 set.**



**VARO 3093A 15KV power module only.....\$69ea**

**IR SOURCE with 1,000,000CP!** Hand held, long range illuminator. One of the most powerful available. Quartz halogen spotlight combined with the best military glass IR filter. Because it's solid glass & not laminated plastic it can take the heat. Includes a coiled cord, std. cig. lighter plug. Operates from 12VDC. **IR-SPOT.....\$129ea.**



**GIANT WEATHER BALLOONS, Real military surplus,** black latex meteorological instrument balloons. 3 ft., 3/4 pound lift, or the monster >15R. model with attached shock absorbing section and internal ball stopper of fill port 0.0035" thick latex. Manufacturers individual packages. A rare find. Limited Quantity. Please note we recommend filling only to half max size as they are extremely fragile when fully inflated. Instructions included. **3 ft. diam. 2 for \$15, 15 ft. diam. \$24ea. 3/\$59**



**SEM-52, MILITARY, VHF, FM TRANCEIVER** Beautiful, German made radio operates on up to six pre-set, crystal controlled channels. We supply 47 MHz & 55.5MHz. Radio is powered by six standard "AA" cells. Controls include: OFF-ON, SQUELCH, (AUS-EIN-RSP), volume and channel (KANAL) Accessories provided include: two battery packs, 35" Ribbon antenna with flex base, Strap-on "web" headset/mic combination and carry case. Used in very good condition. **Limited quantity.....\$199ea. or \$349 for pair**

## MILITARY HELMUT RADIO type PR-4

450MHz Transmitter & compact receiver operates on 51MHz. Tone or voice. Xmitter operates from 12VDC, w/ 8AAA cell holder provided. Receiver with tone squelch is modified for standard 9V battery! Needs only 20mA. Like new only better! NO military batteries required! Complete with all accessories, earphone, antenna, lanyard and manual. Government reconditioned and guaranteed. Perfect for paint ball! **Special.....\$89/SET**



## AN/PVS-2, U.S. MADE GEN. I, WEAPON SIGHT,

Complete depot refurbished system incl. soft case, High gain 30K to 50K, three stage, intensifier, ABC, 95mm, 4 pwr, f1.2 "CAT" lens, 10.7" FOV, ELCAN MOUNT. Operates 40 hours on 4 AA batts., 17.5" x 3.5", 7.7" **Special.....\$649**



## AN/PVS-4, 25mm, GEN. II WEAPON SIGHT, U.S. MADE,

The AN/PVS-4 Night Vision Weaponsight, used extensively by U.S. & NATO forces worldwide, with over 100,000 produced. For use on a variety of weapons incl. 5.56mm & 7.62mm rifles. The PVS-4 has an adj. lighted reticle & 25mm Gen II intensifier with ABC (automatic brightness control). Tube and reticle brightness also manually adjustable. Daylight cover, rubber eyeguard, M-16 weapon mount, transit case & manual incl. **Special.....\$2195ea.**



**Specifications**  
Photocathode S-25  
Resolution 28-32 lp/mm  
Photo Response 450 Ma/u  
Tube Gain 25,000x  
System Gain 3,000x  
Signal To Noise 12:1  
Battery Type 2 AA  
Battery Life 20-30 Hours  
Magnification 4x  
Objective Lens 11.5mm F1.2  
Field Of View 14.5°  
Focus Distance 6.5m To Infinity  
Size 24x12x11 cm  
Weight 1800 gm  
Reticle Rangefinding

**AN/PVS-4, WEAPON SIGHT.....\$2195ea.**

## NEW, GEN. III, WEAPON SIGHT/VIEWER SYSTEM,

• Made In USA • Shock Resistant • Camera Adaptable  
• Interchangeable Lenses • Elcan Mount Included  
The Viper generation three night vision sight represents the future of modular NVDs. This U.S. made, state-of-the-art minitelscope offers camera adaptability, interchangeable c-mount lenses, and head mounting options. The included Mil-Spec Elcan® weapon mount makes sighting a simple task and allows the sight to be removed and reattached without losing zero. The easy to operate Viper is light weight and offers a generous field of view with any optic. The Viper is a user friendly night vision system that is ready for the most professional of applications



**Specifications:**  
System Gain: 3,500x  
Signal To Noise: 18:1  
Battery Type: 2 AAA  
Battery Life: 20 Hours  
Magnification: 3x  
Photocathode: Gallium Arsenide  
Resolution: 45 lp/mm  
Photo Response: 1200 Ma/u  
Objective Lens: 75mm F1.4  
Field Of View: 12°  
Tube Gain: 35,000x  
**Viper, Gen. III Scope.....\$3495ea.**

## MILITARY LASER RANGEFINDER SYSTEM!

**CUBITAPE, DM-60 IR Laser based distance measuring system** offers precise measurement up to 2000M or 6000ft. with resolution of .001m and repeatability of .01M, (that's less than 1/2"!) Reading displayed on 8 digit LED display. Accessories include, 12VDC gel cell pack, cable, tripod for laser, triple retroreflector target (required for use), 6X zoom spotting scope with cross hair reticle, Transit cases for laser and reflectors. Operating instruction card and service manual. Very good condition. These cost Uncle Sam a bundle. **SPECIAL DM-60.....\$749 complete.**

## NEW, GEN III, INTENSIFIED GOGGLES, STATE OF THE ART, U.S. MADE.

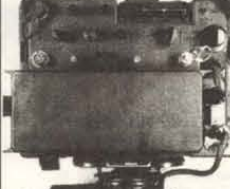
The NQ5001, the world's most rugged and reliable, high performance night vision goggles for ground operations. Extensively used by the U.S. Army, it is the State-of-the-Art in mono-tube Night Vision Goggles. Utilizing the MX-10130 Gen III intensifier, it can be used in the darkest of conditions, headstrap mounted or handheld. Engineered for maximum comfort and simple to use. The system contains an IR illuminator, low battery indicator & high light sensor for automatic power off to image tube.

**Specifications:**  
Photocathode Gallium Arsenide  
Resolution 45 lp/mm  
Photo Response 1200 Ma/u  
Tube Gain 35,000x  
System Gain 3,200x  
Signal To Noise 18:1  
Standard Accessories:  
Soft Case, headstrap, demist shields, sacrificial filter, eye cups, 2 AA batteries, and operators manual.  
**Battery Type 2 AA**  
**Battery Life 20 Hours**  
**Magnification 1x**  
**Objective Lens 25mm F1.2**  
**Field Of View 40°**  
**Focus Distance 2.5m To Infinity**  
**Size 14.9 x 14.9 x 9.1 cm**  
**Weight 680 gm**  
**Special.....\$295ea.**



## PORTABLE, PERIMETER, PROTECTION PPS-15V, SURVEILLANCE RADAR.

Up to 3000 Meter range. Provides audible indication of objects w/alarm. Control panel with LED display of battery, signal strength, range and azimuth. Can be operated remotely via supplied cable and detachable control panel. 12VDC or 28VDC powered. Includes heavy duty, military, aluminum transit case, headphones, battery and tripod. Only 14 lbs.w/ battery. Latest flat antenna design. Motorized sweep. **Limited Quantity.....\$2495**



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## THE ULTIMATE NIGHT OBSERVATION SYSTEM THE AN/TVS-4, NOD

The AN/TVS-4 Night Observation Device. Designed for extreme amplification and magnification, the TVS-4 NOD as it is known, is a truly awesome instrument. Originally designed for monitoring movements along the Ho Chi Minh trail. The NOD combines a 40mm cascaded intensifier with a massive catadioptric lens to perform it's magic. This unbeatable combination provides gain over 75,000X with a magnification of 7.5X! Automatic brightness control completes the technical tour de force. Specifications include: 8" FOV, 30lp/mm Resolution, Length 33", Width 13", Height 14", Weight 34 lbs. Aluminum transit case, battery and tripod included. Don't miss the chance to own a piece of incredible history. Excellent condition. **AN/TVS-4, NOD.....\$3500**



## MILITARY, CODE SIGNAL LIGHT,

U.S. Army type, M-437 with removable rifle stock. (not shown in photo) The powerful light operates from standard D-cell batteries. Complete with adjustable height tripod and canvas soft case. Other acc's may be available on a first come first served basis. Call early for better selection. We don't know the history of these but they are very unusual and look like a real collectors item to us! **Special.....\$69ea.**



## LASER RANGEFINDER, MORE THAN ONE MILE RANGE, Hand Held Tool!

**APPLICATIONS**  
Hunting, Sailing, Military, Surveying, S.W.A.T. team.  
**KEY FEATURES**  
Made in USA, Invisible/Eyesafe class I Laser  
Doubles as high power Monocular  
Auto/Manual Shut-off, Tripod Adaptable, Belt Clip  
Low Power Consumption, Test Tone Boreighting.  
Rugged, submersible (1 meter, 1 hour), one-piece aluminum, if floats.  
Gating - Ensures readings are within shooting area.  
Computation - Can determine relative distance.  
Interchangeable Scope - Night Vision Compatible.  
Electronic Filtering - Can discriminate through brush to reflective targets.  
Error Displays - Audio and visual indicators ensure confidence of target acquisition.  
Yards or Meters display switchable.  
Offset Capabilities - can add or subtract variables  
Backlit LCD Panel - enables day or night operation.  
**OPTIONAL ACCESSORIES** Tripod, Monopod  
**Specifications:**  
WEIGHT: 2.2lbs, SIZE: 6" x 2.5" x 5"  
MAX RANGE: 2200m (7,216ft)  
RANGE ACCURACY: +/-1meter @ 2200 meters  
RANGE RESOLUTION: 1meter/yard  
POWER SUPPLY: 2AAA bat. up to 20 hours use.  
Every XLR comes with a custom foam carrying case. WARRANTY: Rangefinder guaranteed for 6 mos. If rangefinder should fail to perform, except for abuse or negligence, it will be repaired at no cost to the original owner.  
**XLR Rangefinder.....\$1695ea.**



## YOU CAN NEVER BE TOO THIN or TOO POWERFUL. Unique "Thinline

Energy Cell from Portable Energy Products. Their model PLA02V50. A super thin, high performance, patented technology, sealed lead acid battery. Each cell provides 2V@5AH. Their size is an amazing 3.1" x 5.3" x 0.3" thick! They can be mounted in any orientation. Can line the bottom of a briefcase or be covertly worn on the body. 30% higher energy density than conventional lead acid batteries. **Super, 6 cells for \$15 or 24 for \$49**

## 10V @ 2.5 AH SEALED, LEAD ACID, PACK

Each pack consists of five, 2 Volt cells. Each cell the size of a std. "D" battery. They are arranged as 1X5 cells. Enclosed in an ABS outer shell. (removed for photo) Mint condition. Perfect for robotics and other high drain applications. Buy several, make custom packs of any rating. Size: 7.5" x 2.8" x 1.5"  
**5-five packs (Yes 25 Cells) for \$20**  
**30-five packs, (We're crazy, 150 cells) for \$99**

## 6V@12AH SEALED, RECHARGEABLE, BATTERY

New Panasonic, LCR6V12PL. Tough to get at the discount. Very compact. Two top mounted 1/4" faston connectors. Perfect for high drain projects. Size: 5.9" x 3.7" x 1.9"  
**2 for \$20, or 10 for \$89**

## Switchmode power supply, 15VDC @ 1.6A,

Toshiba PA2401E. Brand new. Very high quality, regulated design. Supplied with 6ft ac cord and 6 foot DC cord. Standard tip positive barrel plug for DC. Size: 1.8"x2.8"x5.5" UL and CSA approved. Can be used with Toshiba 2700 series printers as well. New and individually boxed. **Special.....7.95ea. or 3 for \$20**

## FIVE OUTPUT POWER SUPPLY, Will power just about anything you can dream up. New, Elpac

Model 1822 fully enclosed in an attractive brushed steel and black enclosure. Industrial quality power supply with five individually fused outputs as per below:  
+5VDC @ 2.5Amps  
+12VDC @ 0.5Amps  
+20VDC @ 2.5Amps  
Trimmer externally adjusts up to ±15 and ±24VDC. Operates from 110VAC or 220VAC. Size: 6"H x 8"W x 16"D. Fantastic. **\$24.95ea. or 3 for \$59**

## VICOR, DUAL DC POWER SUPPLY, provides up to 400Watts,

Like new, Vicor "FLATPAC" model VI-PF01-CUJ, 12V@16A & 5V@40A with cooling. Universal AC input accepts from 90-270VAC. BUS & AC, OK status out. Agency approvals. Fully protected: I limit, Short circuit, OVP & overtemp. Current sense and V trim pins. Size: 9.3"x5"x1.4" **Reg.....\$400ea. Special.....\$39ea.**

## Do you have any of these items?

- Small precision gearmotors.
- Detectors, Stirling coolers etc.
- Thermal imaging systems.
- Optical mounts and related.

## NVPS-10, TACTICAL NIGHT VISION SYSTEM

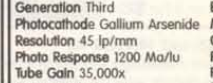
Generation III, Made In USA, interchangeable Lenses, Camera Adaptable, Headstrap Adaptable, Built In IR Illuminator The NVPS-10 advanced Night Vision system provides durability & high performance in a compact package. The multi-functional design operates as a handheld viewer, head-mounted monocular, or as a video surveillance platform when coupled to 35mm or video camera. A wide variety of objective lenses are available. A tactical design that fits all needs. Optional hands free headstrap. **Battery Type 2 AAA Battery Life 20 Hours**  
**Magnification 1x Objective Lens 25mm F1.3**  
**Field Of View 40° Focus Distance 2.5m To Infinity**  
**Size 11.5x7.5x5 cm Weight 350 gm Reticle None**  
**Std. Accys: Locking hard Case, eyecup, batteries, & Manual**  
**Optional Accessories: 2X lens, 3X lens, Zoom lens, Lens doubler, soft case, Camera Adapter, & Headstrap**  
**NVPS-10, Scope.....\$3235ea.**

## NEW, THIRD GEN, MIL SPEC., COMBAT SIGHT

The BlackCat, cutting edge gen III night vision combat sight. Compact size & "simple" design for complete flexibility & maneuverability while maximizing night vision target detection & acquisition. Highest quality optics, lens coatings, & image intensifier available. Currently being used in special operations throughout the world. Interchangeable with the renowned Elcan Day sight.

## Specifications

**Generation Third**  
**Photocathode Gallium Arsenide**  
**Resolution 45 lp/mm**  
**Photo Response 1200 Ma/u**  
**Tube Gain 35,000x**  
**System Gain 3,200x**  
**Signal To Noise 18:1**  
**Battery Type 2 AAA**  
**Standard Accessories**  
Locking hard case, flip-up lens cap, 2-AAA batteries Elcan 223 mount, and operator's manual.  
**BLACK CAT SCOPE.....\$5895**  
**Battery Life 40 Hours**  
**Magnification 3.1x**  
**Objective Lens 75mm F1.4**  
**Field Of View 12°**  
**Focus Distance 30m to Inf.**  
**Size 13.9x7.3x5.3 cm**  
**Weight 810 gm**  
**Reticle Post with Stadia Line**





## ADJUSTABLE TORQUE WRENCHES,



Utica TCI-150RA, 1/4" drive, 5-150 in./lbs., 9° OAL or Consolidated 2502MR, 1/2" drive, 50-250 in./lbs., 14° OAL both with 1 lb res. New or like new. **Your Choice \$49ea.**

## STARRETT, DEPTH GAGE Model 445BZ-3RL, 0-3"

Beautiful, super quality set with three rods, adjustment tool and foam lined case. Limited quantity. **Reg. \$125 Special.....\$49set**

## MITUTOYO DIAL INDICA 0.01mm Resolution and 10mm Stroke

New, Model # 2046-11 indicator. Individually boxed with certificate of calibration. A beautiful instrument. A 2" diameter face with high contrast yellow background. Fits all standard holders.

Mitutoyo Indicator  
**Special.....\$39ea.**



## WAGNER INSTRUMENTS, FORCE DIAL PUSH - PULL FORCE GAGE, Type FDK-4 Dual Scale, 0-4 OZ. x 1/32 OZ. and 100gr. x 1gr.

New, Model FDK-4 indicator. Individually boxed with certificate of calibration and +/-1% accuracy. A 2" diameter face with high contrast yellow background. Supplied with push plunger and pull hook attachments. Similar to photo. **Special, FDK-4.....\$49ea.**



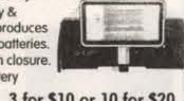
## BRAND NEW, QUALITY, TRANSIT CASE.

Grey high density, polyethylene, ribbed top and bottom. Scratch & dent resistant. Alum. frame with two latches. Size: 20 1/2" W x 9 1/2" D x 17 1/2" H. Inside size: 18 3/4" W x 8" D x 15 1/4" H. Completely padded with 1/2" soft foam. Center & end handles. Weight: 8 lbs. Perfect for hunting, fishing or transport of delicate, bulky or sensitive items. Don't delay. **REG.....\$100ea. NOW.....\$39ea.**



## XENON STROBE FLASH,

NEW from Polaroid. High quality & powerful! Oversize flash tube produces 20 JOULES powered with 4AA batteries. Trigger with DC signal or switch closure. Self contained with internal battery compartment. NEW.



3 for \$10 or 10 for \$20

## 19" PLASMA DISPLAY MONITOR

IBM type 3290-2. Hi Resolution. They power up and self test but we have no data. Only 5" deep. Tilt stand. A fantastic unit. Originally >\$5000! Very limited quantity.



**Special.....\$149ea.**

## 100Kohm 1% DIGIPOT BOURNS 3682S-1

Two, decades, 1K per step & 10K per step. Snap in panel mounting. Size: 1" x .8" x 1.2" d



**New.....\$10ea. or 3 for \$20**

## MERCURY DISPLACEMENT RELAY

New, Dayton 6X598 Hermetic, class "B" Coil volts: 120VAC, AC contact rating: 35Amps @480V, Tungsten 35A @120 V. BOXED w/data.



**Special.....\$10ea. or 3 for \$27**

## ELECTRET, COMPUTER MIC

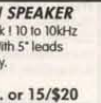
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Only 1.56" sq. x .125" thick 10 to 10KHz response. 8ohm, 0.4W With 5" leads attached. Limited quantity.



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Ball bearing. Brushless mini fan. New, Panasonic, FBK04F12H, 40mm sq. x 20mm thick 1" Long life, 40K hour rated! 12VDC, 0.2A, Low noise. With 12" leads.



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## PRESSURE SENSOR IC,

VLSI and micro-machining technology. The NovaSensor NPH, Absolute Series. Piezoresistive strain gage in a Wheatstone bridge configuration. Fully integrated on a micromachined silicon diaphragm. <0.1%, linearity. Metal, 10-8 pc mmf. package output of 100mV. 0-15 psi Laser trimmed thick film compensation resistors. 3/16" OD pressure port.



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## NEW, PANAVISE ADJUSTABLE BASE

Model 400 Low Profile holds all Panavise heads.

Variable load control knob and exclusive split ball feature have a range of tension which permits moving work to any position. A slight additional turn locks the head firmly in place. Only 3 1/2" high. Designed for working close to the bench surface. Four hole, 4" square mounting base for permanent attachment to surface. Steel with Grey color

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## NEW, KEITHLEY/ACCULEX, DP-2000, 4 1/2 DIGIT, LCD, Digital Panel Meter

Industrial quality 5VDC powered, 19,999 count DPM with 1/2" digits. Requires only 15mW and only 0.73" space behind panel. Perfect for any application requiring precision and portability. User selectable range control provides +/-200mVDC and +/-2VDC option. Auto polarity, overrange, selectable decimal point and display hold functions. Full differential inputs. 100M Ohm input imped. on 200mV range. 1M ohm on 2V range. Snap in mounting. Stability 100ppm/deg C. Keithley. \$99ea. **Special...\$39.00ea. 2 for \$69**



## STEREO HEADPHONES from KOSS.

Brand new type HP/1, "walkman" style, very light, good quality. Adjustable metal headband with padded earpieces. They sound good and the price is right. Now is the time to replace that beat up pair you've been using since the 1900's. Standard 1/8" stereo phone plug with extra long 8 1/2 ft. cable. Black color.

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Brand New, PLANTRONICS, BOOM MIC HEADSETS  
Single ear with over the head metal band for comfort.

New, boxed with RJ11 style plug attached to 6ft. cable with clothing clip, metal headband. Grey color

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Orphaned scanner industry color calibration source.

A stepper motor driven color wheel is sandwiched between two anodized black alum. plates. A 3/4" hole in the plates lines up with red, green, blue and neutral gray filters installed in the wheel. A "U" shaped mini fluorescent lamp provides illumination. The lamp is powered by a solid state, 12DC inverter board, supplied. As the wheel rotates a phototransistor detects it's position. A precision gage that is waiting for a new home. Size: 4" W x 4" L x 0.2" Deep. NEW



**FLURO SOURCE with INVERTER, \$15ea. or 2 for \$25**

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with Fan and Heatsink

Super cooler brand air to air (shown left) and air to surface units. (shown right). Operate from 12VDC and provides ~20Watts of cooling or about 30deg. F differential for the air to air and about >40deg. F differential for the air to surface. Ice will actually form on the plate. The air to air unit has two brushless fans for heat removal and one for cool air circulation. The air to surface unit has one brushless fan for heat removal and an aluminum cold plate. The overall size of the air unit is: 4" L x 5.2" H x 2.6" W The surface unit is: 3.75" L x 3" H x 2.3" W Removed from equipment. Excellent condition. Black anodized aluminum construction. Very pricey from the manufacturer.



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Commercial Quality, Solderless, Solderless Type.

Concord Electronics type: 21-2070, American made. Standard banana plugs with nylon insulated covers. Available in four bright colors. Why fool around with those old trayed test leads you've had since the 1900's. Now you can make your own shiny new ones in minutes.

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(They look like hams!)

"BIG ASS" CAPS,  
50uf @ 2500VDC

New, CSI model 3N629TN energy discharge cap. Size: 10.5" H x 3.75" D x 4.5" W, NO PCB's, a real beauty! Please discharge before handling. Limited Quantity, **Special.....\$39ea.**



## EVEN BIGGER,

"BIG ASS" CAPS,

We call them

"HUGE ASS" CAPS.

16uf @ 10,000VDC +/-10%  
New, NWL model 10077 energy discharge cap, Size: 12" H x 14" W x 5" D, NO PCB's, NEW!

Please discharge before handling.  
Limited Quantity, **Special.....\$69ea.**

## REALLY HIGH VOLTAGE CAPS

We Mean HIGH.....UP to 60KV

New, from Del Electronics. Three models from which to choose NO PCB's, NEW! Very Limited Quantity Available.

Type DA, 46,000V, triple cap. Ltd. Qty.....\$79ea.

Section 1: 0.05uf all sections

Section 2: 0.001uf +15%, -5%

Section 3: 0.001uf

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Please Use Responsibly!



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New, SPRAGUE, 36DX Series

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All include mounting clamp:

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Also: from Concord Elecelectronics

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## Average HIGH VOLTAGE CAPs

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Three types from which to choose.

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GE, metal can, 10uF @ 1500V Pk @ 10KHZ, +/-10%

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A must have for serious high voltage work.

New, non inductive, 5% tol., low tempco.

Mini size only: 1" x .27" x .06" Hard to find.

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**SLIM MOX  
104 100M 5%**

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STANCOR, Type: RT-202

Primary: 117VAC, 50-60Hz

Secondary: 12.0 to 29.8V, C.T.

Provide 4ADC from F.W.C.T. config. or 2ADC bridged config. Heavy duty construction with mounting ears. Size: 3.5" H x 3.5" D x 2.9" W. Boxed with data.

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Standard 5 Volt Logic Control.

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60VDC output @ up to 1 Amp,

Standard 5 Volt Logic Output.

DC INPUT MODULE:

Opto 22, Type: G4 IDCs,

10 - 32VDC Input,

Standard 5 Volt Logic Output.



Your Choice, specify model, **Special...\$5ea.**

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HOW 'BOUT a COUPLE

"BIG ASS" POWER RESISTORS!

Two types available:

DALE: DPW 1-1 series, 500KOhms, +/-15%, 20 Watts

Size: 1.2" diameter x 7.7" long

Special.....\$8ea.

