

ROBOTICS • MICROCONTROLLERS • COMPUTER CONTROL • LASERS

Nuts & Volts

THE PREFERRED MAGAZINE OF THE
ELECTRONICS HOBBYIST/INDUSTRY

March 2002
Vol. 23 No.3



COMPUTER INTERFACING

Connecting
the PC to the
Outside World

Build the
Dustmeister
Intelligent
Vacuum
Controller

Ultrasonic Distance
Measurement
Using the TI MSP430

Triac Principles
And Circuits

U.S. \$5.50 CANADA \$9.25



www.nutsvolts.com

AUCTION BLOWOUT!

Over 2,000 Items on Ebay! Many from Distressed or Bankrupt Dot-Coms!



24GB Ultra SCSI DAT Tape Drives
No Minimum Bids!



Cisco Routers and Hubs
Bids Start at \$50



Sun Workstations and File Servers
No Minimum Bids!



15,000 RPM Ultra 160 Hard Drives
\$10 Minimum Bid

Disk drives cost too much. Take advantage of dot-com closeouts and bankruptcies. We're liquidating thousands of PCs, hard drives, and accessories. Visit www.scsidrives.com and name your own price! Join our mailing list for advance notice when special sale items arrive!



CORPORATE SYSTEMS CENTER

3310 Woodward Avenue, Santa Clara, CA 95054 (408) 588-1110

Wall Wart Special!

- ◆ 12VAC, 1600mA Class 2 transformer
- ◆ 11n:120VAC, 60Hz, 26W w/coaxial plug
- ◆ Plug: 2.1mm dia center, 5mm sleeve
- ◆ Available by the case - 3000 available
- ◆ Case of 25 - (29 lbs)
- ◆ New units - 90-day warranty



HSC# 18524 \$29.50

Variable Transformer

- ◆ Model AEEC-2090
- ◆ 10 - 130 VAC output @ 20A
- ◆ Measures 8" x 10" x 8" tall
- ◆ Meter, illuminated switch
- ◆ New...90-day warranty



HSC# 80461 \$95.00

DMM w/tilt-display!

- ◆ AEEC-2890 DMM with extras!
- ◆ AC/DC volts, Ohms, Current, Capacitance, Frequency, Temperature, hFE
- ◆ Wide range measurements
- ◆ Compare at \$70, \$80 +!
- ◆ New, w/test leads, temp probe, cradle



HSC# 80504 \$39.95

Pentium M/B

- ◆ Asus Model No. P599VM
- ◆ For Intel P55C-MMX/P54C/P54CS AMD K6-2/K6-III, IBM/Cyrix MII
- ◆ 13-DIMM, 3-PCI, 1-ISA, SIO/PIO/USB
- ◆ 18MB AGP, 2MB Flash, 1MB cache
- ◆ Much more!! 90-day warranty



HSC#19237 \$39.50

HSC Special Package Deal!

BUY THE ABOVE MOTHERBOARD & ADD A AMD K6-2/450 MHz CPU FOR just..... **\$59.50!!**

-OR-

ADD A AMD K6-2/333 MHz CPU FOR only..... **\$49.50!!**

56K modem/hub

- ◆ Four-port hub card, with 56K V90 modem
- ◆ For multi-PC web access!
- ◆ ISA-type, OEM package
- ◆ 90-day warranty



HSC# 18942 \$17.50

Variable Transformer

- ◆ Model AEEC 590
- ◆ 10 - 130 VAC output @ 5A
- ◆ 17" dia. (8.5" w/ext.), 6.5" tall
- ◆ Illuminated switch, meter
- ◆ New...90-day warranty



HSC# 80474 \$45.00

Disk Drive Deals!

2.1GB IDE Laptop

- ◆ Model No. DCRA-22160
- ◆ 14200 cyl, 16 heads, 63 sec/T
- ◆ 15VDC @ 520mA. (peak)
- ◆ HSC 90-day warranty

HSC# 19220

\$39.95



4.3 GB SCSI 1/2 HEIGHT

- ◆ ST15150N hard drive
- ◆ 121 Hds, 11 Disks, 3,711 Cyl.
- ◆ 17,200 RPM, 9.0 mS avg. seek
- ◆ HSC 90-day warranty

HSC# 18412

\$24.95



9.1GB SCSI ULTRA-W

- ◆ Seagate ST19171WC
- ◆ 17200RPM, 4.6mS av. latency
- ◆ 180-pin connector
- ◆ HSC 90-day warranty

HSC# 18753

\$39.95



HSC Web Specials!

You can find these in the "Specials" area of our on-line shopping pages at www.halted.com...check them out and use our secure site to place your order.

20KOhm/V Analog VOM HSC# 18260 \$9.95	Mouse, 2-button HSC# 18731 \$3.95	10-Base T card, ISA HSC# 18943 \$4.95
Tower, cabinet, 7-bay HSC# 80544 \$42.50	SCSI Controller, PCI HSC# 18218 \$9.95	Mouse, w/ keypad HSC# 80539 \$4.95
Color camera, digital HSC# 17503a \$9.95	SCSI Controller, ISA HSC# 17995 \$7.50	Motherboard, 486DX4 AT HSC# 18529 \$9.95
Batt charger, NiMH HSC# 19151 \$17.50	A/V 'Firewire' card, HSC# 80613 \$45.00	Memo Recorder w/VOX HSC# 80618 \$14.95
Solder Pot, 600W HSC# 80611 \$97.50	12VDC 40 AH, lead/acid HSC# 18917 \$29.50	Networking Kit, ISA card HSC# 80599 \$29.95
ATX, 145W Power Supply HSC# 18350 \$9.95	Pixie2 Tranciever Kit HSC# pixie \$9.95	Joystick, "FX2000" HSC# 18772 \$3.00
Table Top Solder Pot HSC# 80610 \$32.00	Advanced Clamp Meter HSC# 80609 \$110.00	ATX 200W Power Supply HSC# 18665 \$14.95
Server Cabinet, ATX HSC# 80541 \$149.95	Bargain DMM HSC# 80370 \$14.95	

Pentium II Special!

- ◆ Dell 'GX1', P-2/350 MHz
- ◆ 6GB HD, 32X CD, 3.5" FD
- ◆ 164MB RAM (128MB - add \$10)
- ◆ Video, sound, USB, Netwk, SIO/PIO
- ◆ Keyboard & mouse included! Limited quantities!



HSC# 19251 \$249.00

PCMCIA Ethernet!

- ◆ EPSON Type II PCMCIA interface card
- ◆ 10Base2 & 10BaseT cables included!
- ◆ For notebooks/PCs with Type II slots
- ◆ For Windows 3.1, 95/98
- ◆ No jumpers or switches - Two LED status lights
- ◆ New, boxed, diskette & manual, 90-day warranty



HSC# 19125 \$9.95

PCMCIA SCSI!

- ◆ EPSON PCMCIA interface card
- ◆ Epson/Adaptec APA-460B
- ◆ Up to 2MB/sec. bus rate
- ◆ For DOS, Win3.1, 95/98 & NT
- ◆ OEM pack, w/DB-25 cable
- ◆ 90-day warranty



HSC# 19160 \$49.50

For secure, online shopping...
www.halted.com

Plus...more info...
..BIGGER pictures!

Clamp Meter

- ◆ Model No. AEEC-2891
- ◆ AC Volt: 200/600 - DC Volt: 2-600
- ◆ AC Current: 200/600 Amps
- ◆ Diode/Continuity Test, Date Hold
- ◆ Up to 2 Meg Ohm, w/test probe
- ◆ New, 90-day warranty



HSC# 80608 \$45.00

Cat5 Patch Cable

Just under \$.50 each by the case!!

- ◆ 'Foxconn' #CT88B12T88-A17, Yellow
- ◆ New, sold by case only (80 cables/case)

HSC#19234 \$39.95

Lab Power Supply!

- ◆ AEEC-350, 0-50VDC @3 Amp
- ◆ 110VAC, 60Hz - 150VA
- ◆ Digital voltage/current display
- ◆ Short-circuit protected
- ◆ New, w/IEC power cord, manual, 90-day warranty



HSC# 80606 \$129.00

HSC Electronic Supply

Since 1963!...
**Silicon Valley's
Electronic Marketplace**

3 Retail/Wholesale Locations:
Main Office - Mail Orders...
3500 Ryder St. Santa Clara, CA 95051

Santa Clara 1-408-732-1573
Sacramento 1-916-338-2545
Rohnert Park 1-707-585-7344



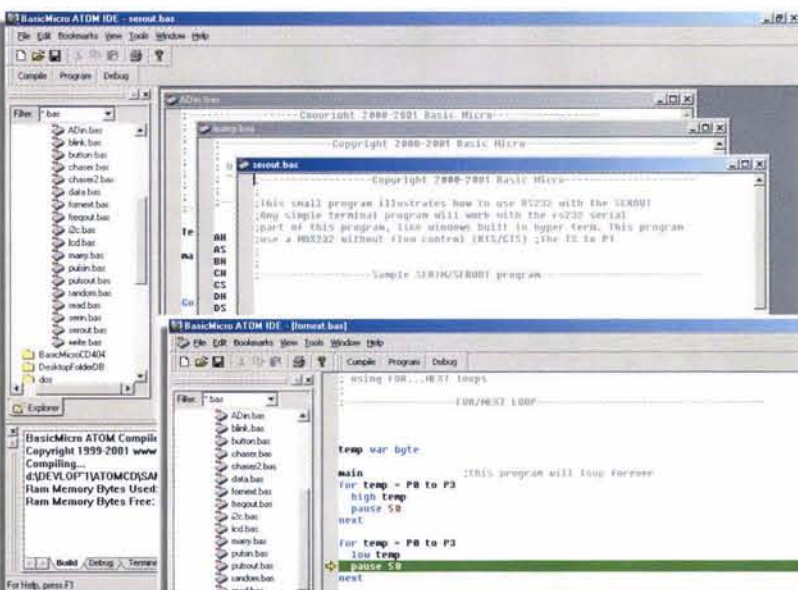
Order Toll-Free:
1-800-4-HALTED (442-5833)
or...ONLINE, AT: www.halted.com

Terms: Some quantities limited; all items are subject to prior sale. Minimum order: \$10.00 plus shipping. Orders under \$20.00 subject to \$2.00 handling fee, in addition to shipping. All orders shipped by UPS Surface unless otherwise specified. \$6.00 UPS charge added for COD. Visit our website for detailed information on domestic and international shipping methods.

MORE POWER...

The New Basic Micro Atom, offers more in the same package you are already familiar with. Built-in features like upgradeable firmware, Analog to Digital, Hardware Serial, In Circuit Debugging, 32 Bit Math, 32 Bit Floating Point Math and more !

The Atom includes powerful expanded BS2 syntax compatible software with commands such as; OWout, OWin, ADin, LCDwrite, If..Then..Elseif..Else..Endif, LCDread, HPWM, Hserout, Hserin, Do..While, Repeat..Until and more !

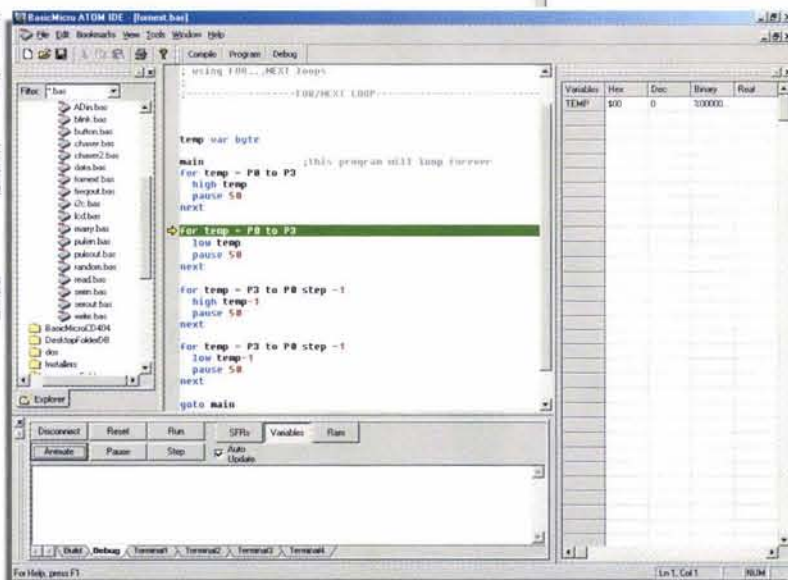


POWERFUL SOFTWARE

Easy to use multi document interface. Open as many files as you want all in the same interface. Easily navigate your files with the built-in explorer window.

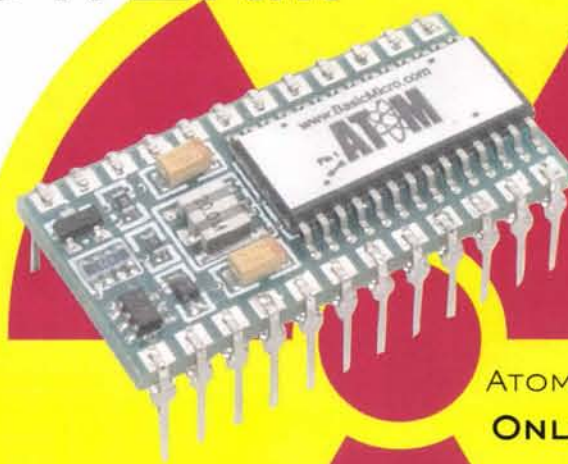
IN CIRCUIT DEBUGGING

Watch your program run step-by-step as the Atom executes each line of code. Easily debug your code. Bring your programs to life quicker than you ever thought possible !



WATCH IT COME TO LIFE

No more strategically placing debug statements throughout your program! Not only can you watch your program execute live, you can keep an eye on every variable and ram location as they are affected by your program. Each program variable is displayed in binary, hexadecimal and its real values.



ATOM-IC MODULE
ONLY \$59.95

FEATURES

- Graphical Debugging (ICD)
- More Software Commands
- 32 Bit Integer Math
- 32 Bit Floating Point Math
- BS2p Compatible Syntax
- Expanded BASIC library
- Firmware upgradeable
- Unlimited Support
- Free Software Updates
- Plus More!
- Over 300 Bytes of RAM
- 256 Bytes of Data EEPROM
- External & Internal Interrupts
- 3 10 bit A/D Converters
- 2 Capture and Compare
- Internal Adjustable Vref
- + / - External Vref
- 3 Timers, 2 PWM
- UARTS, I2C, SPI
- Plus More!

DEVELOPMENT KITS



Kit Includes: Development Board, Atom, Manual, Cable and power supply

ONLY \$149.95

BASIC MICRO inc
Microcontrollers Made Easy™

TO ORDER VISIT WWW.BASICMICRO.COM OR CALL US AT 734-425-1744 M-F 10 AM TO 6 PM

The Basic Atom is a registered trademark of Basic Micro Inc.

Nuts & Volts

VOLUME 23 • NO. 3 • MARCH 2002



10 LEARNING RVK-BASIC — PART 3

Learn how to measure and control time using RVK-Basic.
By Bob Vun Kannon



35 ULTRASONIC DISTANCE MEASUREMENT USING THE MSP430

Meet Texas Instrument's MSP430 family of ultralow power 16-bit RISC microcontrollers in this sound wave measurement application.
By Murugavel Raju

38 COMPUTER INTERFACING — PART I

Get in and out of "the box" with this every-other-month series which will introduce the basics of computer interfacing.
By David A. Ward

44 KRONOS CRAWLER PHASE 3 — SWITCHES AND MODS

This month, add a couple of bump switches for object detection, plus make a few modifications to the platform.
By Michael Simpson

67 TRIAC PRINCIPLES AND CIRCUITS — PART 2

Our discussion of triac principles and circuits concludes.
By Ray Marston

73 HAM RADIO EXTRA CLASS TEST CHANGES

July 1st marks the date a "new" question bank will be released for the Element 4 Extra class test. The question pool will jump from 665 to 807. By Gordon West

75 DUSTMEISTER — PART I

The Search for an Intelligent Vacuum Controller. Although designed for a workshop dust collector, the circuitry described in this article can be used to control any large or small motor application. By Robert Lang and Thomas Ober



COLUMNS

TECHKNOWLEDGEY 2002

6

Night vision for cars a step closer; Speedier file transfer available; Computer-aided composting; ID chip generates controversy; Emergency cell phone charger; Nuke power is 50 years old; and Motorola, Nokia file \$3 billion lawsuit. By Jeff Eckert

STAMP APPLICATIONS

20

Where in the world is my BASIC Stamp? Connect your Stamp to your GPS receiver. By Jon Williams

MICRO MEMORIES

NEW COLUMN!!

25

This every-other-month column will profile significant micro and mainframe computers from our recent past. This month, take a journey with Xerox's Alto: The Time Machine. By Edward B. Driscoll, Jr.

LASER INSIGHT

48

A different type of laser is introduced this month: pulsed lasers. By Stanley York

AMATEUR ROBOTICS

59

Handy schematics for the Camtronics three-axis chopper board and clubs, clubs, clubs. By Robert Nansel

ELECTRONICS Q & A

62

What's Up: Do plants show fear? Discover for yourself using a Backster monitor. A collection of circuits: busy phone, five-amp current regulator, FM transmitter, and dynamic microphone preamp. Finally, all about voltage clamps and the atomic clock. By TJ Byers

DEPARTMENTS

NV Bookstore	83
Reader Feedback	13
News Bytes	17
Tech Forum	27
Events Calendar	31
Classified Ads	51
Classified Ad Info	55
Dealer Directory	56
Advertiser's Index	72
Electronics Showcase	42
Prize Drawing	80
New Product News	81
New Books	66

TechKnowledge 2002

Advanced Technologies

Night Vision for Cars a Step Closer

Indigo Systems Corporation (www.indigosystems.com), a manufacturer of infrared cameras and telecommunications devices, recently announced a strategic partnership with Autoliv, a company that deals with automotive safety systems. The alliance is intended to jump start the development of affordable infrared devices for use in automobiles and other vehicles, extending a driver's night vision capability up to three times beyond the area covered by conventional headlights. Using technology developed in conjunction with the US Army, tiny cameras that detect heat radiated by objects are calibrated to be sensitive to the wavelength of humans and animals. This provides a broader and longer view than obtainable with conventional headlights, allowing the motorist to see not only farther down the road, but also to detect animals and pedestrians on the roadside.

In practical terms, the cameras are likely to be mounted close to the driver's head where they will not interfere with normal vision. The display will be on a television-like screen that can be stowed away in the instrument panel during daylight hours.



An Indigo Systems Merlin infrared camera shows car in the road ahead (note hot area of exhaust system) and a pedestrian outside the headlight beam. Photo courtesy of Indigo Systems.

When the driver switches on the night vision system, the transparent screen will swing into position in front of the driver, and the infrared view will be displayed on the screen.

General Motors has already paired with Indigo as a "Cooperative Source Partner" in this same effort to establish industry standards and solutions to night vision systems. At present, the technology is too expensive for consumer-level devices and has been used mostly in military applications. However, like the once-expensive global positioning system (GPS) equipment, costs are expected to fall quickly.

Computers and Networking

Speedier File Transfer Available

One of the most annoying aspects of using a computer is the time it takes to transfer files, particularly over wide-area networks such as the Internet. Using file transfer protocol (FTP) and transport control protocol (TCP), the sending and receiving computers engage in a relatively slow dialog in which the sender transmits a packet of information to the receiver, waits for it to acknowledge that the packet has been received, and only then transmits the next packet. This is one of the reasons why your 56k dial-up connection will never transfer files at anything close to that rate. But a new approach has been devised by Digital Fountain (www.digitalfountain.com) that eliminates the send-acknowledge process. According to the company, it would typically take 10 hours to transmit a 2 GB file across the Atlantic over a 10 Mbps network. But with the company's "Transporter Fountain" system, it would take just half an hour.

The key is the use of the patented "Meta-Content" technology, which ignores the sequence and timing with which packets are sent and received, and simply counts the packets to make sure

that the right number have arrived. It also uses proprietary algorithms that encode and send a model of the data rather than the data itself, which is decoded at the other end.

Two versions of the system are available. Transporter Fountain 1000 is a single rack-mount appliance that includes 5 GB of storage and supports data rates up to 10 Mbps. Transporter Fountain 3000 requires three racks, includes 85 GB of storage, and supports rates up to 70 Mbps. The bad news is that you need a server at each end, and prices are .00 for the low-end version and \$150,000.00 for the other. But who knows? In a few years, maybe there will be a \$99.00 version for use with dial-up modems.

Computer-Aided Composting

Many of us feel that our desks and computer systems occasionally become overloaded with, metaphorically speaking, manure. But if you are having problems with the real thing, don't go another day without Co-Composter, developed by Cornell University's Department of Biological and Environmental Engineering and Waste Management Institute (www.cfe.cornell.edu/wmi/Compost/CoCompost.html). The software was developed by Prof. Douglas Haith and Jean Bonhot and is offered free of charge to farm managers and composters who "want to meet toughened environmental regulations while making the most of excess animal waste."

An Excel® spreadsheet model for the planning of co-composting systems for mixtures of dairy manure and other organic wastes, Co-Composter provides mass and volume balances, area estimations, and a cost analysis of alternate composting systems based on user input.

Co-Composter consists of seven worksheets:

User Input Page
User Output Page

Background
Mass Balance
Areas and Volumes
Pad and Building Costs
Turning and Handling Costs

According to Cornell, most users will usually need to use only the input and output pages, where most of the data can be entered and the results are presented. Co-Composter models a range of conditions and can handle municipal solid wastes, bulking materials, animal bedding, yard wastes, and manure separation. The primary data outputs are the physical dimensions of composting components, equipment requirements, compost quantities and characteristics, energy requirements, and system costs.

Circuits and Devices

ID Chip Generates Controversy

A new product with unsurpassed potential for intrusive and repulsive application is the VeriChip miniaturized identification device recently introduced by Applied Digital Solutions (www.adsx.com). Ostensibly intended for use in a variety of medical, security, and emergency applications, the device — which measures 12 by 2.1 mm — can be implanted under your skin, after which it transmits an RF signal that contains a unique ID number plus any other data that has been stored in the chip. The information is picked up by a scanner that displays the data or transmits it via telephone or Internet to a central storage facility.

According to the company, "Inserting the VeriChip device is a simple procedure performed in an outpatient, office setting. It requires only local anesthesia, a tiny incision, and perhaps a small adhesive bandage. Sutures are not necessary." How can you resist?

Suggested uses include implanting the device alongside pacemakers, artificial joints, medication pumps, etc., to allow med-

ical personnel to access information about the devices and patients. Less appetizing possibilities include having a virtual Visa card implanted in your arm, employers demanding that you have one installed for security purposes, and use of the devices as electronic national ID cards to be accessed by government agents. Privacy advocates are alarmed (see, for example, www.orwelltoday.com), but Applied Digital expects to sell between \$2.5 and \$5 million worth of the chips in 2002, with most initially sold in South America and Europe in conjunction with pacemakers and defibrillators. About one million similar devices have already been implanted in dogs and cats.

Emergency Cell Phone Charger

Let's say you set sail from a tropic port, aboard a tiny ship, for a three-hour tour. Sure, the mate is a mighty sailin' man, and the skipper brave and sure. But soon the weather starts getting rough, the tiny ship is tossed, and you end up aground on an uncharted desert isle.

Worse still, your cell phone batteries are dead, which means that you may be there for a long, long time. What can you do?

Well, you need have no fear if you have FreeCharge, a portable, self-sufficient power source for wireless phones jointly developed by Motorola, Inc. (www.motorola.com), and Freeplay Energy Group (www.freeplayenergy.com). FreeCharge can be powered either by its hand-cranked wind-up generator or charged by DC input via the phone's own adapter. According to the unit's specifications, only 45 to 60 seconds of cranking will charge its nickel metal hydride batteries sufficiently to provide up to three to five minutes of talk time or several hours of standby time. If you can keep cranking for 35 minutes, you will achieve a full charge. FreeCharge also comes equipped with an LED light indicator, which tells users the unit is delivering a charge and suggests the optimal winding speed.

The adapter must be matched to your phone model. At present, adapter modules are available for most major models of Motorola phones, with other modules for most major brand cellular phones expected later this year. Freeplay



On Dec. 20, 1951, EBR-I lighted four bulbs with the world's first usable nuclear electrical power.

Photo courtesy of Idaho National Engineering and Environmental Laboratory.

also markets a line of radios and other devices that employ multiple energy sources including solar panels, rechargeable batteries, and wind-up generators.

The retail price is \$65.00.

Industry and the Profession

Nuke Power Is 50 Years Old

In case you missed the event, last December 20 was the 50th anniversary of nuclear power generation. The reactor was the Experimental Breeder Reactor 1 (EBR-I), designed and operated by Argonne National Laboratory

(www.anl.gov) and built by Bechtel Group, Inc.

On that day in 1951, scientists and technicians readied for the first test of the power-generating system. "We got the reactor critical, which was a rather slow process," according to retired Argonne scientist Kirby Whitham. "Generating steam for the first time was a problem, because we hadn't done it before. Technicians were running everywhere, measuring temperatures and so on."

"It took quite a while to get the turbine up to speed, then we had



Argonne personnel load radioactive material into the core of EBR-I.

Photo courtesy of Idaho National Engineering and Environmental Laboratory.

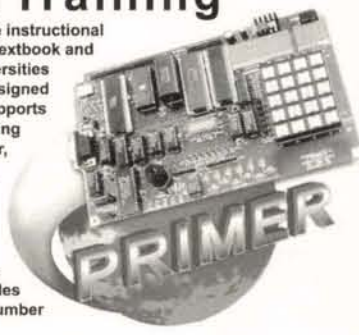
to load the generator. The generator put out 440 volts, so we used four light bulbs wired in series."

When the bulbs lit up, "we didn't clap our hands or anything," Whitham said. "We were just glad it worked."

EBR-I provided the first proof that breeding is possible. On June 4, 1953, the US Atomic Energy

Microprocessor Hands-On Training

The PRIMER Trainer is a flexible instructional tool featured in a Prentice Hall textbook and used by colleges and universities around the world. Ruggedly designed to resist wear, the PRIMER supports several different programming Languages including Assembler, Machine Language, C, BASIC, and FORTH. A comprehensive Instruction Manual contains over 25 lessons with several examples of program design and hardware control. The Applications Manual provides theory and sample code for a number of hands-on lab projects.



Application Projects Include:

- Scan Keypad Input & Write to a Display
- Detect Light Levels with a Photocell
- Control Motor Speed using Back EMF
- Design a Waveform Generator
- Measure Temperature
- Program EPROMs
- Bus Interface an 8255 PPI
- Construct a Capacitance Meter
- Interface and Control Stepper Motors
- Design a DTMF Autodialer / Remote Controller

The PRIMER can be purchased as an unassembled kit (\$120) or as an assembled/tested kit (\$170). Upgrades provide battery-backed RAM and PC connectivity via an RS232 serial port (shown in picture). Additional options include a heavy-duty keypad (shown in picture) and a 9V power supply - see our website. Quantity discounts are available. Satisfaction guaranteed.

Since 1985
OVER
16
YEARS OF
SINGLE BOARD
SOLUTIONS

EMAC, inc.
Phone 618-529-4525 Fax 618-457-0110
2390 EMAC Way, Carbondale, Illinois 62901
World Wide Web: <http://www.emacinc.com>

Circle #68 on the Reader Service Card.

Tools for the Imagination

Micro Modules



Specialty Products



RTC Processor Boards

With dozens of embedded controllers and countless configurations, we can help you turn your imagination into reality. For a complete look at our product line, visit our website at www.micromint.com.

Micromint

www.micromint.com

(800) 635-3355

Circle #69 on the Reader Service Card.

Commission announced that EBR-I had become the world's first reactor to demonstrate the breeding of plutonium from uranium.

In 1962, EBR-I became the world's first reactor to produce electricity with a plutonium core. For the next year, the reactor provided valuable data on breeding in a plutonium-fueled reactor and helped to improve scientists' understanding of the behavior of plutonium in an operating reactor.

On Dec. 30, 1963, its scientific mission complete, EBR-I was officially shut down. Today, more than 100 nuclear power plants provide 20 percent of the electricity consumed in the United States. More than 435 reactors provide some 17 percent of the world's electricity, and dozens of more plants are under construction around the world.

Motorola, Nokia File \$3 Billion Lawsuit

Motorola Credit Corporation (www.motorola.com) and Nokia Corporation (www.nokia.com) have filed a suit in US District Court for the Southern District of New York to reclaim more than \$3 billion from Telsim Mobil (Telekomunikasyon Hizmetleri A.S.), a Turkish telecommunications company controlled by the Uzan family. The suit alleges 13 separate counts of wrongdoing, including four counts of criminal activity in violation of the Racketeer Influenced and Corrupt Organizations Act, commonly known as "RICO." The RICO counts allege that members of the Uzan family entered into loan arrangements with Motorola and Nokia with the intention of defrauding the two companies.

Motorola is seeking more than \$2 billion in compensatory damages and Nokia seeks more than \$700 million in compensatory damages. The two companies are also seeking to collect punitive damages, as well as treble damages under the four counts relating to RICO. Finally, they also are asking the courts to restore the collateral for Motorola's and Nokia's loans, which was wrongfully devalued by the Uzans.

The complaint claims that "through an elaborate scheme of deceit and intimidation, the Defendants committed numerous crimes and offenses against Plaintiffs Motorola and Nokia, the ultimate purpose and result of which was the theft of more than \$3 billion from the companies."

The money loaned by Motorola and Nokia was to be used for the purchase of base stations, switching equipment, telephones,

and other equipment needed for the development of a GSM and 2.5G wireless network in Turkey, as well as payment toward the acquisition of a license from the Turkish government to develop this network. The suit alleges that some of these funds were diverted for other purposes and to other Uzan-controlled entities and little — if any — of the funds were ever meant to be repaid by the Uzans. The suit also alleges that the Uzans' illegal scheme to defraud Motorola and Nokia fits a pattern of "the Uzans' long-standing practice of defrauding investors and co-venturers by obtaining goods and funds based on false assurances that their debts would be repaid, and then seeking to escape their obligations through criminal fraud and extortion."

It appears that the Telsim Mobil public relations department faces quite a challenge. **NV**

Two Step Tuning Step One: Pick up microphone. Step Two: Transmit.

(Please note: HF Tuning doesn't get much easier than this.)



SGC Smartuner™ HF Automatic Antenna Couplers

"For me and my radio dollar, there isn't a better coupler made!"

Jack Huebschen N9XRO

Power Input: From 1.5W - Up to 500W*
HF Frequency Range: From 1MHz - Up to 60MHz*
Up to 4,000,000 element combinations*

Five Sensor Devices

*Specs differ per model

"Undoubtedly the best piece of hamgear I have ever owned."

Ronnie Kane K9MNI

**Marine, Commercial, Amateur Radio,
Aviation, Special Applications**

Starting at \$249



www.sgcworld.com

Toll Free (800) 259-7331 • Tel (425) 746-6310 • Fax (425) 746-6384 • Email: sgc@sgcworld.com

Mailing: PO Box 3526, Bellevue, WA 98009 • Shipping: 13737 SE 26th St. Bellevue, WA 98005 USA

Copyright 2001 SGC, Inc.

SolderingDesoldering.Com

Your SMD Rework Specialist
800-394-1984

Turn Your Multimedia PC into a Powerful Real-Time Audio Spectrum Analyzer

Features

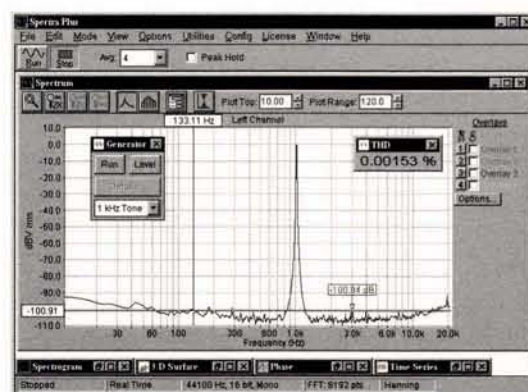
- 20 kHz real-time bandwidth
- Fast 32 bit executable
- Dual channel analysis
- High Resolution FFT
- Octave Analysis
- THD, THD+N, SNR measurements
- Signal Generation
- Triggering, Decimation
- Transfer Functions, Coherence
- Time Series, Spectrum Phase, and 3-D Surface plots
- Real-Time Recording and Post-Processing modes

Applications

- Distortion Analysis
- Frequency Response Testing
- Vibration Measurements
- Acoustic Research

System Requirements

- 486 CPU or greater
- 8 MB RAM minimum
- Win. 95, NT, or Win. 3.1 + Win.32s
- Mouse and Math coprocessor
- 16 bit sound card



Priced from \$299

(U.S. sales only – not for export/resale)

**DOWNLOAD FREE 30 DAY
TRIAL!**

www.spectraplus.com

PHS Pioneer Hill Software
24460 Mason Rd.
Poulsbo, WA 98370
a subsidiary of Sound Technology, Inc.

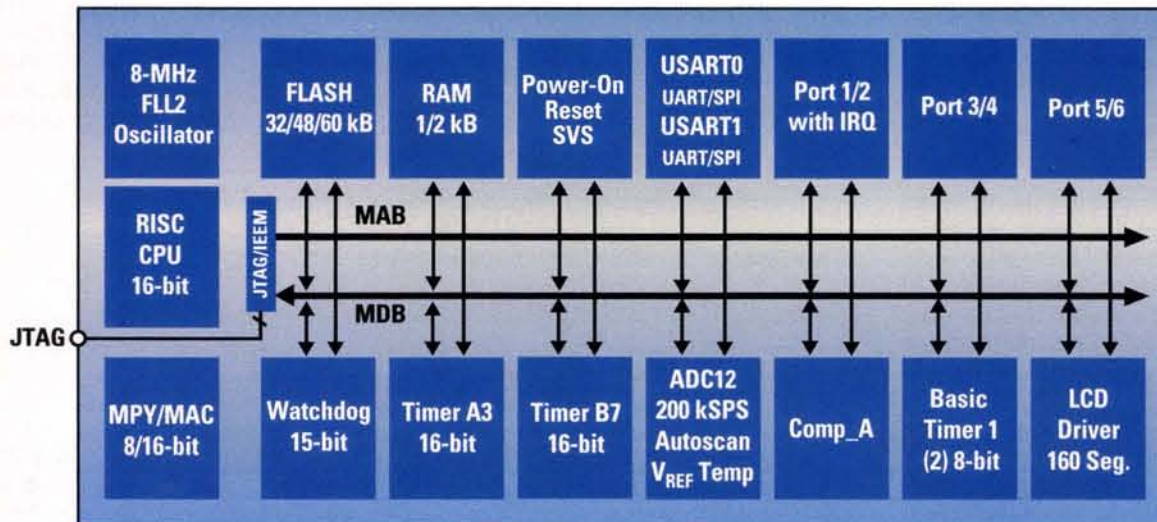
Sales: (360) 697-3472

Fax: (360) 697-7717

Spectra Plus
FFT Spectral Analysis System

e-mail: pioneer@telebyte.com

MSP430F449: Imagine the possibilities.



Features:

- Ultralow-power Flash MCU with high-performance 200-kSPS ADC and LCD driver on one chip
- Power consumption of $<1 \mu\text{A}$ in standby mode extends battery life
- Modern 16-bit RISC CPU enables new applications at a fraction of the code size
- In-system programmable Flash permits last-minute code changes, field upgrades and data logging to Flash

MSP430 – the choice in ultralow-power Flash MCUs

Experience the ultimate SOC solution for battery-powered measurement. A flexible clock system switches from ultralow-power standby to high-performance signal processing in less than 6 μs . Embedded emulation reduces design cycle time. Get your design started today with the easy-to-use MSP-FET430P440 Flash emulation tool.

Device	Flash Memory	Price 1K
MSP430F449	60 kB	\$7.03
MSP430F448	48 kB	\$6.47
MSP430F447	32 kB	\$5.71

Device	Flash Memory	Price 1K
MSP430F437	32 kB	\$4.90
MSP430F436	24 kB	\$4.70
MSP430F435	16 kB	\$4.45



MSP-FET430P440 development tool-\$99

Contact us to request:
development tools
product bulletin (SLAB034C)
MSP430F44x data sheets

www.ti.com/sc/hpa7227u

1-800-477-8924, ask for ext. 7227

Learning RVK-Basic

Part 3

By Bob Van Kannon

RVK-Basic is a free Basic compiler for the Atmel AVR line of microcontrollers. You can download a copy of this compiler from the *Nuts & Volts* web site. With this compiler, you can write and compile very fast, efficient programs for most of the AVR microcontrollers.

In this article, we will learn how to measure and control time using RVK-Basic. It is assumed that the reader has learned the material presented in Parts 1 and 2 of this series. If you missed the previous article, get a back issue.

Time measurement and control is probably the most used function of a microcontroller. It is for this reason that even the smallest AVR chip — the 1200 — contains a counter-timer and the largest of the AVRs contains three counter-timers. Counter-timers are useful.

Time Control

First of all, let's write a program to control time on a development board. I am going to write this code for the STK200 board where the B port is connected to the LEDs. If you are using an STK500 board you can just jumper port B to the LEDs.

The first new statement we will use in this exercise is the PAUSE statement. This statement allows you to cause the program flow to stop for a specified time. To specify the time, just follow the PAUSE with the desired time in milliseconds. For example, if we want to make an LED flash once per second, it will need to be on for one-half second and off for one-half second. So we could turn it on or off and then just pause for 500 milliseconds. This is done by:

```
PAUSE 500
```

The PAUSE statement allows a wide latitude of time. You may specify times as small as 10 microseconds (PAUSE 0.01) and as large as 16 seconds (PAUSE 16000) when using a 4 MHz processor clock. Please read the documentation about the PAUSE statement in the RB.TXT file supplied with the compiler. One more useful statement is the TOGGLE. This statement will simply change the state of the output of a single pin. So here is a program to flash the B,4 LED once per second. I have chosen a 1200 for the processor and I have used the MHZ statement to tell the compiler that we are running on a development board where the clock is 4 MHz.

```
DEVICE 1200
MHZ 4
MAKEOUT B,4

DO
  TOGGLE B,4
  PAUSE 500
LOOP
```

The diligent student is expected to compile and execute this program and then modify it to do something different!

Time Measurement

The next problem is different: instead of controlling time, we will measure time.

When we used the PAUSE statement in the above program, we actually used the eight-bit counter in the chip called TIMER0. What the compiler did for us was to set up the timer and start it running at a speed appropriate to the time we specified and then wait until the timer overflowed before resuming program flow. If that sounds complicated, it's because it is, but the compiler solved the problem for us.

In our next program, we will measure the period of a frequency coming in on the D,0 pin. To do this, we wait for a rising edge of the input pin. At that time, we will read the TIMER0 counter to learn what the period of the signal was and then initialize TIMER0 back to 0 and wait for the next edge.

Let's assume that we need to measure a frequency down to 20 Hz. The

timer can be "prescaled" by 1, 8, 64, or 256. That is, the frequency going into the timer will be the processor clock divided by whichever of those prescale values we pick. TIMER0 is an eight-bit timer, that is it counts from 0 to 255. So the frequency at which it overflows is 256 times slower than its own clock. So let's calculate the overflow frequency of this timer as a function of prescale value.

Overflow frequency = Processor clock / prescale / 256

Prescale	Overflow frequency (Hz)
1	15,625
8	1,953.13
64	244.14
256	61.04
1024	15.26

Since we want to measure down to 20 Hz, we need a counter that won't overflow at that frequency, so our prescale will be 1024. For the fun of it, after we have measured the frequency we will write that number (the period of the signal) out on port B so that it can show up on the LEDs. That way, the diligent student can hook a signal generator up to his development board and see the result change on the LEDs as he changes the input frequency.

Here's the program.

```
DEVICE 1200
MHZ 4

DIRPORT D,IN
DIRPORT B,OUT

INBIT last,D,0
period = &HFF

DO
  OUTPORT B,period
  INBIT temp,D,0
  IF last = 0 THEN
    IF temp | 0 THEN
      ' this is where we read the counter
      TIMER0 READ period
      ' this is where we reset the counter
      TIMER0 ON 1024
    END IF
  END IF
  last = temp
LOOP
```

A comment is necessary about the notation of numbers in RVK-Basic. You may specify a number as hexadecimal (base 16) by prefixing it with "&H". You may also choose to write a number in binary by using a prefix of "&B". So the statement in the program

Period = &HFF

sets the variable "period" to a value of 255 decimal.

Again the student is exhorted to try this program out.

Gee, that was fun, but how can we handle more than one frequency input at a time? There is a way and it is only a little more complicated than the previous example. What we will do is let the counter run freely. Each time that we get an appropriate edge on an input, we will simply read the counter. The period of that signal is then the difference between the current reading and the previous counter reading. This type of math deserves a comment. Let's assume that the incoming frequency is five clock periods of the counter-timer. If we get an edge when the timer reads 254, the next edge will occur when the timer reads 03. Using byte variables, if we subtract the earlier value from the latter, we will find that

This is true in byte arithmetic because the computation overflows and leaves a carry bit set, but the answer still comes out to be 5. Expressing this in binary, we would have

```
00000011
- 11111110
00000101
```

So we can see that our process of subtracting successive readings will always give the correct answer so long as the input period is less than the overflow period of the timer. Let's assume that our input frequencies won't fall below 20 Hz again. So we will set the count up to freerun and then just watch for edges on the two signals. In the following program, I do all this but I have not provided an output path for the result. The periods for the two signals are in the byte variables per0 and per1.

```
DEVICE 1200
MHZ      4
```

```
DIRPORT D,IN
TIMER0 ON 1024
```

```
per0 = &HFF      'period count for D,0
per1 = &HFF      'period count for D,1
```

```
DO
```

```
'make measurements on D,0
```

```
INBIT tempd0,D,0
```

```
IF last0 = 0 THEN
```

```
IF tempd0 | 0 THEN
```

```
TIMER0 READ temp
```

```
per0 = temp - temp0
```

```
temp0 = temp
```

```
END IF
```

```
END IF
```

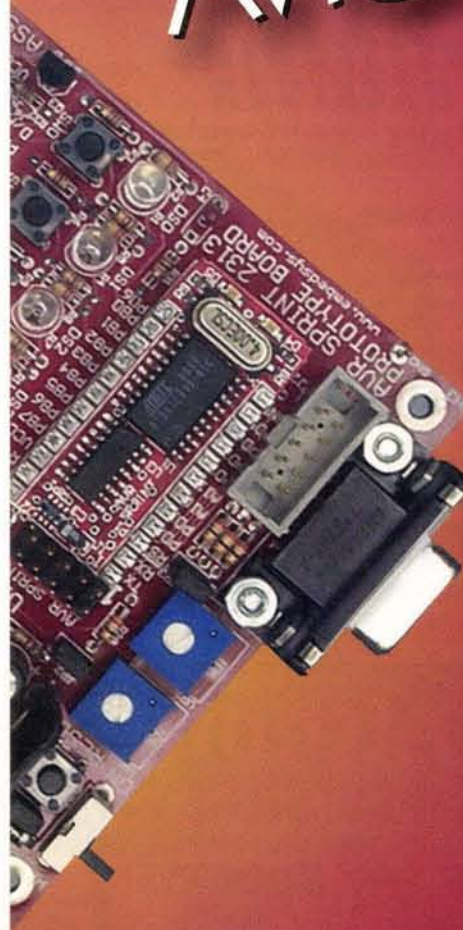
```
last0 = tempd0
```

```
'make measurements on D,1
```

```
INBIT tempd1,D,1
```

```
IF last1 = 0 THEN
```

Lick the StampTM with AVRSPRINTTM



Speed

10x faster than the Stamp
Up to 20 MIPS

Freedom

Royalty Free Code

Flexibility

Program in BASIC, 'C',
or Assembler

Seamless

Edit, Compile, then
Download to Target

100,000 +
**ELECTRONIC
COMPONENTS**

SEARCH & BUY ONLINE
www.mouser.com



MOUSER[®]
ELECTRONICS

A **tij** COMPANY

(800) 346-6873

Fast Delivery

Friendly Service

Circle #65 on the Reader Service Card.

AVR Sprint 8535 Development System \$189.95

- ♦ AVR Sprint 8535 module Program the Sprint in circuit.
- ♦ AVR Sprint Experimentation Station II[™] Includes programming cable, power supply, CD with Sprint Basic (full version) and C compiler, printed Sprint Basic manual, and complete device descriptions manuals.

AVR Sprint 2313 Development System \$134.95

- ♦ AVR Sprint 2313 Microprocessor Module Program the Sprint in circuit.
- ♦ AVR Sprint 2313 Experimentation Station Includes 1 AMP regulated power supply, programming cable, 8 LED's and 8 switches. Includes reset switch, connector for output to standard LCD displays, 2 analog voltage sources, in addition to a prototyping area, and wall power supply.
- ♦ Sprint Basic Compiler[™] Plus the GNU 'C' Compiler.

See our Web site for additional AVR Sprint products.

Embedsys.com

(763) 767-2748 • ESI 11931 Highway 65 NE, Mpls., MN 55434

AVR Sprint, Sprint Basic, and "Lick the Stamp" are registered trademarks of ESI. AVR[™] is a registered trademark of Atmel[™], Inc. PC is a registered trademark of Philips Electronics NV. Other trademarks are the trademark of their respective companies.

Circle #63 on the Reader Service Card.

Nuts & Volts Magazine/MARCH 2002 11

20 MS/s Pen-type Scope

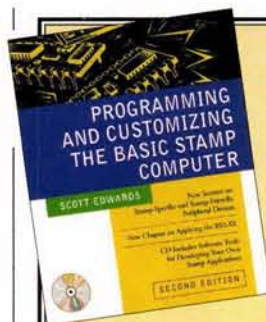
US\$ 79.-

Options
PC Software V6.0 incl. Adapter Cable 29.90
BatteryPack (to hold 9V bloc) 16.90
AC Adapter 9.90
Rubber Protection Boot 17.90
Palm Software V2.0 incl. Adapter Cable 19.90
Active Opto-Isolating RS232 Cable 39.90

NEW
PC Software V6.0 features long term data logging, exporting data to EXCEL or text file, scrolling mode

Wittig Technologies

Wittig Technologies, Inc.
266 East Meadow Avenue
East Meadow, NY 11554
Phone (516) 794 4080, Fax (516) 794 1855
www.wittigtechnologies.com



Classic guide
to customizing
BASIC Stamp
computers for
hobbyists and
designers.

by **Scott
Edwards**

(former Stamp Applications
columnist for *Nuts & Volts*)

Only \$39.95

Available from
the *Nuts & Volts* bookstore
www.nutsvolts.com

```
IF tempd1 | 0 THEN
  TIMER0 READ temp
  per1 = temp - temp1
  temp1 = temp
END IF
END IF
last1 = tempd1
LOOP
```

The student is now expected to copy this program and compile it. There's no point in running it as it stands because there is no output. I recommend you modify this program to output per1 or per0 on port B. When you have that working, try making the output on port B selectable via a push button on D.2. Another idea is to compare per0 with per1 and set or clear a single LED based on which is bigger. Have fun!

In the next article, we will continue to build our skills in using the compiler. We will take up using the A/D converter and the UART.

See you then. **NV**

GLOBAL POSITIONING SYSTEM RECEIVER

**CUSTOMERS SAY THEY ARE
USING THEM FOR:**

TIMING, FREQUENCY REFERENCE & PRECISION
(ACCURATE TO 3 BILLIONTHS OF A SECOND)

NAVIGATING BOATS

HAM RADIO

WEATHER MACHINE

**MAPPING DEVICE FOR
LAND USE:**

IN A CAR

**HIKING (HOOK UP TO A LAPTOP W/ DATA CABLE
AND NAVIGATE WHICH MOUNTAINS YOU WILL CLIMB)**

SYNCHRONIZES WITH GPS SATELLITES

HEWLETT PACKARD/TRIMBLE Z3801A
6 CHANNEL SMARTCLOCK TECHNOLOGY

**QUANTITY DISCOUNTS- CALL
YOUR SALES REP!**

\$399!

GPS RECEIVER

Visit us on the web at <http://www.hitechcafe.com>

HiTechCafe.com

25 Years in the business
100,000 sq. ft. of inventory

1-800-708-2867

945-A Spice Island Drive Sparks, Nevada 89431
Free tech support on all products
1-775-356-8289

Circle #62 on the Reader Service Card.

WWW.CONITEC.NET

\$333
COMPLETE KIT

GALEP-4
UNIVERSAL PROGRAMMER

Introducing a pocket programmer
with true **Universal Output**

Latest generation Galep-4 uses
ASIC universal pin technology for
each pin of 40 pin ZIF-socket. 1300+
device library / lifetime free updates.
Programs 8/16-bit EPROM's,
EEPROM's, 0-Power RAM, FLASH,
Serial EEPROM's, GAL, PALCE,
microcontrollers such as 87/89xxx,
PIC, AVR, ST62, etc. Low voltage
devices down to 1.3V. No adapter
required for DIL devices. 8 Hrs.
operation on battery (AC charger
included). Runs **WIN 98, NT, ME,**
2000, XP with Hex/Fuse Editor.

Remote control from other apps, (e.g.
VisualBasic). Substitutes high priced
universal programmers e.g. ALL-11
(HIL0) or LAB-TOOL-48 (ADVANTECH)
Providing virtually matching performance
at only 1/3-1/5 the price.
Info, orders, softwar : 619-702-4420

info, downloads: www.conitec.net

CONITEC DATASYSTEMS - 1951 4TH AVE, SUITE 301 - SAN DIEGO, CA 92101 - TEL: 619-702-4420 FAX: 619-702-4419

Circle #66 on the Reader Service Card.

We accept Visa,
Mastercard, AmEx,
and Discover

Attention: TECHIESTUDS

Fax: 318-424-9771

To Order Call 1-800-227-3971 **www.shrevesystems.com**

A MONITOR FOR ANY BUDGET!

14" Voxon VGA NEW
ONLY....\$59!!!
15" Voxon VGA NEW
ONLY....\$89
16" Rasterops fixed 832 X 624
ONLY....\$79

Hot Deals
on New
Monitors!!!

H.P. 17" fixed res
832 X 724
ONLY....\$79
H.P. 17" fixed res
640 X 480
ONLY....\$79

I'm
only
\$29!

15" 640x870
Raster Full
Page Display
Refurbished
Macs
ONLY....\$49



\$39 **VST External
Firewire Case**
Accepts
any IDE
Hard
Drive!

**AS LOW AS
\$59!**

14" VGA refurb ONLY....\$29

Be sure to check us out on the web at <http://www.shrevesystems.com> for the best prices on Vintage Mac gear!

Peltier Junction Blowout!
with heat sink, works on 5V & 12V
1 3/16" x 1 3/16"



Less Than \$5 Each or 4 for \$19

Paper Shredders
On Sale!
Protect your Privacy!
Requires 12V



ONLY \$2

Global Village
Bronze
External
Modem
2400
Bps/9600
Fax
ONLY \$0.50



RAM
1 MB 30 Pin 4 For \$1
4 MB 72 Pin 2 For \$5

Miscellaneous
Apple 8 bit Video Card \$19
LaserWriter IINT \$149
Apple ADB Keyboard \$19
1.44 Super Drive \$19
Clone ADB Mousell \$19
Quicktake 100 Camera \$99
Bernoulli 90 MB EXT \$10
44MB SyQuest Ext \$10
88MB SyQuest Ext \$19

CMS SCSI Case
Holds 4 5.25 SCSI
full ht. drives



Only \$49



**PDA Genuine Leather
Carry Case**
Let your palm pilot
lead the life of luxury!
Stock up now!

ONLY \$3



**PAS16 Audio
Spectrum**
For Mac LC Family16
Bit Sound Editing Card

\$10

**Apple II 256K
Memory
Expansion Kit**
HM51256P-10
ONLY \$1



**20/30 GB External
Firewire Hard Drives**
Starting at \$169!

Huge inventory! Huge savings!
\$25 minimum order.

Shreve Systems
1200 Marshall st
Shreveport, La 71101

Prices reflect a 2% cash discount and are subject to change without notice. Returns
are subject to a 15% restocking fee. Not responsible for typographical errors.

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

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

Subscription
 Order ONLY Line
 1-800-783-4624

PUBLISHER
 Jack Lemieux N6ZTD

EDITOR
 Larry Lemieux KD6UWV

MANAGING EDITOR
 Robin Lemieux KD6UWS

CONTRIBUTORS

Robert Nansel
 Jon Williams
 Jeff Eckert
 TJ Byers
 Murugavel Raju
 Stanley York
 Gordon West
 Bob Van Kannon
 Michael Simpson
 Ray Marston
 David A. Ward
 Robert Lang
 Thomas Ober
 Edward B. Driscoll, Jr.

ON-THE-ROAD EXHIBIT
 COORDINATOR
 Audrey Lemieux N6VXW

STAFF

Natalie Sigafus
 Mary Gamar

Copyright 2002 by
 T & L Publications, Inc.
 All Rights Reserved

All advertising is subject to publisher's approval. We are not responsible for mistakes, misprints, or typographical errors. Nuts & Volts Magazine assumes no responsibility for the availability or condition of advertised items or for the honesty of the advertiser. The publisher makes no claims for the legality of any item advertised in Nuts & Volts. This is the sole responsibility of the advertiser. Advertisers and their agencies agree to indemnify and protect the publisher from any and all claims, action, or expense arising from advertising placed in Nuts & Volts. Please send all subscription orders, correspondence, UPS, overnight mail, and artwork to: 430 Princland Court, Corona, CA 92879.

Reader Feedback

Dear Nuts & Volts:

As the former chief engineer for a company that produced (among other things) TV commercials, I would like to clear up a common misconception about the audio level of TV commercials being louder than normal program audio.

TV commercials are NOT recorded at a higher level than regular TV programs. In fact, tapes would be rejected and returned by the engineering departments of most TV stations, and especially the networks, if they exceeded standard program level specifications.

TV commercials only SOUND louder, because they

very often are recorded using a compression algorithm that decreases the overall dynamic range and then squeezes it all up towards the acceptable top limit of the VU scale.

Another way of describing it is that in a normal program, the audio may "peak" occasionally, but the audio in a TV commercial is constantly at its peak. The end result is that it SEEMS louder to the human ear, but is in actuality NOT recorded any louder than any other audio on TV.

I agree, however, that regardless of whether it is actually louder or only perceived as louder, the end result is equally annoying!

I enjoy your magazine and

Continued on Page 57



EPROM+

A device programming system
 complete info at www.arlabs.com

♦ EXCEPTIONAL POWER FOR THE PRO
 ♦ EASY-TO-USE FOR THE NOVICE

Here's what you get: A rugged, portable programming unit including the power pack and printer port cable both of which store inside the case. A real printed user and technical manual which includes schematic diagrams for the programming unit plus diagrams for all technology family adapters*. Comprehensive, easy-to-use software which is specifically designed to run under Windows 95, 98, ME and DOS on any speed machine. The software has features which let you READ, PROGRAM, COPY and COMPARE plus much more. You have full access to your system's disk including LOADING and SAVING chip data plus automatic processing of INTEL HEX, MOTOROLA S-RECORD and BINARY files. For detailed work the system software provides a full screen buffer editor including a comprehensive bit and byte tool kit with more than 20 functions.

Broad device support: Including FIRST GENERATION EPROMS (2708, TMS2716*, 25XX etc.) SECOND GENERATION EPROMS (2716-27C080)(8 MEG), 40 and 42 PIN EPROMS* (27C1024-27C322)(32 MEG) EEPROMS (2816-28C010) PLUS ER5901, FLASH EPROMS (28F29C, 29EE, 29F)(32 MEG), NVRAMS (12,20,X2210/12) 8 PIN SERIAL EEPROMS* (24, 25, 85, 93, 95, 80011A) PLUS ERI400/MS8657* BIPOLAR PROMS* (74S82S), SERIAL FPGA CONFIGURATORS (17CXXX) MICROS* (874X, 875X, 87C5X, 87C75X, 89C) ATMEL MICROS* (89S, 90S)(AVR) PIC MICROS* 8, 18, 28, 40 PIN (12CXXX, 16C5X, 6X, 7X, 8X PLUS FLASH & 17C) MOTOROLA MICROS* (68705P3/U3/R3, 68HC705C8/C9/J2/P9, 68HC11 all families)

\$289

Includes step-by-step tutorial plus explanation of EPROM fundamentals \$7.00 SHIPPING ♦ \$6.00 C.O.D.
 1 YE. AR WARRANTY - 30 DAY MONEY BACK GUARANTEE VISA ♦ MASTERCARD ♦ AMEX
 *REQUIRES SNAP-IN ADAPTER (ORDER FACTORY DIRECT OR BUILD YOURSELF)

ANDROMEDA RESEARCH, P.O. BOX 222, MILFORD, OHIO 45150
 (513) 831-9708 FAX (513) 831-7562
 website - www.arlabs.com email - arlabs@worldnet.att.net MADE IN THE U.S.A.

DMOS & JFETS & MOSFETS & TRANSISTORS

@
LINEAR SYSTEMS

Second Source Replacements
 for Interfet, Motorola,
 National, Siliconix

- ♦ Custom Screening
- ♦ Die, SMT, Thru-Hole

LINEAR SYSTEMS

Full Service U.S. Manufacturer
 of Specialty Linear Products

4042 Clipper Court
 Fremont, CA 94538
 (TEL) 510-490-9160
 (FAX) 510-353-0261
JFETS@LINEARSYSTEMS.COM
WWW.LINEARSYSTEMS.COM

Circle #90 on the Reader Service Card.

Check out the newest
 "editions" to the Nuts
 & Volts Book Store.
 See our ad on Page 66!

AMAZING DEVICES

See in Action video on our web
 site at www.amazing1.com

Tesla Lightning Machine

- 2 to 3" Spark Discharges
- 12 VDC/115 VAC/battery
- Safe High Frequencies
- Adjustable Output and Optional Timer

TLITE Plans...\$6.00 TLITE1K-Kit/Plans...\$39.95
 TLITE10-Assembled and Tested...\$54.95

Shocker Trigger Ignitor

Variable 20,000 volt pulser used for laser flash tube, spark gap and pyro ignitor, garden pest shocker, electric fence, snake venom removal etc. 12 volt battery operation.

TRIG1K - Kit/Plans...\$29.95
 TRIG10 - Lab Assembled...\$49.95

Body Heat Telescope

Detects living bodies over 300' Heat leaks etc. Built in chopper and sens control

BHT6 Plans...\$10.00 BHT6K Kit...\$99.95
 BHT60 Ready to use...\$149.95

Mass Driver



Above photo shows burst impact of Mass Driver

Ion Ray Guns

Star Wars Technology Directs Energy



Star Wars Technology Demonstrates Weapons Potential, Force Fields, IonMotors, Antigravity etc Projects electric shocks without contact!! Conduct many weird and bizarre experiments. Handheld battery operated and easy to operate.

IOG9 Plans...\$10.00
 IOG9K Kit/Plans...\$129.95
 IOG90 Assembled/Testing...\$199.95

New Health Concept

Pulsed magnetic breakthrough provides miraculous healing and rejuvenating properties.

THMAG10 Magnetic Pulser...\$24.95

Mini TESLA Coil

Lights up a 4' fluorescent tube-all without any contact!! Yet only 3" tall!

MTC1K Kit/Plans...\$24.95
 MTC10 Assembled...\$34.95

Ultrasonic Painfield Generators

For property and personal protection. Four transducer matrix intensifies and concentrates effect on target area.

PPF4 Plans...\$20.00
 PPF4K Kit...\$199.95
 PPF40 Ready to use...\$299.95

3 Mi Voice Transmitter

Crystal clear. Many applications. Easy to build

FMV1 Kit and Plans...\$39.95

Low Cost 100,000 Volt DC Supply

Amateur experimenters source of HVDC for many applications

- 100,000 volts at .2ma
- Built in dry filled multiplier.
- Operates on 12vdc or 115vac

HVOLT1 - Plans...\$8.00
 HVOLT1K - Kit/Plans...\$149.95
 HVOLT10 - Assembled...\$249.95

Combo Tesla Coil, Jacobs Ladder, Plasma Tornado

Amazing and bizarre effects turn a normal light bulb into a spectacular plasma display!! With adjustable frequency control. Safe 12vdc input

TCL5 Plans...\$8.00 TCL5K Kit/Plans...\$59.95
 TCL50 Assembled and Tested...\$99.95

Can Crusher

A can is crushed into the shape of an hour glass demonstrating the awesome power of magnetics. Very popular demo in science museums as users get to crush and keep their own can. Kids love this!!

Wire Exploding

Generate pyrotechnical explosive blasts for many applications. Create a new artistic concept. Uses our unique high energy pulser shielded explosion chamber.

HEP9 High Energy Pulser...\$20.00

Plans pack includes above MASS1 Mass driver, CANCRU1 Can crusher and WIREXPLOD1 Wire exploder/Blast art plans. We stock all parts, kits and completed units for the above items.

Above HEP9 pulser is used for:
 EMP / HERF Generation, Build a Rail or Coil Gun, Electrothermal Gun, High Power Pulsed Laser, Mass Warping etc etc

Information Unlimited PO Box 716 Amherst N.H. U.S.A. 03031 E-mail <info1@xtldl.com>
 1 800 221 1705 Orders/Catalogs Only! Fax 1 603 672 5406 Information 1 603 673 4730 Free Catalog on Request
 Pay by MC, VISA, Cash, Check, MO. Add \$5.00 S&H. Overseas Contact for Proforma

Circle #93 on the Reader Service Card.

WESTERN TEST SYSTEMS

WE BUY AND SELL

Inquiries 307-635-2269 • Fax 307-635-2291

Orders 800-538-1493

2701 Westland Court, Unit B, Cheyenne, Wyoming 82001

OSCILLOSCOPES & ACCESSORIES

OSCILLOSCOPES

TEKTRONIX 2430-opt.05, 11" 100 MS/s Dual Channel Oscilloscope, TV trig., GPIB" \$1000.00

PROBES

TEKTRONIX 1101"Accessory Power Supply, for FET probes" \$175.00
TEKTRONIX A6902B"Voltage Isolator, DC-20 MHz, 20 mV-500 V/division" \$500.00
TEKTRONIX P6201900 MHz 1X/ 10X/ 100X FET Probe \$400.00
TEKTRONIX P6202500 MHz 10X FET Probe \$150.00

WAVEFORM GENERATORS

FUNCTION GENERATORS

HP3310A5 MHz Function Generator \$250.00
HP3312A13 MHz Function Generator \$500.00
HP3325A-001"21 MHz Synthesizer/Function Generator, OCXO ref." \$1100.00
HP3325A-002"21 MHz Synthesizer/Function Generator, high voltage" \$1200.00
HP3325B-002"Synthesizer/ Function Generator, 1 uHz-21 MHz, GPIB" \$4000.00
TEKTRONIX AWG5102"Arb. Waveform Gen., 20 MS/s, 12 bits, 50 ppm synthesis <1MHz" \$650.00
TEKTRONIX AWG5102-opt.2"Arbitrary Waveform Generator, dual channel option" \$800.00
TEKTRONIX DDS01"Digital Delay & Burst Gen., for function & pulse gen's" \$200.00
TEKTRONIX FG510"Programmable 20 MHz Function Generator, TM5000 series" \$600.00
TEKTRONIX FG502"11 MHz Function Generator, TM500 series" \$275.00
TEKTRONIX FG503"3 MHz Function Generator, TM500 series" \$250.00
TEKTRONIX RG501"Ramp Generator, TM500 series" \$175.00
WAVETEK 288"20 MHz Synthesized Function Generator, GPIB" \$650.00

PULSE GENERATORS

BERKELEY NUC.7085B"Digital Delay Gen., 0-100 mS, 1 nS res., 5 Hz-5 MHz" \$400.00
HP214B"10 MHz Pulse Generator, up to 50V/ 50 Ohms" \$1200.00
HP214B-001"10 MHz Pulse Generator, pulse counting option" \$1400.00
HP8007B100 MHz Pulse Generator \$450.00
HP8012B"50 MHz Pulse Generator, variable transition time" \$600.00
HP8013A50 MHz Dual Output Pulse Generator \$500.00
HP8013B50 MHz Dual Output Pulse Generator \$600.00
HP8112A"50 MHz Pulse Generator, GPIB" \$3000.00
HP8116A-001"50 MHz Pulse/Function Generator, burst & log sweep option" \$3500.00
TEKTRONIX PG502"250 MHz Pulse Generator, TM500 series" \$500.00
TEKTRONIX PG508"50 MHz Pulse Generator, TM500 series" \$350.00

VOLTAGE & CURRENT

VOLTMETERS

FLUKE 845AR"High Impedance Voltmeter / Null Detector \$350.00
HP3456A"6-1/2 digit Voltmeter, GPIB" \$450.00
HP3457A"7-1/2 digit Voltmeter, GPIB" \$1000.00
HP3478A"5-1/2 digit Multimeter, GPIB" \$450.00
KEITHLEY 181"6-1/2 digit Nanovoltmeter, 10 nV sensitivity, GPIB" \$675.00
TEKTRONIX DM5010"4-1/2 digit Multimeter, TM5000 series" \$300.00
TEKTRONIX DM501A"4-1/2 digit Multimeter, TM500 series" \$225.00

CALIBRATION

FLUKE 510A"AC Reference Standard, 10 VRMS, 0-10 mA" \$450.00
FLUKE 5220A"Transconductance Amplifier, DC-5 kHz, 0-20 A" \$1250.00

VOLTAGE SOURCES

HP6114A"Precision Power Supply, 0-20 V 2 A/ 0-40 V 1 A" \$650.00
HP6115A"Precision Power Supply, 0-50 V 0.8A/ 0-100 V 0.4A" \$650.00
TEKTRONIX PPS5004"Precision Power Supply, 0-20 V 0-300 mA, 1 mV res." \$950.00

CURRENT METERS & SOURCES

HP4140B"DCV Source / Picoammeter, GPIB" \$3500.00
HP6177C"DC Current Source, to 50 V, 500 mA" \$500.00
HP6181C"DC Current Source, to 100 V, 250 mA" \$500.00
KEITHLEY 225"Current Source, 0.1 uA-100 mA, 10-100 V compliance" \$450.00
TEKTRONIX P6022"AC Current Probe, 935 Hz-120 MHz, 6 A peak" \$250.00
VALHALLA 2500"AC/DC Current Calibrator, 2 uA-2 A, DC-10 kHz" \$500.00

IMPEDANCE & COMPONENT TEST

L.C.R.

BOONTON 62AD"1 MHz Inductance Meter, 2-2000 uH" \$500.00
BOONTON 72BD"1 MHz Capacitance Meter, 2-2000 pF f.s. 3 digits" \$800.00

BOONTON 72C"1 MHz Capacitance Meter, 1-3000 pF f.s. analog" \$800.00
GENERAL RADIO 1658"RLC Digibridge, 120 Hz / 1 kHz" \$1000.00
HP4262A"3-1/2 digit LCR Meter, 120 Hz / 1 kHz/ 10 kHz" \$950.00
HP4274A"5-1/2 digit LCR Meter, 100 Hz-100 kHz, GPIB" \$3250.00

STANDARDS

E.S.I.SR-1"Standard Resistor, various values" \$125.00
E.S.I.SR1010"Resistance Transfer Standards, 1 Ohm-100 K/step" \$500.00
GENERAL RADIO 1406-series"Standard Air Capacitors, GR900 connector, 0.1% acc" \$275.00
GENERAL RADIO 1409-series"Standard Capacitors, 0.001-1.0 uF values available" \$150.00
GENERAL RADIO 1433-J"4-Decade Resistor, 0-11.11 Kilohms, 1 Ohm steps" \$150.00
GENERAL RADIO 1433-K"4-Decade Resistor, 0-1.11 Kilohms, 0.1 Ohm steps" \$150.00
GENERAL RADIO 1433-P"5-Decade Resistor, 0-1.1111 Megohms, 10 Ohm steps" \$200.00
HP4440B"Decade Capacitor, 40 pF-1.2 uF" \$750.00

HI & LO RESISTANCE

HP4329A"High Resistance Meter, 500 Kilohms-2x 10e16 Ohms" \$875.00

T.D.R.