MADE BY?: P/N, G332487-6, 75 Ohm, 5%, 200Watts

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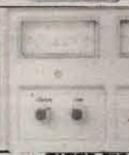
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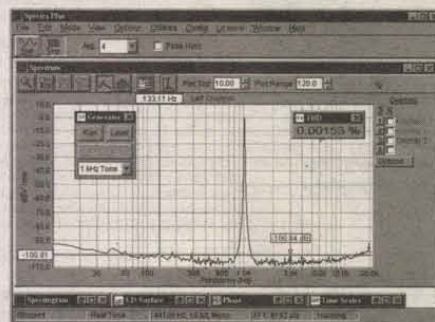
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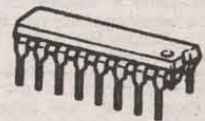
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SHOWN ACTUAL SIZE

**LIE DETECTOR** This kit can be great fun at parties. When you lie, generally your hands will sweat and the more you sweat the louder the tone. This kit allows you to measure these changes, only a slight amount of change will cause the tone to increase in frequency. Power requirement 6 to 12v DC. SIZE: 8" x 12"

LD-1 KIT \$9.95

**BUSY PHONE LIGHT** Add this little kit to any or all of your telephones. When one phone is used a red LED will light on the other extension. This lets everyone know when your computer modem is in use. Power requirement 9v DC. SIZE: 1.1" x .6"

TEL-LITE KIT \$9.95

**RAINBOW KITS KIT BOOK \$14.95**

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

AA-1 BUILT \$29.95 KIT \$10.95

**STROBE LIGHT** Do you need an attention getter, warning light, or flashing light for model airplanes? Then this kit is for you. Use it as an emergency light for your auto, radio tower, even use it on your bicycle. Has a variable flash rate. Power requirement 6 or 12v DC. SIZE: 3.5" x 1.9"

ST-1 KIT \$11.95

**AUDIO PREAMP** Boost your microphones output up to 10x level! Plug your mic into our AP-1 and drive your amp. To full capacity. Connect an AP-1 to a pair of amplified speakers, plug your mic in and you have an instant PA system. Requires 8 to 12v DC. SIZE: 1.75" x 1"

AP-1 KIT \$9.95

**16 TONE DECODER** Sweet 16 tone decoder operates great over phone lines, radios or scanners.

- 16 TTL Level Outputs
- DTMF Decoder Decodes 16 different touch tones using the phone, radios, or scanners.
- One relay & driver circuit on board.
- 9v battery powered. Size: 2 3/4" x 2 1/8"

TT-16 KIT \$34.95

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

WM-2 KIT \$14.95

**DC VOLTAGE MONITOR** If battery status is important, you need this kit. This kit uses 7 LEDs to monitor 12v DC in 1v, 1/2v, or 1/4v steps. Monitor 8v or 5v in 1/4v steps. Great for boats, motor homes, model planes or race car ni-cads. All parts and instructions are included. SIZE: 1.3" x 2.7". If you want to switch more power see our Triac (TP-1) or Relay (RP-1) Power kit.

VM-1 KIT \$7.95  
For 110 AC VM110 KIT \$10.95

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

IA-1 KIT \$14.95  
IA-1CABINET \$8.95

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

DT-3 KIT \$8.95

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

CA-1 KIT \$12.95

**VOICE ACTIVATED SWITCH** This VOX circuit can be used to operate a tape recorder, ham radio, CB radio, or turn on an alarm.

The VOX-1 kit has 100mA of output that operates a relay, light, motor, ? What could you do with a sound activated switch? Power requirement 7.5 TO 18v DC. SIZE: 1.5" x 1.3"

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

VOX-1 KIT \$6.95

**PHONE RECORDING SWITCH** This phone line powered switch is small enough to be installed anywhere. Every time the phone is picked up the recorder will record both sides of the conversation automatically. Use it in your office to record all phone calls so you don't lose important information. SIZE: 1" x .6"

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

TEL-SW1 KIT \$12.95

**WATER ALARM** Don't ever get stuck with a flooded basement or over fill your water bucket. When the liquid level reaches the sensor it automatically turns the pump on or off. The Water Alarm supplies you with 100 mA of output that activates a relay (at your supply). This relay can turn on a pump, or in applications where you are filling a area with liquid it turns off the pump. Sensor included. Size 1.4" x 2"

WA-2 KIT \$17.95



## Stackable RS-232 Kits

Digital I/O - 12 I/O pins individually configurable for input or output. DIP switch addressable; stack up to 16 modules on same port for 192 I/O points. Turn on/off relays. Sense switch transitions, button presses, 4x4 matrix decoding using auto-debounce and repeat. **\$32**

Analog Input - 8 input pins. 12-bit plus sign self-calibrating ADC. Returns results in 1mV steps from 0 to 4095. Software programmable alarm trip-points for each input. DIP switch addressable; stack up to 16 modules on same port for 128 single-ended or 64 differential inputs. **\$49**

Home Automation (X-10) - Connects between a TW523 and your serial port. Receive/transmit all X-10 commands with your home-brewed programs. Full collision detection with auto re-transmission. **\$39**

Caller ID - Decodes the caller ID data and sends it to your serial port in a pre-formatted ASCII character string. Example: \*12/31 08:45 850-863-5723 Weeder, Terry <CR>. Keep a log of all incoming calls. Block out unwanted callers to your BBS or other modem applications. **\$35**

Touch-Tone Input - Decodes DTMF tones and sends them to your serial port. Keep a log of all outgoing calls. Use with the Caller ID kit for a complete in/out logging system. Send commands to the Home Automation and/or Digital I/O kits using a remote telephone. **\$34**

## IR Remote Control Receiver

Learns and responds to the data patterns emitted by standard infrared remote controls used by TVs, VCRs, Stereos, etc. Lets you control all your electronic projects with your TV remote. 7 individual output pins can be assigned to any button on your remote, and can be configured for either "toggle" or "momentary" action. **\$32**

## Telephone Call Restrictors

Two modes of operation; either prevent receiving or placing telephone calls (or call prefixes) which have been entered into memory, or prevent those calls (or call prefixes) which have not been entered into memory. Use touch-tone phone to program.

Block out selected outgoing calls. Bypass at any time using your password. **\$35**

Block out selected incoming calls. Calls identified using Caller ID data. **\$46**

## Phone Line Transponder

7 individual output pins are controlled with buttons 1-7 on your touch-tone phone. Automatically answers telephone and waits for commands. Monitor room noises with built in mic. "Dial-Out" pin instructs unit to pick up phone and dial user entered number(s). Password protected. **\$49**

## DTMF Decoder/Logger

Keep track of all numbers dialed or entered from any phone on your line. Decodes all touch-tones and displays them on a 16 character LCD. Holds the last 240 digits in non-volatile memory. Connect directly to radio receiver's speaker terminals for off-air decoding of repeater codes, or numbers dialed on a radio program. **\$55**

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**OLD ICs & TRANSISTORS WANTED:** **HIGHEST PRICES PAID** please FAX your list with part number, quantity & condition of any **semiconductors** to Rick @ ESI, 5363 Broadway Ave., Cleveland, OH 44127. 216-441-8500 FAX 216-441-8503. Since 1946! www.electronic surplus.com

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**RF OSCILLATOR DESIGN.** Learn to design RF oscillators from a pro. 90 page course presents the knowhow of oscillator analysis, simulation and design with breadboard experiments. Requires AC/DC and some calculus. \$39+\$6 S&H. RFLS, PO Box 9185, Gaithersburg, MD 20898-9185.

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If you've got some electronic equipment to sell, why not try the classifieds!?!  
See page 68 for details.

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## SCSI INTERFACE 12X SPEED CD-ROM DRIVE

Toshiba # XM-5701B  
New, 12X disc drive. SCSI interface internal drive measures 1.62"(h) x 5.69"(w) x 7.41"(d). For ease of set-up, comes with SCAM (SCSI Configuration AutoMagically) which automatically configures all aspects of the CD-ROM drive with the computer when connected through a SCSI port to a PC or Macintosh. Data transfer at 1800KB/s. 115ms average random seek time. 256K buffer.

CAT # XM-5701B

**\$22.50 each**

## 3000 MCD ULTRA-BRIGHT RED LED

Everlight # 383URC-2/TR1-C(R) Red, "Ultra-bright" T 1 3/4 LEDs now at our lowest price ever. Due to a special purchase of "tape-and-reel" parts we are able to offer these LEDs at an incredibly low price when purchased on the reel. These are 5 mm diameter water-clear LEDs that light bright red at 20 ma.

CAT# LED-50

**2 for \$1.00**

100 for \$35.00  
1000 for \$250.00  
(25¢ each)

## 3 BUTTON Serial MOUSE

Windows compatible three button serial mouse. Includes 3.5" floppy disk with drivers.

**\$3.50 each**

CAT #MSE-3

10 for \$30.00

## 30 Minute Timer Board

Timer circuit board will operate 120 or 240 Vac devices. Originally designed to run a vibrating motor in a massage chair, the circuit automatically shuts-off a motor, lamp or other device after approximately 30 minutes. Shut-off time can be varied by replacing one of the resistors on the board with a pot or resistor of different value. Hook-up instructions included with the board explain how to make this modification. 1.9" x 2.5".

CAT# TMR-5

**\$3.50 each**

## 10 CD Storage Book

Small padded, refillable binder contains plastic sleeves for protection and storage of 10 CDs. Great for music or computer software. Inside cover has an index page for referencing contents. Velcro flap keeps binder closed in transit. Ideal for car or home. 6.5" x 5.8" x 1.2".

CAT# CDB-1425

**\$4.25 each**

10 for \$37.50 100 for \$300.00

## INCREDIBLY CHEAP!! Switching Power Supply

Voltek Corp # SPEC7188B  
Input: 100 - 240 Vac  
Outputs: +5 Vdc @ 3.70 A,  
+12 Vdc @ 0.60 A,  
-5 Vdc @ 0.05 A,  
+5 Vdc Trickle @ 0.1 A  
Metal encased switching supply. Standard three-prong IEC socket power input. 7 conductor, Molex-type connector output. 9" x 2.1" x 1.36". UL recognized. Removed from new equipment.

CAT # PS-27

**\$3.50 each**

## 20 Character X 4 Line LCD

Optrix # DMC 20434-CEM (PWB 20434-CEM)  
5 x 8 dot format.  
3" x 1" viewing area.  
3.88" x 2.38" module.  
Removed from new equipment. May have felt padding on metal bezel. 14 pin single row header is pre-attached. Spec/hook-up sheet included.

CAT# LCD-46

**\$7.00 each**

10 for \$60.00

## Microphone For Fish

Consists of a dart-shaped underwater transducer on a 21' wire and a small amplifier. According to the manufacturer, it enables you to hear the fish striking your bait, thus allowing you to catch more fish. We don't have the instructions, and you will need some headphones with a 3.5 mm phone plug. Also requires 4 AAA batteries (not included). Transducer is 3.3" long. Amplifier assembly is 3.5" x 2.4" x 1".

CAT # AQS-1

**\$5.00 each**

## NEODYMIUM MAGNET

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# Events CALENDAR

Continued from page 22

**TX - TEXAS CITY** - Hamfest. Tideland ARS, Joe Wileman AA5OP, 409-945-6794  
**WI - EAU CLAIRE** - Hamfest. Eau Claire ARC, Jim Staats KG9MV, 715-838-9108. E-Mail: kg9mv@arrl.net Web: <http://www.ecarc.org>

## JULY 11

**IL - PEOTONE** - Hamfest. Kankakee Area Radio Society, Don Kerouac K9NR, 815-939-7548. E-Mail: k9nr@juno.com Web: <http://www.geocities.com/capecanaveral/hanger/5711>  
**NY - PATCHOGUE** - Hamfest. Mid-Island ARC, Mike Grant N2OX, 516-736-9126. E-Mail: globalcm@erols.com Web: <http://www.qsl.net/mid-islandarc/hamfest.html>  
**PA - KIMBERTON** - Valley Forge Hamfest. Fire Co. Fairgrounds, Rt. 113 (S of Rt. 23), 8am. Mid-Atlantic ARC, Bill Owen W3KRB, 610-325-3995. E-Mail: hamfestinfo@marc-radio.org Web: <http://www.marc-radio.org/hamfest.html>  
**PA - PITTSBURGH** - Hamfest. North Hills ARC, H. Rey Whanger W3BIS, 412-828-3694 (ph & fax). E-Mail: w3bis@freeweb.com Web: <http://nharc.pgh.pa.us/>

## JULY 16-17-18

**MT - EAST GLACIER** - Montana State Convention, Darrell Thomas N7KOR, 406-453-8574. E-Mail: n7kor@mcn.net Web: <http://www.tlatech.com/hamfest/>

## JULY 17

**CA - SANTEE** - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in, 619-561-0052  
**LA - SLIDELL** - Hamfest. Ozone ARC, Ronald Riviere WB5CXJ, 504-882-5067  
**NC - CARY** - Midsummer Swapfest.  
**NY - FRANKFORT** - Hamfest. Utica ARC, Bob Decker AA2CU, 315-797-6614. E-Mail: ktrnd@borg.com  
**OH - ELYRIA** - Hamfest. North Northern Ohio ARS, John Shaaf KC8BAOX, PO Box 432, Elyria, OH 44036-0432  
**PA - SALEM TOWNSHIP** - Hamfest. Beach Haven Carnival Grounds (I-80 Exit 36 or 38 N to US-11), 8am. VE Exams. Talk-in: 145.130 (PL 77.0) & 146.52 simplex. Jonestown Mountain Repeater Assn, Charlie Hooker AD3L, 570-864-2571 or fax 717-864-2377; Rich N3YGL, 570-784-0488; Mike K3EVQ, 570-752-1334; Walter N3IAU, 570-822-0180. E-Mail: chooker@epix.net  
**TX - DENISON** - North Texas Hamfest '99, Wilmer O. Kinsey WB5DCU, 803-993-5872. E-Mail: wb5dcu@gte.net Web: <http://home.gte.net/wb5dcu/nortex99.html>

## JULY 18

**IL - SUGAR GROVE** - Hamfest. Waubesa Community College, Rt. 47 at Harter Rd. (5 mi NW of Aurora), 8am. VE Exams. Talk-in: W9CEQ - 147.210 (+) PL 103.5/107.2 - AFAR repeater. Fox River Radio League, James Von Olnhausen N9UZZ, 630-879-3042. E-Mail: n9uzz@amsat.org Web: <http://www.frrl.org/hamfest.html>  
**MA - CAMBRIDGE** - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: <http://web.mit.edu/w1xm/www/swapfest.html>  
**MO - WASHINGTON** - Hamfest. Zero Beaters ARC, Dave Neal N0PNG, 314-532-2477 days, 314-458-3254 eves. E-Mail: Dave Neal@msn.com Web: <http://zbarc.usmo.com/>  
**NJ - AUGUSTA** - Hamfest. Sussex County ARC, Dan Carter N2ERH, 973-948-6999. E-Mail: n2erh@email.com  
**OH - VAN WERT** - Hamfest. Van Wert County Fairgrounds, US Rt. 127 S. 8am-3pm. VE Exams. Talk-in: 146.85 (-). Van Wert ARC, Bob Barnes WD8LPY, 419-238-1877, Bob KA8IAF, 419-795-5763. E-Mail: barnesb@bright.net Web: <http://www.bright.net/~barnesb/w8fy.html>

## JULY 23-24

**FL - MILTON** - Hamfest. Milton ARC, Dean Clark WB6UKF, 850-626-9752. E-Mail: acordc@worldnet.att.net  
**OK - OKLAHOMA CITY** - Ham Holiday '99. Oklahoma State Fair Park (Hobbies, Arts & Crafts Bldg.), intersection I-40 & I-44. 5-8pm Fri., 8am-5pm Sat. Talk-in: 146.82. Central Oklahoma Radio Amateurs, Thomas Webb WA9AFM. E-Mail: n1pn@swbell.net or tmwebb@telepath.net Web: <http://www.geocities.com/heartland/7332>  
**AZ - FLAGSTAFF** - Hamfest & ARRL AZ State Convention. Norm Martin KC7FNK, 520-297-9562. E-Mail: arcathill@aol.com Web: <http://www.hamsrus.com>

## JULY 24

**NH - NASHUA** - Hamfest. Res Ctr Church. NE Antique RC 617-923-2665  
**OH - CINCINNATI** - Hamfest. OH-KY-IN ARS, Dana Laurie WA8M, 513-761-7388.

E-Mail: wa8m@arrl.net

## JULY 25

**CA - SANTA ANA** - Swapmeet. ACP parking lot. Mary Russo 714-558-8813  
**MD - TIMONIKUM** - Hamfest. Timonium Fairgrounds, York Rd. off I-695, I-83. 8am. VE Exams. Talk-in: 147.030 (+) & 224.960 (-) & 448.325 (-). Baltimore Radio Amateur TV Society, 410-461-0086. E-Mail: brats@smart.net Web: <http://www.smart.net/~brats>

## JULY 30-31-AUGUST 1

**OR - PORTLAND** - Pacific Northwest DX Convention. Willamette Valley DX Club, Al Rovner K7AR, 360-256-7437 E-Mail: alarn@pacifier.com Web: <http://www.qsl.net/wvdx>

## JULY 31

**KY - BOWLING GREEN** - Hamfest. Kentucky Colonels ARC, Fred Painter, KA4CFW, 502-842-3193. Web: <http://kcarc.premiere.net>  
**WAYNESVILLE** - Hamfest. Haywood County Fairground. Western Carolina ARS, Carl Smith N4AA, 828-683-4251. E-Mail: wcars@dxpub.com  
**OR - BANDON** - Hamfest. Coos County ARC, Brian Howard W7MLT, 541-572-5623. E-Mail: w7mlt@usa.net

## AUGUST 1999

### AUGUST 1

**IN - ANGOLA** - Hamfest. Land of Lakes ARC, Bill Brown WD9DSN, 219-475-5897. E-Mail: sharon.l.brown@gte.net  
**OH - RANDOLPH** - Hamfest. Joanne Solak KJ3O, 330-274-8240. E-Mail: jlsolak@apk.net Web: <http://parc.portage.oh.us>  
**VA - BERRYVILLE** - Winchester Hamfest. Clarke County Ruritan Fairgrounds. 8am. VE Exams. Talk-in: 146.82 (-) W4RKC repeater. Shenandoah Valley ARC, Guy Avey W3INT, 540-678-9970; Jane Barb KD4IET, 540-955-1745. E-Mail: ibarb@visualink.com. Web: <http://www.vvalley.com/svarc/hamfest> or <http://www.visualink.com/shenvalleyarc>

### AUGUST 6-7

**TX - AUSTIN** - Texas State ARRL Convention. Austin ARC, Austin Repeater Org & Texas VHF-FM Society, Joe Makeever W5HS, 512-345-0800

### AUGUST 6-7-8

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Nuts & Volts Magazine/May 1999 61



# ELECTRONICS

## Q & A

..... With TJ Byers

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

**What's Up:** Plenty of power: switching voltage regulators, Commodore battery power source, and NiCd battery keeper (not charger). Like playing with flashing lights? Have fun with neon lamps and an LED Star Trek chaser. Solutions for pesky video conversion and parts replacement problems. Finally, test your trivia knowledge on the Web.

### Flaky Fluorescent

**Q.** I have a light fixture from Lights Of America that uses a CMOS component to start the fluorescent lamp. Well, it's shorted, and the company won't sell me a replacement part. Any help would be appreciated.

Jlm  
via Internet

**A.** Don't hold it against them. They sell lamps, not parts. The original part is an IRF624, a 250-volt HEXFET, which isn't easy to find. I'd replace it with an IRF830, another HEXFET that's rated at 500 volts and sells for about \$4.00. You can get it from RadioShack, part number RSU11369865. Another suitable substitute is the NTE2398 made by NTE Semiconductors and available from many retailers.

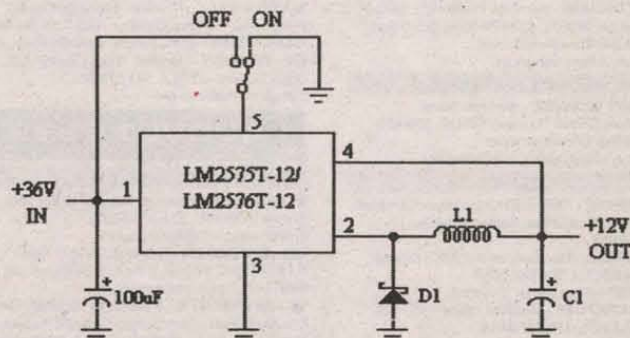
### 36V to 12V Switching Regulator

**Q.** I'm a maintenance technician for a large distribution center. In the summer, when the outside temperature often reaches 100 degrees, our forklift drivers get extremely hot because the heat dissipated by the forklift's electric drive motor is awesome. These fellas are about 12 inches away from the motor's heatsink, which is a 1-1/4-inch steel plate. Anyway, to keep their cool, they buy and install 48-volt fans at a cost of \$75.00 each. If they're lucky, the fans last two summers. Most don't. Could you concoct an inexpensive DC/DC converter that can handle a 2-1/2 amp surge and supply about 1 amp continuously? I'm hoping to go from 36 volts down to 12 volts, so that inexpensive car fans can be used instead.

Bill Pippin  
Dallas, TX

**A.** First let me direct your attention to the companion article "Switching Voltage Regulator Basics - Part 1" on page 76. That way, this terse answer will make more sense. What you need is a step-down (buck) switching regulator, like the LM2575T-12 or LM2576T-12. These two chips are identical except for output current. The

LM2575-12 is rated at 1 amp with a surge capacity of 2.3 amps, and the LM2576-12 is rated at 3 amps with a surge capacity of 5.8 amps. Both are 88% efficient, and require just four external parts. An added benefit of this regulator is an ON/OFF pin (pin 5) that lets you turn on and off the fan by simply shutting down the regulator. They are available from Digi-Key (1-800-344-4539; <http://www.digikey.com>) for \$5.15 and \$9.00, respectively. Here are the component values for 36-volt operation.



Component	LM2575 (1A)	LM2576 (3A)
C1	330 uF	1000 uF
D1	1N5820	1N5822
L1	330 uH	100 uH

When building this circuit, be sure to provide an adequate heatsink. For your environment, I suggest a 4x4 inch aluminum plate that has access to air flow, like when the forklift is in motion. The IC doesn't have to be isolated from the heatsink; the tab is at ground potential.

### Neon Lamp Basics

**Q.** I am an 11-year-old attending school in Yorkshire, England, and I'm trying to find out something for my homework. I need to know what voltage a neon light needs to light it. Please help if you can.

Daniel  
via Internet

**Q.** I bought a kit at RadioShack many years ago that had five neon lights that blinked in sequence. I have since lost the kit and its manual, and can't remember the circuit. Can you help?

Peter Lawrence  
via Internet

**A.** Sure. As a kid I played a lot with neon lamp circuits. Here's a medley of designs that you might find interesting, including Peter's long-lost five-lamp ring counter. Before we begin, though, I caution against using rectified AC power from an outlet to experiment with. Instead, I

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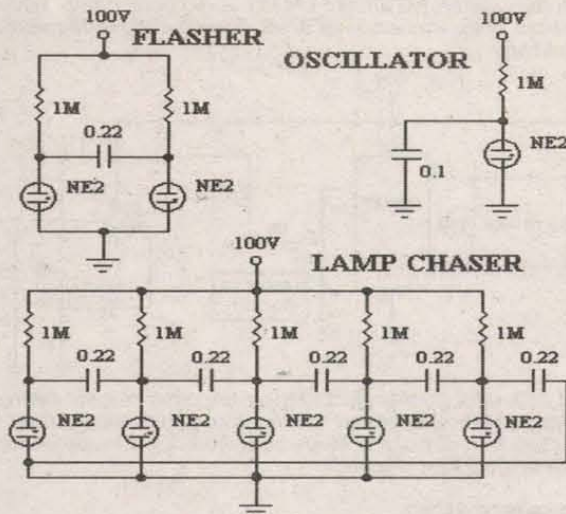
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recommend using a dozen 9-volt radio batteries wired in series. The output is 108 volts, and the shock of accidentally touching the power source isn't lethal. Now on with the show.



The neon lamp is a negative resistance device. That means its resistance decreases as the voltage increases — well, sort of. Let's take the oscillator circuit above, for example. When power is applied, the 0.1uF starts to charge. When the voltage across the capacitor reaches about 90 volts, the neon lamp "fires" — that is, it lights. When the lamp lights, its internal resistance decreases, which causes the capacitor to discharge, which extinguishes the NE2 bulb, which forces the capacitor to recharge again and fire the bulb ... which starts the cycle all over. This is called a relaxation oscillator, and its output is a triangular wave with a 30-volt amplitude. When two neon lamps are paralleled with a connecting capacitor, the bulbs alternate. What happens here is that one side of the capacitor is high and the other low, depending on whether the lamp is on or off. When one bulb fires, it forces that lead of the capacitor low, causing the opposite lead to charge high which, in turn, causes the alternate lamp to fire and extinguish the first ... well you get the scenario. The flash rate is determined by the formula  $t = RC$ . Now that you know the characteristics of a neon lamp, you can easily figure out how the ring counter works, and even use its negative-resistance properties to invent circuits of your own. Have fun!

### Battery-Powered Tools and Dead Batteries

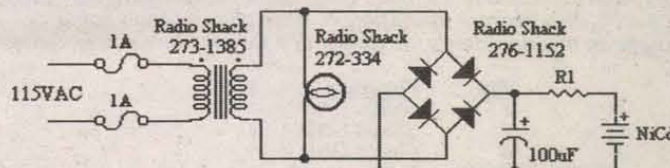
**Q.** I read with great interest your answer on NiCd batteries in the Feb. '99 issue. I have a wire wrap tool which is used only occasionally and in an electric screwdriver which is used rarely. Every time I want to use them, the batteries are dead. Black & Decker recommends leaving them in their charging stands, but they generate a lot of heat and that bothers me. So I'd like to discharge them when not in use, and I like the idea of using a light bulb instead of a dead short. What would you recommend as a discharge load for a pair of sub C cells in series? I appreciate any light (no pun intended) you can shed on the subject.

Gene Riding  
via Internet

**Q.** I have a need for battery chargers which can recharge and maintain several battery packs without overcharging them. The battery-powered hand tools involved include: drill driver, hedge trimmer, grass clipper, flashlight, hand vacuum, and more. When they were new, all came with wall transformers mounted in a charging bracket (or reasonable facsimile). Most of the battery packs incorporate 2, 3, 4, and 5 sub-C NiCd cells connected in series. The exception is the hand vac, which has a 6-volt sealed lead-acid battery. All these units are intended to be left in their charger cradle or otherwise plugged in when not in use — at least there are no instructions to the contrary. I fried two hand vac batteries in about two months before I realized that keeping these units in their cradles isn't good. None of these hand tools are in use on a frequent schedule; i.e., they would spend more than 95% of the time connected to a charger if I could be sure they wouldn't overcharge. I've had enough battery replacement problems to cause me to leave tools unplugged and hence not be sufficiently charged when needed. What's the simplest and least costly way to keep these battery packs up to snuff?

Ken Allison  
Hereford, AZ

**A.** Yes, NiCds have a bad habit of going dead when you leave them just lying around. The cells discharge about one percent a day, maybe a bit less. At this rate, they'll be dead in about three months. But keeping them on the charger does more harm than good because they overcharge the batteries if left on the charger for more than two days. Overcharging a NiCd has the same effect as the legendary "memory effect" where the capacity is diminished. The best way to keep NiCds fresh is to recharge them after use according to the manufacturer's directions, then remove them from the charger and place them on a "maintenance" charger, like the one below.



Let's take the sub C cell, for example, that's typically rated at 1400 mAh (milliamp hours). One percent of 1400 is 14 mA — let's call it 10 mA to be on the safe side. Two cells in series is 2.4 volts. The source voltage from the schematic above is about 16.8 volts. Using Ohm's Law,  $R = E/I = 14.4/0.01 = 1.4K$ . Let's call it 1.5K. Here's a table of R1 values for other battery packs.

Number of Cells	Voltage	Battery Capacity	Maintenance Current	R1
1	1.2	1400 mAh	10mA	1.5K
2	2.4	1400 mAh	10mA	1.5K
3	3.6	1400 mAh	10mA	1.2K
4	4.8	1400 mAh	10mA	1.2K
5	6.0	1400 mAh	10mA	1.0K
6	7.2	600 mAh	6mA	1.5K
7	8.4	130 mAh	2mA	4.3K

As for completely discharging the battery after every use, I don't recommend it. It does nothing more than shorten the life of the battery, which has a finite number of charge/discharge cycles. Intentional deep-discharge (called "battery conditioning") should only be done when the battery experiences lackluster performance. Moreover, be aware that a NiCd battery should never be discharged below one volt per cell to prevent damage. In other words, don't hook

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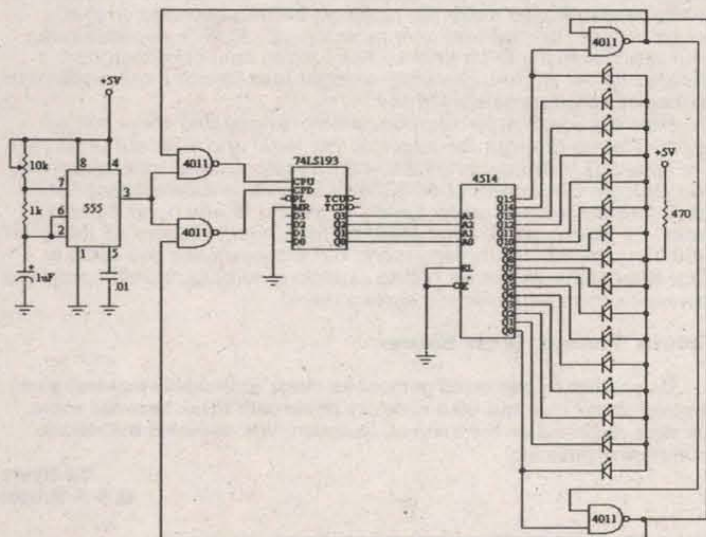
that obsolete part as item number one.

### Scotty, Beam Me Up!

**Q.** I'm looking for a circuit that will sweep back and forth from left to right, then right to left — Star Trek style. Initially, I'd like to sweep 10 LEDs, but would like to be able to add more LEDs (up to 20 or 30, total). Ideally, the circuit would run on 3 to 9 volts.

**Steve Hjelden**  
Antelope, CA

**A.** Here's a simple circuit that will sequentially light 16 LEDs and looks a lot like the moving light bar beneath the Star Trek's viewing screen.



It uses a 555 astable multivibrator to sequence a 74LS193 up/down counter that drives a 1-to-16 demultiplexer chip. The direction of the count is determined by the 4011 gates, which are cross wired as an RS flip-flop. Each time the top or bottom LED is activated, the flip-flop changes state, and reverses the counting order.

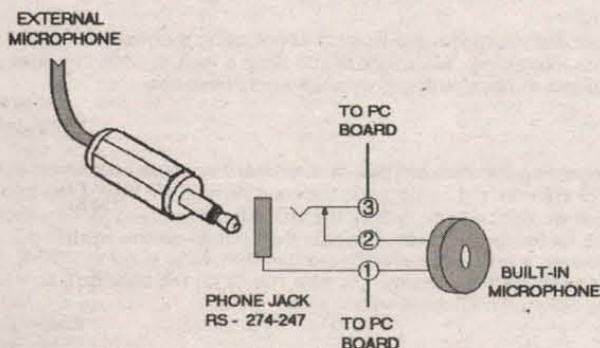
### Add External Mike To Cassette Recorder

**Q.** I own a Panasonic IC recorder, model RR-DR60, which has what I consider to be three flaws. First, it has no external microphone jack. Second, during playback there's a lot of electronic-sounding background noise. Finally, there are no provisions, as in a jack, for turning off the voice-activated record. Can it be modified to include these features?

**John Rommelt**  
Williamsport, PA

**A.** What you have is a "portable secretary" that lets you record messages, and then time stamps them. This tiny, handheld machine is great for "jotting" down thoughts in elevators or when you're on the road. I suspect that the background sound you hear is ambient noise that comes by placing the recorder on your dashboard or a conference table, where it picks up vibrations. Your idea of adding an external mike is excellent because it'll reduce this noise considerably — plus it will solve the voice-activated record problem. In other words, three solutions with one modification. Here's how it's done.

First, open the case and locate the built-in microphone. It's probably glued to the case and not the circuit board, so be careful. There'll probably be two wires. You want to break the red wire and insert the phone jack shown below in line with the wire.



The new mike jack is of the closed-circuit type. When the external mike plug is inserted, it breaks the connection to the built-in mike and connects the external mike. So much for the external mike. The easiest way to defeat the voice-activated record is to insert a switch in line with one of the external mike wires. An excellent choice is the Radio Shack 33-1067 cassette mike which is inexpensive (\$5.99) and easily modified. In fact, all you need to do is rewire the on/off switch so that it's in series with one of the mike leads. Now when the switch is turned off, the voice-activated circuit can't respond (no voice!).

### Mac II to VGA Video

**Q.** It would seem to be an easy thing to do, but I can't find a reference on how to connect the Mac IIs to a VGA monitor.

**Bryan McPhee**  
via Internet

**A.** You can buy Mac to VGA cables from several sources, including Bottom Line Online (1-800-347-0052; <http://www2.blol.com>) and PC Connection (1-800-800-0009; <http://www.pcconnection.com>), for about \$12.00. Want to make your own? Here's how.

Mac Pin	VGA monitor Pin	Function
1	6	Red GND
2	1	Red
3	-	Composite TTL sync
4	-	Monitor sense 2
5	2	Green
6	7	Green GND
7	10	Monitor sense 1
8	-	not used
9	3	Blue
10	7	Monitor sense 0
11	-	GND
12	14	Vertical sync
13	8	Blue GND
14	10	Horizontal sync GND
15	13	Horizontal sync

Of course, this cable presupposes that you have a SVGA monitor with support for 800 by 600 screen resolution or higher. If not, remove the jumper between pins 7 and 10.

### Very Practical Fiber Optics

**Q.** I work for a school district which is adjacent to several large petroleum refineries. The district has several emergency notification plans for relaying messages to the schools, but all have one shortcoming in that it's impossible to phone all schools in a timely manner. I've hatched an idea for immediate notification using our LAN's spare fiber optic cables which are connected at the Administration Building and routed to each school over telephone poles. My plan is to provide two strobes of different colors in the main hallway of each school to declare a level 3 or level 4 emergency. The school administrators would then know which plan to put into effect without verbal communication. I don't want to rely on the LAN, just the spare fibers. I've tried using a RadioShack infrared transmitter and receiver without much luck. Not experienced in fiber optics and finding little literature, I'm hoping that you might have some answers.

**Tim Parker**  
via Internet

**A.** There are two reasons why you're having trouble getting your

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**MCM Electronics** (page 65, April issue)

### Electronics Q & A

message through. First and foremost, the line that you describe as "single-fiber," isn't. Somewhere along the way there has to be a repeater (most single-mode fibers are only good for a mile or two before the signal degrades into noise). Second, you need a light source more powerful than an LED — specifically a laser. Finally, and I assume you already know this, is that the signal has to be modulated before it can pass through the repeaters. So what do we have here? A frequency-modulated (not a steady light source like the Radio-Shack LED) laser at the head and a PLL (phase-locked loop) receiver at the school. One frequency triggers a level 3 alert, and another trips the level 4 strobe. If it were me, I'd include a third frequency — an "OK" signal — that would let the school know that the link was functional and not broken. If this signal drops out, another alert would be put into effect prompting the administrator to place a phone call as to why. Who knows when an explosion might take out a telephone pole or two? I would also make the receivers battery operated so that a power outage (like we had here recently with PG&E) wouldn't bring your clever scheme to its knees. (The battery can, of course, be charged by the AC line and only brought into service if the power fails — like power-failure safety lights.)

Now the \$64,000.00 question: Where do you find these components? Thumb through the pages of this issue and seek out vendors like Meredith Instruments (602-934-9387; <http://www.mi-lasers.com>) and Unicorn Electronics (1-800-824-3432; E-Mail: [unielect@aol.com](mailto:unielect@aol.com)). You'll find them listed under Lasers in the By Product and Category index. Of course, you'll need polished fiber interfaces and all that stuff which makes this technology work, but it sounds like you already have a lot of this in house. Living close to a refinery myself, I pray you can make this early warning system work!

### Trivia Teaser Web Sites

Do you like to play mind games like chess or Scrabble that test your strategy skills? Now test your memory power with trivia. Here are some fun sites you'll find on the Internet. Question: Who invented the electric toothbrush? Have fun!

**TJ Byers**  
Q & A Editor

\*Trivia World — <http://www.triviaworld.com/>  
Trivia World at <http://www.triviaworld.com/> asks multiple choice trivia questions in seven categories. Great for trivia beginners and just plain fun.

\*Useless Knowledge — <http://www.uselessknowledge.com/>  
The most useful site for Useless Knowledge, <http://www.uselessknowledge.com/> has an endless parade of facts and factoids, all of which you can find via their search engine. In addition, there's a great test of trivia skills, with multiple choice questions that change monthly, and the usual plethora of daily quotes, fact of the day, today in history, and other junk.

\*Trivial Pursuit — <http://www.trivialpursuit.com/>  
An on-line version of Trivial Pursuit Genus IV can be found at <http://www.trivialpursuit.com/>. The game consists of just six categories. To win, you just have to answer just one question in each category. Sound simple? Wrong, the answers have to be typed in — with correct spelling! No multiple choice, no true/false, no hints. Not for the faint of heart.

\*Fun Trivia — <http://www.funtrivia.com/>  
Touted as the largest collection of fun and trivia facts on the Internet. Fun Trivia at <http://www.funtrivia.com/> includes facts on everything from US presidents to science to McDonalds hamburgers. Has search engine to look up facts.

\*Jeopardy! — <http://www.station.sony.com/jeopardy/>  
And, of course, the granddaddy of them all — Jeopardy!

### MAILBAG

Dear TJ:

Your answer to Howard Epstein about using a remote doorbell (Jan. '99) was interesting. You might like to have a look at what I've done on this subject at <http://wd5gnr.virtualave.net/rfrem.htm>

**Al Williams**  
via Internet

Regarding the Packard Bell motherboard upgrade mentioned in the Mar. '99 column, did he upgrade the hard drive also? If so, I ran into an IBM that wouldn't let me restore the HD. After searching IBM's website, I found a fix for the problem. It seems they put ID on the HD INT 13. I downloaded a program called fix partion that, after you run FDISK, FORMAT, and fix partion, changes or puts the ID on the hard disk so that the restore disk/ cd command would work.

**Larry Cowgill**  
via Internet



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### Elenco Model M-1740



**\$39.95**

- 11 Functions:**
- Freq. to 20MHz
  - Cap. to 20µF
  - AC/DC Voltage
  - AC/DC Current
  - Beeper
  - Diode Test
  - Transistor Test
  - Meets UL-1244 safety specs.
- Model M-2780 - \$24.95**  
(9 functions)

### Elenco Model LCR-1810



**\$99.95**

- Capacitance .1pF to 20µF
- Inductance 1µH to 20H
- Resistance .01Ω to 2000MΩ
- Temperature -20°C to 750°C
- DC Volts 0 - 20V
- Frequency up to 15MHz
- Diode/Audible Continuity Test
- Signal Output Function
- 3 1/2 Digit Display

### Fluke 87III



**\$299**

Features high performance AC/DC voltage and current measurement, frequency, duty cycle, resistance, conductance, and capacitance measurement.

Series II (limited qty.)  
**\$289**

## Generators and Counters

### Elenco Sweep Function Generator with built-in frequency counter Model GF-8036



**\$225**

This sweep function generator with counter is an instrument capable of generating square, triangle, and sine waveforms, and TTL, CMOS pulse over a frequency range from 0.2Hz to 2MHz.

### 20MHz Sweep / Function Generator with Frequency Counter Model 4040

**\$399**



- 0.2Hz to 20MHz
- AM & FM modulation
- Burst Operation
- External Frequency counter to 30MHz
- Linear and Log sweep

**BK PRECISION**

**10MHz Model 4017 \$309**

**5MHz Model 4011 \$239**

### Elenco Handheld Universal Counter 10Hz - 2.8GHz Model F-2800



**\$99**

- Sensitivity:**
- <1mV @ 100MHz
  - <6mV @ 200MHz
  - <6mV @ 1GHz
  - <100mV @ 2.4GHz

Features 10 digit display, 16 segment and RF signal strength bargraph. Includes antenna, NiCad battery, and AC adapter.

### Elenco RF Generator with Counter (100kHz - 150kHz) Model SG-9500



Features internal AM mod. of 1kHz, RF output 100mV - 35mV. Audio output 1kHz @ 1V RMS.  
**SG-9000 (analog, w/o counter) \$119.95**

### B&K Frequency Counter Model BK-1875



**1Hz - 2.8GHz**  
**3 Channels**  
**\$189**

- Sensitivity:**
- <0.8mV @ 100MHz
  - <6mV @ 300MHz
  - <7mV @ 1GHz
  - <100mV @ 3GHz

Ultra sensitive synchronous detector bargraph and RF strength.

### Elenco 10Hz - 1MHz Digital Audio Generator Model SG-9300



**\$175**

Features built-in 150MHz frequency counter, low distortion and sine/square waves. **SG-9200 (w/o counter) \$119.95**

## Elenco Oscilloscopes

Free Dust Cover and 2 Probes



S-1325	25MHz	Dual Trace	\$325
S-1330	25MHz	Delayed Sweep	\$439
S-1340	40MHz	Dual Trace	\$475
S-1345	40MHz	Delayed Sweep	\$569
S-1360	60MHz	Delayed Sweep	\$749
S-1390	100MHz	Delayed Sweep	\$995

### DIGITAL SCOPE SUPER SPECIALS

DS-203	20MHz/10Ms/s	Analog/Digital	\$695
DS-303	40MHz/20Ms/s	Analog/Digital	\$995
DS-603	60MHz/20Ms/s	Analog/Digital	\$1295

## Four Functions in One

### Elenco Model MX-9300



**\$459.95**

### Features:

- One instrument with four test and measuring systems:
- 1.3GHz Frequency Counter
- 2MHz Sweep Function Generator
- Digital Multimeter
- Digital Triple Power Supply - 0-30V @ 3A, 15V @ 1A, 5V @ 2A

## Elenco Educational Kits

### Model AR-2N6K



2 Meter / 6 Meter  
Amateur Radio Kit  
**\$34.95**

### Model AM/FM-108K



Transistor  
Radio Kit  
**\$29.95**

### Model AK-700



Pulse/Tone  
Telephone Kit  
**\$15.95**

### Model AK-870



Radio Control Car Kit  
• Solderless  
• 7 Functions  
• Radio Control  
Included  
**\$24.95**

### Model M-1005K



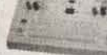
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Multimeter Kit  
• 18 Ranges  
• 3 1/2 Digit LCD  
• Transistor Test  
• Diode Test  
**\$19.95**

### Model XP-720K



Power Supply Kit  
• 1.8VDC - 18VDC @ 1A  
• 1.8VDC - 18VDC  
• 8VDC @ 3A  
• 8.8VAC @ 1A and  
12.8VAC center  
tapped @ 1A  
**\$54.95**

### Model XK-150



Digital / Analog  
Trainer  
**\$89.95**

### Model EP-50



Electronic  
Playground and  
Learning Center  
**\$19.95**

## Tekk Radios

### Pro-Sport FRS Two-Way Radio Model PRO-SPORT+

- 14 Channels
- Battery Monitor
- Key Lockout
- Monitor Button
- Lightweight
- Palm Sized
- Large LCD Display
- Removable Belt Clip
- Removable Antenna
- Two Radio Call Tones
- Busy Channel Lockout
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**or**  
**\$149.95**  
Set of 2

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2 miles!



**PRO SPORT Model**  
**\$109.95 set of 2**

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### Elenco Technician Tool Kit Model TK-1500

28 tools plus a DMM contained in a large flexible tool case with a handle ideal for everyone on the go.



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4 Fully Regulated DC Power  
Supplies in One Unit  
4 DC voltages: 3 fixed - 5V @ 3A, 12V @ 1A, 12V @ 1A  
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# AMATEUR ROBOTICS

# NOTEBOOK

by Robert Nansel

This month, I want to take another step toward one of my goals for the year, namely to give Breadbot some modest navigation and obstacle avoidance abilities. In my Jan. '99 column, I presented pseudocode for two elementary

fect wheel would make. Still, navigating with odometric feedback is far better than navigating with no feedback at all. Down the road, maybe I'll add a simple magnetic compass heading sensor to Breadbot to help overcome some of the deficiencies of pure odometry. For the next few months,

encoder types: *absolute* and *incremental*. Absolute encoders use multiple optical tracks to allow sensing the absolute angular position of the encoder disk. The disks usually use a Gray code instead of a straight binary pattern; Gray code is a pattern where only one bit changes between each

high resolution — typically up to 2,000 stripes per revolution of a two-inch wheel. On the downside, they tend to need more room because there must be access to both sides of the encoder disk. They also tend to be relatively expensive.

Reflective mode sensors, on the other hand, have the IR emitter and receiver on the same side of the encoder disk, making for a slimmer package (see Figure 6). Resolution tends to be lower for reflective mode encoders, limited by how small a spot can be focused on the encoder disk by the emitter and resolved by the receiver. Other limits to resolution are the lower signal-to-noise ratio of reflective sensors and more critical mechanical alignment requirements, combining to limit low-cost designs to something like 200 stripes per revolution of a two-inch wheel.

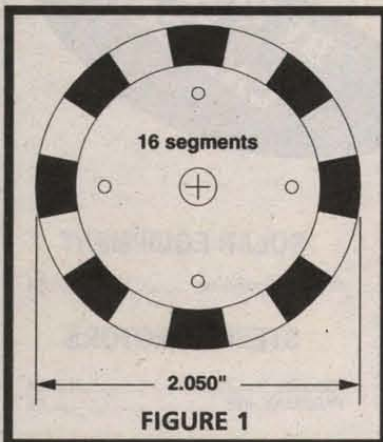


FIGURE 1

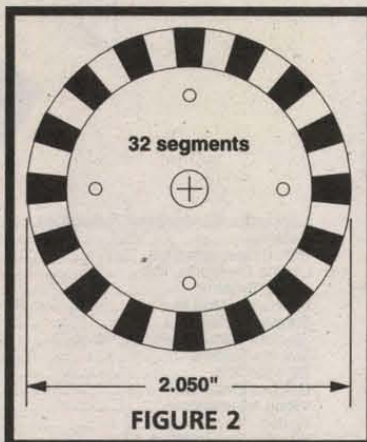


FIGURE 2

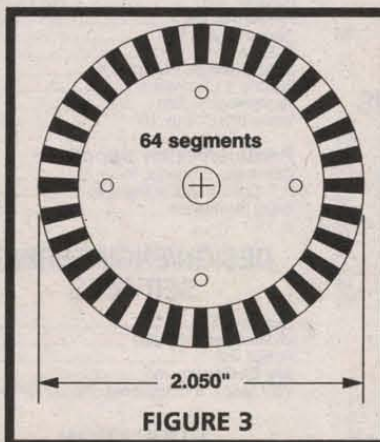


FIGURE 3

obstacle-traversal algorithms: the Lumelsky Bug1 and Bug2 algorithms. These are capable of finding their way from any start position to any goal position (provided such a path exists).

One prerequisite for implementing either Bug algorithm, though, is that the robot must know its position and be able to move in straight lines. The spiffy new brain I installed in Breadbot a couple months ago (Feb. and March '99 *Nuts & Volts*) can handle the code for the Lumelsky Bug algorithms, but Breadbot's mechanical hardware just isn't up to the task — yet. This month, I begin a series on upgrading the drivetrain to provide the wheel odometry Breadbot will need to stay on the straight and narrow.

"Odometry" is just a fancy term for keeping track of how far a vehicle has come by counting how many times its wheels have turned — a form of dead reckoning. Since Breadbot has two drive wheels, it's necessary to track the revolutions of both wheels in real time in order to estimate the robot's current position.

I say "estimate" because no wheel is perfect, nor is the surface it runs on completely smooth. Wheels slip, and bumps and cracks in the running surface distort the measurements even a per-

though, I'll concentrate on making those wheels turn in synchrony.

## Spinning Wheels

There are many ways to sense wheel rotations, from analog tachometers and resolvers to Hall-Effect gear-tooth sensors; but the most widely used method in robotics is the optical shaft encoder. Optical encoders are popular because they are fairly rugged and cheap to build (witness the fact that most computer mice use optical encoders). Also, the signal output from an optical encoder is inherently digital, with good noise immunity.

There are two basic optical

code. The kind of encoders we're interested in, though, are the incremental variety, which only allow counting the number of pulses in a revolution, not the absolute position of the wheel.

For both absolute and incremental encoders, there are two modes of optical operation: *transmissive* and *reflective*. Transmissive systems use one or more opposed-pair sensors, where a focused beam of light (usually infrared) is aimed at a matched detector. The encoder wheel, also known as an optical "chopper," interrupts the beam with its coded pattern of opaque and transparent stripes.

Transmissive mode encoders are extremely reliable and can have very

## Roll Your Own

The good news is that we don't need high resolution to do odometry; as we'll see, 32-segment encoder wheels will do for most tasks, and you can make your own high-quality encoder wheels for the price of a few photocopies. Figures 1 through 3 are encoder patterns for use with either Breadbot- or GrowBot-style wheels. Suitable reflective photosensors include the QT Optoelectronics QRB1114 or QRD1114; both can be obtained from Digi-Key and Mouser Electronics for less than \$2.00 US each in small quantities.

As for the encoder disks, touch up any printing imperfections in the magazine artwork with a black marking pen. Then photocopy the patterns on a quality plain-paper photocopy machine — one that gives dense, even blacks, and smudge-free whites. Try to get the wheel diameter as close as you can to the dimensions shown; next month, I'm going to show how to build a compact reflective sensor board that depends on those dimensions.