TEKTRONIX"1503B-03,04" TDR, 0-50,000 feet; chart rec. & battery options" \$2500.00

POWER SUPPLIES

SINGLE OUTPUT

HP6002A-001"0-50 V / 0-10 A / 200 Watts max. Supply, GPIB" \$650.00
HP6011A"0-20 V / 0-120 A / 1000 Watts max., CV/CC Supply" \$1800.00
HP6028A0-60 V / 0-10 A / 200 Watts max. Autoranging Supply \$1000.00
HP6033A"0-20 V / 0-30 A / 200 Watts max. Supply, GPIB" \$1200.00
HP6038A"0-60 V / 0-10 A / 200 Watts max Supply, GPIB" \$1200.00
HP6203B0-7.5 V 0-3 A CV/CC Power Supply \$175.00
HP6205C"Dual Power Supply, 0-40 V 300 mA/ 0-20 V 600 mA" \$300.00
HP6207B0-160 V 0-200 mA CV/CC Power Supply \$200.00
HP6263B0-20 V 0-10 A CV/CC Power Supply \$375.00
HP6266B0-40 V 0-5 A CV/CC Power Supply \$375.00
HP6267B0-40 V 0-10 A CV/CC Power Supply \$550.00
HP6271B0-60 V 0-3 A CV/CC Power Supply \$375.00
HP6274B0-60 V 0-15 A CV/CC Power Supply \$650.00
HP6384A4.0-5.5 V at 8 A CV/CL Power Supply \$125.00
HP6443B0-120 V 0-2.5 A CV/CC Power Supply \$375.00
HP6525A0-4000 V 0-50 mA CV/CC Power Supply \$650.00
HP6552A0-20 V 0-25 A CV/CC Power Supply \$1000.00
HP6643A"0-35 V 0-6 A CV/CC Power Supply, GPIB" \$1200.00
HP6651A"0-8 V 0-50 A CV/CC Power Supply, GPIB" \$1500.00
HP6652A"0-20 V 0-25 A CV/CC Power Supply, GPIB" \$1875.00
KEPCOATE 36-8M0-36 V 0-8 A CV/CC Power Supply \$300.00
SORENSEN SRL 20-120-20 V 0-12 A CV/CC Power Supply \$350.00
SORENSEN SRL 60-80-60 V 0-8 A CV/cc Power Supply \$450.00

MULTIPLE OUTPUT

HP6228B"Dual Power Supply, 0-50 V 0-1 A, CV/CC" \$375.00
HP6236B"Triple Output Supply, +/-20 V 0.5A & 0-6 V 2.5 A" \$375.00
HP6237B"Triple Output Supply, +/-20 V 0.5 A & 0-18 V 1 A" \$375.00
HP6253A"Dual Power Supply, 0-20 V 0-3 A, CV/CC" \$375.00
HP6255A"Dual Power Supply, 0-40 V 0-1.5 A, CV/CC" \$375.00
HP6627A"Quad Output Power Supply, 0-20 V 2A or 0-50V 800mA" \$2750.00
TEKTRONIX PPS503A"Dual Power Supply, TM500 series" \$200.00

MISCELLANEOUS

ACMEPS2L-500"Programmable Load, 0-75 V / 0-75 A / 500 Watts max" \$350.00
ACMEPS2L-500"Programmable Load, 0-75 V / 0-75 A / 500 Watts max." \$300.00
HP6827A"Bipolar Power Supply / Amplifier, +/-100 V +/-500 mA" \$900.00
KEPCOBOP 50-2M"Bipolar Amplifier/ Power Supply, to 50 V, 2 A" \$400.00
TRANSISTOR DEVDAL 50-15-100"Programmable Load, 0-50 V, 0-15 A, 100 Watts max." \$200.00

TIME & FREQUENCY

UNIVERSAL COUNTERS

HP5314A100 MHz/ 100 nS Universal Counter \$175.00
HP5315A100 MHz/ 100 nS Universal Counter \$350.00
HP5315A-003"100 MHz/ 100 nS Counter, 1 GHz C-channel" \$450.00
HP5315B100 MHz/ 100 nS Universal Counter \$375.00
HP5316A"100 MHz/ 100 nS Universal Counter, GPIB" \$450.00
PHILIPSPM6672/ 411"120 MHz/ 100 nS Universal Counter, 1 GHz C-channel" \$300.00
TEKTRONIX DC5004"100 MHz/ 100 nS Counter/ Timer, TM5000 series" \$200.00
TEKTRONIX XDC5009"135 MHz/ 10 nS Counter/ Timer, TM5000 series" \$350.00

TEKTRONIX XDC503A"125 MHz/ 100 nS Universal Counter, TM500 series" \$250.00
TEKTRONIX XDC509"135 MHz/ 10 nS Universal Counter, TM500 series" \$275.00

FREQUENCY COUNTERS

EIP548A-0626.5 GHz Frequency Counter & mixers for 26-60 GHz \$3950.00
EIP578-02,05"26.5 GHz Source Locking Counter, GPIB & power meter" \$2750.00
HP5342A18 GHz Frequency Counter \$900.00
HP5343A-001"26.5 GHz Frequency Counter, OCXO reference" \$2500.00
HP5345A/55A/56B26.5 GHz CW/ Pulse Frequency Counter \$3500.00
HP5352B-010"40 GHz Frequency Counter, OCXO reference option" \$7500.00
HP5384A"225 MHz Frequency Counter, GPIB" \$450.00
XL MICROWAVE3401 "40 GHz Source Locking Frequency Counter, GPIB" \$5500.00

STANDARDS

HP105B"Quartz Oscillator, 0.1/ 1.0/ 5.0 MHz, battery pwr." \$1100.00

AUDIO & BASEBAND

SPECTRUM ANALYSIS

HP3586C"Selective Level Meter, 50 Hz-32.5 MHz, 50 & 75 Ohms" \$1000.00

DISTORTION ANALYZERS

HP8903A"Audio Analyzer, 20 Hz-100 kHz, GPIB" \$1200.00
HP8903B-001,010,053"Audio Analyzer, 20 Hz-100 kHz, GPIB" \$1850.00
HP8903E"Audio Analyzer, 20 Hz-100 kHz, GPIB" \$1650.00

RMS VOLTMETERS

FLUKE B922A"True RMS Voltmeter, 180 uV-700 V, 2 Hz-11 MHz" \$450.00

OSCILLATORS

TEKTRONIX SG502"Sine/ Square Osc., 5 Hz-500 kHz, 70 dB step atten., TM500" \$200.00
TEKTRONIX SG505-opt.2"Oscillator, 10 Hz-100 kHz; IM test & 50/150/600 Ohms" \$800.00
WAVETEK 98"1 MHz Synthesized Power Oscillator, GPIB" \$750.00

MISCELLANEOUS

HP3575A"Phase-Gain Meter, 1 Hz-13 MHz, single display" \$600.00
HP3575A-001"Phase-Gain Meter, 1 Hz-13 MHz, dual display" \$750.00
HP467A"Power Amplifier \$375.00
KROHN-HITE 3200"High Pass / Low Pass Filter, 20 Hz-2 MHz" \$275.00
KROHN-HITE 3202"Dual HP/LP/BP/BR Filter, 20 Hz-2 MHz" \$450.00
ROCKLAND 852"Dual Highpass/ Lowpass Filter, 0.1 Hz-111 kHz" \$650.00
TEKAM502"1 MHz Differential Amplifier, TM500 series" \$450.00

RF & MICROWAVE

SPECTRUM ANALYZERS

HP11517A/19A/20A"Mixer Set, 18-40 GHz, for HP 8555A / 8569A" \$475.00
HP11970A"WR28 Harmonic Mixer, 26.5-40 GHz" \$1000.00
HP11970K"WR42 Harmonic Mixer, 18.0-26.5 GHz" \$1000.00
HP11970Q"WR22 Harmonic Mixer, 33-50 GHz" \$1400.00
HP11970U"WR19 Harmonic Mixer, 40-60 GHz" \$1600.00
HP11971A"WR28 Harmonic Mixer, 26.5-40 GHz, for 8569B" \$800.00
HP11971K"WR42 Harmonic Mixer, 18.0-26.5 GHz, for 8569B" \$800.00
HP11974U"WR19 Preselected Mixer, 40-60 GHz" \$8500.00
HP8562A"Spectrum Analyzer, 1 kHz-22 GHz, 100 Hz min.res. Bw" \$16000.00
HP85640A"Tracking Generator, 300 kHz-2.9 GHz, for HP 8560 series" \$4000.00
HP8565A-100"Spectrum Analyzer, 10 MHz-22 GHz, 100 Hz min. res. Bw" \$3000.00
HP8569B"Spectrum Analyzer, 10 MHz-22 GHz, 100 Hz min.res. Bw" \$4500.00
TEKTRONIX WM782V"WR15 Harmonic Mixer, 50-75 GHz" \$1500.00

NETWORK ANALYZERS

HP11650A"Network Analyzer Accessory Kit, APC7" \$600.00
HP11650A"Network Analyzer Accessory Kit \$500.00
HP11665B"Modulator, 0.15-18 GHz, for HP 8755/6/7" \$250.00
HP11665B"Modulator, 0.15-18.0 GHz, for HP 8755/6/7" \$250.00
HP3577B"Network Analyzer, 5 Hz-200 MHz" \$9500.00
HP4191A"RF Impedance Analyzer, 1-1000 MHz, 1 milliohm-100 Kilohms" \$3750.00
HP4193A"Vector Impedance Meter, 400 kHz-110 MHz, 10 Ohms-100 K" \$4500.00
HP8502B"75 Ohm Transmission/ Reflection Test Unit, 0.5-1300 MHz" \$675.00
HP8504AB"75 Ohm Transmission/ Reflection Test Unit, 300 kHz-2 GHz" \$1250.00
HP85054A"Type N Calibration Kit, for HP 8510 series" \$1800.00
HP8717B-001"Transistor Bias Supply \$350.00
HP8751A-001,002"Network Analyzer, 5 Hz-500 MHz" \$12500.00
HP8756A"Scalar Network Analyzer, GPIB" \$1375.00
HPR85026A"WR28 Detector, 26.5-40 GHz, for HP 8757 series" \$1200.00



90 DAY WARRANTY PARTS AND LABOR • 10 DAY INSPECTION TEST EQUIPMENT WANTED CALL OR FAX LIST • OPEN ACCOUNTS



SIGNAL GENERATORS

FLUKE6060B/AK*Signal Generator, 0.1-1050 MHz, 10 Hz res., GPIB	\$1250.00
FLUKE6060B-130,830*Signal Generator, 0.1-1050 MHz, 10 Hz res., GPIB	\$1600.00
GIGATRONICS1018*Signal/Sweep Gen., 0.05-18 GHz, 1 kHz res., +8 dBm	\$5000.00
GIGATRONICS600/ 6-12*Synthesized Source, 6-12 GHz, 1 MHz res., GPIB	\$1500.00
GIGATRONICS6000/ 8-16*Synthesized Source, 8-16 GHz, 1MHz res., GPIB	\$2250.00
GIGATRONICS6061A-830*Signal Generator, 0.1-1050 MHz, 10 Hz res., AM, FM, GPIB	\$1900.00
GIGATRONICS900/2-8*Signal/ Sweep Generator, 2-8 GHz, 1 MHz res., GPIB	\$1750.00
HP11707A*Test Plug-in, for HP 8660 series	\$400.00
HP11720A*Pulse Modulator, 2-18 GHz, 80 dB on/off ratio	\$450.00
HP8642M*Signal Generator, 0.1-2100 MHz, 1 Hz res., HPIB	\$3750.00
HP8656B-001*Signal Generator, 0.1-990 MHz, 10 Hz res., HPIB, OCXO	\$2750.00
HP8657A*Signal Generator, 0.1-1040 MHz, 10 Hz res., AM, FM, HPIB	\$3000.00
HP8660C/603A/633B*Signal Generator, 1-2600 MHz, 1 or 2 Hz res., AM, FM	\$3250.00
HP8660D/86603A-002*Signal Generator, 1-2600 MHz, 1 or 2 Hz res., phase modulation	\$6000.00
HP8672A*Signal Generator, 2-18 GHz, 1-3 kHz res., AM, FM, +3 dBm	\$4500.00
HP8672A-008*Signal Generator, 2-18 GHz, 1-3 kHz res., AM, FM, +8 dBm	\$5000.00
HP8673H-212*Signal Generator, 2.0-12.4 GHz, 1 kHz res., AM, FM, +8 dBm	\$8500.00
HP8673M*Signal Generator, 2-18 GHz, 1 kHz res., AM, FM, +8 dBm	\$9500.00
HP8683B*Signal Generator, 2.3-6.5 GHz, cavity tuned, AM/ WBFM/ Pulse	\$2250.00
HP8683D*Signal Generator, 2.3-13.0 GHz, cavity tuned, AM/ WBFM/ Pulse	\$3750.00
HP8684B*Signal Generator, 5.4-12.5 GHz, cavity tuned, AM/ WBFM/ Pulse	\$2250.00
HP8684D*Signal Generator, 5.4-18.0 GHz, cavity tuned, AM/ WBFM/ Pulse	\$3750.00
MARCONI2019*Signal Generator, 80 kHz-1040 MHz, 10 or 20 Hz res	\$850.00
WAVETEK952*Signal Generator, 1-4 GHz, +10 dBm, AM, FM	\$750.00
WAVETEK955*Signal Generator, 7.5-12.4 GHz, +7 dBm, AM, FM	\$750.00
WAVETEK957*Signal Generator, 12-18 GHz, +7 dBm, AM, FM	\$750.00

SWEEP GENERATORS

HP8350B/ 83522A*Sweep Oscillator, 10-2400 MHz, +13 dBm levelled	\$3750.00
HP8350B/ 83525A*Sweep Oscillator, 10 MHz-8.4 GHz, +13 dBm levelled	\$5000.00
HP8350B/ 83540A-002*Sweep Oscillator, 2.0-8.4 GHz, 70 dB step atten.	\$3250.00
HP8350B/ 83545A-002*Sweep Oscillator, 5.9-12.4 GHz, 70 dB step atten.	\$3750.00
HP8350B/ 83570A*Sweep Oscillator, 18.0-26.5 GHz, +10 dBm levelled	\$7000.00
HP8350B/83570A-H22*Sweep Oscillator, 17-24 GHz, +10 dBm levelled	\$5000.00
HP8620C*Sweep Oscillator Frame	\$500.00
HP86222B-002*RF Plug-in, 10-2400 MHz, +13 dBm, 70 dB step atten.	\$1250.00
HP86222B-E69/8620C*Sweep Osc. & frame, 0.01-2 GHz & 2-4 GHz bands	\$1200.00
HP86240B*RF Plug-in, 2.0-8.4 GHz, +13 dBm levelled	\$450.00
HP86241A*RF Plug-in, 3.2-6.5 GHz, +8 dBm levelled	\$300.00
HP86245A*RF Plug-in, 5.9-12.4 GHz, +16 dBm unlevelled	\$350.00
HP86251A*RF Plug-in, 7.5-18.6 GHz, +10 dBm levelled	\$500.00
HP86260A*RF Plug-in, 12-18 GHz, +10 dBm unlevelled	\$400.00
HP86260A-H04*RF Plug-in, 10-15 GHz, +10 dBm unlevelled	\$400.00
HP86290B*RF Plug-in, 2.0-18.6 GHz, +10 dBm levelled	\$1500.00
HP86290C*RF Plug-in, 2.0-18.6 GHz, +13 dBm levelled	\$1750.00
WAVETEK2001*Sweep Generator, 1-1400 MHz, +10 dBm, 70 dB atten.	\$750.00
WAVETEK2002B*Sweep Generator, 1-2500 MHz, +13 dBm, GPIB	\$1750.00
WILTRON6647M*Sweep Generator, 10 MHz-20 GHz, +10 dBm, GPIB	\$4500.00
WILTRON6717B-20*Synthesizer/ Sweeper, 10 MHz-8.4 GHz, +13 dBm, GPIB	\$6000.00

POWER METERS

BOONTON42B/ 41-4E*Analog Power Meter, with 1 MHz-18 GHz sensor	\$400.00
HP435B/8481A*Power Meter, -30 to +20 dBm, 10 MHz-18 GHz	\$900.00
HP436A-022/ 8481A*Power Meter, -30 to +20 dBm, 10 MHz-18 GHz, HPIB	\$1200.00
HP436A-022/ 8482A*Power Meter, -30 to +20 dBm, 100 kHz-4.2 GHz, HPIB	\$1200.00
HP436A-022/ 8484A*Power Meter, -70 to -20 dBm, 10 MHz-18 GHz, HPIB	\$1200.00
HP436A-022/ 8485A*Power Meter, -30 to +20 dBm, 50 MHz-26.5 GHz, HPIB	\$1500.00
HP436A-022/ 8485D*Power Meter, -70 to -20 dBm,	

50 MHz-26.5 GHz, HPIB	\$1700.00
HP438ADual Channel Power Meter	\$3000.00
HP8477A*Power Meter Calibrator, for HP 432 series	\$400.00
HP8487D*High Sensitivity Sensor, -70 to -20 dBm, 50 MHz-50 GHz, 2.4mm	\$1850.00
HP8900D/84811A*Peak Power Meter, 0.1-18 GHz, 0-20 dBm peak	\$2500.00
HPQ8486A*Power Sensor, 33-50 GHz, -30 to +20 dBm, for 435/6/7/8	\$1500.00
HPR8486A*Power Sensor, 26.5-40 GHz, -30 to +20 dBm, for 435/6/7/8	\$1500.00
HPR8486D*Power Sensor, 26.5-40 GHz, -70 to -20 dBm, for 435/6/7/8	\$1750.00

RF MILLIVOLTMETERS

BOONTON92C*RF Millivoltmeter, 3 mV-3 V f.s., 10 kHz-1.2 GHz	\$500.00
RACAL-DANA9303*RF Millivoltmeter, -70 to +20 dBm, 10 kHz-2 GHz, GPIB	\$750.00

AMPLIFIERS, MISCELLANEOUS

AMPLIFIER RESEARCH4W1000*Amplifier, 40 dB gain, 4 Watts, 1-1000 MHz	\$950.00
BOONTON82AD*Modulation Meter, AM/ FM, 10-1200 MHz	\$500.00
C.P.I.VZC6961K1*TWT Amplifier, 35 dB gain, 4-8 GHz, 20 Watts	\$3500.00
ENI525LA*Amplifier, 50 dB gain, 1-500 MHz, 25 Watts	\$3250.00
HP11713A*Switch / Attenuator Driver, HPIB	\$800.00
HP11729B-003*Carrier Noise Test Set, 5 MHz-3.2 GHz	\$1900.00
HP3730B/3738B*Downconverter, 5.9-8.9 GHz & 8.7-11.7 GHz	\$1200.00
HP415ESWR Meter	\$200.00
HP8347A*RF Amplifier, 25 dB gain, 100 kHz-3 GHz, +20 dBm, HPIB	\$2750.00
HP8403A-002*Pulse Modulator, 0.8-2.4 GHz, 80 dB dynamic range	\$450.00
HP8406A*Comb Generator, 1/ 10/ 100 MHz increments, to 5GHz	\$500.00
HP8447A-001*Dual Amplifier, 20 dB, 0.1-400 MHz, +6 dBm Po, NF <7 dB	\$650.00
HP8447E*Amplifier, 22 dB, 0.1-1300 MHz, +13 dBm output	\$650.00
HP8447F-H64*Dual Amp., 0.01-50 MHz 28 dB & 0.1-1300 MHz 25 dB	\$900.00
HP8901A*Modulation Analyzer, 150 kHz-1300 MHz, HPIB	\$1350.00
HP8901B-001*Modulation Analyzer, 150 kHz-1300 MHz, HPIB	\$1900.00
HUGHES8010H13F000*TWT Amplifier, >30 dB gain, 3-8 GHz, 10 Watts	\$2500.00
RACAL9009*Modulation Meter, 30-1500 MHz, AM, 1.5-100 kHz pk FM	\$350.00
RF POWER LABSML50*Amplifier, 2-30 MHz, 47 dB gain, 50 Watts, metered, 28 V	\$200.00
ROHDE&SCHWARZESH2*Test Receiver, 9 kHz-30 MHz	\$3250.00

COAXIAL & WAVEGUIDE

AEROWAVE28-3000/10*WR28 Directional Coupler, 10 dB, 26.5-40 GHz	\$300.00
AMERICAN NUC.AM-432*Coaxial Backed Spiral Antenna, LHC, 2-18 GHz, TNC(f) "NEW"	\$95.00
AVANTEKAMT-400X2*WR28 Active Doubler, +10 dBm in & out	\$450.00
BIRD8201*500 Watt Oil Dielectric Load, DC-2.5 GHz	\$350.00
FXR/MICROLABSL-03N*Stub Stretcher, 0.3-6.0 GHz, 100 Watts max., N(m/f)	\$75.00
GENERAL RADIO874-LTL*Constant Impedance Trombone Line, 0-44 cm, DC-2 GHz	\$400.00
HP11590A-001*Bias Network, 1.0-18.0 GHz, APC7	\$450.00
HP11691D*Directional Coupler, 22 dB, 2-18 GHz, N connectors	\$450.00
HP11692D*Dual Directional Coupler, 22 dB, 2-18 GHz	\$800.00
HP33327L-006*Prog. Step Attenuator, 0-70 dB, DC-40 GHz, 2.9mm	\$1000.00
HP778D-011*Dual Dir. Coupler, 20 dB, 0.1-2.0 GHz, APC7	\$450.00
HP8498A-030*30 dB Attenuator, 25 Watts, DC-18 GHz	\$500.00
HP87300C-020*Directional Coupler, 20 dB, 1.0-26.5 GHz, 3.5mm	\$475.00
HPK422A*WR42 Flat Broadband Detector, 18.0-26.5 GHz	\$350.00
HPK532A*WR42 Frequency Meter, 18.0-26.5 GHz	\$450.00
HPK752A*WR42 Directional Coupler, 3 dB, 18.0-26.5 GHz	\$450.00
HPK752C*WR42 Directional Coupler, 10 dB, 18.0-26.5 GHz	\$450.00
HPK752D*WR42 Directional Coupler, 20 dB, 18.0-26.5 GHz	\$450.00
HPK870A*WR42 Slide Screw Tuner, 18.0-26.5 GHz	\$275.00
HPK914B*WR42 Moving Load, 18.0-26.5 GHz	\$250.00
HPQ752D*WR22 Directional Coupler, 20 dB, 33-50 GHz	\$650.00
HPR422A*WR28 Crystal Detector, 26.5-40 GHz	\$400.00
HPR752A*WR28 Directional Coupler, 3 dB, 26.5-40 GHz	\$450.00
HPR752D*WR28 Directional Coupler, 20 dB, 26.5-40 GHz	\$450.00
HPR914B*WR28 Moving Load, 26.5-40 GHz	\$250.00
HPV365A*WR15 Isolator, 25 dB, 50-75 GHz	\$750.00
HPV752D*WR15 Directional Coupler, 20 dB, 50-75 GHz	\$650.00
HPX870AWR90 Slide Screw Tuner	\$150.00
HUGHES45322H-1110/120*WR22 Directional Couplers, 10 or 20 dB, 33-50 GHz	\$350.00
HUGHES45712H-1000*WR22 Frequency Meter, 33-50 GHz	\$750.00

HUGHES45714H-1000*WR15 Frequency Meter, 50-75 GHz	\$900.00
HUGHES45721H-2000*WR28 Direct Reading Attenuator, 0-50 dB, 26.5-40 GHz	\$1000.00
HUGHES45722H-1000*WR22 Direct Reading Attenuator, 0-50 dB, 33-50 GHz	\$1000.00
HUGHES45724H-1000*WR15 Direct Reading Attenuator, 0-50 dB, 50-75 GHz	\$1000.00
HUGHES45732H-1200*WR22 Level Set Attenuator, 0-25 dB, 33-50 GHz	\$250.00
HUGHES45752H-1000*WR22 Direct Reading Phase Shifter, 0-360, 33-50 GHz	\$1400.00
HUGHES45772H-1100*WR22 Thermistor Mount, -20 to +10 dBm, 33-50 GHz	\$400.00
HUGHES47316H-1111*WR10 Tunable Detector, 75-110 GHz, pos. polarity	\$600.00
HUGHES47741H-2310*WR28 Phase Locked Gunn Osc., 32 GHz, +18 dBm	\$2000.00
HUGHES47742H-1210*WR22 Phase Locked Gunn Osc., 42 GHz, +18 dBm	\$2750.00
KRYTAR201020010*Directional Detector, 1-20 GHz, SMA(f)/SMC	\$200.00
KRYTAR2616S*Directional Detector, 1.7-26.5 GHz, K(f)/m/SMC	\$200.00
M/A-COM3-19-300/10*WR19 Directional Coupler, 10 dB, 40-60 GHz	\$450.00
NARDA3000-series*Octave Band Directional Couplers, N connectors	\$150.00
NARDA3020A*Bi-Directional Coupler, 50-1000 MHz	\$500.00
NARDA3024*Bi-Directional Coupler, 20 dB, 4-8 GHz	\$375.00
NARDA3090Precision High Directivity Couplers	\$225.00
NARDA368BNM*Coaxial Hih Power Load, 500 Watts, 2-18 GHz, N(m)	\$500.00
NARDA3752*Coaxial Phase Shifter, 0-180 deg./GHz, 1-5 GHz	\$900.00
NARDA3753B*Coaxial Phase Shifter, 0-55 deg./GHz, 3.5-12.4 GHz	\$950.00
NARDA4000-series*Octave Band Directional Couplers, SMA connectors	\$75.00
NARDA4247-20*Directional Coupler, 20 dB, 6.0-26.5 GHz, 3.5mm(f)	\$200.00
NARDA5070-seriesPrecision Reflectometer Couplers	\$300.00
NARDA562*DC Block, 10 MHz-12.4 GHz, 100 V max., N(m/f)	\$65.00
NARDA765-10/10 dB Attenuator, 50 Watts, DC-5 GHz, N(m/f)	\$165.00
NARDA791FM*Variable Attenuator, 0-37 dB, 2.0-12.4 GHz	\$500.00
NARDA792FF*Variable Attenuator, 0-20 dB, 2.0-12.4 GHz	\$375.00
NARDA793FM*Direct Reading Variable Attenuator, 0-20 dB, 4-8GHz	\$225.00
NARDA794FM*Direct Reading Variable Attenuator, 0-40 dB, 4-8GHz	\$375.00
OMNI-SPECTRA2085-6010-00*Crystal Detector, 1-18 GHz, neg. polarity, SMA m/f	\$50.00
PAMTECHKY1014*WR42 Junction Circulator, 18.0-26.5 GHz	\$250.00
SOMMA SCI.21A3*WR42 Circulator, 20 dB, 20.6-24.8 GHz	\$75.00
TEKTRONIX2701*Step Attenuator, 0-79 dB, DC-1 GHz	\$150.00
TRGB510*WR22 Direct Reading Attenuator, 0-50 dB, 33-50 GHz	\$900.00
TRGV551*WR15 Frequency Meter, 50-75 GHz	\$600.00
TRGV510*WR10 Direct Reading Attenuator, 0-50 dB, 75-110 GHz	\$1000.00
TRGW551*WR10 Frequency Meter, 75-110 GHz	\$750.00
WAVELINE100080*WR28 Terminated Crossguide Coupler, 30 dB	\$200.00
WEINSCHEL150-110*Programmable Step Atten., DC-18 GHz, SMA	\$450.00
WEINSCHELD109*Double Stub Tuner, 1-13 GHz, N(m/f)	\$150.00
WEINSCHELD109LL*Double Stub Tuner, 0.2-2.0 GHz, N(m/f)	\$150.00

COMMUNICATIONS

HP37204A-003*HPIB Extender, fiber-optic connection "unused"	\$250.00
HP4934A-J02TIMS; CCITT option; battery power	\$1650.00
HP59401A*HPIB Bus Analyzer	\$375.00
TAMPA MW. LABBUC1W-02W-CST*Ku band Upconverter, 1 Watt 14.0-14.5 GHz WR75 "NEW"	\$150.00
TEKTRONIX1411R-opt.04*PAL Test Gen., w/ SPG12, TSG11, TSP11, TSG13, 15, 16	\$1400.00
TEKTRONIX147A*NTSC Test Signal Generator, with noise test signal	\$800.00

MISCELLANEOUS

EG&G/ P.A.R.5302 / 5316*Lock-in Amplifier, 100 mHz-1 MHz, GPIB / RS232C	\$2250.00
FLUKE2180ARTD Digital Thermometer	\$500.00
HP59307A*HPIB VHF Switch	\$200.00
P.A.R.5206-95.98*Two-Phase Lock-in Amp., 2 Hz-100 kHz, GPIB	\$1250.00
TEKTRONIXTM5003TM5000-series 3-slot Programmable Power Module	\$450.00
TEKTRONIXTM5006TM5000-series 6-slot Programmable Power Module	\$500.00
TEKTRONIXTM503TM500-series 3-slot Power Module	\$150.00
TEKTRONIXTM504TM500-series 4-slot Power Module	\$175.00
TEKTRONIXTM506TM500-series 6-slot Power Module	\$250.00
TEKTRONIXTM515TM500-series 5-slot Portable Power Module	\$250.00



SUPERB SLIDE, TRAVERSES 2" with STEPPER DRIVE
The motorized, linear ball slides from NEAT are extremely rigid. No slop with these hefty units. Top and bottom machined from a 1" thick and 1.25" thick solid alum. plate. Flex coupled, 12VDC @ 0.44A. Rapidsyn size 23, 6 wire stepper is included. These slides are in excellent condition and removed from equipment. Overall size of slide is 3" x 4" x 2" add 2.75" to length for the stepper. Excellent for applications which require extreme repeatability. Limited quantity.
NEAT 3X4.....\$129ea. or 2 for \$229

TRIPLE OUTPUT SUPPLY PUMPS OUT 12VDC @ 8AMPS! and That's just for Starters!

Brand New, Digital Power Corp. model US155-301, Universal power supply. Open frame design sports 200Watts in a compact 3.75"W x 6.75"H x 1.5"H package. Universal AC input operates from 90 to 250VAC. Additional outputs of -12VDC @ 1Amp and 5VDC @ 20Amps as well as the 12VDC @ 8Amps. This is one honkin' little unit. I/O is via a standard 0.1" male pin header. As with any power supply, adequate cooling is required. These are the nicest units we have seen in a while. Don't be left out. **DIGIPOWER.... \$20 ea. or 3 for \$49**

IEE, 1X20 VACUUM FLUORESCENT DISPLAY MODULE

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

B&W QUAD PROCESOR, The GM4-BQ is an unbeatable value. Four camera inputs with loop through. Full screen image, REAL TIME display, high resolution: 960 x480, brightness adj. for each chan. Alarm time (1-20 sec.) 4 alarm inputs. Auto Sequencing mode with adj. dwell: 1-4 sec. Quality video processing. Specs: •4 video inputs. •1 monitor out and VCR in/out. •4 alarm inputs •Buzzer •2 Alarm Out •Dim: 239 x166 x55 mm. **GM4-BQ QUAD.....\$169**

NEW, GM960R TIME LAPSE VIDEO RECORDER
Finally a brand new, 4 head, T/L recorder with all the features at a price you can afford. Features: • Up to 960 hours on a standard T-120 VHS tape • 12 different modes for record and playback • Audio recording in the 12H and 24H mode. • 30Day memory backup • Easy mode setting. • On-screen menus • Auto-Repeat recording mode • Serial or One-shot recording • Time, Date, speed, and Alarm indicators on screen. These deluxe units are front loading and are 14"W x 3.5"H x 12.2"D, 110VAC powered. **SPECIAL, GM960R-VCR\$379ea.**



A VIDEO MICROSCOPE in the PALM of your HAND! NEW, MAGCAM, VIDEO INSPECTOR, OFFERS HIGH POWER and LOW COST. Two optical magnifications at the flick of a lever. Choose either 40X or 140X.

A high quality, digital, color CCD camera, with dual optical magnification settings and built in object illumination via two ultra bright, white LED's. Entire system is fully integrated into a rugged and ergonomically designed, hand held unit only 2.7"W x 3"H x 1.8"D Video output is standard NTSC via a RCA jack. 12VDC powered. CCD provides 380 lines of resolution and 0.8lux sensitivity. Complete with power supply and 3 foot RCA cable. A fantastic and useful device for inspection, diagnostics and observation of small objects. Perfect for SMT inspection. **SPECIAL, GM- MAGCAM.....\$199ea.**

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



NEW! 0.005 Lux, COLOR NIGHT VISION CAMERA! UNBELIEVABLE LOW LIGHT PERFORMANCE.

State of the Art Video, Exclusive ON SCREEN, menu driven setup of all camera parameters!

For covert, military & scientific applications that must be color, this is it. Unbelievable 0.005Lux @ f1.2 performance is enhanced through low speed electronic shuttering, digital frame integration and advanced DSP. Auto sensitivity mode starts as it becomes dark. 24 hour surveillance is possible with the optional f1.2 auto iris lens shown below. Seven Gain/Shutter modes are user selectable. Normal, X4, X8, X16, X24, X32, X64. These provide frame rates of 60, 15, 8, 4, 3, 2 and 1 per second. Auto/Man. white balance 3200° to 10000°K, auto/man BLC, S/N >52dB, Mirror on/off, Gain on/off, auto electronic shutter 1/60 to 1/120,000 sec., Alum. housing, dual 1/4x20 mtg. Specs: 1/2" CCD, 768H x 494V, with 380K pixels, 470 lines, 12VDC ±1V @ 200mA, Std. video out on BNC. Size: 51mm x 51mm x 115mm long. Regulated power adapter included. All functions can be externally controlled. Use standard C-mount lens not included. **GMV-3K-OSD.....\$449ea.**
High performance auto iris lens, 12mm, f1.2...\$199ea.

SONY, ROBOTIC COLOR CAMERA, 450LINE, 8X ZOOM, NTSC & S-VIDEO OUT, Serial Control of Pan, Tilt and Zoom, Auto Iris and Auto Focus too! Five user presets allow one click "go-to" scenes with pan, tilt and zoom for each in memory. (Under software control 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. SVHS jock. Size: 8"D x 6.5"H. With software and serial cable for remote control. Regular price over \$4K. Limited quantity. What more could you want? **PICTEL-4K \$399ea. or 2 for \$699**



KOLLMORGEN, ServoDisc MOTOR with 2500ppr optical encoder, S6M4H Type, Rugged, ironless, low inertia rotor for high acceleration and zero cogging. Very compact 3.4" diameter x 4.2" high including the encoder. Peak torque 214 oz-in, rated speed 3000 RPM, conf. torque, 21 oz-in, Power output 46W, Max. speed 6000 rpm, Peak acceleration, 251 kRads/s². Rated voltage 17.7V @ 5.2Amps, Weight 2.3lbs. A fantastic servomotor. Removed from new equipment. **KOLL-S6M4H.....\$99ea.**



CARL ZEISS, S-PLANAR LENS,

GCA type 37, 1.4/75, M1:5nA=0.30,
A fantastic lens with a current replacement cost of \$20K. Extremely flat field and extremely high quality. Removed from wafer-lithography system, excellent condition. **ZEISS-PLANAR.....\$495**

WEATHER RESISTANT and HEATED Outdoor, Camera Enclosure,

Solid, extruded aircraft aluminum. Glass window. Strain reliefs for cables. Size: 3.5"W x 3.7"H x 14"L. New. Perfect for our new "Night vision cameras" **GM-10H.....\$69ea.**
Adjustable Heavy Duty Mount.....\$19ea.



FESTO, Pneumatic linear drive, with recirculating-ball guide, type DGPL-25--PPV-A-KF-B #161792, BRAND NEW!

Adjustable end position cushioning at both ends. The piston is fitted with a permanent magnet whose magnetic field can be sensed by means of appropriate proximity switches. Not included. This facilitates contactless sensing of intermediate and end positions of the drive. The cylinder is double-acting. Compressed air is used to produce the forward and return stroke. Space-saving, rodless linear drive. The point of force delivery is protected against rotation around the longitudinal axis of the drive. Mode of operation: Double acting. Shape of piston: Round. Sensing type: Magnetic. Adjustable pneumatic cushioning: up to 18 mm. Ball-bearing guide, Piston size: 25 mm, X-stroke: 10 mm Min. 3000 mm Max., Operating pressure min. 2 bar /max. 8 bar, Air connections: 1/8" Female thread, Effective force at 6 bar 295 N, Air consumption at 6 bar/10 mm 0.034 litre
LIMITED QUANTITY, \$175ea. 2 for \$299

BRAND NEW, VIDEO MOTION SENSOR. The model VM-10 connect 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. Auto or manual reset. Internal buzzer with volume control and adjustable on time. VCR record and VCR stop output. (use with time lapse VCR.) 110VAC powered. Adjustable sensitivity. Video loop through. **NEW, VM10.....\$179ea.**

NEW! 6.8" LCD COLOR, TFT, ACTIVE MATRIX DISPLAY, A huge 23sq. inch VIEWABLE AREA, Super Deal. 2.8X the VIEWING AREA of a 4" WOW! We wish you could see the color saturation and resolution of this superior LCD display. Excellent contrast ratio, high quality, full color images are comparable to a CRT. Perfect, portable, general purpose color monitor for standard NTSC color or B&W video. Fully compatible with all our cameras as well as Camcorders, VCR's, DVD's etc. OEM "component" style unit has no outer cabinet. Designed to be installed in YOUR housing via four mounting tabs as shown. Specs: Resolution, 1152H x 234V, 270K Pixels! Viewing angle, Top 10°, Down 30°, Left 45°, Right 45°. Brightness, 300 nit, Size: W x H x D Imm/inch, 157.2 x 122.6 x 8.0, 6.2" x 4.83" x 1.1". Weight, 10oz. Supplied with 30" input cable. Video input via BNC jack, 12VDC input via a standard barrel connector. **BRAND NEW, FIRST QUALITY. GMTF68.....\$169ea.**
Regulated 12 VDC/110VAC power supply.....\$8.95ea.



ORDERS. 800.810.4070
Tech 603.668.2499

RESOURCES UN-LTD.

Fax 603.644.7825, All CCards, COD,
300 Bedford St. Manchester, NH 03101
WWW.RESUNLTD4U.COM

NEW! 0.005 Lux, COLOR NIGHT VISION CAMERA! UNBELIEVABLE LOW LIGHT PERFORMANCE.
State of the Art Video, Exclusive ON SCREEN, menu driven setup of all camera parameters!

For covert, military & scientific applications that must be color, this is it. Unbelievable 0.005Lux @ f1.2 performance is enhanced through low speed electronic shuttering, digital frame integration and advanced DSP. Auto sensitivity mode starts as it becomes dark. 24 hour surveillance is possible with the optional f1.2 auto iris lens shown below. Seven Gain/Shutter modes are user selectable. Normal, X4, X8, X16, X24, X32, X64. These provide frame rates of 60, 15, 8, 4, 3, 2 and 1 per second. Auto/Man. white balance 3200° to 10000°K, auto/man BLC, S/N >52dB, Mirror on/off, Gain on/off, auto electronic shutter 1/60 to 1/120,000 sec., Alum. housing, dual 1/4x20 mtg. Specs: 1/2" CCD, 768H x 494V, with 380K pixels, 470 lines, 12VDC ±1V @ 200mA, Std. video out on BNC. Size: 51mm x 51mm x 115mm long. Regulated power adapter included. All functions can be externally controlled. Use standard C-mount lens not included. **GMV-3K-OSD.....\$449ea.**
High performance auto iris lens, 12mm, f1.2...\$199ea.

SONY, ROBOTIC COLOR CAMERA, 450LINE, 8X ZOOM, NTSC & S-VIDEO OUT, Serial Control of Pan, Tilt and Zoom, Auto Iris and Auto Focus too! Five user presets allow one click "go-to" scenes with pan, tilt and zoom for each in memory. (Under software control 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. SVHS jock. Size: 8"D x 6.5"H. With software and serial cable for remote control. Regular price over \$4K. Limited quantity. What more could you want? **PICTEL-4K \$399ea. or 2 for \$699**



NEW! WEATHERPROOF B&W mini TUBE CAMERA Industrial strength, solid machined housing.

"Sleek black anodized, BRASS, housing is O-Ring sealed & WATERPROOF. Adjustable mount included. Specs: 1/3" CCD, 400 Lines resolution, 0.05 Lux sensitivity, AGC, Auto Shutter. Operates on 12VDC @ 200mA, 4mm, 78° FOV lens, A real glass lens. NTSC video out. Superior construction. SENSITIVE to IR. Ultra small Size only: 1.25" diam. X 2" long. With 60 ft. cable. Great for outdoor use too. **NEW, GM300K-N.....\$99**

NEW, lower cost, High quality, MINI BOARD CAM.

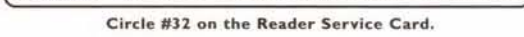
1/3" CCD, 420 Lines Res., 0.3 Lux sens., AGC, Pwr. from 9 to 12VDC @ 100mA, 266k PIXELS, 3.7mm, 92° FOV lens, A real glass lens. Auto shutter from 1/60 to 1/100,000 sec. Focus from 10mm to infinity. Std. NTSC video out. 1/2 ounce! SENSITIVE to IR. Size: 1.25" sq. x 1"D. Connections via a 3" pigtail with PC board connector. **GM-1000B-STD.....\$45ea.**

PULNIX, TMC7 INDUSTRIAL 1/2", COLOR CCD CAMERA, with Pentax lens. For No Compromise Performance.

Specs: 1/2" CCD, 460 Lines resolution, 768H x 494V Pixels, 2 Lux sens. @ f1.4, Auto/Man AGC, Auto/Man Shutter: 1/60 to 1/10,000 remotely controllable via 6 pin connector (not incl.) Auto/Man white balance. Manual gain and hue controls are external. Complimentary color filter. 12VDC @ 320mA, Pwr supply incl. Pentax, 16mm f1.4 lens, A real glass lens. Included. Std. NTSC video out on BNC. Y/C (S-Video) output available on 12 pin connector supplied. Superior construction. Compact size only: 1.6"W x 1.25"H x 5.5" long. Perfect for use in process monitoring, medical, surveillance and microscopy. Used, excellent condition, Regular price \$600. Limited quantity. **PULNIX, TMC-7.....\$149ea. or 2 for \$249**

NEW! 4 or 8 CHANNEL, VIDEO AUTO SWITCHERS

Connect four or eight std. 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/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, 4 Chan.....\$65, GM38, 8 Chan.....\$75**



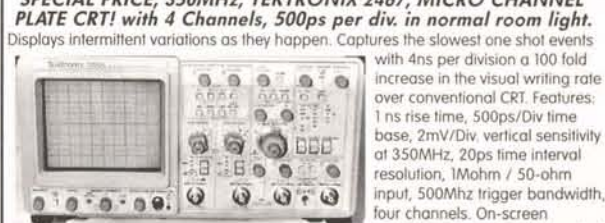
NEW! 0.01 Lux, COLOR NIGHT VISION CAMERA! FANTASTIC LOW LIGHT PERFORMANCE. Exclusive ON SCREEN, menu driven setup of all camera parameters.

NEW, STATE of the ART, GMV-35KOSD,

Perfect for covert, military & scientific applications that must be color. Unbelievable 0.01Lux @ f1.2 performance is enhanced through low speed electronic shuttering, digital frame integration & advanced DSP. Auto sensitivity mode starts as it becomes dark. 24 hour surveillance is possible with the optional f1.2 lens shown below. Specs: Shutter speed auto or manual, 1/60 to 1/120,000, 60dB S/N ratio, 154dB smear rejection, AGC gain 0 dB to 18 dB. Digital gain 0dB to 12dB. Digital zoom continuous from up to 2X in 0.1X steps. Masking mode allows hiding 4 programmable zones for privacy protection. Camera on screen name. Choose your own name for the camera and display it on monitor for easy identification.) White balance modes: Auto tracking, one push or selection from 3200K, 4800K, 5600K, 7800K, and "double white balance" independent white balance circuit for both bright and dark zone, maintains correct white balance even when combined indoor and outdoor lighting. Programmable 48 zone back light compensation mode for difficult lighting situation. Negative mode for negative film reading. Mirror image and up/down selection for rear view and camera mounted upside down. Seven Gain/Shutter modes are user selectable. Normal, X2, X4, X8, X16, X24, X32, X64. These provide frame rates of 60, 30, 15, 8, 4, 3, 2, and 1 per second. Alum. housing, dual 1/4x20 mtg. Specs: 1/3" CCD, 811H x 508V, with 412K pixels, 470 Lines, 12VDC ±1V @ 250mA, Std. video out on BNC. Std S-Video out on 4Pin connector. Size: 2"H x 2"W x 4.5" long. Regulated power adapter included. C-mount lens not included. **GMV-35KOSD.....\$399ea.**
High performance lens, 4mm, f1.3...\$49ea.

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

Displays intermittent variations as they happen. Captures the slowest one shot events with 4ns per division a 100 fold increase in the visual writing rate over conventional CRT. Features: 1 ns rise time, 500ps/Div time base, 2mV/Div vertical sensitivity at 350MHz, 20ps time interval resolution, 10Mohm / 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. With 2 probes, pouch and manual. EX. cond. 90 day warranty. **New..\$12K Now SALE, TEK 2467.....\$1995.**



Driver Training Center Corrects Virtual Mistakes Before They Become Reality

The road to safe driving has taken a digital turn for the better.

GE Capital I-Sim has opened its first Driver Development Service Center in the Midwest. The new facility combines classroom instruction with new, state-of-the-art driving simulators. Whether it's truck drivers, police officers or emergency vehicle operators, the I-Sim program focuses on real-life scenarios that train drivers how to avoid accidents without endangering life or property.

"We can train truck drivers to maneuver their 18-wheelers through hazardous road conditions, or emergency vehicles to reach a disaster scene quickly and safely," says Mark Stulga, CEO of GE Capital I-Sim. "Our complete program lets drivers take classroom learning straight to a life-like simulator."

"I-Sim technology allows instructors to correct virtual mistakes before they become reality." GE Capital I-Sim's three part training approach — classroom instruction, computer-based training with a complete driver skills evaluation, and hands-on simulation time — provides drivers, at any level, with a thorough training development program, Stulga says.

In addition to the Burr Ridge training center, Stulga says GE Capital I-Sim plans to open new Driver Development Service Centers in Anaheim, Dallas, Denver, Philadelphia, and Salt Lake City. For additional information, visit www.i-sim.com.

Gateway Brings Business Services to Store Shelves

Making technology services as easy to purchase as a box of software, Gateway, Inc., now offers a variety of online training, tech support, web site, and e-commerce plans that can be bought as retail packages at Gateway stores. Depending on the service, packages may include a detailed manual, simple step-by-step instructions on getting started, and if applicable, a pre-paid calling card or an enrollment key that activates their order.

"When it comes to purchasing something intangible like a service, customers tell us they want to talk to someone in person and see demonstrations of the service — in essence, to see and touch what they're buying," said Jim Jones, vice president of segment marketing at Gateway. "Our stores give people the opportunity to do all of that, and packaging services in this manner complements their technology buying experience."

Via the Internet, customers can learn at their convenience — any time

and just about anywhere. For just around \$99.00 each, the packages include a full year of unlimited access to online learning courses, some of which include: Microsoft Excel; Microsoft PowerPoint; Microsoft Word; Microsoft Access; Microsoft Outlook; WordPerfect and QuickBooks 2000.

Historic 'No Payment, 0% Financing' Program For

Qualified Sony Customers: Make No Payments and Pay No Interest until January 2003

Sony Electronics now has a highly flexible and comprehensive "No Payment, 0% Financing Program" available to all existing and new customers on a broad range of Sony professional products. Under the program, cus-

tomers can defer all costs until January 2003 and interest payments on products of \$2,000.00 or more purchased by March 29, 2002.

Once a customer is approved for the program by Sony Financial Services, the purchased product(s) will ship to the customer and the "No Payment/No Interest" period will begin. For a complete list of eligible models, the terms, and conditions, go

USB DAQ



LabJack™
U12
\$99

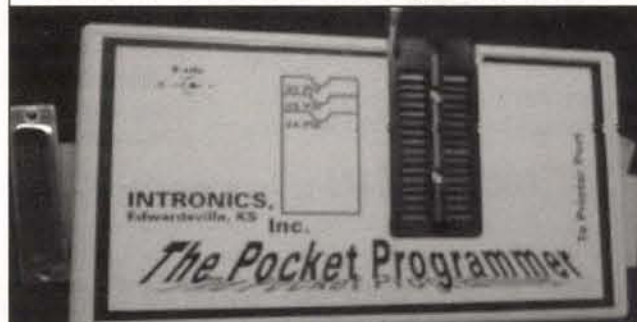
- * 12-bit analog inputs
- * 10-bit analog outputs
- * 20 digital I/O
- * 32-bit counter
- * Watchdog function
- * Built-in screw terminals
- * Easy-to-use USB
- * Everything included
- * Use with C, VB, LabVIEW
- * Windows 98SE/ME/2000/XP



LabJack Corporation
info@labjack.com
(303) 942-0228

www.labjack.com

The Pocket Programmer



The portable programmer that uses the printer port instead of a internal card. Now with easy to use Windows software that programs E(E)prom, Flash & Dallas Ram. 25/27/28 & 29 series from 16K to 8 Megabit with a 32 pin socket. Adapters available for MCU's 874X, 875X, Pic, Atmel, 40-Pin X16, Serial Eprom's, PLCC, Bi-Prom's, Eprom Emulator to 32K X

Only \$149.95

Same Name, Address & Phone # for 19 Years....
Isn't it Amazing ?

Intronics, Inc.

Box 12723 / 612 Newton St.
Tel. (913) 422-2094
Fax (913) 441-1623

Add \$7.00 COD
Add \$6.00 Shipping

WWW.IN-KS.COM

Visa/MC/Amex/Disc

Test Equipment Connection Corporation

Test Equipment Connection is looking to purchase your excess or underutilized electronic test and measurement equipment. We buy the largest variety of electronic test equipment in the industry.

WE BUY TEST EQUIPMENT



RENT

REPAIR



TRADE

SELL



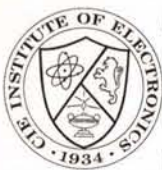
CALL: 800.615.8378

FAX: 800.819.8378

WWW.TestEquipmentConnection.COM

Specialist in Hewlett-Packard, Tektronix, and many more manufacturers.

Earn Your Degree at Home!



Cleveland Institute of Electronics offers comprehensive yet affordable independent study training programs in electronics and computer technology. Experience a step-by-step teaching method designed specifically for the independent study student.

Build on what you already know!

You may be eligible to apply for advanced standing in CIE's A.A.S. Degree Program based on your previous work life experience, military training or academic history. If you're like most readers of this magazine, your electronics background can help you receive your degree in less time than you think!

Choose from many programs!

Earn an Associate in Applied Science in Electronics Engineering Technology or a Diploma from one of our other high tech programs. All the lab equipment and instructor support you need to succeed is included with every program.

Name _____
 Address _____
 City _____
 State _____ Zip _____
 Phone _____ ANV03
 Send for a **FREE Course Catalog**
 CIE: 1776 E. 17th, Cleveland, OH 44114

Call (800) 243-6446 or visit www.cie-wc.edu for a **FREE Catalog!**

FCC Course with Certificate

A Powerful 19 Lesson Self-Study Program on one CD!

After completing this course you will be ready to take the FCC examination for a General Radiotelephone Operator License.

The General Radiotelephone Operator License is required to adjust, maintain or repair any FCC licensed radiotelephone transmitters in the aviation, maritime and international fixed public radio services. It is issued for the lifetime of the holder.

19 FCC Lessons on CD ROM

Every lesson is presented in a clear and easy-to-understand format which makes learning this material fun and easy. After each lesson you'll take an exam. You can take it on-line or fill out one of the answer sheets we provide and mail it. After you finish the 19 lessons we'll send you a Certificate of Completion from Cleveland Institute of Electronics that's suitable for framing.

CIE Instructor Assistance with Priority Grading

Use our toll-free hot line to talk with our faculty if you ever need assistance with your lessons. Your exams will be graded and sent back to you within 24 hrs.

(800) 321-2155 or visit www.ciebookstore.com

CIE Bookstore: 1776 E. 17th, Cleveland, OH 44114 CA, HI & OH residents must add sales tax. \$5.25 shipping.



Circle #58 on the Reader Service Card.

News Bytes

to <http://www.sony.com/professional>.

Better Power Alternative for Digital Cameras That Use AA Cells

If you're tired of changing your digital camera's AA batteries every few hours or waiting for AA rechargeables to recharge when you run out of juice, Electric Fuel's new INSTANT POWER™ batteries for Olympus, Kodak, and Nikon Coolpix digital cameras will provide instant relief.

These disposable power sources deliver as much as 12 hours of continuous use — up to five times more than on-board AA alkaline batteries and considerably more than AA

rechargeables. Their 3300 mAh capacity makes it possible to take up to 4,000 digital photos without changing or recharging the battery, offering a special advantage for vacations, family celebrations and similar events involving lengthy photo sessions.

As an added benefit, INSTANT POWER batteries come fully charged and ready to use right out of the package. The digital camera batteries weigh just six ounces, plug into the camera's DC jack via a 36" cord, and attach to a built-in belt clip for easy carrying. They have a three-year shelf life when stored unopened in their original packaging, and will last up to three months between uses when resealed in the aluminum pouch provided. For more info, visit www.electric-fuel.com.

Electro Mavin

Great Buys - Great Products - Great Gadgets
Check Out Our Great WebSite at

<http://mavin.com>

For Computer Items, Hobbies Projects,
Microwave Goodies and Some of the
Greatest Prices on the Web....

800-421-2442 or FAX 310-632-3557

E-Mail

john@mavin.com or sean@mavin.com

Stepper Motor Book

Easy Step'n

- For the experimenter.
- Determine surplus stepper motor specs using simple easy to build test equipment.
- Design and build microcontroller-based control systems (flow charts and code examples included).
- Design and build stepper motor driver circuits.
- Analyze the mechanical characteristics of stepper motor-driven devices.
- The book is full of experiments, circuits and code.
- 8.5x11 format. 205 pages. \$34.95

Table Of Contents And Ordering Information On Web Site

<http://www.stepperstuff.com>

SQUARE 1 ELECTRONICS

P.O. Box 501, Kelseyville, CA 95451
Voice (707) 279-8881 Fax (707) 279-8883

We have been selling on the Internet since 1996. We will ship the day we receive your order or the next business day.

PICmicro® PIC16F87x Series and ICD Book

Easy Debug'n

- Features of PIC16F87x microcontrollers
- In-circuit debugging using Microchip ICD
- Companion for our PIC'n book series
- 8.5x11 format.
- 72 pages. \$12.95

Table Of Contents And Ordering Information On Web Site

<http://www.sq-1.com>

PICmicro® BOOKS

LEARN ABOUT MICROCONTROLLERS

Easy PIC'n - Beginner \$29.95

- Programming Techniques
- Instruction set, addressing modes, bit manipulation, subroutines, loops, lookup tables, interrupts
- Using a text editor, using an assembler, using MPLAB
- Timing and counting (timer 0), interfacing, I/O conversion

PIC'n Up The Pace - Intermediate \$34.95

- Serial communication - PICmicro to peripheral chips
- Serial EEPROMS
- LCD interface and scanning keypads
- D/A and A/D conversion - several methods
- Math routines

PIC'n Techniques - Intermediate \$34.95

- 8-pin PICmicros
- Timer 1, timer 2 and the capture/compare/PWM (CCP) module
- Talking to a PICmicro with a PC using a terminal program
- Test equipment and data logger experiments

Serial PIC'n - Advanced \$49.95

- Synchronous - bit-bang, on-chip UART, RS-232
- Asynchronous - I2C (Philips Semiconductor)
- SPI (Motorola), Microwire (National Semiconductor)
- Dallas Semiconductor 1-Wire bus

PICmicro and MPLAB are trademarks of Microchip Technology Inc.

Table Of Contents And Ordering Information On Web Site

<http://www.sq-1.com>

1/3" COLOR OUTDOOR CAMERA



Made in the USA

This camera merges the gap between bullet or lipstick cameras and full-size housings with cameras. Unlike bullet or lipstick cameras with limited features, this unit has many features only found on larger, cased cameras. The AV-48WC8 keeps the best part of the bullet/lipstick line in that they install quickly and come pre-assembled, ready for installation. Auto iris and vari-focal lens options are available upon request. We have 6 different configurations to meet your requirements for outdoor or indoor self-contained cameras.

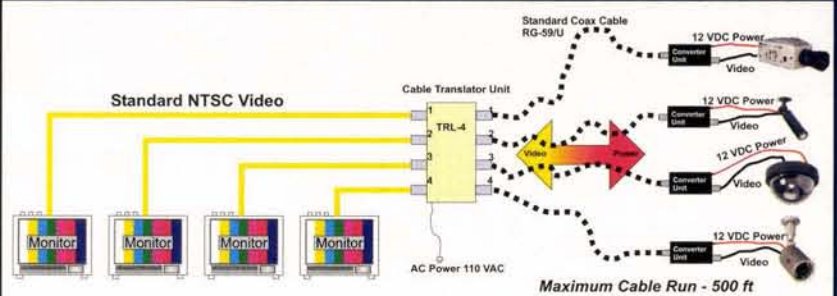
6 Configurations

- B/W: Regular, Auto Iris, Vari-Focal Lens
- Color: Regular, Auto Iris, Vari-Focal Lens

AV-48WC8 - 235.95

Industrial "O" Ring Sealed Aluminum Case

CABLE TRANSLATOR



TRL-4 This fantastic cable translator provides DC power through your existing coax cable to supply power to cameras. At the same time, and via the same cable, the video signal is received and relayed to a monitor. With four input/output connectors, this translator is very simple to install.



TRL-4 \$189.95

Converters Are Included

200mA Limit Per Channel

Maximum Cable Run - 500 ft

HIGH GAIN DIRECTIONAL PATCH ANTENNAS

The Patch or Panel Antenna elements are temperature stable with a low return loss and low frequency drift vs. temperature. They offer heavy duty use, yet are lightweight construction. Maximum wind survival speed of 180 km/h is achieved by use of a solid aluminum mounting back (DA-12, DA-18) High gain signal feature is guaranteed by the excellent VSWR specification of 1.5dB.



DA-6 - \$29.95



DA-12 - \$119.95

Visit our website for more information

USB VIDEO CONVERTER



USB-01 \$89.95

USB-01 The USB Video Converter acts as an interface for your analog video sources and converts analog output to digital for your computer. The USB Video Converter accepts high resolution SVHS video and standard composite NTSC video.

- Other features include:
- High Speed
 - Snap Shot
 - Editing Capabilities
 - Compact & Portable

- Compression Capabilities
- Two Video Inputs
- Plug-N-Play
- Independent Power Source

Call today for more information.

DIGITAL MONITORING & RECORDING SYSTEM "YOUR WEB BROWSER IS YOUR REMOTE EYE!"



The PV-140 Series turn your own PC into a commercial grade digital security system in a few minutes. The PV-140 Series integrates a color quad processor, multiple zone video motion detector, multiplexer, and a real time digital video recorder (DVR).



PV-140-A - \$299.95

- ✓ TCP/IP
- ✓ MODEM
- ✓ LAN/WAN



PV-140-B

Each card can connect up to 4 cameras.

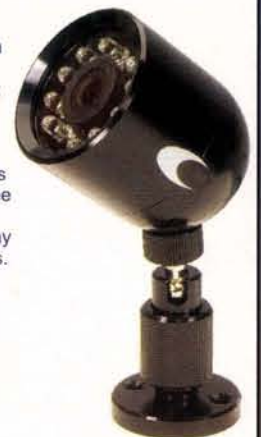


GFR-2400 - 2.4GHz Receiver - \$149.95

Works Great With Our Wireless Receivers, Too!

B/W INFRARED LIPSTICK CAMERA

Designed for surveillance applications, the LP-850W B/W Infrared Camera operates in extreme low-light conditions. Recently developed technology allows this camera to see in total darkness up to 20 feet away with built-in LEDs. Excellent for mounting on a wall or ceiling. Infrared light is controlled by an auto-sensing photo cell.



LP-850W - 99.95

Call today for more information!

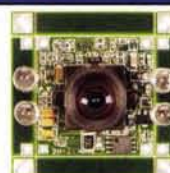
MICRO BOARD CAMERAS MANY MODELS TO CHOOSE FROM!



MB-1250HRVF
Color Varifocal
\$169.95



MB-1250P
Color Pinhole
\$89.95

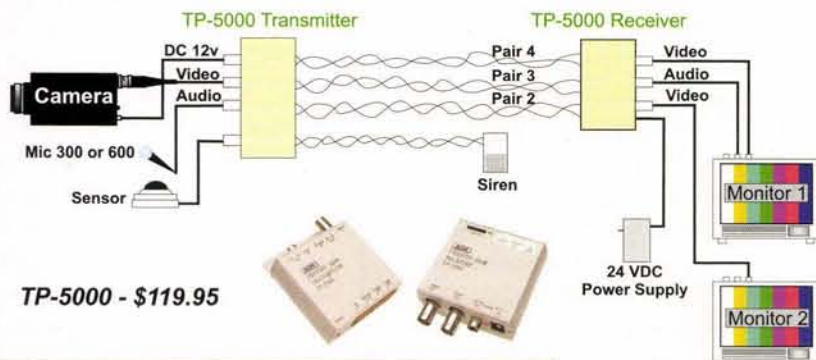


MB-810B
Infrared B/W
\$69.95



MB-650U
B/W Audio
\$39.95

LONG DISTANCE TWISTED-PAIR AV TRANSMISSION SYSTEM



TP-5000 - \$119.95

- Use Category-5 Twisted-pair Wire, Easy And Fast To Install
- Selectable 6-zone Transmission Range, Up To 1.2 Km
- Will Power Most (12vdc) Cameras, No Need For External Power At Camera Location (200m Max.)
- System Is Ready To Accept PIR Sensors Or Alarm Inputs
- Video And Audio Transmitted With Clarity And Immune From Noisy Electrical Environments

Call today for more information.

MICRO AUDIO RECEIVER

We offer two models of audio receivers or microphones. Surface mount technology and the latest in MOSFET audio amps are used in the design. Automatic Gain Control (AGC) and Dynamic Level Control (DLC) are employed to assure every sound will be picked-up while not overwhelming other sounds.

MIC-300 - \$14.95



5" COLOR WIRELESS OBSERVATION SYSTEM

ADD UP TO 3 ADDITIONAL CAMERAS!

Now you can enjoy peace of mind with our new wireless observation system. Comes with a 5" wireless color monitor, a wireless color camera. Just Plug-&-Play for perfect wireless video any time! Great for around the house, office or technical field work.



GW-2400SA - \$379.95



12 VOLT RECHARGEABLE BATTERY PACK



RBP-12V - \$69.95

There's no need to wait until your battery pack is fully discharged, you can re-charge at any time! This 12V high-capacity portable, rechargeable battery pack will operate any of our 12V cameras, transmitters and TFT Monitors. It has a charge time of 4 hours and allows for a total of 2000 re-charges.

800-752-3571

WWW.POLARISUSA.COM

POLARIS INDUSTRIES

Tech 404-872-0722 • Fax 404-872-1038

470 Armour Drive NE • Atlanta GA 30324-3943

Stamp Applications

Where In The World Is My BASIC Stamp?

A few days before I started writing this article, President Bush submitted his budget proposal to Congress. Part of the new budget calls for dramatic increases in military spending to make up for lack of technological progress in the past several years. I'm not trying to be political here. I simply want to point out that we, as civilians, do and will benefit from technology developed by our military and space programs.

Case in point: GPS, the Global Positioning System. GPS was originally developed by the military to provide precise location and navigation capabilities in a wide range of military applications. We've certainly all heard of GPS-guided "smart" bombs. The American military dropped quite a few of them on those Taliban idiots in Afghanistan. Yes, a few of them missed the mark with tragic consequences. This wasn't the fault of the weapon or the GPS system; it was a problem with the location data loaded into the bombs.

Luckily for us, the technology has been made available to the civilian world and the uses for GPS are far more friendly. GPS navigation systems in cars are very useful, particularly for those driving in an unfamiliar city. Not long ago, I went to lunch with a friend who has his car equipped with such a system. From a menu he selected his favorite restaurant and the system — using GPS and voice synthesis — "talked" us all the way there ... with a very friendly female voice, no less. He even made a deliberate mistake to show me how the system could compensate for the error. The system was very cool, telling us about approaching intersections and to be prepared to turn. It was a very impressive demonstration of GPS technology.

On a smaller scale, GPS receivers have become incredibly popular with hikers and others involved in outdoor recreational activities. One of the most popular consumer GPS units for these applications in the eTrex GPS from Garmin. Garmin actually has a family of eTrex GPS receivers. At the low end, the unit goes for about \$120.00 retail. That's not too bad for a piece of equipment that can tell you where you are on the planet with an accuracy of down to 150 feet or so — much better depending on conditions. I routinely see estimated accuracies of less than 20 feet on my eTrex. While any of the models of the eTrex family will work with this month's program, the entry-level model works just fine and is what I used to test the code.

GPS Basics

There are several excellent explanations of the GPS system on the Internet (see sidebar), so I won't go into a lot of detail here. Fundamentally, the system works like this: There are 24 GPS satellites in orbit around the planet. The orbit of these satellites is very carefully controlled by the US Department of Defense. Each satellite broadcasts the precise time (using an atomic clock) and other information required by GPS receivers. The GPS unit on the ground receives signals from

three or more satellites and, using some fairly tricky math, is able to triangulate its planetary position.

And all of this happens in a unit the size of a cellular telephone. Beyond basic position, the GPS receiver can tell us accurate time, speed, heading, and other information relevant to navigation. It's very neat stuff.

Getting Connected To The BASIC Stamp

Most GPS receivers output a stream of data so that it can be used by other devices. The most common format is NMEA 0183 (National Marine Electronics Association). This data is provided as a series of comma-delimited ASCII strings, each preceded with an identifying header. The data output rate is very tame: 4800 baud, N-8-1. This is no problem for the BASIC Stamp.

The trickiest part about connecting the eTrex to a BASIC Stamp is the mechanical connection. The eTrex uses a proprietary connector and the cables from Garmin are fairly pricey — about a third of the cost of the receiver itself. I can vouch for the quality though; they are made very well.

It seems that the popularity of the eTrex GPS has created a cottage industry of third party connector and cable manufacturers. In the web sites sidebar, you'll find a list of sites that will sell you the connectors and a variety of prefabricated cables that will work with your eTrex. For this month's program, I used the Garmin bare wire cable (#010-10205-00). You can either purchase that cable from Garmin or go the DIY route. If using the Garmin cable, the wire colors are shown in Figure 1.

Decoding The GPS Output

The purpose of the program this month is to "listen" to the GPS

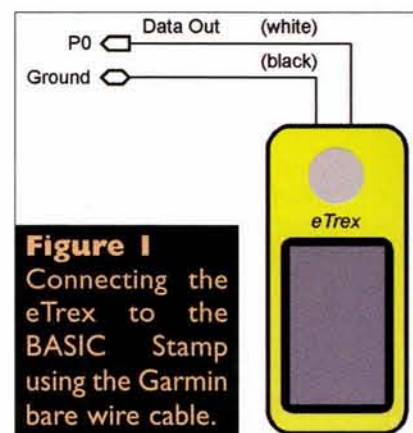


Figure 1
Connecting the eTrex to the BASIC Stamp using the Garmin bare wire cable.

output until a certain string is transmitted, grab it when it is, and then pull all the data out of it and convert it to numbers that can be used or manipulated. To do this, we will be using the BS2p. The BS2p has a (undocumented) serial modifier called SPSTR. This modifier collects serial input and saves it in the scratchpad RAM, starting at location zero. Once the string is in the scratchpad, it can be parsed and converted as required.

The main string the program waits for is called \$GPRMC — Recommended minimum specific GPS/Transit data. If you connect your eTrex to a terminal program, you'll see that the \$GPRMC sentence is the first line of several that are output every two seconds (see Figure 2). The baud rate and number of characters transmitted for all of the sentences are what determine the two-second delay between transmissions.

After I had the basic code working, I decided to add another piece: altitude. This is transmitted in the same format using a Garmin-specific string: \$PGRMZ. As it turns out, the altitude can be intercepted and decoded within the SERIN statement — without buffering it into the scratchpad RAM. And with the speed of the BS2p (program speed, not ground speed ...), there is plenty of time between the arrival of \$GPRMC and \$PGRMZ to decode the \$GPRMC data.

Stamp Applications

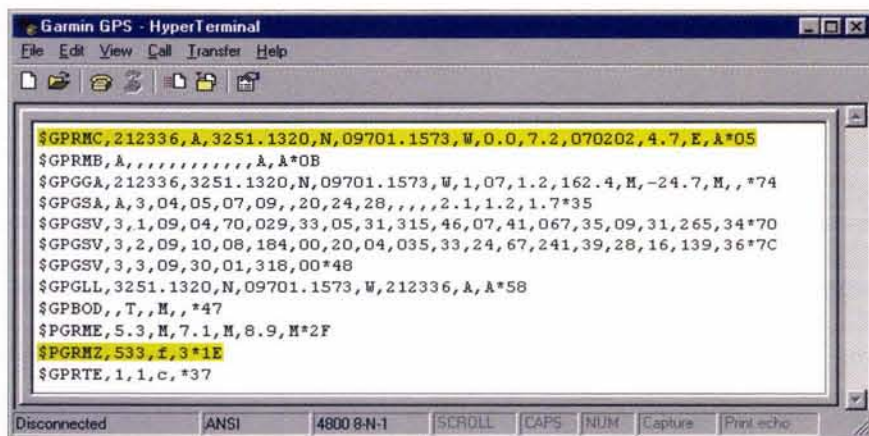


Figure 2
The \$GPRMC sentence is the first line of several that are output every two seconds.

The Code, The Code

Since the connection between the Stamp and the eTrex is electrically trivial, I'll jump right into the code. This looks like a long program but it really is fairly straightforward and there are a few neat tricks inside. Again, the purpose is to capture the GPS output and then parse out specific data and convert it to numeric form so that it can be manipulated. The output of the program is a report sent to the DEBUG screen. You can use the guts of this program as a jump-off point for your own GPS-based projects.

The Initialization section opens the DEBUG screen, draws a ruler to help us analyze the \$GPRMC sentence, and sets up some labels where the GPS data is displayed. This is all pretty easy stuff. I've started using more of the built-in formatting functions available with DEBUG. Notice the constant called MoveTo. This

code will cause the cursor to move to a specific X/Y location in the DEBUG screen. Another that is used a little later is ClrRt. The ClrRt code will clear everything from the current cursor position to the end of the current line. This code is handy for keeping the screen neat and uncluttered with old data.

The first line in the Main section does the work of waiting on the \$GPRMC sentence and storing it in the BS2p's scratchpad RAM. As you can see, the SERIN command is set up for 4800 baud with a timeout of three seconds (3,000 milliseconds). This value makes sense since the sentence should show up every two seconds. And notice that the program is actually waiting on "GPRMC," instead of "\$GPRMC" as you might expect. The reason for this is twofold: the WAIT modifier is limited to six characters and I want the first data character (position UTC) to be placed in address zero of the scratchpad.

When using SPRSTR, we have to tell the Stamp how many characters to buffer. In this case, I've

set the character count to 65. Usually, the \$GPMRC string will be about 60 characters long. I'm going to allow 65 so that when I take this project "on the road" and the variable-width speed field gets wider, everything will be captured. Be careful when using the length specification in SPSTR — it's okay if the length is specified short, too long and the Stamp will be left waiting for more characters. That's not a problem for this program since several hundred bytes of data are transmitted after the \$GPMRC string.

Now comes the real work: extracting numeric data from the string.

Some of you may have seen a little project we did at Parallax with GPS and model airplanes. Just for fun, we created a little GPS data logger from a BS2p and strapped the receiver and Stamp to the wing of a trainer aircraft. My boss, Ken, flew the plane while the program was running and when we got back to the office we were able to graph the flight path of the airplane. It was a lot of fun.

As I look back on that code, it was a bit, well ... inelegant ... and I really wanted to clean it up and make it easier to use with different GPS strings. That's what I'm presenting here.

One of the key elements of the program is a subroutine called String_To_Value. The purpose of the routine is to convert an ASCII string to a 16-bit number. The string is stored in the scratchpad. The subroutine starts by knowing the position of the first digit in the string and how many digits to

convert.

Take a look at the code. The routine starts by clearing the return variable workVal. Next, the field width is checked to make sure it falls in range. We have to be a little careful when specifying a field width of five since 65,535 is the largest value that a Stamp variable can hold.

The heart of the routine retrieves a character from the scratchpad, converts it from ASCII to a number by subtracting "0" (decimal 48), and then adds the digit value into the return variable. The field width is decremented and checked for zero. If it's zero, the routine is done and the value of the field is returned in workVal. If not, the digits in workVal are shifted left to make room for the next. Since we're dealing with decimal numbers, this is accomplished by multiplying workVal by 10. Quite a lot of the work in the program is done with this routine. After calling String_To_Value, the value is moved from workVal to the specific variable used for storage.

Just a couple notes on the numeric values. The decimal portion of the latitude and longitude values are fractional minutes. To convert fractional minutes to seconds, we multiply by 60. In the case, we actually use 0.06 to get tenths since the routine returns the fractional value multiplied by 1,000.

In the past, I've used the */ (star-slash) operator for fractional values. In this case, the ** (star-star) operator is used for better precision. Star-star can only be

Web Sites Worth Checking Out

How GPS Works

- celia.mehaffey.com/dale/theory.htm

Decoding NMEA 0183 Strings

- celia.mehaffey.com/dale/nmea.htm
- home.mira.net/~gnb/gps/nmea.html

eTrex Related

- www.garmin.com
- www.firstwaypoint.com
- www.etrax.webz.cz
- www.geocities.com/etraxkb

Alternate Sources for eTrex Cables and Connectors

- www.pfranc.com
- www.gpsmemory.com
- www.blue-hills-innovations.com

BASIC Stamps and GPS

- www.parallaxinc.com/downloads/Resources/Aero%20GPS%20Brief.PDF
- www.stoneflyers.com/gps_guided_truck.htm

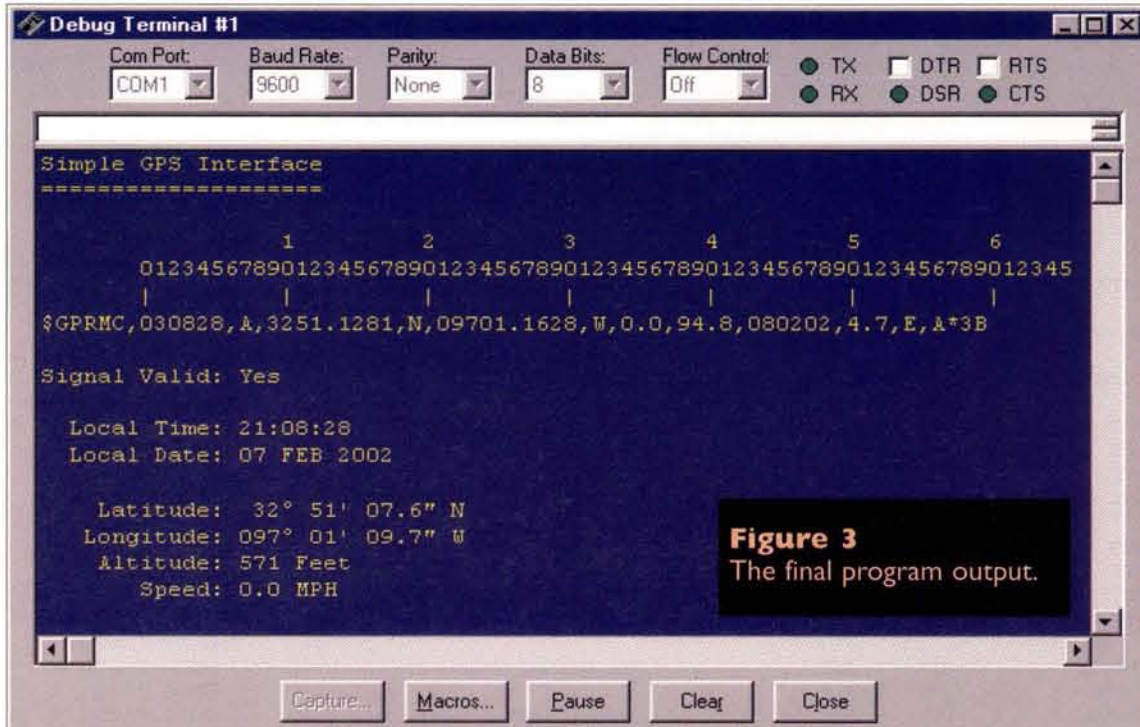


Figure 3
The final program output.

Stamp Applications

used with fractional values of less than one. To get the value for this operator, multiply the fraction by 65,536. So, $0.06 \times 65,536$ is 3932 (\$0F5C). To use a star-star with fractional values greater than one, you need to multiply the whole portion separately. Take a look at the code that converts knots to miles per hour.

The next step in the decoding process is getting the signal validity, latitude indicator, and longitude indicator. These arrive in the \$GPRMC string as letters. Since there's really no need to waste eight bits of storage for what are, essentially, binary values, the program uses a variable called flags to hold them as bits. Simple com-

parisons are used to set or clear the associated bits in flags.

Next comes speed. The speed value (knots) starts in a fixed position but is a variable-width field. The legal values are from 0.0 to 999.9. Decoding speed is not much different from what has previously been done — the difference, of course, is that the field width is not known. The routine `Mixed_To_Tenths` deals with this problem by looking for the decimal point in the field. Since the decimal point is expect-

ed, the return value is in tenths.

The last bit of data that I want to collect from the \$GPRMC string is the location date. This is a fixed-width field, but is it located after the variable-width speed field so finding it requires a strategy. The way it's done in this program is by counting the field-delimiting commas. I created a subroutine called `Move_To_Field` to handle this. To use the routine, I put the field number in field, then call the routine. When it RETURNS, the variable `idx` holds

Author's Note: For more hints and tricks on using star-star, be sure to visit Dr. Tracy Allen's web site. Tracy is the coolest Ph.D. you'll ever meet — a Stamp guru and a real regular guy!
www.emesys.com/BS2math1.htm

```
' -----[ Title ]-----
'
' File..... SIMPLE GPS.BSP
' Purpose... Simple GPS Interface
' Author.... Jon Williams
' E-mail.... jonwms@aol.com
' Started... 16 JUL 2001
' Updated... 07 FEB 2002

' {$STAMP BS2p}

' -----[ Program Description ]-----
'
' Reads NMEA data string from GPS receiver and parses data. GPS string is
' buffered into scratchpad RAM with SPSTR modifier. Once in SPRAM, data is
' parsed out based on its position.

' $GPRMC,POS_UTC,POS_STAT,LAT,LAT_D,LON,LON_D,SPD,HDG,DATE,MAG_VAR,MAG_REF,*CC
'
' POS_UTC - UTC of position. Hours, minutes and seconds. (hhmmss)
' POS_STAT - Position status. (A = Data valid, V = Data invalid)
' LAT      - Latitude (ddmm.ffff)
' LAT_D    - Latitude direction. (N = North, S = South)
' LON      - Longitude (dddmm.ffff)
' LON_D    - Longitude direction (E = East, W = West)
' SPD      - Speed over ground. (knots) (0.0 - 999.9)
' HDG      - Heading/track made good (degrees True) (x.x)
' DATE     - Date (ddmmyy)
' MAG_VAR  - Magnetic variation (degrees) (x.x)
' MAG_REF  - Magnetic variation (E = East, W = West)
' *CC      - Checksum

' Custom Garmin string:
'
' $PGRMZ,ALT,F,X*CC
'
' ALT,F    - Altitude in feet
' X        - Position fix dimensions (2 = user, 3 = GPS)
' *CC      - Checksum

' -----[ Revision History ]-----
'
' -----[ I/O Definitions ]-----
'
GPSpin      CON      0          ' GPS serial input

' -----[ Constants ]-----
'
N4800       CON      16884      ' baud rate for GPS

MoveTo       CON      2          ' DEBUG positioning command
LF           CON      10         ' linefeed
ClrRt        CON      11         ' clear line right of cursor

EST          CON      -5         ' Eastern Standard Time
CST          CON      -6         ' Central Standard Time
MST          CON      -7         ' Mountain Standard Time
PST          CON      -8         ' Pacific Standard Time

EDT          CON      -4         ' Eastern Daylight Time
CDT          CON      -5         ' Central Daylight Time
MDT          CON      -6         ' Mountain Daylight Time
PDT          CON      -7         ' Pacific Daylight Time

UTCfix       CON      CST        ' for Dallas, Texas
Comma        CON      ", "       '
DegSym       CON      176        ' degrees symbol for report

MinSym       CON      39         ' minutes symbol
SecSym       CON      34         ' seconds symbol

' -----[ Variables ]-----
'
idx          VAR      Byte       ' index into GPS data in SPRAM
flags        VAR      Byte       ' holds bit values
valid        VAR      Flags.Bit3 ' is data valid?

tmHrs        VAR      Byte       ' time fields
tmMins       VAR      Byte
tmSecs       VAR      Byte

latDeg       VAR      Byte       ' latitude
latMin       VAR      Byte
latSec       VAR      Word
latNS        VAR      flags.Bit0 ' 0 = N

longDeg      VAR      Byte       ' longitude
longMin      VAR      Byte
longSec      VAR      Word
longEW       VAR      flags.Bit1 ' 0 = E

speed         VAR      Word       ' in tenths of mph
altitude      VAR      Word       ' in feet

day           VAR      Byte       ' day of month, 1 - 31
month         VAR      flags.Nib1 ' month, 1 - 12
year          VAR      Byte       ' year, 00 - 99

char          VAR      Byte       ' byte pulled from SPRAM
workVal       VAR      Word       ' for numeric conversions
eeAddr        VAR      workVal    ' pointer to EE data

field         VAR      Nib        ' field #
fldWidth      VAR      field      ' width of field

' -----[ EEPROM Data ]-----
'
NotValid      DATA      "No", 0
IsValid       DATA      "Yes", 0
DaysInMon     DATA      31,28,31,30,31,30,31,31,30,31,30,31
MonNames      DATA      "JAN",0,"FEB",0,"MAR",0,"APR",0,"MAY",0,"JUN",0
                DATA      "JUL",0,"AUG",0,"SEP",0,"OCT",0,"NOV",0,"DEC",0

' -----[ Initialization ]-----
'
Initialize:
  PAUSE 250          ' let DEBUG open
  DEBUG CLS          ' clear the screen
  DEBUG "Simple GPS Interface",CR
  DEBUG "===== "

Draw_Ruler:
  FOR idx = 0 TO 65
    IF (idx = 0) THEN Print_Ones
    IF (idx // 10) > 0 THEN Print_Ones
    DEBUG MoveTo, (7 + idx), 3, DEC1 (idx / 10)
  Print_Ones:
    DEBUG MoveTo, (7 + idx), 4, DEC1 (idx // 10)
  Print_Ticks:
    IF (idx // 10) > 0 THEN Next_Digit
    DEBUG MoveTo, (7 + idx), 5, "|"
  Next_Digit:
    NEXT

Draw_Data_Labels:
  DEBUG MoveTo, 0, 8, "Signal Valid: "
  DEBUG MoveTo, 0, 10, "Local Time: "
  DEBUG MoveTo, 0, 11, "Local Date: "
```


the position of the first digit in that field. Once the position of the date field is known, the rest is easy.