If you are designing your own sensors, enlarge or reduce the patterns according to your requirements. Carefully cut the

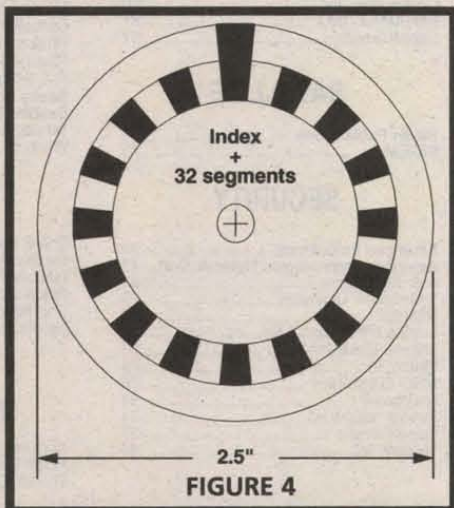


FIGURE 4

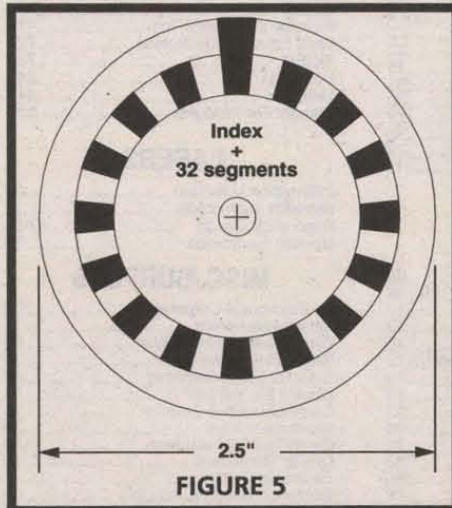


FIGURE 5



disks out, as well as a couple of plain white paper backing disks of the same diameter. Depending on the paper and sensors you use, the backing disks may or may not be needed to make the white stripes reflect back enough IR to the sensors.

To mount the encoder disk to a Breadbot wheel, use the four-hole pattern to align the disk with the screws of the wheel hub mount (see Figure 5). For GrowBot, simply align the central circle with the wheel hub. With GrowBot, you may need to use double sticky tape or contact cement to bond the encoder disk to the wheel but, with Breadbot, the arms of the wheel hub will hold the encoder disk in position.

Figure 4 is an indexed encoder pattern. An additional outer track, requiring its own emitter/sensor pair, gives one index stripe per revolution. This wheel is meant to be used with GrowBot, which has larger wheels to accommodate the larger diameter encoder wheel. The idea could also be used on a Breadbot-size wheel if the tracks were made narrower.

Once an indexed encoder wheel is "homed" to the index pulse, it's possible to emulate the function of an absolute posi-

tion encoder simply by keeping track of how many regular counts beyond the index stripe you've gone. This works only if the wheel turns in one direction between index pulses; otherwise the count will be off, since a single channel encoder can only give speed and not direction information. Likewise, anything that causes the system to lose the pulse count (such as a power interruption) loses the position information until the wheel is re-homed.

### What's All This Quadrature Stuff?

In order to get full speed and direction sensing, you must add a second emitter/sensor channel to the

main track. It's not good enough to add a second sensor just anywhere along the track; it must be in a definite phase relationship to the "A" sensor channel, such that the output of the second "B" channel leads or lags the first by 90 degrees or one-fourth of a cycle (see Figure 7).

In the figure, I show the A and B channel sensors being 39.4 degrees apart on the encoder wheel in relation to its center of rotation. Yet I said above that the sensors must be in quadrature phase, which is 90 degrees. What gives?

The answer is that the mechanical phase angle of the sensors is not the same thing as their electrical phase angle; it's the electrical phase angle that must be in quadrature.

The two angles are related, however.

To see how, first notice that, with the encoder wheel in the position shown in the figure, A-channel straddles the boundary between a black stripe and a white stripe.

If the sensor produces a logic high level when it "sees" a black stripe and a logic low for a white stripe, then a small clockwise rotation of the encoder disk will bring the black stripe underneath A-channel and produce a

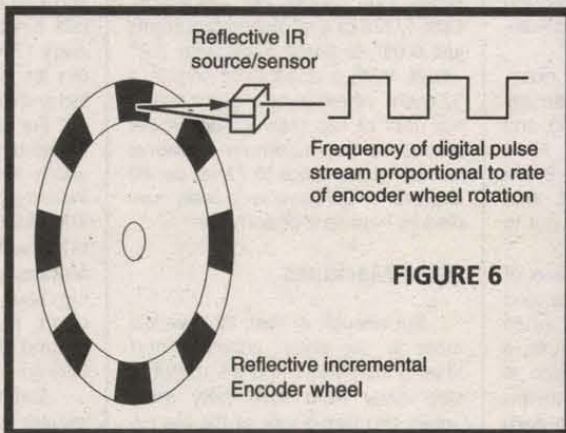


FIGURE 6

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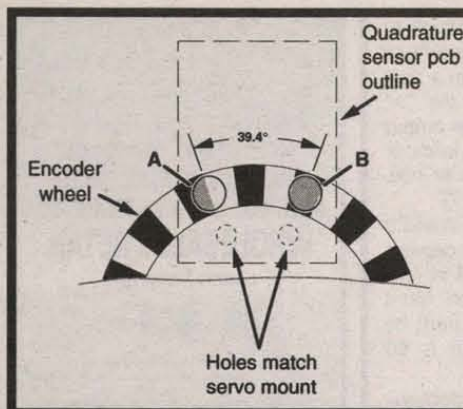


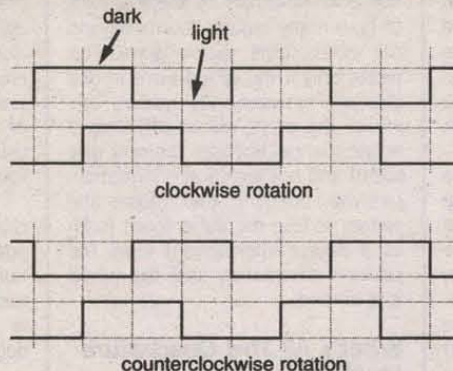
FIGURE 7

A Channel:

B Channel:

A Channel:

B Channel:



low-to-high transition. A small counterclockwise rotation from the same position will produce a high-to-low transition as the white stripe comes under the A-channel sensor.

Next, consider what happens with the B-channel sensor. B-channel already has a black stripe centered beneath it. For a small clockwise rotation, at the same instant that A-channel is transitioning from white to black, B-channel still sees black. The same is true of a small counterclockwise rotation. The wheel must turn at least half the angular width of the stripe either direction before B-channel will see a white stripe.

For the two sensors to be in quadrature electrical phase, they must be positioned so that when one sensor straddles a black/white transi-

tion between two stripes, the other sensor is exactly centered on one stripe (black or white — it doesn't matter which). In other words, the sensors must be spaced an odd number of half angular divisions.

The encoder wheel in this example has 32 stripes around its circumference (16 white and 16 black), and each stripe subtends  $360 \div 32 = 11.25$  degrees. Since A and B are three and a half stripes apart, their mechanical phase angle works out to about 39.4 degrees.

You can detect the direction of rotation simply by noting what kind of transition A-channel makes when B-channel is high: in this example, a high-to-low means the direction is clockwise, and a low-to-high means counterclockwise. By counting each

transition from both channels, you get an effective quadrupling of resolution. A 32-division encoder wheel yields 128 counts per revolution. Each 1/128 of a revolution represents just 0.05" of linear travel with a 2" wheel. With a quadrature sensor, a 32-count wheel gives a pulse repetition rate of less than 97 pulses per second at the maximum rotational rate of Futaba servos (0.22 sec per 60 degrees, or 0.76 rev/sec), easily handled by hardware or software.

### Mere Machines

But enough of that; I'll have lots more to say about encoders next time. Sometimes I find it's useful to step away from such nitty gritty details and take a look at the big pic-

ture in robotics. One book I read 10 years ago that's great for this is Hans Moravec's *Mind Children: The Future of Robot and Human Intelligence*.

In this book, he predicted mobile utility robots would be in homes by the end of the nineties (a prediction that missed), and human-level AI by 2030 (we'll see). His predictions were based, in part, on Moore's law — the apparently unending ability of the computer industry to double compute power per dollar every two years. The trend has been ongoing for most of this century, and it's a trend that is, if anything, accelerating. In the eighties, the doubling occurred every 18 months and, in the late nineties, it appears to happen every 12 months. You can buy a heckuva lot more computing horsepower today than you could 10 years ago.

For example, in 1989, \$1,000.00 would buy you a machine capable of about 1 MIPS. Ten years later, the industry stands poised to drop nearly 1000 MIPS on your desk for the same price, with no end in sight. Most of Moravec's predictions about computing have proven out, but we still don't have those robot helpers around the house. What went wrong?

Some answers may be found in my pick for this month's robotics book

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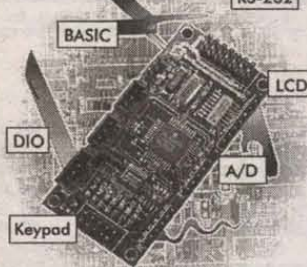
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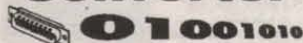
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of the month, and, by no coincidence, it's Hans Moravec's newest: *Robot: Mere Machine to Transcendent Mind* (Oxford University Press, New York, 1999, ISBN 0-19-511630-5).

In *Robot*, Moravec revisits the arguments and projections of *Mind Children*, and he expands and improves on his earlier themes, stretching them to astonishing and wondrous new heights. In seven crisp chapters, he took me from nodding and taking notes to a cosmic infinity mindblowing worthy of Stanley Kubrick. I'm still breathless.

## Insects Do It

Why aren't home utility bots

ubiquitous in 1999? Part of it, Moravec says, is simply underestimating the amount of computing power needed for household robots. We once thought a robot as smart as, say, an insect could do the job. Insects are very successful in nature (they're the real masters of the planet, after all), so it seems reasonable that insect-level intelligence in robots would suffice.

We also used to think that 1 MIPS was the equivalent of insect-level intelligence — if only you could write the program. That's the first mistake. As it turns out, 1 MIPS is only equivalent to an earthworm. To get to insect level you need more like 100 MIPS, the equivalent of a

100,000-neuron neural network.

Not coincidentally, 100 MIPS is also about twice the compute power used by Navlab 5, the Plymouth minivan that drove autonomously from Washington, D.C., to San Diego, CA, in the summer of 1995. Navlab 5 was equipped with a video camera and a 50 MIPS laptop running road-following software called 1995 RALPH which allowed it to drive 98.2% of the time along the route, at an average speed over 100 km/h.

The second flaw in the argument is that insect success depends not only on intelligence, but on sheer numbers. It doesn't matter if a thousand moths fry when they mistake your porchlight for the moon; a mil-

lion more moths don't see your light and many of them will live to carry out their basic function.

If we could make robots cheaply in insect-swarm quantities, then insect-level intelligence really would be enough. I suspect, though, the prospect of a house littered with little-dead-robots-that-couldn't would limit their market appeal.

Of course, you could introduce another swarm of robots whose only job is to clear away robot corpses, a whole ecology ...

## Transcend This

One argument that Moravec makes in the book is fascinating in



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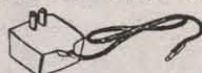
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that it appears to explain something that's puzzled and frustrated gear-heads for decades: With compute power going up exponentially, why hasn't AI technology also advanced exponentially? Or even linearly?

The answer seems to be that while general computing power grew a hundred thousandfold from 1960 to 1990, the budgets of AI researchers fell during those same years. True, each year they could buy more computer for the dollar, but there were also more AI researchers among whom to spread those dollars around. The net result was for 30 years, AI researchers never had more than roughly 1 MIPS machines to work with, and mobile robotics was

even worse off (Shakey, SRI's ground-breaking robot of the sixties had about 0.3 MIPS).

In the fifties, when AI budgets were at their peak in constant dollars, a common research machine was the IBM 704 — as costly in its day as a super computer today. It was capable of a decent fraction of 1 MIPS. In the sixties medium-scale budgets paid for medium-scale machines costing a few million dollars, like the DEC PDP-1 and PDP-6. The seventies brought still lower budgets, and the PDP-10 was the AI workhorse of choice.

There was a bit more money in the eighties — but also more researchers. Most had to make do

with \$100,000.00 VAX machines, also 1 MIPS. The mid-eighties saw the first 1 MIPS personal workstations costing about \$10,000.00.

By 1990, though, the price of 1 MIPS dropped below \$1,000.00, and there was no longer any budgetary reason for AI researchers to continue to use such wimpy machines. Since 1990, the computer power available to individual researchers has doubled yearly, and AI research has finally begun to make real strides (such as Navlab 5).

## More MIPS, More MIPS!

This also means that amateur roboticists can finally afford to keep

up with leading edge AI research. And those robots we've been building in the last quarter century with eight-bit processors ranging from the Z-80 to the 68HC11 (and now PICs!)? All of them are pitifully underpowered, even by insect standards, folks, and it's time we moved up to more horsepower — way more horsepower.

Moravec estimates a 1,000 MIPS machine would make an adequate home robot vacuum cleaner about 2005, and a 3,000 MIPS machine — about lizard-scale intelligence — would give us the first true general-purpose home robot by 2010. A few thousand MIPS is just barely enough for a robot to build a coarse map of its environment and



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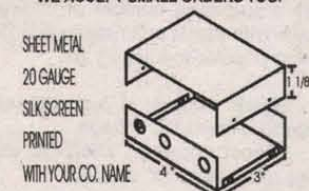
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SPDT	D129	6A/125V	Solder	.77 .67
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on-off-on	D133	3A/250V	Solder	.77 .67
DPDT	D135	6A/125V	Solder	.92 .82
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use that map for reliably locating itself.

A 100,000 MIPS brain in 2020 will get us to mouse-scale intelligence, and robots so equipped will be capable of rudimentary learning and adaptation. By 2030, 3,000,000 MIPS brains will provide monkey-level intelligence to robots, making them capable of doing all but the most demanding creative work. This is the first class of robots that would benefit from anything as abstract as Asimov's Laws of Robotics.

And, in 2040, 100,000,000 MIPS brains will allow robots to reach human-scale intelligence. You could give vague commands to this sort of machine, such as "build me a bigger

house," with some reasonable expectation that the robot could do a good job of it.

If the above prediction delights you, you should read the book, because this is only chapter four. Chapter five deals with the myriad implications such a development would have on the world, and in chapters six and seven, well, prepare to have your sense-of-wonder fuses blown more than once.

If, however, the prospect of human-scale intelligence in robots frightens you, then I urge you to read the book anyway. Moravec may not win you over, but you'll certainly come away with an altered point of view.

## Back To Earth

As usual, I have way more to say than I have space for. Quickly, then: don't forget the SIMMStick99 design contest deadline November 1, 1999; check out <http://www.simmstick.com> for details. Also, be sure to buzz by Wirz Electronics new amateur robotics website, <http://www.hobbyrobot.com>.

Next time, we'll finish up Breadbot's encoder hardware and take a look at what a next gen robot development system might look like.

Meanwhile, I have to apply my 100,000,000 MIPS to figuring my taxes this year. **NV**

As always, if you have suggestions for improving Breadbot, if you've built a Breadbot, or if you have questions or comments about amateur robotics topics, you can reach me at:

**Robert Nansel**  
69 S. Fremont Ave. #2  
Pittsburgh, PA 15202  
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# SWITCHING VOLTAGE REGULATOR BASICS — PART 1

**M**ost electronic equipment operates from low-voltage DC. Traditionally, the solution has been a power supply made of a 50/60-Hz step-down transformer followed by a rectifier and a linear voltage regulator, like an LM350. The weight and bulk is large, the heat beyond that of Death Valley, and the efficiency low (about 60%).

As equipment grows more portable, slimmer, lighter, and sexier, though, these numbers are unacceptable.

Along with more numerous high-current, low-voltage requirements comes zero-glitch load switching and increased efficiency that characterize power-down standby modes to conserve battery power, size, and weight. No longer is the standard wall adapter (brick) able to meet these demands.

Reduced size, flexible output options, and high efficiency have made switching regulators the power supply of choice for today's equipment.

Unlike linear regulators, which regulate by converting excess voltage into heat, switching regulators adjust the output voltage by using a method called pulse-width modulation.

In this article — the first of two parts — I'll show you how the industry converts voltage from one value to another without wasting power using switching con-

## Weighing The Options

by TJ Byers

verters. Better yet, I'll show you how to do it yourself.

### Topology Choices

Choosing the right switching topology can be challenging. There are a surprising number of choices, each with merits and drawbacks. The most popular topologies are:

**Buck:** Reduces a high DC voltage to a lower DC voltage.

**Boost:** Increases a low DC voltage to a higher DC voltage.

**Flyback:** Generates an output voltage that is lesser or greater than the input, including multiple output voltages.

**Invert:** Generates a DC voltage which is opposite in polarity to the input voltage.

As you see, more than one

topology can be used to solve the same problem. For example, a flyback configuration provides buck, boost, and invert, as well as multiple outputs. However, buck regulators may be used as inverters, and many boost regulators can provide multiple

outputs. In the following discussion of these four topologies, application information will be provided, along with circuit examples. Remember, this article is cut into two parts. The buck and boost come first, followed by the flyback and invert.

### Buck Converter

The most popular switching regulator is the step-down buck convert-

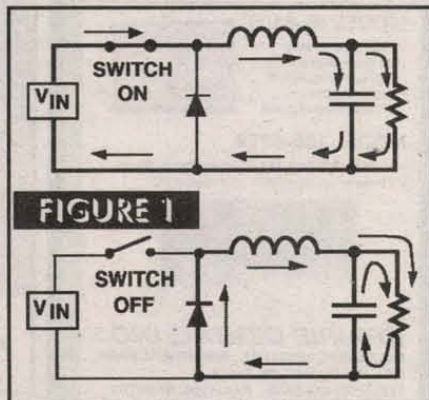


FIGURE 1

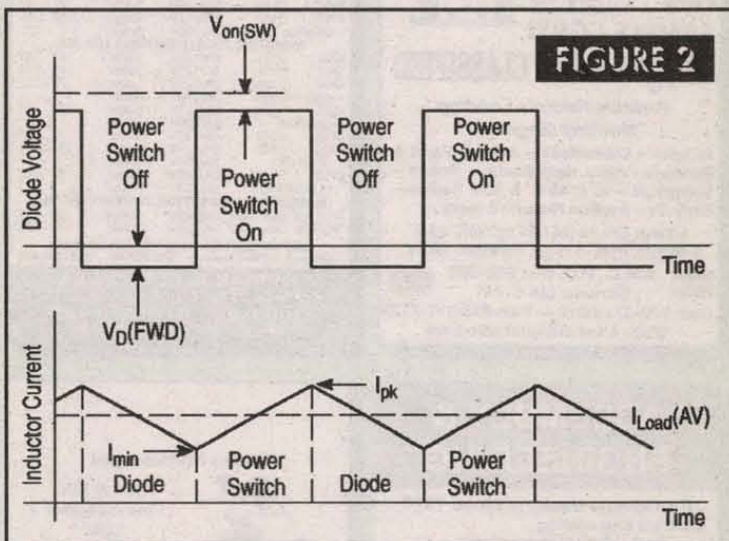


FIGURE 2

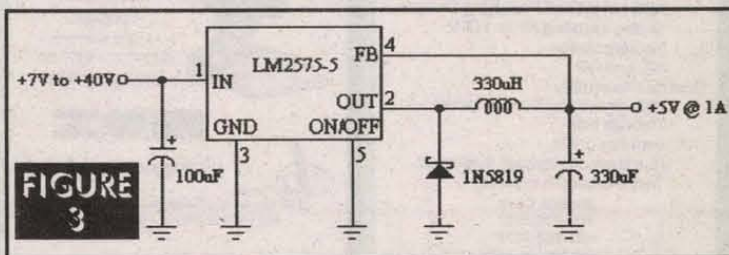


FIGURE 3

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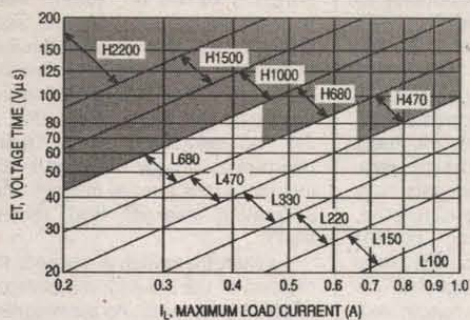
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## PART 1 — Weighing The Options



**FIGURE 4**

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Inductor Selection Guide

Inductor Code	Inductor Value	Pulse Ring	Part No.	AME	Test 20
L100	100 µH	PE-62180	FL2444	415-0200	77.308 BV
L150	150 µH	PE-62113	FL1804	415-0202	77.358 BV
L220	220 µH	PE-62026	FL1953	415-0202	77.658 BV
L330	330 µH	PE-62027	FL1952	415-0206	77.420 BV
L470	470 µH	PE-62174	FL1801	415-0207	-
L680	680 µH	PE-62029	FL1950	415-0208	77.558 BV
H1500	1500 µH	PE-62115	FL2445	415-0206	77.368 BV
H1000	1000 µH	PE-62116	FL2446	415-0208	77.410 BV
H680	680 µH	PE-62117	FL2447	415-0205	77.480 BV
H470	470 µH	PE-62118	FL1901	415-0204	-
H220	220 µH	PE-62119	FL1902	415-0205	77.510 BV
H150	150 µH	PE-62120	FL1903	415-0204	77.558 BV
H100	100 µH	PE-62121	FL1904	415-0203	-
H50	50 µH	PE-62122	FL2448	415-0203	77.610 BV

**INDUCTOR CURRENT**

$I_{ND(AVE)}$

**SWITCH CURRENT**

$I_{SW(PK)}$

**DIODE CURRENT**

$I_D(PK)$

**FIGURE 6**

tor (Figure 1).

When the switch is on, current flows through the inductor into both the load and output capacitor, during which time energy is stored in the inductor in the form of magnetic flux (an increasingly stronger magnetic field).

When the switch is opened, the input voltage is removed. Without sustained input current, the magnetic field begins to collapse, inducing a voltage in the inductor as the magnetic flux lines cut across the windings that now maintain a forward current

and time off is called the duty cycle, which is mathematically defined as

$$d = \frac{\text{ton}}{\text{ton} + \text{toff}}$$

In a buck converter, the voltage is held constant by controlling the duty cycle. For the ideal buck converter, the duty cycle can be described as

$$d = \frac{V_{in}}{V_{out}}$$

Figure 2 shows the idealized waveforms for a buck converter.

### Typical Buck Converter Application

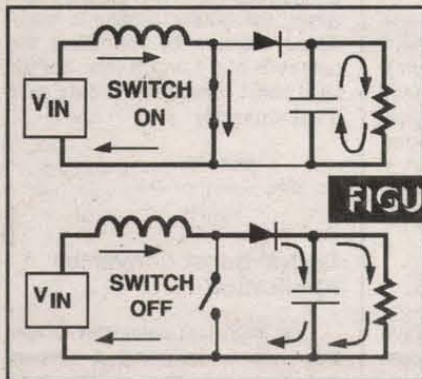
Unlike buck converters of yesterday, which needed lots of outside compensation help, most of today's buck converters are five-terminal devices that require just three external components: a switching diode, inductor, and capacitor. For our example, I've selected an LM2575 from National Semiconductor (Figure 3). (You can download an LM2575

data sheet from <http://www.national.com/pf/LM/LM2575.html>).

For good measure (and circuit design smarts), a bypass capacitor is typically hung on the input pin. This input bypass capacitor is needed to prevent large voltage spikes at the input (caused by the switching action) and, to be effective, must be located as close as possible to the IC's input and ground pins using very short leads.

The most important parameter of this capacitor is its RMS current rating — the current density it can handle when charging and discharging. Capacitors that are physically larger, and therefore have large surface area, typically have a higher RMS current rating. In high-current applications, it's better to parallel two or more capacitors to achieve high RMS at the desired capacity.

An output capacitor has two duties: filter the output ripple and provide stability for the regulator feedback loop. Here the important factor is low ESR (Equivalent Series Resistance). Tantalum capacitors offer the lowest ESR values, which is great for filtering ripple. However, they're not so great for feedback loop stability. If the ESR value is too



**FIGURE 5**

er, which converts a high DC voltage to a lower DC voltage of the same polarity. This regulator is an essential part of a distributed power system where 24 or 48 volts is stepped down to 5 or 12 volts for local board use.

The buck converter has a switch that alternately connects and disconnects the input voltage to an induc-

tor, and diode.