One last thing to do with the \$GPRMC data ... I live in Dallas, TX, which is six hours behind UTC time reported by the GPS receiver. Correcting for the offset isn't very hard, it just takes a bit of code because there may be a date change as well. The time and date correction code looks for a day cross, then adds or subtracts a day based on the UTC offset specified by the program. The only thing this code doesn't do is account for leap years.

Since negative values are stored in two's-complement form, bit 15 will be set in negative numbers. This fact is used by the BRANCH line to direct the code to adding or subtracting a day — with month and year correction, if necessary.

I mentioned earlier that we've played with attaching GPS units to model airplanes. Doing that, it would be nice to know the altitude. One thing to understand is that GPS altitude from civilian

receivers is terribly inaccurate, but we're willing to pull it out anyway. Later, we'll experiment with some of the higher-end Garmin units that have barometric altimeters for better accuracy.

The altitude is broadcast in the Garmin-specific \$PGRMZ string. The cool thing about this is that it's a whole value in a single field so we can grab it on-the-fly using the DEC modifier. When the comma after the altitude field is hit, DEC terminates and the value is stored in altitude.

We Got It, Let's Show It

Okay, now the latest \$GPRMC string is safely stored in RAM, its data is parsed out, so it's time to display the results of the program's cool code. First comes the display of the raw \$GPRMC string. The display routine is fairly simple. Since the header isn't actually captured with SERIN, it gets printed manually. Then, one-by-one, characters are retrieved (with GET) from the scratchpad and displayed on screen. Remember that these are ASCII characters so

there is no conversion requirement.

Since the string length can vary, what the program does is look for the asterisk which comes right before the two-digit checksum. Once the asterisk is detected and printed, it's a simple matter to GET and print the next two characters. Finally, the rest of the line is cleared with ClrRt in case the current string was shorter than the previous.

Next, the signal validity is printed. To make the display a little user-friendly, zero-terminated strings are stored in EEPROM and printed using Print_Z_String. If the signal was good, the values are printed, otherwise the screen is cleared. Done! The final output of the program is shown in Figure 3. Notice that the time and date have been corrected for the six-hour difference between Dallas and UTC time.

What Will You Do With It?

Okay, it's your turn. Now that you know how to get GPS data into your Stamp, what will you do

Resources:

Jon Williams

jonwms@aol.com

Parallax

599 Menlo Drive, Suite 100

Rocklin, CA 95756

(888) 512-1024

www.parallaxinc.com

with it? Me? Well, I'm thinking about driving to my brother's house in Ohio this summer so I have this idea about creating a "head up" speedometer reading (reflecting large seven-segment displays off the front windshield) and, using a Quadravox QV306, having the system tell me the time, inside and outside temperatures, estimated time to my next waypoint ... and anything else I can figure out. It should be fun. If it works like I hope, I'll write about it when I get back to "Big D."

Until next month, have fun with GPS and Happy Stamping!
NV

```

DEBUG MoveTo, 0, 13, "    Latitude: "
DEBUG MoveTo, 0, 14, "    Longitude: "
DEBUG MoveTo, 0, 15, "    Altitude: "
DEBUG MoveTo, 0, 16, "    Speed: "

' -----[ Main Code ]-----
Main:

' wait for $GPRMC string and store data in SPRAM

SERIN GPSPin, N4800, 3000, No_GPS_Data, [WAIT("GPRMC,"), SPSTR 65]
GOSUB Parse_GPS_Data      ' extract data from SPRAM

' wait for GARMIN custom string
' -- use DEC to extract altitude

Get Altitude:
SERIN GPSPin, N4800, 2000, Show_GPMRC_String, [WAIT("PGRMZ,"), DEC altitude]

Show_GPMRC_String:
DEBUG MoveTo, 0, 6, "$GPRMC,"      ' print header
idx = 0                          ' start at position UTC

Print_GPRMC_Char:
GET idx, char                    ' print the $GPRMC data string
DEBUG char                      ' get char from SPRAM
IF char = "*" THEN Print_Checksum ' display it
idx = idx + 1                   ' look for checksum indicator
GOTO Print_GPRMC_Char           ' point to next char

Print_Checksum:
GET (idx + 1), char              ' get first checksum char
DEBUG char                      ' display
GET (idx + 2), char              ' get second checksum char
DEBUG char, ClrRt                ' display, clear to end of line

Show_Report:
DEBUG MoveTo, 14, 8              ' was the signal valid?
LOOKUP valid, [NotValid, IsValid], eeAddr ' get answer from EE
GOSUB Print_Z_String             ' print it
DEBUG ClrRt                      ' clear end of line
IF (valid = 0) THEN Signal_Not_Valid

Signal_Is_Valid:
DEBUG MoveTo, 14, 10, DEC2 tmHrs, ":", DEC2 tmMins, ":", DEC2 tmSecs
DEBUG MoveTo, 14, 11, DEC2 day, " "
```

```

eeAddr = (month - 1) * 4 + MonNames ' get address of month name
GOSUB Print_Z_String                 ' print it
DEBUG " 20", DEC2 year

DEBUG MoveTo, 15, 13, DEC2 latDeg, DegSym, " ", DEC2 latMin, MinSym, " "
DEBUG DEC2 (latSec / 10), ".", DEC1 (latSec // 10), SecSym, " "
DEBUG "N" + (latNS * 5)

DEBUG MoveTo, 14, 14, DEC3 longDeg, DegSym, " ", DEC2 longMin, MinSym, " "
DEBUG DEC2 (longSec / 10), ".", DEC1 (longSec // 10), SecSym, " "
DEBUG "E" + (longEW * 18)

DEBUG MoveTo, 14, 15, DEC altitude, " Feet"
DEBUG MoveTo, 14, 16, DEC (speed / 10), ".", DEC1 (speed // 10), " MPH "
GOTO Main

Signal_Not_Valid:
DEBUG MoveTo, 14, 10, "?", ClrRt      ' clear all fields
DEBUG MoveTo, 14, 11, "?", ClrRt
DEBUG MoveTo, 14, 13, "?", ClrRt
DEBUG MoveTo, 14, 14, "?", ClrRt
DEBUG MoveTo, 14, 15, "?", ClrRt
DEBUG MoveTo, 14, 16, "?", ClrRt
GOTO Main

' -----[ Subroutines ]-----
No_GPS_Data:
DEBUG CLS, "Error: No GPS data detected"
PAUSE 2500
GOTO Initialize      ' try again

Parse_GPS_Data:
idx = 0 : fldWidth = 2      ' UTC hours
GOSUB String_To_Value
tmHrs = workVal

idx = 2 : fldWidth = 2      ' UTC minutes
GOSUB String_To_Value
tmMins = workVal

idx = 4 : fldWidth = 2      ' UTC seconds
GOSUB String_To_Value
tmSecs = workVal

idx = 9 : fldWidth = 2      ' latitude degrees
GOSUB String_To_Value
```


Stamp Applications

```

latDeg = workVal

idx = 11 : fldWidth = 2          ' latitude minutes
GOSUB String_To_Value
latMin = workVal

idx = 14 : fldWidth = 4          ' latitude fractional minutes
GOSUB String_To_Value
latSec = workVal ** $0F5C        ' x 0.06 --> tenths of seconds

idx = 21 : fldWidth = 3          ' longitude degrees
GOSUB String_To_Value
longDeg = workVal

idx = 24 : fldWidth = 2          ' longitude minutes
GOSUB String_To_Value
longMin = workVal

idx = 27 : fldWidth = 4          ' longitude fractional minutes
GOSUB String_To_Value
longSec = workVal ** $0F5C        ' x 0.06 --> tenths of seconds

' get non-numeric data

Get_Valid:
  GET 7, char
  valid = 1
  IF (char = "A") THEN Get_Lat_Dir
  valid = 0

  ' assume valid
  ' it is, so skip
  ' set to 0 if not valid

Get_Lat_Dir:
  latNS = 0
  GET 19, char
  IF (char = "N") THEN Get_Long_Dir
  latNS = 1

  ' assume North
  ' check it
  ' confirm
  ' set to 1 if South

Get_Long_Dir:
  longEW = 0
  GET 33, char
  IF (char = "E") THEN Get_Speed
  longEW = 1

  ' assume East
  ' check it
  ' confirm
  ' set to 1 if West

' get variable length data

Get_Speed:
  idx = 34
  GOSUB Mixed_To_Tenths
  ' speed = workVal
  speed = workVal + (workVal ** $2699)

  ' convert "xxx.x" to number
  ' speed in knots (tenths)
  ' x 1.1507771555 for mph

' get date
' -- past variable data, so we need to use field search

Get_Date:
  field = 8
  GOSUB Move_To_Field
  PUT 125, idx

  ' set field to find
  ' go get position
  ' save date position

  fldWidth = 2
  GOSUB String_To_Value
  day = workVal

  ' UTC day, 1 - 31

  GET 125, idx
  idx = idx + 2 : fldWidth = 2
  GOSUB String_To_Value
  month = workVal

  ' get stored position
  ' UTC month, 1 - 12

  GET 125, idx
  idx = idx + 4 : fldWidth = 2
  GOSUB String_To_Value
  year = workVal

  ' get stored position
  ' UTC year, 0 - 99

' adjust date for local position

Correct_Local_Time_Date:
  workVal = tmHrs + UTCfix
  IF (workVal < 24) THEN Adjust_Time
  workVal = UTCfix
  BRANCH workVal.Bit15, [Location_Leads, Location_Lags]

  ' add UTC offset
  ' midnight crossed?
  ' yes, so adjust date

Location_Leads:
  day = day + 1
  eeAddr = DaysInMon * (month - 1)
  READ eeAddr, char
  IF (day <= char) THEN Adjust_Time
  month = month + 1
  day = 1
  IF (month < 13) THEN Adjust_Time
  month = 1
  year = year + 1 // 100
  GOTO Adjust_Time

  ' east of Greenwich
  ' no, move to next day
  ' get days in month
  ' in same month?
  ' no, move to next month
  ' first day
  ' in same year?
  ' no, set to January
  ' add one to year

Location_Lags:
  day = day - 1
  IF (day > 0) THEN Adjust_Time

  ' west of Greenwich
  ' adjust day
  ' same month?

month = month - 1
IF (month > 0) THEN Adjust_Time
month = 1
eeAddr = DaysInMon * (month - 1)
READ eeAddr, day
year = year + 99 // 100

' same year?
' no, set to January
' get new day
' set to previous year

Adjust_Time:
  tmHrs = tmHrs + (24 + UTCfix) // 24
  RETURN

  ' localize hours

' *****
' Convert string data (nnnn) to numeric value
' -- idx - location of first digit in data
' -- fldWidth - width of data field (1 to 5)
' -- workVal - returns numeric value of field
' *****

String_To_Value:
  workVal = 0
  IF (fldWidth = 0) OR (fldWidth > 5) THEN String_To_Value_Done

Get_Field_Digit:
  GET idx, char
  workVal = workVal + (char - "0")
  fldWidth = fldWidth - 1
  IF (fldWidth = 0) THEN String_To_Value_Done
  workVal = workVal * 10
  idx = idx + 1
  GOTO Get_Field_Digit

  ' get digit from field
  ' convert, add into value
  ' decrement field width
  ' shift result digits left
  ' point to next digit

String_To_Value_Done:
  RETURN

' *****
' Convert string data (nnn.n) to numeric value (tenths)
' -- idx - location of first digit in data
' -- workVal - returns numeric value of field
' *****

Mixed_To_Tenths:
  workVal = 0

Get_Mixed_Digit:
  GET idx, char
  IF (char = ".") THEN Get_Mixed_Last
  workVal = (workVal + (char - "0")) * 10
  idx = idx + 1
  GOTO Get_Mixed_Digit

  ' read digit from speed field
  ' skip decimal point
  ' add digit, move data left
  ' point to next digit

Get_Mixed_Last:
  GET (idx + 1), char
  workVal = workVal + (char - "0")
  RETURN

  ' point to tenths digit
  ' workVal is in tenths

' *****
' Find field location after variable-length data (i.e., speed)
' -- field - field number
' -- idx - returns position of first digit in field
' *****

Move_To_Field:
  idx = 0
  IF (field = 0) THEN Move_To_Field_Done

  ' if zero, we're there

Get_Char:
  GET idx, char
  IF (char = ",") THEN Found_Comma
  idx = idx + 1
  GOTO Get_Char

  ' get char from SPRAM
  ' is it a comma?
  ' no, move to next char

Found_Comma:
  field = field - 1
  idx = idx + 1
  IF (field = 0) THEN Move_To_Field_Done
  GOTO Get_Char

  ' was comma, dec field counter
  ' point to next char
  ' if field = 0, we're there

Move_To_Field_Done:
  RETURN

' *****
' Print Zero-terminated string stored in EEPROM
' -- eeAddr - starting character of string
' *****

Print_Z_String:
  READ eeAddr, char
  IF (char = 0) THEN Print_Z_String_Done
  DEBUG char
  eeAddr = eeAddr + 1
  GOTO Print_Z_String

  ' get char from EE
  ' if zero, we're done
  ' print the char
  ' point to the next one

Print_Z_String_Done:
  RETURN

```


Micro Memories

There's a scene near the end of TNT's 1999 made-for-TV movie "Pirates of Silicon Valley" which portrays Bill Gates (played by Anthony Michael Hall) and Steve Jobs (Noah Wylie) as the Austin Powers and Dr. Evil of the computing world — where Jobs realizes that Gates, in the middle of developing software compatible with Apples, also has a soon-to-be-released graphical operating system called Windows, designed to compete with the Macintosh.

Jobs: What is this? This is like doing business with ahhh-like a praying mantis, huh? You get seduced, and then eaten alive afterwards?

Gates: Get real, will ya? You and I are both like guys that had this rich neighbor — Xerox — that left the door open all the time. And you go sneaking in to steal the TV set. Only when you get there, you realize that I got there first. I got the loot, Steve! And you're yelling, "that's not fair! I wanted to try and steal it first!"!?!?

Like most movies, it's a compressed and simplified version of what really happened. But there's no doubt that the subtext of the scene is absolutely true: Whether you're a Mac or a Windows user, your computer owes a big debt to the folks at Xerox's Palo Alto Research Campus, more popularly known as PARC.

Putting It All Together

The engineers at PARC didn't invent all of its components (though they did invent a lot of them), but in the early 1970s, they built the Alto, the first computer that brought together everything computer users today take for granted: a stand-alone computer (rather than a shared mainframe) with a graphical user interface, being viewed on a CRT, controlled by both a mouse and a keyboard, able to do what-you-see-is-what-you-get (WSYWIG) word processing, able to cut and paste text. And it printed it to a laser printer, which was connected via Ethernet.

Sound familiar? Sound exactly like the computers we see today in our homes and offices? How all this

came about — and the end result — is a legendary story of Silicon Valley. Chris Garcia, the Historical Collections Coordinator of the Computer History Museum (see the July 2001 *Nuts & Volts*) says, "The whole Xerox PARC thing is probably more important than any other story in computing, from the 1970s."

Alan Kay, arguably the chief visionary behind the Alto, called it "the time machine," and indeed, it did appear to be something from the future. It marks the watershed from which the old, pre-1970s paradigm of computing, built around big, shared mainframes, with difficult to use input devices, gave way to personal computers (a term invented by Kay). The one computer for one person concept began at Xerox PARC.

\$7,000.00 for the Memory Alone

Of course, nowadays, lots of people have more than one PC. Their prices have dropped to the point where an under \$500.00 PC is more than powerful enough for millions of people, and allows millions more to have multiple PCs in homes and small businesses, connected to each other via Ethernet. But when the Alto was envisioned, the memory for it alone cost \$7,000.00. The 1979 versions of the Altos were equipped with up to 512 kilobytes of RAM — an astonishingly tiny size when compared to the hundreds of megabytes which today's PCs routinely ship with (keep that in mind, next time there's a \$39.95 for 256MB of RAM sale at the local CompUSA). "We were thought to be the most reckless and profligate people in the world for having 512K bytes when we went out the door," David Liddle, one of the developers of the Alto and its later commercial version, the Xerox Star recently joked.

Garcia says, "They were sort of trying to make the microcomputer, as we know it today, using materials from the '70s. It also used Diablo disk packs — big old single disk packs — that were probably, I think, 18 inches across."

Garcia says the Altos "were really, really slow, and if you were doing a drawing, or say, mapping a trajectory (there was a game on there, where you tried to shoot a little target along the way, and you could do some really complex stuff



The Star and Alto

with it), one of the ways you would make it speed up was turn off your monitors."

Err, doesn't that sort of defeat the purpose of a computer game, you have to turn the monitor off? "Well, you didn't have to, it just sped it up by about five minutes!" Garcia says.

The Birth of WSYWIG

Of course, the Alto was never designed to compete with the first video games that Nolan Bushnell and Atari were building up the road in Sunnyvale. Much of the Alto's revolutionary hardware and software was built around word processing. Michael Hiltzik, the author of *Dealers of Lightning: Xerox PARC and the Dawn of the Computer Age* (HarperBusiness, 2000. ISBN: 0887309895), an invaluable and in-depth look at the history of PARC says, "Word processing was the most important thing, because it was something that these guys understood well, as a program that had a great deal of utility." Even the monitors on the Alto and the Star were designed, portrait style, to represent an 8 x

11-1/2 piece of paper standing up.

The PARC engineers would show their Altos to friends who would frequently respond by saying, "Hey, I've got a paper due. Can I write it on your Alto?" The engineers at PARC would sneak their friends in, in the middle of the night to write papers on their Altos, who would then marvel at how professional their papers would look as they were ejected from a laser printer connected via Ethernet.

Hiltzik says, "the engineers at PARC could see their friends going nuts about this, and they knew that this was going to be a major thing. And you had people like Chuck Geschke and John Warnock, who were graphics experts, who began to develop fonts, and solve the problem of sizing fonts on the screen, and creating them in a way to get the what-you-see-is-what-you-get effect, and they went off and founded Adobe on that principle."

Another Xerox PARC engineer, Charles Simonyi wrote Bravo, the original word processing program for the Alto. Eventually, Hiltzik says, Simonyi "got hired as like employee number 40 at Microsoft, and brought Bravo with him. And he

then converted Bravo to what is today Microsoft Word. And I believe that it's said that there's still code in the source code to Word that you can trace back to Bravo."

The Time Machine Gets Run Over

If their technology was so good, why did Xerox get run over by Apple and Microsoft? In a nutshell, economics.

Xerox released the Star — the commercial version of the Alto — in

April 1981. It was targeted at Fortune 500-type corporations, using the same marketing models by which they successfully sold their copiers for many years. Unfortunately, Xerox set the price for the Star at \$16,000.00 a pop, and aimed it at executives.

Hiltzik says "They put 30,000 of these units out into the marketplace, and I talked to people whose secretaries had them, and who loved them — they never wanted to give them up. And it was a radical departure from anything anybody

had ever seen."

So what was the problem they ran into? Four months after the Star was released, in August of 1981, the IBM PC was launched. "Compared to Star, it was a flint age device," Hiltzik says. There were no graphics, very little power, no connectability to other machines, much less a laser printer, but they were selling for \$2,000.00 to \$5,000.00 each, making them much, much cheaper than the Star. "With the IBM PC," Hiltzik says, "not only could you equip a secretary

with a \$3,000.00 or \$4,000.00 piece of equipment, you could give it to her boss, too."

And, of course, prior to that, Steve Jobs of Apple toured PARC, along with several of his engineers. And several of Xerox's PARC employees, soon began taking jobs with Apple and Microsoft, and taking their engineering alchemy with them.

And the rest is history. The rich neighbor had been broken into, and the young pirates of Silicon Valley were off and running. **NV**

www.gatewayelec.com

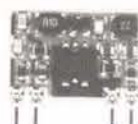
(Electronically Speaking, Gateway's Got It!)



MAIL ORDERS CALL TOLL-FREE 1-800-669-5810

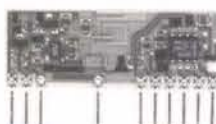
Circle #74 on the Reader Service Card.

RF Data Modules



AM TRANSMITTER

- Small size: 17.78 x 11.43mm
- CMOS/TTL input
- No adjustable components
- Low Current, 4mA typical
- 418MHz or 433.92MHz OOK
- Simple to integrate - simply add antenna, data and power
- Range up to 250ft.
- Wide supply range, 2-14Vdc
- SAW controlled - stability
- Also available in DIP package



AM RECEIVER

- Compact size: 38.1 x 13.7mm
- On-board data recovery, CMOS
- Low current, 2.4mA typical
- 2kHz data rate, CMOS/TTL output
- 5Vdc operation
- On 418MHz or 433.92MHz (4xx)
- No adjustable components
- Patented Laser Trimmed component
- High stability
- Sensitivity: -105dBm
- Available also in 0.8mA version

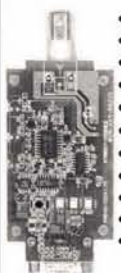


FM TRANSCIVER

- Only 23 x 33 x 11mm
- Up to 40k bps data rate
- 19200 baud with ASCII
- Up to 500ft. range
- 5v operation
- 0.25mW into 50
- 418 or 433MHz FM
- Fast 1ms enable
- Direct interface to 5V CMOS
- Auto TX/RX changeover

AM-RT5 \$12.10 AM-HRR3-4xx \$10.95 BIM-4xx-F \$87.36

RS232 TRANSCEIVER MODULES



- 4,800 to 38,400 bps half duplex
- 3-wire RS232 interface
- μ Controller with user EEPROM
- RS232 interface protected to $\pm 15kV$
- Data packetizing performed by user
- Auto TX/RX changeover
- 418 MHz and 433MHz versions
- Range up to 500ft. (0.25mW ver.)
- 0.25mW & 10mW versions
- Reset switch and status LED's
- 7.5-15V dc via DB9 connector, 20mA



Transceiver.....
Transmitter.....
Receiver.....

- Up to 19,200 bps half duplex
- 3 wire RS232 interface
- Range up to 500ft
- Transparent data packetizing
- Supports 8 or 9 bit protocols
- Self test function
- Reset Switch & Status LED's
- 1/4 wave wire antenna on board
- Available in a Simplex Tx/Rx pair.(RTcomTX & RTcomRx)
- 7.5V-15Vdc operation

RTcom-4xx..... \$247.90
RTcomTx-4xx..... \$ 87.15
RTcomRx-4xx..... \$105.52

BIM-4xx-RS232 \$139.30



ABACOM
TECHNOLOGIES

Free Catalog

Tel: (416)236-3858
Fax: (416)236-8866
www.abacom-tech.com
abacomtech@compuserve.com

PICmicro[®] MCU COMPILER

A high order language with extraordinary optimization specifically designed for the PICmicro[®] MCU.

CUSTOM COMPUTER SERVICES, INC.

- Access to all PICmicro MCU hardware features from C.
- Built-in libraries that work with all chips for RS232 serial I/O, I²C, discrete I/O and precision delays.
- Source code drivers and ready to run programs included for LCD modules, keypads, 24xx and 93xx serial E² PROMS, X10, DS1302 & NUU6355 Real Time Clocks, Dallas Touch Memory Devices, DS2223 & PCF 8570 serial SRAM, LTC1298 & PCF8591 A/D converters and more.
- Integrates with simulators/emulators such as MPLAB.

LINUX COMPILERS ALSO AVAILABLE

```
#include <PIC16C56.h>
#define delay(clock) 200000000
#define rs232 (baud=9600,unit=pin.A1, rcvpin.A2)
main () {
    printf ("press any key to begin\n");
    getc();
    printf ("*1 khr signal activated\n");
    while (TRUE) {
        output_high (pin.BB);
        delay_us (500);
        output_low (pin.BB);
        delay_us (500);
    }
}
```

PCB Compiler for 12 Bit
OPCODE Chips \$ 99
PCM Compiler for 14 Bit
OPCODE Chips \$ 99
PCH Compiler for 16 Bit
PIC18 Chips \$ 99
PCW Compiler Professional
Package
Windows IDE CD-Rom with
both PCB / PCM \$ 350
PIC18 PCW add on (PCI) \$ 50

MENTION THIS AD
WITH YOUR ORDER
AND RECEIVE A
FREE
NIGEL GARDNER
PIC C BOOK

CUSTOM COMPUTER
SERVICES, INC.

P.O. Box 9452 • Brookfield, WI 53008
262-797-0455 ext. 35 • FAX: 262-797-0459
http://www.pic-c.com
EMAIL: ccs@ccinfo.com

NEW! CREDIT CARD COMPUTER II



MVS PLUG-N-GO[™] no cables/power supply to buy!
Low-power RISC cpu 10x faster than PIC. Z80. 8051
4m FLASH,ser.par,RTCC,4ch 12bit ADC,ISA104 bus
Built-in BASIC/Assembly, other compilers available
Friendly instructions, RS232 download (DOS/WIN)
Eval kit (1) \$75, oem (1k) \$21, CC computer I \$14.20

\$95 UNIVERSAL SINGLE CHIP COMPUTER PROGRAMMER



Lowest cost, fastest, easiest
to use! Do FLASH,NVRAM,
EEPROM to 8m. Adapters
for micros,plc,etc. Optional
gang banger for up to 10 ICs.
Parallel port version available
for notebooks. UV eraser \$95

ZERO external components!
Built-in BASIC / Assembly
RS232 program download
1K flash, 64ee, 3irq, 2timers
15 i/o bits, ADC, 20pin DIP
20mips, faster than PIC/z80
oem(1k): eval kit(1):
\$1.99 \$7.00



NEW! 8K
SUPER CHIP
40x the BASIC pgm space
32 i/o, 12irq, 3timers, bus
8K flash, 512ee, 512nvram
watchdog w/internal timer
40 pin DIP part #MV8515
eval(1) \$25, oem(1k) \$7.10

SERIAL MINI-TERMINAL \$27 MINI-PC



RS232 terminal for Stamp, PC, Z80, AVR etc.
-super low current, powers from serial line
-LED backlit LCD, visible in all conditions
-115.2kpbs, DB9 conn, simple commands
-specify 20 customizable or 16 tactile keys
eval(1) \$75,oem(1k) \$21.30,w/BASIC cpu \$27



Includes DOS, ADC, 2par, 3ser,
ISA bus, keypad/LCD interface.
Complete! not a "core/engine"
All utilities & tutorial included.
Use TurboC,BASIC,MASM etc.
eval kit (1) \$95, oem (1k) \$27
386 version eval \$195, oem \$55

STAMP DRIVE !!



Read/Write PC compatible hard
disk, PCMCIA, Compact Flash,
RS232 to ATA adapter for Stamp,
Z80,8051,AVR,PIC,x86. ANY cpu
- 4 gigabyte capacity
- low power (5ma @5v)
- baud 115.2k and above
eval \$95,oem \$27,IDE ver. \$14.20

WWW.STAR.NET/PEOPLE/~MVS

MVS Box 803
Nash.,NH 03060
(508) 792 9507



5yr Limited Warranty
Free Shipping
Mon-Fri 10-6 EST

SERVING THE EMBEDDED
COMMUNITY SINCE 1979!

TECH FORUM

QUESTIONS

How can I measure the voltage and frequency of the discharge from a Tesla coil? It utilizes solid-state components and a flyback transformer. I assume the voltage to be several thousand volts and the frequency to be about 60 KHz.

I have access to an o-scope, frequency counter, and an assortment of multimeters.

**3021 Victor Maciejewski
Rochester, NY**

I help out my local school system from time to time and recently installed an independent PA system in the gymnasium. I would like to tie this system into the

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

Send all material to *Nuts & Volts Magazine*, 430 Princeland Court, Corona, CA 92879, OR fax to (909) 371-3052, OR email to forum@nutsvolts.com

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. Be sure to include your mailing address if responding by email or we can not send payment.
- Your name, city, and state, will be printed in the magazine, unless you notify us otherwise. If you want your email address printed also, indicate to that effect.
- The question number and a short

summary of the original question will be printed above the answer.

- Unanswered questions from a past issue may still be responded to.
- Comments regarding answers printed in this column may be printed in the Reader Feedback section if space allows.

QUESTION INFO

To be considered

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

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

Information/Restrictions

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

Helpful Hints

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

school-wide PA system so that when there is a school-wide announcement, it could use the speaker system that is in place in the gym.

The Gym teacher uses the gym PA system to play music during class and it would be really nice to have the gym speaker system switch to the school-wide PA during those school-wide announcements.

**3022 Rick Simard
Freeport, ME**

I've admired radio clocks for a while. I plan to make a PIC clock next. Is there a chip I can integrate in for self-setting time?

**3023 Matt Maberino
via Internet**

Does someone have a good schematic and parts list of a PC-based stepper motor controller that a beginner could build for a three-axis controller? Or where can I find a kit?

**3024 Les
les@antigopro.net**

I have a 5.7" LCD display made by AND and I need the pin out assignment. The part number is CS057Q-010.

It has a 15-pin male connector on one side of the display board and two wires — pink and white — wired to a three-pin female connector on the other side of the display board.

The three-pin female connector connects to a three-pin male connector on a much smaller second board which also has a four-pin connector.

I have contacted the manufacturer, Purdy Electronics via email at Purdyelectronics.com. They have advised that module is no longer produced and that they cannot help. I would appreciate anyone that might have the pin out information or data sheets.

**3025 David Kamulski
Oxford, MI**

I am currently in my second year of GCSE electronics and as a

main project have decided to make an airband radio. Unfortunately, I am having a serious problem finding a circuit suitable for this purpose and would appreciate any help.

**3026 Paul
via Internet**

How does a DC clamp meter work? Is it based upon Hall-Effect transistors?

Can someone provide a low-cost circuit for a 10-60 amp DC clamp meter using a digital panel meter?

**3027 Qui Nguyen
via Internet**

I want to drive an LCD display from a computer with a VGA output using a VGA/NTSC converter. The display has a NTSC input and a resolution of 1152H x 234V. Would this work for displaying text and graphics? The VGA is 640 x 480 and I wonder if this would work with the resolution of the display.

**3028 David Kamulski
Oxford, MI**

The clock in my 1989 Mercury has a problem. The dig-its light and it keeps time, but the set functions don't work. I tried cleaning the contacts and this was no help. Also, the resistor seems to be running hot. Appreciate any tips on getting this thing to work?

**3029 Art Millin
via Internet**

ANSWERS

[10213 - JAN. 2002]

I've been trying to rig up a simple time delay circuit so the power on/off button on my PC has to be held for several seconds to operate.

From what I can tell, the ATX motherboard has a pin that is ground and a pin that is about 3.4 volts connected to the on/off switch. I've tried to come up with a simple resistor-capac-

TECH FORUM

itor circuit to accomplish the time delay, but so far my efforts have failed.

My computer, monitor, print-

er, and scanner are plugged into a power strip which has an on-off switch that is out of the way, so if I had your problem, I would disconnect the CPU power switch.

However, if you want to make a time delay circuit, this one will do it.

C1 keeps the base current flowing to the transistor while it is

turning off the power source (the 3.4-volt pin).

The capacitors are Tantalum for low leakage.

The 900 numbers are

[110111 - NOV. 2001]

I am looking for schematics or designs for an IR repeater. I've found a few designs on the Internet, but the emitter and transmitter need to be hard wired together. A wireless design would be ideal.

#1 A remote control extender, which does not have these drawbacks was described in the *Radio Electronics 1991 Electronic Experimenters Handbook*. It used only commonly available parts (LM339, LM741 etc.) and a PC board was available through Fen-Tek, P.O. Box 5012, Babylon, NY 11707-0012.

**Walter J. Heissenberger
Hancock, NH**

#2 A simple "wired" IR repeater circuit can be built with an inexpensive IR receiver module such as RadioShack part #276-0137, a 555 timer, an IR LED attached to a short two-wire cable, and several "glue" components.

The basic idea behind such a repeater circuit is that the IR module receives the IR signal from the remote, which is riding on a 40KHz carrier. The IR module removes the carrier and sends the signal to the 555, which is set up as a 40KHz oscillator. The output from the 555 is then fed to the base of a transistor which is used to drive the IR LED attached to the end of the cable.

Assuming you have access to the Internet, a repeater circuit which makes use of these parts is shown at www.nysaes.cornell.edu/cc/staff/pool/electronics/irrepeat.html. (Just scroll down about half-way on the page

to see the diagram).

If you need more distance, you might want to look into the IR repeater sold by RadioShack, catalog #15-1959. This device uses RF rather than a cable to send the signal to the remote IR emitter. At around \$50.00, it's more expensive than the do-it-yourself approach, but it might be worth it if the extended range (up to 100') is an issue.

**Mark Winters
Orem, UT**

#3 There are a wealth of circuits and consumer products for improving the range of IR. The best solution depends on the range required, the number of devices that need to be controlled, the environment, and the application.

Short range solutions aim to improve reliability within a single room.

Your best options include moving equipment away from direct sunlight (always a good idea with electronic equipment, anyway) and increasing the power of the transmitter with a booster.

Medium range solutions start with the IR repeater in your question and include several room-to-room ready-built products offered by Home Automation Systems (HAS) and MCM. The two designs listed below under "Repeaters" are very very close to the build-it-yourself design you wanted.

For long range and whole-house needs, MCM and HAS carry an overwhelming number of solutions. One family of prod-

ucts converts IR to simple electrical signals carried over regular zip cord to home theater equipment and IR emitters in an adjoining room. Other products convert the IR signal to RF which is transmitted through the air (or over the TV coax system) to receivers anywhere in the home.

Finally, HAS carries products that convert IR to X-10 signals which travel throughout the home on the AC power lines.

Check both websites for over two dozen transmitter and receiver products. Some very sophisticated arrangements are described.

The articles referenced under "Theory" are listed in case you want to experiment with IR and roll-your-own design. **Digi-Key (1-800-344-4539, www.digi-key.com)**, **JAMECO (1-800-831-4242, www.jameco.com)**, **MCM (see below)**, and **Mouser Electronics (1-800-346-6873, www.mouser.com)** carry a wide selection of IR modules, PICs, BASIC Stamps, and general electronic needs.

MCM Electronics

650 Congress Park Dr.
Centerville, OH 45459-4072
Tel: 1-800-543-4330
Fax: 1-800-765-6960

www.mcmelectronics.com
50-6485 - IR Repeater (wired)
2-6680 - IR-to-RF Repeater/Extender
21XX - Family of IR-to-RF Modules

Home Automation Systems, Inc.

17171 Daimler St.
Irvine, CA 92614-5508
Tel: 1-800-762-7846 (orders)
1-949-221-9200 (Customer Service & Tech Support)

Fax: 1-800-242-7329

www.smarthome.com

8220A & 8210RCA IR-to-RF room-to-room repeater/extender
81XX Family of products relays IR signals by RF, wires, coax, or X10.

REPEATERS

"Q&A" Column, (TJ Byers), *Nuts & Volts*, Mar. '99, Page 81. An IR Tx/Rx repeater pair.

"Build a Remote Control Relay Station," (John Yacono), *Popular Electronics*, May '94, Page 69. This is precisely what the reader wanted. It's based on a 555 and \$5.00 worth of parts.

THEORY

"Control from the Couch," (Jon Williams), *Nuts & Volts*, Aug. '01, Page 20 (An excellent look at IR projects using a BASIC Stamp.)

"Build an IR Remote Control Toggle Switch," (Fred Blechman), *Nuts & Volts*, Sept. '00, Page 32. (IR Remote ON/OFF Switch based on an IR module and three transistors! No 555, no uP — Does anyone remember transistors?)

"IR Remote Decoder," (Terry J. Weeder), *Nuts & Volts*, Feb. '98, Page 38. An excellent IR tutorial, as well as the design for a PIC-based Rx.

**Bob Miller
Trenton, NJ**

—AUTOTIME CORPORATION—

**\$79.00
+ Parts**

**LCD Flat Screen Repairs
Displays and Laptops**

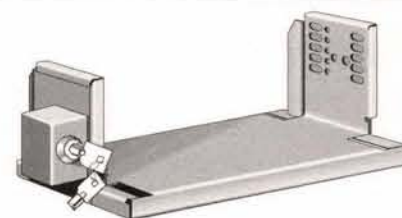
For Details

www.recycleLCD.com

Autotime Corporation (503) 452-8577
6605 SW Macadam, Portland, OR 97201

THEFT & TAMPERING & UNAUTHORIZED REMOVAL can be controlled!

Equip your mobile 2-way radios with the ET-850 Locking Slide Mount. A standard mounting platform, simple and effective. Stop blind fumbling to release hidden fasteners. Easily transfer radios from vehicle to vehicle but prevent unauthorized transfers. With a black powder coat finish, it is at home in a luxury car or a delivery truck. Use in the office, too.



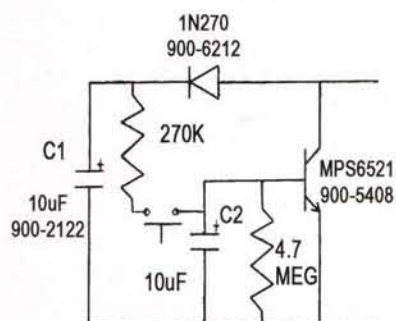
**Fits most mobile 2 ways on
the market today.**

(Ask about our new Double Stack Slide Locking Mount and our maximum security Radio Cages™)

E TIP, Inc.

Addison, IL 60101 USA
(800) 530-5064 FAX (630) 530-5019
www.etipinc.com | sales@etipinc.com
(E TIP is a small, Veteran Owned Business)

RadioShack.com part numbers.



**Russell Kincaid
Milford, NH**

[1025 - JAN. 2002]

I am trying to record a movie from DVD to VHS tape. But, when I press record, the brightness cycles from very bright to very dark. I tried using the s-video jack and the regular video jack with the same results.

Why does this happen and what I can do about it?

You are seeing the effects of Macrovision DVD copy protection, also known as the Analog Protection System (APS).

It is currently used on the majority of DVD-Video discs to degrade unauthorized copies made on VCRs. DVDs have activation bits that instruct the DVD player to add analog copy protection to the output video, so it is present regardless of which video output you connect the VCR to.

The changes in brightness are caused by the addition of pulses to the video that occur during the vertical blanking interval, which is the period of time when the electron gun in a TV resets itself from the bottom right of the screen to the top left. These pulses should not affect the image displayed on the TV, but do totally confuse a

[120110 - DEC. 2001]

I would like to put a sensor at each of my 20 air conditioning units and wire them back to a panel in the shop, so I can just look and see if they are running by what temperature the air is.

I would like a small digital display with a wire going to the sensor (longest run would be about 900 ft.).

#1 Chris Salter did not specify what air conditioning (AC) parameter he wants to monitor. Assuming that he is interested in air cooling (not dehumidification with reheat) and does not want to alter the wiring of each AC unit, he might try using a pair of current mode temperature sensors for each of his AC units. These are off-the-shelf devices made by Maxim, National Semiconductor, and others, available for \$2.00 or less each.

Set up one sensor in the output air stream of each AC unit, the other in its input air stream. These can be wired to a monitoring panel using a common supply (+) conductor and two separate returns, a total of three conductors per AC unit.

Use of current mode devices eliminates the effects of modest power supply fluctuations and connecting wiring voltage drop.

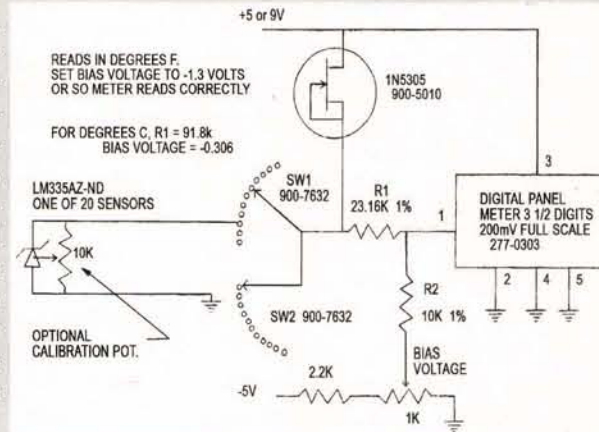
Observe the voltage and power limits and appropriate

wiring materials and methods as detailed in article 725, etc., of the National Electrical Code (NEC). The 2002 NEC has been published, but most jurisdictions are still using the 1999 edition.

At the monitoring panel, use the outputs of each sensor pair as inputs to a comparator, again cheap generic ICs, which can be set up to indicate a temperature difference of less than one which reflects normal operation. This approach confirms that both the cooling and air handling functions are working. Individual LED indicators and/or a wired OR to a single LED would allow for easy monitoring. If (an) audible alarm(s) is/are required (a) 555, or some other timer, could be added to minimize nuisance alarms.

**D. Cameron Smith
via Internet**

#2 The LM335A temperature sensor outputs 10mV per degree C and is linear with temperature, so all that is needed is translation to the digital meter input. The translation provides 1mV per degree F to the meter so it reads the temperature directly.



**Russell Kincaid
Milford, NH**

VCR's automatic gain control circuitry.

Another part of the scheme changes the colorburst information to cause lines across the picture when played back on a VCR. For more information see www.macrovision.com/.

I am not sure under what circumstances, if any, it is legal to eliminate Macrovision protection that might be causing problems.

From a technical point of view, there are two main approaches to this problem. Some DVD players have the ability to turn Macrovision off, see www.area450.com/ and www.dvdcity.com/ for some examples.

The other approach is to purchase or build a video stabilizer that restores the integrity of the video signal, such as those sold

by www.bgsales.com/.

There are lots of schematics for do-it-yourself video stabilizers on the web, like www.electronic-projects.net/projects/video_stab/index.shtml.

**Henry Berg
Menlo Park, CA**

12011 - DEC. 2001

I have several clocks that set themselves from NIST atomic clock

BATTERIES FOR EVERY ELECTRONIC APPLICATION

Authorized Sanyo Battery Distributor

See us at batterystore.com

21 years of Battery experience

TNR Technical, Inc.

Sanford, FL • 800-346-0601

Santa Ana, CA • 800-490-8418

Circle #40 on the Reader Service Card.

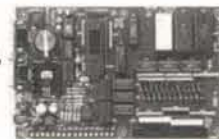
Real-world connectors!

Tired of those .1 inch headers? Try our products with easy to use screw terminal block connectors.

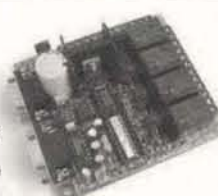
Power supply, cable, and software included with most products - no hidden charges for "accessories"!

Stop by our web site to see our entire line of products, including the complete reference manuals.

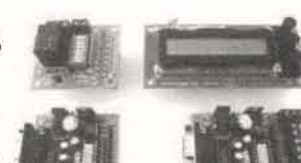
SBC-1 \$199
Intel 80C51,
EEPROM, A/D,
RAM, RTC,
50 digital I/O,
Industrial I/O
connectors.



TC51 SBC \$129
Atmel 89C4051, serial
EEPROM, two 12 bit
A/D, four digital I/O,
high current relays,
plus Tiny Machine Basic
with LCD support - a
complete control system
for the price of an SBC.



T51 SBC \$49
Atmel 89C2051,
9 digital I/O,
Tiny Machine
Basic, serial
EEPROM, plus
T51 family
plug-in boards.



RS51-SPR \$49
addressable
and chainable
high current
RS-232 relay.



IndustroLogic®

3201 Highgate St. Charles, MO 63301 USA
(636) 723-4000 (800) 435-1975
www.industrologic.com

Circle #41 on the Reader Service Card.

TECH FORUM

radio signal. The signal is so weak where I live that only the one in the attic can get this signal.

Is there a repeater that can retransmit the signal to the rest of the house? Or, is there possibly a transmitter I can connect to a PC, because it can get the correct time from the Internet.

I have no direct familiarity with these clocks, but can offer the following about how they work.

First, it must be determined if the clocks in question are receiving the WWV/WWVH (5, 10, 15 MHz) or the WWVB signal (60 KHz). The time information is encoded in these signals as a "time code." One bit of this code is sent each second. For the WWV/WWVH signals, a 100 Hz sub-audible carrier is used. For the WWVB signal, a 10 dB change in carrier is used.

If the clock is receiving the WWVB signal, most likely the receiver is using a ferrite rod antenna. It may be necessary to reposition the clocks having problems. Consider the proximity of the house wiring to the clocks. After all, 60 KHz is a harmonic of 60 Hz. And Romex cable and the old knob and tube wiring in old houses make wonderful 60-Hz transmitting antennas. It may be possible that the clock receiver is being "de-sensed" by power circuits in the house. A non-elegant solution would be a receive antenna in the attic feeding a 1 to 3 dB gain

RF amp. This amp should not be broadband. Place a small coil antenna behind each affected clock. Make sure the receive antenna is no where near any of these coil antennas, otherwise a very nice feedback loop will occur and no telling where the intermod frequencies will appear.

As for using the PC ... you will need to build a transmitter on the proper frequency and modulate it in the proper format. Sorry, more trouble than it's worth. There are FCC Part 15 considerations and interference from the WWV/WWVH/WWVB signals. But consider this ... a 120 VAC wall clock accuracy is based on the 60 Hz line frequency which must average 60 Hz over any 24 hour period. If this didn't occur, the power grids could never be interconnected. Okay, so it's a pain to reset all of these clocks after a power failure.

For more information about the timecode encoding on the WWV/WWVH and WWVB signals, check out www.boulder.nist.gov/timefreq.

Information about CHU (Canada) is a little more complicated to find. Start your search at www.cisti.nrc.ca or look for possible links at www.tycho.usno.navy.mil.

Finally, a trivia question ... which government organization is the "Master Time Keeper" for the United States? A hint ... it's not NIST.

**Douglas Hall
Windsor, NJ**

[1028 - JAN. 2002]

I'm looking to design and construct a small amber flashing light for nighttime bicycle riding, which can be worn on the waist band or other visible areas.

#1 A simple battery-operated flasher can be constructed using a CMOS 555 timer chip, N channel MOSFET, and a few components as shown in the schematic. It can be operated by a common nine-volt battery, or any similar power source.

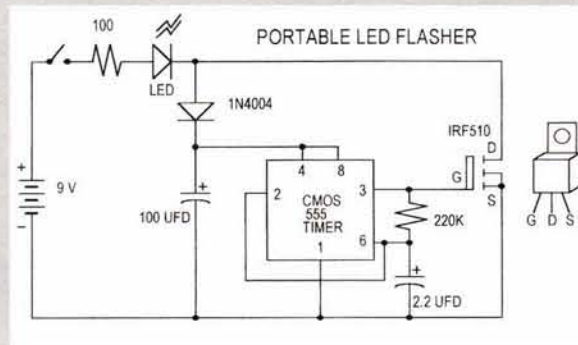
Power for the 555 timer is derived through the 1N4004 diode, which charges up the 100uFd storage capacitor to about eight volts. When

the output of the timer chip (pin 3) goes high, the MOSFET is turned on, shorting out the timing circuit and lighting the LED.

When the 555 output goes low, the transistor turns off and current through the LED is very small, effectively extinguishing it.

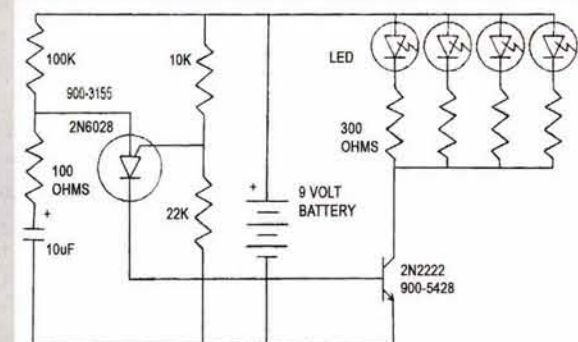
Using the 220K and 2.2uFd timing components shown, the flash rate is a very effective 100 flashes per minute.

**Anthony J. Caristi
Waldwick, NJ**



#2 I built this circuit to check it out. It blinks about once per second and draws less than one milliamp from the nine-volt battery. It should last over 500 hours.

I checked it out at night with one LED, it was not really noticeable beyond 200 feet, so I added three more. You could have a total of eight LEDs without overloading the 2N2222.



The 900 numbers are RadioShack.com part numbers.

**Russell Kincaid
Milford, NH**

#3 The easiest way to accomplish this is through the use of a blinking LED in the base circuit of a switching transistor. A resistor is required from base to emitter to turn the transistor completely off at low LED current. A resistor in the collector circuit is required to limit the amber LED

or LED array's current. The value of this resistor will depend upon the forward voltage, battery voltage, and desired current. High brightness/efficiency types will keep the battery current low and the weight down.

**Walter Heissenberger
Hancock, NH**

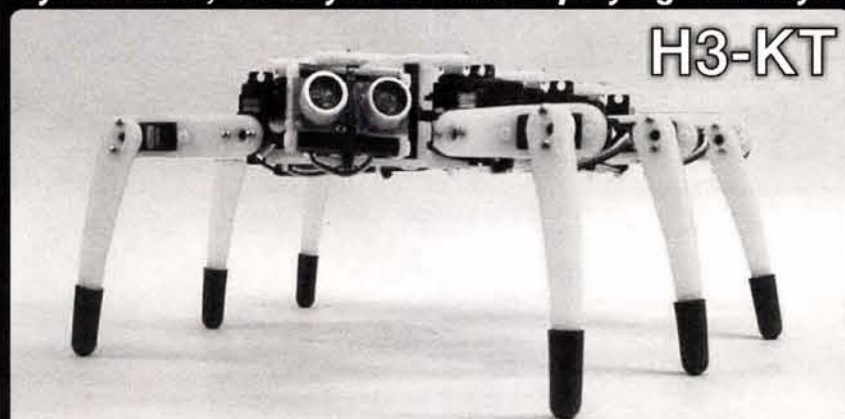
SolderingDesoldering.Com

Your SMD Rework Specialist

800-394-1984

Lynxmotion, When you're tired of playing with toys!

H3-KT



Lynxmotion, Inc.
PO Box 818
Pekin, IL 61555-0818
www.lynxmotion.com

Lynxmotion
Visit our website or ask for our free catalog!

Tel: 309-382-1816
Fax: 309-382-1254
sales@lynxmotion.com
tech@lynxmotion.com

**UPGRADING
VIDEO SURVEILLANCE
AT YOUR COMPANY?**

www.cctvpros.com

Discount Prices on Major Brand CCTV Products
20 years of friendly, knowledgeable service!

(800) 486-2288

info@cctvpros.com

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

All listing information should be sent to:

**Nuts & Volts Magazine
Events Calendar**
430 Princeland Court
Corona, CA 92879
Phone 909-371-8497
Fax 909-371-3052
E-mail
events@nutsvolts.com

MARCH

MARCH 2002

MARCH 2

AR - RUSSELLVILLE - Hamfest. Arkansas River Valley AR Foundation, John Evans WB5BHS, 501-967-6001. Email: jevans@cswnet.com Web: www.cswnet.com/~arvarf/hamfest.htm
CA - REDDING - Hamfest. Shasta Cascade ARS, Jim Bremer KE6OUA, 530-222-8001. Email: ke6oua@arrrl.net
FL - NEW PORT RICHEY - Hamfest. Gulf Coast ARC, Rick Brown AG4JN, 727-934-8741. Email: ag4jn@arrrl.net Web: www.gulfcoastarc.org/
KY - CAVE CITY - Hamfest. Cave City Convention Center, I-

65, Exit 53. 7:30am-2pm. VE testing. Talkin: 146.94/34. Mammoth Cave ARC, Jim Erskine KD4GNN, Email: mail@chirotoons.com
NJ - PARSIPPANY - Hamfest. PAL Bldg., 33 Baldwin Rd. Splitrock ARA, Maria Turner KB2VKP, 888-511-SARA. Email: hamfest@splitrockara.org Web: www.splitrockara.org
OK - ELK CITY - Hamfest. West OK ARC, Earl Bottom N5NEB, 580-821-0633. Email: n5neb@logixonline.net
TN - KNOXVILLE - Hamfest. Kerbel Temple, 315 Mimosa Ave. 8am-4pm. Talkin: 144.83/145.43 or 146.52 simplex. Shriners of Kerbel ARS, Paul Baird K3PB, 865-986-9562

MARCH 3

PA - GREENSBURG - Hamfest. Foothills ARC, Tim Bartlow K3TB, 724-834-6517. Email: k3tb@yahoo.com Web: www.geocities.com/foothills007
VA - ANNANDALE - Hamfest. Northern VA Community College, 8333 Little River Turnpike (Rt. 236). VE testing 9am. Talkin: 146.31/91 & 146.685-. Vienna Wireless Society, Jim Parsons W4JTP, 703-392-0150. Email: w4jtp@aol.com Web: http://winterfest.home.att.net
WI - WAUKESHA - Hamfest. SEWFARS, Gary Pierce N9LGE, Email: sewfars@hotmail.com Web: www.sewfars.com

MARCH 9

AR - HARRISON - Hamfest. Boone County Fairgrounds, Hwy. 65B. VE testing. 8am-2pm. North AR ARS, Bill Rose N5VKF, 870-741-7074. Email: billrose@cox-internet.com Web: www.qsl.net/naars/hamfest/index.html
AZ - SCOTTSDALE - Hamfest. Scottsdale ARC, Ed Nickerson WU7S, 480-949-5162. Email: bnickers@qwest.net
FL - PORT CHARLOTTE - Hamfest. EARS & PRRA, Larry Brown KD4KVE, 941-625-0830. Email: kd4kve@aol.com

NC - CHARLOTTE - Hamfest. Charlotte County Fairgrounds. 7am-5pm. Talkin: 147.255+. PRRA & EARS, Vic Emmelkamp, 941-473-5560. Web: www.fcrosby.com/hamfest/index.html
ND - WEST FARGO - Hamfest. Red River Valley Fairgrounds. 8am-3pm. VE testing. Web: www.rra.org
WA - PUYALLUP - Hamfest. Mike and Key ARC, Michael Dinkelman N7WA, 425-867-4797 days or 253-631-3756 eves. Email: mwdink@eskimo.com Web: www.mikeandkey.com

MARCH 9-10

LA - RAYNE - Hamfest. Rayne Civic Center, 300 Frog Festival Dr. VE testing. Talkin: 146.820-600, 147.030+ 600 PL. LCARC, Web: www.w5ddl.org
NC - CHARLOTTE - Hamfest. Mecklenburg ARS, Tom Hunt KA3VVJ, 704-948-7373. Email: hamfest@w4bfb.org Web: www.w4bfb.org

MARCH 10

CANADA - BC - NEW WESTMINSTER - AR & Electronics Flea Market. Burnaby & New Westminster ARC, Bob Kungl VE7KW, 604-524-9177. Email: VE7KW@rac.ca
MA - AMHERST - Hamfest. Amherst/Pelham Regional Middle School, 170 Chestnut St. Exams. Talkin: 146.940- & 145.130+ 71.9 PL. Mount Tom Amateur Repeater Assn., Bob Meneguzzo K1YO, 877-481-8131. Email: k1yo@arrrl.net Web: www.mtara.org/hamfest/flea.html

MARCH 15-16

OK - CLAREMORE - Hamfest. Green Country Hamfest Committee, David Jackson KE4OPA, 918-622-2277. Email: info@greencountryhamfest.org Web: www.greencountryhamfest.org

MARCH 16

CT - POMFRET - Hamfest. Eastern CT ARA, Paul Rollinson KE1LI, 860-928-2456.

COMPUTER SHOWS

AGI Shows, 317-299-8827
E-Mail: info@agishows.com
http://www.agishows.com

Blue Star Productions
612-788-1901
www.supercomputersale.com

Computers And You
734-283-1754
www.a1-supercomputersales.com

Computer Central Shows
630-782-4625
Fax 630-834-2594
E-Mail: cc@gats.com
www.computercentralshows.com

Computer Country Expo
847-662-0811
Web: www.ccxpo.com

Five Star Productions
810-379-3333
E-Mail: jeff@fivestar
www.fivestarsshows.com

Gibraltar Trade Center, Inc.
734-287-2000 Taylor, MI
E-Mail: taylor@gibraltartrade.com
www.gibraltartrade.com

Gibraltar Trade Center, Inc.
810-465-6440 Mt. Clemens, MI.
E-Mail: mtclermens@gibraltartrade.com
www.gibraltartrade.com

KGP Productions
1-800-631-0062, 732-297-2526
E-Mail: kgp@mail.com

MarketPro, Inc., 201-825-2229
www.marketpro.com

MarketPro, Inc., 301-984-0880
E-Mail: md@marketpro.com
http://marketpro.com

ComputerShow
770-663-0983
E-Mail: narisaam@aol.com
Web: www.showsale.com

Northern Computer Shows
978-744-8440
E-Mail: inquiries@ncshows.com
Web: ncshows.com

Peter Trapp Computer Shows
603-272-5008
Web: www.petertrapp.com

Events Calendar

Email: ke1li@arrrl.net

FL - FT. WALTON BEACH - Hamfest. Playground ARC, Louis Carter KF4HRM, 850-243-4315 or 815-461-0859.

Email: parcfest@w4zbb.org

Web: www.w4zbb.org

FL - STUART - Hamfest. Martin County ARA, David Millard KE4AMW, 561-288-7100.

Email: millard@onearrow.net

Web: www.qsl.net/martin

MI - MARSHALL - Hamfest. Southern MI ARS & Marshall HS Industrial Arts Club, John Malinowski N8BGM, 616-781-4540. Email: n8bgm@aol.com

NJ - CLINTON - Hamfest. North Hunterdon Regional High School, Rt. 31. VE testing. Talkin: 147.375. Cherryville Repeater Association II, 908-788-4080.

Web: www.qsl.net/w2cra

WV - CHARLESTON - Charleston Area Hamfest & Computer Show. William H. (Jack) Kibler K8WMX, 304-722-3150. Email: k8wmx@juno.com

MARCH 16-17

GA - MARIETTA - Hamfest. Kennehoochee ARC, Bob Butler

W4RBB, 770-579-9420. Email:

w4rbb@arrrl.net

Web: http://qsl.asti.com/hootch/KARC-HamF.html

TX - MIDLAND - Hamfest. Midland ARC, Larry Nix N5TQU, 915-699-5441.

Email: oilman29@home.com

Web: http://www.w5qgg.org

MARCH 17

IL - STERLING - Hamfest. Challand Middle School Gymnasium, 1700 6th Ave. VE testing. Sterling-Rock Falls ARS, Lloyd Sherman KB9APW, 815-336-2434.

Email: lsherman@essexl.com

OH - MAUMEE - Hamfest. Lucas County Recreation Center, 2901 Key St. 8am-2pm. Talkin:

147.27+. Toledo Mobile Radio Assn., Paul Hanslik N8XDB, 419-385-5056. Email: kb8iup@arrrl.net

Web: http://tmrahamradio.org

PA - MONROEVILLE - Hamfest. Palace Inn. 8:30am-3pm. Two Rivers ARC, Bill Hetrick N3LQC, 412-751-1937.

Email: n3lqc@home.com Web: www.qsl.net/w3oc/hamfest.htm

WI - JEFFERSON - Hamfest. Tri-County ARC, John Satterlee WA9SAB, 920-563-6381.

Email: satterlee@ticon.net

MARCH 22-23

NE - NORFOLK - State Convention. Elkhorn Valley ARC, Dave Thege N0XBN, 402-371-3550. Email: n0xbn@arrrl.net

Web: www.qsl.net/evarc

MARCH 23

FL - PLANTATION - Cy Harris W4MAQ Memorial Free Flea. Northeast parking lot of Motorola (8000 W. Sunrise Blvd). Talkin: 146.79 -600. Robin Terrill N4HHP, 954-583-3625.

Email: kg4chw@arrrl.net

Web: www.geocities.com/bcepn/freefleah.html

IN - MICHIGAN CITY - Hamfest. Michigan City High School, 8466 W. Pahl Rd. 8am-2pm CST. Michigan City ARC, Inc., Ron Stahoviak N9TPC, 219-325-9089

TX - WEATHERFORD - Hamfest. ARC of Parker County, Jerry Thompson K5JWT, 817-594-8091 or 817-597-6789 (mobile). Email: k5jwt@arrrl.net

MARCH 23-24

PA - PHILADELPHIA - Robot Combat. East Coast Hobby

ALL ELECTRONICS

C O R P O R A T I O N

QUALITY Parts
FAST Shipping
DISCOUNT Pricing

CALL, WRITE, FAX
or E-MAIL For A
Free 96 Page
CATALOG.
Outside the U.S.A.
send \$3.00 postage.

Cheap LED Flasher

The simplest electronic flasher ever. Great for attention getting displays, party decorations, night time warning signals. A red 5mm LED with flasher chip is attached to a battery snap that snaps onto a 2 AA cell battery holder. Will flash for months on a set of batteries. Flash rate, approximately 120 flashes per minute. Batteries not included.

CAT# FSH-10
\$1.00 each
100 for 70¢ each
500 for 60¢ each
1000 for 50¢ each

Special Purchase! 5 Vdc 1.9A Switching Power Supply

Autec # DT25-1004
Input 100-240 Vac
Output: 5 V @ 1.9 Amp, 8 V @ 1.1 Amp, 15 V @ 0.36 Amp, -15V @ 0.09 Amp. If you need a constant regulated output for scanners, cameras or sensitive equipment, have a look at this inexpensive benchtop supply. 3.25" x 6.39" x 2.35" high. 7" 6" output cord is terminated to custom Molex-type connector. Requires detachable IEC power cord like our CAT# LCAC-60. UL, CSA listed.

CAT# PS-531
\$5.00 each
10 for \$4.50 each
50 for \$4.00 each
100 for \$3.50 each

LED Tester

Pocket-size led tester. Makes it easy to check functionality, color, brightness and uniformity. Plug any led LED into one of 12 positions on the socket strip to test at current ratings from 2-50ma. The seven middle positions on the strip are set at 10 mA allowing comparison of LEDs in those spaces. Requires 9 v battery (not included).

CAT# LT-100
\$8.95 each

Lithium Battery CR123A

Tekcell CR123A. 3 Volt lithium cell. Commonly used in photographic equipment. 1.34" long x 0.65" diameter.

CAT# LBAT-123
\$2.85 each
10 for \$2.60 each
100 for \$2.35 each
800 for \$1.90 each

Humidity Meter

Duracraft. Relative humidity scale calibrated from 20% to 100%, with 30% to 50% being designated the "Comfort Zone." 2" diameter meter in a wall-mount or table-top gray plastic case, 3.55" high x 2.66" wide x 1.18" deep.

CAT# HMR-1
\$2.50 each

Nickel-Metal Hydride 4.8V 850 mA Battery Pack

Philips # 25733. New, rechargeable pack manufactured for cell phones. Contains four 1.2 Volt, 850 mAh cells. Each cell is 1.8" x 0.65" x 0.3". With little effort you can remove the cells from the enclosed battery pack and reconfigure them to suit your needs.

CAT# NMH-53
\$2.00 each
10 for \$17.50

1.38" Piezo Disc

Kyocera. 35mm brass piezo element with exciter circuit. Three 2" wire leads.

CAT# PE-44
\$1.00 each
10 for \$8.50
100 for \$60.00

Great Price! 60 Watt Switching Power Supply

Autec # UPS61-1004-T
Input: 115/230 Vac
Outputs: 3.3V @ 4A, 5 V @ 2A, 12V @ 3A, 32V @ 5 mA. New, open-frame switching supply. 5" x 3.46" x 1.68." "Panasonic-type" two conductor receptacle for AC input, can be hardwired if desired. Fused input. 10 conductor molex-type plug output. Ferrite bead for EMI suppression on output wires. Large quantity available.

CAT # PS-70
\$4.50 each
case of 48 pieces for \$3.50 each

16 Character X 2 Line LCD with LED Backlight

Alesis Corp. G8 LCD 16 x 2 LCD. Module size: 4.85" x 1.7." Display size: 3.67" x 1.05." Black bezel around the display, 4" x 1.46." Input through 16 pin male header, 2 x 8 pins on 0.1" centers. LED backlight operates on 5 Vdc. No spec or hook-up sheet available.

CAT # LCD-68
\$5.00 each

Inverter, 5 Vdc Input

TDK-2090. Inverter for small to medium CCFT lamps. Operates on 3-5 Vdc. No official specs available at this time. Our tests indicate that it lights lamps of 250mm length or less. Module is 2.17" x 1.1" x 0.4" high. PC pins on 2" x 0.84" centers. Large quantity available.

CAT# INV-7
\$5.00 each

CCFT Lamp 3.2mm X 250mm

3.2 mm diameter X 250 mm long. White. JKL BF3250-20B.

CAT # BF-3250
\$7.50 each
100 for \$6.00 each

ORDER TOLL FREE 1-800-826-5432

Shop ON-LINE www.allelectronics.com

MAIL ORDERS TO:

ALL ELECTRONICS CORP.

P.O. BOX 567 • VAN NUYS, CA 91408-0567

FAX (818) 781-2653 • INFO (818) 904-0524

E-MAIL allcorp@allcorp.com

NO MINIMUM ORDER • All Orders Can Be Charged to Visa, Mastercard, American Express or Discover • Checks and Money Orders Accepted by Mail • Orders Delivered in the State of California must include California State Sales Tax • NO C.O.D. • Shipping and Handling \$6.00 for the 48 Continental United States • ALL OTHERS including Alaska, Hawaii, P.R. and Canada Must Pay Full Shipping • Quantities Limited • Prices Subject to change without notice.

MANUFACTURERS - We Purchase EXCESS INVENTORIES... Call, Write, E-MAIL or Fax YOUR LIST.

Events Calendar

Show, Ft. Washington Expo Center. Sat: 9am-6pm, Sun: 10am-5pm. Northeast Robotics Club, Ed McCarron, 610-583-6136 eves. Email: emccarron@robotconflict.com Web: www.robotconflict.com

MARCH 24

IL - GRAYSLAKE - Hamfest. North Shore Radio Club, Jacob

Fishman NEONS, 847-291-4160. Email: ne0ns@arrl.net Web: http://www.ns9rc.org
NC - KINSTON - Hamfest. Down East Hamfest Assn., Doug Burt W4OFO, 252-524-5724. Email: jeanh@icomnet.com
OH - MADISON - Hamfest. Lake County ARA, Roxanne N8BC, 440-209-8953 (9am-9pm). Email: lcarahamfest@hotmail.com

Web: http://hamnet.org/lcara

MARCH 30

TX - BRENHAM - Hamfest. Washington County Fairgrounds. 8am-12pm. Talkin: 147.260 +.600. Brenham ARC, Dan Lakenmacher N5UNU, 979-836-8739. Email: briang@comwerx.net Web: www.alpha1.net/~barc

Tired of Expensive Inkjet Cartridges? Save 90% on Inkjet Inks!

Refill kits Black (8 oz) Color (4 oz C, Y, M) Printer (Call for Others Not Listed!)	# of Refills		Cost/Refill		Kit Price	
	Black	Color	Black	Color	Black	Color
HP500 Series, 400, Officejet 300, 350, Fax	7	14	4.71	2.85	32.95	39.95
HP600 Series, Officejet 500, 570, 600, 610 630, 700	7	14	4.71	3.21	32.95	44.95
HP820C, 855C, 870C, 1000C, 1150C, Copier 120, 210	6	12	6.67	3.33	39.95	39.95
HP720C, 722C, 712C, 880C, 890C, 895C, 1120C, 1170C	6	12	6.67	3.75	39.95	44.95
HP900C Series, P1000 Series, Officejet G55, G85, G95	6	12	6.67	3.75	39.95	44.95
HP2000C Pro Color Printer, 2200, 2500	6	12	6.67	3.75	39.95	44.95
Canon BJ-10, 200, 210, 240, 250 Apple StyleWriter 1200, 1500	14	20	2.15	2.00	29.95	39.95
Canon BJC-4000 Series, 2000, 5000 Series, Multipass Series	60	60	0.50	0.67	29.95	39.95
Canon BJC-6000, 3000, S400, S450, S600, Multipass 755	14	8	2.85	1.67	39.95	39.95
Epson Stylus Color 500, 200	20	17	1.50	2.35	29.95	39.95
Epson Stylus Color 400, 600, 800, 850, 1520, Photo	20	17	1.50	2.65	29.95	44.95
Epson Stylus Color 440, 660, 670, 740, 760, 860	20	17	1.50	2.65	29.95	44.95
Epson Stylus Color 480, 580, 880 NEW	20	17	1.50	2.65	29.95	44.95
Lexmark 3200, 5700, Z11, Z12, Z31, Z32,	15	17	2.67	2.35	39.95	39.95
Compaq IJ300, IJ600, IJ700, IJ900 Xerox XJ8C	15	17	2.67	2.65	39.95	44.95
Lexmark Z42, Z51, Z52, Z83, Compaq IJ1200, A1000 NEW	15	17	2.67	2.65	39.95	44.95
Lexmark Photo kit for 3200, 5700, 7000, 7200, Z42, Z51, Z52		9		3.11		27.95
Lexmark 2030, 2050, Execjet II/IIc, Medley 4C, Compaq IJ200	10	17	3.00	2.35	29.95	39.95
Xerox HC 450, XJ4C, XJ6C	22	12	1.36	3.33	29.95	39.95
New Combination Kits Black dye 4 oz / Color 2 oz each					44.95	
New Combination Kits Black pigmented 4 oz / Color 2 oz each					49.95	

Save 30 - 60% on New Compatible Cartridges Quantity Discounts for 3 or 6+ cartridges Mix and match

Printer (Call for Others Not Listed!)	BLACK Cartridge			COLOR Cartridge		
	Qty	1 / 3 / 6+		Qty	1 / 3 / 6+	
Canon BJC-4000 Series, 2000, 5000 Series, Multipass Series	4.50	3.83	3.69	10.95	9.31	8.98
Canon BJC-6000, 3000, S400, S450, S600, Multipass 755	7.95	6.76	6.52	7.50	6.38	6.15
Canon BJC-70, 80, 85 (3 pack Black / 3 pack color)	9.95	8.46	8.16	14.95	12.71	12.26
Epson Stylus Color, Color Pro, Pro XL	9.95	8.46	8.16	13.95	11.86	11.44
Epson Stylus Color II, IIs, 200	9.95	8.46	8.16	13.95	11.86	11.44
Epson Stylus Color 400, 500, 600, 800, 850, 1520, Photo	9.95	8.46	8.16	13.95	11.86	11.44
Epson Stylus Color 440, 660, 670, 740, 760, 860	9.95	8.46	8.16	13.95	11.86	11.44
Epson Stylus Color 750, 900, 980, 1200	10.95	9.31	8.98	15.95	13.51	13.08
Epson Stylus Color 480, 580, 880 NEW	10.95	9.31	8.98	14.95	12.71	12.26
Epson Stylus Color 777, 870, 875, 1270 Requires Empty Return!	11.95	11.95	11.95	15.95	15.95	15.95

Quality Inks and Toners for:
HP Epson Lexmark
Canon Apple Xerox

New Combination Black / Color Kits
4 oz black dye / 2 oz C,M,Y color - **\$44.95**
4 oz black pigmented / 2 oz C,M,Y - **\$49.95**

Mon - Fri 8:30-5:30 PDT 11:30-8:30 EST

Call or see us online!

Inkjet Southwest



www.inkjetsw.com
(480) 668-1069 Fax

1-800-447-3469
(480) 668-0959

Circle #41 on the Reader Service Card.

PICmicro MCU development tools
from microEngineering Labs, Inc.
www.melabs.com

LAB-X Experimenter Boards

Assembled development platforms. Each has RS-232 serial port, in-circuit programming connector, power supply, plus other hardware.

LAB-X1 for 40-pin (shown) - \$199.95
LAB-X2 for 28 or 40-pin MCUs - \$69.95
LAB-X3 for 18-pin MCUs - \$119.95



PicBasic and PicBasic Pro Compiler

Write programs for PICmicro MCUs in BASIC. Can be used in Windows or DOS (includes Windows editor/IDE software).

PicBasic Compiler - \$99.95
PicBasic Pro Compiler - \$249.95

EPIC Plus PICmicro Programmer

Programs the following PICmicro MCUs: PIC12Cxxx, 12CExxx, 14C000, 16C505, 16C55x, 6xx, 7xx, 84, 9xx, 16CE62x, 16F62x, 7x, 8x, 87x, 17C7xx, and 18Cxxx (some MCUs require adapters). Software for Windows and DOS. Requires two 9V batteries or AC adapter (not included). Adapters available for various device packages.

Bare PCB w/software - \$34.95, Assembled - \$59.95
Assembled w/AC adapter, cable and ZIF adapter - \$99.95



PICProto Prototyping Boards

High-quality blank prototyping boards for PICmicro MCUs. Holds your microcontroller, 5-volt regulator, oscillator, capacitors, DB9-25 connector.

microEngineering Labs, Inc.

Phone: (719) 520-5323
Fax: (719) 520-1867
Box 60039, Colorado Springs, CO 80960

For product information
or to order online,
visit our website at: www.melabs.com

Circle #42 on the Reader Service Card.

Future Horizons Advanced Technology

Ambient Power Module

Low cost circuit provides up to 9 watts of electrical power from free-energy in the air. Can replace batteries in many devices.

#PWRM Plans - \$24.00
#PWRZ Ready to use - \$140.00

Ion Propulsion Motor

Plans show construction of several types of ion motors. Spins by ion propulsion. Similar to NASA's ion probe spacecraft. Great for gravity research. #HIDC or #HIDZ needed to power ion motor.