Simultaneously, the capacitor discharges through the load, contributing to the total current supplied to the load. After a timed period of discharge, triggered by the feedback input, the switch again turns on and rebuilds the magnetic field.

The ratio between the time on

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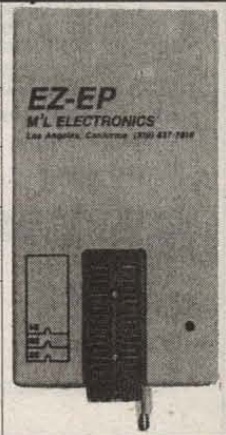
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## PART 1 — Weighing The Options

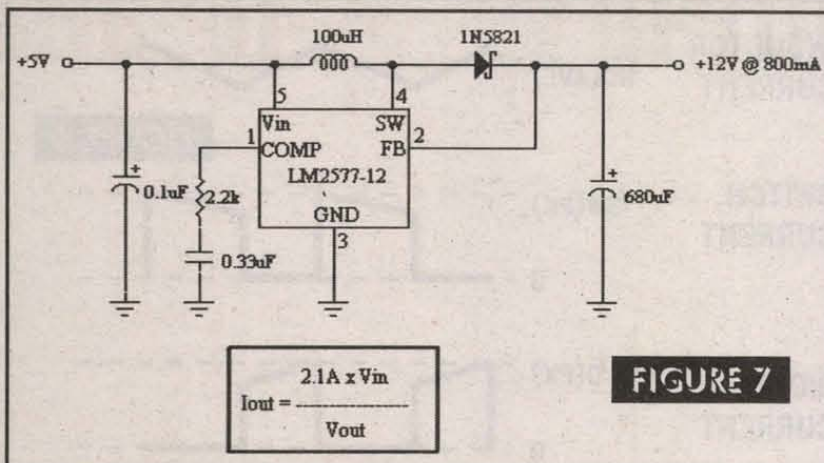


FIGURE 7

matching the inductor to the job at hand. This magnetic component is the cornerstone of all switching regulators, and its interactive properties are elusive to even the most experienced design engineer. If the core gets magnetically over-saturated, the controlling current flattens out and the pulse-width modulator has no control of the output voltage. On the other hand, if you over-compensate by adding more iron to the core, the circuit gets sluggish and can't respond to changing load demands fast enough. Talk about a real Catch 22!

To simplify the induc-

switch is turned on, current flows through the inductor only; the diode blocks current flow through the load or output capacitor at this point simply because the voltage drop across the diode junction exceeds that of the "no resistance" switch. During this period, energy is stored in the inductor in the form of magnetic flux (increasing magnetic field, remember?).

When the switch is opened, the tag end of the inductor remains connected to the input. As the magnetic field collapses, it now adds to the input voltage rather than buck it. At this point, the diode becomes forward-biased and current flows through the load while the output capacitor charges. The output voltage now equals

$$V_{out} = V_{in} + V_{inductor}$$

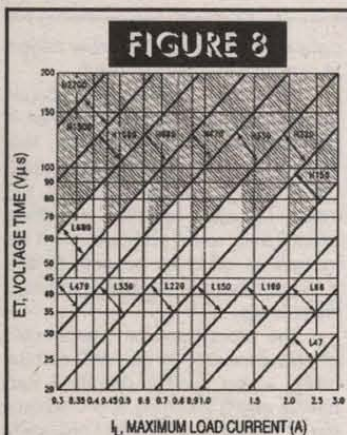
Turn the switch on again, and the diode cuts off. The inductor now rebuilds its flux field, and the output capacitor sustains current flow through the load. As in the buck converter, the output voltage is maintained constant by controlling the duty cycle of the on/off time. For the ideal boost converter, the duty cycle is approximately

$$d = \frac{V_{out} - V_{in}}{V_{out}}$$

## Typical Boost Converter Application

An important parameter to consider when designing a step-up switching converter is the total power. Like a transformer, you can't get more power out of a boost converter than you put in. There's no such thing as a free lunch. Simply put, if you put 10 volts at 10 amps into a boost converter, you can't get more than 100 watts out ( $P = P \times A = 10V \times 10A = 100W$ ). So, if the source is 5V at 1A, the best you can hope for at 12 volts is 400 mA.

As the voltage goes up, the current goes down: 300 mA at 15 volts, 200 mA at 24 volts, and so forth. In

 $I_L$ , MAXIMUM LOAD CURRENT (A)

Inductor Code	Manufacturer's Part Number		
	Schott	Pulse	Renco
L47	67126900	PE - 53112	RL2442
L68	67126900	PE - 92114	RL2443
L100	67127000	PE - 92108	RL2444
L150	67127010	PE - 53113	RL1954
L220	67127020	PE - 52626	RL1953
L330	67127030	PE - 52627	RL1952
L470	67127040	PE - 53114	RL1951
L680	67127050	PE - 52629	RL1950
H150	67127060	PE - 53115	RL2445
H220	67127070	PE - 53116	RL2446
H330	67127080	PE - 53117	RL2447
H470	67127090	PE - 53118	RL1961
H680	67127100	PE - 53119	RL1960
H1000	67127110	PE - 53120	RL1959
H1500	67127120	PE - 53121	RL1958
H2200	67127130	PE - 53122	RL2448

low (below 0.05 ohms), the feedback loop can and will oscillate, placing a high-frequency component atop the DC output voltage. For heavy, fluctuating loads, it's recommended that you parallel aluminum electrolytics with tantalums to prevent this from happening. The value of the tantalum should not exceed 10% to 20% of the total capacitance.

The diode, often called a catch diode, provides a return path for the inductor current when the input voltage switch is open. This diode has to have a switching speed fast enough to react to the 52-KHz speed of the buck regulator, but not to be so fast that it abruptly turns off and creates EMI (Electro-Magnetic Interference) problems.

Schottky diodes provide the best switching because of their fast response time and low forward-voltage drop (0.3 volts), but ultra-fast diodes with soft turn-off — like Motorola's MUR120 — are good substitutes. Standard power supply diodes like the 1N4001 and 1N5400 are NOT suitable substitutes; don't even try it!

The trickiest part of designing a buck-converter regulator is

charts that match the inductance requirement to off-the-shelf components. Here's a typical LM2575 inductor nomograph (Figure 4).

By drawing a straight line between the voltage and current extremes (minimum and maximum), the nomograph identifies a magnetic core type and impedance value. From here, you can build (wind) the inductor yourself, or — better yet — just buy one off-the-shelf from the listed vendors (see the sidebar: Where To Buy).

## Boost Converter

A mirror-image of the step-down buck converter is the step-up boost converter, which converts a low DC voltage to a higher DC voltage of the same polarity. This regulator finds use in battery-powered instruments where a single 1.5-volt alkaline battery has to power a 3.3-volt cell phone, or generate a 12-volt output from an 8.4-volt source, as is the case with many laptop PCs.

In the boost configuration, the inductor is placed across both the input and output pins — and the output, rather than the input, is interrupted. See Figure 5. When the

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## PART 1 — Weighing The Options

other words, a 5A boost converter will not deliver 5 amps out — it's simply the amount of current the switching transistor can force through the inductor, so size your regulator accordingly.

For our example, I chose the LM2577, a three-amp boost converter. It can boost 5 volts to 12 volts at 800 mA. For lower voltages, the current can be higher, as the formula in Figure 7 shows.

The switching action of the step-up regulator produces a triangular ripple current at the source which, in turn, causes ripple on the output. For proper operation, the LM2577 input should be decoupled with a bypass capacitor. Bypassing the input voltage pin to ground with a low ESR 0.1µF capacitor (typically tantalum) is usually sufficient. This is in contrast to the heavy input filtering recommended for the buck converter.

On the other hand, the inductor is more critical to the boost converter's performance, for more reasons than I have room to go into. Let me say that the type of core material, winding resistance, and core topology are all factors — sometimes for EMI reasons and other times for efficiency. Selecting the right boost inductor is a journey of mystic, voodoo, and sheer luck. Fortunately, there's a list of suitable inductors on the LM2577 data sheet (<http://www.national.com/pf/LM/LM2577.html>) that lists the pros and cons of commercially available products. Bottom line: It's hard to choose an inductor without a nomograph or software program. Here's the inductor nomograph for the LM2577.

The inductors listed here have the following characteristics:

**Schott:** Ferrite pot-core inductors. The benefits of this type are low EMI, small size, and very low core loss (heat dissipation). Be careful not to operate these inductors too far beyond their maximum current rating, because the core easily saturates.

**Pulse:** Powdered iron toroidal cores. The benefits are low EMI and the ability to tolerate peak currents above rated value better than ferrite pot-core inductors.

**Renco:** Ferrite, bobbin-core inductors. The benefits are low cost and the best ability to withstand peak currents above rated value. The downside is that they generate more EMI than the other two, and may interfere with sensitive equipment.

The output capacitor has less responsibility in a boost configuration than it does in a buck converter. That's because there's a compensa-

tion pin on the LM2577 and similar boost converter ICs that remove the output capacitor from the feedback loop. Instead, a zero-pole compensation (RC) network stabilizes the regulator. Two more parts, yes, but worth it. The compensation capacitor is also part of the soft-start circuitry, found in many boost converters, which gives the circuit time to ramp up to the on-off sequence before full power is applied to either the load or inductor. Can you imagine the inrush current surge consequences of applying full power to this topology with no residual flux in the inductor or charge on the output capacitor? 'Nuf said.

The switching diode in a boost switching regulator must withstand the rigors of high peak reverse voltage and fast switching, yet be soft enough to prevent switching spikes that can lead to EMI and false triggering. Gee, that sounds like a Schottky barrier diode to me. In fact, that's the only diode recommended for boost outputs up to 50 volts, with less-efficient, fast-switching diodes like the MUR110 picking up pressures at the high end.

### Coming Next Month

But that makes sense because beyond 100 volts, I wouldn't use a boost converter, anyway. I'd use a flyback converter, but let's save that for next month. Meanwhile, you can obtain more information on switching regulators from the data sheets cited and the answers you'll find in this month's Electronics Q & A column. Want even more? Download the f5.pdf National Semiconductor file — a whitesheet on switching regulator technology — that's posted on our website (<http://www.nutsvolts.com>). NV

### WHERE TO BUY

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2764A-25	2.99	2.84	2.56
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# TECH FORUM

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## QUESTIONS

I need information on portable generator connections. I have a 1/2 HP Sears water pump (Jet) 115V 12.4 amp start, 6.2 amp run. I also have a 1850 watt maximum "Coleman Sporta" generator that will not start the pump.

I also have a small Coleman 800 watt generator that I would like to parallel to get more wattage. Coleman says it can't be done, is this true? Can anyone give me any way of doing it? I would like to do this in case of power failure.

**5991 Ron Wineland  
Meadville, PA**

Whatever happened to McGee Radio? They were in Kansas City, MO. Are they still in business or did they move?

**5992 Anonymous**

How do I set up equipment to determine the resonant frequency of a capacitor in the .001-.01 uF range, using an RF signal generator, voltmeter, scope, inductors, etc.?

**5993 Russell Robertson  
Holley, NY**

I have a telephone recorder and was wondering if it is or would be possible to kill the in-line beep while recording on the phone line? The model type is called Tele-Recorder 500.

**5994 Arnaud C. Milner**

I have a Masco three channel amp. (Circa 1947.) I just finished restoring it, but I'm unable to acquire a mike.

Each mike input uses a 7B4 tube with 15 megohm grid resistor to GRND.

Can I use a 500Ω impedance mike on the input? I don't find too many 52-year-old mikes around.

**5995 A. Heyman  
Apple Valley, CA**

I want to build a circuit to interface my music CD changer to my PC, and I need to know the following:

Do music CDs have a header containing the title and catalog number in an alphanumeric code, such as ASCII, and does each track have a similar header with the song title? If so, I would like to access this information and display it, using software that I will write. I need title and source of literature explaining music CD headers.

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**5996 Richard Herman  
Costa Mesa, CA**

I presently have a DPDT switch that forward and reverses a 12 VDC, 3 amp maximum draw gear motor with two limit switches that control in and out, off positions. My desire is to replace the DPDT switch with an RF transmitter and receiver.

I purchased a transmitter and receiver in kit form and built them, they work. My problem is I need additional circuitry to make it work the same as the DPDT switch. A garage door opener does exactly what I want except it controls an AC motor.

Is there a schematic with the receiver and switch combined, so I could make it myself, or add to my present receiver?

**5997 Richard L. Klitzke  
Spring Valley, CA**

I have an old Electron alert tone receiver (which is no longer made). The model number is not printed on it, but I know it was made in 1970. I took it apart and found only one crystal, but it was not the receive frequency of 154.43 MHz.

Inside, it appeared to have several variable capacitors. I am wondering how to change the radio frequency and the tone frequency, or where I can find information how to change it? I would like to modify it to receive the National Weather Service/NOAA severe weather alert tones.

**5998 Michael Weber  
Mifflinburg, PA**

I am looking for a four pin 6 VDC logic buzzer that is controlled by a ca555 chip. The circuit is from an in-ground mole chaser that emits sequenced buzzing to annoy moles. The case is approx. 1/2 in X 1 in X 1/2 in with four pins labeled 1-7-8-14. Can anyone help or offer suitable substitution?

**5999 Louie cioccio  
via Internet**

I have an underground 110VAC line that has a cut and is causing the 15 amp breaker to trip every so

often. I can put an ohmmeter across it to read between 3K to 40K. I am sure at times it goes much lower to trip the breaker. Also, everything is disconnected when I tested it.

Does anyone know of a way to sense where the cable is cut and shorting out without digging up the wire? The wire is only 6" deep.

**59910 Joe Reed  
Charlotte, NC**

I have got several Sony EVO210 Video8 VCRs I would like to use in a security camera application. The front 'remote' is a five-pin DIN (similar to S-VHS, but the keys and pins are different). There is a sliding panel (labeled 'multi connector') on the right side with a 24-pin rectangular male connector (22 of which have pins).

At the right rear is another flap concealing a 12-pin female DIN socket labeled 'camera' (the keys make it appear to be somewhat octagonal).

How may I go about finding the correct connectors (or fabricate one from the pin-out specifications)?

**59911 Ross Goeres  
via Internet**

I need help to find a distributor for a stepper motor driver IC and other ICs for stepper motors. I know of the UCN5904, but I would like to know if there are any other stepper motor ICs out there.

**59912 Charles Raimond  
via Internet**

I am interested in building a 4x16 LED changeable display, by using what I have (5x7 matrix LED display). The problem is, I have no drawing for the wiring of the matrix showing how to connect to the IC which drives the display. I have a ZWORLD microcontroller starter kit with C or 68HC11.

**59913 via Internet**

Where can I find share-ware or free-ware to do the following: DOS based programs are preferred, Win-95 acceptable.

1. A low end drafting (CAD) program which will permit sketching, dimensioning, making notes on and revising drawings.

2. A programming low-charting

## ANSWER INFO

- Include the question number that appears directly below the question you are responding to.
- Payment of \$25.00 will be sent if your answer is printed.
- In most cases, only one answer per question will be printed.
- Your name, city, state, and E-Mail address, (if submitted by E-Mail), will be printed in the magazine, unless you notify us otherwise with your submission.
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All questions should relate to one or more of the following:

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

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

program which will automatically number pages, organize flow connectors and permit revisions.

**59914 D. Cameron Smith  
Bloomington, MN**

I am a high school student very interested in working with infrared video.

Does anyone know of a source for infrared video cameras? Hopefully at a price a mortal human can afford? I am hoping to make a school project out of it.

**59915 Joey Reed  
Charlotte, NC**



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### NTSC COMPOSITE 4" LCD MONITOR \$69.<sup>00</sup>

Write in 116 on Reader Service Card.

## TECH FORUM

I have come into possession of an Arium ML4100 Logic Analyzer. It seems to work okay but I don't have the manuals or a pod. I could probably get by without either one of them if someone could tell me how to fool the analyzer into thinking that it has a pod connected to it.

59916 Rick Haub  
Brookings, SD

## ANSWERS

ANSWERS TO #3995 - MAR. 1999  
Needs info on linking a BASIC Stamp to a PC, one-half mile away, to control fans.

Echelon makes a line of network transceivers meant to work with the Neuron™ networking IC manufactured by Motorola and Toshiba. There is no reason you couldn't use them with the Stamp, though.

The main application for the parts is building automation, which is what you're talking about doing. I think you probably want to use their power line transceiver. As I recall, they cost about \$25.00.

More information can be found at: <http://www.echelon.com/Products/datasheets/transceivers.htm>

Look into the Neuron, too. It costs about \$5.00 and may match your application better than the Stamp.

Tom Tillander  
Bay Village OH

ANSWERS TO #3995 - MAR. 1999

For a complete example of an X-10 home remote control application which meets most of your requirements, I suggest that you obtain a copy of Scott Edwards's new book *Programming and Customizing the*

*BASIC Stamp Computer* and refer to chapter 13 which is titled "World Wide Remote Control With C2TERM."

In this chapter, Scott describes a BS2 terminal program which uses a Hayes-compatible modem to receive commands over the phone. The commands are then relayed to X-10 appliance control modules via the BS2 "xout" command.

To order this book, refer to the ad on page 10 of the Apr. '99 *Nuts & Volts* issue. This book is a "must have" for anyone programming a Stamp.

Regarding your specific application, I would suggest customizing the C2TERM software to control your remotely located fans by adding the appropriate X-10 control commands,

device codes, and house codes. You will also need to dedicate a local phone line between your central PC and the X-10 remote controller, using two Hayes-compatible modems.

The modems should have a bit rate of 2400 baud or faster. These types of modems can be purchased from surplus electronics dealers in order to realize great savings, because 56K modems are overkill for this application.

Daniel F. Ramirez  
Amherst, NH

ANSWER TO #3992 - MAR. 1999

Needs to lower volume of car radio when car is not moving.

Years ago, there was a device sold by J. C. Whitney that consisted

of a pot — probably an L-Pad that connected to the speaker wires, and mounted either under the car or at the front of the car.

It consisted of the L-Pad with a vane mounted on the shaft. When the car was moving, it caused the vane to move up, obviously the faster the car was moving, the higher the vane would go, and the louder the volume from the speakers.

That was prior to the days of the stereo and quad audio systems, so there was only one speaker line to control, something could probably be constructed for today's stereo and quad systems by using the stereo L-Pads, and constructing a flat metal vane that attached to the shaft of the L-Pad. Then locate a suitable location to mount the L-Pad so the vane

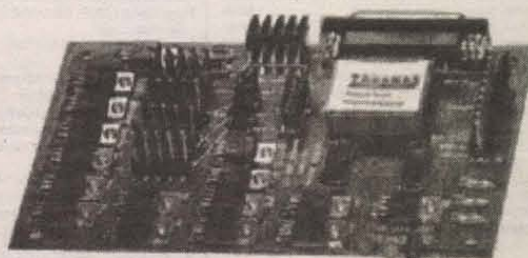
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# TECH FORUM

is perpendicular to the air flow, under or at the grill area.

As the speed increases, the vane will move toward a horizontal position, and slowing will allow it to return to a vertical position. Weighting of the vane will have to be adjusted for the vane to move properly, and location would have to be experimented. The wiring must be protected, and connected for the proper operation of the L-Pad to maintain the proper impedance, and not create shorts that could damage the output devices in the radio.

If you have a line level equalizer or outboard power amp, the same principle could be applied in the line level inputs to the equalizer or amp. This would allow the use of a potentiometer, wired as a voltage divider (DUAL FOR STEREO), and keeping the input impedances in mind for selecting values.

There may be more sophisticated ways, such as sensing RPM, or speedometer output pulses (maybe from a cruise control sensor), and using logic and analog gates to switch in or out attenuators. These would get much more complex.

Ed Pruitt  
Keller, TX

## ANSWER TO #39911 - MAR. 1999

Adding two relays to alarm circuit, one for each of two different alarms. Reader explains circuit function.

In all due respect, I think Paul is missing something in his analysis of the circuit.

The way he describes it, if there was a high-temp continuously, the rising water would never be able to pulse the line B ... it would be held high by the high-temp alarm. I think maybe line A is the high-temp and line B is the rising water alarm (it pulses to probably flash a lamp).

Paul needs to re-investigate his circuit in order for someone to correctly give him a schematic that he can use.

Max Seim  
Cottage Grove, MN

## ANSWERS TO #3999 - MAR. 1999

Designing a data acquisition system for a race car, using Qbasic, that must write data every 100 microseconds.

A 100 microsecond sampling rate corresponds to 10,000 samples a second, which is probably too slow if you want to reconstruct the entire waveform of the spark signal, and the Hall-Effect sensor, which is what your question implies you're thinking about doing.

I don't think you need to do that. However, even at 10,000 RPM, there are only 167 sparks per second per cylinder. Use comparators to square up the signals and have them generate interrupts. The interrupts service routines should simply record

the value of a timer for each interrupt which I assume is the information you are really interested in.

Tom Tillander  
Bay Village OH

## ANSWERS TO #3999 - MAR. 1999

You can get vehicle speed pulses from the speedometer and spark pulses from the tachometer lead in the ignition circuit. You'll have to do some waveshaping to square up the pulses through a two- or three-stage amplifier followed by some arithmetic division (divide by 500) with flip flops to get the pulses down into a 50mS region. Then your QBasic could handle it.

Bill George  
via Internet

## ANSWERS TO #3999 - MAR. 1999

Invest in a commercial data collection PC board that meets most of your requirements.

National Instruments, Cyber Research, Inc., and Keithley are manufacturers that build excellent quality PIO and A/D cards for both the ISA and PCI bus.

The cards have sampling rates of more than 1 MB/Sec. They also feature singled ended and differential inputs, on-board high resolution timers, support for programming sample rates, and some models even contain large RAM buffers.

The manufacturers provide drivers [DLLs] for Visual Basic, C, Visual C++, and offer phone support and examples in order to help you to write your own applications.

In your application, you specify a sampling period of 100 microseconds, or a sampling frequency of 10 KHz. If you have not already done so, you must take the Nyquist rate into account by choosing a sampling frequency of at least twice the highest frequency component or, in this case, 20 KHz to allow correct sampling of the vehicle speed and the spark sensors.

The sensor readings may need to be low-pass filtered, if they are too noisy or if high frequency noise component exceeds the Nyquist rate.

Life gets complicated if you want to build your own data collection system using a PC. The following information may help you to construct such a DIY data collection system.

Regarding which language should be used, you will need to write the software in C, C++, or assembly language, because in my opinion, QBasic will not be fast enough.

I also suggest that you try to get access to a fast Pentium with clock speeds of 233 MHz or more, with at least 16 MB RAM and Windows-95/98 that can be booted with real DOS (not a DOS window). Furthermore, you must be willing to experiment since there are no guarantees that this system will work on a PC.



The PC also has other architectural limitations that will cause problems when sampling data at high speeds. As you observed, the PC's timer is only good to 18.2 ticks per second, for a period of 55 milliseconds, no matter how fast the PC runs. The PC's 8253 timer can be re-programmed for higher speeds (see the answers to question #129815, in pages 65-66 of the *Nuts & Volts* Jan. '99 issue).

I suggest that you avoid programming the timer in favor of connecting a 10 KHz or 20 KHz oscillator directly to the PC's parallel port ACK line, pin10, that triggers an interrupt via the parallel port. By doing so, you get your 100 microseconds sampling period without messing around with the PC's operating system.

An impediment to collecting data on a PC is its parallel port. The parallel port should be one of the newer cards that allow ECP and EEP mode transfers, to provide eight-bit bi-directional data transfers instead of the older parallel port card, which limits you to four-bit (nibble) data transfers.

In order to find out more about using the PC's parallel port and all its modes of operation, I recommend that you obtain a copy of Jan Axelson's new book *"Parallel Port Complete."* The book has Visual Basic examples that can be adapted for your application.

The maximum transfer rate for new Parallel port cards is greater than 1 MHz, which is more than adequate for your application.

Another problem is latency introduced by the PC's operating system. Since a PC uses a general-purpose microprocessor that executes in protected mode, it is less efficient when processing interrupts than a dedicated micro-controller such as a high-end PIC would be. The PC's interrupt controller uses an 8259 or 8259-compatible interrupt controller, which is clumsy to program because it stays backward compatible to the old AT 80286 architecture.

This brings up the issue of an interrupt service routine (ISR) that will be needed to service the interrupts generated by the parallel port ACK line. It is here that the use of the DOS operating system becomes crucial to your application. The fact is that writing a protected mode ISR under Windows-95/98 is not for the faint at heart. So to keep things simple, an efficient real-mode ISR can be written in C or assembly that programs the 8259 interrupt controller to service the ACK interrupt and sample your sensors. There is a good example of a realmode ISR written in C, in Paul Bergsman's book *Controlling The World With Your PC*, pages 147-150.

A large RAM buffer is also required to store the data collected by your application, so that it can be

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stored to disk after the data has been collected. The buffer is needed, because to write to the hard disk while processing the interrupt, would likely cause loss of data due to the relatively slow disk write times. The problem here is to keep the buffer size below the dreaded 1 MB boundary, otherwise, you would need to switch to protected mode to access the buffer.

The data collection software encapsulated by the ISR, consists of logic to simply read a byte of data

from the parallel port (using the inpb function), store it in the buffer using the current buffer index, and increment the buffer index.

The data is written to disk when the buffer is full. Double buffering and DMA transfers are two possible improvements for your data collection system, but they require additional hardware support.

To test your ISR, you connect a scope to bit D0 of the PC's parallel port card. If you set bit D0 to logic-1 upon entry to your ISR, and set bit D0

to logic-0 upon exit from your ISR, you should be able to measure the time inside the ISR by the length of the trace on the scope. You should also be able to measure the interrupt latency and jitter. If you compare the scope trace from running your application under DOS, to running your application under Windows, you will notice that the jitter under DOS is negligible, but for Windows it is on the order of 100 microseconds. This means that your sampling rate is no longer accurate, even though you are

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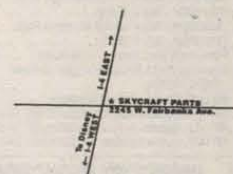
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## TECH FORUM

using an oscillator to generate the interrupts.

The cause of this phenomena is that Windows 95/98 preempts the ISR in order to service its own ISRs, such as the mouse driver, the RAM refresh, and its multitasking scheduler.

Daniel F. Ramirez  
Amherst, NH

### ANSWER TO #4992 - APR. 1999

Needs source for parts for an ancient PU-286 military surplus generator.

While I'm not familiar with the PU-286, I get all of my parts for my military generator at our local "Tractor" farm supply. These types of companies handle all of the old equipment, including electrical generators, brushes, and rewinding facilities, going back 50 or more years, and often have a catalog or two that will cross-reference almost anything ancient.

A lot of the parts that you will need are common to other pieces of equipment and if you can't locate a catalog, you can often match parts visually and by measurement.

I would try them first and if this doesn't work, a little more information on "who actually made the PU-286" (plate on the side of the motor) might jog someone's memory.

Also try "Fair Radio Sales" (in Nuts & Volts) for military surplus electrical components, catalogs, and the occasional wiring diagram.

Chris  
Bieber, CA

### ANSWER TO #4998 - APR. 1999

Computer power supply trips off

in one second. How to hook up the "power good" lead.

The supply's Power Good signal is an output, not an input. When this signal goes to a logic high state, it indicates to the external circuitry that the supply's output voltages are stable (and "good"). This is important when the supply is powering up since the processor needs a conditioned reset signal.

Also, during power on or off cycles, CMOS memory protect circuits must prevent data corruption or your vital CMOS related BIOS data will get messed up.

If your supply trips off in less than one second, I suspect it is because you have an incorrect load on it. Besides the obvious over-current protection (are you drawing too much current?), some switcher supplies need a minimum DC current load, usually at least 20% of the rated capacity, or they will shut down to prevent over-voltage faults. This minimum load is usually only needed on the 5VDC output.

During bench testing, a 1-ohm 10-watt resistor on the 5-volt output is a good start.

Thomas Black  
Folsom, CA

### ANSWERS TO #4999 - APR. 1999

Two UPSs shut down immediately after switching to battery power.

If your two UPS supplies are shutting off while in the emergency power mode, then I would suspect three different causes.

First, be sure that you have not exceeded the rated output wattage or the UPSs over-current protection will shut the unit off.

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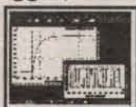
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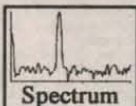
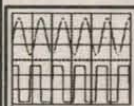
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## TECH FORUM

Second, the gel-cell batteries may be defective. I understand that you have fully charged them, but if they have been in service for two or more years, then they probably cannot withstand the intense current that is drawn from them when the UPS is generating AC power.

If you replace the batteries, be sure to match the part number since most UPS units use specially constructed types designed for high current applications.

Third, the UPS may have an electronic failure. Although the application is simple (generate AC power when mains power fails), the task of converting a low-voltage DC source to 120VAC/60Hz at high-current levels is not.

*I do not recommend that you attempt to repair them yourself. No matter what the failure reason, be aware that you can be seriously hurt (and killed) by the voltages produced by the UPS supply. Don't be fooled by the low voltage battery — the inverter inside the unit produces power with the same lethal forces that you get out of your AC wall outlet.*

Thomas Black  
Folsom, CA

ANSWERS TO #4999 - APR. 1999

Ninety percent of the problems

with small UPS are battery related. You can expect three to five years lifetime from the batteries as a rule. You said the batteries were "good, fully charged." A battery can look fully charged with the proper voltage, but may not be able to supply voltage and current when load is applied.

Use a voltmeter to monitor the battery voltage when you "pull the plug" with load connected. If the voltage goes from 13.85 volts to 10V, 9V, or lower voltage in a second or two, replace the battery with a new one.

Jack Donovan  
Orange, CA

ANSWER TO #49912 - APR. 1999

*Change VCR channel 3 or 4 output to channel 2 with adjustable fine tuning.*

If you open up your VCR, you will find a small silver box at the location of the output cables leading to your TV hookup. This little box is a demodulator that takes the standard 6 MHz signal coming from the VCR and converts it to channel 2, 3, or 4 depending on the manufacturer.

There are two simple ways to go about what you seek, and tuning the old "silver box" is one way. These boxes — the modulators — are "voltage-to-frequency" dependent. By

adjusting the feed voltage on these units, the channel output is varied.

By measuring the voltage difference at the channel selector switch where you choose between the output of channel 3 or 4. You can modify this value with a resistor or potentiometer and set it to channel 2 and 3, or with a three-way switch, channel 2, 3, and 4.

If your unit fails to tune in channel 2, you can find many new and surplus tuners from most electronics surplus dealers for less than \$5.00, and they usually come complete with the schematics and resistor/voltage values necessary to accomplish the channel of your choice.

You can also use two units at the same time, using your old unit and a new one tuned to channel 2, by using a splitter on the input side of both modulators. This will give you two separate channel outputs at the same time.

Chris  
Bieber, CA

ANSWER TO #49916 - APR. 1999

*Sending TV audio output to a strip of 10-20 headset jacks without overload.*

Depending on the volume output required, you need to purchase a mono or stereo amp probably rated

at around 30 to 60 watts. This will give each headset around three watts, depending on how many are actually hooked up.

Your big problem here is the impedance of all of those independent headsets. The total combined impedance will probably add up to an odd number that won't match any standard stereo output and so here lies the problem.

You're probably going to need some help from an audio person who will check out the individual impedance of each unit, add up the total, and probably have to custom-design a "Matching Transformer Tree" which is made up from multiple units that will allow the headsets to all be plugged in while imposing the proper impedance at the finals of the amplifier.

These matching transformers are similar to a step-up or step-down transformer where one-half of the circuit has one impedance, while the other has a different set of values, with a power transfer occurring across the magnetic coupling. Doing this allows a isolation of the headsets to the final output circuit and balances the final amp output at the same time.

Chris  
Bieber, CA



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Continued from page 16

household, Internet Telephony is destined to take over the majority of long distance communications in the near future.

E-Tech Canada Limited, a high-tech company based in Markham Ontario, is proud to announce their successful development and release of the Video VoxPhone Gold. This product is the latest, most advanced and sophisticated Internet Telephony software available on the market. This revolutionary new product provides superior quality in real-time audio PC-to-PC telephone communication. This allows PC users to connect with another PC anywhere in the world via the Internet - absolutely free from long distance charges! The Video VoxPhone Gold also offers direct PC-to-phone calling capabilities which gives Internet Phone users the ability to call regular telephone numbers anywhere in the world. This allows users to save up to 90% on long distance charges by using an Internet Telephone Service Provider (ITSP). The Video VoxPhone Gold provides software which is ready-to-go out of the box.

One important facet of the Internet revolves around e-commerce. As well as providing obvious advantages to consumers, many advantages also exist to manufacturers, since much of their operations can become centralized. Also, the rising popularity of e-commerce provides a huge customer base from which to advertise to. E-Tech Canada Limited has chosen Digital River, Release Software and NetSales as worldwide online distributors for the Video VoxPhone Gold. These recognized leaders in Internet commerce development and sales are contracted to develop support and maintain online sales of this world-leading, Canadian product.

"There are many new and exciting features added to this GOLD version," states Paul Li, President of E-Tech Canada Limited. "The user is also able to see the other party in full live-motion if equipped with a camera." This is just one of the many features of the Video VoxPhone Gold. Other features include:

- \* PC-to-PC real-time, full-duplex voice communications
- \* PC to regular telephone voice communications
- \* Full live-motion video
- \* Five-party conferencing
- \* Voice E-Mail
- \* Text chat
- \* Direct Call
- \* Smart global online-user list & directory
- \* Selectable codec (voice compression)
- \* Automatic file transfer
- \* Call blocking
- \* Caller ID
- \* VoiceFonts
- \* Local address book

Video VoxPhone Gold is ideal for users who make frequent long distance and international calls. Due to the use of the Internet, savings are incredible and provide a viable alternative to typical long distance telephone carriers. Also, its full-duplex capabilities allow for up to five participants to communicate simultaneously over the Internet. Video VoxPhone Gold can also be used for Intranet communication between corporate branches worldwide. This cost-saving capability is only one example of the many advantages to using the Video VoxPhone Gold.

Video VoxPhone Gold is packaged with world-leading microphone and microphone/headset accessories. These units use high performance noise-canceling technology to drastically improve speech clarity and sound quality, while dramatically reducing background noise. In addition, we are proud to offer our customers the Smart PC Cam. These sophisticated digital PC cameras provide both, still and full live-motion images. These cameras feature excellent resolution and high sensitivity, in an easy-to-use, compact and attractive package. We feel that this winning combination is the best Internet Telephony communication package available on the market today.

Video VoxPhone Gold is extremely easy to use and install. Developed for the first-time user, the installation CD-ROM comes complete with a full motion tutorial, produced in layman's terms for customers who are not familiar with computer operation. It is

Continued on page 90



# RESOURCE BIN

number eighty eight

## The hydrogen scene: It's a gas.

**O**ur usual reminder here that the *Resource Bin* is a two-way column. You can get tech help, consultant referrals, and off-the-wall networking on nearly any electronic, *tinaja* questing, personal publishing, money machine, or computer topic by calling me at (520) 428-4073 weekdays 8-5 Mountain Standard Time.

Be certain to frequently check out my new *Guru's Lair* web site you'll find at (where else?) [www.tinaja.com](http://www.tinaja.com). This is the place you'll go for instant tech answers. Among the many files in our library, you will find complete reprint sets for all of the *Resource Bin* and other columns. Plus a brand new Research InfoPack Service.

### Hydrogen as a Resource

It seems reasonable to expect that hydrogen is probably going to play a big role in future transportation and energy developments. Hydrogen can make a great student paper or a nice research topic. And eventually might lead to a technical buck or two.

At the same time, there sure is a lot of hogwash and misinformation out there. Especially on the web. So, the more you know about real hydrogen resources, the more intelligently you can dismiss all the rest of them.

### Just The Facts, Ma'am

Hydrogen today seems an odd mix of facts, fallacies, fictions, and frauds. We can replace some misconceptions with these hard facts ...

**Hydrogen on earth is not a fuel. It is only an energy carrier.**

**There is more hydrogen in gasoline than there is in liquid hydrogen.**

**Electrolysis is not usually your best way to generate hydrogen.**

**Hydrogen combustion emphatically does not implode.**

**The available energy in a**

**hydrogen flame is very low.**

**No hydrogen flame has the ability to truly melt tungsten.**

**Solar electricity today is much too valuable to waste on hydrogen apps.**

**Equipment amortizations and time value of money engineering economics must be included in energy analysis.**

**So, today's oil is at least four times more "free" than solar energy is.**

**Hydrogen improperly burned in air creates polluting nitrogen oxides.**

**NEXT MONTH: Don looks at boat anchors and those who sink them.**

**Hydrogen can rot metal through an embrittlement and will easily diffuse through most other materials.**

**A closed-loop electrolyzer stops a car in less than its coasting distance.**

**Pulsing, AC, or sparking will only reduce electrolysis efficiency.**

**Water is not a fuel. It is an ash.**

**Normally, a monatomic gas only briefly exists in tiny amounts.**

**Hydrogen creates severe and largely unresolved safety issues.**

### Energy Carriers

Any intelligent energy discussion has to start with a crucial point. There are substances which are capable of delivering *net* energy to the economy. There are other substances that only can move energy around.

Let's use these definitions ...

*Fuel — a substance which is capable of delivering net BTU's of new energy to the on-the-books economy.*

*Energy carrier — a substance*

*that's only able to move a previously acquired energy from one place to another.*

Yeah, there's lots of free hydrogen on our sun and on other moons and planets. And a few rare gas wells do release some free hydrogen. But here on earth, *hydrogen is not a fuel!* At least not by our strict definition. Hydrogen is simply an energy carrier that you will have to fill with energy before you can empty it. Just like a lead acid battery or a flywheel.

*No terrestrial non-nuclear means to produce hydrogen is known that does not consume more energy than it delivers.*

So, you *always* waste energy when you create and use hydrogen.

Just how useful is hydrogen as an energy carrier? Here's how hydrogen compares against gasoline: Gasoline offers around 9,000 watt hours per liter and 13,000 watt hours per kilogram of storage. Hydrogen at its normal STP pressures offers an outstanding 39,000 watt hours per kilogram.

But only a pitiful 3.5 watt hours per liter.

We can immediately see the major problem here. Hydrogen uses up too much volume to be very useful as an energy carrier. Uh, compress it into a liquid? Well, yes, but you'll increase your costs and losses. Your efficiency goes down. Safety and infrastructure issues appear. And there *still* is four times less hydrogen in any gallon of liquid hydrogen than there will be in a gallon of gasoline.

So the key problem is finding a safe and dense way to store hydrogen. All sorts of methods are being explored. Some involve *hydrides* while others try mechanical carbon bonding. Sadly, *no means is known that makes hydrogen use practical for personal vehicles.*

The "best" way to make hydrogen is through the reformation of methane. Commercial methane reformation can be around 68 percent efficient.

Naturally, the methane really has to want to reform.

A poorer way to make hydrogen is by the *electrolysis* of water. Apply a low DC voltage and you get hydrogen from one terminal and oxygen from the other. The best electrolysis is only 62 percent efficient.

Almost all commercial hydrogen is produced by reformation.

Besides new energy uses, hydrogen gets widely used to make ammonia, to stabilize fats, for welding, rocket fuel, acid manufacture, ore reduction, balloon filling, radioactivity studies, and

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### SYNERGETICS

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cyrogenic research.

### Fallacies and Frauds

Hydrogen sure attracts the wishful thinkers, the misguided "giving free energy to mankind for God" populist fanatics, those "science challenged," or the criminal fraud people. There are mountains of "not even wrong" urban lore out there ...

### The water powered car —

This beast comes out of the woodwork every decade or so. It has



# RESOURCE BIN

## SOME HYDROGEN ENERGY RESOURCES

<b>American Hydrogen Assn</b> 216 S Clark Dr Ste 103 Tempe AZ 85281 (602) 921-0433	<b>EREC</b> PO Box 3048 Merrifield VA 22116 (800) DOE-EREC	<b>Hydrogen &amp; Fuel Cell Ltr</b> Grinnell St PO Box 14 Rhinecliff NY 12574 (914) 876-5988	<b>Rocky Mountain Institute</b> 1739 Snowmass Creek Rd Snowmass CO 81654 (970) 927-3851
<b>Argonne Natl Laboratory</b> 9700 S Cass Ave Argonne IL 60439 (600) 627-2596	<b>EDM Today</b> 1212 State Rte 23 Butler NJ 07405 (201) 633-3130	<b>Intl Jnl Hydrogen Energy</b> PO Box 248266 Coral Gables FL 33124 (305) 284-4666	<b>Science/AAAS</b> 1333 H St NW Washington DC 20005 (202) 326-6400
<b>Ballard Power Systems</b> 9000 Glenlyon Pkwy Burnaby BC V5J 5J9 (604) 454-0900	<b>EPRI Journal</b> PO Box 10412 Palo Alto CA 94303 (415) 855-2000	<b>Jnl of Electrochem Soc</b> 10 S Main St Pennington NJ 08534 (609) 737-1902	<b>Slip Net</b> Warsitz Enterprises San Jose CA (408) 736-2742
<b>Breakthrough Tech Institute</b> 1625 K St NW Ste 790 Washington DC 20006 (202) 785-9620	<b>EV World Magazine</b> PO Box 461132 Papillion NE 68046 (402) 339-9877	<b>Jnl of Power Sources</b> Box 945 New York NY 10159 (888) 4ES-INFO	<b>Soc Amat Scientists</b> 4735 Clairemont Dr #179 San Diego CA 92101 (800) 873-8767
<b>CA Sel: Electrochem Reactions</b> 2540 Orlantany River Rd Columbus OH 43202 (600) 753-4227	<b>Fuel Cell Bulletin</b> Box 945 New York NY 10159 (212) 633-7300	<b>National Hydrogen Assn</b> 1800 M Street NW, Ste 300 Washington DC 20036 (202) 223-5547	<b>Soc Auto Engineers</b> 400 Commonwealth Dr Warrendale PA 15096 (412) 776-4841
<b>Calif Energy Commission</b> 1516 Ninth St Sacramento CA 95814 (916) 654-4989	<b>Home Power</b> PO Box 520 Ashland OR 97520 (916) 475-3179	<b>Natl Renew Energy Lab</b> 409 12th St SW #710 Washington DC 20024 (202) 651-7500	<b>Synergetics</b> Box 809 Thatcher AZ 85552 (520) 428-4073

attracted everyone from rock stars to Ohio con artists. Another name for an on-board closed loop auto hydrogen generator is a *dynamic brake*. One that, if activated, causes your car to stop in *much* less than its normal coasting distance.

There are *always* heat losses in all alternators, electrolyzers, and heat engines. All closing your engine to alternator to electrolyzer loop does is cascade these losses.

**Brown's Gas** — A normal optimum mix of hydrogen and oxygen has several unexpected and unusual properties. The colorless flame is nearly invisible, has remarkably low heat energy, and its temperature is exceptionally hard to measure. Tungsten melting illusions are easily created with side reactions. Illusions of implosion can be caused by a post-combustion condensation that always goes away as temperature increases and heat flow balances.

Using subtle differences that have never been explained, a *Brown's Gas* variant supposedly offers exceptional temperatures, long term monatomics, overunity

operation, and radioactivity reduction. No credible evidence for these outrageous claims has ever been presented. Chalk this one up to bad labwork amplified by urban lore.

**Pulse Electrolysis** — A DC voltage near 1.28 volts might end up as one-sixth endothermic, meaning that some of the input energy comes from ambient heat, rather than the electricity. Below this optimum, you get no gas at all. Exceed the *thermoneutral* voltage of 1.47 volts and you start wasting heat.

Claims are made that pulses can greatly improve hydrogen generation. This flies in the face of these optimum DC levels. It is exceptionally hard to accurately measure any pulse power. Casual measurements end up wildly low because of differences between RMS and average currents. Electrolysis current is wildly non-linear.

More on these RMS versus average measurement errors in *MUSE112.PDF* and *MUSE113.PDF*.

The highly capacitive nature of an electrolysis cell reduces your

"pulse" right on back into a DC level and a few very weak sinewave harmonics. These cells are inherently low pass filters.

Standard EIS instruments routinely measure the pulse characteristics of electrolytes. Details in *MUSE137.PDF*. None of the EIS I've looked at shows anything unexpected here.

Yeah, it is possible to "resonate" a water molecule. But the frequencies involved are up in the microwave and infrared range. No energy advantages to doing so have been shown.

**Underwater Arcing** — Wild claims are made for underwater sparking. Well, it seems that there's many thousands of EDM underwater sparking tools in daily use by machine shops. Not one of them has reported their machines vaporizing or generating more than trivial amounts of hydrogen.

Catch the ongoing details in *EDM Today* magazine.

There is also a web scheme to arc underwater and collect the mixed gas. While this works, it flies in the face of thermodynamics. Which *demands* that an efficient process be *reversible*. And no way does introducing some mixed gas above water make an underwater arc. More on thermodynamics can be found in *HACK64.PDF*.

### Periodical Charts

Your first venture in exploring any chemical element should be with the periodical table of the elements.

You should find a really superb one at [ww2.shf.ac.uk/~chem/web-elements](http://ww2.shf.ac.uk/~chem/web-elements). Present are background info, physical properties, uses, isotopes, structures, compounds, and related info.

These folks like hydrogen so much they've even made it number one on their charts.

### NASA Safety Site

Before you do anything else with hydrogen, be sure to *thoroughly* study the NASA hydrogen safety site found at [www-osma.lerc.nasa.gov/lsm/lsm6.htm](http://www-osma.lerc.nasa.gov/lsm/lsm6.htm). Note that hydrogen will burn in air between 4 and 75 percent and burns in oxygen between 4 and 95 percent. It explodes violently in air between 18 and 59 percent and in oxygen between 15 and 90 percent.

The tiniest spark sets it off. Other essential lab considerations include your use of flame arrestors to prevent back explosions into lines and tanks. And your choice of excessively sturdy materials that do not fragment during an explosion.

The bottom line is that hydrogen is nasty stuff and should not be casually messed with. Not in any way.

### Peavey, Pyle, and Sandfort

There are all sorts of good books on hydrogen. I've placed a hotlinked list to [www.tinaja.com/h2gas01.html](http://www.tinaja.com/h2gas01.html).

Start with Peavey's *Fuel From Water*. Yeah, this has an absurd title, is dated, and is rather rough around the edges. But this remains your best homebrew hydrogen info available today.

*The Solar Hydrogen Chronicles* is a Walt Pyle book that consists mostly of interesting *Home Power* reprints.

Sandfort's *Heat Engines* is a must read. While not hydrogen

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# RESOURCE BIN

specific, it is an excellent text on thermodynamic fundamentals. Look for the *Doubleday Science Library* paperback.

Also be sure to read *Combustion* by Irwin Glassman.

## Journal of Hydrogen Energy

This one appears to be the leading tech resource in the field. Published by all of the folks at that *International Association for Hydrogen Energy*. It seems a tad pricey at \$1,470.00 per year, so you might want to pick up this one through your local technical library. But *Elsevier* does sometimes send free samples to professional requests.

Other important periodicals are the *Hydrogen & Fuel Cell Letter*; that *Fuel Cell Bulletin*; *Journal of Power Sources*; *CA Selects: Electrochemical Reactions*; or the *Electrochemical Society Journal*.

## Rocky Mountain Institute

That *Rocky Mountain Institute* up at [www.rmi.com](http://www.rmi.com) also deserves a special mention. Here you will find objective studies for transportation and energy efficiency alternatives, hydrogen, and otherwise. Don't miss this one.

## And the Rest of the Gang

Other helpful hydrogen resources are the *American Hydrogen Association*, that *California Energy Commission*, the *Electric Power Research Institute*, an *EV World* magazine, that *D.O.E. Hydrogen Infonet*, that *Breakthrough Technologies Institute*, *National Hydrogen Association* the *National Renewable Energy Lab*, that hydrogen man at his *Slip Net*, Shawn Carlson's *Society of Amateur Scientists*, or the *Society of Automotive Engineers*.

## The Web

The leading hydrogen newsgroup is [sci.energy.hydrogen](mailto:sci.energy.hydrogen). Be sure to note that the professional decorum here is both expected and enforced. Utterly ridiculous pseudoscience hydrogen is seen at [alt.energy.hydrogen](mailto:alt.energy.hydrogen) and also at [alt.energy.over-unity](mailto:alt.energy.over-unity).

Other newsgroups that might be of hydrogen interest are ...

[alt.energy.homepower](mailto:alt.energy.homepower)  
[alt.energy.hydrogen](mailto:alt.energy.hydrogen)  
[alt.energy.over-unity](mailto:alt.energy.over-unity)  
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## Some Real Opportunities

Where is hydrogen research coming down these days? Here are several areas being actively explored ...

**Fuel Cells** — These convert hydrogen and oxygen (or air) into electricity. In theory, they could bypass heat engine efficiency limitations. Big bucks are being thrown at this and only limited progress is being made. But problems do remain in membrane lifetimes and costs. *Ballard* is one proponent, while [www.fuelcells.org](http://www.fuelcells.org) is a useful website. A *Fuel Cell Bulletin* and a *Hydrogen and Fuel Cell Letter* give key info.

**Carbon Nanofibers** — Nelly Rodriguez and Terry Baker claim they can store 75 percent hydrogen by weight using carbon nanofibers. This clearly beats all known hydrogen storage systems and could lead to a 5,000 mile gas tank for cars. But verification seems slow in coming. Start off with the February 1997 *Hydrogen & Fuel Cell Letter*.