#IOPM Plans - \$20.00
#IOPZ Ion Motor Ready to use - \$150.00
#HIDC 30kv power unit Plans - \$20.00
#HIDZ 30kv unit ready to use - \$250.00
#ANTI Antigravity video lecture - \$35.00

Cordless Phone Extender

Extend your cordless phone range to 50 miles. Place calls all around town. Great alternative to cell phones.

#CPHE Plans - \$23.00

Sonic Devestator Pistol

Creates an invisible ultrasonic force field capable of inducing intense pain and discomfort in any attacker. Effective to 20 Ft.

#SONI Plans - \$15.00
#SONZ Ready to use - \$150.00

Traffic Light Buster

Has been known to turn traffic lights green in many cities by the touch of a button. Emergency vehicles use it to pass through traffic lights quickly. Opens security gates in gated communities too.

#TLBU Plans - \$20.00
#TLBZ Ready to use - \$250.00

Please add \$6.00 Shipping/handling

Catalogs are available for \$3.00

Po Box 125 Marquette, MI 49855
(906) 249-5197 www.futurehorizons.net

Circle #43 on the Reader Service Card. 33

CALL TOLL-FREE
(800) 292-7711 Orders
Only

Se Habla Español

C&S SALES

Secure On-line Ordering @ cs-sales.com

CALL OR WRITE
FOR OUR
FREE

64 PAGE CATALOG!
(800) 445-3201

Digital Multimeters

Elenco Model M-1740



\$19.95

- 11 Functions:**
- Freq. to 20MHz
 - Cap. to 20µF
 - AC/DC Voltage
 - AC/DC Current
 - Beeper
 - Diode Test
 - Transistor Test
 - Meets UL-1244 safety specs.

Elenco Model LCR-1810



\$89.95

- Cap. 0.1pF to 20µF
- Inductance 1µH to 20H
- Resistance 0.01Ω to 2,000MΩ
- Temperature -20°C to 750°C
- DC Volts 0 - 20V
- Freq. up to 15MHz
- Diode/Audible Continuity Test
- Signal Output Function
- 3 1/2 Digit Display

Elenco Model LCM-1950



\$65

- Large 1 3/4 Digit LCD
- Autoranging Freq. to 4MHz
- Cap. to 400µF
- Inductance to 40H
- Res. to 4,000MΩ
- Logic Test
- Diode & Transistor Test
- Audible Continuity Test

LCR Bridge

B&K Model 878



\$229

- Accurately measures capacitance, resistance, and inductance.
- Measures dissipation factor of capacitors and Q of inductors.
- Simultaneously displays measures, value, and Q or dissipation factor.

Deluxe Soldering Stations

Elenco SL-5 Series

Electronically controlled, ideal for professionals, students, and hobbyists. Available in kit form or assembled.

Works w/ any iron! Turn any soldering iron into a variable iron.

As Low As
\$24.95

Features:

- Cushion Grip Handle
- Soldering Iron (optional) with Grounded Tip for Soldering Static-Sensitive Devices. Easily Replaceable. Uses Long-Life, Plated Conical Tip.
- Heavy Steel, Non-Slip Base.
- Iron Holder Funnel - Reversible, left or right side.
- Steel Tray for Sponge Pad.
- Sponge Pad.

Ordering Information:

Model SL-5 - No iron. (Kit SL-5K) **\$24.95**

Model SL-5-40 - Includes 40W UL iron. (Kit SL-5K-40) **\$29.95**



Elenco Model SL-30

\$79.95

- Tip temperature changeable from 300°F (150°C) to 900°F (480°C).
- Temperature is maintained within +10°F of its preset temperature.
- The tip is isolated from the AC line by a 24V transformer.
- The tip is grounded to eliminate static charges.

SL-10 - Same as SL-30 w/o digital display **\$59.95**

Weller® Low Cost Soldering Iron Model WLC100



- Variable power control produces 5-40 watts.
- Ideal for hobbyists, DIYers and students.
- Complete with 40W iron.

\$54.95

Test Equipment

Elenco Four Functions in One Instrument Model MX-9300B

Features:

- One instrument with four test and measuring systems:
 - 1.3GHz Frequency Counter
 - 2MHz Sweep Function Generator
 - Digital Multimeter
 - Digital Triple Power Supply



\$450

Elenco 3MHz Sweep Function Generator with built-in 60MHz Frequency Counter Model GF-8046

\$199.95



Generates square, triangle, and sine waveforms, and TTL, CMOS pulse. GF-8025 - Without Counter **\$139.95**

20MHz Sweep / Function Generator with Frequency Counter Model 4040A

- 0.2Hz to 20MHz
- AM & FM Modulation
- Burst Operation
- External Frequency Counter to 30MHz
- Linear and Log Sweep



10MHz Model 4017A **\$325**
5MHz Model 4011A **\$259**
2MHz Model 4010A **\$225**

\$445

BK PRECISION

Elenco Handheld Universal Counter 1MHz - 2.8GHz Model F-2800



\$99

Sensitivity:

- <1.5mV @ 100MHz
- <5mV @ 250MHz
- <5mV @ 1GHz
- <100mV @ 2.4GHz

Features 10 digit display, 16 segment and RF signal strength bargraph.

Includes antenna, NiCad battery, and AC adapter.

C-2800 Case w/ Belt Clip.....**\$14.95**

Elenco RF Generator with Counter (100kHz - 150MHz) Model SG-9500



\$225

Features internal AM mod. of 1kHz, RF output 100mV - 35MHz. Audio output 1kHz @ 1V RMS. SG-9000 (analog, w/o counter) **\$119**

Elenco Quad Power Supply Model XP-581

4 Fully Regulated Power Supplies in 1 Unit



\$75

4 DC Voltages: 3 fixed; +5V @ 3A, +12V @ 1A, 1 variable; 2.5 - 20V @ 2A • Fully Regulated & Short Protected • Voltage & Current Meters • All Metal Case

Elenco Power Supply Model XP-603



\$75

- 0-30VDC @ 3A Output
- 3A Fused Current Protection
- Current Limiting Short Protection
- 0.025Ω Output Impedance

Elenco 10Hz - 1MHz Digital Audio Generator Model SG-9300



\$225

Features built-in 150MHz frequency counter, low distortion and sine/square waves. SG-9200 (w/o counter) **\$119**

Elenco Oscilloscopes

Free Dust Cover and 2 Probes



S-1325 25MHz Dual Trace **\$325** S-1345 40MHz Delayed Sweep **\$549**
S-1330 25MHz Delayed Sweep **\$439** S-1360 60MHz Delayed Sweep **\$725**
S-1340 40MHz Dual Trace **\$475** S-1390 100MHz Delayed Sweep **\$895**

Deluxe 29pc. Computer Service Tool Kit \$36.95 Elenco Model TK-1200

Includes Soldering Iron, Solder, Long Nose Pliers, Diagonal Pliers, 11 pc. Screwdriver Bit Set, Wire Stripper, IC Insertor, IC Extractor, Screwdriver, Phillips Screwdriver, Desoldering Pump, and more!



Elenco Educational Kits

Model XK-150

Digital / Analog Trainer

\$89.95



OWI Model OWI-007

Robotic Arm Trainer

\$82.50



Model AK-700

Pulse/Tone Telephone Kit
Flashing Neon Lights
Great School Project

\$14.95

Model M-1005K

DMM Kit

• Transistor Test
• Diode Test
• Overload Protection
• Pocket Size
\$18.95

Model AM-780K

Two IC Radio Kit

\$9.95



Model RCC-7K

Radio Control Car Kit

\$27.95

Model K4001

7W Amplifier

\$12.95



Electronic Science Lab

Maxitronix 500-in-1 Electronic Project Lab Model MX-909

Everything you need to build 500 exciting electronic projects:

- Learn the basics of electronics. 500 different electronic experiments, special lighting effects, radio transmitter and receivers, sound effects, cool games and MORE!
- Includes built-in breadboard and an LCD.
- Explore amplifiers, analog and digital circuits plus how to read schematic diagrams.
- Includes 11 parts.
- Lab-style manual included.
- Requires 6 "AA" batteries.



MX-908 - 300-in-1 Lab **\$59.95**
MX-907 - 200-in-1 Lab **\$44.95**
MX-906 - 130-in-1 Lab **\$29.95**
EP-50 - 50-in-1 Lab **\$18.95**

\$149

Guaranteed Lowest Prices

UPS SHIPPING: 48 STATES 5% (Minimum \$5.00)

OTHERS CALL FOR DETAILS

IL Residents add 8.25% Sales Tax

SEE US ON THE WEB

C&S SALES, INC.

150 W. CARPENTER AVENUE

WHEELING, IL 60090

FAX: (847) 541-9904 (847) 541-0710

<http://www.cs-sales.com>

15 DAY MONEY BACK GUARANTEE

2 YEAR FACTORY WARRANTY



PRICES SUBJECT TO CHANGE WITHOUT NOTICE

Ultrasonic Distance Measurement Using the MSP430

By Murugavel Raju

The ultrasonic distance measuring system presented here is based on the MSP430F413 which belongs to the Texas Instruments MSP430 family of ultralow power 16-bit RISC microcontrollers. The MSP430F413 was selected for this design because of the choice of its peripherals and the integrated LCD driver.

The measurement is initiated by the system by transmitting a burst of ultrasonic sound waves towards the subject and then receiving the corresponding echo. The integrated analog comparator — Comparator_A in the MSP430 — is used to detect the arrival of the echo at the system. The time taken for the ultrasonic burst to travel the distance from the system to the subject and back to the system is accurately measured by the MSP430.

Assuming the speed of sound in air at room temperature to be 1100 feet/second, the MSP430 computes the distance between the system and the subject, and displays it using a two-digit static LCD, driven by its integrated LCD driver. The distance is displayed in inches with an accuracy of ± 1 inch. The minimum distance that this system can measure is eight inches and is limited by the transmitter's transducer settling-time. The maximum distance that can be measured is 99 inches.

The amplitude of the echo depends on the reflecting material, shape, and size. Sound-absorbing targets such as carpets and reflecting surfaces less than two square feet in area reflect poorly. The maximum measurable range is lower for such subjects. If the amplitude of the echo received by the system is so low that it is not detectable by the Comparator_A, the system goes out of range, which is indicated by displaying the error message E.

Theory of Operation

Ultrasonic distance measurement is based upon the reflection of sound waves — defined as longitudinal pressure waves in the medium in which they are travelling. Subjects whose dimensions are larger than the wavelength of the impinging sound waves produce reflected waves called the echo.

If the speed of sound in the medium is known and the time taken for the sound waves to travel the distance from the source to the subject and back to the source is measured, the distance from the source to the subject can be computed accurately. This is the principle of this distance-measuring device. Here the medium for the sound waves is air, and the sound waves used are ultrasonic, since it is inaudible to humans.

Assuming that the speed of sound in air is 1100 feet/second at room temperature and that the measured time taken for the sound waves to travel the distance from the source to the subject and back to the source is t seconds, the distance d is computed by the formula $d = 1100 \times t \times 12 \times \frac{1}{2}$ inches. Since the sound waves travel twice the distance between the source and the subject, the actual distance between the source and the subject will be $d/2$.

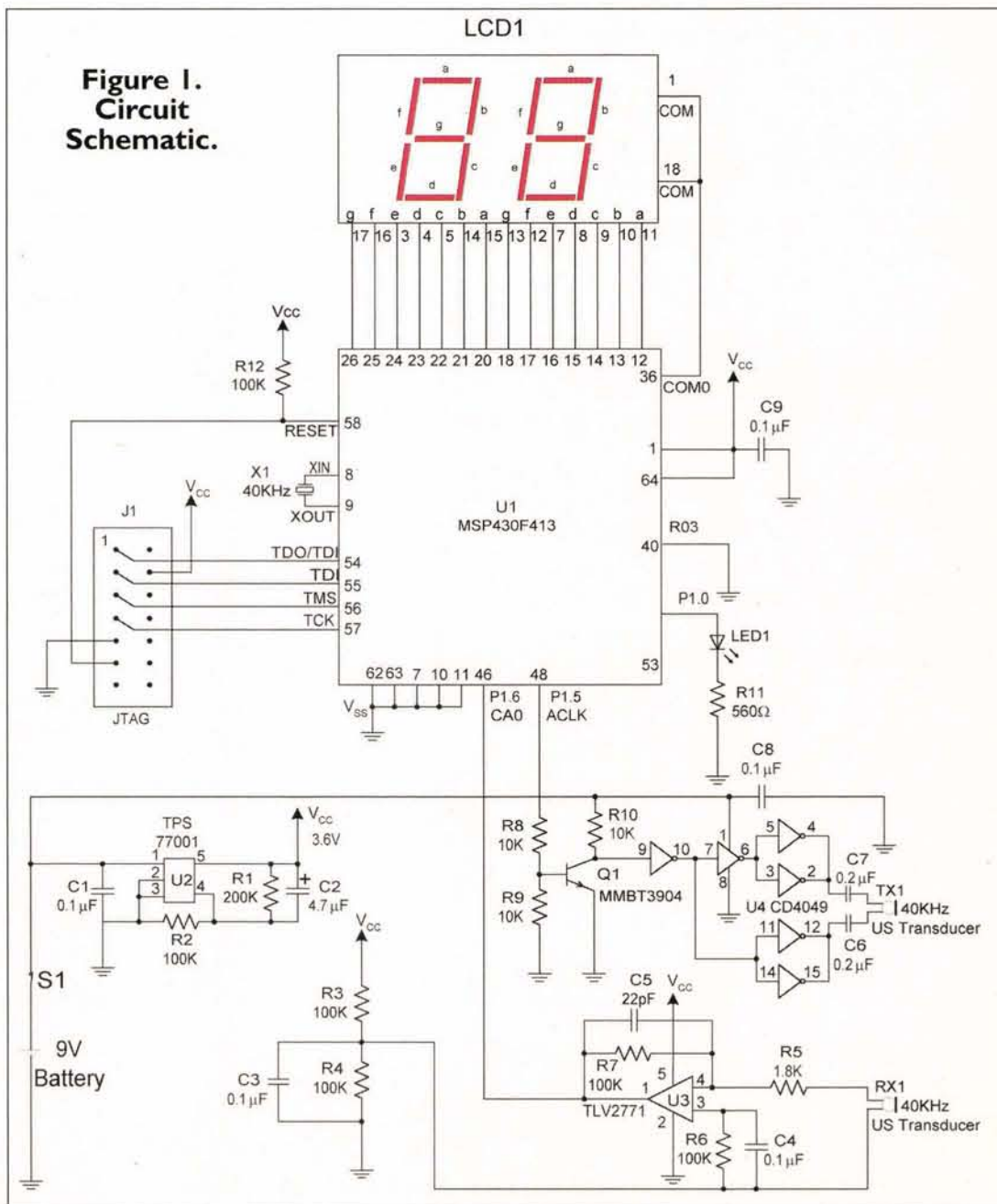
Circuit Description

The elements used to transmit and receive the ultra-

sonic sound waves in this system are 40-kHz ceramic ultrasonic transducers. The MSP430 drives the transmitter transducer with a 12-cycle burst of 40-kHz squarewave signal derived from the crystal oscillator and the receiver transducer receives the echo. The 16-bit timer Timer_A in the MSP430 is configured to count the 40-kHz crystal frequency such that the time measurement resolution is 25 ms, which is more than adequate for this application. The measurement time base is very stable as it is derived from a quartz-crystal oscillator.

An operational amplifier amplifies the echo received by the receiver transducer and the amplified output is fed to the Comparator_A input. The Comparator_A senses the presence of the echo signal at its input and triggers a capture of Timer_A count value to capture compare register CCR1. The capture is done exactly at the instant the echo arrives at the system. The captured count is the measure of the time taken for the ultrasonic burst

Figure 1.
Circuit
Schematic.



Ultrasonic Distance Measurement Using the MSP430

to travel the distance from the system to the subject and back to the system. The distance in inches from the system to the subject is computed by the MSP430 using this measured time and displayed on a two-digit static LCD.

Immediately after updating the display, the MSP430 goes to LPM3 sleep mode to save power. The Basic Timer1 is programmed to interrupt the MSP430 every 205 milliseconds. The interrupt signal from the Basic Timer1 wakes up the MSP430 to repeat the measurement cycle and update the display.

Figure 1 shows the circuit schematic diagram of this application. The MSP430F413 (U1) is the core of this system. (Reference [1] is the data sheet for this device.) LCD1 is a two-digit low-voltage static LCD driven by the integrated LCD driver. R03 is connected to VSS, and R13 and R23 are left open for static-LCD-drive mode operation of the LCD peripheral. A 40-kHz crystal X1 is conveniently chosen for the low-frequency crystal oscillator to match the resonant frequency of the ultrasonic transducers used in this application.

R12 serves as the pull-up resistor for the reset line, and the integrated brownout-protection circuit takes care of brownout conditions. C9 provides power-supply decoupling to the MSP430 and is located close to the power supply lines of the device. A 14-pin box header (J1) allows JTAG interface to the MSP430 to provide in-circuit debugging and programming using the

MSP430 flash emulation tool. LED1 is provided to indicate measurement cycles. Port pin P1.5 is configured to output the buffered 40-kHz square-wave — ACLK — required by the ultrasonic transmitter. The output drive circuit for the transducer is powered directly from the nine-volt battery and provides 18 VPP drive to the ultrasonic transmitter. The 18 VPP is achieved by a bridge configuration with hex inverter gates U4-CD4049. (Reference [6] is the data sheet for this device.) One inverter gate is used to provide a 180-degree phase-shifted signal to one arm of the driver.

The other arm is driven by the in-phase signal. This configuration doubles the voltage swing at the output and provides the required 18 VPP to the transmitter transducer. Two gates are connected in parallel so that each arm can provide adequate current drive to the transducer, while capacitors C6 and C7 block the DC. Since the CD4049 operates on 9 volts and the MSP430 operates on a VCC of 3.6 volts, there is a logic level mismatch between the MSP430 and the output driver circuit. Bipolar transistor Q1 acts as logic-level shifter between these two logic levels.

Operational amplifier U3 is the five-pin high-slew-rate TI operational amplifier TLV2771. (Reference [5] is the data sheet for this device.) This amplifier has a high-gain bandwidth and provides sufficiently high gain at 40-kHz. The operational amplifier is connected in an inverting amplifier configuration. R7 and R5 set the gain to 55 and C5 provides high-frequency roll-off. R3 and R4 bias the non-inverting input to a virtual mid-rail for single-supply operation of the operational amplifier. The amplified ultrasonic signal swings above and below this virtual mid-rail. The high Q of transducer RX1 provides selectivity and rejection of unwanted frequencies other than 40 kHz. The output of the operational amplifier is connected to the Comparator_A CA0 input of the MSP430 via port pin P1.6.

The Comparator_A reference is internally selected to be 0.5VCC. When no ultrasonic echo is received, the voltage level at CA0 is slightly lower than the reference at CA1. When an echo is received, the voltage level increases above the reference and toggles the Comparator_A output CAOUT. R3 can be fine-tuned for the required sensitivity and the measurable range can be optimized.

The MSP430 and the ultrasonic signal amplifier circuit are powered by a regulated 3.6-volt supply, derived from the nine-volt battery via TI LDO TPS77001. (Reference [4] is the data sheet for this device.) Resistors R1 and R2 program the regulator output voltage to 3.6 volts. C1 and C2 are the recommended supply capacitors for correct functioning of the regulator. The transmitter driver is powered directly from the nine-volt battery. Switch S1 functions as the power-on switch for this application.

Construction

I built the prototype using a double-sided through plated PCB designed out of 'expresspcb.com.' I used the MSP430F41x flash emulation tool (MSP-FET430P410) to develop and debug the code and to program the device. You can also use the MSP430 serial programmer (MSP-PRGS430) to program the MSP430 device. Both tools use the JTAG port of the MSP430 to communicate with the device. The flash emulation tool (FET) has the advantage of providing in-system-debugging capability. The FET tool is a low-cost MSP430 development tool offered by Texas Instruments and combined with the JTAG on-chip emulation logic of the MSP430 rules out the requirement of ICE (in-circuit emulator) for microcontroller application development.

Software Ultrasonic.s43 Init_Device

This subroutine initializes and configures the peripherals used. The Watchdog Timer is disabled first. A software delay is provided to

References

Franco, Sergio. *Design with Operational Amplifiers and Analog Integrated Circuits*. New York: WCB McGraw-Hill, 1998.

Texas Instruments Datasheets:

MSP430x41x mixed signal microcontroller datasheet (SLAS340)
MSP430x4xx Family User's Guide (SLAU056)
MSP430 Family Mixed-Signal Microcontrollers Application Reports (SLAA024)
TPS770xx Ultra Low-Power LDO Linear Regulators (SLVS210)
TLV277x Family of High-Slew-Rate operational amplifiers (SLOS209)
CD4049UB, CMOS Hex Inverting Buffer/Converter (SCHS046A)
MSP430x41x Application report (SLAA136)

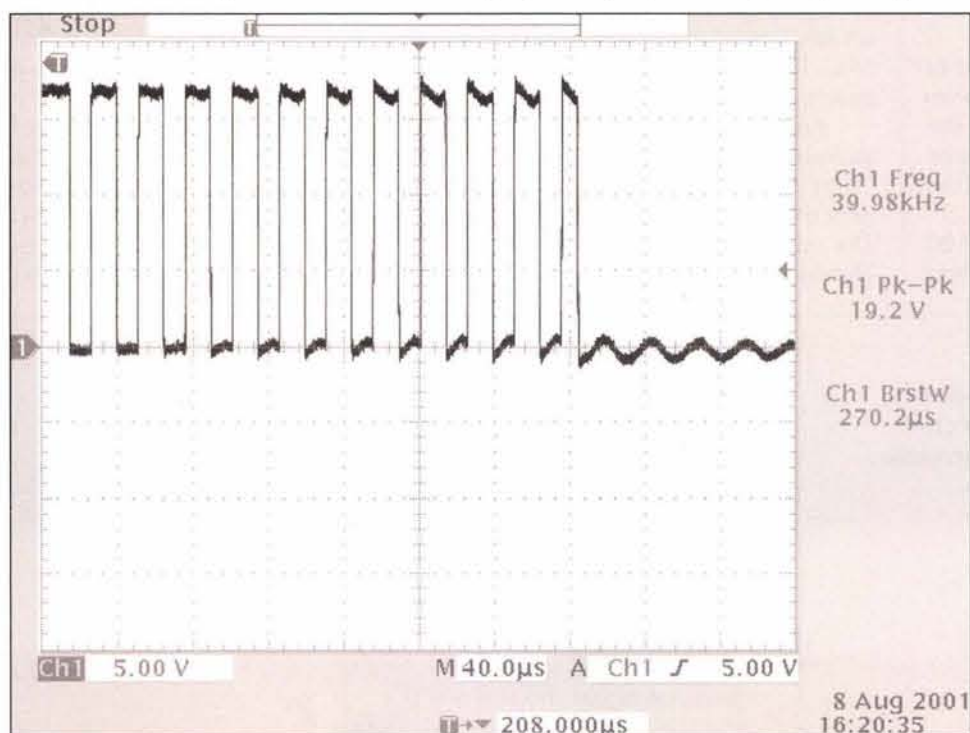


Figure 2. Oscilloscope Trace of the Transmitter 40KHz Burst.

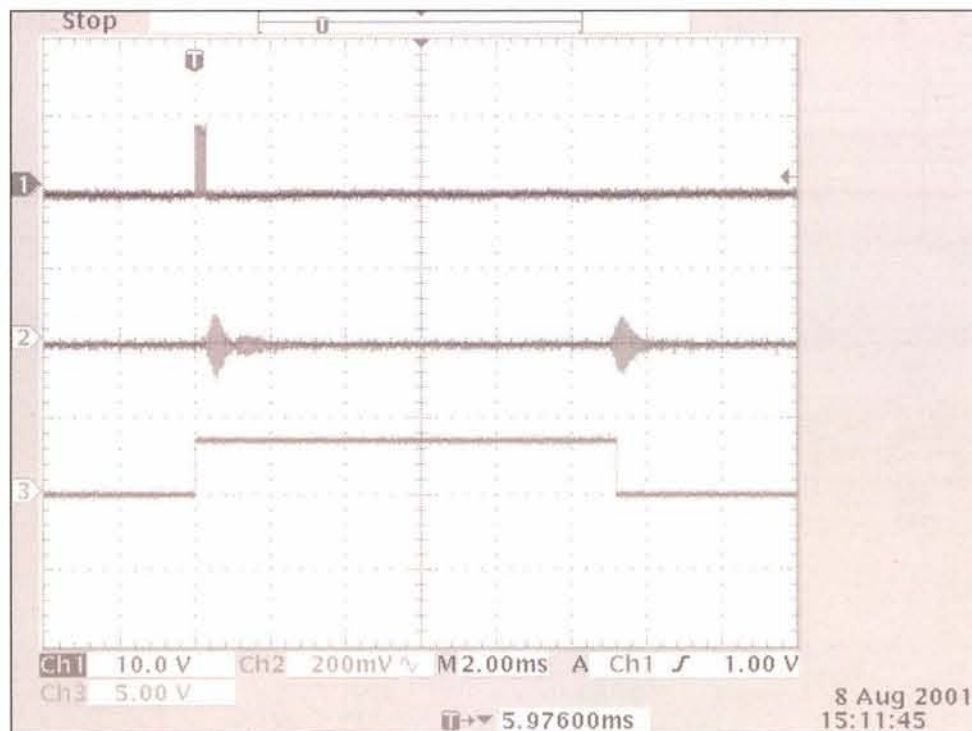


Figure 3. Oscilloscope Trace for One Measurement Cycle.

allow the low-frequency oscillator to stabilize. The FLL+ multiplier is set to 64 for a MCLK frequency of 2.56 MHz. P1.0 is configured as output for the LED. The unused port pins are configured as outputs and port pin P1.5 is configured to output the buffered ACLK frequency of 40KHz. The Basic Timer1 is enabled and configured to provide a 150Hz LCD frequency and also interrupt the CPU periodically every 205 milliseconds to initiate a measurement cycle.

The Comparator_A is configured with 0.5VCC internal reference and the CAPD bits are set to disable the input buffers for the comparator-input pins. The LCD module is turned ON and configured for static mode operation to drive the two digit static LCD in the application. The LCD memory locations are cleared such that the LCD displays '00' initially. The Basic Timer1 interrupt and the global interrupt enable are enabled finally so as to allow the Basic Timer1 to periodically interrupt the CPU.

Mainloop

The mainloop updates the LCD with the value stored in the buffer DIGITS and then puts the MSP430 to LPM3 sleep mode. The MSP430 remains in sleep mode until a Basic Timer1 interrupt occurs and the BT_ISR returns it to active mode. Now a measurement cycle is initiated. Timer_A is configured to 16-bit up-mode and ACLK is selected as the clock source for Timer_A. CCR1 is set to compare mode with a value of 12 so as to output 12 cycles of 40KHz burst on P1.5. Next, a delay of 36 ACLK cycles is allowed for the output transducer to settle. This is realized by setting CCR1 in compare mode with a value of 36. During these CCR1 compare wait states, the MSP430 stays in LPM0.

Now the system is set ready to receive the echo via the receiver transducer. The Comparator_A is configured to await the echo and, at the instant of the echo, it provides a capture interrupt. The Timer_A count is captured in the capture compare register CCR1 and the value is the measure of the time taken for the ultrasonic burst to travel the distance from the transmitter transducer to the subject and back to the receiver transducer. The count value is adjusted by adding 48 to compensate for the time lost in the 12-cycle burst and the 36-cycle transducer settling time delay. The adjusted value in CCR1 represents the exact time interval from the instant of the start of the burst to the instant of the start of the echo at the system.

Next, the math subroutine is called to compute the actual distance in inches and then return the result. If the system is out of range, the echo signal is not received and the Comparator_A does not provide a capture interrupt. The MSP430 stays in LPM0 until the next Basic Timer1 interrupt wakes it up. The CAIFG bit in the CCTL1 control register is tested now to make sure that the echo was never received. To indicate this condition, a value of 0xBE is stored in DIGITS to display E on the LCD. The program finally loops back to Mainloop to update the LCD and go back to LPM3 sleep mode. The next Basic Timer1 interrupt returns the MSP430 to active mode to repeat the program execution sequence.

Math_calc

The Math_calc subroutine takes care of the mathematical calculations required in this application. The adjusted 16-bit value from CCR1 is stored in the variable Result and is the representation of the time taken for the ultrasonic burst to travel the distance from the system to the subject and back to the system. Since the Timer_A counts in 25mS steps, the equivalent value in time will be Result x 25mS.

Assuming the speed of sound as 1100 feet/second at room temperature, the Result from the Timer_A counts works out to be six counts per inch of distance. Therefore, dividing the Result by 6, we get the required value of the distance in inches.

To achieve the required precision with the available integer math of the MSP430, the 16-bit Result is first multiplied by 100, then divided by 6. This 16 x 16-bit multiplication is done by the subroutine Mul100. The 32-bit result is stored in the variables htX100_msw and htX100_lsw.

This 32-bit result is then divided by 6 and the result is stored in the variable DIGITS. The value in DIGITS is in hexadecimal format. The hex2bcd subroutine converts this hexadecimal value to BCD (binary coded decimal) value and the last two digits of the BCD number are discarded to compensate for the multiplication by 100 done earlier. The resulting two-digit value is returned to the variable DIGITS.

BT_ISR

The Basic Timer1 interrupt subroutine BT_ISR manipulates the bits in the status register SR residing in the stack such that the MSP430 returns to active mode on return from this ISR. This allows the MSP430 to continue to execute the code following the LPM3 instruction in the Mainloop.



Display

This subroutine updates the two-digit static LCD with the value in the variable "DIGITS." The segment data for the static display is stored in the look-up table "LCD_Tab." The LCD memory is loaded with the required segment data by correlating the numbers in the "DIGITS" and indexing to the required location in the "LCD_Tab" look-up table.

Delay

This subroutine does a 16-bit software delay. No registers are affected as the variable to be counted down by software is assigned to the TOS (top of stack). After the delay is timed out, the SP (stack pointer) is incremented back to the original value before returning from this subroutine.

Conclusion

The integrated analog Comparator_A, the 16-bit Timer_A with hardware capture/compare registers, the Basic Timer1, and the LCD driver peripherals simplify this ultrasonic distance measurement application design and provide a system-on-a-chip solution. The average current consumed by the application is 1.3-mA during a 15-inch distance measurement. This includes the quiescent current of the LDO U2, Opamp U3, and the CMOS hex inverter U4. The opamp alone has a quiescent current of 1mA and the remainder of the circuit current consumption is 300mA. The LED draws 5-mA while it is ON.

The MSP430 draws an average current of 2.1mA with the LCD active all the time, the MSP430 sleeps in LPM3 most of the time, and the CPU resource used by this application is only 5.6%. Since the speed of sound is temperature-dependent, the measured reading will be less accurate at temperatures other than the room temperature. Simple thermistor-based temperature measurement and distance compensation could be employed in this situation to allow the system to measure accurately over a wide range of temperature.

The measured distance and temperature data could also be stored into the Flash memory, if required. The measurement range can be increased by adding receiver gain stages and using a multiplexed LCD to read out as many digits as required. **NV**



Murugavel Raju currently works as Systems Engineer for Texas Instruments. He was selected as the Worldwide winner of the first Texas Instruments Analog Challenge in the year 1999 (www.ti.com/sc/cash) and won the grand prize. He may be reached at m-rajul@ti.com.

By David A. Ward

To begin with, let's take a look at what's available in the PC architecture that can be used for interfacing. There are several different types of expansion slots presently available on PC motherboards but these articles will only deal with the oldest and simplest one, the eight-bit ISA (Industry Standard Architecture) expansion slot (see Figure 1). The eight-bit ISA expansion slot consists of a PCB (printed circuit board) edge connector with 62 pins, 31 on each side. The pins in this connector can be grouped into three types of buses: the data bus, the address bus, and the control bus, as well as pins for power and a clock signal. We won't get into all of the 62 pins here but only

discuss those that pertain directly to interfacing.

The data bus consists of eight bi-directional connections, D0 through D7. The eight pins allow data to be either sent out or written from the PC motherboard to a card placed in the expansion slot or for eight bits to be input or read from the card into the motherboard. Since there are only eight data bits, the data transfers are limited to the range of 00000000 (binary) through 11111111 (binary) or 0 (decimal) through 255 (decimal).

The address bus has 20 lines available — A0 through A19 — however, only the first 10 lines (A0 through A9) will be needed for typical interfacing projects. The PC I/O map that assigns and standardizes address ranges for devices such as printer ports, disk drives, etc., provides for 32 addresses for prototyping beginning at 0300 (hexadecimal) through 031F (hexadecimal) or 768 (decimal) through 799 (decimal).

Activating your interfacing projects in these 32 addresses reduces the chances that any other device in the PC will be activated at the same time as your interfacing circuitry.

The control bus contains lines that control such things as the direction of data flow. Although the ISA expansion slot has over 20 control lines, only a few are required for typical interfacing. The most important are: IOW, IOR, and AEN. When the IOW (input/output write) line goes low, the computer will be writing data out to the expansion slot. This line can be activated or asserted in QBASIC using the "OUT" command that has the following syntax: OUT Address, Data, for example: OUT 768, 234.

When the IOR (input/output read) line goes low, the computer will be reading or inputting data from the expansion slot. This line can be asserted with the QBASIC command "INP" which has the following syntax: INP(Address), for example; X = INP(769). Of course, both the IOW and IOR lines would never be asserted by the computer at the same time; the data cannot flow in two directions at the same time. The AEN or address enable

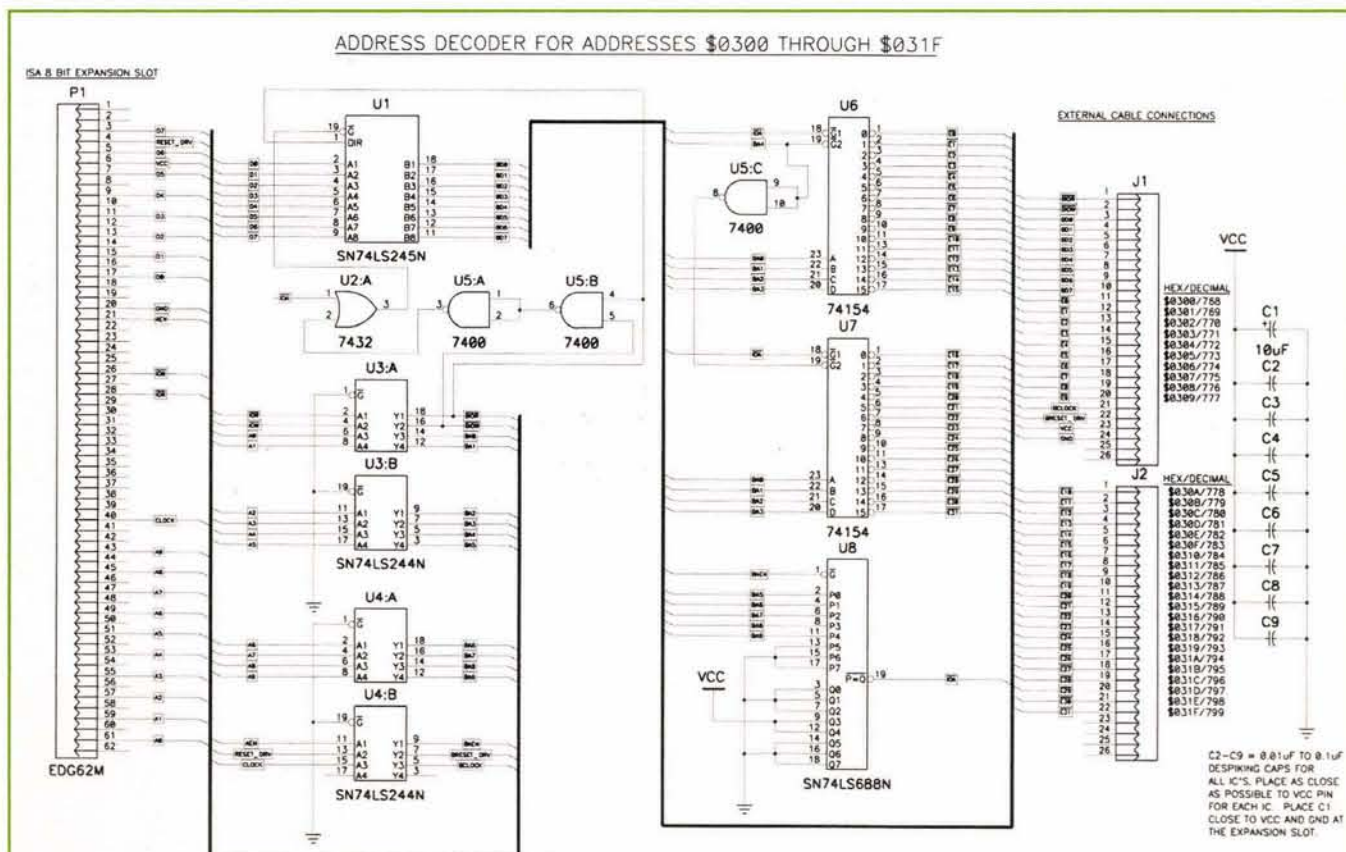
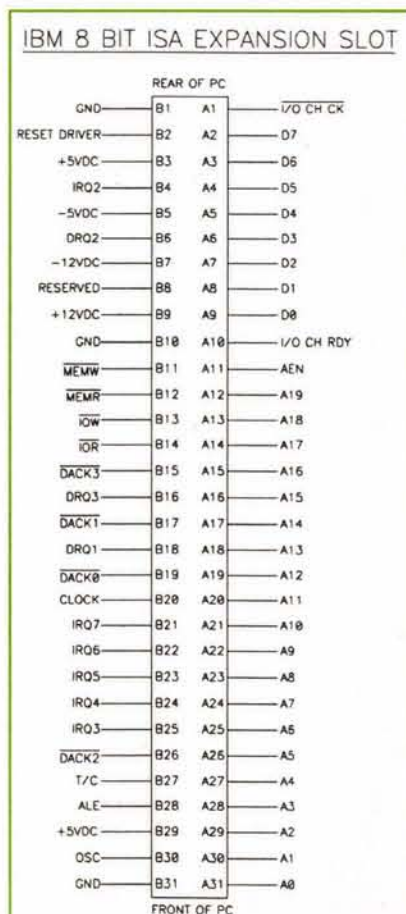


FIGURE 2

Tompkins/Webster, INTERFACING SENSORS TO THE IBM PC, Copyright 1988, PP.68, 69
Adopted by permission of Pearson Education, Inc., Upper Saddle River, New Jersey.

**FIGURE 1**

line is also an important control line when using the expansion bus. If this line goes high, it can be used to prevent bus collisions between two devices trying to use the data bus at the same time. The AEN line will go high when another device takes control of the expansion slot when performing operations such as DMA or direct memory access.

Now that we've looked at the ISA expansion slot on the PC motherboard, it is time to look at the circuitry that will fit in that slot to provide the correct address decoding and make the appropriate lines available for interfacing, see Figure 2. On the left side of the schematic diagram is the 62 pin ISA expansion slot which is labeled P1. On the right side of the schematic are two 26 pin connectors, J1 and J2, which connect to ribbon cables to take the needed lines out of the computer to a breadboard for the external interfacing circuitry.

The circuitry in the center area of the schematic provides two major functions. First, it decodes the 32 addresses in the prototyping area and provides an active low enable signal for each of these addresses, E0 through E31. Secondly, it buffers all of the necessary lines that will go out to the external interfacing circuitry. Buffering places a chip or gate between each ISA expansion slot line and the external circuitry. The buffered lines are marked with a "B" so that data line D0 becomes BD0, etc.

Buffering serves two purposes. First, it — hopefully — prevents any electrical damage caused by the external interfacing circuitry from getting back into the PC's motherboard. Secondly, buffering provides you with a known fan-out availability for your external circuitry.

For instance, if you were to connect directly to, say, data line D0, you would have no idea of how many other devices were also connected to that same line and therefore, no idea of what that data line's fan-out load or capability was. If D0 is buffered, however, you can see exactly how many devices are connected to it and plan accordingly.

That was a brief overview of how the address decoder/buffer circuitry functions. Now we can look at its functions in detail, chip by chip. U1 is a 74LS245 tri-state octal bus transceiver. With its DIR or direction pin, pin 1, it can either send data out to the external circuitry (DIR pin high) or let data flow from the external circuitry into the PC's motherboard (DIR pin low).

The data direction through U1 is controlled by the BIOR line. U1 is enabled when pin 19, G, is taken low; this will occur when either a read or write operation is called for and the proper address range is triggered from the IOA line or input/output address line. If U1 is not enabled, pin 19 is high, the data lines will be put in a high impedance or high "Z" state which, in effect, electrically disconnects the lines from the PC's data bus, thus preventing data bus conflicts and computer lock-up. Gates U2:A, U5:A, and U5:B logically tie the BIOR, BLOW, and IOA signals together so that U1 is only enabled when properly addressed during a read or write operation. IC's U3 and U4 are 74LS244 tri-state octal drivers which are always enabled and carry signals in one direction only, out from the PC motherboard.

They buffer address lines A0 through A9, control lines IOR, IOW, and AEN, as well as the reset driver line which will go high while the PC's reset button is depressed, and finally, the bus clock signal. The bus clock signal measured 8.2MHz on a 133MHz Pentium computer I was using. This signal is available for any of your interfacing ICs that may require an external clock signal.

U6 and U7 are 74154 4-to-16 line decoder/demultiplexer ICs which provide the 32 enable lines, E0 through E31. They are essentially the lower end of the address decoder because they connect to address lines BA0 through BA3. Only one of

0	3	0	0	Hexadecimal Address
A15 A14 A13 A12	A11 A10 A9 A8	A7 A6 A5 A4	A3 A2 A1 A0	Address Lines
X X X X	X X 1 1	0 0 0 X	X X X X	U8 Lower Range 0300
X X X X	X X 1 1	0 0 0 1	1 1 1 1	U8 Upper Range 031F
		X X X 0	0 0 0 0	U6 Lower Range 00
		X X X 0	1 1 1 1	U6 Upper Range 0F
		X X X 1	0 0 0 0	U7 Lower Range 10
		X X X 1	1 1 1 1	U7 Upper Range 1F
X = Don't Care				

FIGURE 3

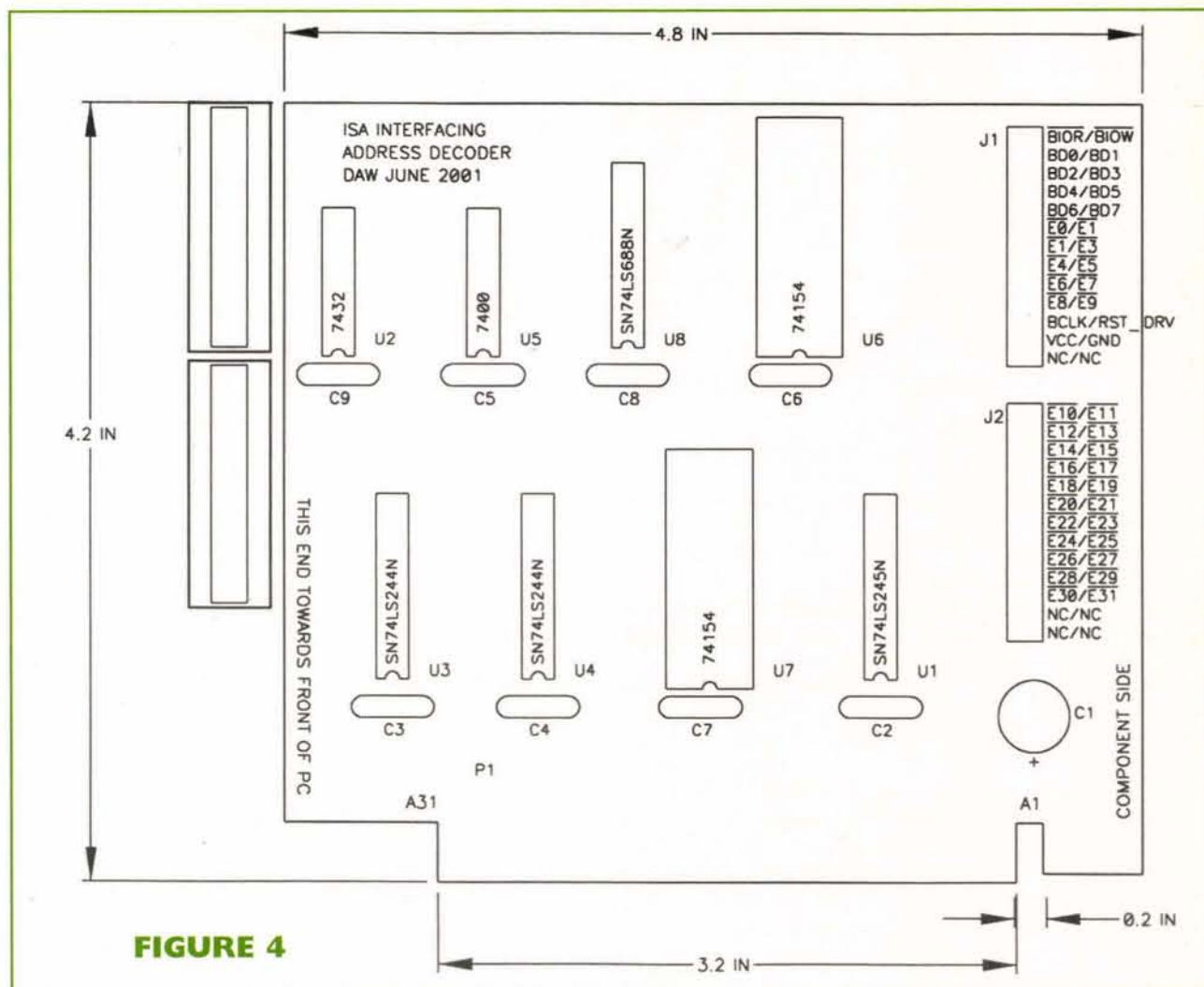


FIGURE 4

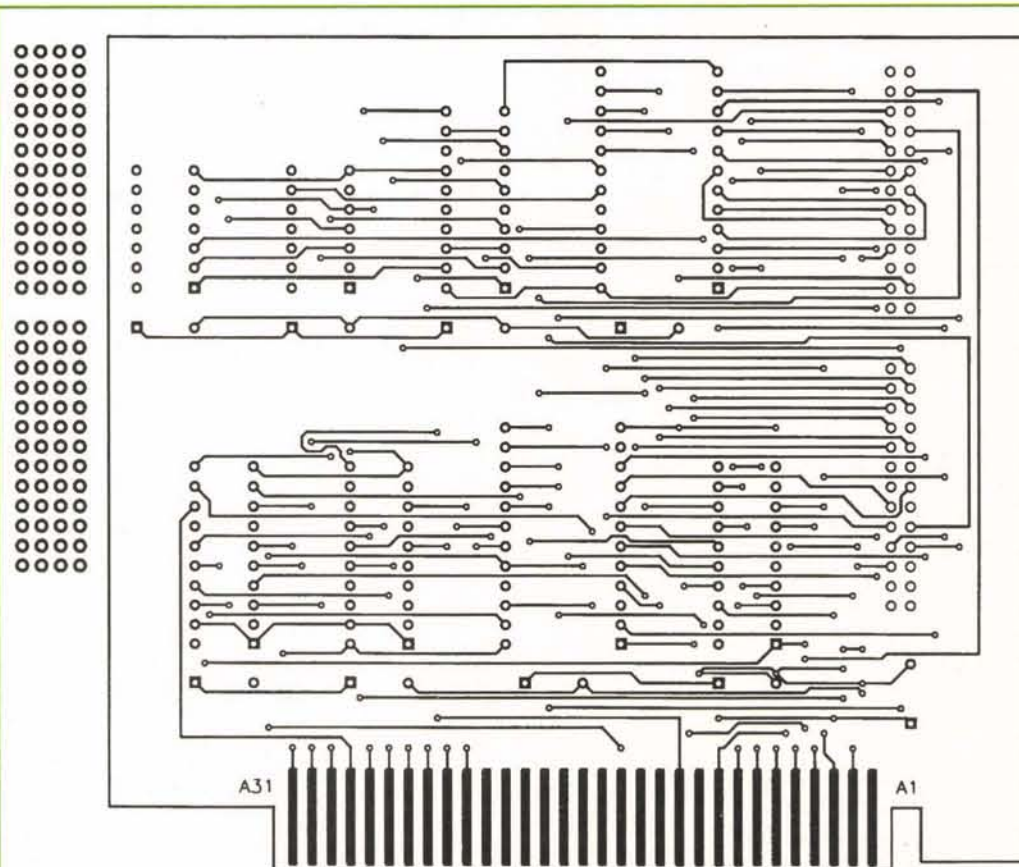


FIGURE 5

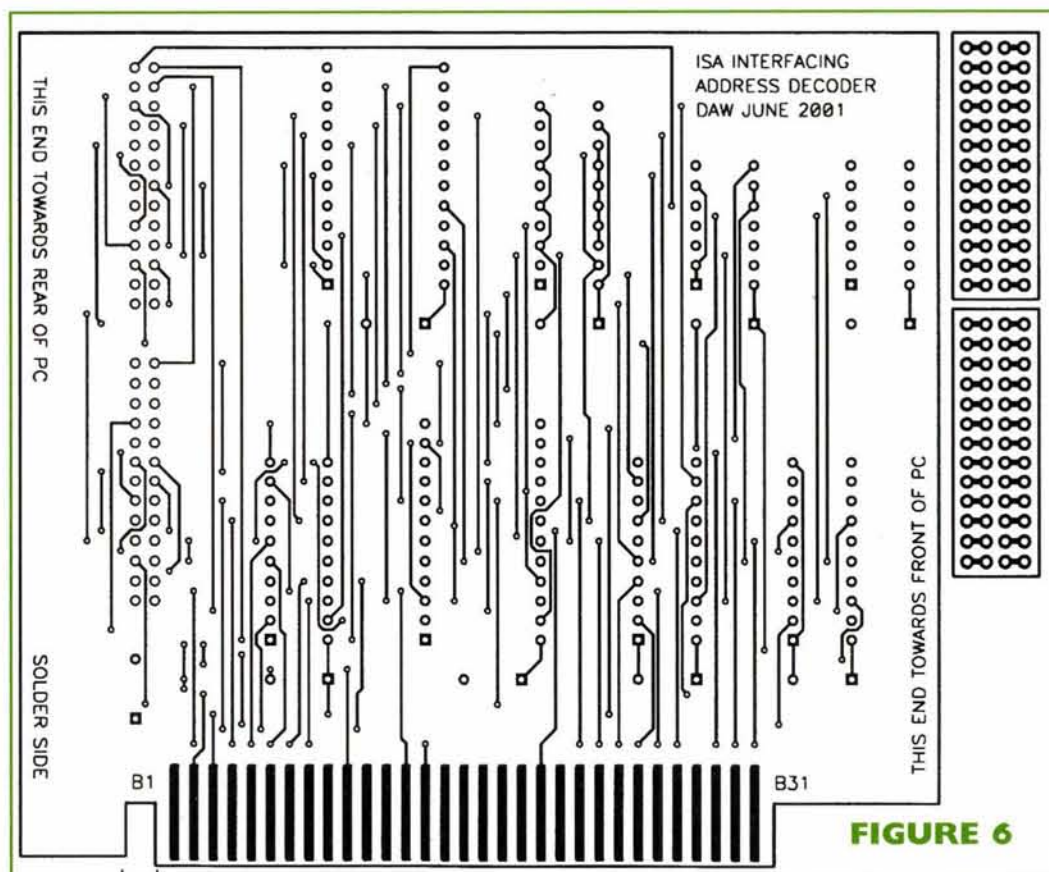


FIGURE 6

their 16 outputs can go low at a time according to the data placed at their input lines, A, B, C, and D.

BA4 is connected to U6 pin 19 and then it is inverted on its way to pin 19 of U7 by gate U5:C. When address line BA4 is low, U6 is enabled and U7 is disabled, this decodes the first 16 addresses. When BA4 goes high, U6 will then be disabled and U7 will be enabled, and continue on with the remainder of the 32 addresses.

Finally, U8 is a 74LS688 eight-bit magnitude comparator IC which is the upper part of the address decoder. U8 will be disabled whenever the BAEN (buffered AEN) or address enable line goes high, which will occur when another device takes control of the PC data bus for an operation such as a DMA; this will keep U8's output, pin 19 IOA high which will prevent U1, U6, and U7 from being enabled. U8 compares the "P" pins connected to BA5 through BA9 against the "Q" pins which are tied high and low according to the address you wish to decode. When they are equal in magnitude, pin 19 (IOA) will go low, thus enabling U1, U6, and U7. You can also study the address decoding chart in Figure 3 to see how all of the address decoding takes place.

All of this circuitry is incorporated in the PCB design shown in Photo 1. The PCB artwork for this double-sided PCB with plated through-holes is included with this article in Figures 4, 5, and 6. You can make your own PCBs from the artwork shown or they can be purchased along with their parts as a kit. (See the PCB Purchasing Information sidebar.) Note that connector J1 on the PCB contains all of the necessary lines needed for interfacing and enables E0 through E9. Enables E10 through E31 are on connector J2, so most of the time you can get by using one cable connected to J1; 10 interfacing circuits connected at one time is quite a few.

Well, that finally gets us out of the "box" with the proper address decoding and the necessary buffered data and control lines. At this time, only a basic eight-bit TTL level input port and output port will be introduced. Other types of inter-

facing ports such as; A-to-D (analog-to-digital) converters, and input and output with non-TTL level devices (such as motors) will need to be addressed in subsequent articles.

A basic eight-bit TTL level input and output port schematic diagram is shown in Figure 7 and a close-up of a protoboard with a scope probe and two ribbon cables attached to it is shown in Photo 2. Let's look at the input port first since it employs the 74LS244 tri-state octal driver which was discussed earlier. Notice that all that is necessary to enable the port is OR'ing an enable line — E1 or whichever enable you choose — with the BIOR line, through a 7432 OR gate, U3:A. The "A" pins of the 74LS244 IC are tied to +5VDC through 47K ohm pull-up resistors (the value of the resistors is not too critical) and then connected to an eight-position DIP switch which has the other side grounded.

If a switch is left open, the bit that is input will be a +5VDC or a logic "1;" if a switch is closed, the "A" side of the IC will be taken to ground and the bit that is input will be at 0VDC or a logic "0." The pull-up resistors are necessary so that there is never a "floating input" condition on the port.

Floating inputs are IC input pins that are not connected to either ground or +5VDC, they are unconnected and are susceptible to stray electrical noise and voltages. Floating input pins can give you erratic and unpredictable results so you should always use either pull-up or pull-down resistors to prevent a floating input condition. Now all that is necessary is to write a little software to make it work. The QBASIC listing below can be used to test the input port. As the DIP switches are toggled off and on, the numbers displayed on the computer monitor should change accordingly.

```
CLS
PRINT "Press any key to exit"
WHILE LEN(INKEY$) = 0
  X = INP(769) '769=E1
  PRINT X
WEND
```

Now let's take a look at the output port. The output port consists of a 74LS374 octal D flip-flop, which is enabled by OR'ing an enable line, in this case, E0 and the BIOR line. The 74LS374 IC will latch out or hold the data that is written to it until new data is received. Therefore, if you output a particular number, the LEDs will be on accordingly and remain on until another value is written to the port. Notice that the eight LEDs connected to its output side are connected through resistors to their cathodes rather than their anodes, so that the IC "sinks" their current rather than "sources" their current. This is done because the 74LS374 can only source 2.6mA of current per pin,

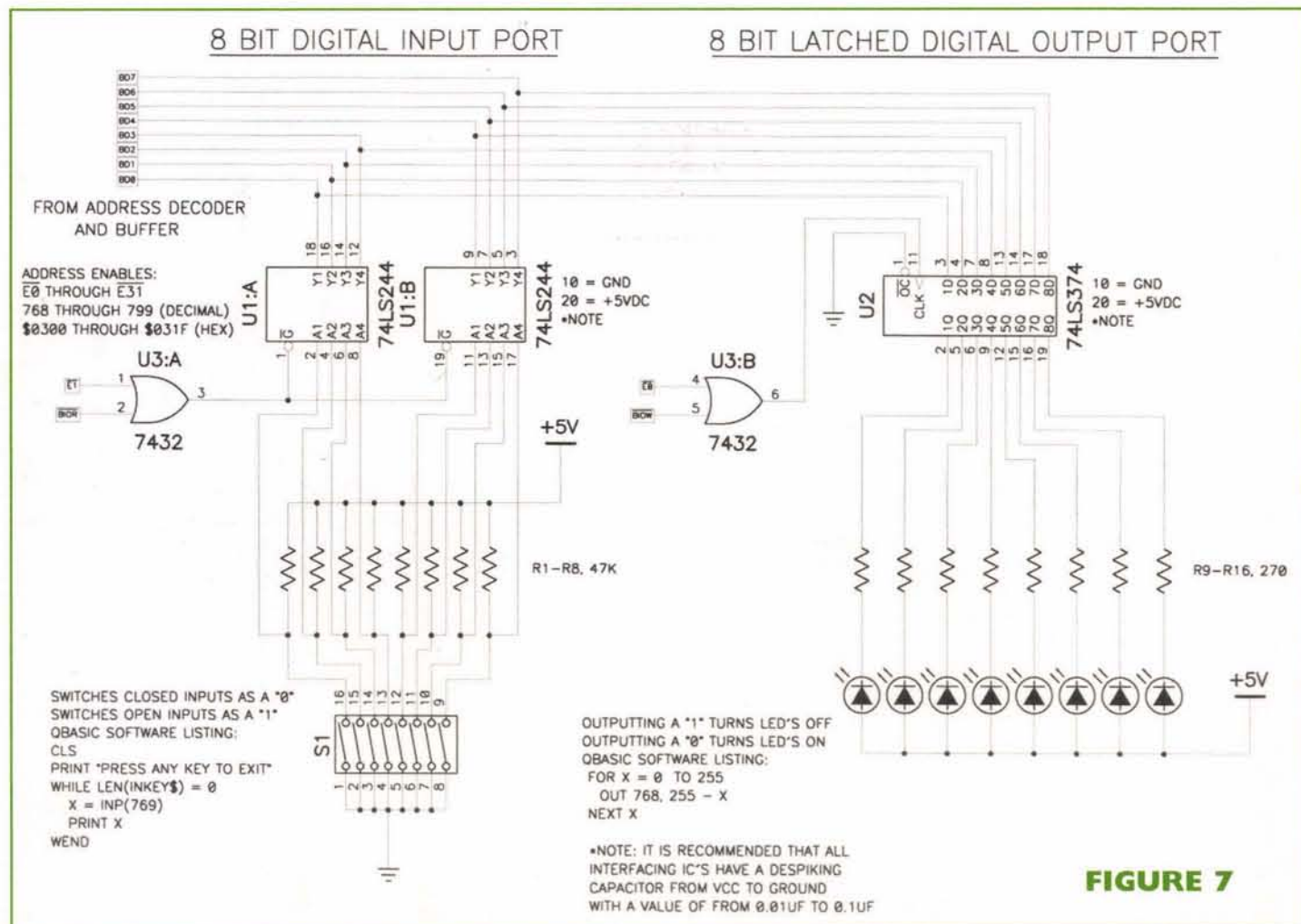


FIGURE 7

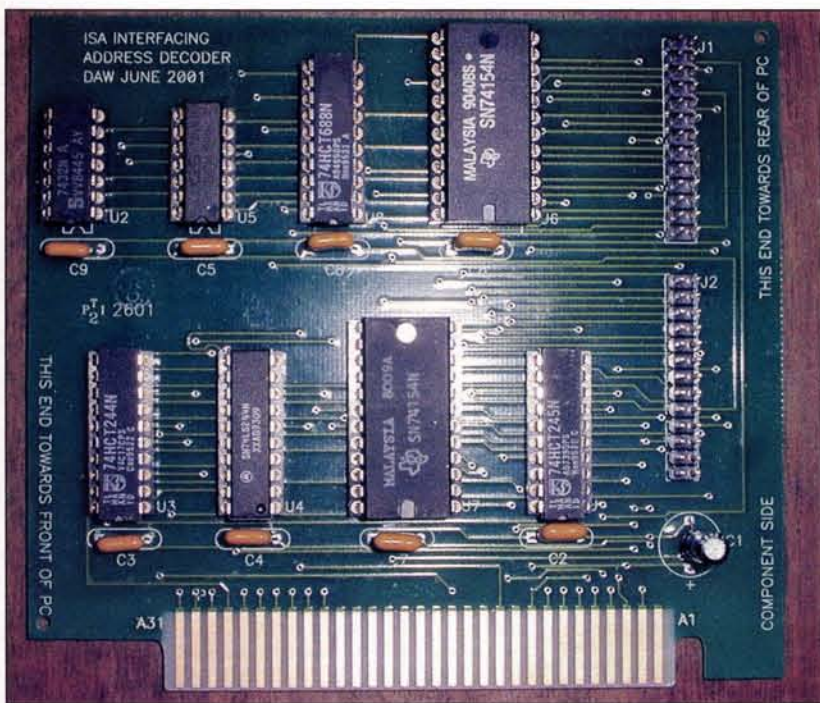


PHOTO 1

but can sink, or take to ground, 24mA of current per pin and a typical LED requires about 20mA. This causes an inverted logic at the LEDs, in other words, writing a "1" out to the LEDs will turn them off rather than on as you would normally expect. If this bothers you, it can be fixed in the software by subtracting the number you wish to output from 255; see the QBASIC software listing below. This program simply counts up from 0 to 255. If the program runs too fast or too slow for your computer, simply adjust the number

PCB Purchasing Information

Bare PCB doublesided with plated through holes, includes two break-off cable adapter PCBs for proto-boarding. **\$25.00 includes shipping and handling.**

Parts kit for PCB and I/O ports, includes: eight IC sockets, 11 ICs, 11 capacitors, one eight-position DIP switch, eight LEDs, 16 resistors, 2-26 wire ribbon cables each 2-1/2 feet long (cables are made with IDC sockets installed), four male headers for the cables, and proto-boarding pins for the cable adapter PCBs. All parts are included to build the interfacing circuitry on the PCB and the eight-bit I/O ports excluding the proto-board. **\$25.00 includes shipping and handling.**

Send a check or money order to:

David A. Ward
2261 West Skyview Dr.
Cedar City, UT 84720
Phone: 435-586-7235

(I am unable to accept credit cards.)

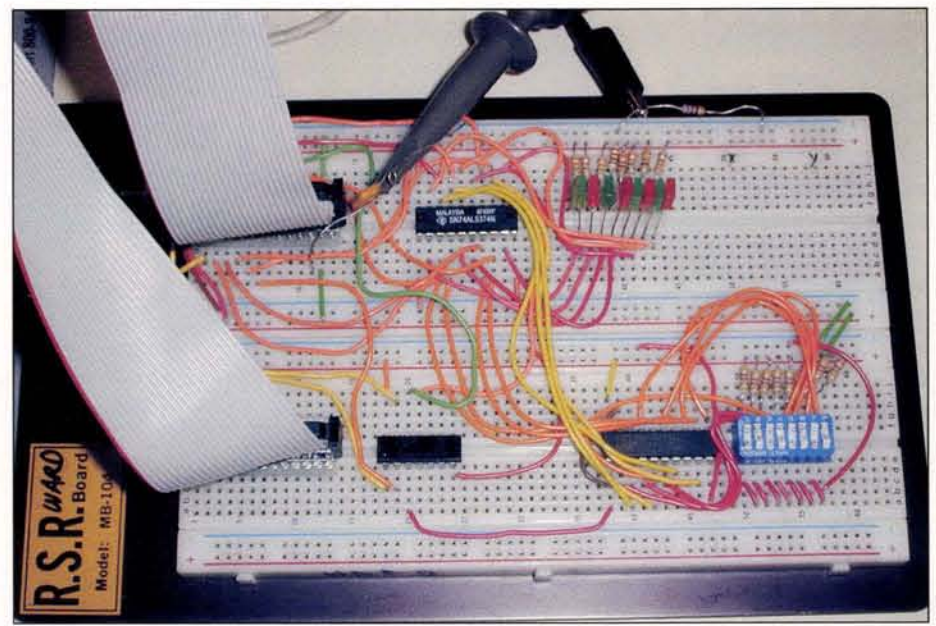


PHOTO 2

that Y counts up to (it currently counts up to 1,000).

```
FOR X = 0 TO 255
  OUT 768, 255 - X      '768=E0
  FOR Y = 0 TO 1000: NEXT Y
NEXT X
```

Well, that's plenty to get you started. In the next installment, a Visual BASIC GUI (graphical user interface) software project will be introduced and how to build it explained in detail. **NV**

Item	Quantity	Description
U1	1	74LS245 Octal Bus Transceiver 20 pin DIP
U2, U3 (I/O Port)	2	74LS32 Quad 2 Input OR Gate 14 pin DIP
U3, U4, U1 (I/O Port)	3	74LS244 Tri-state Octal Driver 20 pin DIP
U5	1	74LS00 Quad 2 Input NAND Gate 14 pin DIP
U6, U7	2	74LS154 4-to-16 Line Decoder/Demultiplexer 24 pin DIP
U8	1	74LS688 Eight-Bit Magnitude Comparator 20 pin DIP
U2 (I/O Port)	1	74LS374 Octal D Flip-Flop 20 pin DIP
	2	14 pin DIP sockets
	2	24 pin DIP sockets
	4	20 pin DIP sockets
C1	1	10uF/50V Radial Lead Electrolytic Capacitor
C2-C9, 3 (I/O Port)	11	0.1uF/50V Ceramic Despiking Capacitors
	4	0.1" Straight Male Headers
	5 ft.	28 AWG 26 Conductor Ribbon Cable
	4	26 pin IDC Sockets for Ribbon Cable
R1-R8 (I/O Port)	8	47K Ohm 1/4 Watt Resistors
R9-R16 (I/O Port)	8	270 Ohm 1/4 Watt Resistors
I/O Port	1	Eight-Position DIP Switch
I/O Port	8	LEDs

\$42

ECL-ACC120
DOOR STRIKE
FOR WOOD
OR ALUMINUM
12VDC
FAIL SECURE



\$89

ECL-ACC300
600LB MAGLOCK
12/24 VDC



\$39

ECL-374
B/W MINI CAMERA
420 LINES 0.1 LUX
36 X 36mm



\$325

SRV-960A
SAMSUNG 960 HOUR
RECORDER - 24 HOUR
REAL TIME - 110 VAC



\$85

ECL-902
9 INCH B/W MONITOR
GREAT PICTURE!!
1000 LINES



ECL-ACC200
ACCESS KEYPAD
PROXIMITY CARD
READER
WEATHERPROOF
12VDC



\$154

\$39

ECL-2400MINI
2.4GHz VIDEO SENDER
500 FEET L.O.S.
MIC. ON BOARD
4 CH. SELECTABLE



\$38

ECL-CMOS
COLOR CMOS CAM
TINY SIZE!
7-12 VDC 60mA



ECL-11L
B/W BOARD CAMERA
420 LINES 0.1 LUX
VERY SHARP PICTURE!
32 X 32mm



\$32

ECL-2400CK
2.4 GHz CAMERA KIT
500 FEET L.O.S.
RECIEVER INCLUDED
12 VDC - PINHOLE LENS



\$149

CCTV OUTLET

WWW.CCTVOUTLET.COM

1-800-323-8746

SUPER LOW PRICES!!!

Electronics Showcase

Special products and services
for the electronics enthusiast.

Special
Advertising
Section!

Top Secret Consumertronics
In business 25+ years - established professionals

Free Online Catalog!

www.tsc-global.com

Exciting Hi-Tech Survival Books, Manuals, Tapes

Stopping Power Meters Cellphone/Pager Manuals
KW-HR Meters/VHS Fax Machine Security
Polygraph Secrets Beyond Phone Color Boxes
B. vanEck Tempest/VHS Caller ID & ANI Security
ATM/Credit Card Security Radionics/ Heal Thyself
Hacker Files/Dirty2Doz EM Brainblaster
Computer/Internet Security Mind Control/Under Attack
Identity Theft Manual Social Engineering
High Voltage Devices Remote Office Strategies
Stealth Technology Casino Secrets - 100 more!

Catalog has descriptions, prices, policies

Consumertronics
P.O. Box 23097, ABQ, NM 87192
(505) 321-1034 Printed Catalog: \$3

UHF RADIO MODEM RM-232-914 FCC APPROVED

High Performance Low Power Wireless Data Link
Capable of Through Put Rates of 9600bps

- Fully acknowledged data transfer
- Addressable point-to-point mode
- Extended range in repeater mode
- Built-in software configurator
- Remote over-air configuration
- Broadcast multi-drop mode
- DTE speed 600-115200bps
- Indoor range to 30m
- Outdoor range to 150m
- Low current consumption



IDEAL FOR ADDING WIRELESS CONNECTIVITY
TO ANY RS232 LINK!

www.lemosint.com

LE MOS
INTERNATIONAL
Microwave and RF Specialists

1305 Post Road
Fairfield, CT 06430
Tel: (508) 798-5004
Fax: (508) 798-4782
Email: Sales@lemosint.com

SERIAL GRAPHIC LCD



PICL-2464 \$99.00

Sharp LM24014 240 x 64 LCD
E.L. Backlight
5" x 1 5/16" Viewable Area
PIC 16F877 Re-Programmable
Switches, A/D & I/O Bits

LCD MONITOR KIT



A Complete 12.1
TFT LCD Kit With
Controller and 180
Nit 16.7M Color
XGA Panel- Just
Plug Into VGA port
and add 12 volts
D.C.!

SK-2005R \$299

12.1" LCD MONITOR



Rugged Metal Case
On Screen Display
Free Z-Mount
Resistive & Capacitive
Touch Screen Options
Available. 1024 x 768
16.7 Million Colors
VGA and SVGA

MTR-EVUE-12 \$399.00

EARTH LCD .COM
"The World Wide LCD Source"

32701 Calle Perfecto - San Juan Capistrano, CA 92675
Ph: (949) 248-2333 Fax: (949) 248-2392

See the World's Largest Collection of LCD's and LCD
Products at <http://www.EarthLCD.com>

QUALITY KITS

SOLAR PANELS, Multimeters, Calipers,
Oscilloscopes, Camera Modules, PIC & ATMEL
Programmer Kits, Relay Cards, Electronic Lab
Kits, RF Codelock Kits, Computer Interface Kits,
Strobe Lights, and much more ...

Toll Free Order Line:
1-888-GO 4 KITS

Secure On-Line Ordering
www.qkits.com

Call 613-544-6333
for free catalog
49 McMichael St., Kingston, ON
K7M 1M8, CANADA

Download a Complete Virtual Workbench Today

Shareware version www.labcenter-electronics.com

PIC Micro Special \$99 includes; Graphical LCD, Logic Analyzer, Scope, Signal generator Probes, & more

PROTEUS
NEW **VSM**
Virtual System Modeling

www.labcenter-electronics.com
Build It In Cyberspace

Develop and test complete micro-
controller design without building a
physical prototype. PROTEUS
VSM simulates the CPU and any
additional electronics used in the
design. And it does it in real time.

Email, phone or fax for a
free demo CD Today

www.labcenter-electronics.com

- CPU models for 8051 and PIC series, 68HC11 & ATMEL AVR micro-controllers available now. More CPU models under development.
- Interactive device models include LCD displays, RS232 terminal, universal keypad plus a range of switches, buttons, pots, LEDs, 7 segment displays and more.
- Extensive debugging facilities including register and memory contents, breakpoints and single step modes.
- Source level debugging supported for selected development tools.
- Over 4000 standard SPICE models included.
- Integrates with PROTEUS PCB Design to form a complete electronics design system.

R4 Systems Inc.
Tel: 905.898.0665
Fax: 905.898.0683
info@r4systems.com



ARES PCB

ISIS Schematic



- No tooling charge!
- Lot charges start at \$80
- Simple order process
- Quickturn, low quantities

TWO SERVICES FOR
CIRCUIT BOARDS



www.pcbpro.com

- Quick price comparisons
- More options & added features
- Prototype & production quantities



INSTANT
ON-LINE QUOTES!
(NO SIGN-UP REQUIRED)

For a
DISCOUNT
on your next
order enter this
Code: NV3611

SINGLE SIDED PCB'S SAVE MONEY

PROTOTYPES TO VERY HIGH VOLUMES NO
MINIMUM SIZE ORDER, VERY COMPETITIVE
DOUBLE SIDED PCB'S

\$1,000.00 MINIMUM ORDER, LOWEST PER UNIT PRICE
IN THE INDUSTRY, FOR MEDIUM TO HIGH VOLUME ORDERS

UL & CSA, AN ISO-9002 COMPANY

OTHER SERVICES: MULTILAYER, FLEXIBLE PCB'S, DESIGN OF PCB'S,
FROM YOUR HAND DRAWN SCHEMATICS AND ASSEMBLY (SMT/APT)

V&V MACHY & EQUIP. INC.
V&V MACHY AND EQUIP. INC. (HOUSTON TX OFFICE)
PH: (281) 387 8101 FAX: (281) 387 8220
MARKETING TECH. S.A. (MEXICO PLANT)
PH: 011 525 3613351, FAX: 011 525 3615966
EMAIL: sales@vandvmachy.com SITE: www.vandvmachy.com

LOWEST PRICE IN THE
INDUSTRY FOR SINGLE
SIDED PROTOTYPES
DELIVERY IN 5 DAYS

CUSTOM PLASTIC PARTS

MODELS (WOOD AND RESIN). TO EVALUATE YOUR PARTS BEFORE YOU COMMIT TO MANUFACTURE A MOLD. MOLD DESIGN AND BUILDING.

PRODUCTION OF INJECTION MOLDED PARTS. NO ORDER TO SMALL OR TO BIG. VERY COMPETITIVE ON HIGH LABOR PARTS.

We can also inject your parts on manual low pressure machines for very small runs or prototypes of parts up to 2 oz. At a surprisingly low price.

USA. Office: V & V Mach. And Equip. Inc.
Tel. (281) 397-8101, Fax. (281) 397-6220

Please send blue prints or samples to:
Marketing Tech. S.A. Alamo 93, 4o. Piso, Santa Monica Tlal. Edo. De México. C.P. 54040.
TEL. 011 (525) 3613351, Fax. 011 (525) 3615996
ATTN. VICTOR M. MENDOZA.
Mobil. 011 (525) 4398913

PLEASE VISIT OUR SITE
www.vandvmachy.com

CABLE CONVERTS

TV86/3	86/CH	TV86/3V/A
TRIVISION	550/3	\$37.95
VIEW MASTER	2600	
125 CHANNEL UNITS		
TRI 860/3	10 LOT	\$49.95
TRI 860/3V/A	10 LOT	\$59.95
V/MASTER	3800/3V/A	

FOSS WAREHOUSE DIS.