**Metalloradicals** — No, their album has not gone platinum. These may be the long sought key to photosynthesis. A magic box where you pour water and solar energy into their top, hydrogen comes out one side and electricity out the other. Meanwhile, oxygen oozes out the bottom as a waste product. A key paper is *Hoganson & Babcock in Science* for September 26, 1997.

**Direct Solar to Hydrogen** — At present, solar electricity is way too expensive to waste on hydrogen apps. Caused by highly inefficient silicon being the wrong horse to bet on. But a first step towards direct solar to hydrogen has been taken by *Turner & Khaselev in Science* for April 17, 1998. Efficiency is in the 14 percent range.

**Methane Oxidation** — Methane is the best known hydride with a very high 25 percent hydrogen storage ability. This gas also often is "burned off" oil wells because there is no cheap way to transport it. Roy Periana and others describe the new 70 percent efficient methane-to-liquid conversion process. It appears in *Science* of April 24, 1998 starting on page 560.

**Modest Injection** — A "water powered car" is clearly absurd,

but adding a little hydrogen to an otherwise stock gasoline engine seems to give you a few emission, economy, power, and lifetime benefits. Whether these can justify the added cost and complexity remains to be shown.

**Ionic Filters** — These are the magic new filters which can intelligently separate gas streams. Such as oxygen from air or hydrogen from carbon monoxide. Research here is mostly from *Argonne Laboratories*. Check their *Tech Transfer Highlights* Volume 9 #4 for details.

**Welding Apps** — Typical oxy-hydrogen torches give you an extremely clean but rather low energy flame having a precise control for jewelry and similar needs. Use of a hydrogen atmosphere during regular welding could create a reducing shield that stops oxidation. But one with extreme dangers.

**Also Rans** — A new type of dihydrogen bond was announced in the December 11, 1998 issue of *Science*. There is lots of interest in solid hydrogen, which demands extreme temperatures and pressures. *Bose-Einstein Condensates* a new form of matter that only happens at ultra low temperatures. Ongoing hydrogen developments are described in David Newton's *Chemistry* volume of the 1999 *Frontiers of Science* books.

## For More Help

More info on any of these hydrogen opportunities can easily be found by entering chosen names and keywords into [www.hotbot.com](http://www.hotbot.com) or your favorite search engine. Use [www.dejanews.com](http://www.dejanews.com) to check for newsgroup mentions. I've also covered these on my website.

Speaking of which, I have built a hydrogen resources web page up as my [www.tinaja.com/](http://www.tinaja.com/)

[h2gas01.html](http://h2gas01.html). Here you'll find tutorials, hot links to most of the players, recommended books, and newsgroup access links.

There's even a few links on nitrogen powered cars. These are a cute and an amazingly low technology alternate to electric cars. An approach which is 20 times cheaper than using lead-acid batteries!

And one you can literally beat out on a brick in your backyard.

More detailed assistance involving hydrogen or any other technical topic is found at [www.tinaja.com/info01.html](http://www.tinaja.com/info01.html) or at [www.tinaja.com/consul01.html](http://www.tinaja.com/consul01.html).

## This Month's Contest

As our contest for this month, just tell me about any hydrogen resource I don't already know about. Either real science or off-the-wall pseudoscience. And why you like it or why others are getting sucked in on it.

There'll be a dozen or more of my new *Incredible Secret Money Machine III* books going to the better entries. And an all expense paid *tinaja quest* for two (FOB Thatcher, AZ) going to the very best entries of all.

Let's hear from you **NV**

**Don Lancaster** is the author of 35 books and countless tech articles. Don maintains his no-charge US tech helpline found at (520) 428-4073. Don also offers free catalogs of his unique products and electronic bargains. The best calling times are 8-5 weekdays, MST.

Don is the webmaster of his *Guru's Lair* found at <http://www.tinaja.com/tinaja>.

Full reprints and preprints of all Don's columns and ongoing tech support appear here. You can reach Don at Synergetics, Box 809, Thatcher, AZ 85552. Or send any messages to [don@tinaja.com](mailto:don@tinaja.com).

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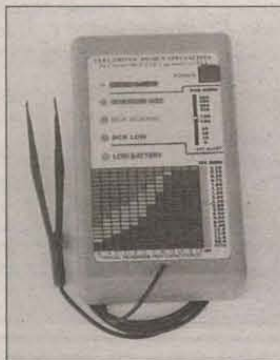
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Continued from page 86

offered for Windows 95, 98 and NT platforms and is available in a multitude of languages.

A FREE 14-day trial version is already available on our Website (<http://www.voxphone.com>) to allow customers to test the performance of the software. There will be many separate Websites carrying our download with an option to purchase in the near future.

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### WEBSTORM 2.5 — Power Your Way Thru' The Web

SharpeWare has released version 2.5 of WebStorm, a program that takes the pain out of searching the Web. WebStorm takes care of finding and reviewing the text from the links you need; checking their performance and age and managing their browsing. No need to wait for slow-loading search sites packed with advertising graphics — cut straight to the results you want.

Now with SiteStorm technology, WebStorm version 2.5 will also take any site then find and check all links to other sites + even following pages within the site to build a single, complete and easy-to-browse list of checked links. And alongside each good link WebStorm displays an extract of the actual page.

Whether obtained from search sites, or SiteStorm, checked results can be saved as formatted web documents — or exported into other programs. A history of past searches, and their results, is maintained automatically — together with a handy index page to share them via any browser.

You determine which sets of search sites to use and what keywords you're interested in finding. WebStorm does the rest — with everything controlled from one simple toolbar. Whether using Dial-up or Firewall access to the Internet, WebStorm manages the entire process. With Dial-up access WebStorm will automatically dial-up, connect, and when finished, disconnect the line.

WebStorm lets you filter your results further — remove unwanted results with the Stop Lists and never be bothered by them again + whether it's a particular site, or a word or phrase in a title that you want to ignore. Instantly identify those links that have recently been updated and see their country or state of origin. WebStorm uses color-coded icons to highlight slow, moved, or broken links.

And also new to version 2.5 — with one click review link details ranging from who's registered the domain and the 'freshness' of the site, to the company's latest SEC figures.

WebStorm integrates easily with Navigator or Internet Explorer — or most other Browsers. Bookmarks from your favorite browser are automatically highlighted when reviewing your results — and you can even add a link to your Browser from within WebStorm with the click of your mouse.

SharpeWare provides free updates to search site information via an automated download from their Web site. You can also add your own favorite search site to any collection of sites quickly and easily via the 'Add New Site' wizard.

WebStorm v2.5 remains priced at \$34.00 US when buyers provide an E-Mail address (\$39.00 US otherwise) and is a 32-bit program designed for Windows 9x or NT. WebStorm can be ordered directly using its own 'Buy Now' button, on-line using an encrypted Web form or via 1-800 Phone or Fax. Site licenses are available. For more information, contact: SharpeWare, 10 Gallow Hill, Peebles EH45 9BG, Scotland. E-Mail [sales@sharpeware.com](mailto:sales@sharpeware.com), Web <http://www.sharpeware.com>. A free full function trial copy is available for download from:

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# The Computer Controlled World: RS-232 Network Control Methods and Applications

## Video for Windows

by Ryan Sheldon, National Control Devices (404) 244-2432 <http://members.aol.com/ncdcat>

Watch 16 Video Sources Simultaneously in a Windows 98 Window

*Today's powerful tools allow users to replace previously expensive hardware with low-cost software solutions.*

It's been a few months since I have had an opportunity to write an article for *Nuts & Volts*. Writing in this magazine has the fortunate side-effect of putting me in touch with people all over the world. Often times, hundreds of people call or write with questions and I do my very best to answer each of you. So, I would simply ask that my readers be patient with me over the next few months as I stumble in and out of this magazine in a desperate attempt to manage my time. I should have this under control by the end of the year, at which time, I will be writing every month.

Like my readers, I like to play with technology. I like to see what I can do to combine technologies to make interesting things happen. I often times release devices just because they are interesting to me, having no idea how useful they will be to you. While I like to see my

work used by my readers, the simple reality is that most of my creations are born out of the simple desire to make bizarre devices do cool things.

The device highlighted in this article definitely fits this category. A couple of years ago, I created the ASEL audio/video switcher. ASEL is short for Analog SElector, and is used to route any video input to any output. There are 16 inputs and two outputs. The user can use anything from a BASIC Stamp to a desktop PC to control this device via RS-232 communications.

### So What's This All About?

The application shown in this article uses the ASEL to connect a com-

puter to 16 video sources. The program displays all 16 video sources on a computer monitor at the same time. This is accomplished by switching to each video source, grabbing an image, and

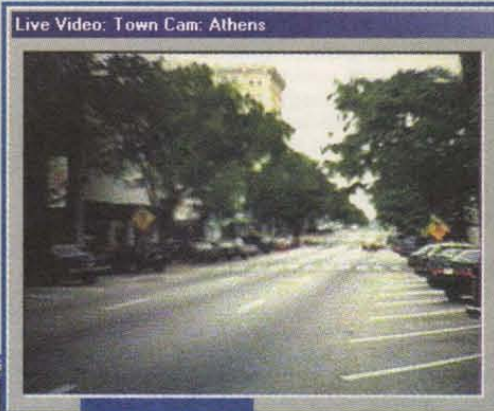


FIGURE 3

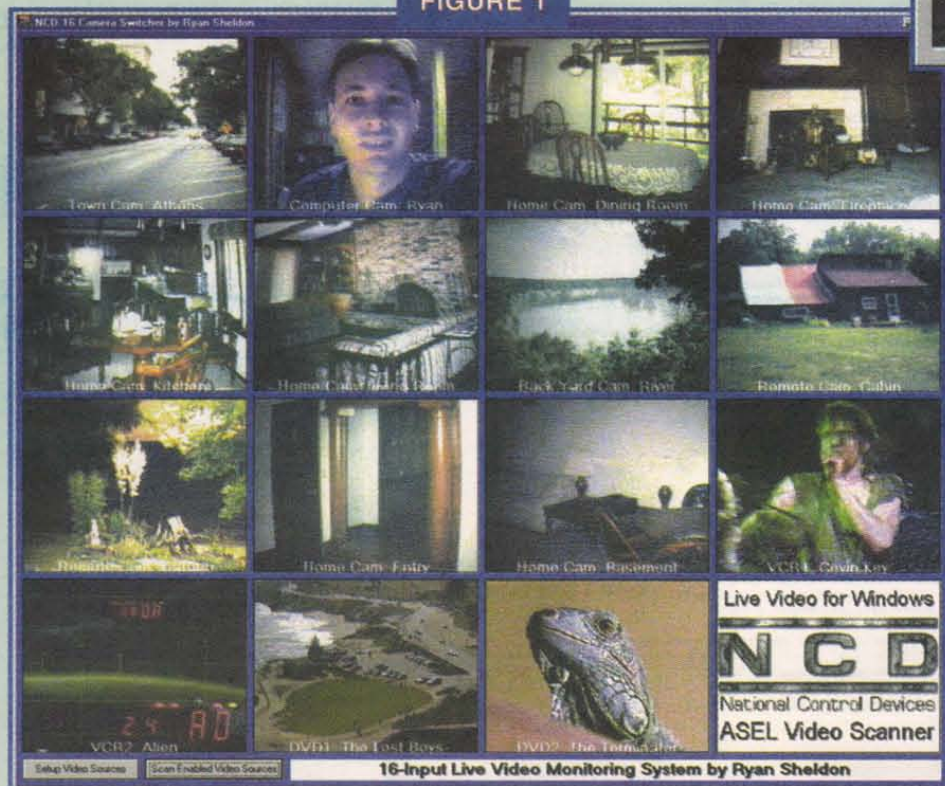


FIGURE 1

FIGURE 2





putting the image on the screen. The refresh rate of each video varies from one frame per 2.5 seconds to 25 frames per second depending on how many video inputs are being "scanned." The user can control which inputs are being scanned, and even create a simple title for each video source so you can keep track of what videos are on-screen.

In this application, the ASEL serves as a video routing engine, and is used to "Scan" between each video source. I have connected several video signals to the ASEL as shown in Figure 1.

Should I be interested in watching any given camera at full-speed 30-frames per second, all I have to do is click on the image box for the selected camera and live video is routed exclusively to the selected camera. I call my program "ScanCam," and in a few minutes, I am going to dissect the most important portions of this program so you see how this thing works. I think you'll be surprised at how simple this program is.

Before I go much further, I should warn you that doing all this is not cheap, you'll need a serious play budget. The software tools alone for pulling this off can cost between \$700.00 and \$1,300.00. The hardware for camera switching and video capture will cost less than \$300.00.

This is a small price to pay if you are developing a high-end security monitoring system or an elaborate time-lapse photographic workstation. If this hasn't scared you off, then let's move on to system requirements.

## System Requirements

The ScanCam program does require some relatively new hardware. Slower systems will probably work fine at the sacrifice of slower video frame rates. Here's a rundown of what I am using on my system:

- Pentium II 400 MHz w/128 Megs RAM and 20 Megs free HD space
- Available COM Port
- STB TV-PCI TV-Tuner Card
- ASEL Analog Selector used to scan between the video inputs
- Visual Basic 5.0 (or VB 6.0) Professional or Enterprise Edition
- LEAD Tools Multimedia
- CCD Cameras and other video sources, up to 16
- 19" or larger monitor recommended

The video capture card is made by STB, and so is the TV-PCI tuner card (which is my favorite). Most TV capture cards should work; the software drivers are generically compatible for controlling all types of video capture devices. If you buy a TV card, I would strongly recommend the STB TV-PCI because it is so simple to install and is very compatible with many high-speed video cards and multimedia programs.

I would strongly warn against the purchase of the Win98 TV card. It is very difficult to install and took me a couple of weeks to undo the damage

caused by the software installation of this card ... and I never got it to work. And since CompUSA would not take it back because of their trendy 14-day return policy, I am gladly giving it away to the first person to purchase an ASEL video switcher in need of a headache. But please don't say I didn't warn you.

## Connections

The ASEL video switcher is compatible with just about every camera with a composite video output. Up to 16 cameras or other video sources

can connect to the ASEL video inputs. The video output of the ASEL is connected to the composite video input of the STB TV-PCI video card. The serial port of the computer is also connected to the ASEL switcher to provide software control over video switching operations.

The software was written under Visual Basic 5 Pro using Lead Tools Multimedia Edition for control of the TV-PCI card. Communication to the video switcher is done via RS-232 provided by the Microsoft Comm Control (VB Pro and Enterprise versions only).

By popular request, I will not be switching to VB 6 until later this year, even though I have it sitting on my shelf. Also, I wanted to quickly address the issue of where to purchase Visual Basic cheaply. I found that somebody always has it for sale at [www.ebay.com](http://www.ebay.com), Pro version and all for less than \$100.00. **Be warned!!! I do not know if this is a legitimate source for legal software.**

In my application, I connected several cameras all around my house. Figure 1 illustrates the user interface. Note that each of the images shown in Figure 1 are constantly updating, one at a time. If I want to view a live feed from any of the cameras, I simply double click on the picture clip and that video is shown exclusively in a 320x240 window at 30 frames per second. I can click the "Scan Enabled Video Sources" button to continue monitoring the cameras. I can update images at faster rates by telling the program to avoid scanning certain cameras by using the "Setup Video Sources" button. Figure 2 illustrates the control box for selecting which cameras are updated. You can also use this dialog box to change the name of the video sources.

Figure 3 shows the monitor window. The monitor window shows what the TV-PCI card sees. Under normal operation of viewing 16 video sources, the monitor window often flickers as different video sources are fed into the TV-PCI card. When a single video source is monitored, the monitor window shows stable incoming video at 30 frames per second.

## Programming

Figure 4 shows how to use Lead Tools to initialize the video capture card for Visual Basic Control. The program starts by unlocking the video features of Lead Tools; more about that in a second.

Next, the Lead Tools capture driver is connected to the TV-PCI Video Card. This enables Lead Tools to control every aspect of your TV-PCI Video Card under Visual Basic.

The Lead Tools capture mode is then set to "Overlay," which genlocks the incoming video signal with the SVGA signal before it is sent to your monitor. This effectively frees the PC from grabbing and displaying images. Instead, the images are hardware overlaid with the outgoing SVGA signal.

Finally, the titles for each video

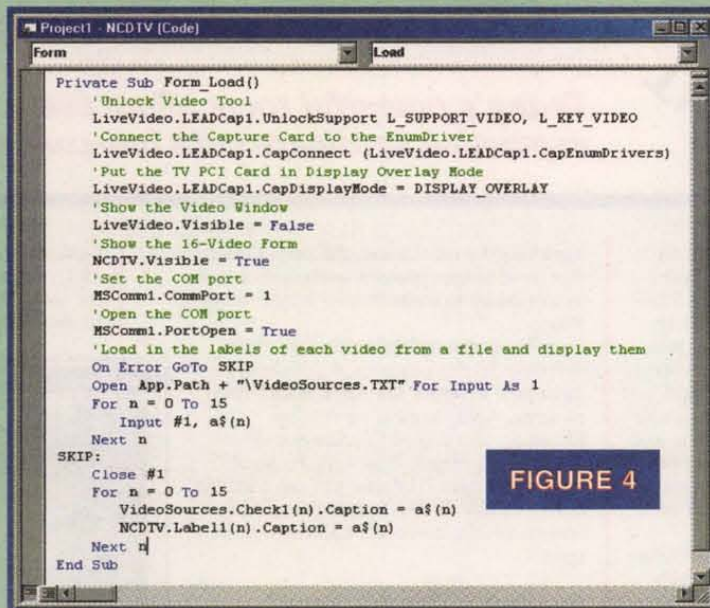


FIGURE 4

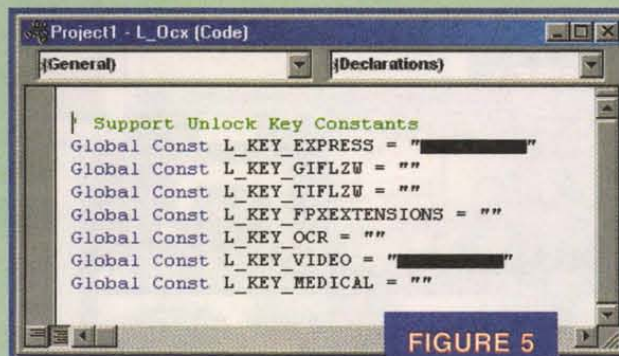


FIGURE 5

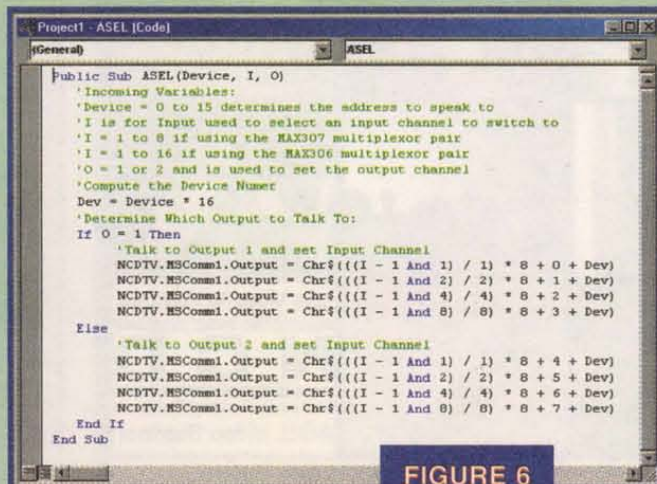
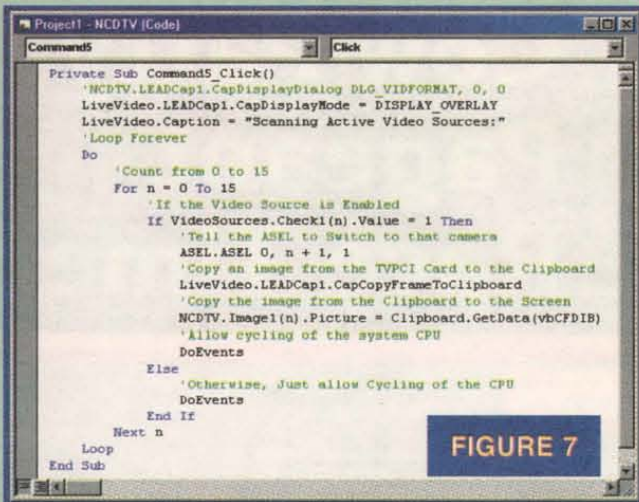


FIGURE 6

# The Computer Controlled World





clip are loaded and displayed. An error trapping routine is employed so the program does not crash the first time you run it (when video titles have not yet been defined).

### Security Key

Note that a security key is used to access

Lead Tools functions. A valid key must be used to enable this device. The key is placed within quotes as shown in Figure 5.

Of course, my key code cannot be published, but you can put your own key code here when you purchase your copy of Lead Tools Multimedia Edition.

Figure 6 illustrates the ASEL control subroutine. This routine handles all the ASEL video switching operations. All you have to do is tell this routine which video device you want to switch, the input to read, and the output to send it to.

Figure 7 illustrates the guts of the ScanCam program. This is the routine that literally grabs an image from each video source and displays it in a window. This

routine starts by making sure the monitor window is in overlay mode. This provides a slight boost in performance.

Next, the routine uses the N variable to count from 0 to 15 in an infinite loop. As N rises, the program looks to see if the video source is enabled (see Figure 2). If the video source is enabled, then the ASEL video switcher routes the video source to the TV PCI card. An image is grabbed from the TV PCI card to the clipboard.

The image is then loaded onto the screen from the clipboard. The DoEvents command serves two critical functions. First, it allows the system enough time to redraw the latest frame. Second, it allows the system to service other tasks such as mouse-clicks and other operations.

### ASEL Connections

Make sure jumpers are set and power/data

signals are properly connected as shown in Figure 8.

Figure 9 illustrates the 16 video inputs and two video outputs on the ASEL. Connect video signals as shown.

### ASEL Analog Signals

This article demonstrates how the ASEL can be used for video switching applications. The ASEL may also be used for general-purpose analog signal routing. Any type of analog signal may be fed into the ASEL as long as the voltage levels are not below -5 or above +5 volts. Bandwidth begins to degrade beyond 10 MHz, but that's plenty fast for most audio/video applications.

The output signal is not buffered, making it more universally compatible across all types of analog signals. A low on-resistance combined with low cross-talk between signals, makes this a perfect choice for most A/V signal switching applications.

### ScanCam Software

The ScanCam program is now available on the NCD-CDROM. Please visit <http://members.aol.com/nccat> for complete details or E-Mail me at [nccat@aol.com](mailto:nccat@aol.com). NV

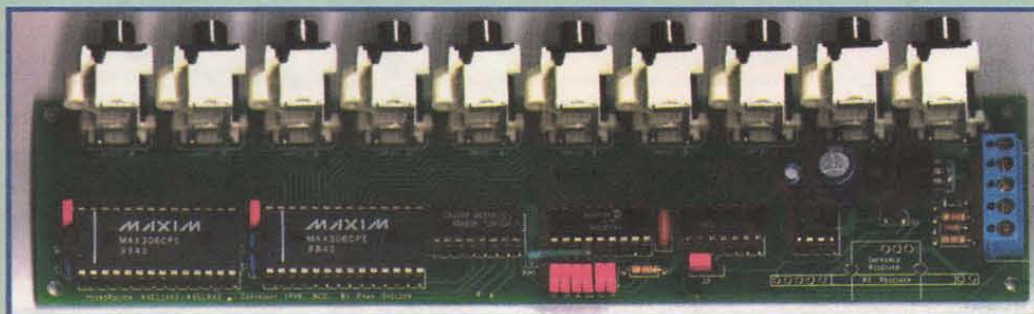


FIGURE 8

+12V Power Supply Input  
Power Supply Ground  
RS-232 Ground  
RS-232 Data Input

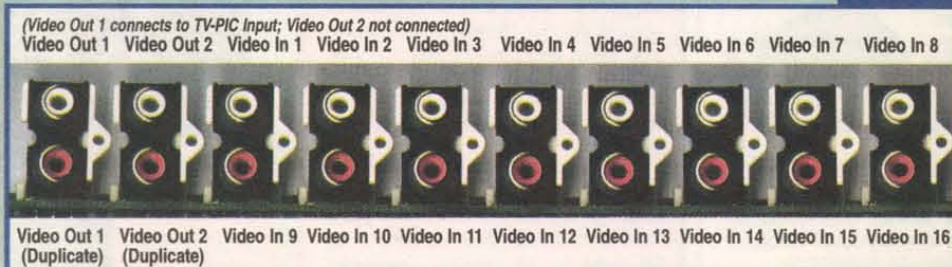


FIGURE 9

### Boards and Chips Available

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The LCD Animator 128 is available exclusively to Nuts & Volts readers for the discounted price of \$199.00.