289 SCHENCK ST., N. TONAWANDA, NY 14120

800-473-0506 • 800-488-0525 FAX

716-694-6400 716-693-4322 FAX

E/M FOSS@BUFFNET.NET

WEB PAGE: WWW.FOSSW.COM

NO DESCABLERS ONLY CABLE CONVERTS

Synthesizer Modules, Guitar Effects, Mixers, EQs, Tube PreAmps, and dozens of other kits for

ELECTRONIC MUSICIANS

PAIA

Theremin
The PAIA Theremin uses the same heterodyne principles as the original turn of the century instrument for classic tone and adds features made possible by modern ICs. Shown with optional lectern case.

9505K Kit \$89.75

FatMan Analog MIDI Synth
A complete music synthesizer with all the big bottom and phat sound that makes analog famous. 20 knobs and controls for real-time sound sculpting. Compatible with standard MIDI sources like keyboards or computers. Desktop case or rack panel available.

9308K Kit \$154.00

Check out <http://Paia.com> for schematics, tech details, firmware source files and more...

PAIA Electronics • 3200 Teakwood Lane • Edmond, OK 73013
405.340.6300 • fax: 405.340.6378 • email: info@paia.com

BiM2

433 MHz

900 MHz Available January 2002

High Speed Wireless Data Transceiver
Physical Dimensions: 33 mm x 23 mm x 4 mm

- Data rates up to 160 kbps
- RX sensitivity -100dBm
- Usable range up to 200m
- SAW controlled FM transmitter
- 3V and 5V versions
- Low power requirements
- TX power 10mW @ 5V
- Fully screened
- Double conversion Superhet receiver
- Plug in replacement for BiM-433-F



www.lemosint.com

LEMONS INTERNATIONAL
Microwave and RF Specialists

48 Sword Street
Auburn, MA 01501
Tel: (508) 798-5004
Fax: (508) 798-4782
Email: Sales@lemosint.com

SX-800 \$79

BX-123-AU \$69
BX-123-CAU (color) \$149

PC-103 \$99

ES-8960 \$329

A-330-SC (4 pcs/\$25 ea)

AX-800 \$79

WR-700 Weather Resistant \$99

ASK-7003-TR \$169

New Price Specials!

Fax: 847-303-0660
Canada: 877-720-9222

MATCO

EverSecure™
www.matco.com

- On-Line Ordering
- OEM Security Products
- Monitors, Cables, Accessories
- Law Enforcement Equipment
- Discreet Wireless Systems { \$89-\$269 }

Sales: 847-303-9700
Toll Free: 800-719-9605

HVW TECHNOLOGIES

HIGH-TECH SOLUTIONS TO HIGH-TECH PROBLEMS

BASIC Stamp™ Prototyping Made Easy...



\$32.95 (Kit)

Stamp Stacks™ mount directly on any breadboard to make prototyping easy. Complete - just assemble, connect power and a serial cable. 100% BASIC Stamp™ compatible. Robust, Repairable, Inexpensive. Starter kits available.

Pic Compilers/Programmers/Protoboards-Serial LCDs IR Ranging Sensors...

HVW Technologies Inc.
Tel: (403)730-8603
Fax: (403)730-8903

VISA/MC Accepted
www.HVWTech.com

CONTROL • MEASURE • INPUT

MODEL 40-\$109

- RS-232 interface
- 28 lines digital I/O
- Eight analog inputs
- PWM output
- Three stepper ports



MODEL 100-\$279

- 12-bit 100KHz A/D
- Four analog outputs
- Three timer counters
- 24 digital I/O



PRAIRIE DIGITAL, INC.

920 SEVENTEENTH ST., INDUSTRIAL PARK
PRAIRIE DU SAC, WI 53578

TEL: (608) 643-8599 • FAX: (608) 643-6754

Scope + ScopeAlyzer™ = Logic Analyzer



- Attach to 20 MHz scope
- 100 MHz sample rate
- 16 channels
- 128K sample memory
- Trigger (0.1X, edges)
- Pan and zoom
- One key data snapshot
- Scope trigger output

The ScopeAlyzer™ is a precision crafted, professional grade instrument that attaches to an ordinary 20 MHz oscilloscope and extends its capability to a high performance logic analyzer.

Model 61050 \$395 Model 61100 \$595

Barrett Instruments

www.BarrettInstruments.com 800 272-1936

PRINTED CIRCUIT BOARDS

QUALITY PRODUCT
FAST DELIVERY
COMPETITIVE PRICING

- * UL approved
- * Single & Double sided
- * Multilayers to 8 layer
- * SMOBC, LPI mask
- * Reverse Engineering
- * Through hole or SMT
- * Nickel & Gold Plating
- * Routing or scoring
- * Electrical Testing
- * Artwork or CAD data
- * Fast quotes

We will beat any competitor's prices!!!

yogii@flash.net • flash.net/~yogii

10 pcs (3 days)
1 or 2 layers \$249

10 pcs (5 days)
4 layers \$695
(up to 30 sq. in. ea.) includes tooling, artwork, LPI mask & legend

PROTOTYPE THROUGH PRODUCTION
PULSAR, INC.

9901 W. Pacific Ave.
Franklin Park, IL 60131
Phone 847.233.0012
Fax 847.233.0013
Modem 847.233.0014

Oscilloscope Special

Wavetek Model 1910

\$99⁰⁰ Each + S&H

www.westshoretech.com

ActiveWire® USB
Simple USB Interface!



- Works with MacOS 8/9, Win98/2K/ME
- FreeBSD and Linux!
- 24Mhz CPU core with USB
- Firmware downloadable via USB
- 16 bit parallel Input/Output
- See web-site for add-on boards
- All drivers, manuals, demos are on our web-site for immediate download!

\$59 plus shipping

ActiveWire, Inc.
www.activewireinc.com

ph +1.650.493.8700 x203 fax +1.650.493.2200

Kronos Crawler Phase 3

Switches & Mods

By Michael Simpson

Important Change

On the last two Kronos Crawler articles, the schematics list the pins for the VSS connection on the SN754410 chip as 4,5,13,14. This is incorrect and should read 4,5,13,12.

This month, we are going to add a couple of bump switches for object detection. Before we get started, we need to make a few modifications to the platform. These modifications will allow us to attach two bumpers to the front of the Crawler. They will also allow us to off-load some of the circuitry on the development board to a few multipurpose PC boards.

Platform Modifications

These enhancements involve drilling nine more holes and widening another. I will go through each step needed to upgrade the platform by referring to Figure 1.

Step 1

Remove the platform from the base and remove all components currently mounted on the platform.

Step 2

Widen the center hole as indicated in Figure 1. This hole is currently used to run the motor wires. Although this step is not absolutely necessary, it will make life easier in the future and will also protect the wires going through the hole.

Step 3

Place a 1/8" support hole 3-7/8" from the right edge and 6-1/2" from the back edge.

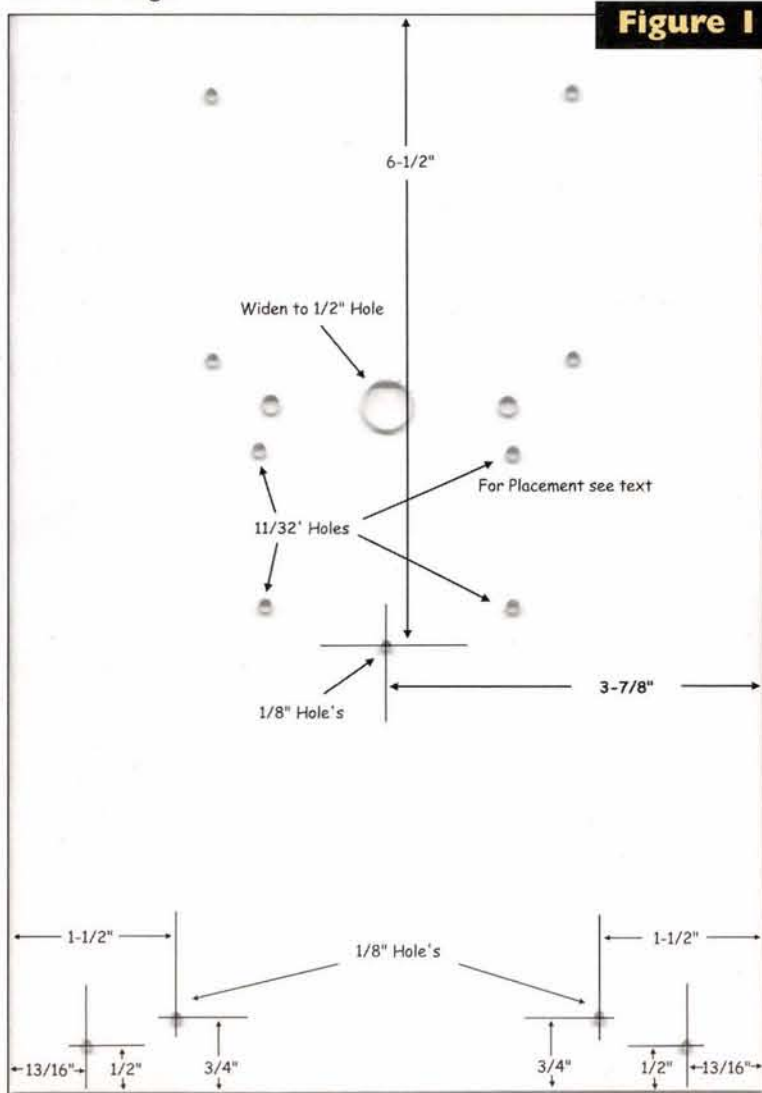
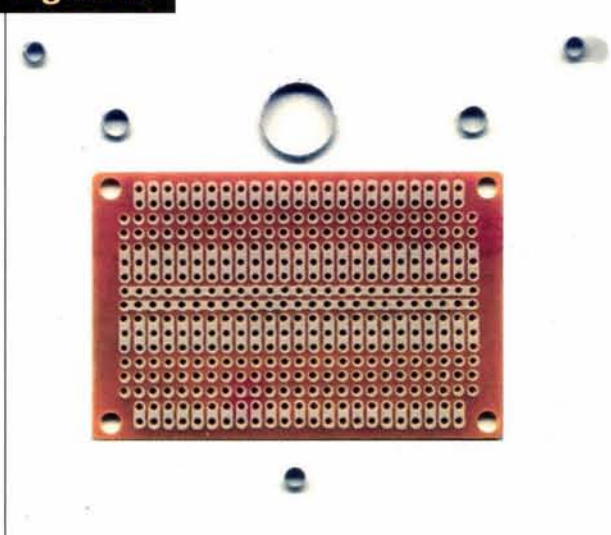


Figure 1

Figure 2



Step 4

Drill the four 1/8" holes near the front of the platform. These will be used to mount the bump switches.

Step 5

Drill the four 11/32" holes near the center of the board. I did not give measurements on these because the best way is to just mark the holes with the multipurpose PC board as shown in Figure 2. Placement is not that critical. I show 11/32" holes for this, but you may want to make them a bit bigger to give your mounting screws some adjustment.

Now with the platform modifications, we can start to reassemble the Crawler. If you are going to paint your Crawler, now is the time. Remove the tracks and cover the wires. Lay the platform upside down on a flat surface and paint the bottom. Be sure to let it dry before you continue.

Step 6

Take a 3/8" rubber grommet and insert it into the 1/2" hole that you widened.

Step 7

Take four 6-32 3" machine screws and insert them into the four holes you created for the multipurpose PC board. Use four 6-32 hex nuts to attach the screws. Tighten the nuts.

Step 8

Take a 1" 4-40 machine screw and attach a hex nut. Slip on a #4 lock washer. Now take that screw and insert it into the new 1/8" support hole from the top. Attach with a second hex nut from the underside of the platform as shown in Figure 3. (Your platform should look like the one in Figure 3.)

Step 9

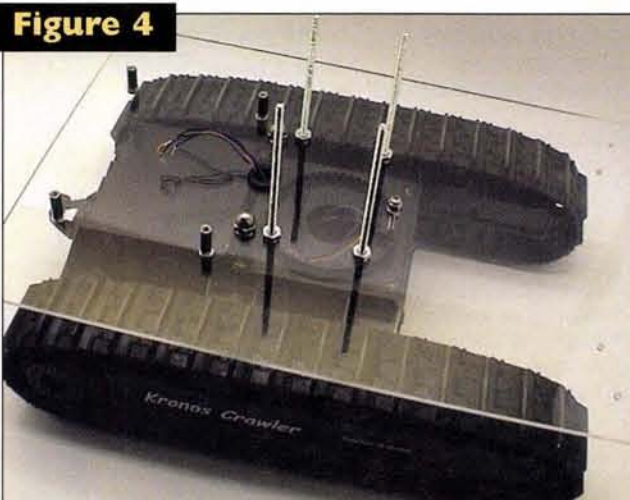
Another enhancement I made was to use 1/2" stand-offs instead of just machine screws. This allows you to remove and attach the development board without the removal of the platform.

As shown in Figure 4, take four 1/4" 4-40 machine screws and insert a #4 lock

Figure 3



Figure 4



Kronos Crawler

washer on each one. From the bottom of the platform, insert the machine screws into the four development board holes on the platform. Take the four standoffs, attach them to the screws, and tighten firmly in place.

Step 10

Reattach the platform to the Crawler base using the two 10-24 Acorn nuts. Be sure to feed the motor wires through the grommet. At this point, your Crawler should look like the one in Figure 4.

Step 11

Reattach the development board to the four standoffs with four 1/4" 4-40 machine screws.

That's it for the modifications. Now with very little effort, we can add extra boards to free up our development area.

Contact Bumpers

The contact bumpers consist of two switches with mounting hardware configured in such a way that if the Crawler bumps into anything from the front, we can detect it.

We start with two snap action lever switches. The ones I used have a 2" lever. We are going to attach a 7" piece of piano wire to each lever. We will use some heat shrink tubing for this. The tubing will also keep the wire from scratching any delicate surfaces the Crawler may come in contact with.

Take a 3" piece of the 1/16" red shrink tubing and slip it over the piano wire. Leave about 1/4" excess tubing on the end. Heat the tubing and twist the excess on the end to a point as shown in Figure 6.

Now slip a 6" piece of 1/8" shrink tubing over the lever of the switch. Work it all the way to the bend in the lever as shown in Figure 7. Don't heat the tubing yet.

As shown in Figure 8, slip the non-covered end of the wire into the tubing so that it slides along the top of the lever. The wire should be flush with the bend in the lever. Heat the tubing now to secure the wire in place.

It is time to attach the wires to the switch. I prefer to use colored wire so that I can figure out which switch is which once everything is installed.

Referring to Figure 8b, start by connecting a 13" brown or black wire to the common lead of each switch. This connector is marked COM on most switches. If it's not marked on your switch, you will have to use a voltmeter to find this lead.

Next, connect a 13" yellow wire to the normally open lead on one switch and a 13" orange wire to the normally open lead on the other switch.

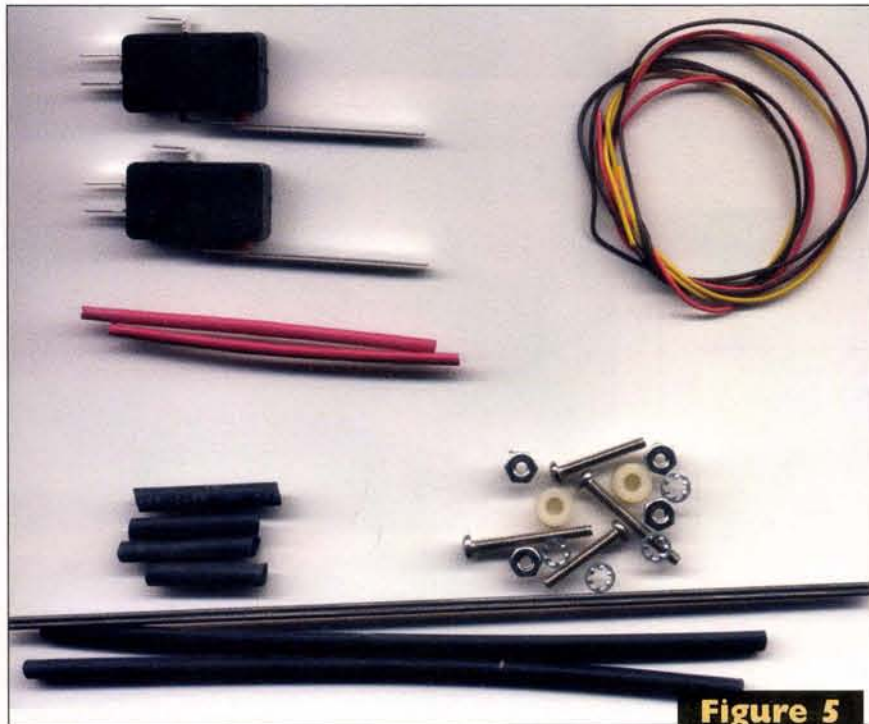


Figure 5



Figure 6



Figure 7

Solder in place and slip a 1" piece of 1/8" shrink tubing over the lead and heat.

As shown in Figure 9, attach the right bumper switch (yellow wire). Use two 3/4" 4-40 machine screws and #4 lock washers. Attach the left switch using two 1" 4-40 machine screws and lock washers. On the left switch, you should also use two 1/4" spacers between the switch and the platform. This helps keep the two bumpers from interfering with each other.

Run the wires up through the grommet. You can use the support screw we put in place earlier to help with the routing of the wires. Make sure they are up against the bottom of the platform and not rubbing on any of the tracks. If necessary, use a bit of tape to hold the wires in place.

Hook-up

Let's start by reconnecting the motor controller.

I wired up the SN754410 to a multipurpose board as shown in Figure 10. If you mount the SN754410 on one end of the board, it leaves room for enhancement later. I will be offering a serial controller for the SN754410 in the future so you only need one pin to control your motors. Also notice in Figure 10 that I added a small switch. This switch is completely optional, but it does allow me to turn off the motor power source without pulling wires.

Figure 11 shows a complete schematic of the current Crawler configuration. It even includes a few CDS cells that we will be using in a future article.

At this point, I need to make a few points. Many of the pin assignments on the Atom have been changed. I did this to exploit another feature of the microcontroller.

The Atom has two PWM signal generators, and even though both use the same timing circuitry for the frequency, they both can have separate duty cycles. This allows control over the individual tracks on the Crawler.

Why would you want to do this? No two motors are exactly alike. You may find that the Crawler slowly pulls to one side or the other when it travels in a straight line. By tweaking the left or right track, we can correct this.

With the motor controller mounted on a multipurpose board, we are ready to mount it on the mounting screws. Before we do this, we need to add a 1/4" spacer as shown in Figure 12.

In Figures 13 and 14, you can see my controller board and battery placement. The headers make it very easy to wire the board without solder-

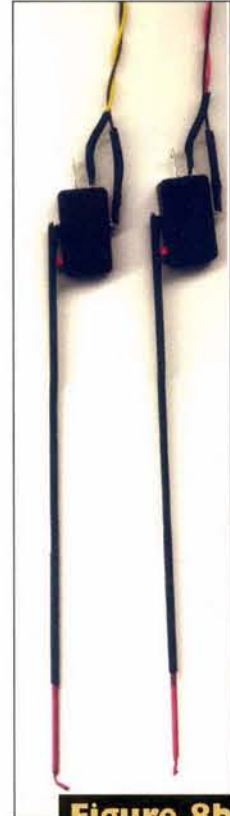


Figure 8a



Figure 8

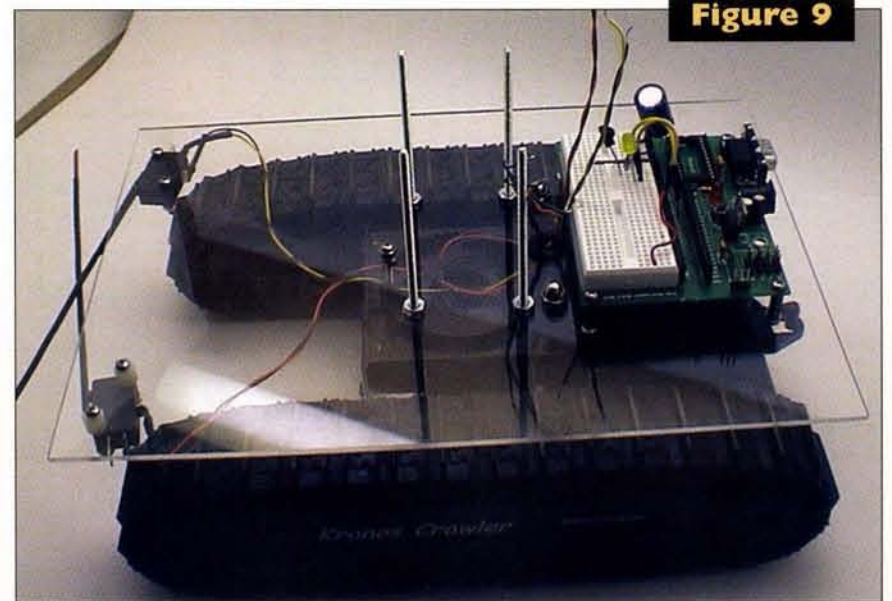


Figure 9

ing.

Figure 15 shows the Crawler with a second base mounted on the top of the mounting screws. This gives you lots of room for expansion and experiments.

The Program

This program was designed to reflect the modifications we made to the schematic, so you will notice the motor controller definitions have changed. The IR routines now also reflect the new lead we are using there.

As far as additions go, we have added a checkbumpers routine that will stop the motors if either bumper comes in contact with an object while the Crawler is moving forward.

The extra PWM generator code has also been added to each of the speed subroutines. Tweak these as necessary if your Crawler drifts to the right or left.

For instance:

```
HPWM 1,10000,9900 : Return 'Left track
HPWM 0,10000,10000 : Return 'Right track
```

will cause the Crawler to very slightly drift to the left.

```
HPWM 1,10000,10000 : Return 'Left track
HPWM 0,10000,9900 : Return 'Right track
```

will cause the Crawler to very slightly drift to the right.

One last addition was a small routine that will place the Crawler into a

search mode. You enter this mode by hitting the #9 on the remote.

The Crawler will move forward until it encounters an object, then will back up and turn to move forward again.

In Closing

I started using rechargeable batteries and I feel a word of caution is needed. Rechargeable batteries can put out quite a bit of current all at once and easily start a fire if shorted out. This is one of the reasons I installed the switch to remove the motor power.

I have also used two four-cell battery holders for this project. This is a total of eight batteries. With rechargeable batteries at 1.2 volts each, that's 9.6 volts. With 1.5 volt drop across the motor controller, that gives us 8.1 volts, which is a bit more than the six volts the motors are rated at. By lowering the duty cycles, we can compensate for this.

What's Next

More sensors.
NV

For updates and enhancements, be sure to visit the Kronos Robotics web site at www.kronosrobotics.com

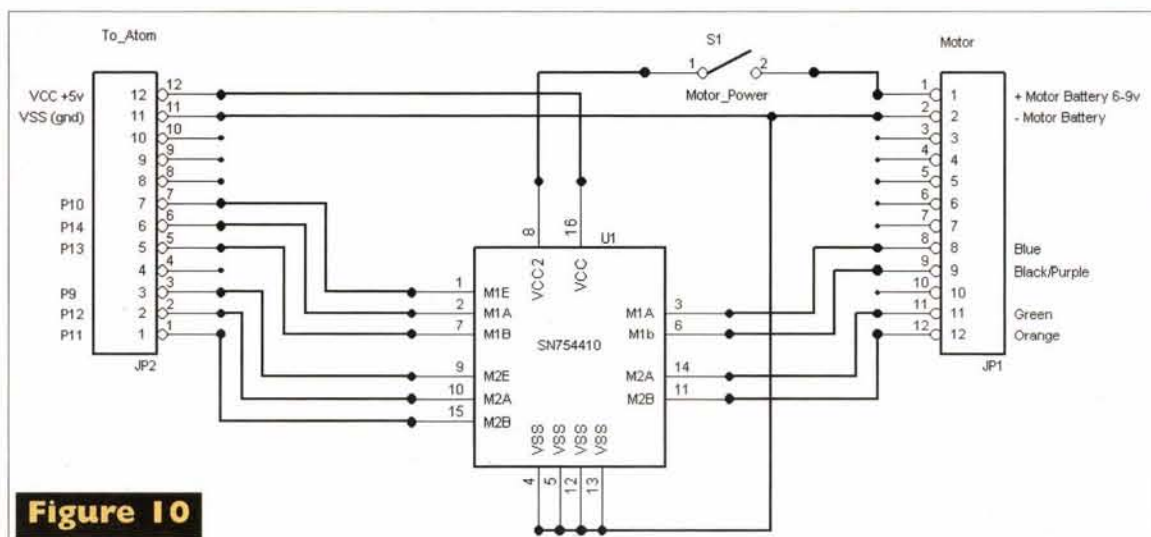


Figure 10

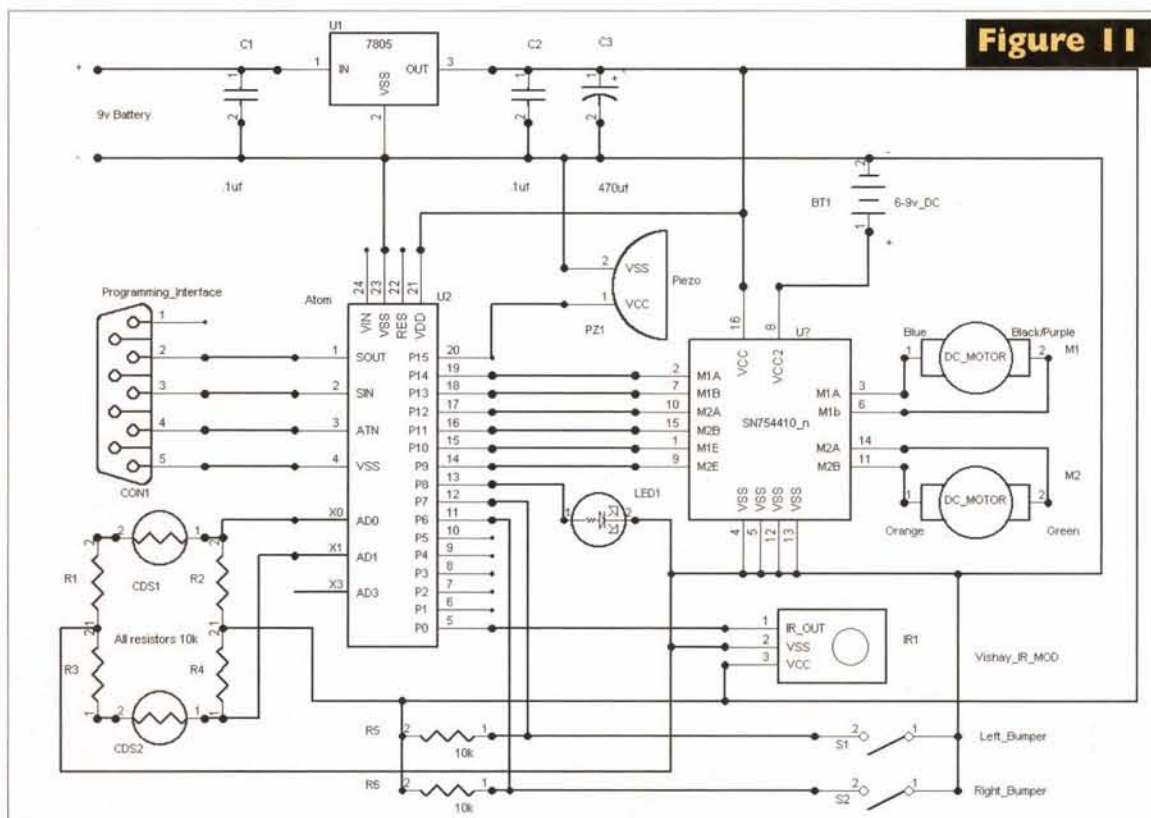


Figure 11

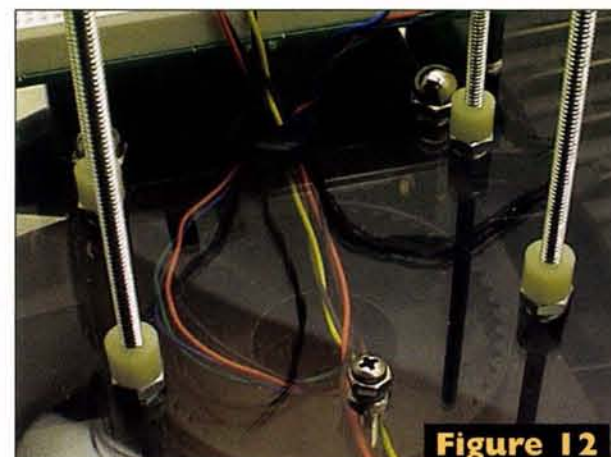


Figure 12

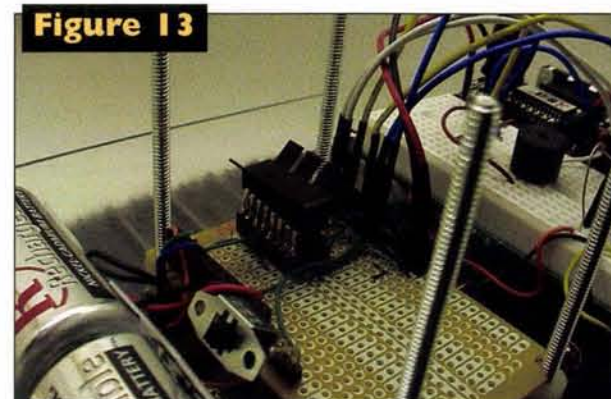


Figure 13

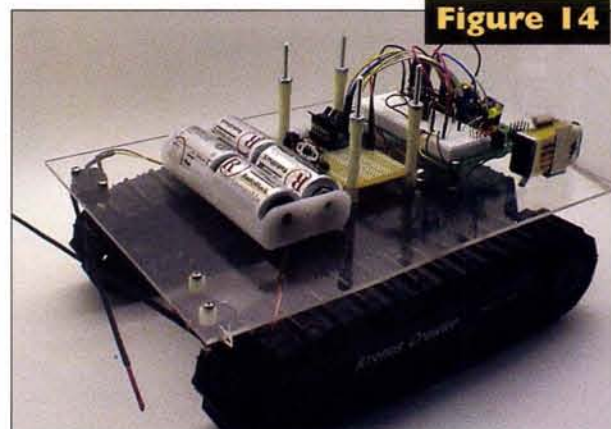


Figure 14



Figure 15

Program Listing I

'IR Settings

devicecode var byte
cmdcode var byte

'Holds the pulse width of the current bit under test
bitvalue var word

'Holds the divisor for testing the width of each pulse
levelvalue var word

'In this case 1200ms or longer will be a high state
levelvalue = 1200

'We will divide bitvalue by levelvalue to determine
' if bitvalue is less than 1200 (high state pulse width value).
'If it is then the bit is 0 other wise its 1.

' By using some simple integer math I can still scan each
' bit in time for the next. Had I used an IF statement
' we would eat too much time between pulses in the stream.

'We use this as a form of IR indication
output 8 'LED
output 15 'Piezo alarm

' Motor Settings

'----- Sets up the constants for the motor controller
M2InputA Con 12
M2InputB Con 11

M1InputA Con 14
M1InputB Con 13

'----- Setup the ports for motor controller
Output M1InputA
Output M1InputB

Output M2InputA
Output M2InputB

'----- Setup the initial speed
gosub CrHigh

main:

gosub checkbumpers

gosub getsoneycode

'---- Time out (no key pressed)
if devicecode = 0 and cmdcode = 0 then
gosub Crstop
low 8 'Turn indicator off
goto main
endif

high 8 'Turn indicator on

'---- Reverse ----
if cmdcode = 17 then 'CH -
gosub Crrev
endif

'---- Forward ----
if cmdcode = 16 then 'CH +
gosub Crfwd
endif

'---- spin left ----
if cmdcode = 19 then 'Vol -
gosub CrLspin
endif

'---- spin Right ----
if cmdcode = 18 then 'Vol +
gosub CrRspin
endif

if cmdcode = 1 then
gosub CrLow
gosub beep1
endif

if cmdcode = 4 then
gosub CrMed
gosub beep2
endif

if cmdcode = 7 then
gosub CrHigh
gosub beep3
endif

if cmdcode = 8 then
gosub searchmode
endif

Goto main

checkbumpers:

'see if ether bumper is pressed
if in7 = 0 or in6 = 0 then

'If ether motor is moving forward then stop

if (in14=1 and in13 = 0) or (in11=1 and in10=0) then
gosub Crstop
gosub beep1
endif
endif

return

' Simple Piezo sounds

beep5:

high 15
pause 50
low 15
pause 50

beep4:

high 15
pause 50
low 15
pause 50

beep3:

high 15
pause 50
low 15
pause 50

beep2:

high 15
pause 50
low 15
pause 50

beep1:

high 15
pause 50
low 15
return

searchmode:

'Test right bumper
if in7=0 then
gosub Crrev
pause 1000
gosub CrLspin
pause 1000
endif

'Test left bumper
if in6=0 then
gosub Crrev
pause 1000
gosub CrRspin
pause 1000
endif

gosub Crfwd

goto searchmode

' This is the main IR routine
' It populates cmdcode and
' devicecode variables

GetSoneyCode:

'Clear the lrbits
devicecode=0
cmdcode=0

getstartbits:

'We have to clear the variable used with the pulsing command
as
' the Atom will not clear the variable if it times out.
bitvalue = 0

Pulsin 0,0,bitvalue
if bitvalue = 0 then
return
endif

if bitvalue < 2000 then getstartbits

'At this point we are ready to get the command
'code (7 bits)

pulsin 0,0,bitvalue
cmdcode.bit0 = bitvalue/levelvalue
pulsin 0,0,bitvalue
cmdcode.bit1 = bitvalue/levelvalue
pulsin 0,0,bitvalue
cmdcode.bit2 = bitvalue/levelvalue
pulsin 0,0,bitvalue
cmdcode.bit3 = bitvalue/levelvalue
pulsin 0,0,bitvalue
cmdcode.bit4 = bitvalue/levelvalue
pulsin 0,0,bitvalue
cmdcode.bit5 = bitvalue/levelvalue
pulsin 0,0,bitvalue
cmdcode.bit6 = bitvalue/levelvalue

'Now lets get the device code (5 bits)
pulsin 0,0,bitvalue
devicecode.bit0 = bitvalue/levelvalue
pulsin 0,0,bitvalue
devicecode.bit1 = bitvalue/levelvalue
pulsin 0,0,bitvalue

devicecode.bit2 = bitvalue/levelvalue
pulsin 0,0,bitvalue
devicecode.bit3 = bitvalue/levelvalue
pulsin 0,0,bitvalue
devicecode.bit4 = bitvalue/levelvalue

return

' Motor Routines

' Speed routines

' You can tweak the left and right tracks if
' find the crawler pulls to left or right.

CrLow:

HPWM 1,10000,7500 : Return 'Left track
HPWM 0,10000,7500 : Return 'Right track
return

CrMed:

HPWM 1,10000,8000 : Return 'Left track
HPWM 0,10000,8000 : Return 'Right track
return

CrHigh

HPWM 1,10000,10000 : Return 'Left track
HPWM 0,10000,10000 : Return 'Right track

return

' Crawler movement routines

Crfwd:

gosub rfwd : gosub lfwd : return

Crrev:

gosub rrev : gosub lrev : return

CrLspin:

gosub rfwd : gosub lrev : return

CrRspin:

gosub rrev : gosub lfwd : return

Crstop:

gosub loff : gosub roff : return

' Motor Routines

'-----Left Motor (M1)

Lfwd:
High M1InputA : Low M1InputB : Return

Lrev:

Low M1InputA : High M1InputB : Return

Loff:

Low M1InputA : Low M1InputB : Return

'----- Right Motor (M2)

Rfwd:
High M2InputA : Low M2InputB : Return

Rrev:

Low M2InputA : High M2InputB : Return

Roff:

Low M2InputA : Low M2InputB : Return

The Parts

All items listed below are available from
Kronos Robotics; www.kronosrobotics.com

Motor Controller

Item	Qty	Description	Part #
U1	2	SN754410	#MDR1
JP1-JP2	2	12-pin female header	#H3
S1	1	SPDT	#S8TOG
PCB	1	Multipurpose printed circuit board	#PCB1

Item	Qty	Description	Part #
U2	1	Atom	#ATM1
IR1	1	Vishay IR Module	#IR2
	1	Atom development board	#ATM3
CDS1-CDS2	2	Photocells	#PC2
R1-R6	6	10K Resistors	#resistors
PZ1	1	Piezo Alarm	#PZ1
C3	1	470uF Capacitor	#C470-50
LED1	1	LED with integrated resistor	#LED5YR
	1	Dip Heatsink	#HSDIP
	1	9V bat. connector w/pwr connector	#CO5
	1	Four cell C battery holder	#BH4C
	1	9V Battery holder clip	#BH9V
	1	Crawler Base	#RB1
Hardware	1	Complete Hardware Kit for Platform	#KCHWK1
Bumper Kit	1	Complete Bumper Kit for Crawler	#KCBK1
	1	Crawler Platform	#RB2
	1	Sony Compatible Remote Control	#RMT1

Laser Insight

In this series of articles, we have covered many different laser types, and looked in some depth at how some of these lasers operate and are used. If you hadn't guessed it already, most of my laser career has been with industrial laser systems. I have worked on a few scientific laser projects, and a few SDI-related projects and they are, of course, much more demanding. In terms of stability, mode structure, and service repeatability anyway. This month, I want to introduce another laser type — one we haven't discussed yet.

Pulsed lasers

All the lasers we have discussed so far in this series have had one thing in common: they all use a continuously excited medium. That is, a continuous discharge through the lamp or gas mixture. The type I want to discuss this month does not use continuous excitation by arclamp or high-voltage discharge through a gas to excite the laser medium, but instead uses a pulsed excitation source. The excitation source could be a high-voltage discharge through a low-pressure gas, or else a flashlamp. Not the kind of flashlamp you would take on a camping trip, but a high voltage, high current Xenon flashlamp. This kind of lamp is rather like an overgrown version of a camera flashlamp, and uses essentially the same technology to charge and discharge.

Lasers of this type have very high round-trip gain characteristics, and can produce enormously high peak power output — not just in tens of kilowatts as I described in the laser marker article last month — but in megawatts, gigawatts, and even terawatts! Mega = 106, Giga = 109, and Tera = 1012.

I was looking around the inter-

net while researching some information for this article, and found a very good website showing many high power pulsed laser system setups. The page loads about 7Mb of photographs and sketches, so you'll have to be patient. The URL is <http://home.achilles.net/~jtalbot/history/laserimages.html>. Most of these images are taken from research labs around the world, and give you some ideas as to how enormous and complex some of these laser systems are.

I'll explain how these high powers are possible soon, but first let's go back in time a little, and take a look at the first laser ever made.

The first laser to be demonstrated anywhere in the world, was developed at Hughes Labs in 1960, and used a synthetic ruby crystal as the lasing medium. (Actually, the lasing medium was chromium, the synthetic ruby was made from aluminum oxide, and was the host material.) It was a pulse-pumped system, excited by a helical flashlamp, as shown in Figure 10-1. The ruby rod was held concentrically in the flashlamp as shown, and one end was completely silvered, and acted as the fully reflecting mirror. The other end was only partially silvered, and acted as the output mirror. Silver was used because it was a good broadband reflector of all visible wavelengths.

The flashlamp was triggered by a high-voltage generator through a spark gap, discharging a high-voltage capacitor through the lamp. The trigger pulse was fired into the trigger electrode shown between the lamp and the rod; the electric field crossing the lamp was sufficient to initiate the discharge. When the flashlamp fired, the capacitor discharged very quickly through the lamp (on the order of about a millisecond). The resulting flash caused a rapid population inversion in the chromium atoms, and effect-

ed a very high round-trip gain in the resonator (between the mirrored ends of the rod).

There were no standard ways of measuring pulsed laser energy at this time (1960), and so a makeshift 'standard' was introduced to rate laser energy. If a laser could penetrate a razor blade in one shot, it would be rated at one Gillette. If it could penetrate two blades in one shot, it would be rated at two Gillette, and so on. Eventually, of course, a more reliable and traceable standard was devised to measure pulsed laser energy. The unit of energy is the Joule, named after James Prescott Joule, the noted English scientist and inventor. Joule did much of the research to link heat with work, power, and energy. The Joule is equal to one watt acting for one second, and is roughly equal to 0.24 calorie. When calculating the peak power of a laser pulse, it is customary to measure the laser energy in Joules, measure the width of the laser pulse in seconds, and divide the energy by the time to get the peak power.

As an example, suppose we have a pulsed laser system that emits a 200mJoule pulse, and we measure the pulse width at 10 μ Seconds at the FWHM (Full Width, Half Max) points. Now divide the energy by the time to get the peak power. So,

$$\frac{0.20/10 \times 10^{-6}}{= 20,000 \text{ watts}}$$

Thus, it is relatively easy for us to generate very high laser power levels, if we can do it in a short enough time period. Later in this series, I will describe a couple of simple pulsed laser systems that anyone may build. With them, you may be able to produce enough energy to penetrate a couple of razor blades (one or two Gillette).

I will warn you now though, that the power supplies we will be building for these lasers are lethal, and anyone not familiar with the dangers of working with high voltage should not attempt to build them.

These days, there are many ways of measuring laser energy, and one method that is popular now is the thermopile. In this device, a blackbody absorber (see sidebar) is placed in intimate contact with a simple thermopile. When the pulsed laser beam hits the blackbody, the energy is converted to heat that then warms the thermopile. The small voltage difference between the sides of the

thermopile is amplified and calibrated as input energy in Joules (J), millijoules (mJ), microjoules (μ J), and even picojoules (pJ).

Laser amplifiers

Pulsed laser systems lend themselves very well to amplification of the output beam. How it works is this: A conventional pulsed laser oscillator is aligned so that the output beam enters an upcollimator. I briefly mentioned these early in this series of articles, but in case you missed it, an upcollimator is essentially a telescope, but used in reverse. Instead of the light entering the larger lens (as in a conventional telescope), the laser light is projected through the smaller lens. On its passage through the telescope (sorry, upcollimator), the beam is expanded by the lenses. It then passes through the amplifier stage, where the pulsed energy delivered to the amplifier rod may be added to the oscillator beam. Normally, the amplifier stage of a laser system is larger in cross-section than the oscillator, and is therefore pumped much harder. The upcollimator serves to expand the primary beam so that the maximum volume of the amplifier medium is used. This ensures that the maximum energy can be extracted from the amplifier. See Figure 10-2 to see how this arrangement looks. Further amplifier stages may be added as indicated in some of the photos and drawings show in the website mentioned earlier.

Q switching

Amplifiers are one way to increase the energy output from a laser system, but in doing so, consume a lot of energy. If the goal is to achieve higher peak power without necessarily increasing the energy, another technique — 'Q' switching — is the method most often used.

If you are a regular reader, you may remember I discussed 'Q' switching in last month's article on laser markers. In that application, a quartz block is made to physically vibrate within the CW laser resonant cavity, thereby producing a physical interruption to the beam similar to a mechanical shutter (this process is known in laser circles as an AO Q-switch). During the 'closed' period of the cycle, energy in the laser rod rises to above the normal CW level. Laser action cannot take place because the shutter is closed. When the shutter opens

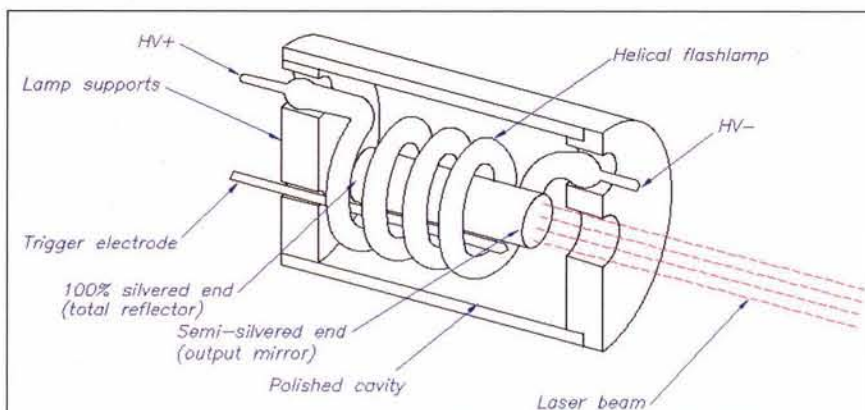


Figure 10-1 This drawing shows the basic arrangement of the first laser demonstrated — a pulsed Ruby system.

briefly (10 μ Sec), the high gain in the laser rod causes the release of a giant pulse of laser power, dumping most of the built-up energy into a single pulse, lasting about 50-150nSec. The peak power reached using this method may reach several tens of kilowatts.

In the pulsed laser, such a 'Q' switch would be unsuitable. The rise time of the shutter is too slow, and is difficult to synchronize the opening of the 'shutter' to the highest peak on the rod pumping cycle. The method of choice here is to use a different kind of 'Q' switch, known as an EO Q-switch (Electro-optic Q-switch) and sometimes called a Pockels cell or EO modulator. See Figure 10-3 for the laser layout using a Pockels cell.

In the Pockels cell, the 'shutter' effect is done through polarization switching, rather than physically blocking the beam, and is consequently several orders of magnitude faster than AO-Q switching. The Pockels cell is a block of material that exhibits a different refractive index when a voltage is applied across it. In other words, under conditions of zero voltage, the material has a certain refractive index. However, when a bias voltage is applied across the input and output faces of the block, the refractive index assumes a different value. For an unpolarized input beam, there will be little change in the output. For a linearly polarized beam, however, it is a different story. Some time ago, I discussed polarized laser beams, I hope you remember some of that because here it is again!

In a polarized laser beam, the electric and magnetic fields are mutually perpendicular to the plane of propagation. If such a beam were passed through an activated Pockels cell, the plane of polarization would be rotated in accordance with the crystal material, the applied voltage, and the wavelength of the laser beam. It is important to note that different wavelengths require different excitation voltage across the cell to affect the rotation in polarization. As an instance, the half wave voltage for a linearly polarized laser beam of 546.1 nm (Green) is around 2.9-3.4kvolts for a KD*P (Potassium Dideuterium Phosphate) crystal. There are other crystal types used for Pockels cells, but KDP allows the use of lower voltages. See Figure 10-4 for an explanation of the layout of a laser cavity containing a Pockels cell.

In Figure 10-4, the laser cavity is equipped with the normal laser components, plus two polarizer crystals (1 and 2), and an EO Q-switch. Here, the two polarizer crystals are arranged on either side of the Pockels cell, with their polarization axes vertical. With an unmodulated Pockels cell (no bias voltage applied), the laser will emit a pulse of laser light with the electric field vertically polarized. Being unmodulated, the Pockels cell will exert no influence on normal laser action, and the beam is able to pass

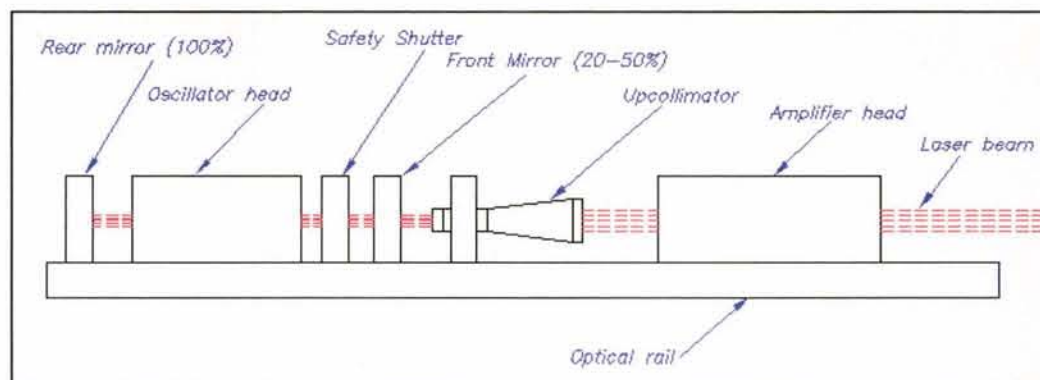


Figure 10-2 This drawing shows the basic arrangement of an oscillator-amplifier set-up.

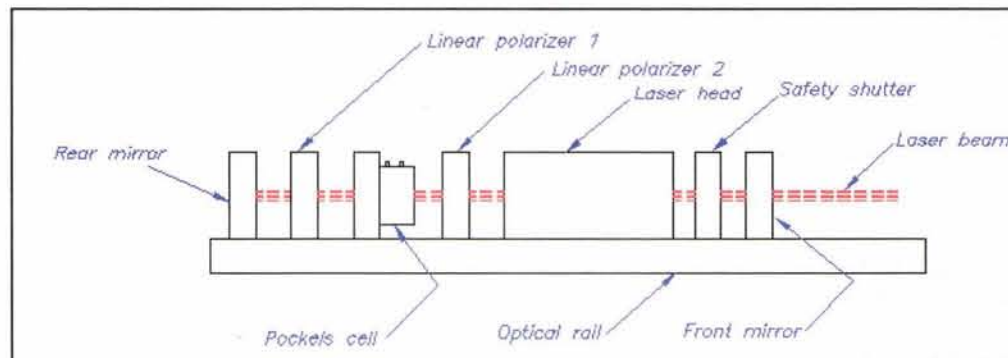


Figure 10-3 This drawing shows a typical arrangement of a pulsed laser equipped with a Pockels cell "Q" switch.

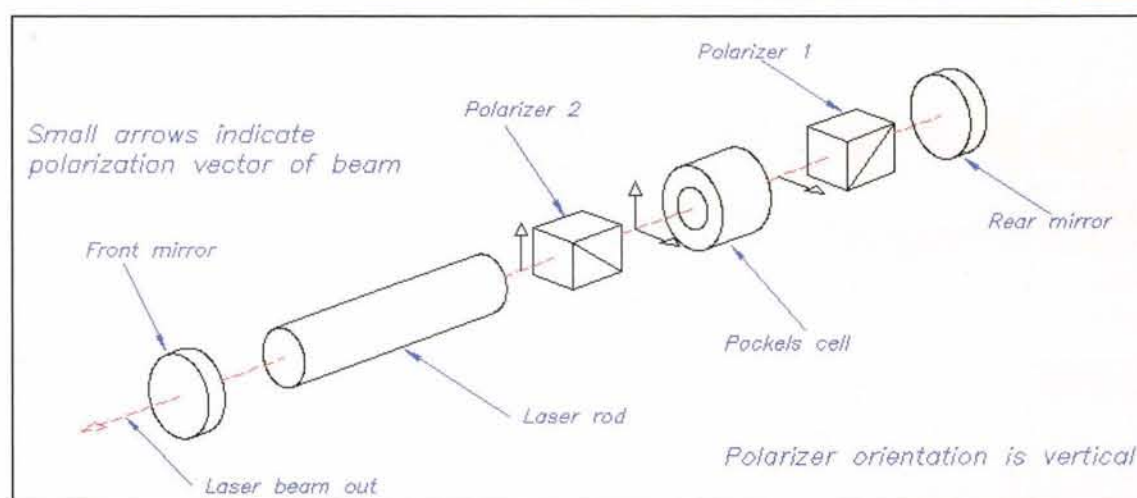


Figure 10-4 This drawing illustrates the mechanism of Pockels cell operation.

through unchanged. The two polarizer crystals will strongly polarize the exiting beam, so that the output beam is vertically polarized.

If a bias voltage is applied to the Pockels cell, it will cause transmitted polarized light through the cell to be rotated according to the wavelength of light, the material used for the Pockels cell, and the applied voltage, as mentioned above. A potential of about 3,000 volts DC across the faces of the cell will cause a rotation of 90° in the polarization axis of 546nm light in the green part of the visible spectrum. If the beam is intercepted by a second polarizer, as in the case illustrated, the beam will be attenuated because the polarization axes of the beam and the polarizer are different. Remember when I discussed polarization a few months ago, I suggested an experiment where crossed polarizer plates can block light passing through? Well, here is an application that uses that principle.

In the lay-out illustrated, the light leaving the rod and entering polarizer 1 has its electric field oriented vertically. On passing through the biased Pockels cell, the electric field is rotated through 90°. Since the electric field is now horizontal, it cannot pass through the second polarizer without being dramatically attenuated. Thus, by

introducing this lossy element to the cavity, laser gain is reduced to the point where normal laser action cannot take place because of the low round-trip cavity gain.

During a laser firing, the bias voltage is held on the Pockels cell to prevent laser action. At a critical point in the lamp discharge, the bias voltage is reduced to zero, allowing very high gain in the cavity, and producing a gigantic laser pulse of much shorter duration than would normally be provided.

Normal flashlamp times vary around one millisecond or so, and in normal laser action, this would result in a laser pulse of somewhat shorter duration (perhaps 500-800 μ Sec). If the EO Q-switch is fired at the proper time, a pulse of perhaps 25-50nSec is possible, with peak power levels greatly exceeding one megawatt! Figure 10-5 shows the general form of a conventional laser pulse, with a Q-switched pulse superimposed on it. Note the scales used to indicate the normal mode pulse and the Q-switched pulse.

It is customary to trigger the EO Q-switch shortly after the laser pulse reaches its peak in power output (or where it would be if it were allowed to lase normally). The trigger point is usually synchronized to the leading edge of the lamp firing pulse, and the delay time determined by experimentation. The

optimum output is normally met when the output beam reaches a peak in power output, and this corresponds roughly with the shortest pulse time.

In the graph shown, the lamp is fired at $T = 0$. The lamp begins to discharge the capacitor, and reaches a peak in intensity at $T = 250 \mu$ Sec. During the discharge, the laser energy starts to build up in the rod, and normally would produce an output beam that followed a similar curve to the flashlamp envelope. Thus, the peak output would occur at roughly the same time as the lamp peak. In the Q-switched mode, the laser is prevented from issuing a beam until the rod is fully saturated in upper level electron activity. When triggered, the laser gain goes from zero to high gain in a few nanoseconds, releasing the built-up energy in the rod as one giant pulse of laser light. Peak power levels can easily reach several tens of megawatts for a short time, until laser energy is depleted from the rod. For the type of laser discussed here, typical Q-switched pulses range from a few nSecs up to 100nSecs.

There is a lot more I would like to tell you about these pulsed lasers, but I've used up all my space again, so I guess I'll save it for later. In forthcoming columns, I will be describing other pulsed lasers, and

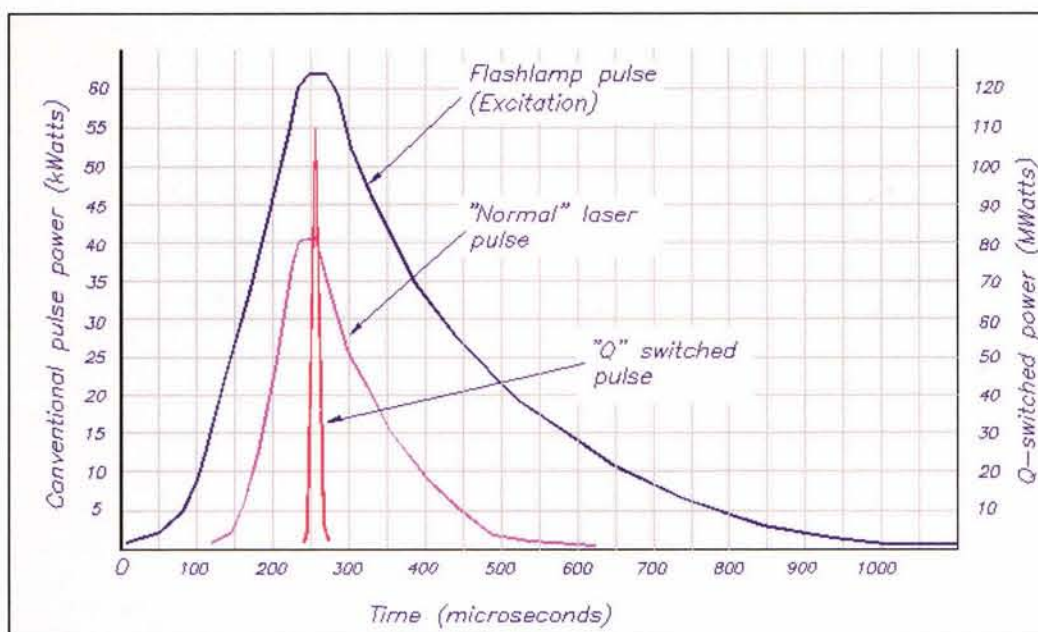


Figure 10-5 This graph illustrates the timing sequence between the conventional mode laser pulse and the Q-switched pulse.

will also describe some simple lasers we can construct and run some interesting experiments with. So don't go away, some of the best is yet to come. I'd also like to

remind you that your ideas and comments are welcome. I have received a number of requests for an article on building a small CO₂ laser, and I will be working on this

for a future issue. If you have any interesting ideas for projects, you can reach me here, care of this magazine, or you may email me at stanley.york@att.net. **NV**

A blackbody absorber is a device that will absorb all radiation striking its surface. There are theoretically no reflection losses.

I don't want to get too technical in this series, but if you are interested in reading more about blackbody radiation and absorption, there are many very interesting websites dedicated to this subject.

BLACKBODY — The perfect absorber of all radiant energy that strikes it. The blackbody is also a perfect emitter. Therefore, both its absorbance (A) and emissivity (E) are unity. The blackbody radiates energy in predictable spectral distributions and intensities which are a function of the blackbody's absolute temperature.

From **Electronic Development Labs, Inc.**
(<http://www.edl-inc.com/infrared%20glossary.htm>)

See also <http://cosmos.col-orado.edu/astr1120/L1S3.html> for an interesting animation on blackbody radiation and absorption.

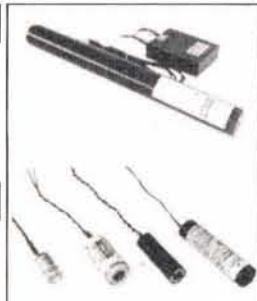
LASERS & ACCESSORIES

HELIUM NEON LASERS

- ✓ Complete Systems
- ✓ Plasma Tubes
- ✓ Power Supplies

ACCESSORIES

- ✓ Optics
- ✓ Electro-Optics
- ✓ IR Viewers
- ✓ Books & More



MEREDITH
INSTRUMENTS

DIODE LASERS

- ✓ Visible / IR
- ✓ Complete Modules
- ✓ Collimating Optics
- ✓ Drive Circuits

WEBSITE:

WWW.
mi-lasers.com

Phone: 623-934-9387 • Fax: 623-934-9482

Circle #36 on the Reader Service Card.

EZ-EP DEVICE PROGRAMMER - \$169.95

Check Web!! -- www.m2l.com

Fast - Programs 27C010 in 23 seconds

Portable - Connects to PC Parallel Port

Versatile - Programs 2716-080 plus EE and flash (28, 29) to 32 pins

Inexpensive - Best for less than \$200

- Correct implementation of manufacturer specified algorithms for fast, reliable programming.
- Easy to use menu based software has binary editor, read, verify, copy, etc. Free updates via bbs or web.
- Full over current detection on all device power supplies protects against bad chips and reverse insertion.
- Broad support for additional devices using adapters listed below.

Available Adapters

EP-PIC (18C5x, 61, 62x, 71, 84)	\$49.95
EP-PIC64 (16C82-5, 72-4)	\$39.95
EP-PIC12 (12C50x)	\$39.95
EP-PIC17 (17C4x)	\$49.95
EP-51 (8751, C51)	\$39.95
EP-11E (68HC11 E/A)	\$59.95
EP-11D (68HC711D3)	\$39.95
EP-16 (16bit EPROMs)	\$49.95
EP-Z8 (Z86E02, 3, 4, 6, 7, 8)	\$39.95
EP-SEE2 (93x, 24x, 25x, 85x)	\$39.95
EP-750 (87C750, 1, 2)	\$59.95
EP-PEEL (ICT22v10, 18v8)	\$59.95
EP-1051 (89C1051, 2051)	\$39.95
EP-PLCC (PLCC EPROMs)	\$49.95
EP-SOIC (SOIC EPROMs)	\$49.95
EP-TSOP (TSOP EPROMs)	\$59.95

Many Other Adapters Available

M²L Electronics

970/259-0555
Fax: 970/259-0777
250 CR 218
Durango, CO 81301
CO orders please add 7% sales tax
<http://www.m2l.com>



Circle #38 on the Reader Service Card.

Use your PC as a scope and datalogger!

Parallel Port Scope
spectrum analyzer, and digital multimeter

Environmental Logging
record temperature, humidity, etc.

DRDAQ for PCs
sciencelogger with sensors



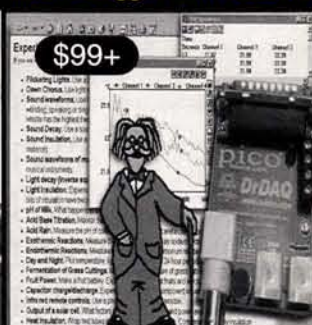
\$99 - \$799

ADC Virtual Instruments turn your PC or laptop into a sophisticated storage scope AND spectrum analyzer AND multimeter. Display simultaneously on large screen! 100MS/s 8-bit or 1.2MS/s 12-bit or 333KS/s versions. Great for schools, test depts, etc. Input to Excell! LabView/NT drivers included.



\$129 - \$645

ENVIROMON - temperature (thermistor), humidity & light sensors, door position, etc. Record for 365/24 without a PC even if power fails. Monitor 30 sensors 400 yds away. With cables and easy software. Remote audio alarm. Use TC-08 for most thermocouples.



\$99+

DRDAQ - is a PC adapter with sensors for light, pH, volts and temp. Great for science fairs! Supplied with ready-to-run software and lots of physics/chem exp'ts.

PC-based Instruments!

Download **FREE** demo software. Sales only: 1-888-7SAELIG

www.saelig.com 716-425-3753 • -3835 (fax) saelig@aol.com

Stocked in NY by Saelig Company: Virtual Instruments, I2C and embedded controllers, BITlink 2-wire networks, RS232/422/485, CANbus, etc. See www.saelig.com for Product of the Month!

pico
Technology Limited

2-Channel 100 MS/s Scope

US\$ 499.-

- Options
- PC Software incl. Adapter Cable 99.00
 - Signal Probe 1:1/10:1 24.90
 - Rubber Protection Boot 19.90
 - AC Adapter 9.90
 - hard-shell anti-static carry case 39.90
 - Complete Set Scope + options (2 Probes) 695.00

Wittig Technologies

Wittig Technologies, Inc.
266 East Meadow Avenue
East Meadow, NY 11554
Phone (516) 794 4080, Fax (516) 794 1855
www.wittigtechnologies.com

Subscribe today!

Call toll-free at 1-800-783-4624 or go online at www.nutsvolts.com

Classifieds

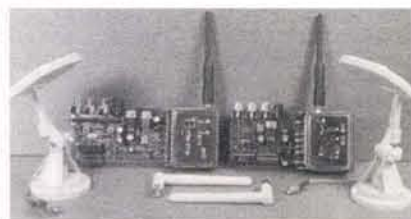
HAM GEAR



NEW ICOM IC-V8 VHF 5.5W handheld with full keypad, CTCSS/DCS encode/decode, tone scan, 1100mAh battery and charger + optional battery case \$199.99. Easy modification for full TX 136-174MHz. To order call 1-800-977-0448 or visit <http://www.nsiradio.com/>



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



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



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

COMMUNICATION RECEIVER Icom-ICR3 #05225, operator manual, service manual, 7 months old, works perfect. Make offer to Daniel 707-984-8796 10am-10pm Pacific Time.

SATELLITE TV. Complete selection of C & Ku band equipment, WWW.DAVESWEBSHOP.COM



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

BATTERIES/CHARGERS



THE SMART BATTERY CHARGER for lead acid or gel cell batteries. Can be left connected to the battery **INDEFINITELY**, will not overcharge! Standard kit is 12V @ 1 amp. This kit is 100% complete. For the kit order #150-KIT at \$59.95. For an assembled and tested unit, order #150-ASY at \$79.95. CA residents add 7.75% sales tax. Add \$6.50 per unit shipping. MC/VISA accepted. A&A Engineering, 2521 W. La Palma #K, Anaheim, CA 92801. 714-952-2114, FAX 714-952-3280. www.a-a-engineering.com

CB — SCANNERS

CB MODIFICATIONS! Frequencies, books, kits, high-performance accessories, plans, repairs, amplifiers, 10-meter conversions. The best since 1976! Catalog \$3. CBCI, Box 30655NV, Tucson, AZ 85751. www.cbciintl.com

240+ CHANNEL CB/HAM/FRS/COMMERCIAL radios: AM/FM/SSB/CW export/domestic: RCI, TEKK, Motorola, Uniden, Cobra, Alinco, Kenwood. Mics, antennas, linear, meters, mod books, manuals, schematics, night scopes, and tons more stuff! Catalog \$3. MAXTECH, Box 8086, New York, NY 10150. 718-547-8244. www.penny-circus.net

COMPUTER HARDWARE

NewComputer.com COMPARES prices and detailed product specifications from top online sellers. Visit NewComputer.com to save time when shopping for new computer equipment.

VGA DISTRIBUTION AMPLIFIER made by Extron Electronics. Model P/2 DA 6 Plus. Drives up to 6 other monitors or LCD panels from one source. New in the box \$75 each, 10 pcs. available. Call Roger @ GS&E, 585-338-7001. VISA/MC.

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

DEC EQUIPMENT WANTED!!! We are buying DEC systems, boards, terminals, drives and peripherals. Also Scientific Micro Systems (SMS), CMD, Datability, Dialog, DSD, EMULEX, other DEC compatibles. Please contact us for a quote or fax/email your equipment list. We buy, sell, and trade. **KEYWAYS, INC.**, 937-847-2300 or fax 937-847-2350 or email buyer@keyways.com



VGA TO COMPOSITE (NTSC) VIDEO CONVERTER — ULT-2000. Handheld. Powered from keyboard with S-video and RGB outputs, too. 3:1 zoom control with many extras. **\$99/ea.** Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com

EVERYTHING NEW w/warranty! Best prices. Motherboards with CPU 900MHz \$145, custom configured systems. Pentium II systems \$199. Pentium III systems \$349. Modems, multimedia kits \$29, scanners, monitors, cases, \$20. Hard drives to 200 gigabytes. 540 megabyte \$15. Call 714-778-0450. Email: ccis@surfside.net



900MHz AMD Duron computer system. 20 gigabyte hard drive, 52X CD-ROM drive, 128MB memory, 64MB video, 2 USB ports in back and 2 in front, LAN, 56K modem/voice/fax, sound, speakers, keyboard, mouse, ATX case, many FREE applications, 2 year warranty! \$369. Visa/MasterCard/Amex/Discover, order toll free 1-877-882-0431, or online www.saveware.com



PLAY BACKUP COPY of Sony Playstation CD. Plug-in GAME ENHANCER \$25 or solder-in mod-chip \$15! You don't need the original to play backup! Sony Playstation 2 plug-mod \$49. Visa/MasterCard/Amex/Discover, order toll free 1-877-882-0431, www.saveware.com

COMPUTER SOFTWARE

CAM & MOTION SW/HW: NC Z-trace PCB tool path. Plotcam motion control. <http://www.ddt-us.com>

KEYSTROKE LOGGER: This new software hides in the background on your computer allowing you to view what other people have been doing on the installed computer. Great for monitoring the children or the wife. www.spousewatcher.com

DEGREE ON A DISK!

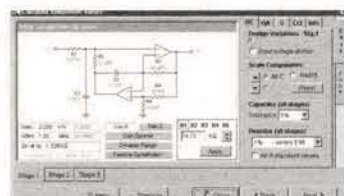
EM FORMULARY

500+ formulas, conversions, and tables. Electronics, science, math. Practical, educational, and easy to use. Internet Special \$19.95 + tax/ship. Now with PSpice examples. Order online, more info and sample screen at our web site.

ELECTRO SCIENCE APPLICATIONS
(310) 541-1862
www.esap.com

LIQUIDATION WINDOWS 95/98/2000, Office suites \$10-69. Windows companion \$5. Windows tutorials \$5. Norton bonus PACK \$15. 714-778-0450.

FREE!!! CD-ROM and software disk catalog. **MOM 'N' POP'S SOFTWARE**, PO Box 15003-N, Springhill, FL 34609-0111. 352-688-9108. momnpop@gate.net



WWW.SCHEMATICA.COM FOR professional freeware and shareware. Active and passive filter design, 555 designer, linear simulators.

COMPUTER EQUIPMENT WANTED

WANTED: FOR historical museum, pre-1980 microcomputers, magazines, and sales literature. Floyd, VA 24091-0341 (540-763-3311/540-382-2935).

DEC EQUIPMENT WANTED!!! We are buying DEC systems, boards, terminals, drives and peripherals. Also Scientific Micro Systems (SMS), CMD, Datability, Dialog, DSD, EMULEX, other DEC compatibles. Please contact us for a quote or fax/email your equipment list. We buy, sell, and trade. **KEYWAYS, INC.**, 937-847-2300 or fax 937-847-2350 or email buyer@keyways.com

TEST EQUIPMENT

A-COMM ELECTRONICS: we buy and sell test equipment. <http://www.a-comm.com> 11891 E. 33rd Avenue, Aurora, CO 80010. Tel: 303-341-2283, fax 303-341-2293.

KENTRONIX TEST EQUIPMENT SPECIALS. Check our WEB site at <http://www.kentronix.com> for monthly specials. We are also looking to buy test equipment, coaxial and waveguide components, manuals, etc. Contact Brian at 732-681-3229 or FAX 732-681-3312. E-Mail: brian@kentronix.com

DEC EQUIPMENT WANTED!!! We are buying DEC systems, boards, terminals, drives and peripherals. Also Scientific Micro Systems (SMS), CMD, Datability, Dialog, DSD, EMULEX, other DEC compatibles. Please contact us for a quote or fax/email your equipment list. We buy, sell, and trade. **KEYWAYS, INC.**, 937-847-2300 or fax 937-847-2350 or email buyer@keyways.com



POCKET TESTBENCH, inexpensive RS-232 virtual instrument, with oscilloscope, logic analyzer, counter, and generator modes. **New WST-100.** www.oricomtech.com

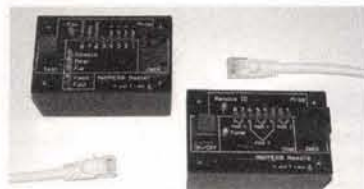
CHECK OUR growing line of audio test instruments: data sheets, user guides, software. **TDL Technology, Inc.**, www.zianet.com/tld.

GIANT DIRECTORY ONLINE: Over 500 dealers in used test equipment, used semiconductor production equipment, surplus lasers, optics, vacuum equipment, etc. Test equipment auction and rental sites, US and foreign dealers, manual dealers, too! No registration or cookies. **www.big-list.com**

CABLE WIZARD Universal CableMeter & Fault Locator™, Model 321 quickly measures "open" length on most coax, twisted, semi-twisted, single-pair and multi-pair cable, on spools, in boxes, or already installed, also measures distance to "open" faults. For further information write or fax **CABLE DYNAMICS, PO BOX 34594**, Phoenix, AZ 85067, fax 623-931-6262.

USED TEST equipment sale specials. Equipment on sale. Check this page to see what equipment we are offering at our lowest prices! www.calibration.com Instrument Repair & Rental Labs, Inc., 1-888-573-5468. Colorado 303-469-5335. Mail to sales@testequip.com

FEITEK PROVIDES repair, calibration and traceable certifications of test equipment. Free estimates. We buy, sell and trade all makes of test equipment. Visa and MasterCard accepted. Check out our inventory and specials at WWW.FEITEK.COM 2752 Walton Road, St. Louis, MO 63114, 314-423-1770.



ETHERNET CABLE tester. The Mapper8 provides complete connectivity testing of 8-wire modular cables as well as other cables. Displays both a quick pass/fail indication as well as details on how the cable is wired or mis-wired. Easy to build kit or assembled. **www.a-and-t-labs.com**

SECURITY

ALARMLAND.COM SECURITY devices for professionals. Motion detectors, panels, contacts, CCTV, and more. Fax your order to 732-840-1390.

SURVEILLANCE-COUNTERSURVEILLANCE: I buy and sell used equipment. Steve 410-879-4035.

KEYSTROKE LOGGER: This tiny piece of hardware installs between your keyboard wire and computer in seconds. Then it logs all keystrokes, which you can view at your convenience. www.spousewatcher.com



THE TLC-I records automatically all telephone conversations up to 12 hrs. on a single tape, \$79. The **FMX-I** detects and locates bugging devices, \$69. The **TLP-I** stops others from listening in or recording your telephone conversations, \$49. Send check to Vakis, 2930 Pine Ave., Niagara Falls, NY 14301. Buy wholesale directly from manufacturers.



COUNTER-SURVEILLANCE=\$250 HR! Electronic eavesdropping is unbelievably widespread! Are you sure you're safe? Learn how others (without prior experience) earn **\$250 HR** in the fascinating field of COUNTER-SURVEILLANCE! For FREE catalog call: **1-800-732-5000**. [HTTP://WWW.SPY-CITY.COM](http://WWW.SPY-CITY.COM)



2.4GHz WIRELESS transmitter/receiver kit. ASK-2008-TR, 8 frequencies up controlled 2.300 to 2.481 MHz, video NTSC/PAL with 2 channels of audio for development testing. 12VDC/100 mA for both transmitter and receiver. Includes 2 rubber duck antennas. **\$125.** Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com



9 VOLT IR sensitive B/W high res 430 TVL camera with optional black low-profile swivel adjustable enclosure. Pin hole or Std. lens type. 6, 8, and 12mm lens are available. 1/3" CCD, 3.6mm/F2.0 lens included; works from **7.5-13 VDC**, highest voltage range in market. 0.08 lux, 1.27" x 1.27" x 0.5"D pinhole or 1" deep standard. **\$49 each.** Enclosure: \$8; optional lens: \$18. Dealers welcome. Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com



AS-1004 WIRELESS 2.4GHz, FCC approved. 2.4GHz transmitter & receiver with audio! Capable handling total of 4 wireless cameras, range: >300'. Built-in camera, 400 TV line. **Reduced price! \$179/system.** Additional cameras, **\$110/ea.** Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com



CCD BULLET CAMERAS B/W & COLOR. AX-800 series, weather resistant high impact design with swivel bracket. Will work with Matco's scanning motor. 3/4" diameter x 3" long approx. B/W: 400 line/0.2 lux. **\$79/each.** Color: 350 lines/2 lux, **\$119/each** — price reduction. Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com

SECURITY DISTRIBUTORS needed for our complete line of products. See our product features in the center color spread on page 43. **www.matco.com** and call **1-800-719-9605**.



40 DAYS and 40 NIGHTS RECORDER. Time lapse, with remote, can be activated by either contact closure or continuous duty operation with standard T-120 tape. **Models from \$349-\$529.** Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com



WEATHER RESISTANT OUTDOOR CAMERAS. WVR-700 type, high impact tempered glass with stand. Black & white (430 lines), or color (420+ lines) available. Standard 3.6mm lenses with optional lenses of 6, 8, and 12 mm at \$20 extra. **B/W \$119/each. Color \$179/each.** Small compact size with sun shield. Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com

SEE THE NEW MATCO PRODUCT FEATURES AND PRICES in the color center spread on page 43.