Please mention this article in Nuts & Volts when ordering to receive this discounted price.

### Sources:

STB TV-PCI TV Tuner Card  
(Available from Best Buy and other Internet sources)  
ASEL Video Switcher, NCD (404) 244-2432, (404) 307-5386,  
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Lead Tools Multimedia Edition (704) 332-5532,  
<http://www.vbxtras.com>  
Visual Basic Pro, <http://www.microsoft.com>

#### Highly Recommended Development Tools:

If you ever wanted to program your own PIC processors for specific computer-control applications, try PicBasic Pro, the quickest way to get your custom device connected to the outside world. PicBasic Pro, microEngineering Labs, Inc. (719) 520-5323, <http://www.melabs.com>

If you don't have Visual Basic Pro or Enterprise, you don't have RS-232 capabilities. PDQ Comm adds RS-232 capabilities to whatever version of VB you happen to be using. A fully functional demo version is available for free download. PDQ Comm, Progress Software, <http://crescent.progress.com>



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Nor-fax Doc. #5545

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# Cow-Patty Pageant Race Timer

by Lawrence Foltzer

For the last five years, I have participated in an open class paddling event known as the Cow-Patty Pageant. The event takes place on the Estero Americano in Sonoma County, CA, and is open to all classes of paddling craft. The race is an out-and-back event from Valley Ford, CA, to the Pacific.

At the mid-point of the race, contestants must embark upon dry land, run a short obstacle course to the "Shrine," pay homage to the Cow-Patty Goddess (verification that contestants did the course), and then return to their boat for the sprint back to the starting point.

The event gets its name from the fresh bovine deposits frequently found along the boundary of the land and the waterway. The Pageant takes place in February ... towards the end of the local rainy season ... so most of the oldtimers have long since learned to wear high top boots in case they have an urgent need to venture upon "dry?" land.

The race participants include a broad spectrum of people. There are the serious racers that are capable of completing the 14-mile course (seven out, seven back) in just over an hour, while the less competitive may take up to four hours, enjoying the paddle through the pristine (watch your step) farmland.

At the end of the race, just about everyone congregates at the Union Hotel in Occidental, CA, for a pasta feed to replenish their precious body fat, and to be publicly humiliated (everyone gets a trophy) during the awards ceremony.

Over the years, the number of race contestants has ranged from 40ish to 70ish. And traditionally, we have had three or four volunteers time the race with stopwatches, paper, and pen. Last year, it was my turn to help, which meant I wouldn't be able to participate in the race. So rather than train for the event, I decided to drink milk and eat cookies while developing a way to automate the task. The timer that resulted from this effort is the subject of this article, and is shown in Figure 1 along with the printer/plotter.

### Features, Features, and More Features

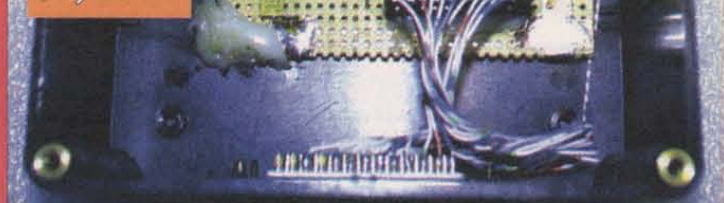
The following is a list of the timer requirements:

- Had to have a continuous battery life of at least six hours, including printer power.

Figure 1



Figure 2



- Needed to be small, rugged, and waterproof since it frequently rains during the event.

- Needed to be inexpensive since it was funded by me.

- Capture race data for up to 99 contestants.

- Capture race start and finish times with one second resolution.

- Support staggered and group starts up to four contestants at a time.

- Provide race status printout during the event.

- Provide printed, sorted race results at end of race.

- Provide non-volatile storage of

race statistics for subsequent retrieval after powerdown.

- Provide method of transferring data to a PC.

### A Little Bit of Hardware

The guts of the hardware is shown in Figure 2, and the associated schematic in Figure 3. The circuit is simple and cost-effective by virtue of the fact that several of the processor ports are used double-duty.

The electronics consist of a PIC16F84 microprocessor (MCU), a 3.6864 MHz crystal to generate





accurate timing, an eight-pin serial EEPROM (ATMEL AT25040) to store contestant start and finish times, an eight-bit serial input/parallel output shift register (74HC595) as the printer interface, and an MC340T voltage regulator.

A surplus 14-key keypad (Figure 4) serves as the only input device, which is scanned using the eight I/O lines associated with port "B" of the MCU. Two of the keypad column lines, RB0 and RB1, are time-shared with the EEPROM and shift register. RB0 is used to scan the ENTER key column and serves as an MCU read line for the retrieval of EEPROM data. RB1 is used to scan the decimal-point key column and serves as the data line from the MCU to both the shift register and the EEPROM.

The other five I/O lines of the MCU, RA0-4, are used as control signals to govern the flow of data between the printer, EEPROM, and shift register. This is one well-used 16F84!

The keypad wiring for the keypad is shown in Figure 5. The keypad was an unconnected set of switches that I wired together with adhesive-backed copper foil.

I wired the columns together first, and strategically laid down strips of masking tape to serve as insulation for the foil strips that I then used to wire the rows together.

A final layer of masking tape covered all but the places where I attached wires to make up a harness to attach to the MCU. Works quite well too, considering it only cost \$2.00 surplus. Figure 6 shows the completed keypad assembly.

A printer was selected as the output device since it was important to be able to list and post intermediate race results periodically during the race. In keeping with the low-cost objective — and because I didn't want to haul my laser printer out to a pasture — I used an old RadioShack plotter that I had left over from the early Color Computer days. It prints on 4" wide roll paper.

This printer was ideal since it could be powered from a 12-volt battery. But I almost gave up on the plotter because the plotter pens are no longer commercially available. But as it turned out, a friend of mine also owned one of the plotters, and had a large stash of the pens, and donated a half dozen to the cause.

But in the future, I suspect I'll have to redesign the unit to use an LCD,

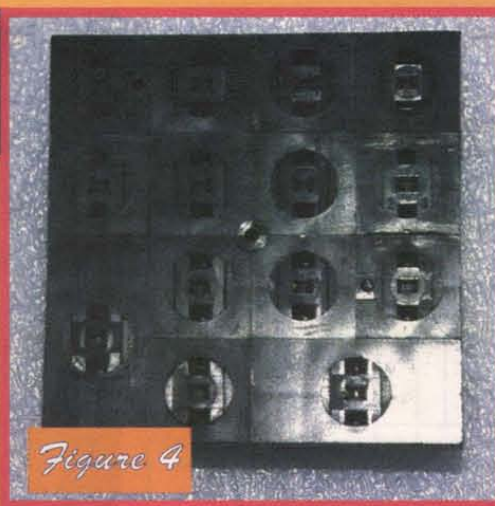


Figure 4

and be satisfied with having to dump the results to a printer at a later time.

Portable power for the timer was obtained from a seven amp-hour, 12-volt sealed lead-acid battery.

## Lots of Code

When I write assembler code, I usually start by making a flowchart to follow, concentrating the coding first on the more obvious subroutines, i.e., those that speak in a universal way to the I/O. However, when it comes to writing the main body of the code, more often than not, I end up writing stringy code to start, which is okay as long as the memory holds out. But when writing for a PIC16F84, with just 1K words of space, some of which will be used to hold text information for display annotation, and various and sundry lookup tables, you run out of program memory fast.

This means I end up rewriting code segments in an effort to create more subroutines to make it all fit. And this project was no exception in that regard.

In fact, memory was so scarce at one point that I ended up having to make rather terse/cryptic prompting menus. But in the end, the code rewrite freed up enough space to allow me to restore some intelligence to the menus. It was a good thing that I started this project when I did, or the timer may not have made it on time.

The trickiest part of the code to write was that which services the keypad. What made this such a challenge was the section dealing with the parsing of two, three, and four key command sequences. Why so many keys, you ask? The short answer is that this timer is feature rich, i.e., we have nine functions to perform, and only have three keys with which to signal our intent to the microprocessor.

A portion of the PIC16F84 assembler code is given in Listing 1 for your enjoyment. The complete listing is available on *Nuts & Volts* website at [www.nutsvolts.com](http://www.nutsvolts.com).

## How it Works

When the unit is first turned on,

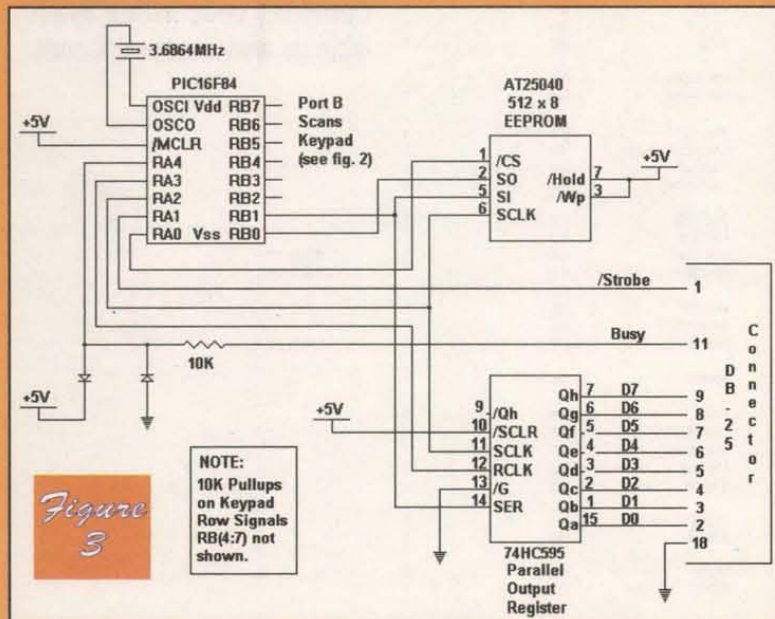


Figure 3

Table 1

Enter	==>	Terminates a contestant entry string.
Comma	==>	Separates multiple contestant IDs for simultaneous starts.
Minus	==>	Backspace key.
Period	==>	Escape key used in combination with other command keys.
Period + Minus	==>	Print current race status, finishers only.
Period + Comma	==>	Print contestant count and lapsed race time.
Period + Enter	==>	Disregard last input string.
Period + Comma + Minus	==>	Print sorted list of all contestants with start, finish, and lapsed times.
Period + Comma + Minus + Enter	==>	Restart timer from the beginning.

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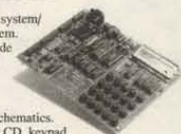
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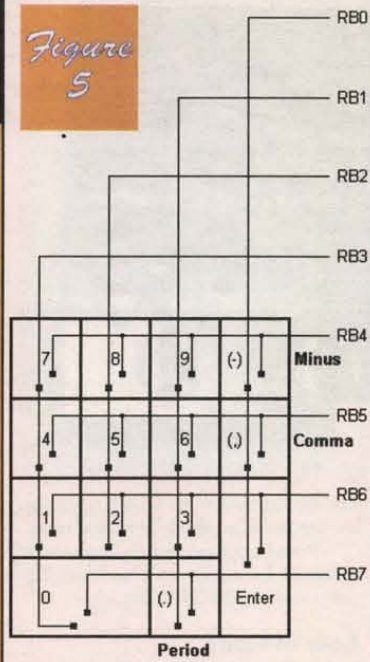
it goes through a sequence whereby it checks to see if race data is in the EEPROM. If so, the timer queries the operator to erase the data "or not." In this way, the unit can be shut off at the end of the race, and accessed at a later time to dump out the race results for inclusion in a report in a local paper.

With memory cleared, a new timing sequence starts. The timer is capable of recording events nine hours in length (so turtles in hard shells may participate). As a contestant, or a group of contestants are about to start, the operator enters their respective ID, or group of IDs, delimited by commas.

When a contestant(s) crosses the start line, the operator presses the enter key, initiating the timing sequence for the individual(s) in that heat.

A contestant's race is terminated when a particular ID is entered for the second time. And if there was an entry error, e.g., contestant #23 was entered prematurely or by mistake, don't worry, because when entered for the third time, the stored start, finish, and computed interval for that data set will be printed, and the old finish time will be over-written with the time of the third entry so the final results show the

Figure 5



aggregate race time.

Race statistics are stored in the outboard EEPROM, ordered by contestant number or Boat ID#. Each contestant record consists of four bytes. The first two bytes hold the binary start time in seconds, while the last two bytes hold the binary finish count

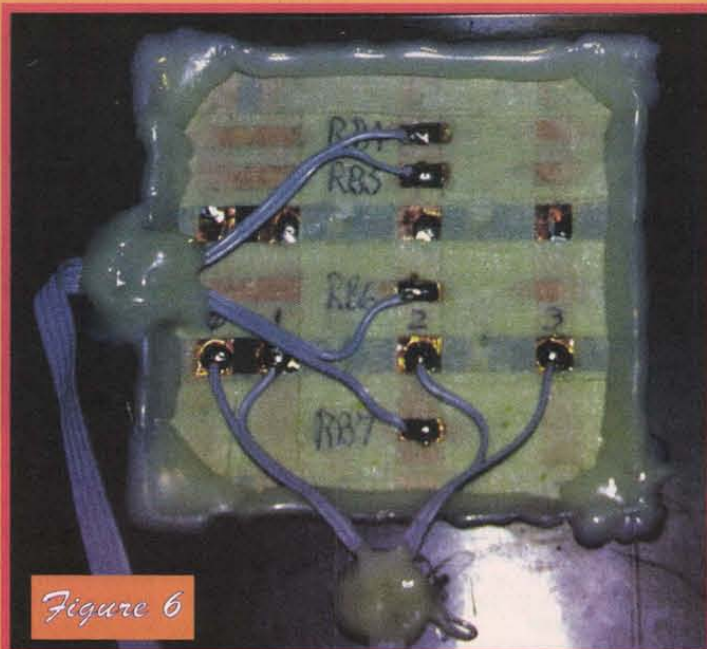


Figure 6

in seconds. The most significant bit of the 16-bit count is not used for timing. It is used instead as a flag to indicate that an entry has already bubbled to the top in the lapsed time sorting process.

Table 1 shows the set of functions provided by the non-numeric keys, both individually, and as double, triple, and quadruple-key sequences.

## Conclusion

I hope you found this article enjoyable and illustrative of the capability of Microchip's small but powerful microcontrollers. In a time where desktop machines with 64 megabytes of RAM is commonplace, I find it refreshing to be able to do so much with so little. **NV**

```
.....
;cowpatty.asm
;Tuesday, February 3, 1998 21:14:00
;everything works
;838 total bytes
;.....
```

```
;trisa:      1      0      0      0      0      0      0      0
;PORTA:      RA4      RA3      RA2      RA1      RA0      RA0      RA0
;            busy      RClk      SPIClk      /St      = 0x10      = 0x03
;            = 0x03      = 0x03      = 0x03      = 0x03      = 0x03      = 0x03
;PORTB: RB7      RB6      RB5      RB4      RB3      RB2      RB1
;RB0      KB8      KB7      KB6      KB5/SPIRx KB4      KB3      KB2/SPITx
;KB1/MemData
```

```
.....
LIST
include
p=16F84
"P16F84.inc"
```

```
LF      equ      0x0a
CR      equ      0x0d
RClk    equ      3
St      equ      1
busy_bit equ      4
CSN     equ      0
Dout    equ      1
Din     equ      0
SCLK    equ      2
```

```
Write_Enable equ
WRDI      equ      0x04
RDSR      equ      0x05
RDY       equ      0
WRSR      equ      0x01
READL     equ      0x03
READH     equ      0x0b
WRI TEL   equ      0x02
WRITEH    equ      0x0a
WEN       equ      1
```

```
;TOIF      equ      2
;TOIE      equ      5
;prescaler equ      3 ; 7 for serial interface, 3 for parallel
```

```
.....
; 38 variables + input_string_length
tempw    res      1
status_image res      1
```

```
flags    res      1
irq_bit   equ      7
got_one   equ      6
period_bit equ      5
one2sort  equ      4
```

```
hi_lo    equ      3
irq_cnt   res      1
bit_cnt   res      1
shifts    res      1
```

```
tab_index_h res      1
tab_index_l res      1
row_colm    res      1
row_colm_image res      1
KeyPad      res      1
LastValue   res      1
```

```
Seconds    res      1
Minutes     res      1
lsectime    res      1
hsectime    res      1
```

```
BoatID     res      1
ref_boat    res      1
NumBoats    res      1
```

```
spidata    res      1
```

```
Acc        res      1
hnumerator res      1
Inumerator  res      1
hResult     res      1
lResult     res      1
```

```
msBCD      res      1
lsBCD      res      1
```

```
hStart      res      1
lStart      res      1
```

```
hFinish     res      1
lFinish     res      1
```

```
cap_time    res      1
cap_hime    res      1
lo_laptime  res      1
hi_laptime  res      1
lo_reftime  res      1
hi_reftime  res      1
```

```
input_string res      1
```

```
.....
org      0x00
reset    goto    init
.....
```

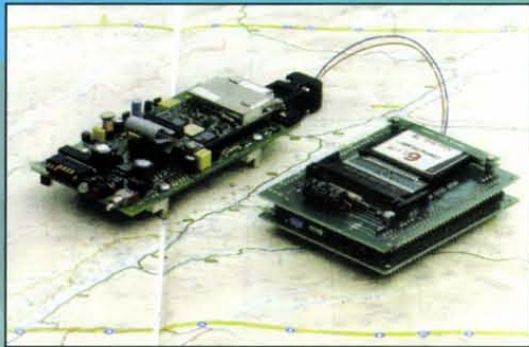
**SAMPLE**  
Complete code listing available at [www.nutsvolts.com](http://www.nutsvolts.com)

; init to zero  
; init to zero  
; init to zero

; FSR reference for indirect storage of boat ID



# New Product News



## GPS DATALOGGING SYSTEM

The TDS2020GDL GPS Datalogging System makes it easy to build a custom datalogger to store position and other information on to PCMCIA or CF cards for later retrieval and examination. Equipment used in agriculture, security, transport, or seagoing vessels often needs to be monitored and correlated with position information.

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## O-SCOPE FOR WINDOWS 32

Allison Technology Corporation announces the release of their O-Scope II, a digital storage oscilloscope PC-based virtual instrument.

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The O-Scope II sells for \$349.00. It comes with an AC wall adapter, software, cable, and manuals. Optional accessories include probes, battery pack, and an advanced spectrum program.

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## SBC2000-062

Vesta Technology's SBC2000-062 is designed to be an inexpensive single board computer that offers both exceptional hardware versatility and programming simplicity in a very small board (2.25 inches by 1.3 inches).

The SBC2000-062 has many resources that embedded systems designers need. The SBC2000-062 provides an RS-232 serial port, 8K EEPROM, PWM generator, four programmable input/output lines that can be either AIN, DIO or both, low power "sleep" mode, LCD port, and keypad port. When the LCD and keypad ports are not used, the SBC2000-062 provides a total of 14 additional I/O lines.

Along with its compact size and the mix of inputs and outputs, the SBC2000-062 is offered with the most complete development software package on the market - Vesta Basic. Vesta Basic is a Windows95-based, embedded, IDE-driven, compiled Basic which is easy, fast, and can literally make programming the SBC2000-062 as simple as 1-2-3.

The unit operates at temperatures from -40C to +85C. It consumes 6 mA and runs at 5 VDC with a sleep mode consumption of only 2 mA. Best of all, this board only costs \$29.00 or \$44.00 (with the optional A/D lines).

For more information, contact:

**VESTA TECHNOLOGY, INC.**

11465 W. I-70 FRONTAGE RD. N., DEPT. NV  
WHEAT RIDGE, CO 80033

303-422-8088 EXT. 111 FAX: 303-422-9800

E-MAIL: [creish@sbc2000.co](mailto:creish@sbc2000.co)

WEB: [WWW.SBC2000.COM](http://WWW.SBC2000.COM)

## XT-4 CW MEMORY KEYS

Unified Microsystems introduces its newest product, the XT-4 CW Memory Keyer. Its small size and battery operation makes it the perfect keyer for Field Day, DXpeditions, QRP, or any portable or mobile operation.

The XT-4 is fully lmbic with self-completing characters. Each of the four memories hold approximately 100-110 Morse characters in non-volatile storage. Memories 1-2 and 3-4 can be chained together for even longer messages.

A knob gives smooth speed control (8-45 WPM) as opposed to clumsy up-down buttons or complex codes.

A paddle reverse function switches the dit and dah keys around for operators who send with the other hand.

The tune function simplifies adjusting your rig or amplifier.

Although the XT-4 will run for several hundred hours of heavy use on a single nine-volt battery, an automatic power down feature kicks in after 30 minutes of inactivity to further extend battery life.



The list price is \$79.95. An optional cable set with cables to the paddle and rig are available for \$9.95.

For more information, contact:

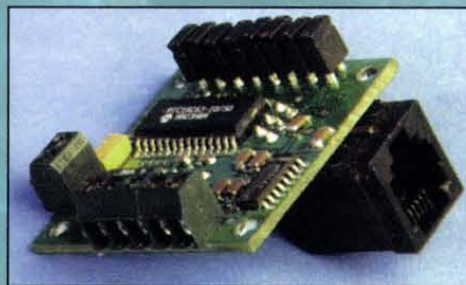
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## MODEL JDS-148 REMOTE TEMPERATURE MODULE

J-Works, Inc., announces that it has begun shipping the Model JDS-148 Remote Temperature Module.

The Model JDS-148 interfaces to Dallas Semiconductors DS-1820 or DS-1821 tem-

perature probes and provides temperature measurement over either RS-232 or multi-drop RS-485. Each module automatically scans and records the temperature conversions and communicates back to a host computer with ASCII commands.

Complete product specification is available on J-Works web site at [www.j-works.com](http://www.j-works.com).

The single unit price for the Model JDS-148 is \$45.00.

For more information, contact:

**J-WORKS, INC.**

12328 GLADSTONE AVE., UNIT 4, DEPT. NV

SYLMAR, CA 91342

818-361-0787 FAX: 818-270-2413

E-MAIL: [admin@j-works.com](mailto:admin@j-works.com)

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Other Models are Available. See [www.web-tronics.com](http://www.web-tronics.com) under "hard drive and accessories" for more details and pictures.

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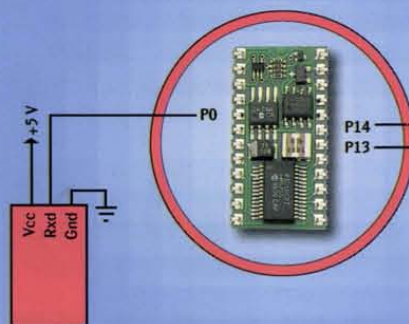
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## WWVB Atomic Time Clock Receiver (#27971 - \$79)

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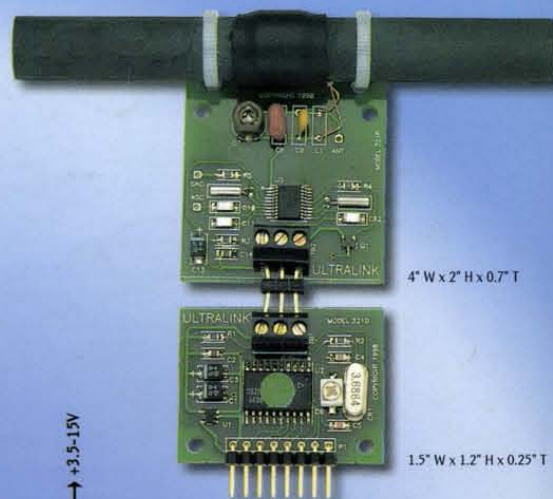
Download datasheet and sample PBASIC code from <http://www.parallaxinc.com>.



Dimensions are 3.2" W x 2.0" T



Dimensions are 3.7" W x 2.8" T



4" W x 2" H x 0.7" T

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## BASIC Stamp II Module (#BS2-IC - \$49)

## BASIC Stamp II Starter Kit (#27203 - \$159)

The BASIC Stamp II Starter Kit consists of the BS2-IC module, the new Super Carrier board, BASIC Stamp Manual Version 1.9, software and cable.

## 2 x 16 Serial Backlit LCD (#27937 - \$59)

Scott Edwards ILM 2x16 version has the smart serial interface built right into the PCB. Features four inputs for switches / buttons, non-volatile EEPROM storage for user settings; serial controlled- backlight, and extended character set.

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Supports four font sizes arranged as 4 lines x 20 small characters or 2 lines x 10 large characters, but the real fun is the graphic capabilities! Plotting points, drawing lines, easy with a 4 kB non-volatile EEPROM. Package includes a 3.5" disk with HTML manual, a graphics conversion / downloading utility program, and examples using the BASIC Stamp II.

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