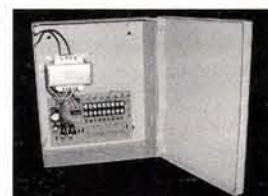


5" AND 5.5" LCD high definition color monitors w/stereo. 960 x 240 pixels w/brightness and tint controls. Attractive enclosure with built-in speaker. Great for security or general purpose use. Both models have a small compact footprint, with an ultra-bright display. RCA inputs NTSC or PAL. Special price with regulated power **\$249/each.** Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com



WIRELESS COLOR rechargeable 2.4GHz system. ASK-7003-TR. 150 foot range. Includes camera/transmitter, receiver and built-in battery pack with charging systems. Range 150 feet. **High volume seller! \$159.** Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com

SURVEILLANCE EQUIPMENT: Micro video cameras, tele-recorders, counter-spy and more. Direct from manufacturer. Buy direct, why not! Check out our great deals at www.mjelectronics.com Phone 914-699-2294 open 7 days late.



CAMERA DISTRIBUTION Box, XF-250-DC/XF-250-AC. Connect your cameras directly to power source with screw terminals or plug in using a 2.1 mm connector. **Special price: \$59 (DC version) and \$49 (AC version).** Can use pre-molded **50 foot video/power cable A-402-CA \$15.** Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com



14" B/W high resolution SECURITY MONITOR. A standard 12" monitor is just too small for most applications. Attractive dark gray enclosure with audio and built-in speaker. 75 ohm termination switch for balancing with all types of CCD board cameras and other video inputs. **\$139/each.** Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com



14" COLOR — high resolution SECURITY MONITOR w/4 channel switcher. High impact enclosure with modern front panel 4 channel video and audio switcher. High quality speaker built-in. Components purchased separately would exceed \$500. Price slashed to **\$249/each.** Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com



INFRARED CAMERA for underwater or all-weather use. AX-808 (B/W) or AX-808-C (color). Designed for lake water to depths of 85 feet. Enclosed LEDs illuminates up to a distance of 20 feet. 12 volt operation. **Color \$149, B/W \$99.** Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com



QUAD PROCESSOR works with VGA monitor. QVS-104-CV. NTSC inputs, composite outputs as well as output for direct connection to VGA monitor. Saves cost of expensive high-grade security monitor, **\$269.** Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com



16 CHANNEL MULTIPLEXER MUX-1600. Display 4, 8, and 16 video outputs directly on a TV or security monitor. This is the only device which allows full screen display of video on VCR playback (see 40 days and 40 nights recorder). Plenty of options including tilting, zoom, individual gain adjustments, etc. **Reduced price! \$799/each. Special 4 channel version, MUX-400, \$429/each.** Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com



BROADBAND: 10 MHz to 4.5 GHz usable range
HIGHLY SENSITIVE: Detects Covert Video and Audio Bugs at 20 ft. • 2.4 GHz "sealed" microwave ovens at 40 ft.
 For Computer Wireless Setup, RF Sniffer, RF Line Leakage
DUAL MODE: LINEAR - For measuring weakest signals
DETECTION: LOGARITHMIC - 1000:1 dynamic signal range
SENSITIVITY CONTROL: > 20 dB manually adjusted gain
80 HR. OPERATION (Approx.): With 2 AA alkaline batteries
ANALOG METER and LED DISPLAYS: The LED display for distance and nighttime
SILENT VIBRATE MODE: Switchable vibrator for signal detection without direct viewing

Including shipping and handling (CA. residents add 8% Sales Tax) **\$89**

Alan Broadband Company Phone: (888) 369-9627
 93 Arch Street
 Redwood City, Ca. 94062 Fax/Phone: (650) 369-9627

www.zapchecker.com



COLOR & B/W board cameras w/cases, BX-120-LC (350 lines color) \$89; BX-125-LC (380 lines color) \$99, sub-miniature BX-123-AU (420 lines B/W with audio) \$69. Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com

SATELLITE EQUIPMENT

SATELLITE REPORT: Find all the latest in satellite descrambling in this 54-page report. Lists all the cheapest and reliable sources for hacked cards and equipment. www.electronickits.com



FREE SATELLITE TV Buyer's Guide. Low prices on big dish systems, upgrades and parts. Upgrade to digital with new 4DTV receiver or sidecar. Best prices on little dish systems, too. Backed by Skyvision's technical expertise, YOU CAN do it yourself! **www.skyvision.com** Call 1-800-334-6455.

WHOLESALE PRICING. Call, fax, or email for free catalog of over 1,600 items from satellites, cable, security, telephone wire and connectors. Quality pricing, fast shipping & great discount pricing. Your accessory connection. Call SkyMarketing @ 1-866-637-4965 or 219-489-7525. Fax: 219-489-2285. Email: skyemark@fwi.com or visit us on the website at www.skymarktech.com

SATELLITE TV. Complete selection of C & Ku band equipment, **WWW.DAVESWEBSHOP.COM**

LEARN HOW TO PROGRAM SATELLITE TV ACCESS CARDS. Send \$24.95 for information packet to: KDV, PO Box 253, Buffalo, MN 55313.

MILITARY SURPLUS ELECTRONICS

DOSIMETERS/RADIATION DETECTING KITS. New Canadian military surplus, now illegal to import due to recent change in Arms Control laws. Ten dosimeters, two chargers, two radiation meters w/carrying cases. Single D cell powers chargers and meters. Survival, nuclear war, nuclear power plants. \$125 shipped US. Credit cards, checks. Dealers/quantities welcome. Steve 410-879-4035 or Steve@swssec.com

AUDIO — VIDEO — LASERS

STUDIO GEAR, antique radios, tubes, pro video, and unusual collectibles at WWW.bibbtek.com Call Tom @ 856-222-0636, fax to 856-222-0638 for printed list. Credit cards welcome.

CABLE TV

CABLE REPORT: This 50 page report contains all the latest in how cable systems have been compromised. Including cheap and reliable sources for test chips and equipment. www.electronickits.com

CABLE PARTS! Computer parts. Call for great prices or visit us on the Web: HTTP://WWW.CB-Electronics.com or call 1-800-436-8630.

POSITIVE AND negative cable TV filters. www.gofilters.com 1-800-235-8080. Mike is back, give us a call. We can help in all situations.

CABLE TV converter wholesaler. Brand new 125 channel converter, 10 lot \$45. Unmodified DPV 7212 \$19.95, SA 8600 \$25. Call us for lowest prices on other models such as BB, CFT, Pioneer, SA 8580. Dealers only, 1-888-860-6365.

CABLE PARTS for all makes and models, raw boxes at low prices. Call 1-888-817-8100. No NY sales. **www.chipplace.com**

DIGITAL CABLE TV converters. Factory original General Instruments/Motorola, DCT 1234/1151/ABCDEFH/R2. Many other models available! We sell raw, unmodified units only! Call 763-684-4325. 9 to 5, M-F, CST.

ABC WHOLESALERS, Inc. Importer & distributor of 125 channel unmodified converter. Monthly specials in lots of 10 remote included. Scientific Atlanta 8600 \$25 ea., SA 8580 \$19.95 ea., Tocom 5507-5503 \$30 ea., Jerrold BB 7312 \$25 ea., Jerrold 7212 \$19.95, Pioneer 6310 \$25 ea. We have many other models in stock and all models replacement remotes. Se habla espanol. Toll free 1-800-510-1924.

RAW UNMODIFIED CONVERTERS. Thousands in stock. No order too big, no order too small. FORGET THE HYPE. \$ ABSOLUTE LOWEST PRICES \$. **Special this month on CFT 2000 series, DPV's, 8580's, and 8600's.** Call today 412-798-1644.

TELEPHONE/FAX

PHONE MANAGER: This unit looks exactly like a Caller ID, except it records time, date, and length of all outgoing calls. www.spousewatcher.com

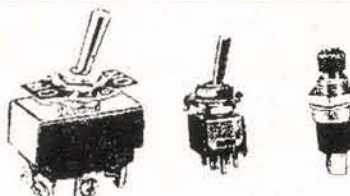
COMPONENTS

WANT TO Buy: ICs, military & aircraft relays, diodes, transistors, connectors, tantalum capacitors, electronic test equipment & most components. Hoffer Electronic Ent., E-Mail: Hoffiel165@aol.com 818-718-1165, FAX 818-341-5506.

PELTIER INFORMATION DIRECTORY ONLINE: Information site on Peltier devices (thermoelectric cooler/heater/generator modules). Tips, manufacturer directory, surplus sources, etc. Free. No registration. **www.peltier-info.com**

ELECTRONIC COMPONENTS, kits, test equipment, books, tools, and supplies for hams, hobbyists, and businesses. Many hard-to-find items like variable capacitors, vernier dials and drives, coil forms, magnet wire, toroids, more. **www.oselectronics.com**

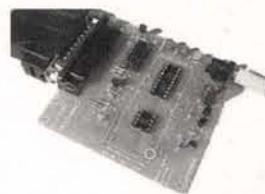
RF TRANSISTORS, TUBES, TEFLON WIRE, SILVER MICA CAPS. 2SC2290, 2SC2879, SD1446, MRF455, MRF454, 2SC1969, 2SC2166, 2SB754, TA7222AP, 2SC2086, TA7222AP, MRF247, MRF317, SAV7, etc., 4CX250B, 4CX1000A, 4CX1500B, 3CX400A7/8874, 3CX3000A7, 4CX400A, 572B, etc. Teflon wire specials 1,000 ft. 16 gauge .15 cents ft., 1,000 ft. 18 gauge .14 cents ft., silver mica caps, resistors, see our catalog for other products. Westgate 1-800-213-4563.



SWITCH SUPERMARKET large variety toggle, rotary, LEDs bipolar 2 & 3 leads, grain of wheat, free list. Fertik's, 5249 "D" St., Philadelphia, PA 19120. Ph/fax 215-455-2121.

MATCO WILL design, engineer, and develop a 2.4GHz wireless 8 channel solution for your remote applications. FCC approved. Matco, Inc., Schaumburg, IL 1-800-719-9605. E-Mail: nsales@matco.com Web site www.matco.com

MICROCONTROLLERS



PIC & ATMEL PROGRAMMERS from \$15.95 and \$29.95! Visit www.electronic123.com for complete details. Amazon Electronics, Inc. Toll free 1-888-549-3749.

PIC PROGRAMMERS: Several different programmer kits that you can build yourself all the most popular PIC and Atmel chips. **www.electronic123.com**

PIC DESIGNS DONE CHEAP! Midwest Micro-Tek, a leader in 8 and 16 bit controller design, is now offering their design services for PIC designs at a low price of \$60/hr for design, routing, and programming. For more info call 605-697-8521. **www.midwestmicro-tek.com**

www.dontronics.com THE world's largest range of AVR & PICmicro hardware and software. Home of the very popular SimmStick™. Hi-Tech PIC C compilers \$100 off. Biggest range of PICmicro/AVR C & Basic compilers from all over the world. Many delivered via a web download. On-line real-time shopping cart. World wide delivery. Microcontroller kits and associated components. Dealer for N&V, CCS, Bascom, Codevision, FED, Hi-Tech, DIY HK, Newfound Warp-13, Tato, Codadesigner, Lawicell, Wirz, Square One, P16PRO/PICALL Rego, and many more. Customer satisfaction guaranteed.

ANTIQUE ELECTRONICS

WANTED: FOR historical museum, pre-1980 microcomputers, magazines, and sales literature. Floyd, VA 24091-0341 (540-763-3311/540-382-2935).

WESTERN ELECTRIC wanted: 1920s-1960s. Amplifiers, mixers, pre-amps, speakers, tubes, etc. **FREE OFFER** 1-800-251-5454.

DEC EQUIPMENT WANTED!!! We are buying DEC systems, boards, terminals, drives and peripherals. Also Scientific Micro Systems (SMS), CMD, Datability, Dilog, DSD, EMULEX, other DEC compatibles. Please contact us for a quote or fax/email your equipment list. We buy, sell, and trade. **KEYWAYS, INC.,** 937-847-2300 or fax 937-847-2350 or email buyer@keyways.com

AVIATION ELECTRONICS

KINGSLEY HOTSTAMP foil machines for imprinting leather, etc., and electrical wire marking. Manual or automatic machines and type available. Call 760-749-0239. bjnash@n2.net

PUBLICATIONS

HIGH-TECH SURVIVAL: Electronics, computers, internet, energy, phones, medical, financial, security, physical survival, unexplained phenomena. **CONSUMERTRONICS, www.tsc-global.com**

BASIC STAMP 2 users: "Inside the BASIC Stamp II" tells how the PBASIC interpreter works, how code is stored in EEPROM, how to optimize code for space and speed. 160 pages, 50 illustrations, many examples. See http://members.aol.com/stamp2book Send \$29.95 check or money order (US funds) to Brian Forbes, 147 Flying Cloud, Foster City, CA 94404-1301.

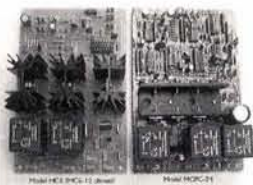
ROBOTICS

ROBOT BOOKS.COM visit our web site for reviews of robotics books, plus robot kits, toys, movies, and magazines! www.robotbooks.com

ARobot KIT from Arrick Robotics uses the BASIC Stamp II. Quality metal construction. Easy to assemble and very expandable. \$235. http://www.robotics.com/arobot

EASY RC. Preprogrammed PIC accepts standard RC pulses and sends control signals to motor controller for direction and proportional speed control. Single channel or dual channel with mixing available. Info: 570-735-5053. http://www.diverseelectronicservices.com email: carl@diverseelectronicservices.com

PIC-BASED controller boards and coprocessors for small bots, singleboard computers and other prototyping components. **www.oricomtech.com**



MOTOR CONTROLLERS, PWM, 12V, 24V, 35A, many features from \$40 plus S&H. Info: 570-735-5053. Details: <http://www.diverseelectronicservices.com> Toll free orders (only) 1-888-314-6998.

ROBOT WEAPONS control, PIC controlled circuit boards use standard RC signals to control any device up to 10A. Selectable momentary or latched. Control motor direction. Four models control from 1 to 3 devices. Diagnostic LEDs. Input 9 to 24 VDC. 5V output for RC receivers. 570-735-5053. www.DiverseElectronicServices.com

ROBOT KITS: Over 30 complete robot kits from beginner to advanced at www.electronickits.com



MOBILE ROBOT PLATFORM. Been wanting to build a powerful robot but don't know where to start? This 15" x 19" x 10" robot platform includes chassis body with four compartments, two-speed high-torque motors, large 8" drive wheels, and 6" rear swivel wheels. Plenty of surface area for adding sensors, cameras, etc. Only \$229 assembled, \$199 unassembled. Ph: 321-757-9280 or online: <http://www.kadtronix.com>.



MOBILE ROBOT FRAME. Need a sturdy frame for your next BattleBots challenge? This steel frame and 8" wheels are just the thing. Heavy-duty 3-piece steel frame has a load capacity of 300 pounds. Measures 18" x 18" x 13" and weighs only 15 pounds. \$89 plus S&H. Ph: 321-757-9280 or online: <http://www.kadtronix.com>.

LINEAR POSITION ACTUATOR made by Lucas. 0-.312" movement with an applied voltage of 0-20 volts, 34 ohm coil, .218" shaft dia. NEW! \$60 each, 10 for \$500. Visit surplusvalues.com/lucas.jpg for picture. Call Roger @ GS&E, 585-338-7001. VISA/MC.

CNC

AFFORDABLE CNC MACHINES



Simple to Use

Run From Any Version of Windows®

www.flashcutcnc.com

Automated Machine Tools to Produce
• Panels • Chassis/Housings
• PCB Prototypes • Any 3D Part

FLASHCUT CNC™

1263 El Camino Real, Menlo Park, CA 94025
4949 St. Elmo Avenue, Bethesda, MD 20814
Tel 888-883-5274 Fax 650-853-1405

PLANS — KITS — SCHEMATICS

ELECTRONIC KITS: Hundreds of electronic kits and projects. Where else except www.electronickits.com

AMAZING KITS, remote control, motor controllers, PIC experimenter boards. Fun and educational. Quality guaranteed. www.dlrkits.com

HIGH-TECH SURVIVAL: Electronics, computers, internet, energy, phones, medical, financial, security, physical survival, unexplained phenomena. **CONSUMERTRONICS**, www.tsc-global.com

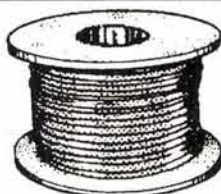
PLANS, BOOKS, kits, surplus, AM/FM/SV broadcasting supplies. Online ordering at www.kenneke.com



HIGH PERFORMANCE ELECTRONIC KITS. A and T Labs offers a line of exceptional audio, test, and other electronic kits and products. Designs that distinguish themselves from their commercial alternatives with superior performance, functionality, and quality! www.a-and-t-labs.com

15MHz FUNCTION GENERATOR \$21.50, 80C320 MICRO-CONTROLLER \$21.50. WWW.CGIMICRO.COM

MISCELLANEOUS ELECTRONICS FOR SALE



ANAHEIM WIRE PRODUCTS. DISTRIBUTOR OF ELECTRICAL WIRE AND CABLE since 1973. Items available from our stock: Hook up wire, Automotive primary wire, GXL, SXL, Plenum cable, Teflon wire, Multi-conductor cable, Irradiated PVC, SO-CORD, Mil-Spec wire, Building wire, Welding cable, Battery cable, Telephone wire, Shrink tubing, Cable ties, Connectors. Wire cut & strip to specs. If interested, please call **1-800-626-7540**, FAX: 714-563-8309. Visa/MC/Amex. SEE US ON THE INTERNET: <http://www.anaheimwire.com> OR E-Mail: info@anaheimwire.com

RS485/422/232/TTL

ASC24T \$45
• Converters
• Repeaters
• Fiber Optics
• Digital I/O
• Multidrop RS232
• Custom Units
• Auto TX Enable

Extensive Interface Product Line

RS232 "Extension Cords"
Up to 115.2 Kbps, 4000 ft. ++
Large Multidrop Networks.
Isolated Units. Smart Units
Remote Relay "Extension Cords"

Call the RS485 Wizards at
(513) 874-4796

RES R.E. Smith
www.rs485.com

LedVision Holdings, Inc.



Scrolling L.E.D. Signs

- Wireless Keyboard
- Includes Windows Software
- Text & Graphics
- Super Bright Multi-Color
- Clock Functions & Scheduler
- Real Time (ASCII) Mode
- 16K Flash Memory
- RS-232 & RS-485 Serial Ports

303 Sherman Ave., Ackley, Iowa 50601

(641) 847-3902 Fax: (641) 847-3889

sales@ledvision.com

www.ledvision.com

HARD-TO-find parts: PTV screens, modules, chassis, flybacks, tuners, tubes, for all brands. Manuals. 478-272-6561. Scarborough TV, 1422 Old River Road, East Dublin, GA 31027. scarboroughstv@pcnow.net



SOLAR-POWERED FAN HAT.

Baseball type hat with solar powered fan. Great for sports fans, golfers, etc. Available in red or blue. \$19 plus \$2.00 shipping. CA residents add 7.75% sales tax. Visa/MC/Disc/Amex OK. H.T. Orr Computer Supplies, 249 Juanita Way, Placentia, CA 92670. 714-528-9822, 1-800-377-2023, FAX 714-993-6216.

Electronics Manufacturing Technology a div. of Ledvision



ISO-9001 Compliant

www.pcboardsinc.com

Bare Printed Circuit Boards

- Design & Layout
- Single, Double & Multi-Layer
- Automated Assembly
- SMT & Thru-Hole
- Prototypes Thru Production
- Product Engineering
- Final Assembly & Test

303 Sherman Ave., Ackley, Iowa 50601

(641) 847-3902 Fax: (641) 847-3889

sales@pcboardsinc.com



PORTABLE CARD SWIPER.

Swipe any card with this incredible tiny device and the complete data on the magnetic stripe is stored instantly in its memory. Stores over 100 swipes at one time. Powered by a small camera battery. It can be use remotely on any type of card with a magnetic stripe. After the magnetic stripe information is saved, you may download the information to any computer or laptop. Applications: data collection, trade shows attendance, conference attendance, classroom attendance and many others. We have many different models and magnetic stripe reader/writers. See our web site: www.mobilecardreaders.com Or write for free catalog. The Information Center, PO Box 876, Hurst, TX 76053. 817-589-7891.

SELLING ELECTRONICS parts business! Over 1,000,000 components/assemblies. 30 year inventory (1970-2000). Consumer, industrial, military, medical parts. Call Jobe Electronics, Ph 618-993-6340 Marion, IL 62959.

TUBE AND transistor tester.

Precision Apparatus Co. model 10-60 Electronamic, \$99. Includes books and G-140 adapter. Also available: Central Electronics **Rejuva-Tube**, model RE-1 CRT rejuvenator, \$69. Shipped UPS, COD, charges added to price. Peter 248-669-3604 Fax: 248-669-3411. strategiccontrol@hotmail.com

MISCELLANEOUS ELECTRONICS WANTED

DEC EQUIPMENT WANTED!!! We are buying DEC systems, boards, terminals, drives and peripherals. Also Scientific Micro Systems (SMS), CMD, Datability, Dilog, DSD, EMULEX, other DEC compatibles. Please contact us for a quote or fax/email your equipment list. We buy, sell, and trade. **KEYWAYS, INC.**, 937-847-2300 or fax 937-847-2350 or email buyer@keyways.com

WANTED: BALANCING machines & vibration analyzing equipment manufactured by the following: Spectral Dynamics, Hofmann, Bentley Nevada, Schenck, IRD Mechanalysis, Gishott. Contact Mike Park at E.T. Balancing, 12823 Athens Way, Los Angeles, CA 90061. 310-538-9738, FAX: 310-538-8273.

WESTERN ELECTRIC wanted: 1920s-1960s. Amplifiers, mixers, pre-amps, speakers, tubes, etc. FREE OFFER 1-800-251-5454.

WANTED: TUBES, radios, transmitters, receivers, gyros, bearings, connectors, relays, lamps, synchros. Hyness Company, 709B Delair Road, Monroe Twp., NJ 08831. Phone: 609-395-1116, FAX 609-395-1117.

UNITEK MODEL DP-125 or DP-250 welder power supplies **WANTED**. 608-831-3443, fax 608-831-1082, ask for Everett.

BBS & ONLINE SERVICES

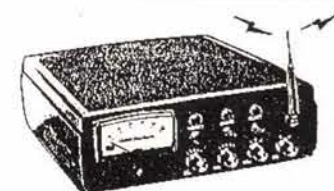
EDUCATION

MAGICIAN IS available to solve your RF problem. I will teach you in my laboratory how to do it. Young engineers and technicians are welcome. SMT prototyping up to 3GHz for customers. Minaret Radio, John Horvath ph: 909-943-3676. Ask for my resume.

FREE CONTROL and embedded systems tutorial, www.learn-c.com

Optional interface board for hands-on learning. Eight 8-bit AD, two 8-bit DA, 27 digital lines and more. Bare board only \$20. Kits and assembled available.

BUSINESS OPPORTUNITIES



COUNTER-SURVEILLANCE=\$250 HR! Electronic eavesdropping is unbelievably widespread! Are you sure you're safe? Learn how others (without prior experience) earn \$250 HR in the fascinating field of COUNTER-SURVEILLANCE! For FREE catalog call: **1-800-732-5000**. [HTTP://WWW.SPY-CITY.COM](http://WWW.SPY-CITY.COM)

Classified Ad Instructions

TYPE or PRINT your **ELECTRONICALLY RELATED** ad copy **CLEARLY (not all caps)** on a separate piece of paper. Spell out words when submitting handwritten copy. Calculate the number of words and multiply it by the appropriate rate (see RATE PER WORD section). Include any charges for **bold** and/or **CAPPED** words, any artwork costs that would be applicable, and/or costs for boxing your ad (explained below). Choose the appropriate classification for your ad(s) to appear in (see below). If no classification is indicated, it will be placed in Misc. Electronics or wherever we deem most suitable. **Enclose your name, address, phone number, and Nuts & Volts account number from your mailing label (if available) for identification purposes.** Include full payment — **CLASSIFIEDS RUN ON A PRE-PAID BASIS ONLY** — and mail your completed order to:

NUTS & VOLTS MAGAZINE
430 Princeland Ct., Corona, CA 92879.

RATE PER WORD

The ad rate for **current PAID subscribers** is **60¢** per word. All others pay **\$1.20** per word. There is a **\$9.00 minimum** charge per ad per insertion.

BOLD WORDS AND/OR CAPS

Words to be set in **bold** or **CAPS** are each **10¢** extra PER WORD. **BOLD CAPS** are **20¢** extra per word. The first two words of each ad are bold capped at no charge. Indicate bold words by underlining. Words normally written in caps (e.g., IBM) and accepted abbreviations such as VAC or MHz are NOT charged as all cap words. Use a two-letter abbreviation for states.

PHOTOS, DRAWINGS, BOXES

A photo or drawing may be run at the top of your classified ad for an additional **\$10.00** (1" depth max.) for camera-ready art. No wording is allowed in this area. To **BOX** your ad, include an additional **\$50.00** for copy-only ads, or **\$75.00** for ads with art or photos. Photos may be emailed to classad@nutsvolts.com.

EMAILING/FAXING AD COPY

You may email or fax in ad copy or changes before the closing date (5:00pm on the **1st**) using MasterCard or Visa. Include credit card expiration date, the name that appears on the card, a daytime phone number, and your *Nuts & Volts* account number. Email ad(s) to classad@nutsvolts.com or fax to 909-371-3052. Ads without credit card information will not be listed as received until payment is received in full. **WE DO NOT CALL, EMAIL, OR FAX BACK VERIFICATION OR QUOTES OF EMAILED AND FAXED-IN ADS.** For verification of emailed or faxed-in ads, please call 909-371-8497.

DEADLINE

Prepaid ads received by 5:00pm on the **closing date (1st of the month)** will appear in the following month's issue. Ads postmarked through the **1st**, but received after the closing date, will be placed in the next available issue. No cancellations or changes after the 1st. Cancellations and changes must be submitted in writing.

IMPORTANT INFORMATION

All classified ads are running copy only. No special positioning, centering, dot leaders, extra space, etc. is allowed. All advertising in *Nuts & Volts* is limited to **electronically related items ONLY**. All ads are subject to approval by the publisher. We reserve the right to reject or edit any ad submitted. We do not take ad copy or changes over the phone. We do not bill for classified ads. Repeat ads or ads run in multiple classifications within the same issue are allowed. Paid subscribers may run ads at the 60¢ rate only through their subscription expiration date. **NO REFUNDS.** Credit only. No credit for typesetting errors will be issued unless you *clearly* print or type your ad copy.

Choose a category for your ad from these classifications.

- | | |
|----------------------------------|---------------------------------|
| 10. Ham Gear | 125. Microcontrollers |
| 20. Batteries/Chargers | 130. Antique Electronics |
| 30. CB/Scanners | 135. Aviation Electronics |
| 40. Music & Accessories | 138. Thermocouple Welder |
| 50. Computer Hardware | 140. Publications |
| 60. Computer Software | 145. Robotics |
| 70. Computer Equipment Wanted | 148. CNC |
| 80. Test Equipment | 150. Plans/Kits/Schematics |
| 85. Security | 155. Manuals/Schematics Wanted |
| 90. Satellite Equipment | 160. Misc. Electronics For Sale |
| 95. Military Surplus Electronics | 170. Misc. Electronics Wanted |
| 100. Audio/Video/Lasers | 175. BBS & Online Services |
| 110. Cable TV | 180. Education |
| 115. Telephone/Fax | 190. Business Opportunities |
| 120. Components | 200. Repairs/Service |

AFFILIATES WANTED: If you have a website you can earn a 10% commission for every person that you refer to our site. See complete details at www.spousewatcher.com

REPAIRS — SERVICES

(E)EPROM PROGRAMMING done quickly and economically. One day turn around typical. Simple copy \$3 per device. Also prototyping, design, and consulting services available. Call or send SASE to: **Luzer Electronics, 4023 North Bayberry, Wichita, KS 67226. 316-687-2127, FAX 316-687-3103.**

MECH ENGINEERING CONSULTING: machine design & packaging from conceptual to manufacturing; detailing, bill of mat'l, part procurement, & proto build. **GSC, MECHANICAL ENGINEERING SERVICES 508-339-7837** or email: SECGSC@aol.com. (Ask for Greg.)

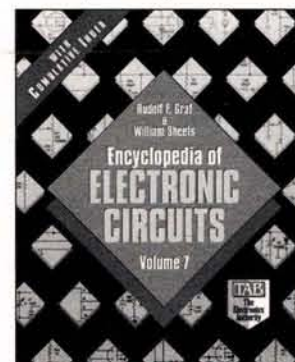
SPECIAL PROJECTS HARDWARE: Unique, original, made-to-order, special needs, controversial: power meters educational module, automated control signal replicator, KX radar emitter, radionics rifle, subliminal mixer/amp, unseen/unknown presence detector, "aura" detector — many, many more! **LONE STAR CONSULTING, INC., www.lonestartek.com**

WELD ALUMINUM WITH PROPANE! EZ, INEXPENSIVE, STRONG. DETAILS: WEEKS, 36 CAROLINA ST., TAYLORS, SC 29687. 1-800-547-WELD(9353) FAX 864-244-6349. <http://www.durafix.com>

SCHEMATIC DIAGRAMS reverse engineered from electronic devices is our business. Can't get schematics from manufacturers? We can possibly help. See our web site, or contact us directly. **Bomarc Services, Box 1113, Casper, WY 82602. 307-234-3488. bomarc.org rollo@trib.com**

"Encyclopedia of Electronic Circuits" Vol 7

by Rudy Graff



ONLY \$39.95

Designed for quick reference and on-the-job use, the *Encyclopedia of Electronic Circuits, Volume 7*, puts over 1000 state-of-the-art electronic and integrated circuit designs at your fingertips. Organized alphabetically by circuit type, this collection includes designs from industry giants such as Advanced Micro Devices, Motorola, Tele-dyne, General Electric, and even right here in *Nuts & Volts*.

As a paid subscriber to *Nuts & Volts*, you'll receive **10% off the list price!!** (See ad on page 83 for ordering details and other titles currently available.)



CMOS "SUGAR CUBE" B/W CAMERA

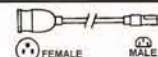
Composite video output approx. 200 lines. Power: 5V reg. @ 15mA. Size: 16mm sq. x 15mm. Lens: 4.9mm F2.8 (for 56° x 41°). **99V010 \$49.95**

39KV 350A



HIGH POWER RECTIFIER STACK

Six 6500V, 350A hockey puck thyristors in series. Each thyristor has trigger network, 400pF 30KV bypass cap, and two 500K-Ohm equalizing resistors. Water cooled. (That's 39KV x 350A = 13.65MW!) Thyristors are ABB #5STP0365D0002, list price \$288 each. Overall size 4" x 5 1/4" x 15". **20S002 \$250.00**



1' MONITOR POWER CABLE

If monitor has a permanent AC power cord attached, plug it into this adapter and then into the back of your computer. **94W002 \$2.95 each**

2N3055 TRANSISTORS

2N3055 \$2.25 each
10 FOR \$20.00

More values on website

RHEOSTAT 6 OHM 50 WATT

50R6 \$8.50 each



Soldering Pot

Pot Capacity: 1.8Kg, Pot Construction: Stainless steel, Rocker On/Off switch, Wide Temperature control, Power 600 Watt, Pot Temperature: 300 ~ 500C, Pot Diameter 100mm, Pot depth: 45mm, Size: 140 X 1454mm, Weight: 1.8Kg 4lbs **AC60P \$89.00**

Many more boxes and cabinets on the website



RACK MOUNT CABINETS

High-quality rackmount enclosures come in an attractive charcoal grey epoxy finish. The top, bottom and sides have ventilation holes to assist in colling. The front and back panels are made of 0.059" thick aluminum for easy custom design. The top, bottom and sides are 0.035" steel. Choose from six sizes. All include handles except RC3120A. **RC3120A - Front panel 19" x 1.75" 9.5"D - \$38.00**
RC3120B - Front panel 19" x 3.5" 9.5"D - \$46.00
RC3120C - Front panel 19" x 3.5" 13"D - \$53.00
RC3120D - Front panel 19" x 5.25" 13"D - \$58.00
RC3120E - Front panel 19" x 5.25" 16.75"D - \$63.00
RC3120H - Front panel 19" x 8.75" 16.75"D - \$83.00

alltronics.com



Mail Orders: PO BOX 730 - Morgan Hill, CA 95038-0730

Phone: (408) 847-0033 Fax: (408) 847-0133

Download our Catalog: <http://www.alltronics.com>

Dealers welcome by appointment. Visa, M/C, AmEx Accepted. All Sales Final. California Residents Add Sales Tax. Shipping Additional on All Orders. Prices Good 60 Days from Date of Publication and Subject to Change Without Notice.

DEALER DIRECTORY

The dealers listed below carry the latest issue of Nuts & Volts, for your convenience.

ALABAMA

Little Professor Book Center
2717 S. 18th St.
Birmingham 35209

ARIZONA

Elliott Electronic Supply
1251 S. Tyndall Ave.
Tucson 85713
Tower Records
3 E. 9th St.
Tempe 85281

AUSTRALIA

DonTronics
P.O. Box 595
29 Ellesmere Cres.
Tullamarine 3043
www.dontronics.com

CALIFORNIA

Abletronics
9155 Archibald Ave. Unit E
Cucamonga 91730
All Electronics
905 S. Vermont Ave.
Los Angeles 90006

14928 Oxnard St.
Van Nuys 91411

Alltronics
2300-D Zanker Rd.
San Jose 95131

Centerfold International
716 N. Fairfax Ave.
Los Angeles 90046

Del Amo Books & News
3758 Sepulveda Blvd.
Torrance 90505

Electro Mavin
2985 E. Harcourt St.
Rancho Dominguez 90221
HSC Electronic Supply
4837 Amber Ln.
Sacramento 95841

3500 Ryder St.
Santa Clara 95051

5681 Redwood Dr.
Rohnert Park 94928
JK Electronics
6395 Westminster Ave.
Westminster 92683

Lion Electronic Labs
4948 E. Townsend Ave.
Fresno 93727

Mar Vac Electronics
2001 Harbor Blvd.
Costa Mesa 92627

12453 Washington Blvd.
Los Angeles 90066

4747 Holt Blvd.
Montclair 91763

2000 Outlet Center Dr.
Ste. 150
Oxnard 93030

1759 Colorado Blvd.
Pasadena 91106

2537 Del Paso Blvd.
Sacramento 95815

5184 Hollister Blvd.
Santa Barbara 93111
OPAMP Technical Books
1033 N Sycamore Ave.
Los Angeles 90038

Sav-On Electronics
13225 Harbor Blvd.
Garden Grove 92643

The Red Barn
Hwy. 299
Bieber 96009

Tower Books
211 Main St.
Chico 95928

7840 Macy Plaza Dr.
Citrus Heights 95610

1280 E. Willow Pass Rd.
Concord 94520

630 San Antonio Rd.
Mountain View 94040

1600 Broadway
Sacramento 95818

2538 Watt Ave.
Sacramento 95821

Tower Records/Video
220 N. Beach Blvd.
Anaheim 92801

6694 Amador Plaza Rd.
Dublin 94568

5703 Christie Ave.
Emeryville 94608

4118 Fremont Hub
Fremont 9453

5611 Blackstone
Fresno 93710

23541 Calle De La Louisa
Laguna Hills 9265

6310 E. Pacific Coast Hwy.
Long Beach 90803

2331 S Atlantic Blvd.
Monterey Park 91754

2525 Jones St.
San Francisco 94133

871 Blossom Hill Rd.
San Jose 95123

Video Electronics
3829 University Ave.
San Diego 92105

CANADA

Com-West Radio Systems Ltd.
8171 Main St.
Vancouver, BC V5X 3L2

Emma Marion Ltd.
2677 E. Hastings St.
Vancouver, BC V5K 1Z5

Muir Communications Ltd.
3214 Douglas St.
Victoria, BC V8Z 3K6

COLORADO

Centennial Electronics, Inc.
2324 E. Bijou
Colorado Springs 80909
Tower Records/Video
2500 E. 1st Ave.
Denver 80206

CONNECTICUT

Archway News
64 Bank St.
New Milford 06776
Tower Records
1145 High Ridge Rd.
Stamford 06905

DELAWARE

Newark Newsstand
70 E. Main St.
Newark 19711

DISTRICT OF COLUMBIA

Tower Records
2000 Pennsylvania Ave.
Washington 20006

FLORIDA

Alfa Electronic Supply
6444 Pembroke Rd.
Miramar 33023

Astro Too
6949 W. Nasa Blvd.
West Melbourne 32904

Clarks Out of Town News
303 S. Andrews Ave.
Fort Lauderdale 33301

Mike's Electronic Distributing Co.
1001 N.W. 52nd St.
Fort Lauderdale 33309

HAWAII

SolarWorks!
525 Lotus Blossom Ln.
Ocean View 96737

Tower Records
4211 Wai'alae Ave.
Honolulu 96816

611 Keeaumoku
Honolulu 96814

IDAHO

Current Source
454 N. Phillippi St.
Boise 83706

ILLINOIS

Tower Records/Video/Books

383 W. Army Trail Rd.
Bloomington 60108

2301 N. Clark St. #200
Chicago 60614

1209 E. Golf Rd.
Schaumburg 60173

INDIANA

Surplus Bargain Center
2611 W. Michigan St.
Indianapolis 46222

KANSAS

Hollywood At Home
9063 Metcalf Ave.
Overland Park 66212

LOUISIANA

Lakeside News
3323 Severn Ave.
Metairie 70002

MARYLAND

Tower Records/Video
2566 Solomons Island Rd.
Annapolis 21401

1601 Rockville Pike #210
Rockville 20852

MASSACHUSETTS

Tower Records/Video
1011 Middlesex Turnpike
Burlington 01803

MICHIGAN

Anything Goes
5108 Rochester Rd.
Troy 48098

Little Professors Book Center
22174 Michigan Ave.
Dearborn 48124

Purchase Radio Supply, Inc.
327 E. Hoover Ave.
Ann Arbor 48104

Spectrum Electronics, Inc.
1226 Bridge St. NW
Grand Rapids 49504

MINNESOTA

Radio City, Inc.
2633 County Road 1
Mounds View 55112

MISSOURI

Electronics Exchange
8644 St. Charles Rock Rd.
St. Louis 63114

NEVADA

Amateur Electronic Supply
4640 Polaris
Las Vegas 89103

Radio World
1656 Nevada Hwy.
Boulder City 89005

Sandy's Electronic Parts
961 Matley Ln #100
Reno 89502

Tower Records/Video
4580 W. Sahara Ave.
Las Vegas 89102

6450 S. Virginia
Reno 89511

NEW JERSEY

H.E.S. Electronics
1715 Route 88
Brick 08724
Tower Records/Video
809 RT 17 S
Paramus 07652

NEW YORK

Durston's Cigar Store
515 W. Genesee St.
Syracuse 13204
Ham Central
3 Neptune Rd.
Poughkeepsie 12601

Hirsch Sales Corporation
219 California Dr.
Williamsville 14221
Tower Records/Video
105 Old Country Rd.
Carle Place 11514

350-370 Route 110
Huntington 11746

1961 Broadway
New York 10023

NORTH CAROLINA

United Electronic Supply
920 Central Ave.
Charlotte 28204

OHIO

Hosfelt Electronics, Inc.
2700 Sunset Blvd.
Steubenville 43952
Keyways, Inc.
204 S. 3rd St.
Miamisburg 45342

OKLAHOMA

Taylor News & Books
133 W. Main, Ste. 102
Oklahoma City 73102

OREGON

News & Smokes
1060 S.E. M St.
Grants Pass 97526
Norvac Electronics
7940 S.W. Nimbus Ave, Bldg. 8
Beaverton 97005

960 Conger
Eugene 97402

1545 N. Commercial N.E.
Salem 97303

Tower Books
1307 N.E. 102nd Ave.
Portland 97220

PENNSYLVANIA

Tower Books
425 South St.
Philadelphia 19147

Tower Records

340 W. Dekalb Pike
King of Prussia 19406

Tower Records

Land Title Bldg.
100 S. Broad St.
Philadelphia 19110

TENNESSEE

Tower Books
2404 W. End Ave.
Nashville 37203

Tower Records
504 Opry Mills Dr.
Nashville 37214

TEXAS

Electronic Parts Outlet
3753-B Fondren Rd.
Houston 77063

Mouser Electronics
958 N. Main St.
Mansfield 76063

Tanner Electronics
1100 Walwood Pkwy #100
Carrollton 75006

Tower Records
2403 Guadalupe St.
Austin 78705

VIRGINIA

Tower Records/Video
6200 Little River Turnpike
Alexandria 22312

4110 W. Ox Rd. #12124
Fairfax 22033

1601 Willow Lawn Dr.
Richmond 23230

8389 E. Leesburg Pike
Vienna 22182

WASHINGTON

A-B-C Communications, Inc.
17541 15th Ave. N.E.
Seattle 98155

Supertronix
16550 W. Valley Hwy.
Seattle 98188

Tower Books
10635 N.E. 8th St.
Bellevue 98004

20 Mercer St.
Seattle 98109

WISCONSIN

Amateur Electronic Supply, Inc.
5710 W. Good Hope Rd.
Milwaukee 53223

WYOMING

Western Test Systems
2701 Westland Ct. #B
Cheyenne 82001

2539 W. 237th Street, Bldg. F, Torrance, CA 90505
 Order desk only: USA: (800) 872-8878 CA: (800) 223-9977
 L.A. & Technical Info: (310) 784-5488 Fax: (310) 784-7590
 email: mraa@earthlink.net http://www.digisys.net/timeline

TIMELINE INC.

Over 16 years and 33,000 customers and still growing

Minimum Order: \$20.00. Minimum shipping and handling charge \$5.00. We accept cashiers checks, MC or VISA. No personal checks or COD's. CA residents add 8.25% sales tax. We are not responsible for typographical errors. All merchandise subject to prior sale. Phone orders welcome. Foreign orders require special handling. Prices subject to change without notice. 20% restocking fee for returned orders.

LIQUID CRYSTAL DISPLAYS

Graphic and alphanumeric WITH BUILT IN CONTROLLER

\$29.00 or 2 for \$49.00

Size	Mfr.	Controller	Backlit
256x128	Hyundai	1330	—
240x128	Hitachi	61830	LED
240x64	AND	6963	EL
160x128	Optrex	6963	CCFL

Alphanumeric—parallel interface

16x1.....\$5.00	20x2.....\$6.00	32x2.....\$5.00
16x1 (lg. char.).....\$7.00	20x4.....\$8.00	40x1.....\$5.00
16x2.....\$5.00	20x4 (lg. char.).....\$10.00	40x2.....\$7.00
16x2 (lg. char.).....\$10.00	24x2.....\$6.00	40x4.....\$15.00
16x4.....\$8.00	32x4.....\$5.00	4x2.....\$4.00

5V power required V Built-in C-MOS LCD driver & controller V Easy Omicroprocessor interface V 98ASCII character generator V Certain models are backlit, call for more info.

Graphics and alphanumeric—serial interface

size	Mfr.	price	size	Mfr.	price
640x480 (backlit)	Epson	\$15.00	320x240	Epson	\$15.00
640x400 (backlit)	Panasonic	\$10.00	256x128	Epson	\$15.00
640x200	Toshiba	\$10.00	240x128 (backlit)	Optrex	\$15.00
480x128 (backlit)	ALPS	\$ 8.00	240x64	Epson	\$15.00
480x128	Hitachi	\$ 6.00	160x128	Optrex	\$15.00

6" VGA LCD 640X480, Sanyo LMDK55-22 \$15.00

MONITORS

Non-Enclosed TTL

Comes with pinout, 12V at 1.4 Amp input • Horizontal frequency 15KHz • Ability to do 40 and 80 column.
 5 inch Amber \$15.00 ¥ 7 inch Amber \$19.00
 9 inch Amber or Green \$19.00

50 COLOR MONITOR \$19.00

• Flat Faceplate • 320 x 200 Dot Resolution • CGA & Hercules Compatible
 • 12 VDC Operation • 15.75 KHz Horiz. Freq. • 60 Hz Vert. Sync. Freq.
 • Open Frame Construction • Standard Interface Connector • Degaussing Coil included • Mfr. Samtron

2 for \$29.00

HACKER CORNER

EMBEDDED 486 COMPUTER

\$59.00 2 for \$109.00

Complete enhanced Intel 486SX-33 based computer in ultra small (9-7/8" x 6-5/8" x 3-1/8") case. Ideal for embedded operations or as a second computer. Features include: VOne 16 bit ISA slot V3 serial ports plus dedicated printer port VParallel optical coupled adapter port VBuilt in IBM PC/AT keyboard port VOn board VGA video and port VUses standard SIMM up to 32 MB VBIOS is PC/AT compatible

Unit has a backup Ni-Cd battery system in case of power failure (5 min. backup time) and lockable front cover to prevent floppy drive access. Mounting / interface provisions for standard 3.5" laptop floppy and 2.5 inch hard drives. Comes with very comprehensive manual.

NTSC COMPOSITE 4" LCD MONITOR \$69.00

Circle #92 on the Reader Service Card.

57 WATT UPS SUPPLY

\$29.00 OR 2 FOR \$49.00
 (COMES W/ 12V @ 2.2AMP BATTERY)

Unit designed to provide uninterrupted DC power in the event of loss of the primary 110 / 220 VAC supply. It utilizes a 12 V sealed lead acid battery as a source of power until the AC supply can be restored. It is a versatile unit which can be used in a number of different applications. The outputs are +5 VDC @ 6.5 A, +3.6 VDC @ 2.5 A, +12 VDC @ .8 A, -12 VDC @ .5 A, and a battery charging output of 12 VDC @ 10 A. The DC outputs are terminated in in-line connectors which interface with standard motherboard and drive connectors. Possible applications include: Robotics, scientific sensing and recording, Linux devices attached to Ethernet or Internet links, etc...

V The unit is small enough (20 x 3.5 x 8.5) to be contained in a standard PC enclosure, in place of the regular power supply - interfacing directly with the motherboard - providing an uninterruptible power supply VIt can function as a DC-DC power supply furnishing multiple outputs using a 12 VDC input VThe 10 Amp, 12 VDC out put can be used as a battery charger with any AC input from 100 - 240 V VThe unit is a versatile 57 watt DC power supply providing +5 and 3.6VDC as well as +/- 12 VDC.

CELL SITE TRANSCEIVER \$19.00 2 for \$29.00

These transceivers were designed for operation in an AMPS (Advanced Mobile Phone Service) cell site. The 20 MHz bandwidth of the transceiver allows it to operate on all 666 channels allocated. The transmit channels are 870.030-889.980 MHz with the receive channels 45 MHz below those frequencies. A digital synthesizer is utilized to generate the selected frequency. Each unit contains two independent receivers to demodulate voice and data with a Receive Signal Strength Indicator (RSSI) circuit to select the one with the best signal strength. The transmitter provides a 1.5 watt modulated signal to drive an external power amplifier. Channel selection is accomplished with a 10 bit binary input via a connector on the back panel. Other interface requirements for operation are 26 VDC (unregulated) and an 18.990 MHz reference frequency for the digital synthesizer. The units contain independent boards for receivers, exciter, synthesizer, tunable front end, and interface assembly (which includes power supplies and voltage-controlled oscillator). Service manual, schematics and circuit descriptions included.

Reader Feedback

Continued from Page 13

patronize as often as possible the many advertisers you have in the San Francisco Bay area. Particularly HSC Electronic Supply and Alltronics, both of whom I "discovered" through your magazine.

Jim Cassidy
 San Francisco, CA

Dear Nuts & Volts:

I am interested in building the Blab Blaster featured on the cover of your February issue, but have been unable to find a source for the NE570 which is the heart of the unit.

I have checked my Jameco, Mouser, Digi-Key, Edlie, All Electronics, and Hosefelt catalogs and none of them list this part.

Any suggestions as to where I can find them. (Your other readers

probably have the same problem.)
 Jim Schmidt

SolderingDesoldering.Com

Your SMD Rework Specialist
 800-394-1984

Easy-to-Use Seetron Serial LCDs

Interface a sharp LCD display to your BASIC Stamp® or other micro-controller project with ease. No-solder wiring harnesses and easy mounting kits available too. See www.seetron.com today.

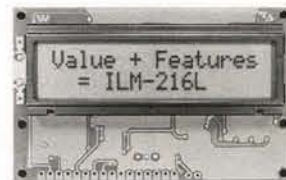
- 3.2 x 1.4 in. supertwist LCD
- 2400/9600 baud serial
- Low (~2mA) current draw
- Popular for use with BASIC Stamps®

\$45
 BPI-216N



- 3.2 x 2 in. backlit LCD
- 1200-9600 baud serial
- Advanced protocol, 4 switch inputs
- EEPROM for configuration settings
- Favorite for OEM applications

\$49
 ILM-216L



- 3.2 x 1.4 in. graphics LCD
- 2400/9600 baud serial
- Font and 15 screens in EEPROM
- Easily draw points, lines, screens

\$99
 SGX-120L



- 3 x 2 in. supertwist LCD
- 1200-9600 baud serial
- ESD-protected, 4x4 keypad input
- Store up to 95 screens in EEPROM

\$119
 TRM-425L



Scott Edwards Electronics, Inc.

1939 S. Frontage Rd. #F, Sierra Vista, AZ 85635
 phone 520-459-4802 • fax 520-459-0623
www.seetron.com • sales@seetron.com

More displays available, including bright VFDs.
 See www.seetron.com

Circle #94 on the Reader Service Card.

Celebrating our 19th Year Of Service !!
 VISIT US AT WWW.UNICORNELECTRONICS.COM

What Do We Have ?

- | | | |
|------------------------|----------------|---------------|
| • TTL | • 74LS | • 74C |
| • EPROMS | • EEPROMS | • PAL's |
| • GAL's | • CMOS | • Z80 |
| • Linear | • Generators | • 8000 series |
| • 6500 series | • 6800 series | • Capacitors |
| • Oscillators | • Connectors | • Crystals |
| • Trimpots | • I.C. sockets | • Switches |
| • Diodes | • Kits | • Tools |
| • Vises | • Laser Diodes | • LED's |
| • Vises | • Transistors | • Resistors |
| • And much, much more! | | |

• Order Line — (800) 824-3432 • International — (724) 495-1230 • Fax Orders — (724) 495-7882
 • Technical Support — (724) 495-1231 • \$25.00 Minimum Order • UPS 3 day, Blue, Red, & Fed. Ex.
 Shipping Available (Call for charges) • PA Res. Add 7 % Sales Tax • Open Mon-Fri 9:00 AM - 5:00 PM (EST) • Corporate Accounts / Quantity Discounts Available • We accept M/C, VISA, Discover & AMEX with no surcharge • Call For FREE Catalog (\$2.00 Outside U.S.)
 • We Carry A Complete Line Of Electronic Components • Email - unielect@aol.com

Visit us on the web! www.unicornelectronics.com

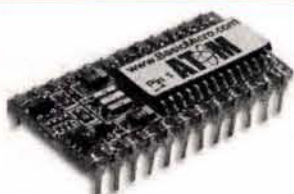
FREE SHIPPING!! on pre-paid orders

Unicorn Electronics
 1142 State Route 18
 Aliquippa, PA 15001

Circle #89 on the Reader Service Card.

MORE POWER

THE
ATM



Setting a new standard in STAMPS

The New BASIC MICRO ATOM®, offers more in the same package you're already familiar with. With built-in features, like upgradable firmware, get more power for your projects now and into the future!

Software Features:

- Graphical Debugging (ICD)
- More Software Commands
- 32 Bit Integer Math
- 32 Bit Floating Point Math
- Easy to use code editor
- BS2p Compatible Syntax
- Expanded BASIC library
- Firmware upgradeable
- Unlimited Support
- Free Software Updates
- Plus much more!

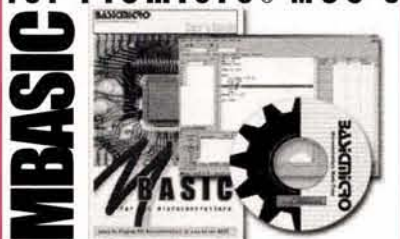
Built in Hardware:

- Over 300 Bytes of RAM
- 256 Bytes of Data EEPROM
- External & Internal Interrupts
- 3 10 bit A/D Converters
- 2 Capture and Compare
- Internal Adjustable Vref
- +/- External Vref
- 3 Timers
- 2 PWM
- UARTS
- I2C, SPI

\$59.95 Complete

Also available in Development Combs and OEM package

MORE FLEXIBILITY for PICmicro® MCU's



Ever wanted to learn how to program PICmicro® MCUs? Now you can with easy to use BASIC. Our software is much simpler than C or Assembly. MBASIC for PICmicro® MCUs creates a one click solution that allows you to experiment and test code changes on-the-fly! From beginner to professional bring your projects to life quicker and easier with MBASIC for PICmicro® MCUs!

New - In Circuit Graphical Debugger built in!

Priced from \$99.95

Educational and Dealer pricing available with all products
PICmicro is a registered trademark of Microchip Inc.

BASIC MICRO INC.

Order online or call 1-734-425-1744
Basic Micro, 34391 Plymouth Rd., Livonia, MI 48150
See More online at <http://www.basemicro.com>

Reader Feedback continues

Response:

Midwest Analog Products
(www.midwest-analog.com)
Allied Electronics (800-433-5700; www.alliedelec.com)
Future Active (800-655-0006; www.future-active.com)
Rochester Electronics
(978-462-9332; www.rocelec.com)

TJ Byers

Dear Nuts & Volts:

Re: Rewiring a magneto phone for dial service.

First, I agree with reply #2 Mike Beaver. Don't make changes.

Second, answer #1 has several problems. Wiring the transmitter, receiver, and hook switch in series will cause the carbon granules to fuse (designed for three volts) and the receiver to get fainter with age due to line voltage (designed for a dry circuit).

Connecting the bell across the

line creates a constant loop. There has to be a 1 mFd capacitor in series to prevent this. Some old phones had a capacitor, but most didn't. As Mike suggested, if you MUST change, get a common battery network and connect your components to it.

I used to work for small telephone companies that had magneto service, and now am a volunteer at a telephone museum.

David Thompson
Bucksport, ME

RAMSEY

GET THE NEW CATALOG TODAY!

New Kits, New LPFM, New Cameras

www.ramseykits.com



35 WATT LPFM STEREO TRANSMITTER



- ✓ 35W RF output, VSWR protected
- ✓ Automatic audio & power controls
- ✓ Digital synthesized PLL
- ✓ Full front panel control
- ✓ 110/220VAC, 12VDC operation

Whether your application is export or LPFM, the PX1 has you covered. From the over-rated continuous duty power supply & power amplifier to the 2 line vacuum fluorescent display, your station will be the easiest to setup and the most reliable for continuous operation. Full microprocessor controls provide a "virtual engineer". Check out www.highpowerfm for full details.

PX1 35W Professional FM Stereo Transmitter \$1,795.95

ELECTROCARDIOGRAM HEART MONITOR



- ✓ Visible and audible display of your heart rhythm
 - ✓ Re-usable sensors included; just like visiting the hospital!
 - ✓ Bright LED "beat" indicator
 - ✓ Monitor output for oscilloscope display
- Enjoy learning about the inner workings of the heart while covering the stage by stage electronic circuit theory of ECG/EKG systems. Be heart smart and learn at the same time!

ECG1 Electrocardiogram Heart Monitor Kit \$34.95
CECG Matching Case & Knob Set \$14.95
AC125 110 VAC Power Adapter \$9.95
ECGP10 Replacement Reusable Probe Patches (10-Pack) \$7.95

PLASMA GENERATOR



- ✓ Generate 2" sparks to a hand held screwdriver!
 - ✓ Build your own plasma balls!
 - ✓ 25KV at 20 KHz from a solid state source!
- Generate really impressive sparks, build your own plasma ball, light fluorescent tubes without wires! From a solid state source, generate over 25KV at 20KHz for the most dazzling displays!

PG13 Plasma Generator Kit \$59.95
PS12 14VAC Output Power Supply \$19.95

ION GENERATOR



- ✓ Generates negative ions with a blast of fresh air!
 - ✓ 7.5KV DC negative, 400uA - that's a lot of ions!
 - ✓ Steady state DC voltage, constant current, not pulsed!
- Learn the basics of ion repulsion by building this ion generator! Creates a continuous blast of fresh air charged with a ton of ions. Perfect for pollution and air freshening; just smell those ions! Solid state wind generation; you'll be amazed!

IG7 Ion Generator Kit \$59.95
AC125 110 VAC Power Adapter \$9.95

TOUCH-TONE TONE GRABBER



- ✓ New-built-in RJ11 phone jack
 - ✓ Large memory holds over 500 numbers
 - ✓ Big bold 8 digit display, auto insertion of dashes
 - ✓ New-output latch jack
- Dialed phone numbers on the radio, repeater codes, control codes, anywhere touch-tones are used, you can read and store them! All new design for 2002. Capture those tones with the TG2!

TG2 Tone Grabber Tone Reader Kit \$59.95
CTG2 Matching Case & Knob Set \$14.95
AC125 110 VAC Power Adapter \$9.95

RCA TO XLR AUDIO CONVERTER



- ✓ Connect consumer outputs to XLR inputs
 - ✓ Left & right audio gain adjustments
- So you're trying to connect consumer audio outputs with RCA connectors (unbalanced) to XLR (balanced) inputs. Always a problem...Not anymore with the R2XL1!

R2XL1 Unbalanced to Balanced Audio Converter Kit \$49.95
CR2XL Matching Case & Knob Set \$14.95
PWR25 12VAC Power Adapter \$9.95

AUTOMATIC COLOR/BW IR CAMERA



- ✓ Color during the day, IR B&W at night!
 - ✓ Automatically turns on IR illumination!
 - ✓ Waterproof to IP57 standards!
 - ✓ Black anodized housing with universal mount
- Best of both worlds! This video camera is a waterproof COLOR camera during the day. When the light level drops, it automatically changes to B&W and turns on its built-in IR illumination, with 10 IR LEDs. Powered by 12VDC and terminated with a professional BNC connector. B&W only model

also available if color is not needed. Both in heavy anodized black housing.

CCD309 Color/B&W IR Waterproof Bullet Camera \$169.95
CCD308 B&W IR Waterproof Bullet Camera \$109.95
AC125 110 VAC Power Adapter \$9.95

MINI B&W CAMERA WITH IR ILLUMINATION



- ✓ Built in IR illumination!
 - ✓ Sees in total darkness!
 - ✓ Black aluminum housing with swivel bracket
- What a deal! This miniature B&W video camera has 6 high power IR LEDs built into it to provide illumination in total darkness! No need for external IR illuminators. Attractive black aluminum housing easily mounts at any angle with the built-in swivel bracket. Runs on 12VDC, and includes professional BNC output plug-in harness.

CCD303 Mini B&W IR Illuminated Camera \$59.95
AC125 110 VAC Power Adapter \$9.95

Check out all our other new cameras at www.ramseykits.com!

PROFESSIONAL FM STEREO RADIO STATION



- ✓ Synthesized 88 to 108 MHz with no drift!
- ✓ Built-in mixer - 2 line inputs and one microphone input!
- ✓ High power module available for export use
- ✓ Low pass filter for great audio response

Our FM100 is used all over the world by serious hobbyists as well as churches, drive-in theaters, and schools. Frequency synthesized PLL assures drift-free operation with simple front panel frequency selection. Built-in audio mixer features LED bargraph meters to make setting audio a breeze. The kit includes metal case, whip antenna and built-in 110 volt AC power supply.

FM100 Super-Pro FM Stereo Radio Station Kit \$249.95
FM100WT 1 Watt, Wired Export Version \$399.95

SYNTHESIZED FM STEREO TRANSMITTER



- ✓ All new design & features for 2002!
 - ✓ Fully adjustable RF output
- Our #1 kit for years has just gotten better for 2002! Totally redesigned, the FM25B has all the features you've asked for. From variable RF output, F connector RF output jack, line input, loop output, and more. Includes case, power supply, whip antenna, audio cables.

FM25B Synthesized FM Stereo Transmitter Kit \$129.95

AND...OUR FAMOUS MINI-KITS



These are easy to build kits that can be used either stand-alone or as building blocks for more complex projects.

TS4	Tickle-Stick Shocker	\$9.95
BN9	Super Snoo Amplifier Kit	\$8.95
BL1	LED Blinky Kit	\$3.95
TD1	Tone Encoder/Decoder Kit	\$6.95
TT7	Touch Tone Decoder Kit	\$19.95
CPO3	Code Practice Oscillator Kit	\$9.95
UT5	Universal Timer Kit	\$8.95

THE RF CONNECTION
213 North Frederick Ave.
Suite 11NV
Gaithersburg, MD USA
20877

<http://www.therfc.com/>

Complete Selection of MIL-Spec Coax, RF Connectors and Relays

UG-21B/U N Male for RG-213/214.....\$5.00
UG-21D/U N Male for RG-213/214.....\$3.25

N Connectors for 9913/Flexi4XL/9096

UG-21B/9913.....\$6.00 Pins Only.....\$1.50
UG-21D/9913.....\$4.00 Extra Gasket......75

Amphenol 83-1SP-1050 PL-259.....\$0.90
UG-176/U Reducer RG-59/8X .25 or 5/\$1.00
UG-175/U Reducer RG-58/58A .25 or 5/\$1.00
Silver Teflon PL-259/Gold Pin.....\$1.00 or 10/\$9.00

MIL-Spec Coax Available (Teflon, PVC IIA)

New Product: Belden 9913F. 9913 with High Density PE Foam dielectric, stranded center cond. and Duobond III Jacket.....\$.80/ft or \$76.00/100ft

Also New: 9092, RG8X with Type II Jacket Intro Price.....\$23.00/100ft

Call for Specials of the Month

Full Line of Audio Connectors for Icom, Kenwood, and Yaesu

8 Pin Mike Female.....\$2.50
8 Pin Mike Male Panel.....\$2.50
13 Pin DIN for Kenwood.....\$2.75
8 Pin DIN for Icom.....\$1.00
8 Pin DIN for Kenwood.....\$1.50

Prices Do Not Include Shipping

Orders 800/783-2666
Info 301/840-5477
FAX 301/869-3680



RAMSEY ELECTRONICS, INC.

793 Canning Parkway
Victor, NY 14564
716-924-4560
sales@ramseykits.com



Order Today! 800-446-2295
www.ramseykits.com

Amateur Robotics

This month, as promised, I have compiled my list of robotics clubs in the United States and around the world. It is available for download on the *Nuts & Volts* website at www.nutsvolts.com. Thanks to reader Gerald Sorrels of Crestline, CA, I also have a complete schematic for the Camtronics three-axis chopper/stepper motor driver board used in my Heavy Iron CNC project. Gerald also generously contributed a schematic for a simple chopper board tester that allows you to test out the Camtronics board without a computer, which is pretty handy when you're troubleshooting your system and aren't sure whether it's the chopper board or the computer causing the trouble. I'll start with the club list.

The List Ate My Column

It's been since June 2000 that I last compiled this list, and a few of the groups on the list seem to have

disappeared or gone dormant. In the meantime, several new groups have sprouted up. In June 2000, I listed 28 groups in the US and nine groups in other countries. Subtracting the lost groups, the list of US groups has grown to 32, and the international groups held steady at nine. Then, as now, I list a few internet-only clubs, but there are scads of online robotics groups on the web, far too many for me keep track of (that's what Google.com is for).

As for the regular groups, I can make no claim that this list is complete or definitive. Shucks, I can't even guarantee that all of the links or contacts are up-to-date; robotics club websites and email addresses sprout and die like fairy ring mushrooms. I spent days trying to verify the info of just the more-established groups. If you spot any errors, or (gasp!) if your club is not listed here, drop me a line.

Chopper Board Wrinkles

Dan Mauch, the owner of

Camtronics, has been so busy selling — and improving — his popular three-axis chopper board kits that he hasn't got a current schematic of the board he now ships; all recent changes have been made directly to the PCB artwork and haven't yet propagated back to the schematic. The schematic shown in Figure 1 was laboriously traced out by Gerald Sorrels when he purchased his kit. I then drafted up Gerald's hand-drawn schematic using Claris CAD, and I rearranged things a bit in the process. Any errors you find in Figure 1 were probably introduced by me.

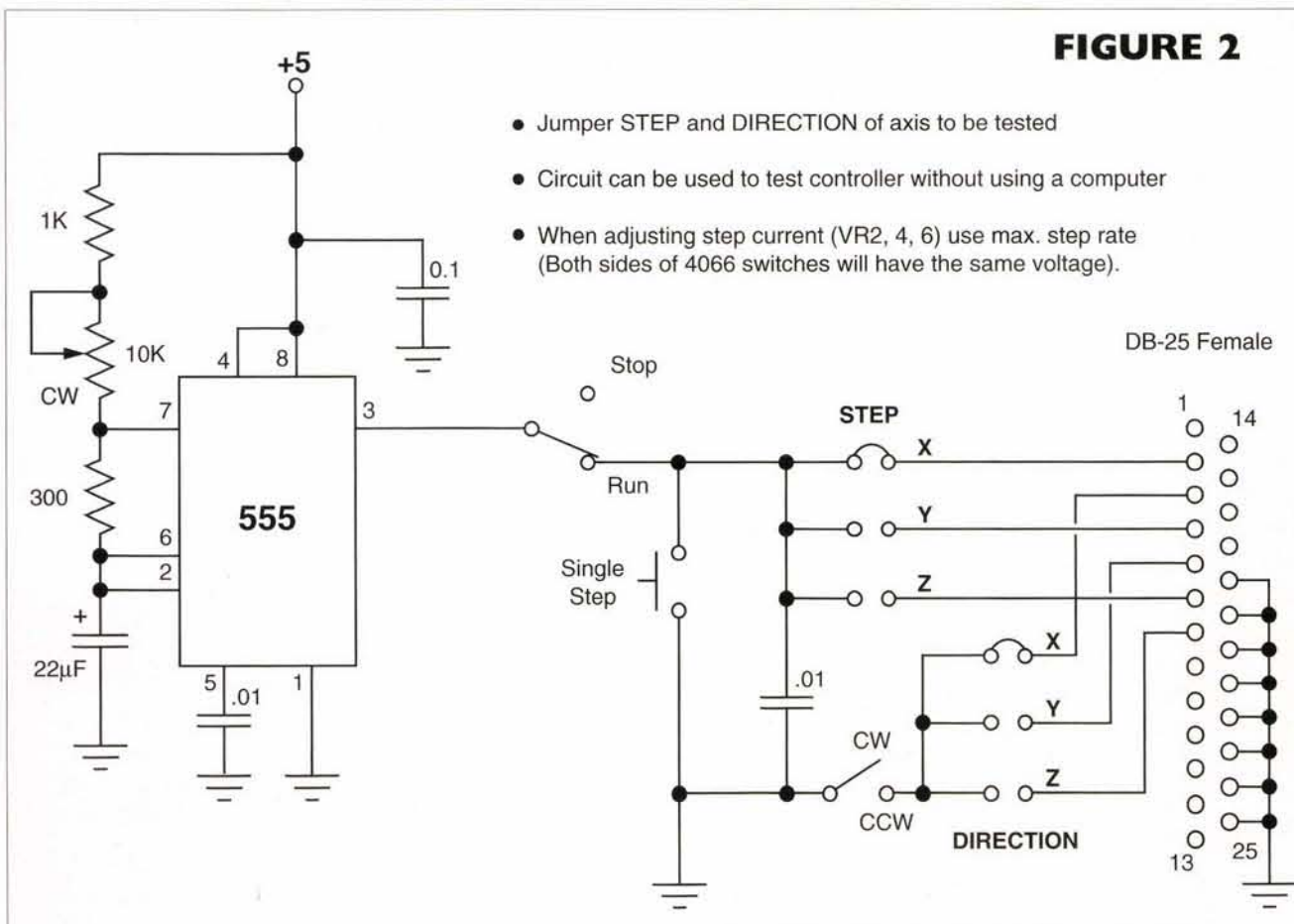
In fact, I've already found a few errors too close to deadline to fix (argh!), so I'll just give y'all a heads up. First, I neglected to include the pin 7 ground of U8 (it could happen to anybody).

More embarrassing is that the labels for the Z-step and Z-hold variable resistors got swapped with those for Y-step and Y-hold. The correct adjustment resistor labels are "VR4" for Z-step, "VR5" for Z-hold, "VR2" for Y-step, and "VR3" and for Y-hold.

Another correction, but this one comes about for a different reason. Last month, I gave the PDM chassis wiring diagram and wiring table. In both, I used "J14," "J15," and "J16," to designate the 15-pin X-, Y-, and Z-axis connectors that bring the phase drive and sense lines out to the chassis top panel. I numbered them this way because on my chopper board — which I got from Camtronics a year ago — the connector numbers stopped at J13.

Well, as I've said, Dan has kept on improving the board. My board is the revision from 4-30-2000, but in later boards, Dan added a J14 connector to make it much easier to add a fourth axis to a three-axis system. J14 — an eight-pin MTA connector — brings all the signals needed to interface to the Camtronics single-axis chopper

FIGURE 2



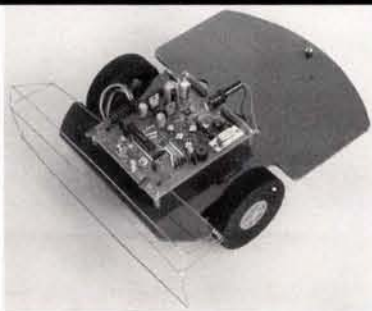
RobotStore
A to Z

RobotStore.com

800-374-5764

www.RobotStore.com

QUICK and PAINLESS Programmable Robotics!



- COMES PRE-ASSEMBLED
- PRICED LOWER THAN A KIT
- Re-Programmable from your PC
- Co-Processor for IR proximity vision, Bumpers, Servo Controller, A/D, and MORE
- Drive servos have Dual Ball Bearings for longer life!
- Lots of free I/O, CPU power, and space for your modifications
- Genuine top of the line Basic Stamp 2p40® processor from Parallax Inc. Great tools, manuals, and books available for training or project development.

JUST ADD 6 AA BATTERIES AND
GO!

Blue Bell Design Inc.

www.bluebelldesign.com

Circle #102 on the Reader Service Card.

Mobile Robotics

Used world wide for research!

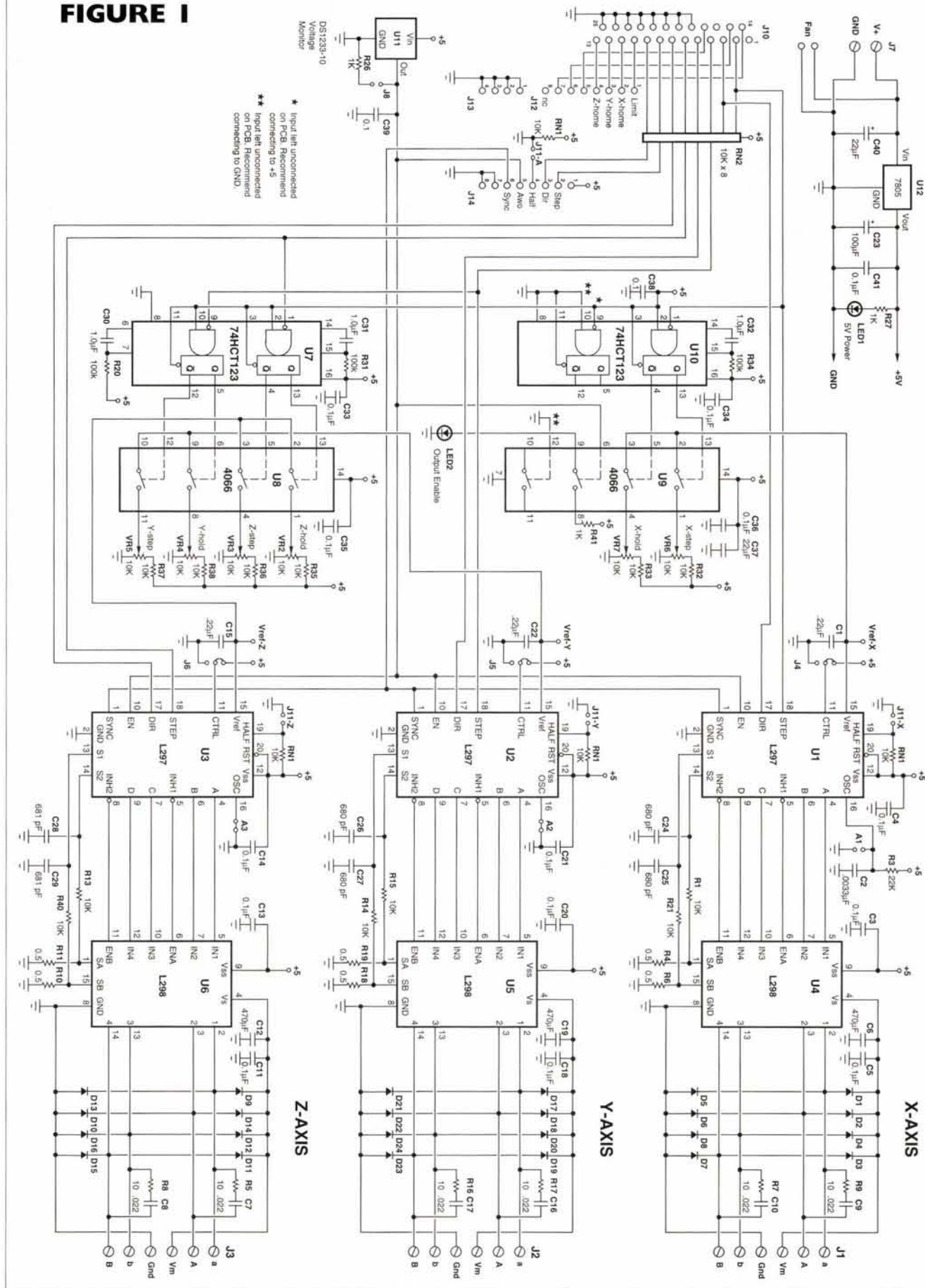


Mobile Robots
Micro Controllers
Artificial Intelligence
Sonar Units
Optics
Vision Systems



Zagros Robotics
PO Box 460342
St. Louis, MO 63146-7342
Phone (314)768-1328 Fax (314)576-5568
<http://www.zagrosrobotics.com>
info@zagrosrobotics.com

FIGURE 1





REFILL INKS FOR INKJET PRINTERS

Refill your old cartridge and save. All refill kits come with instructions and needed materials for refilling inkjet cartridges. Available for Canon, Epson, Hewlett Packard, Apple, Compaq, and Lexmark printers.

HARD-TO-GET PRINTER RIBBONS



Gorilla Banana, Commodore, Texas Instruments, Centronics, Riteman, Apple, Printronix, Star

Over 300 different ribbons in stock.
All ribbons new, not re-inked.

Check our web page or write for complete price list.

H.T. ORR Computer Supplies

249 Juanita Way, Placentia, CA 92870-2216

714-528-9822 • FAX 714-993-6216

Toll Free 1-800-377-2023

e-mail: Htorr@aol.com

<http://members.home.net/htorr/index.htm>



Circle #96 on the Reader Service Card.

PRIMECELL.COM

IF YOU NEED NEW BATTERIES FOR YOUR ELECTRONIC EQUIPMENT
DON'T PITCH EM - SEND THEM FOR REBUILDING! - SAVE \$ \$

- WE INSTALL NEW NI-CAD OR NI-MH BATTERIES INTO YOUR CASE.
- WE IMPROVE PERFORMANCE TO BETTER THAN ORIGINAL.
- WE FIX WHAT CAN'T BE FOUND. (OR AFFORDED)
- WE PROVIDE QUICK SERVICE. / EXTEND LIFE OF OLDER EQUIPMENT
- WE OFFER FREE QUOTES. / FREE RETURN IF QUOTE IS REFUSED.
- WE PROPERLY DISPOSE OF YOUR OLD CELLS BY RECYCLING.
- WE GIVE YOU A 12 MONTH WARRANTY.
- WE WILL BE HERE WHEN YOU NEED US / EST. 1986
- WE SAVE YOU **** MONEY **** \$ \$ \$ \$



WE SERVICE RECHARGEABLE BATTERY ASSEMBLIES FOR ALL TYPES OF ELECTRONICS.
RADIOS, SCANNERS, CORDLESS TOOLS, BAR CODE READERS, GPS, SCIENTIFIC, SURVEILLANCE

GENERAL ELECTRIC	UNIDEN	RADIO SHACK
MPD PLS MPA 4850P \$ 34.50	APX650 1050 1105 \$ 32.50	HTX 202/404 \$ 22.50
MPD PLS MPA 4860P \$ 39.50	1010 1070 1100 \$ 32.50	NEW NiMH HTX pack
MPR MPS MPX 763/777 \$ 39.50	1120 1200 Series \$ 32.50	8.4V 1650mAh \$ 39.60
MONOGRAM 4506P/1/3 \$ 37.50	BP2500 650mAh \$ 19.50	KENWOOD
MAXON SA-1155 1160 \$ 39.95	BP205 1600mAh \$ 22.50	PB2/6/33/34 \$ 28.60
MOTOROLA	ICOM	PB7/8/9/13/14/18 \$ 34.60
MX300 HT600 MT1000 STX	BP2 / BP3 / BP22 \$ 19.60	KNB6/7/12/14/16 \$ 34.60
NTN 4585 4824 5414 \$ 37.50	BP6 / BP23 / 24 \$ 27.50	PB10/25/26/32 \$ 24.60
NTN 5447 5521 5545 \$ 37.50	BP7 / CM7/ BP8 \$ 34.60	CORDLESS DRILLS
NLN 5860 NTN 4327 \$ 39.50	BP157/174/180 \$ 34.60	50% MORE CAPACITY.
	CM140/141/166 \$ 41.60	Any brand 7.2V \$ 21.60
MIDLAND	YAESU	Any brand 9.6V \$ 29.60
70-B10 B16 B19 B21 \$ 39.95	FNB 3 4 12 14 16 \$ 32.95	Any brand 12.0V \$ 36.60
B25 B26 B32 B36 B60 \$ 39.95	FNB19 21 26 27 38 \$ 32.95	Any brand 14.4V \$ 39.60
	FNB 10 1117 25 36 \$ 23.95	Any brand 18.0V \$ 44.60

See our web pages about rebuilding battery packs used for Land Surveying.

BATTERY REBUILD SERVICE

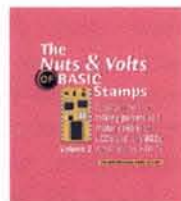
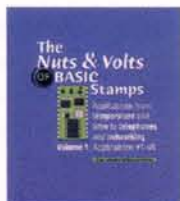
FOR INFORMATION ABOUT YOUR REQUIREMENTS ... CONTACT US:
USE THE EASY INFO. REQUEST PAGE AT <http://www.primecell.com>
PHONE OR FAX: (814) 623-7000 E-MAIL TO: sales@primecell.com
SEND PACKS FOR FREE QUOTATION BY: UPS, FEDEX, OR US MAIL

CUNARD ASSOCIATES INC., 9343 US RT 220, Bedford, PA 15522

Circle #101 on the Reader Service Card.

The Nuts & Volts of BASIC Stamps Volumes 1 & 2

"... is as much of a BASIC Stamp reference book as it is an application idea guide ..."



Order Both Volumes For \$49.95!

\$29.95 each

Call our orderline at 1 800 783-4624
Or order online from the Nuts & Volts Bookstore

www.nutsvolts.com

The Standard for checking Capacitors in-circuit



Good enough to be the choice of Panasonic, Pioneer, NBC, ABC, Ford, JVC, NASA and thousands of independent service technicians.

Inexpensive enough to pay for itself in just one day's repairs. At \$179, it's affordable.

And with a 60 day trial period, satisfaction guaranteed or money-back policy, the only thing you can lose is all the time you're currently spending on trying to repair all those dogs you've given up on.

CapAnalyzer 88A

Available at your distributor, or call 561-487-6103

Electronic Design Specialists

Locate shorted or leaky components or conditions to the exact spot in-circuit

Still cutting up the pcb, and unsoldering every part trying to guess at where the short is?

\$179



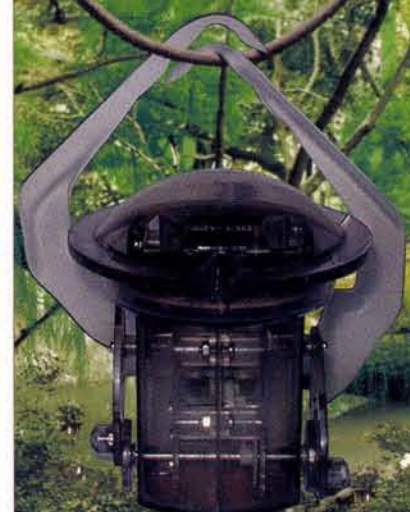
Your DVM shows the same shorted reading all along the pcb trace. LeakSeeker 82B has the resolution to find the defective component. Touch pads along the trace, and LeakSeeker beeps highest in pitch at the defect's pad. Now you can locate a shorted part only a quarter of an inch away from a good part. Short can be from 0 to 150 ohms

LeakSeeker 82B

www.eds-inc.com

Circle #100 on the Reader Service Card.

JUNGLE Robot Kit



New!
Educational! Fun!

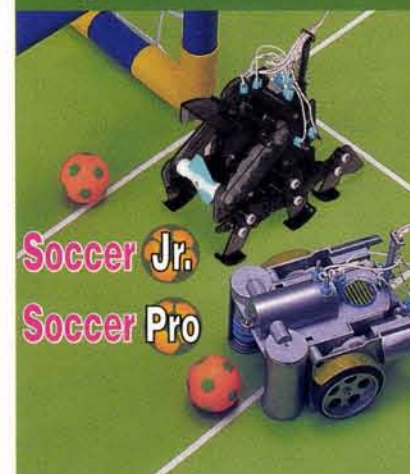
Beginner Level. Complete instructions. No special tools needed. Terrific Value Price:

only \$19.95

Visit our web site - see our fantastic line-up of exciting & state-of-the-art robot kits.

New, Improved Soccer Robot Kits!

Both models surpass last year's Awards Winning Model. Fun to build! Beginner Level. Complete and clear instructions. Order your Soccer Robots online & get 'em fast! Safe & Secure



Both catch, carry, sprint & shoot a ball for goals. Fast action, game of skill & finesse! Play against time or challenge opponents. Jr. runs on 6 legs - Pro has speedy wheels.

only **\$44.95** each
ROBOTIKITS®
DIRECT

17141-B Kingsview Ave. Carson, CA 90746 USA
Toll Free: (877) 515-6651 • Fax: (310) 515-0927
E-Mail: robotikitsdirect@pacbell.net
Visit our website: robotikitsdirect.com

Circle #99 on the Reader Service Card. 61

Electronics Q&A

With TJ Byers

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

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

You can reach me at: TJBYERS@aol.com or by snail mail at Nuts & Volts Magazine, 430 Princeland Ct., Corona, CA 92879.

Backster Effect

Q. I've been looking for a simple circuit to detect electrical changes in plant leaves, specifically the Backster effect. While the original work was done with a conventional lie detector, my idea is to use an amplifier that would output to an oscilloscope. The input would be from two electrodes with low conductivity paste on them. Do you have any ideas on the subject?

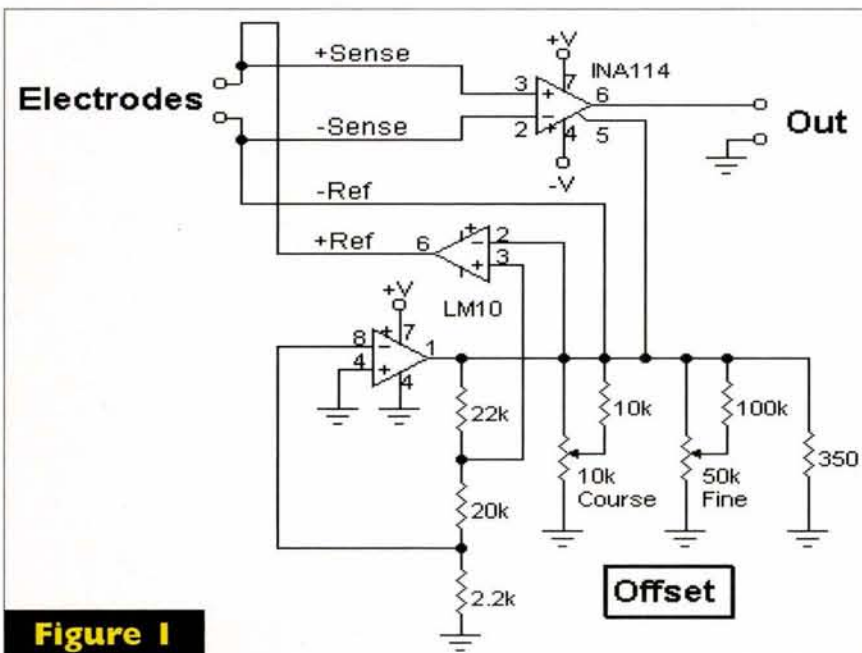
**Gary C. Grinnell
Townshend, VT**

A. Clive Backster is credited with the "discovery" of what he calls "Primary Perception" and others call "The Backster Effect." His research journey started with the 1966 almost accidental rediscovery that plants respond to the spontaneous emotions and strongly expressed intentions of humans. Using an instrument to measure galvanic skin responses (GSR, a part of his polygraph), Backster attempted to determine if it would measure the moment of

rehydration of a plant whose roots were freshly watered. It did not. To his surprise, though, the GSR meter registered his threat to burn the plant leaf when he spontaneously thought of the idea.

Most lie detectors use a Wheatstone bridge to measure changes in skin resistance. Unfortunately, the instrument is prone to drift and needs frequent recalibration. So much so, in fact, that NASA has replaced a good portion of their Wheatstone bridge instruments with a more stable current loop circuit. Pioneered by Karl F. Anderson, the current loop has a lower noise level than data from comparable Wheatstone bridge circuitry, and is unaffected by lead resistance. See Figure 1.

The unique part of this design is the four-terminal measuring system. A constant current, maintained by the LM10 current reference IC is passed through the sense resistor (electrodes), which generates a voltage proportional to the resistance. This voltage is measured by a high-impedance



What's Up:

Do plants show fear? Discover for yourself using a Backster monitor. A collection of circuits: busy phone, five-amp current regulator, FM transmitter, and dynamic microphone preamp. Finally, all about voltage clamps and the atomic clock.

op-amp via the sense leads. Because the input impedance of the amp is substantially higher than the sense resistor, no appreciable voltage is lost through the sense leads. The 350-ohm reference resistor develops an offset voltage, which is subtracted from the output voltage to center the output at zero when the sense resistor is at equilibrium. This output can be input to any voltage measuring device, such as a DVM or oscilloscope.

Busy Phone Indicator

Q. I am looking for a telephone line indicator circuit where an LED can be connected to any telephone line to indicate when the line is ringing and when the phone is off-hook, similar to those used on most multi-line telephones.

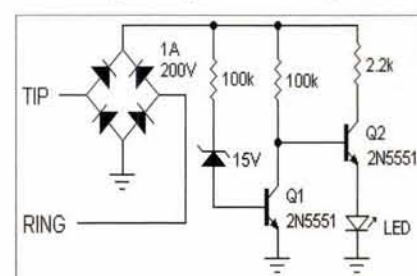
**L. Somers
via Internet**

Q. I'm looking for a simple circuit that will light an LED at one phone jack while another phone or modem is in use (like when my wife is on the computer in another room). I've built testers that will indicate an active line active when the phone is on-hook (just an LED and current limiting resistor), but I'm not sure how to sense and display an off-hook voltage. Maybe some kind of logic gate?

**Quinn Michael
via Internet**

A. There are several circuits that can do what you ask, but most use a separate power supply. I kinda prefer tapping into the telephone company's power which is more stable and reliable than a wall-wart or battery. After

some thought, I came up with the following design. The bridge recti-



fier isn't really used for rectification; its primary purpose is to prevent reverse polarity when plugging into a phone outlet. Most phone lines measure 48 volts on-hook and 10 volts off-hook (although this will vary by the provider and the distance to the central station). Using those parameters, when the phone is on-hook, the line voltage exceeds the breakover voltage of the 15-volt zener, which causes Q1 to turn on and short out the base voltage to Q2, turning it off.

Put A Clamp On It

Q. Could you give a description and capabilities of clamp circuits? I have searched several electronics books and magazines, but it seems to be a topic that's only covered in vacuum tube books, nothing related to solid-state. Specifically, what frequencies can be clamped? Can video and audio frequency signals be clamped to a near zero level that fluctuate as much as five volts above zero reference?

**Larry Keller
via Internet**

A. To begin with, a clamp refers only to voltage not frequency, which means it works with everything from DC up to the highest radio frequencies. Basically, it's a circuit which

places a lid on how high a voltage can go. For example, a one-volt clamp will limit an input voltage to one volt output, no matter how far beyond one volt the input signal may stray. Below one volt, the input signal assumes its normal value and is unaffected by the clamp.

Where are clamps used? In any application that requires a limit on voltage excursions — like voltage regulators, for example. Traditional power supply regulators work on the principle of reducing a higher voltage to a lower voltage using a voltage clamp. A simple zener diode, shown in Figure 2(a) in the drawing below, is a perfect example of a voltage clamp. In fact, any diode can be used for a voltage clamp (b) by stacking them to take advantage of their forward voltage conduction. If two diodes are placed back to back, a sine wave can be converted into a square wave (c) and (d). Note that the ratio between the peak input voltage and the clamp voltage determines the rise and fall times, i.e., the larger the ratio, the faster the rise and fall times.

Voltage clamps are also used for audio and video signal conditioning, especially in the broadcast industry. It's no secret that TV commercials are always louder than the program. That's

because they pack more audio power into the signal by clipping the announcer's voice voltage peaks using a voltage clamp (e), resulting in a gain of almost 15dB more sound than without the clipping. The video signal also uses clamps, this time to block portions of the video during horizontal and vertical retrace, and for editing video tapes. Last but not least, clamps are used everyday for surge and over-voltage protection (MOVs and the like). Bottom line: Anytime you need to put a lid on a voltage, use a clamp.

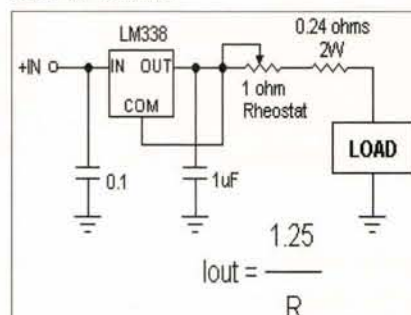
High-Power Constant-Current Source

Q. Do you have a schematic for an adjustable constant-current power supply? I need about three to five amps at around 24 volts DC for a plastic foam cutting wire. My present cutter doesn't control the current, which causes temperature shifts that often lead to burned-out wires.

Jim Halbert
via Internet

A. I'm not sure a constant-current source will cure all your temperature control problems, but it may go a long way toward making the cutting wire last longer. A constant-current

regulator can be made using nothing more than a transistor, zener diode, and a couple of resistors. Personally, I prefer using an integrated voltage regulator, like the LM338. With proper heatsinking, this regulator will easily handle up to five amps of regulated current using the configurations shown below.



The rheostat is a high-power variable resistor that you can buy from Mouser Electronics (800-346-6873; www.mouser.com). The 0.24-ohm resistor limits the output current to five amps. The input voltage can be any source up to 30 volts DC. And that's it — except for the 0.1 and 1 µF caps, which must be placed as close to the LM338 as possible. For those readers who would like to have a constant-current source with lesser currents, you can substitute any LM78xx or LM3xx series regulator, and adjust the series resistor, R, accordingly. For example, 100 mA = 1.25/R = 12.5 ohms.

Crystal-Controlled FM Transmitter

Q. I have a small part-time greenhouse business with eight, heated greenhouses. I haven't had a heat failure yet, but I worry about it. I plan on putting

a HT680 encoded transmitter in each greenhouse with an old thermostat to monitor the temperature and activate the transmitter if the temperature falls too low. In my house, there would be an AM or FM radio that would monitor the transmitters and alert me as to which greenhouse was transmitting. I have found plans for the radio decoder circuit, but cannot find a diagram for a transmitter and encoder. What I need is a crystal-controlled transmitter circuit with a range of about 300 feet.

Richard Stimpson
Freeland, MI

A. This is a simple request that can be filled by almost any wireless microphone circuit — except for the crystal-control part. Here's one of those circuits that has been modified to accept a crystal. The circuit is using the third harmonic of the crystal to generate a 99-MHz RF output. This frequency falls between the assigned FM band frequencies of 89.9 and 99.1, so there should be no interference from a local transmitter. If there is a strong local station near that frequency, you can pull the center frequency off slightly by adjusting the variable capacitor.

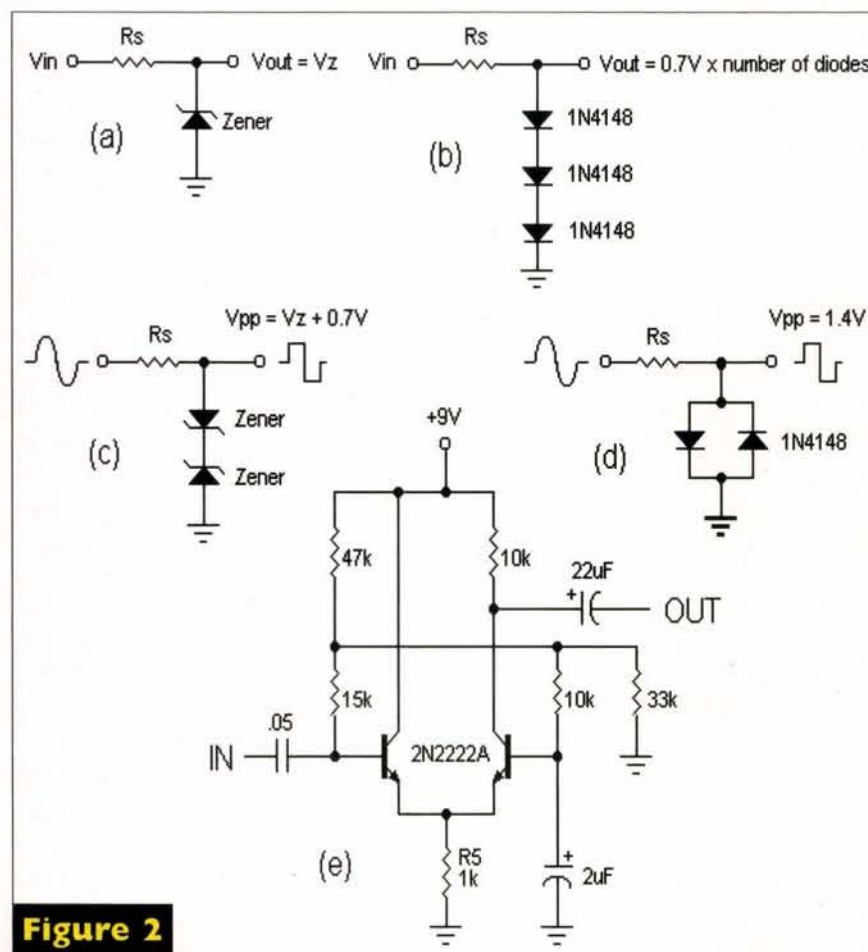
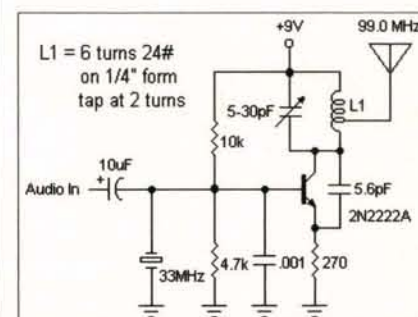


Figure 2

Cool Web Sites!

AdSubtract SE

This free utility prevents Web ads from appearing and selectively blocks cookies. The program works with Internet Explorer, Netscape Navigator, and America Online. This version displays a verification dialog box before cookies are blocked, allowing you to choose the cookies that you want to keep. Two paid versions (CE and Pro) offer advanced cookie management and give you the ability to block animations, Java and JavaScript applets, and pop-up windows.

<http://www.adsubtract.com>

Calculators for electronic formulas. Great for class work or just calculating the values for that tank circuit you're designing.

http://www.citlink.net/~bhamre/A_Electron/Electronic_Calc.htm

Conversion tables for area, length, power, weight, and more.

<http://adamite.igs.indiana.edu/indgeol/reference/conversions.htm#A>

The tuning coil, L1, is an open-air coil made by winding six turns of 24 AWG magnet wire (enamel covered copper wire) around a wooden pencil; the tap is taken at the second turn (turn 2). Parts layout is fairly critical, which means the tuning cap should be as close to the coil as possible, and it would be best if you created a printed circuit board if you plan on doing them in the quantity you describe. Ideal antenna length is six to nine inches; use nothing over 12 inches to comply with FCC rules. If you need more range, up the battery voltage from nine volts to 12 volts.

Low-Impedance Mike Preamp

Q • I have Technics RP3330 cardioid dynamic microphone rated at 400 ohms. I am trying to plug it into a Technics RS-T9023 cassette recorder which requires 60 mV or better. I bought a QK98 preamplifier kit from www.qkits.com, but it only provides 23dB of gain, which is insufficient. Even two of them in series isn't enough. I am fairly certain that I built them correctly, because it works with my Dean Markley magnetic guitar pickup. I would prefer to buy off-the-shelf, but I am not against kit building or circuit breadboards. Do you have any suggestions?

Greg Lehmann
via Internet

A • I think your problem is with impedance matching of the amplifier, and not its gain. If

I interpret the QK98 design correctly, it uses a high-impedance input with a DC feedback transistor pair, which isn't optimum for a low-impedance dynamic microphone — a transducer that's normally interfaced via a 600-ohm matching transformer. I know you wanted to buy off-the-shelf or a DIY kit, but I can't seem to find one that I'd consider in your price range. Instead, I modified a circuit that I found from Elliott Sound Products at www.sound.au.com (sorry, they don't provide a kit at this time). See Figure 3.

The impedance matching is correct for a 600-ohm input. The gain can be varied from zero up to 40 (32dB), with an output of over one volt peak-to-peak using a dynamic microphone. The use of metal film resistors is a must to get the best possible noise performance, and the capacitors should be quality aluminum electrolytic, not tantalum. The design requires a regulated voltage of 15 volts.

Auto Audio Amps

Q • I would like to monitor the current flow through my car power amp, which draws in the range of 30 to 60 amps. A DC clamp meter would be ideal because I wouldn't have to break the power lead to insert an ammeter. However, I cannot find any information on AC/DC clamp meters and how they operate. I was wondering if a PIC or similar circuit could be built to remotely monitor the current?

Qui Nguyen
via Internet

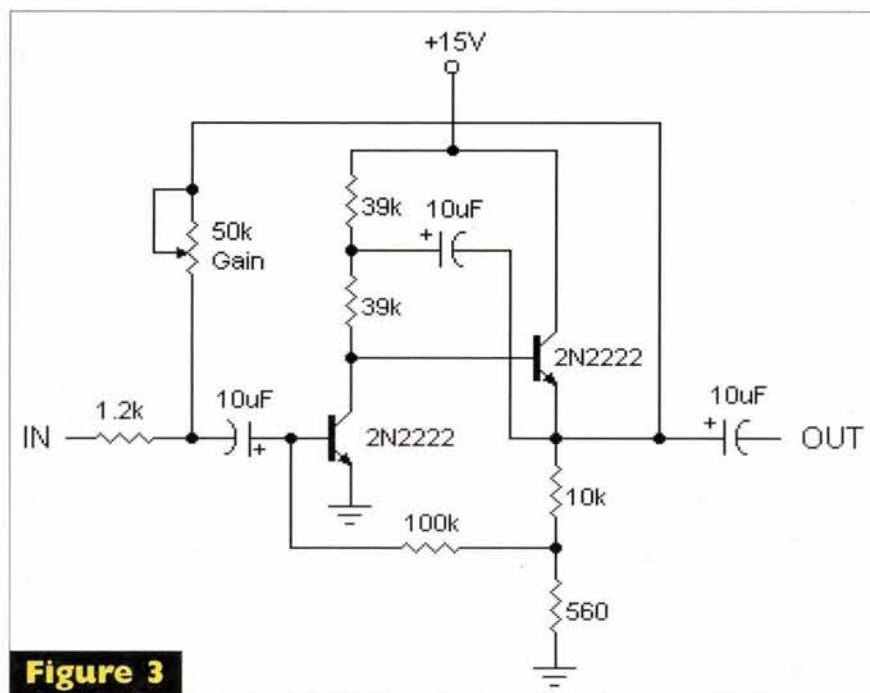


Figure 3

A • I suppose you could monitor the current with a PIC, but why when it can easily be done using a variety of automotive ammeters found at any auto parts store? Basically, there are three types of ammeters for car use. The most common is a series ammeter which has an internal shunt. To install it, you need to break the power wire and insert the meter, which is what you want to avoid. The second type of ammeter uses an external shunt, typically of the 50 millivolt variety. Again, the circuit has to be broken and the shunt inserted. The advantage is that you can place the shunt inside the dash and run a smaller wire to the meter itself. The third meter is called an inductive ammeter. With this meter, the circuit doesn't have to be broken. The power wire is physically clamped to the back of the meter, where the magnetic field created by the current flow deflects the needle.

Still want to use a DC clamp-on ammeter? Get your checkbook ready, because they don't come cheap. Almost all use a linear Hall-Effect sensor that generates a voltage that's proportional to the magnetic field created by the current flow. This voltage is amplified, scaled, and usually displayed on a digital readout. Check out Fluke's web site at www.fluke.com for more information and video demos.

Can Dead Gel-Cell Batteries Be Revived?

Q • My question is about the sealed lead-acid batteries that are in all the UPS systems and other devices. I had a dead unit that wouldn't accept a charge. With nothing to lose, I opened it by popping off the external caps (most had a small amount of pressure on them), put a few drops of water in each cell, and recharged the battery. It seems to work, but I'm not sure it's the right thing to do. Can a person do anything to salvage these units or should they just be properly destroyed?

Gary Regez
Mundelein, IL

A • Many of us have spent small fortunes on gel-cell batteries, because of their advertised advantages. We have also

had them die in a short period of time. That's because gel-cells are highly susceptible to damage from two common factors: ambient temperature and the charge rate.

When the temperature of the battery goes up, gassing occurs and the plate structure begins to degrade. Elevated temperatures within the battery can result from either internal heat from overcharging, or from ambient temperatures.

In contrast to wet-cell batteries (the kind used for automobiles), gel-cell batteries are manufactured using a silica gel and acid electrolyte mixture that surrounds the plates. The charge rate of gel-cell batteries is critical, because overcharging can cause the electrolyte to gas off, and it can also elevate the battery's internal temperature. As the charge current and/or temperature increases, voids develop between the gel matrix and plate to allow for the passage of gasses. This renders that area of the cell inert, which reduces the capacity of the gel battery.

In fact, a charge rate in excess of 2.4 volts per cell can destroy a gel battery in hours. The battery chemistry is most stable between the temperatures of 60 and 77 degrees. For every 18 degrees above 75, the life of the battery is cut in half.

Can a gel-cell battery that won't take a charge be resurrected? Maybe. If a battery is completely discharged, all of the reactive materials are converted and it may very difficult to reverse the chemical reaction. However, some batteries are designed with a plate size imbalance and/or catalyst to help control gas generation and aid in deep cycle recharging. While the battery will never fully recover, it might come back as much as 80 percent.

First, remove all the charge from the battery using a medium load, like a car headlight. If necessary, get rid of the last remaining charge by shorting the battery terminals with a heavy wire for a few hours. Don't let the battery sit for long after it's totally drained, or sulfating will begin. Now, recharge the battery using a "smart" battery charger, one that monitors the charging current and/or time and adjusts it accordingly.

Now as for your "rejuvenat-

ing" method, the valve-regulated gel battery is the most common type. These types of sealed batteries have a spring-controlled valve that vents gasses at high temperatures and charging rates. Since electrolyte levels are preserved by trapping and recombining off-gasses, there should not be any need to add distilled water over the life of the battery. In fact, electrolyte levels cannot, and should not, be maintained. It appears that the water you added has filled some of the voids and provided a path for charging current. You might try replacing the pressure valves and use the recovery method outlined above, but I wouldn't hold out much hope for a long battery life.

Zero Crossing Aids More Than RFI Suppression

Q. My question is in regards to the "SCR Principles and Circuits" article by Ray Marston in the Jan. 2002 issue (page 22). The author does a great job of explaining the subject, but I would like to see the circuitry required to provide the phase delay switching shown in Figure 15. I have experimented with this using both back-to-back SCRs, as well as triacs to obtain outputs of the full (both halves) AC waveform, but can never seem to get any circuits to perform as close to the ends as the drawing shows. It would also be desirable to use an optoisolator in the design.

Don Pomeroy
via Internet

A. The problem with low-angle triggering of SCRs and triacs is the extremely low voltages at the far ends of the sinewave. The solution is to detect when the waveform crosses the zero voltage line, from which you can accurately set a fixed delay

for triggering of the SCR or triac.

In Figure 4, the transistor generates a pulse with each zero crossing of the sinewave. This pulse triggers the 555 monostable (time-delay) multivibrator, which fires the triac when the timer has expired. The blocking diode between the collector of the transistor and the center tap of the transformer guarantees that the transistor's base circuit will see the crossing voltage. Once beyond the diode, the 100uF capacitor filters the rectified DC and provides the voltage needed to power the 555 timer and optoisolator. Not only does zero-crossing triggering eliminate RFI, it lets you more accurately time the AC power duty cycle.

Accessing The Game Port From Visual Basic

Q. Can you point me to any resource explaining how to access a game port from a Visual Basic program (read the potentiometers and buttons)? I've got several books on VB, and they don't address this point.

Steve Roberts
via Internet

A. The easiest way for Visual Basic programmers to access the joystick port is to use the calls of "joyGetPosEx" and "joyGetDevCaps" (remove the quotes) in winmm.dll. In modern games, joysticks are read using the DirectInput part of DirectX gaming API. By working directly with device drivers, DirectInput bypasses the Windows messaging system. Check out "May The Force Feedback Be With You: Grappling with DirectX and DirectInput" at www.microsoft.com/msj/defaultframe.asp?page=/msj/0298/force.htm&nav=/msj/0298/newnav.htm for details.

Time Around The World

Q. I have a radio-controlled atomic clock that I purchased in Germany, but the clock will not keep time here. Is there a difference between the atomic time frequency in Europe than it is the US? If so, is it possible to maybe change the frequency (a crystal?) to convert it for US use?

Ray Samples
via Internet

A. The frequencies are indeed different. In the US, the frequency is 60 kHz, with its transmitter located at Boulder, CO. In Germany the frequency is 77.5 kHz, with its towers located 10 miles outside of Frankfurt. In addition, there's a third atomic clock transmitter located in Allouis, France that transmits on 162 kHz. Even if you could alter the receiver to match the local clock transmitter frequency — which is very doubtful — the time formats are different. In other words, your German clock wouldn't understand a word the US transmitter is saying.

By the way, are you aware that you can access the atomic clock via the Internet? The address is <http://nist.time.gov/>. Moreover, you can have the atomic clock set your PC clock automatically. All you need is the file NISTIME-32.EXE, which you can download from our web site (www.nutsvolts.com). You can have the Internet update your PC clock on a on-demand or at scheduled periods, you choose.

MAILBAG

Dear TJ:

Michael Kiley wrote about auto-transformer attenuators for 70-volt speakers. **Full Compass Systems** (800-356-5844; www.fullcompass.com), from looking at their web site, is primarily a supplier for pro-audio and music customers. Another source for these level controls is **MCM Electronics** (800-543-4330; www.mcmelectronics.com), stock numbers 555-2022, 555-2023, and 555-2029. They come in different finishes, are rated at 25 watts RMS, and sell for just under \$17.00.

Your reply to Will Smith about theremins didn't mention another source for them, **PAIA**

Electronics (405-340-6300; <http://paia.com>). Their ad on page 43 shows theremins at half the price of the kits from Theremin World.

Bill Stiles
via Internet

Dear TJ:

I have a concern regarding your response to Curt Powell regarding GSM/TDMA/CDMA phones. You state: "The band is divided into 395 voice channels, with a bandwidth of 30 kHz ... Between eight and 10 phone calls can be carried per channel using." I'm afraid this only applies to AMPS (Advanced Mobile Phone Service) and TDMA. (Normally the term "channel" in CDMA refers to the pilot, paging, sync, or traffic channels. However, for purposes of our discussion, I will use "channel" to be indicative of frequency.) A CDMA "channel" is 1.25 MHz-1.23 MHz, plus 10 kHz on each side that act as guard bands — and can theoretically carry up to 64 conversations — the number of available Walsh codes. In actual practice, this number ranges from 30 to 40, give or take, based upon the current noise floor. (A much more efficient use of spectrum, compared to AMPS or TDMA, I might add.) Perhaps this is a little too much information for his question. The only real correction is the bandwidth of a CDMA "channel."

Since Mr. Powell is shopping for providers, it should also be noted that CDMA uses rake receivers and employs "soft-hand-offs," both of which are unavailable with TDMA. In other words, the phone should drop calls much less often than one employing TDMA.

(PS: No, I don't work for Sprint or Qualcomm. I've simply studied both technologies in my spare time, and I suppose I've become biased toward CDMA.)

Brian Hill
via Internet

Check out the **NV Bookstore** on page 83. Our new expanded listing has something for just about everyone. If you don't find what you need here, check our website at www.nutsvolts.com

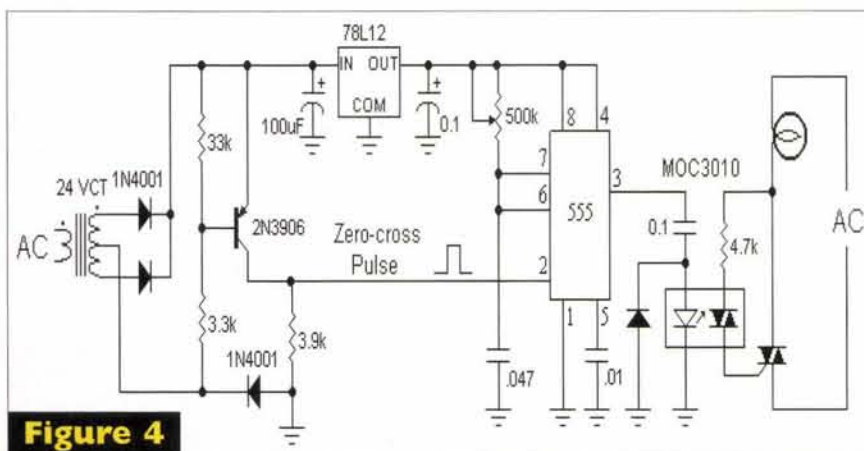


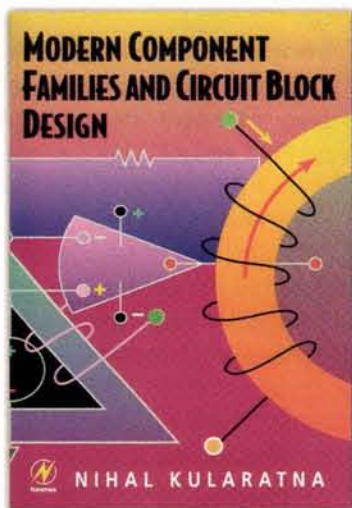
Figure 4

New Books

Modern Component Families and Circuit Block Design

by Nihal Kularatna

\$54.99



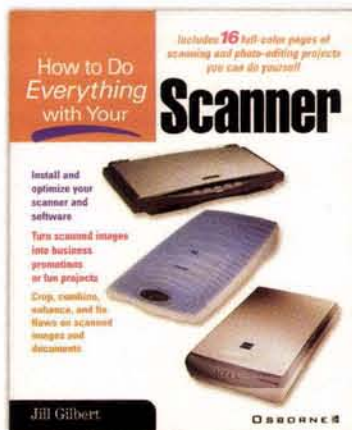
With rapid advancements in electronics and integrated circuits, it is very important to utilize the design approaches and details previously found only scattered in a vast array of application notes, engineering bulletins, and data books. *Modern Component Families and Circuit Block Design* gathers and summarizes this material in a single volume, and also provides a designer's viewpoint on modern components.

This book provides a practical approach to design problems rather than a generic analysis of broad engineering issues.

How to Do Everything with Your Scanner

by Jill Gilbert

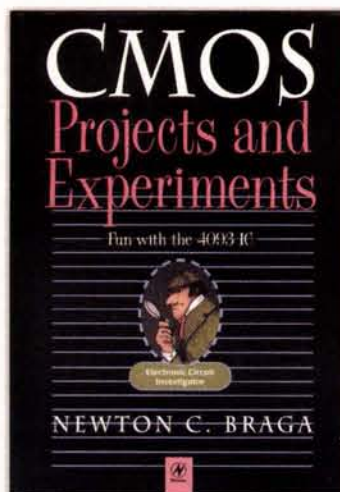
\$24.99



Contains projects, resources, ideas, and simple instructions to help you get the most from your scanner for home or business use.

Learn to use all your scanner's features, as well as professional-caliber image-editing tools that enable you to do everything from colorizing black-and-white photos to switching heads, bodies, and backgrounds. Explore graphic

concepts including color correction, resolution, and image optimizing — plus scanner repair, troubleshooting, and more. Let this great resource show you how to enhance and preserve your family memories, and create state-of-the-art, professional images — all with your scanner.



CMOS Projects and Experiments: Fun with the 4093 Integrated Circuit

by Newton Braga

\$34.99

CMOS *Projects and Experiments* includes instructions to build over 100 unusual and useful projects. They include audio and RF devices, lamps, LEDs, timers, alarms, inverters, and much more. This book offers

hobbyists and students a satisfying, practical way of learning about a hot topic in electronics today.

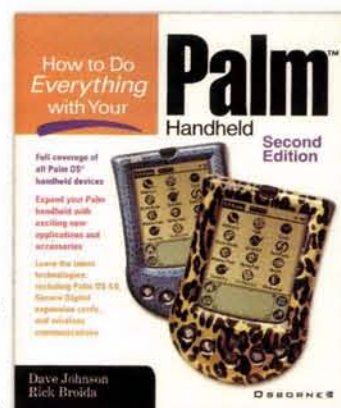
Among the devices you can build using this book are a touch-controlled oscillator, a light-controlled oscillator, insect repellent, a metronome, a Morse code tone generator, a CW transmitter, a two-tone siren, a neon-lamp flasher, an auto turn-off relay, a turn-off timer, a touch-controlled motor, a bistable sonic relay, a coin tosser, a freezer alarm, an ultraviolet lamp, a simple fluorescent lamp inverter, a nerve stimulator, and an experimental high-voltage generator.

How to Do Everything with Your Palm Handheld 2nd Edition

by Dave Johnson and Rick Broida

\$24.95

This book will help you master all the powerful features of your Palm handheld. Learn about new software and accessories, connect to the Internet, play games, manage your contacts and calendar, and much more — all in a easy to follow format. You'll get step-by-step instructions for preparing your Palm for business trips, beaming information to other handhelds, and even troubleshooting common problems. Learn absolutely everything about your Palm handheld by reading the newest edition of the book many say should replace the manual.

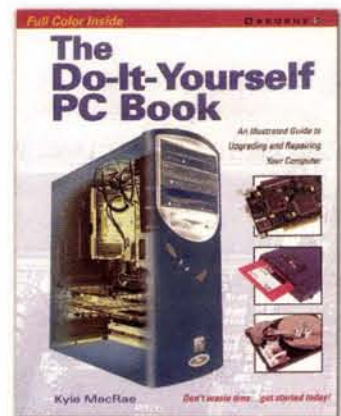


The Do-It-Yourself PC Book: An Illustrated Guide to Upgrading and Repairing Your PC

by Kyle MacRae

\$24.99

This highly illustrated full-color guide is the easiest way to master the art of upgrading, maintaining, and repairing your PC. Written with humor and simplicity, *The Do-It-Yourself PC Book* demystifies and explains the inner workings of your computer and makes it easy for anyone to give their old machine a boost or keep their new one in perfect working order. Each chapter features clear explanations and step-by-step instructions while the accompanying full-color photographs show you every procedure and component. You get all the essential facts quickly and painlessly in special "techie-corner" and "trouble-shooter" features.



These new titles can be ordered from the Nuts & Volts Bookstore. Call 1-800-783-4624 or visit our web site at www.nutsvolts.com

Triac Principles and Circuits — Part 2

By Ray Marston

Ray Marston concludes his description of triac principles and circuits in the final episode of this two-part mini-series.

Last month's opening episode of this two-part feature explained triac basics, looked at various practical triac power switching circuits, introduced optocoupled triacs, and explained basic synchronous 'zero-voltage' power switching principles. That episode concluded by pointing out that the simplest way of making a really efficient synchronous 'zero-voltage' triac-driving circuit is with the aid of a special-purpose IC that functions as an optocoupled low-power synchronous 'zero-voltage' triac that can easily be used as a slave for synchronously driving a normal high-power triac. This month's concluding episode gives practical details of such circuits, together with other triac-related circuits and information.

Optocoupled synchronous power switching

Synchronous 'zero-voltage' triac-driving circuits are widely used in modern electric heating and filament-lamp lighting control systems. Until fairly recently, several companies produced special synchronous 'zero-voltage' triac-gating ICs for use in such applications; the best known of these ICs were the CA3059 (from RCA) and the TDA1024 (from Signetics), which each had built-in AC-derived DC power supply circuitry, a zero-crossing detector, triac gate drive circuitry, and a high-gain differential ampli-

er/gating network.

In the mid-1990s, however, all of these ICs were made obsolete by the introduction of a new and modestly-priced type of IC that functions as an optocoupled low-power synchronous 'zero-voltage' triac that can easily be used as a slave for synchronously driving normal high-power triacs.

Several companies (including Isocom, Motorola, Sharp, Siemens, and Toshiba) manufacture optocoupled synchronous zero-voltage triacs. Most of these devices take the form of a six-pin DIL IC, as shown in Figure 1, and house a simulated triac that has its gate drive controlled via an integral photosensitive zero-crossing detector (ZCD), which can be remotely energized via an integral LED. Typically, this type of optocoupled triac has maximum AC ratings of 400V peak and 100mA RMS (with a surge rating of 1.2A for 10ms), will only trigger when the instantaneous AC voltage is below a fixed zero-cross inhibit voltage (V_{IH}) value of $\pm 15V$ nominal ($\pm 25V$ maximum), has a maximum LED forward current rating of 60mA, has a

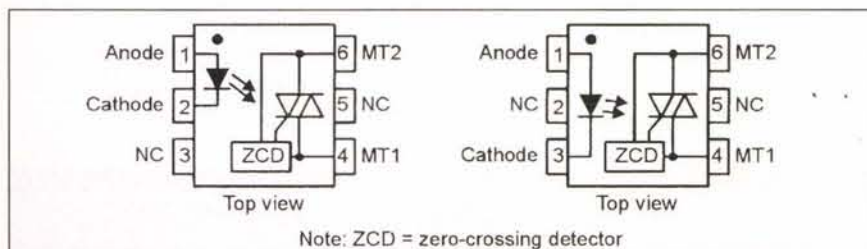


Figure 1. Typical optocoupled synchronous 'zero-voltage' triac outlines and pin notations.

Figure 2. Basic power switching circuit using an optocoupled synchronous 'zero-voltage' triac.

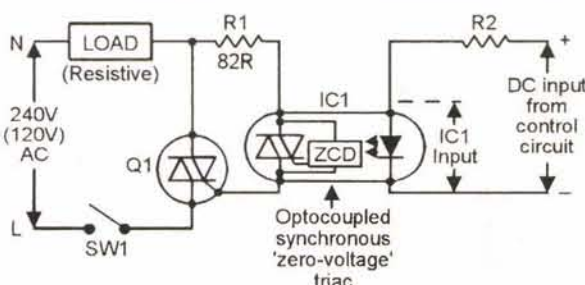


Figure 3. Basic power switching system using an optocoupled synchronous 'zero-voltage' triac.

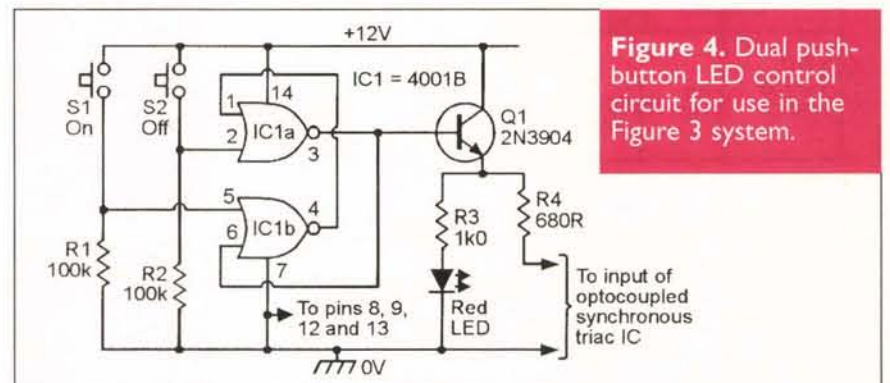
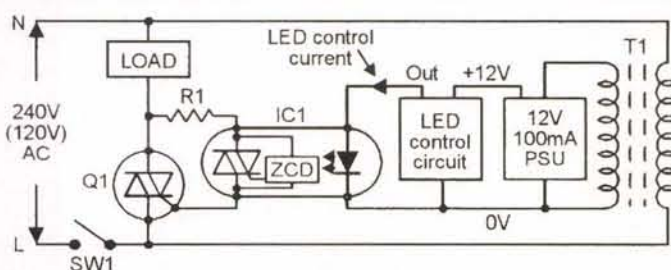


Figure 4. Dual push-button LED control circuit for use in the Figure 3 system.

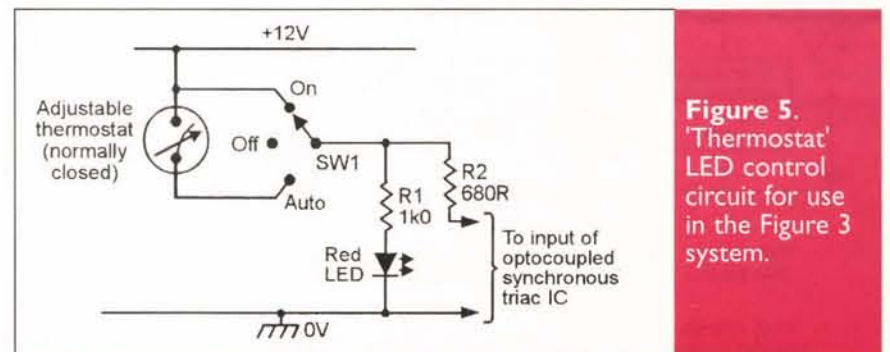


Figure 5. 'Thermostat' LED control circuit for use in the Figure 3 system.

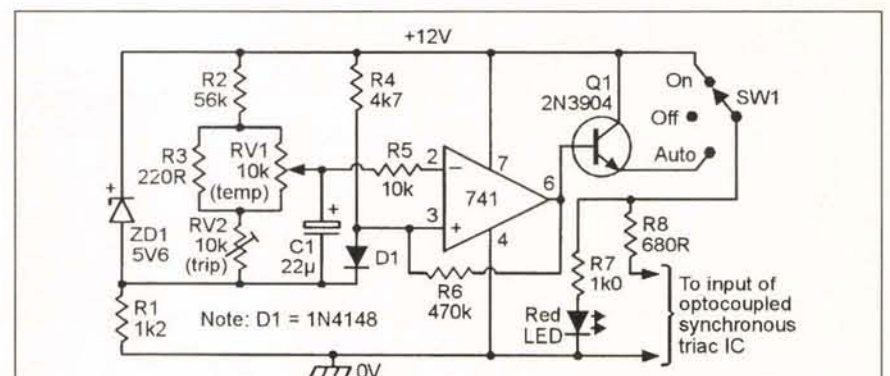


Figure 6. Automatic LED control circuit, using a silicon diode as a temperature-sensing element, for use in the Figure 3 system.

typical input current trigger sensitivity of 8mA or less, and the entire package has an isolating voltage rating of several kV.

Optocoupled synchronous zero-voltage triacs are easy to use and provide excellent electrical isolation between input and output. The input is used like a normal LED, and the output like a low-powered triac. In most practical applications, the optocoupled triac is used to activate the gate of a 'slave' triac, thereby driving a resistive AC load of any desired power rating. Figure 2 shows a practical circuit of this type, which can be manually or automatically switched on or off via a DC input current. Note in Figure 2 that R1 is used to limit the peak switch-on current of the optocoupled triac (and thus the peak gate current of Q1) at IC1's absolute maximum V_{IH} value minus 2V, i.e., typically at 23V; with the R1 value shown, the peak switch-on current is limited to 280mA. R2 is used to limit the LED input current of IC1 to a sensible working value.

Figure 3 shows one way of incorporating the above circuit in a complete electric power switching system. Here, when SW1 is closed, the AC power line is connected to both the load/Q1 circuitry and to the primary of low-power transformer T1, which has its output converted into a 12V DC supply that powers IC1's LED control circuit, which is electrically fully isolated from the AC supply. The LED control circuit can take any of a variety of forms; some simple examples are shown in Figures 4 to 7. The simplest LED control circuit that can be used in the Figure 3 system consists of an on/off toggle switch that — when closed — connects the IC1 LED to the 12V DC supply via a 680R resistor that limits the LED 'on' current to about 15mA, thereby switching the electric load fully on.

Figure 4 shows a dual push-button LED control system, in which the LED and load turn on when S1 is briefly closed, and off when S2 is briefly closed. Here, CMOS NOR gates IC1a-IC1b are wired as a manually triggered bistable multivibrator that has its output buffered by emitter follower Q1 and latches into the 'output high' state when S1 is briefly closed, thereby energizing the circuit's red LED via R3 and feeding a 15mA control cur-

rent to the LED input of the optocoupled triac. The bistable latches into the 'output low' state when S2 is briefly closed, thereby killing the DC power feeds to the red LED and the triac.

The Figure 4 circuit gives purely manual on/off LED control of an electrical power load such as a heater. Figure 5 shows a simple circuit that also provides the option of automatic control via an adjustable thermostat switch that is normally closed but opens when its temperature exceeds a selected value. Here, the red LED and the electric heater are off when SW1 is in the 'off' position or in the 'auto' position when the thermostat is open, but are on when SW1 is in the 'on' position or in the 'auto' position when the thermostat is closed.

Figures 6 and 7 show high-precision versions of the basic Figure 5 circuit, with the thermostat replaced by a temperature-sensitive electronic switching circuit. The Figure 6 circuit uses an ordinary silicon diode (D1) as a thermal sensing element. Here, zener diode ZD1 is wired in series with R1 so that a constant 5.6V is developed across the two potential dividers formed by R2-R3-RV1-RV2, and R4-D1, and a near-constant current thus flows through each of these dividers. A constant reference voltage is thus developed (via RV1) between the R1-ZD1 junction and pin 2 of the 741 op-amp, and a temperature-dependent voltage with a coefficient of $-2\text{mV}/^\circ\text{C}$ is developed between the R1-ZD1 junction and pin 3 of the op-amp. Thus, a differential voltage with a coefficient of $-2\text{mV}/^\circ\text{C}$ appears between pin 2 and pin 3 of the op-amp, which is wired as a high-gain (open loop) voltage comparator with slight hysteresis applied via R6.

In Figure 6, RV1 is a linear rotary pot that is used to manually adjust the heater system's operating temperature over a $\pm 10^\circ\text{C}$ (nominal) range, and RV2 is a multiturn preset that is used to set the circuit's nominal (with RV1 at mid-scale setting) trip temperature. To initially set up the circuit, set RV1 to mid-scale, adjust the temperature of D1 to the desired mid-scale trip value, then trim RV2 so that the red LED is on, but goes off again if the D1 temperature is increased slightly (by briefly applying finger heat to D1). In practice, the circuit has a typical switching sensitivity of about 0.5°C . The Figure 7 circuit uses an inexpensive NTC (negative temperature coefficient) bead or disc thermistor, with a nominal resistance of 4k7 at 25°C , as its thermal sensing element. Here, potential divider RV1-TH1 applies a tem-

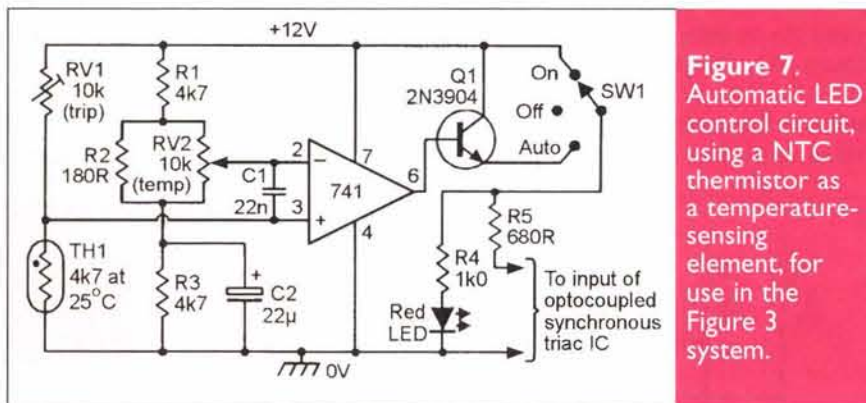


Figure 7. Automatic LED control circuit, using a NTC thermistor as a temperature-sensing element, for use in the Figure 3 system.

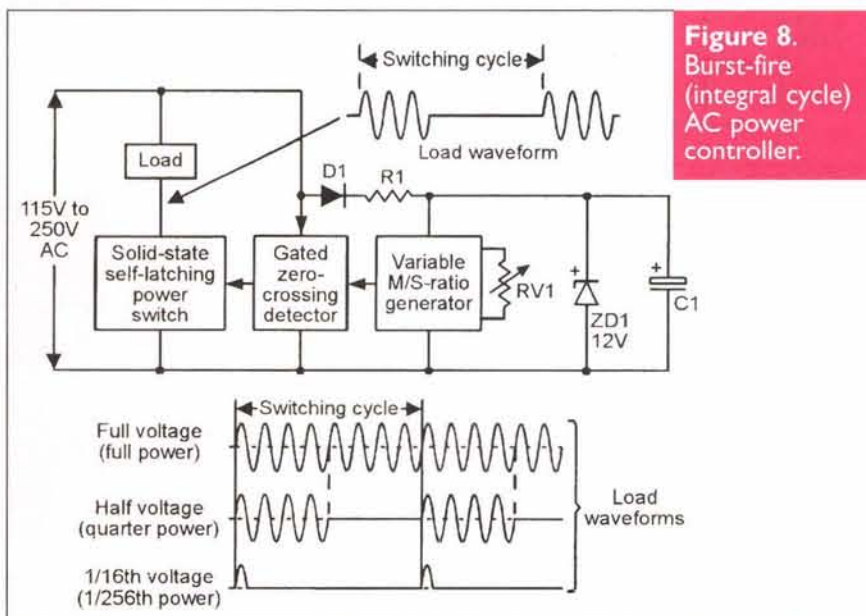


Figure 8. Burst-fire (integral cycle) AC power controller.

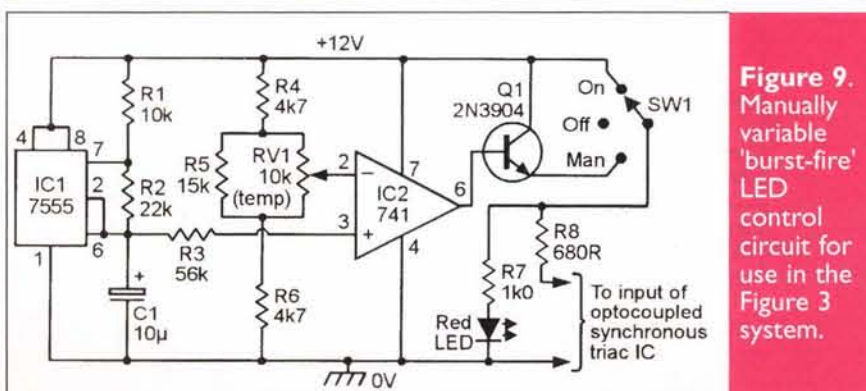


Figure 9. Manually variable 'burst-fire' LED control circuit for use in the Figure 3 system.

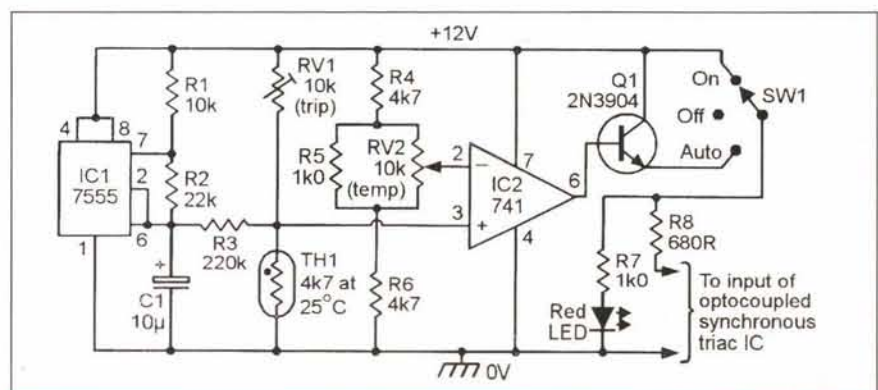


Figure 10. Fully automatic 'burst-fire' LED control circuit for use in the Figure 3 heater control system.

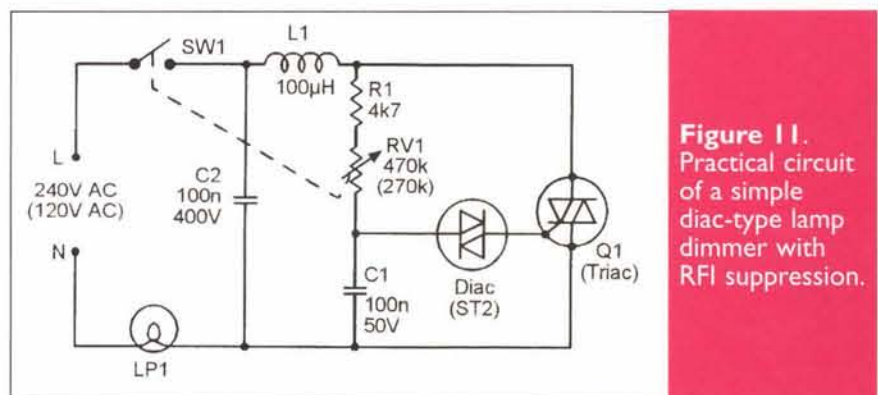


Figure 11. Practical circuit of a simple diac-type lamp dimmer with RFI suppression.

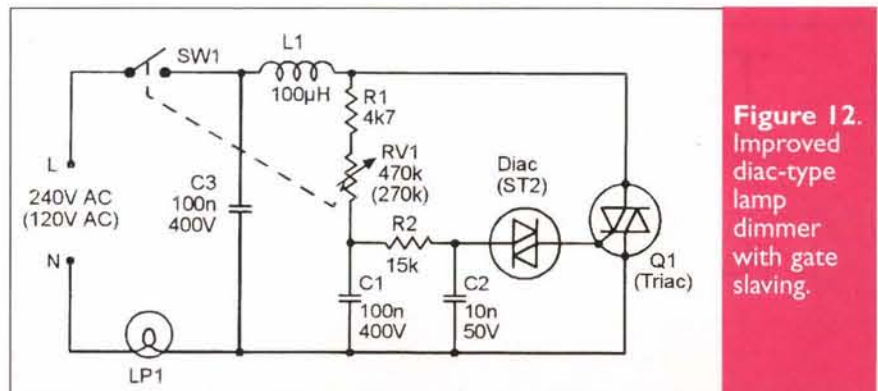


Figure 12. Improved diac-type lamp dimmer with gate slaving.

perature-sensitive voltage to pin 3 of the 741 op-amp, and potential divider R1-R2-RV2-R3 applies a preset reference voltage to pin 2 of the op-amp. The two potential dividers are actually wired in the form of a Wheatstone bridge, and the op-amp is used as a high-gain bridge balance detector; the bridge balance point is unaffected by variations on supply voltage. Capacitors C1 and C2 help to ensure circuit stability.

The action of the Figure 7 circuit is such that (when SW1 is in the Auto position) the output of SW1 is normally low but switches high and activates the red LED and the external triac when the TH1 temperature is below a value pre-set via RV1 and RV2. RV2 is a linear rotary pot that is used to manually adjust the heater system's operating temperature over a limited range, and RV1 is a multiturn preset that is used to set the circuit's nominal (with RV2 at mid-scale setting) trip temperature. To initially set up the circuit, set RV2 to mid-scale, raise the temperature of TH1 to the desired mid-scale trip value, then trim RV1 so that the red LED is on, but goes off if the TH1 temperature is increased slightly.

Note that the Figure 7 circuit has a typical switching sensitivity similar to that of the Figure 6 design (about 0.5°C), but that its thermistor has a far longer thermal time constant than the sensing diode of the Figure 6 circuit; the Figure 7 circuit is thus slower-acting than the Figure 6 circuit. Also note (in Figure 7) that the thermal 'span' range of RV2 can be increased (or reduced) by increasing (or reducing) the value of resistor R2.

Finally, note that — in all cases where an 'automatic' heater-control circuit is used to regulate the temperature of a room — the actual thermal sensor device (thermostat, thermistor, or sensing diode) must be sited roughly one meter above floor level, in a position where it can directly and safely sense the temperature of normally-circulating air; this position must be free of drafts or direct radiation from the heater, and must not be obstructed by furniture, etc.

'Burst fire' AC power control principles

There are three basic ways of controlling the AC power feed to resistive loads such as filament lamps or electric heaters via a triac. One of these is the variable phase-delay-switching system, which gives fully-variable power control and is often used in lamp dimmers, but generates substantial RFI and is thus unsuitable for driving high-power (greater than about 200W) loads. The second is the synchronous zero-voltage power switching system (see last month's Figure 19), which generates minimal RFI but gives only a simple on/off — rather than fully-variable — type of power control.

The third method of AC power control is the burst-fire integral-cycle system shown in Figure 8, in which bursts of complete half-cycles are fed to the load at regular line-frequency-related intervals. Thus, if bursts are repeated at eight-cycle intervals, the mean load voltage equals the full supply line value if the bursts are of eight-cycle duration, or half voltage (equals quarter power) at four-cycle duration, or one-sixteenth voltage (equals 1/256th power) at one half-cycle duration, etc. The burst-fire system thus gives variable power control and generates minimal RFI, and is often used to control the thermal output of electric heaters. Note that the burst-fire integral-cycle control system operates on the synchronous 'zero-voltage' triac switching principle, and practical circuits of this type can thus be made by using suitable control circuitry in conjunction with the basic power switching system of Figure 3. Two suitable circuits are shown in the next section of this article.

'Burst-fire' heater control circuits

The optocoupled synchronous circuits shown in Figures 2 to 7 all — when powering a heater load — give a simple form of control in which the heater is either fully off or is operating at maximum power. Figures 9 and 10 show circuits that drive the heater in the synchronous burst-fire mode, thus enabling the heater's thermal output to be varied over a wide range. The Figure 9 circuit enables the heater's thermal output to be varied manually, via RV1. The Figure 10 circuit varies the heater's output automatically, to maintain a room's temperature at a precise pre-set value.

The operation of the Figure 9 circuit is fairly simple. Here, IC1 (a CMOS version of the 555 'timer' IC) is wired in the astable mode and generates a repeating ramp waveform across C1. This waveform has a period of about 680mS (thus spanning roughly 68 half-cycles of a 50Hz power line waveform or 82 half-cycles of a 60Hz waveform during each period) and is centered on half-supply volts and swings symmetrically between 1/3rd and 2/3rds of supply voltage value. This waveform is fed to pin 3 of op-amp IC2 via R3, and linear rotary pot RV1 feeds a DC reference voltage that is variable from below 1/3rd to above 2/3rds of the supply voltage value to pin 2 of the op-amp, which is configured as a high-gain voltage comparator.

The net effect of the above circuitry is that IC2 converts the 680mS ramp waveform into a switched rectangular output waveform with a mark/space (M/S) ratio that is fully variable from 0:1 (output low for the full 680mS period) to 1:0 (output high for the full 680mS period) via RV1. When SW1 is switched to the Man (manual) position, this output is fed to

the input of the Figure 3 optocoupled synchronous electric heater control system, where it enables the mean power input to the heater to be varied (via RV1) from zero to maximum in 68 discrete 'half-cycle' steps in a 50Hz system or 82 steps in a 60Hz system.

Finally, to complete this look at burst-fire heater control circuits, Figure 10 shows a self-regulating synchronous burst-fire heater controller that automatically varies the heater's input power to maintain a room's temperature at a precise pre-set value. Here, the circuit to the right of R3 is almost the same as the Figure 7 thermistor-controlled automatic circuit, but the IC1 circuit to the left of R3 is taken directly from the Figure 9 circuit and superimposes a 680mS ramp waveform (with a peak-to-peak amplitude of about 40mV) on the RV1-TH1 junction and pin 3 of IC2.

The net effect of the above combination is that the external heater is turned fully on (via the optocoupled triac in the Figure 3 system) if the TH1 temperature is more than (say) 1°C below a pre-set value, or fully off if it is more than 1°C above the pre-set value, but is operated in the burst-fire mode — with its M/S ratio automatically adjusted via TH1 — when the TH1 temperature is within $\pm 1^\circ\text{C}$ of the pre-set value. The circuit thus automatically adjusts the heater's thermal output level to meet the room's heating needs; when the temperature reaches the precise pre-set value, the heater does not switch fully off, but generates just enough output power to exactly match the thermal losses of the room. To initially set up the Figure 10 circuit, set RV2 to mid-scale, raise the TH1 temperature to the desired mid-scale trip value, then trim RV1 so that the red LED flashes on and off (at roughly a 1.5Hz rate) but goes fully off if the TH1 temperature is increased slightly. When experimenting with this circuit, note that the thermal 'span' range of RV2 is determined by the R5 value, and the burst-fire thermal operating span is determined by the R3 value.

Finally, note — when using burst-fire systems to control domestic electric heaters with built-in lamps — that the control system must be fed to the heater elements only, and must not be applied to the lamps.

AC lamp dimmer circuits

Triacs can be used to make very efficient lamp dimmers by using the 'phase-delayed switching' technique in which — in each power half-cycle — the triac is gated on at some controlled phase-delayed time after the start of each AC half-cycle, thus controlling the mean power fed to the lamp. All such circuits require the use of a simple L-C filter in the lamp feed line, to

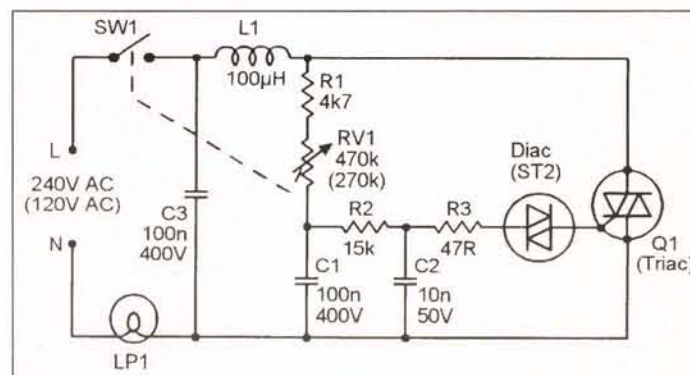


Figure 13. Minimum-backlash diac-type lamp dimmer.

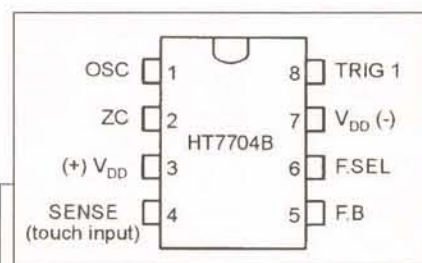
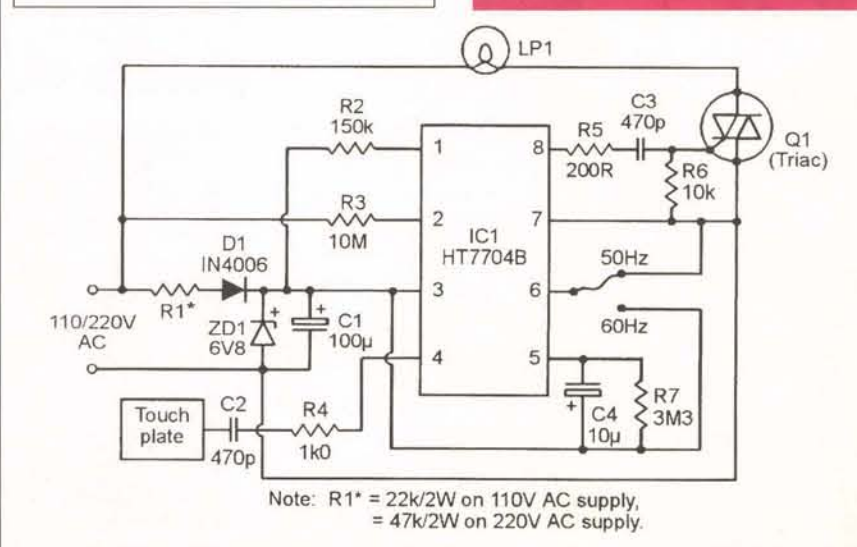


Figure 14. HT7704B outline and pin notations.



minimize RFI problems.

The two most popular ways of obtaining variable phase-delay triac triggering are to use either a diac plus C-R phase delay network, or to use a special-purpose IC as the triac trigger. Figure 11 shows a practical diac-triggered lamp dimmer, in which R1-RV1-C1 provide the variable phase-delay. This circuit is really a simple variant of the basic lamp dimmer circuit shown in last month's Figure 6, with the addition of the L1-C2 RFI suppressor and with RV1 and SW1 ganged together to easily enable the lamp to be turned fully off.

A weakness of the simple Figure 11 design is that it has considerable control hysteresis or backlash, e.g., if the lamp is dimmed off by increasing the RV1 value to (say) 470k, it will not go on again until RV1 is reduced to about 400k, and then burns at a fairly high brightness level. This backlash is caused by the diac partially discharging C1 each time the triac fires. Backlash can be greatly reduced by using the 'gate slaving' technique in Figure 12, in which the diac is triggered from C2, which 'follows' the C1 phase-delay voltage but protects C1 from discharging when the diac fires. If desired, the backlash can be reduced to virtually zero by wiring a current-limiting resistor in series with the diac, to reduce the magnitude of the C2 discharge voltage, as shown in Figure 13.

A 'smart' lamp dimmer IC

Many modern lamp dimmers have their triac driven via a dedicated 'smart' IC that can turn the lamp on or off or control its brilliance, the IC taking its action commands via a touch-sensitive pad or push-button input switch. For many years, Siemens was the leading producer of this type of IC, first with the IC known as the S566B, and then (starting in 1990) with the SLB0586, which remained in full production until 1995 (but was still widely available in early 2000). Today (in 2002), the most popular lamp dimmer IC is a low-cost Holtek product known as the HT7704B 'touch' dimmer.

The HT7704B is an eight-pin DIL IC with the outline and pin notations shown in Figure 14, and provides four levels of brightness plus switch-off control, all sequentially selectable via a simple metal 'touch' pad or plate that is AC coupled to pin 4 of the IC. In use, the first 'touch' turns the lamp on at its lowest brightness level; the next three touches bring the brightness up to maximum level in successive stages; the fifth touch turns the lamp

full off, and so on.

Figure 15 shows the basic application circuit of the HT7704B (without fused overload protection or RFI-suppression circuitry), with alternative component values and pin connections shown for use with 50Hz or 60Hz AC supplies with nominal values of 110V or 220V. Note that R1 is a 2W type and needs a value of 22K on 110V AC supplies or 47K on 220V AC supplies, that pin 6 must be tied to pin 7 on 50Hz supplies or pin 3 on 60Hz supplies, and that the ratings of triac Q1 must be chosen to suit the lamp power and supply-voltage rating of the individual system.

Triac protection techniques

In use, triacs must always have an RMS current rating greater than that of the load that they are driving and must always be protected against catastrophic damage from current surges or malfunctions in their loads. Adequate protection can usually be obtained via a suitably-rated quick-blow fuse that is effectively connected (either directly or via a supply-connection plug) in series with the load and the triac's main terminals, but in a few special applications, additional protection may also be needed. Note that the fuse value must always be chosen with great care, and should be of the minimum practicable rating; a fuse with too high a rating provides no useful protection.

When a triac is used in an electric-heater driving circuit, a quick-blow fuse with a current rating greater than that of the heater but less than the maximum current rating of the triac provides adequate protection. When a triac is used in an electric-motor driving circuit, a quick-blow fuse with a current rating greater than the stalled current rating of the motor but less than the maximum current rating of the triac should be used.

In most filament-lamp driving triac circuits, the triac needs a current rating at least three times greater than the normal running current of the lamp, and should be protected by a quick-blow fuse with a rating of 500mA (1A absolute maximum) per 100W of lamp rating in 240V AC systems, or 1A (2A absolute maximum) per 100W of lamp rating in 120V AC systems; in some special filament-lamp driving circuits, however, additional protection may also be needed, as described later in this article. To understand the principles of triac protection in filament-lamp driving circuits, it is necessary to understand certain characteristics of fuses, filament lamps, and triacs as follows.

FUSE BASICS. An ordinary 'quick-blow' fuse consists of a short length of wire, which burns out ('blows') if the current passing through it exceeds a limit determined by the wire's diameter. Most quick-blow fuses use a copper wire, which has a melting temperature of 1083°C and a resistance that — when referenced to 20°C — increases by about 0.4% per °C increase in temperature. Thus, when the current passed through the fuse exceeds roughly 40% of its rating, its resistance and power dissipation and temperature all increase exponentially with further increases in current, until a point is reached where the ability of the fuse to dissipate power is exceeded by the prevailing input power level; under this condition, the fuse eventually blows at its weakest point; when a fuse blows, its wire first melts at the failure point, which is then widened as current briefly arcs across the gap and vaporizes the adjacent metal.

All fuses carry a 'rating' figure (such as 500mA, 1A, 2A, 5A, etc.) which indicates the maximum current that the fuse can safely carry without blowing or suffering a reduction in its working life. The fuse will only blow if its rating figure is exceeded ('overloaded') for a significant period of time; thus, a 2A quick-blow fuse may take absolute maximum times of several days to blow at 2.2A, 2.5 hours at 3A, 1 second at 4A, 40ms at 6A, 8ms at 10A, 2ms at 20A, 500µs at 40A, and so on. All quick-blow fuses can thus safely handle large-amplitude current transients or surges, provided that they do not exceed a certain critical duration.

FILAMENT LAMP BASICS. An ordinary filament lamp consists of a tightly coiled Tungsten wire filament that is supported on insulated struts, has its two ends made externally available, and is enclosed in a sealed glass envelope or bulb. In use, an electric current passed through the resistive filament raises its temperature to a white heat, causing it to emit white light; the glass bulb that encloses it is normally filled by a non-reactive gas such as argon, to stop the filament burning up under this condition.

The Tungsten filament's wire has a melting temperature of 3370°C and a resistance that — when referenced to 20°C — increases by about 0.45% per °C increase in temperature, making the resistance value rise sharply with filament temperature. The resistance of a 240V 100W lamp is typically 40R at 20°C but is 576R under normal 'white heat' running conditions (the lamp thus shows about a 14:1 resistance variation over its full usage range). Note from this data that this 100W lamp consumes a normal RMS running current of 417mA from the 240V AC supply but — if it is initially switched on at a moment when the AC voltage happens to be at the peak point in a half-cycle — may pass an initial switch-on surge current of up to 8.46A, thus generating a 2030W switch-on power surge in the lamp. By comparison, a 120V 100W lamp consumes a normal RMS running current of 833mA and may pass an absolute peak switch-on surge current of

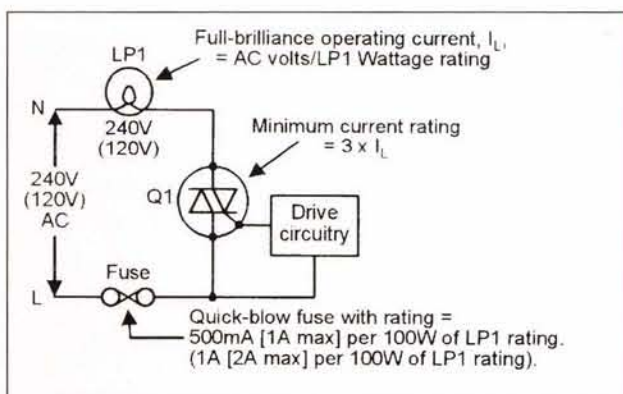


Figure 16. Basic triac and fuse selection data for use in simple on/off lamp switching and lamp dimmer types of application.

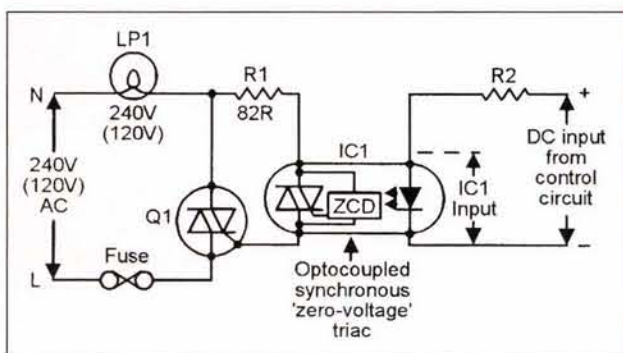


Figure 17. Ideally, all on/off-type lamp switching circuits should be gated via an opto-coupled synchronous 'zero-voltage' triac, to eliminate all switch-on surge current problems.

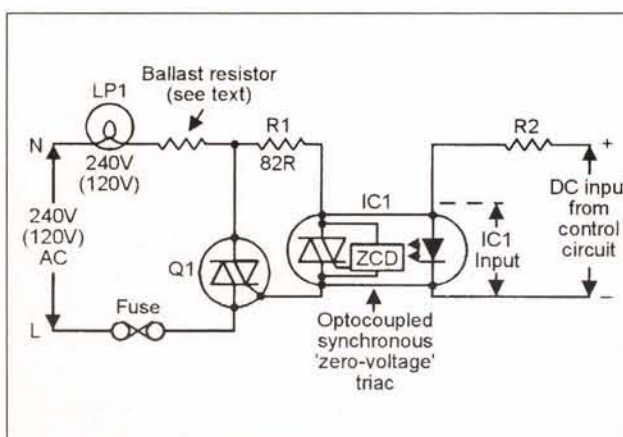


Figure 18. In extreme cases, such as in flashing-lamp disco displays, the main triac (Q1) can be protected against damage from a 'catastrophic' lamp failure by a ballast resistor, wired as shown.

16.5A. In practice, the lamp's initial switch-on power surge makes its filament resistance rise very rapidly (in a few milliseconds) to a value reasonably near to the filament's normal operating value; the lamp-driving triac (and its protective fuse) must be able to handle this surge current without suffering damage.

Tungsten filament lamps have a typical operating life of about 2,000 hours. The outer surfaces of the coiled Tungsten filament slowly 'boil off' with continued use, until the weakened filament eventually blows at its most vulnerable (thinnest) point, in the same basic manner as in a fuse, i.e., the failure point first melts and is then partly vaporized by arcing; usually, the vaporized metal blackens part of the glass bulb's inside surface. Filament lamp failures occur in three basic types, which can be classified as 'simple,' 'recursive,' or 'catastrophic,' these failure types have the following characteristics. Most lamp failures are of the 'simple' type, in which the filament simply burns through and then arcs at its weakest point, vaporizing the local metal; the lamp emits an audible 'ting' as the two halves of the ruined filament spring apart; usually, the arcing debris blackens only the end of the bulb. This type of failure often occurs at the moment of initial switch-on and is usually harmless to triac drivers.

The 'recursive' type of lamp failure can be regarded as a small number of 'simple' failures occurring in quick succession. At the end of the first failure, the broken but still hot and vibrating ends of the filament briefly make contact and weld together, passing a surge of current through the remaining (but shortened) length of filament, which quickly suffers another failure at another weak point, and so on. In this type of failure, the lamp usually flickers on and off a few times before finally dying; the inside of the bulb normally becomes widely blackened as a result of the multiple arcing that occurs in this process. This type of failure may be accompanied by very heavy current surging, which may damage a driving triac that is not adequately rated or fuse-protected.

The 'catastrophic' type of lamp failure is a rare and very savage type of recursive failure, in which the internal arcing is so severe that the entire inner surface of the lamp and the filament's supports becomes coated in conductive vaporized metal, thus shorting out much of the filament and causing a very low resistance to appear across the lamp's terminals. This type of failure sometimes occurs in crude flashing-lamp disco displays in which the triac-driven lamps are switched on and off in response to the fil-

tered amplitudes of the music, often going through thousands of on/off switching sequences (and their associated heavy surge currents) per hour; triacs need special protection in this type of application. In extreme cases of this type of failure, the triac may develop an internal short-circuit, and the fuse may then blow as the lamp filament self-destructs, thus destroying all three components during the 'failure' process.

TRIAC BASICS. From the 'current overload protection' point of view, the two most important parameters of a triac are its basic 'RMS on-state current rating,' $I_{T(RMS)}$, and its non-repetitive peak surge on-state current rating over a period of one full cycle duration, I_{TSM} . Typically, I_{TSM} is 10 times greater than $I_{T(RMS)}$ in 60Hz systems, and eight times greater than $I_{T(RMS)}$ in 50Hz systems. Thus, a 4A triac can typically handle I_{TSM} surge current of up to 32A in a 50Hz system, or 40A in a 60Hz system.

TRIAC PROTECTION CIRCUITS. When all of the above data is put together, it transpires that the simplest on/off-switching or 'dimmer' type of lamp-driving triac circuit should take the basic form shown in Figure 16. The lamp's normal 'fully on' running current, I_L , equals the AC supply voltage divided by the lamp's power rating, the triac needs a minimum current rating of $3 \times I_L$, and the fuse must be a quick-blow type with a current rating of 500mA (1A absolute maximum) per 100W of lamp rating in 240V AC system, or 1A (2A maximum) per 100W of lamp rating in 120V AC systems. Ideally, all modern lamp-driving 'on-off' types of triac circuit (including those used in flashing-lamp disco displays) should take the basic form shown in Figure 17, in which the main triac is gated via an optocoupled synchronous 'zero-voltage' triac (as described earlier in this article), thus completely eliminating all switch-on surge current problems.

In very extreme cases, particularly in flashing-lamp disco displays, the above circuit can be modified to give the main triac additional protection against damage from the 'catastrophic' type of lamp failure by wiring a ballast resistor in series with the load, as shown in Figure 18; this resistor must be a wire-wound type with a resistance equal to at least 5% of the lamp's hot resistance and with a power rating equal to at least the same percentage of the lamp's power rating. If the lamp suffers a near-short-circuit during a catastrophic failure, this ballast resistor limits the surge current to a value that blows the fuse but does not damage the triac; the ballast resistor gives a slight reduction in lamp brilliance under normal running conditions. **NV**



Mr. NiCd

SPRING SPECIALS!

THE BEST BATTERIES IN AMERICA!

Packs & Charger for YAESU FT-50R / 40R / 10R:

FNB-40xh (5w NiMH)	7.2v	650mAh	\$41.95
FNB-47xh (5w NiMH)	7.2v	1800mAh	\$49.95
FNB-41xh (5w NiMH)	9.6v	1000mAh	\$49.95

For YAESU FT-51R / 41R / 11R:

FNB-38 pack (5w)	9.6v	700mAh	\$39.95
------------------	------	--------	---------

For YAESU FT-530 / 416 / 816 / 76 / 26:

FNB-26 pack (NiMH)	7.2v	1500mAh	\$32.95
FNB-27s (5w NiMH)	12.0v	1000mAh	\$45.95

For YAESU FT-411 / 470 / 73 / 33 / 23:

FNB-11 pack (5w)	12.0v	600mAh	\$24.95
FBA-10 6-Cell AA case			\$14.95

Packs for ALINCO DJ-580 / 582 / 180 radios:

EBP-20ns pack	7.2v	1500mAh	\$29.95
EBP-22nh pk (5w)	12.0v	1000mAh	\$36.95
EDH-11 6-Cell AA case			\$14.95

For ICOM IC-21A / T22-42A / W31-32A / T7A:

BP-180xh pk (NiMH)	7.2v	1000mAh	\$39.95
BP-173 pack (5w)	9.6v	700mAh	\$49.95

For ICOM IC-W21A / 2GXAT / V21AT (Black or Gray):

BP-132s (5w NiMH)	12.0v	1500mAh	\$49.95
-------------------	-------	---------	---------

Mail, phone, & Fax orders welcome! Pay with Mastercard / VISA / DISCOVER / American Express

Call 608-831-3443 / Fax 608-831-1082

Mr. NiCd - E. H. Yost & Company
2211-D Parview Road, Middleton, WI 53562

CALL OR WRITE FOR OUR FREE CATALOG!
Cellular / Laptop / Videocam / Commercial & Aviation packs too!
E-mail: ehyst@midplains.net

68HC11 & 68HC12

Microcontroller Modules!

Unique design-- just plug them right into your solderless breadboard!

MicroStamp11™

- tiny 1-inch x 1.4-inch 68HC11 module from \$49

MicroCore-11™

- compact 2-inch x 2-inch 68HC11 module from \$68

Adapt-11™ Family

- 68HC11 modules with lots of I/O lines from \$63

Adapt812™ Family

- based on 68HC812A4
- from \$79

Adapt912™ Family

- choice of B32, D60, DG128
- from \$99

MicroBDM912™

- lowest-cost BDM pod!
- only \$79!

Toll-free: 1-877-963-8996


Technological Arts

Phone: (416) 963-8996 Fax: (416) 963-9179

www.technologicalarts.com

www.gatewayelec.com

(Electronically Speaking, Gateway's Got It!)



gateway
ELECTRONICS, INC.

MAIL ORDERS CALL TOLL-FREE 1-800-669-5810

Professional



Factory Direct

10 HOUR RECORDER

"BUILT LIKE A BATTLESHIP"

- Heavy duty commercial recorder — NOT improvised from consumer models
- 12, 14, and 16 hour models also available
- BUILT-IN voice activation (add \$30)
- Applications information included
- Dimensions: 11.5 x 7.0 x 2.75"

SPECIAL

Nuts&Volts

Price ..

\$159

FREE 40-PAGE SPECIAL EQUIPMENT CATALOG!

COD's OK. Sorry, no credit cards. Free catalog USA only; other countries \$5. Price Includes UPS to 48 States on Pre-Paid Orders

Viking Systems International

100 North Hill Drive #42, Brisbane, CA 94005

Phone (415) 467-1220 • Fax: (415) 467-1221 • Web: www.vikingint.com

Advertiser INDEX

Abacom Technologies	26	Custom Computer Services	26	H.T. Orr Computer Supplies	61	MVS	26	SolderingDesoldering.com	8, 30, 57
ActiveWire, Inc.	43	DesignNotes.com	80	HVW Technologies, Inc.	43	Parallax, Inc.	Back Cover	Square 1 Electronics	18
All Electronics Corp.	32	Detection Dynamics	30	IndustroLogic	29	PAiA Electronics	43	Technological Arts	71
Alltronics	55	Earth Computer Technologies	42	Information Unlimited	13	Pioneer Hills Software	8	Test Equipment Connection	17
Andromeda Research	13	ECD	42	Inkjet Southwest	33	Polaris Industries	19	Texas Instruments	9
Autotime Corp.	28	E.H. Yost & Co.	71	Intronics, Inc.	17	Prairie Digital, Inc.	43	The RF Connection	58
Barrett Instruments	43	Electro Mavin	18	LabJack	17	Pulsar, Inc.	43	Timeline, Inc.	57
Basic Micro, Inc.	4, 58	Electronic Design Specialists	61	Lemos International	42-43	Quality Kits	42	TNR Technical, Inc.	29
Blue Bell Design, Inc.	60	EMAC, Inc.	7	Linear Systems	13	R4 Systems, Inc.	42	Unicorn Electronics	59
C & S Sales, Inc.	34	Embedded Systems	11	Lynxmotion, Inc.	30	Ramsey Electronics, Inc.	58	V & V Machinery & Equip., Inc.	42, 43
CCTV Outlet	41	E Tip, Inc.	28	M2L Electronics	50	Resources Un-Ltd.	16	Viking Systems International	71
Circuit Specialists, Inc.	84	ExpressPCB	74	Matco, Inc.	43	Robotikits Direct	61	Western Test Systems	14-15
Cleveland Institute of Electronics	18	Foss Warehouse Distributors	43	Meredith Instruments	50	Robot Store	59	Westshore Technologies	43
Conitec DataSystems	12	Future Horizons	33	microEngineering Labs	33	Saelig Company	50	Wittig Technologies, Inc.	12, 50, 80
Consumertronics	42	Gateway Electronics, Inc.	26, 71	Micromint	7	Scott Edwards Electronics, Inc.	57	Zagros Robotics	60
Corporate Systems Center	2	Halted Specialties Co.	3	Mouser Electronics	11	SGC	8		
Cunard Associates	61	Hitechcafe.com	12	Mr. NiCd	71	Shreve Systems	12		

AMATEUR RADIO & TV

Alltronics	55
E Tip, Inc.	28
Gateway Electronics, Inc.	26, 71
Hitechcafe.com	12
Ramsey Electronics, Inc.	58
SGC	8
The RF Connection	58

ASSEMBLY SERVICES

BATTERIES/CHARGERS

Cunard Associates	61
E.H. Yost & Co.	71
Mr. NiCd	71
Robot Store	59
TNR Technical, Inc.	29

BUSINESS OPPORTUNITIES

BUYING ELECTRONIC SURPLUS

Earth Computer Technologies	42
Timeline, Inc.	57

CABLE TV

Foss Warehouse Distributors	43
-----------------------------------	----

CB/SCANNERS

CCD CAMERAS/VIDEO

Autotime, Corp.	28
CCTV Outlet	41
Circuit Specialists, Inc.	82
Detection Dynamics	30
Matco, Inc.	43
Polaris Industries	19
Ramsey Electronics, Inc.	58
Resources Un-Ltd.	16
Timeline, Inc.	57

CIRCUIT BOARDS

Cunard Associates	61
ECD	42
ExpressPCB	74
IndustroLogic	29
Pulsar, Inc.	43
R4 Systems, Inc.	42
V & V Machinery & Equipment, Inc.	42, 43

COMPONENTS

ECD	42
Linear Systems	13
Pulsar, Inc.	43
Unicorn Electronics	57

COMPUTER

Hardware

ActiveWire, Inc.	43
Autotime, Corp.	28
Corporate Systems Center	2
Earth Computer Technologies	42
Electro Mavin	18
Halted Specialties Co.	3
Shreve Systems	12

Software

Consumertronics	42
Custom Computer Services	26
Pioneer Hills Software	8
R4 Systems, Inc.	42

Microcontrollers / I/O Boards

Abacom Technologies	26
Basic Micro, Inc.	4, 58
Conitec DataSystems	12
EMAC, Inc.	7
Embedded Systems	11
IndustroLogic	29
microEngineering Labs	33
Micromint	7
MVS	26
Parallax, Inc.	Back Cover
Prairie Digital, Inc.	43
Scott Edwards Electronics, Inc.	57
Square 1 Electronics	18
Technological Arts	71
Texas Instruments	9

Printers/Printer Supplies

H.T. Orr Computer Supplies	61
Inkjet Southwest	33

DESIGN/ENGINEERING SERVICES

DesignNotes.com	80
ExpressPCB	74
IndustroLogic	29
Prairie Digital, Inc.	43
Pulsar, Inc.	43
V & V Machinery & Equipment, Inc.	42, 43

EDUCATION

Cleveland Institute of Electronics	18
EMAC, Inc.	7
Embedded Systems	11
R4 Systems, Inc.	42

EVENTS/SHOWS

KITS

Alltronics	55
Autotime, Corp.	28
C & S Sales, Inc.	34
Earth Computer Technologies	42
EMAC, Inc.	7
Future Horizons	33
Gateway Electronics, Inc.	26, 71
HVW Technologies, Inc.	43
Information Unlimited	13
Inkjet Southwest	33
PAiA Electronics	43
Quality Kits	42
Ramsey Electronics, Inc.	58
Robotikits Direct	61
Robot Store	59
Scott Edwards Electronics, Inc.	57
Zagros Robotics	60

LASERS

Future Horizons	33
Information Unlimited	13
Meredith Instruments	50
Resources Un-Ltd.	16
Unicorn Electronics	57

MISC./SURPLUS

All Electronics Corp.	32
Gateway Electronics, Inc.	26, 71
Halted Specialties Co.	3
Linear Systems	13
Resources Un-Ltd.	16
Shreve Systems	12
SolderingDesoldering.com	8, 30, 57
Timeline, Inc.	57
Unicorn Electronics	57
Viking Systems International	71

PROGRAMMERS

Andromeda Research	13
Conitec DataSystems	12
Embedded Systems	11
HVW Technologies, Inc.	43
Intronics, Inc.	17
M2L Electronics	50
microEngineering Labs	33
Basic Micro, Inc.	4, 58

PUBLICATIONS

Consumertronics	42
Future Horizons	33
Mouser Electronics	11
Texas Instruments	9
Square 1 Electronics	18

RF TRANSMITTERS/RECEIVERS

ROBOTICS

Blue Bell Design, Inc.	60
HVW Technologies, Inc.	43
LabJack	17
Lemos International Co., Inc.	42, 43
Lynxmotion, Inc.	30
Robotikits Direct	61
Robot Store	59
Zagros Robotics	60

SATELLITE

SECURITY

CCTV Outlet	41
Consumertronics	42
Detection Dynamics	30
E Tip, Inc.	28
Information Unlimited	13
Lemos International Co., Inc.	42, 43
Matco, Inc.	43
Polaris Industries	19

STEPPER MOTORS

Alltronics	55
------------------	----

TELEPHONE

TEST EQUIPMENT

Barrett Instruments	43
C & S Sales, Inc.	34
Circuit Specialists, Inc.	82
Conitec DataSystems	12
DesignNotes.com	80
Electronic Design Specialists	61
Intronics, Inc.	17
LabJack	17
Pioneer Hill Software	8
Prairie Digital, Inc.	43
Saelig Company	43
Test Equipment Connection	17
Western Test Systems	14-15
Westshore Technologies	43
Wittig Technologies, Inc.	12, 50, 80

TOOLS

C & S Sales, Inc.	34
The RF Connection	58
SolderingDesoldering.com	8, 30, 57

WIRE/CABLE & CONNECTORS

The RF Connection	58
-------------------------	----

Ham Radio Extra Class Test Changes

By Gordon West

A few issues back, the article "Hams in Hog Heaven" prompted correspondence from our readers that now is a great time to get into ham radio. The dreaded Morse Code tests were eliminated for the entry-level Technician class license. Technician class operators have full access and ALL privileges above 50 MHz.

The 50 MHz six-meter ham band, all by itself, can take the no-code Technician class operator into major voice worldwide skywave DXing. "DXing" means working on a radio band and having your signals come in a whole lot further than you ever dreamed possible.

A Long Island mobile six-meter DXer hooks up with another mobile operator in Spain, and they talk for over half an hour before the band conditions begin to fade in and out. Midwest six-meter hams enjoyed crystal-clear conversations with AL7BJ Rex toasting his footsies by the fireplace in Alaska where the outside temperature was 30 below. And along the West Coast, our six-meter single-sideband contacts with skywaves coming in from Hawaii were suddenly, and pleasantly, interrupted by more powerful Japanese six-meter signals that pounded in for hours.

All this excitement without having to pass a code test, and we still have another good year of hot six-meter activity for Technician no-code operators before we begin to slide down the back side of solar cycle 23. But learning the code at a simple 5 wpm and taking one more theory test puts you into the General class license. This opens up almost 4,000 additional kilohertz of worldwide ham bands below 30 MHz. The General class ticket is the big one — there is always one of the worldwide bands that continues to have daytime and nighttime propagation over thousands of miles with ease.

EXTRA CLASS

The Extra class is at the top of the ham radio pyramid. Less than 20 percent of hams have the Extra, but this is changing rapidly. Now that the Extra class license does not require a 20 wpm code test, hams are easily picking up the Extra class book, spending about 20 days going over the 665 Q & As in the pool, and taking the 50-question Extra class multiple-choice test. And you don't need to get 100 percent — a passing score is 70 percent. Most everyone gets the Extra on the first try now that there is no further Morse Code requirement beyond 5 wpm.

But things will change come July 1 of this year. The VEC (Volunteer Examiner Coordinator) Question Pool Committee (QPC) has just released a "new" question bank for the Element 4 Extra class test administered after July 1, 2002. The pool increases by a whopping 20 percent, going from

the present 665 Extra class question pool to the huge new 807 question pool. Fifty percent of those 807 questions cover electrical principles, circuits, signals, and emissions. Bound to be a brain-buster, right?

Certainly, 100 additional questions beyond 665 will take increased study time. However, rumors that the new 807 July 1 Extra class test question pool contains "new" test questions is absolutely bunk! The "brand new pool" actually contains only about 50 brand new questions, most dealing with rules and regulations, pulled together by former FCC Chief Johnny Johnston, now retired and having a ball on his ranch playing ham radio. He did a nice job with some of the new rules and regs questions.

So where did those 142 additional Extra class questions come from? A few are REALLY new from electrical principles, circuits, signals, and emissions, and the remaining questions are actually resurrected shelved Extra class questions prior to April 2000.

Back in April of 2000, the Question Pool Committee had to hastily combine the now extinct amateur Advanced class test with the present Extra class test back then and, in doing so, they ended up with over 100 questions that were simply set aside when the two pools were merged. The old Advanced class license exam was eliminated in April of 2000, but many of the Advanced class questions would live on when merged into the present Extra class pool.

So as not to have the present Extra class pool explode by combining two pools into one, specific topic areas that might have 10 specific questions on a certain subject were scaled down to three or four questions, and the remaining questions were set aside. Guess what? Beginning July 1 of this year, those "set aside" questions are returning to the new Extra class pool. So don't let anyone tell you that the "new" Extra class test question pool is all that different than what has been already seen in prior Advanced and Extra class textbooks in the past. But here is what is actually new:

- Fifty fresh and timely rules and regulation questions
- Four satellite questions reworked into plain language modes
- A couple new questions on slow-scan television
- Three questions on contest etiquette
- Eight good questions on automatic position/packet reporting system (APRS)
- A couple new questions on PSK digital modes
- A couple new questions on second-order and third-order intermodulation dBm levels
- Elimination of the multiple questions on Thevenin theorem voltage dividers

A ham can never have enough radios!



Hams send GPS data bursts to track one another over the radio.



Plenty of "deals" with new and used ham radio equipment.



- Five new questions on monolithic microwave integrated circuits
- A few new questions on the isotropic radiation
- A couple questions on Yagi angle of radiation
- A handful of questions on basic stuff like velocity of radio waves in space, Zener diodes, and one on a load resistor

It was fun to compare how the "all new" pool was put together — long runs of identical questions, supplemented by runs of past shelved questions, and then two or three genuine new questions at the end of each topic area if they lacked a couple of spots to be filled up. I suppose you could call it a patch job, but you can't blame the Question Pool Committee for not coming up with more new and technologically updated Q & As. Three out of the four QPC men are doing this on their own time yet working or retired as their primary job. One QPC member works a regular job in this testing business, and probably didn't get an official assignment to take him out of VEC duties and put him into brainstorming new Extra class questions.

The Question Pool Committee pleaded with the ham community to come up with ALL NEW questions, but only a few trickled in. It would take

We need more kids to obtain their ham license for our service to remain viable.



a very technical ham volunteer probably three months, eight hours a day, five days a week to do nothing but create new Extra class questions and take just as much time in coming up with the new questions as documenting exacting where they came from in engineering or radio communication handbooks. I know that I had only enough time to send in a few suggested Extra class questions, and it looks like the QPC adopted many of my suggestions.

So the bottom line is, if you're a General class ham operator now, or soon to get your General class, prepare for Extra class right now with the question pool 20 percent smaller. Come July 1, 2002, the Extra class pool goes from 665 present questions to 807 questions. You can buy the present Extra class test preparation book with explanations to each and every question by calling 800-669-9594. You can view the NEW Extra class test at <http://www.arrl.org/arrlvec/pools.html>. You can try your test-taking online with either the old or the new pool at www.qrz.com/testing.html.

NEXT IS TECHNICIAN CLASS

So what will happen a year from now when the QPC releases the entry-level Technician class test question pool? A lot depends on what ham operators and ham instructors throughout the country come up with as suggestions to the present Tech pool, due for a change next year. If the ham community does nothing, just like it did for Extra, the pool will probably remain unchanged. Children by the thousands will take one look at the book, and tell mom and dad they would rather get into computers. Many of us will look at the entry-level Technician class question pool and scratch our heads wondering why there are not more questions on ham radio operating as opposed to internal radio circuits like the inductive reactance of a coil — something that we don't really come in contact with as a new operator.

But who has the time at the end of this year to create close to 400 brand new questions for the beginning operator? One person alone would take months to pull off the job. I suggest the QPC and everybody in the ham radio industry send out a call, LOUD AND CLEAR, that every ham should send it at least one single question and four possible answers, dealing with 10 sub-element areas ranging from rules and regulations to safety around transmitting antennas. JUST ONE QUESTION!

Let the ham community create a brand new entry-level test question pool that has relevance to the beginning operator setting up their first two-meter base, mobile, or handheld station. When your brand new license arrives, and a buddy has preprogrammed your brand new handheld to the local repeater, what's a good way to make that first contact? Do you call CQ? Do you say the letters QRZ? Do you send out your call sign and say, "Gotta copy, good buddy?" Or maybe you just squeeze the transmit button and say your call sign, announce that you are on the air for the very first time, ask if anyone is receiving your signal, and again repeat your call sign phonetically? That would be a great way to go. Seems to me like a good, logical question for the test for beginners, huh?

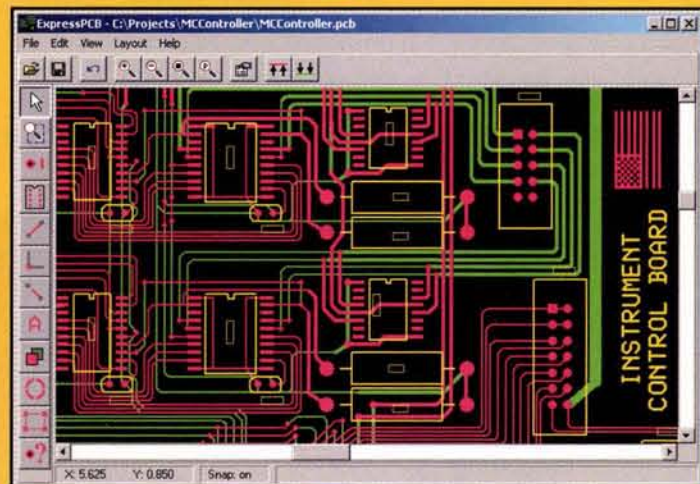
So yes, hams are in hog heaven with equipment prices staying the same or actually dropping, plenty of elbow room out there on the airwaves, ARRL-sponsored ham programs for schools, and thousands of volunteer hams who spend days and weeks teaching classes for free, giving tests for free, helping submit test questions for free, and becoming "Ham Ambassadors" to friends down the street wanting to get into this "secret handshake" hobby.

If you're interested in learning more about ham radio as an electronics techno — guy or girl — call 800-326-3942, or send email to newham@arrl.org. You may also send your suggested new Technician Class questions to Gordon West at swmeow@aol.com. Get your training material at 800-669-9594. We need more technical types like YOU! NV

\$59 PCBs

And our layout software is **FREE!**

Download ► Design ► Send ► Receive



Download our **FREE** layout software
Design your two-sided plated-through PCB
Send us your design with just a click
Receive your boards in a few business days

Select our MiniBoard service and get three top quality
2.5" x 3.8" PCBs for \$59 — shipping included!



expresspcb.com



DUSTMEISTER

The Search for an Intelligent Vacuum Controller — Part I

By Robert Lang and Thomas Ober

The circuitry described in this article can be used to control any large or small motor application.

For over 20 years, I have been a slave to my workshop dust collector. It is always off when I need it on and on when I want it off. I have to stop whatever I am doing and go over and turn the dust collector on or off. I am sure other woodworkers sometimes feel like slaves to their dust collectors, as well. And, if you are not a woodworker, read on. The circuitry described in this article can be used to control any large or small motor application.

In the process of machining wood, it is good practice to remove wood chips and sawdust with some sort of dust collection or vacuum system as they are produced. The inconvenience of manual dust collector controls may lead the woodworker into not using the dust collector and thereby not getting the improved safety or air quality benefits. On the other hand, continuously running a dust collector leads to a distracting, noisy shop and the wasting of electricity and air conditioning.

What I needed was a way to automate a shop-wide vacuum/dust collector system — such as the one shown in Figure 1 — to turn on whenever a woodworking tool is turned on and shut off after the tool is turned off. I searched for such a ready-made device, but could not find one.

I decided it was time to design and build an intelligent dust collector/vacuum controller that I call the DUSTMEISTER. In DUSTMEISTER Part 1, I will cover some basics of current sensing, the design and building of the hardware, and the circuit theory. In Part 2, I will cover the building of a tool sensor from scratch, and the programming and testing of the DUSTMEISTER.

DESIGNING THE SYSTEM

I looked at several approaches to the problem, but I eventually decided to detect the current flowing in the power wires to the tools. I wanted the system to have some intelligence, so I decided upon a microprocessor-based digital approach. I wanted the completed DUSTMEISTER system to:

1. Sense when woodworking tools are turned on or off.
2. Have a user-controlled delay after a tool starts before the dust collector system starts to minimize starting currents.
3. Have a user-controlled delay after a tool stops before the dust collector system stops to clear remaining wood chips.
4. Have no effect on the original dust collector manual control system when the DUSTMEISTER is powered off.
5. Be independent of amperage of the woodworking tools or dust collector system.
6. Avoid cycling the dust collector system unnecessarily when one tool is turned off and another is turned on after a short time.
7. Keep the woodworker informed of system status with simple, easy-to-understand English messages.
8. Be expandable for future improvements.

DUST COLLECTOR MOTOR CONTROLLER

The dust collector motor controller — also known as a magnetic starter — consists of a contactor with the addition of protective control. The controller depends on the magnetic pull of an electromagnet to close and hold its line and auxiliary contacts and offers unlimited flexibility of control. It is dependable and has a long life expectancy. The controller is a standard device for starting and stopping large motors such as those used in wood-

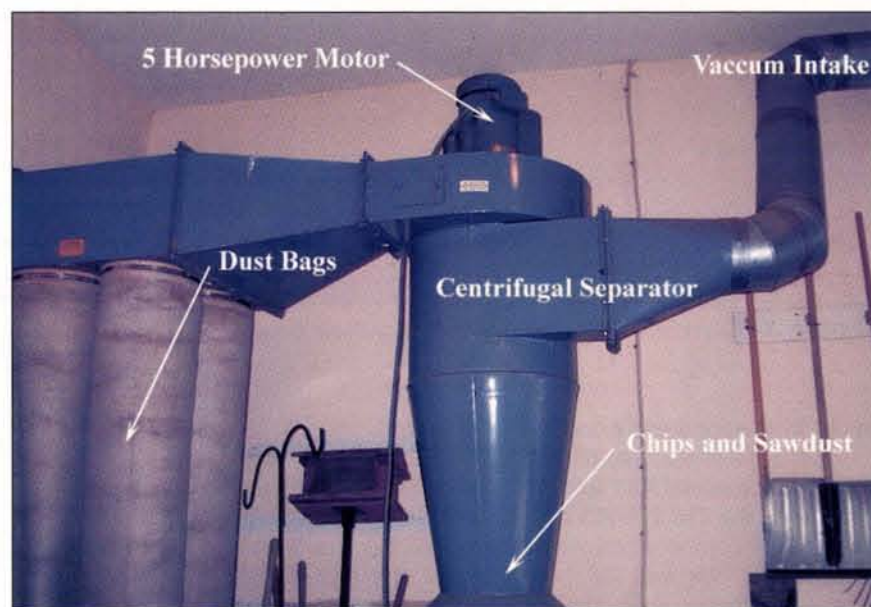


Figure 1 Shopwide Vacuum (dust collector) System

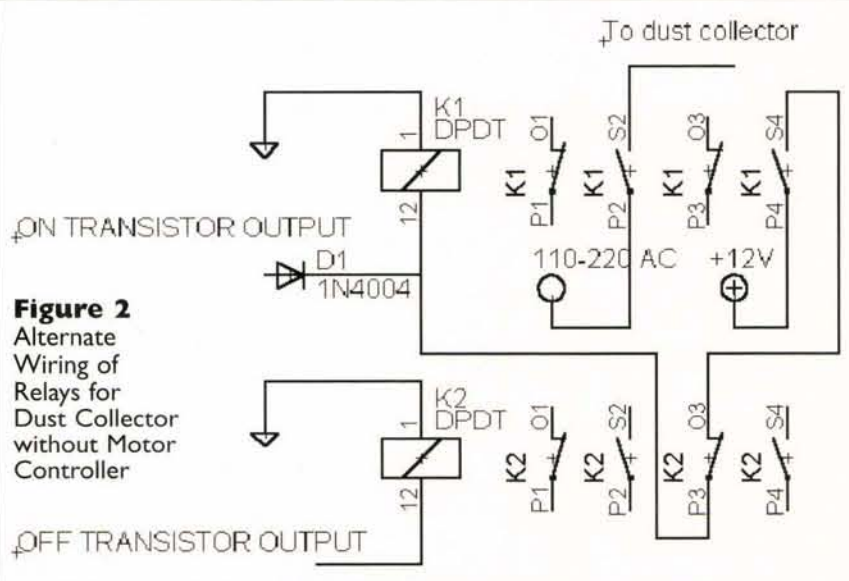


Figure 2
Alternate
Wiring of
Relays for
Dust Collector
without Motor
Controller

working tools or shop-wide dust collector systems. In my case, the dust collector uses a five-horsepower electric motor. A manual ON and OFF switch actuates the motor controller electromagnet which closes and opens the contacts that supply power to the motor. The motor controller electromagnet provides automatic motor shutoff on temporary power loss.

I used a SQUARE-D motor controller, but the description below should apply to most brands of motor controllers. I made no modifications to the SQUARE-D motor controller, but developed a way to control the momentary contact manual ON and OFF switches. Thus, the DUSTMEISTER is independent of the size of the dust collector motor being controlled.

Two 12-volt relays were used to automate the manual ON and OFF switches. The ON switch is a normally open switch used to supply 110-volts AC to the motor controller electromagnet.

I used a double pole, double throw relay in parallel with the manual ON switch. When the relay was energized for a short time, the normally open contacts would close which emulated the manual ON switch.

The OFF switch is a normally closed switch. A similar relay to the one used for the ON switch was connected in series with the OFF switch. When the OFF relay was energized, the normally closed relay contacts would

Tom Ober is an engineer and a member of the Society of American Period Furniture Makers and has built and restored 18th century American furniture and room surroundings as an avocation since 1975. His interest in classic woodworking began by assisting his wife in their antique business in Connecticut. **Robert Lang** is a professional electrical engineer who has written numerous articles for both electronic hobbyist and music magazines. His interests include electronics and building and restoring musical instruments. He has collaborated with Tom on the restoration of pianos from 1840 and 1790. He can be reached at rlang@netdoor.com.

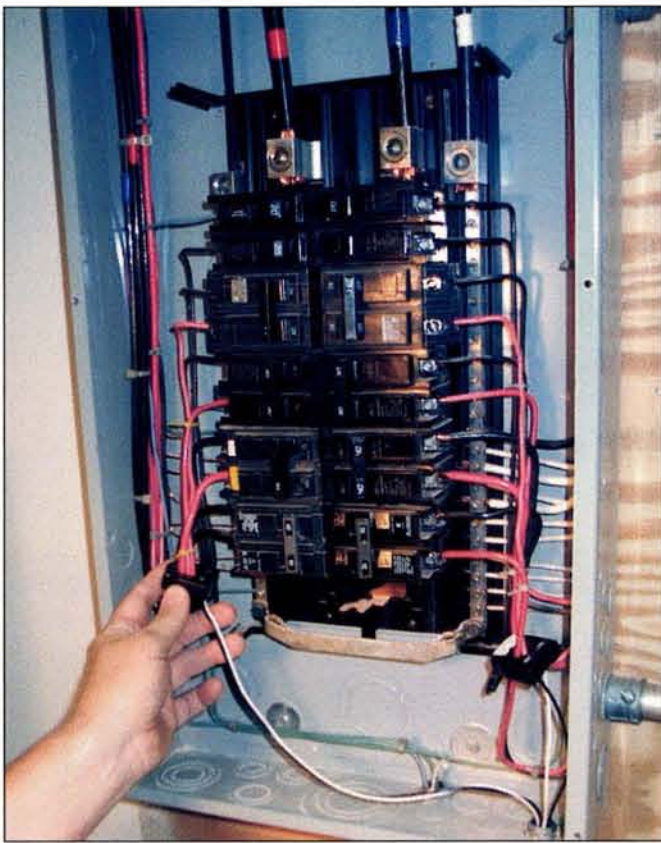


Figure 3 Current Transformer placement in Fuse Box

open. This action emulated the OFF switch.

Because of the way the DUSTMEISTER simply automates the manual ON and OFF switches of the motor controller, the DUSTMEISTER is completely invisible to the manual control when it is powered off. In other words, the manual ON and OFF switches of the SQUARE-D motor controller work the same as always when the DUSTMEISTER is off.

While the DUSTMEISTER circuit board uses only +5 volts and +12 volts, the relays are used to switch 110 volts on and off. Caution must be used when connecting the relays.

Work should never be done on a live circuit.

If your dust collector motor is not large enough to require a motor controller, do not worry. The DUSTMEISTER works just as well without a motor controller on small motors. For the case without a motor controller, the

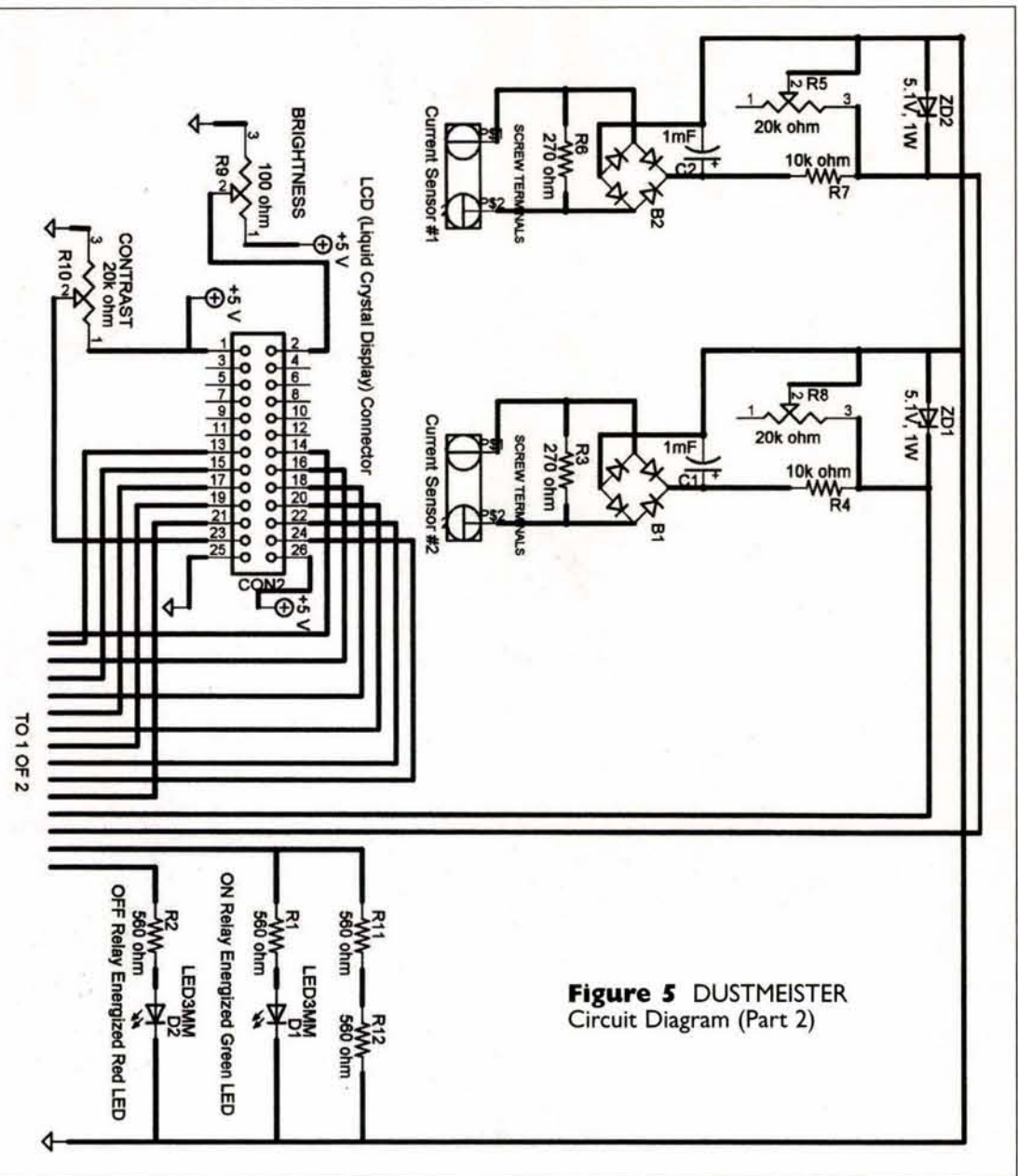


Figure 5 DUSTMEISTER Circuit Diagram (Part 2)

small dust collector motor is connected directly to the ON relay. The ON and OFF relays are connected together as shown in Figure 2 to create a latching relay. As an additional bonus, this set-up gives you one of the benefits of the motor controller. If there is a momentary power outage, the dust collector motor will be disconnected from the power source.

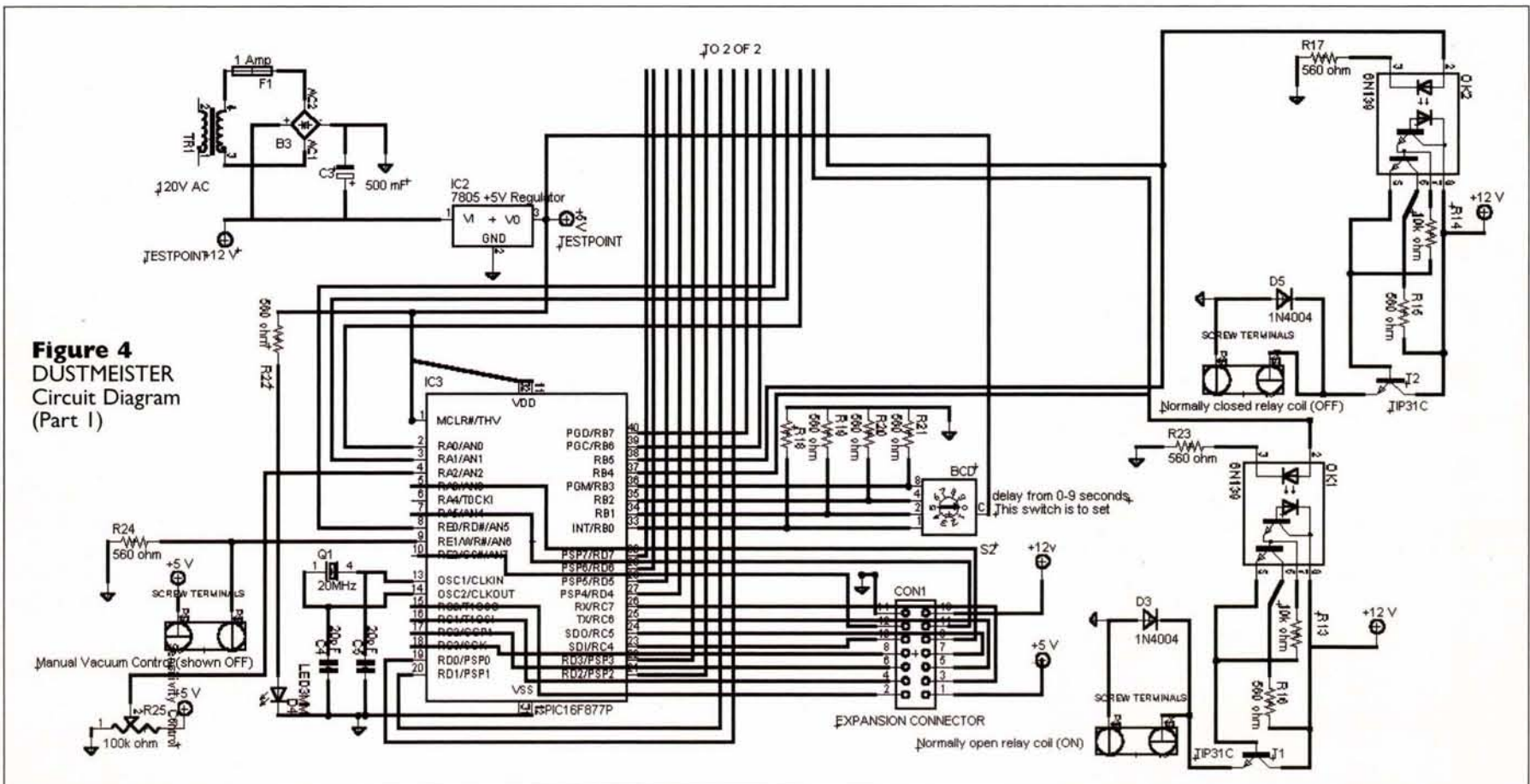


Figure 4 DUSTMEISTER Circuit Diagram (Part I)

CURRENT SENSING BASICS

Detecting current in wires has traditionally been approached in one of three ways:

1. Resistance measurements
2. Hall-Effect measurements
3. Current transformer measurements

Resistive sensing is very widely used, low-cost, and easily understood. Two shortcomings of resistance measurements are the insertion loss (heating and wasted power) and the lack of isolation. Signal amplification is usually required with resistive current sensing techniques.

Hall-Effect sensor integrated circuits represent the next approach to current sensing. Hall-Effect sensors develop an output signal that is proportional to the applied magnetic field. The magnetic field is usually generated by wrapping the current-carrying wire around a gapped toroid. The sensor is placed in the gap. Disadvantages of the Hall-Effect approach include cost, a non-zero output when there is zero current, and external power requirements.

Current transformers are the last of the low-cost current sensing methods. A current transformer is an instrument transformer in which the secondary current is substantially proportional to the primary current and differs in phase from it by an angle which is approximately zero.

As the term transformer implies, current transformers are only useful with alternating currents. While current transformers may be more expensive than the first two options, current transformers avoid insertion loss, offer electrical isolation, and do not require external power. They also exhibit zero output when there is zero current. For these reasons, I chose the current transformer approach using current sensors from Source 1. The most expensive components in the DUSTMEISTER circuit are the current transformers which cost about \$22.00 each. While most woodworkers may feel more comfortable using manufactured current transformers, it is also possible to make your own current sensors from scrap transformers as described in Part 2 of this article.

One phase of the current-carrying wire to each tool must be run through the hole in the current transformer sensor. The most convenient place to do this is in the fuse or electrical service box. Figure 3 shows two current sensors placed in the electrical service box. The two sensors used in the DUSTMEISTER can easily sense three tools each which means that the dust collector system can be controlled by any of the six sensed tools.

DUSTMEISTER CIRCUIT OPERATION

The circuit for the DUSTMEISTER is fairly simple. All voltages on the



Figure 7 Prototype DUSTMEISTER on Breadboard



Figure 6 Current Transformer

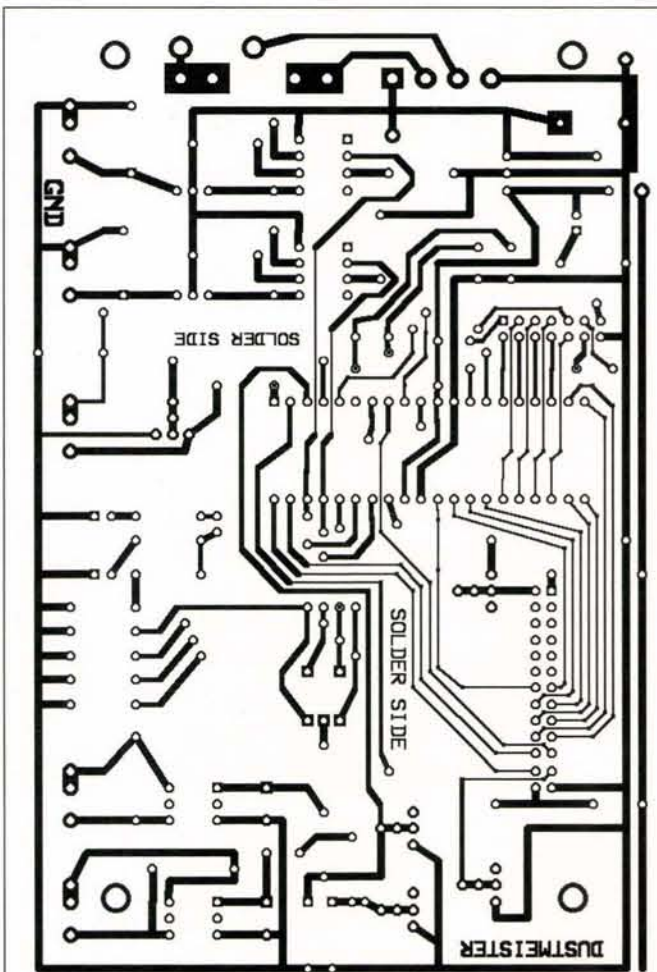


Figure 9 Bottom View of Circuit Board

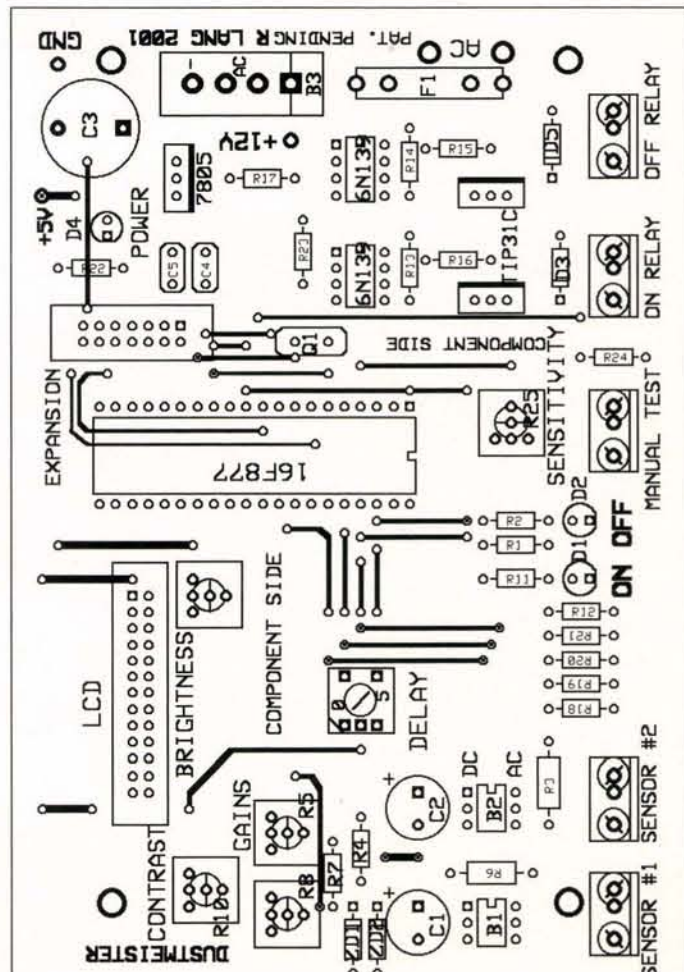


Figure 8 Top View of the Circuit Board

Source 1 CR Magnetics, Inc., for current transformers at <http://www.crmagnetics.com/>.

Source 2 DUSTMEISTER Homepage for preprogrammed PIC16F877 chips circuit boards at www2.netdoor.com/~rlang.

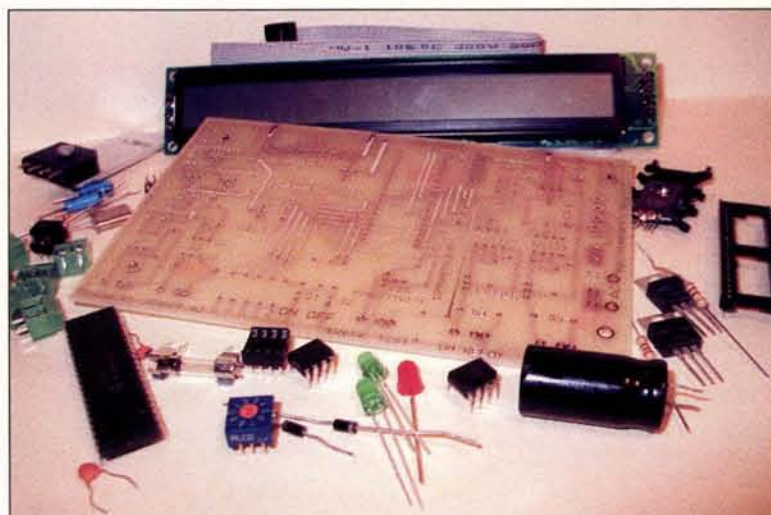
Source 3 Peter Anderson for blank PIC16F877 and ceramic resonators at <http://www.phanderson.com>.

Source 4 Electronix Express for printed circuit making supplies and miscellaneous electronic parts at <http://www.elexp.com>.

Source 5 Marlin P. Jones & Associates, Inc., for electronic parts at <http://www.mpja.com>.

Source 6 Jameco, Inc., at for optical isolators <http://www.jameco.com>.

Figure 10 DUSTMEISTER Parts and Etched Circuit Board



circuit board are 12 volts or less. The major electronic component is the PIC16F877 microprocessor. The circuit is shown in Figure 4 and Figure 5 and works as follows.

Current flowing to a woodworking tool is sensed by using a CR Magnetics remote current transformer connected to the Sensor #1 or Sensor #2 terminal strips. This device — shown in Figure 6 — can detect current flowing through a wire threaded through its circular opening.

The secondary of the current transformer should never be allowed to become open circuited when current is flowing through the primary (the wire supplying power to the tool). When open-circuited, the voltage across

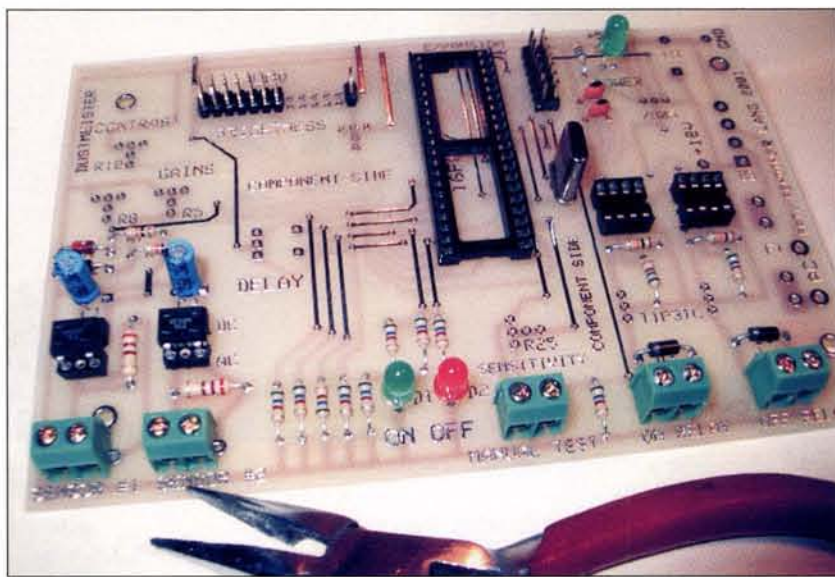


Figure 11 DUSTMEISTER Circuit Board with Diodes, LEDs, Crystal, Capacitors, and Connectors Added



Figure 13 DUSTMEISTER Completed Circuit Board

Table 1 PIC 16F877 and LCD DUSTMEISTER Data Connections

REGISTER/ BIT	INPUT OR OUTPUT	DESCRIPTION	PIC16F877 PIN	CONNECTOR
RA0	I	Current Sensor #1 (analog)	2	NC
RA1	I	Current Sensor #2 (analog)	3	NC
RA2	I	Minimum Turn-on Setting (analog)	4	NC
RA3	I	UNUSED	5	E9
RA4	O	Open drain don't use		
RA5	I	UNUSED	7	E11
RD0	O	Output to LCD	19	L19
RD1	O	Output to LCD	20	L20
RD2	O	Output to LCD	21	L17
RD3	O	Output to LCD	22	L18
RD4	O	Output to LCD	27	L15
RD5	O	Output to LCD	28	L16
RD6	O	Output to LCD	29	L13
RD7	I/O	Input/Output to LCD (LCD BUSY BIT)	30	L14
RB0	I	BCD SWITCH BIT 0	33	NC
RB1	I	BCD SWITCH BIT 1	34	NC
RB2	I	BCD SWITCH BIT 2	35	NC
RB3	I	BCD SWITCH BIT 3	36	NC
RB4	O	ON Relay	37	NC
RB5	O	OFF Relay	38	NC
RB6	O	LCD ENABLE PULSE	39	L22
RB7	O	LCD MODE: 0=COMMAND, 1=DATA	40	L24
		CLOCK	9,10	
GND			12,31	L25,E14
+5V			1,11,32	L26,L1,E1
+12				E13
		LCD CONTRAST		L23
		LCD BACKLIGHT		L2
RC0	O	UNUSED	15	E2
RC1	O	UNUSED	16	E4
RC2	O	UNUSED	17	E6
RC3	O	UNUSED	18	E8
RC4	O	UNUSED	23	E10
RC5	O	UNUSED	24	E7
RC6	O	UNUSED	25	E5
RC7	O	UNUSED	26	E3
RE0	O	LCD READ/WRITE 0=WRITE, 1=READ	8	L21
RE1	I	MANUAL SWITCH	9	NC
RE2	O	UNUSED	10	E12

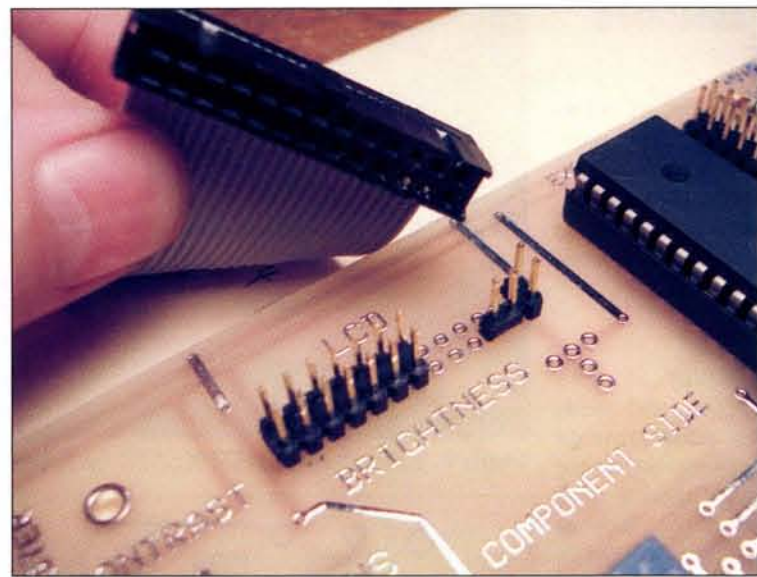


Figure 12 LCD Display Connection

CHECK OUT THE ANIMATION VIDEO OF THE DUSTMEISTER IN ACTION ON THE WEB AT www.nutsvolts.com

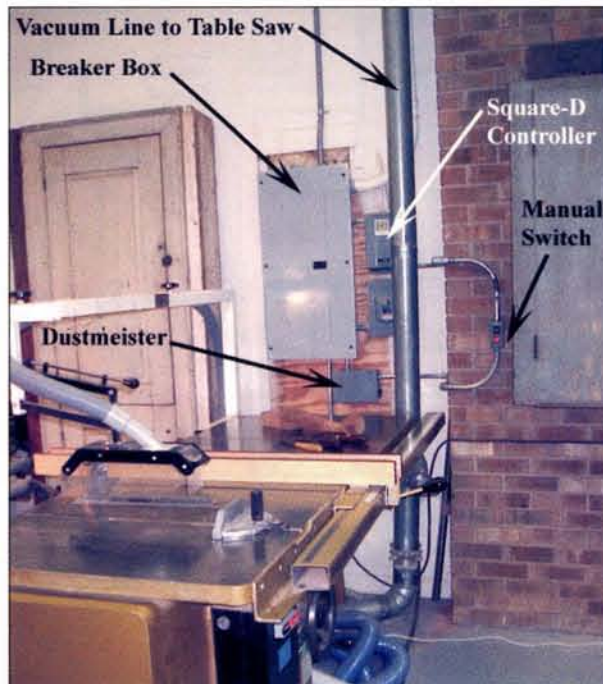


Figure 14 Placement of DUSTMEISTER in Workshop

the secondary becomes so high as to be dangerous and the flux becomes so large in magnitude that the transformer may overheat.

With this caution in mind, each current transformer is connected to a 270-ohm resistor and bridge rectifier. The DC output is filtered by a 1mF capacitor and limited to a maximum of 5.1 volts by the Zener diode. The Zener diode is important because otherwise the voltage across the capacitor can easily exceed the microprocessor analog-to-digital (A/D) input limits. There is

also a 20k ohm potentiometer for each sensor to control the voltage to the A/D converter. The voltage is applied to one of the A/D converter pins on the microprocessor. Up to two sensor circuits can be used.

There are several other controls. A 100k ohm potentiometer acts as a sensitivity control to set the current which will turn on the dust collector. A 100 ohm and a 20k ohm potentiometer act as the brightness and contrast controls for the LCD display.

Microprocessor pins 33-36 are inputs for the number of seconds of delay. Microprocessor pins 19-22, 27-30, 8, and 39-40 are outputs used to drive the Liquid Crystal Display (LCD).

The LCD displays English messages to the woodworker to inform him of the state of the system.

Microprocessor pins 37 and 38 are outputs used to control the two relays. The ON relay closes the normally open switch and supplies voltage to the SQUARE-D automatic motor controller as if the manual ON switch had been pressed. The OFF relay opens the normally closed circuit as if the manual OFF switch had been pressed. The output of the microprocessor is too feeble to control a 12-volt relay.

The output of the microprocessor is used to control the 6N139 optical isolator. The output of the optical isolator is used to control a 40-watt transistor. The transistor supplies more than adequate current at 12 volts to energize the relay coil. Components TR1, B3, C3, and F1 in the circuit diagram make up a 12-volt DC power supply. IC2 is a 7805 voltage regulator that supplies +5 volts to the microprocessor.

BUILDING THE DUSTMEISTER HARDWARE

Initially, I built the vacuum controller circuit on a breadboard, as shown in Figure 7. After I completed the initial design and testing of the hardware and software, I designed and built a printed circuit board. Figure 8 shows the pattern for the component and foil pattern for the circuit board as viewed from the top. The correct size for the circuit board is 3.9" x 5.9".

Figure 9 shows the foil pattern for the bottom side of the circuit board. Table 1 is a wiring list for the microprocessor and the external connectors. You can build your own vacuum controller using the foil pattern and the parts shown in Table 2 for about \$100.00. If you don't want to program your

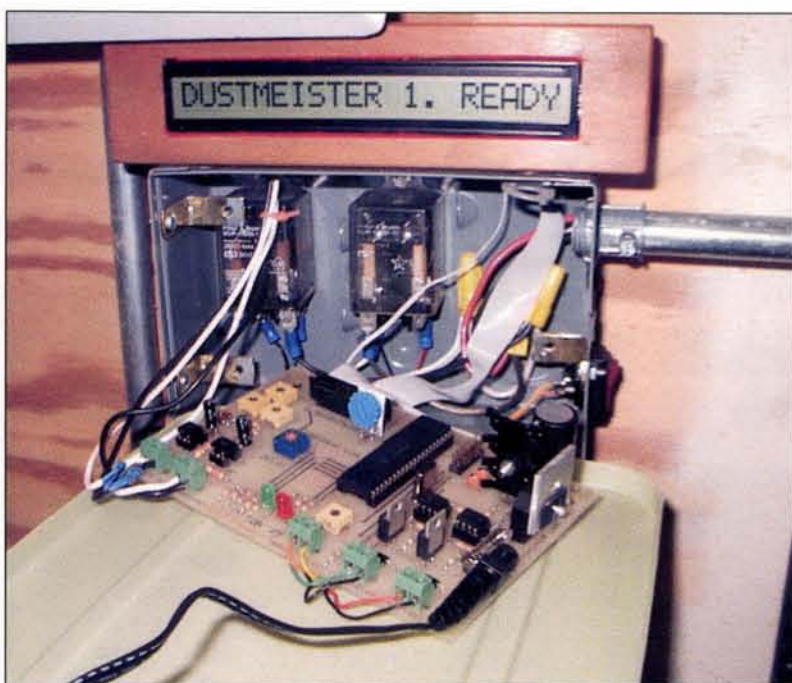


Figure 16 Connecting DUSTMEISTER to Sensors and Relays

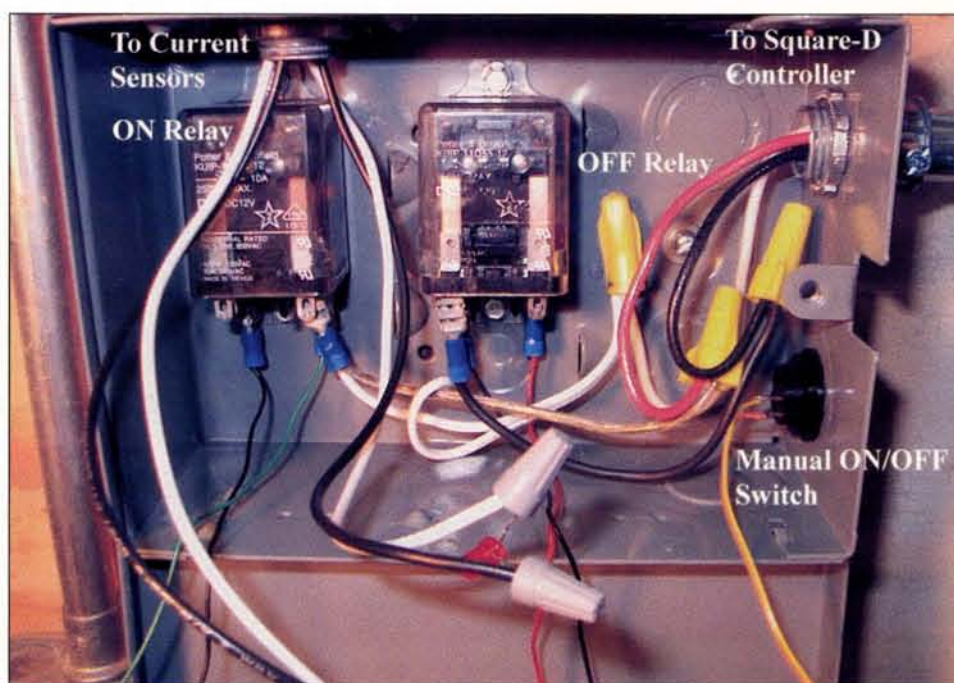


Figure 15 DUSTMEISTER Control Box with Relays

Qty	Value	Device	Parts	Vendor and Part #
1		20 Character LCD Display	LCD1	Source 5 8087-OP
2	1 Amp	100 Piv Bridge Rectifiers		Source 4 11DB01
1		26 Pin Connector	CON2	Source 6 53495
1		+12 Switching Power Supply	PS1	Source 5 12815PS
2	1N4004	Diode	D3, D5	Source 4 111N4004
2	1 mF	Electrolytic Capacitor	C1, C2	Source 4 14ER0501U
2	5.1 V	Zener Diode	ZD1, ZD2	Source 4 1114N4733
2	6N139	Optical Isolator	OK1, OK2	Source 6 42489
4	10k ohm	1/4 Watt Resistor	R4, R7, R14, R13	Source 4 13005100K
1	16F877	Preprogrammed Microchip Microprocessor	IC1	Source 2
1		40 Pin IC socket	For IC1	Source 4 191CM40
3	20k ohm	Potentiometer	R5, R8, R10	Source 4 18CSP20KH
1	100 ohm	Potentiometer	R9	Source 4 18CSP100H
1	100k ohm	Potentiometer	R25	Source 4 18CSP100KH
2	270 ohm	1/2 Watt Resistor	R3, R6	Source 4 13.55270
12	560 ohm, 1/4 watt	Resistors	R1, R2, R11, R12, R15, R16, R17, R18, R19, R20, R21, R22, R23, R24	Source 4 13005560
1	7805	+5V Voltage Regulator, TO-220	IC2	Source 4 107805T
1		0-9 BCD Compliment Out Switch	S2	Source 5 5323SW
1	20MHz	Crystal	Q1	Source 3
2	20pF	Capacitor	C4, C5	Source 3
2		Green LED	D1, D4	Source 4 08I53GD
1		Red LED	D2	Source 4 08I53RD
5		Two Position Screw Terminal Strip	ST1, ST2, ST3, ST4, ST5	Source 5 7398TS
2	TIP31C	3 Amp NPN Transistor, TO-220	T1, T2	Source 4 11TIP31
2		12V DPDT Relay	K1, K2	Source 5 8787RL
2	Model 18	Remote Current Indicator		Source 1
1		Test Switch		Source 4 1700LKR
1		3.9" x 5.9" Circuit Board		Blank board from Source 4, 03PSPb1 or pre-etched and drilled circuit board from Source 2
1	4 Amp	Bridge Rectifier	B3	Source 4 11RS402
1	500 mF	Electrolytic Capacitor	C3	Source 4 19ER035500U
1		110V/9V, 1.5 Amp Transformer	TR1	Source 6 112336
1	1 Amp	5mmx20mm Fuse and Fuse Holder	F1	Source 6 102859, 103907

Table 2 DUSTMEISTER Parts List

own microprocessor or etch your own circuit board, a pre-programmed PIC16F877 microprocessor chip and a double-sided etched/drilled printed circuit board are available from Source 2. To build the DUSTMEISTER, gather the parts and purchase or etch a printed circuit board.

Figure 10 shows most of the parts and the etched circuit board necessary to build the DUSTMEISTER. If you have etched your own single-sided circuit board, begin by examining the circuit board for any copper bridges or open circuits. Place jumpers on the top of the board as shown in Figure 8. If you purchased a board, the jumpers are etched on the top side of the board.

To assemble the board, begin by soldering the IC sockets, resistors, and the five screw terminals to the circuit board. Verify the orientation of all IC sockets before soldering. Be careful when soldering the socket for IC1. The

shown in Figure 11. Add the transistors, potentiometers, and power components to the board. Next, add the BCD switch, S2, being careful to orient it as shown in Figure 8. Complete the assembly by connecting the transformer and plugging the LCD to the LCD connector. Note the orientation of the LCD connector in Figure 12. You may want to add indexing pins at unused pin locations 4 and 6 to avoid incorrectly connecting the plug.

The completed DUSTMEISTER circuit board is shown in Figure 13. The DUSTMEISTER was placed near the workshop electrical service box as shown in Figure 14. I purchased a metal box to protect the relays and TEST switch as shown in Figure 15. I connected the relays, TEST switch, and sensors to the DUSTMEISTER as shown in Figure 16. Figure 17 shows the completed DUSTMEISTER with the LCD readout in a wooden frame. Next time, I will complete the DUSTMEISTER with a discussion of building a tool sensor from scratch, and the programming and testing of the DUSTMEISTER. **NV**



Figure 17 Completed/ Installed DUSTMEISTER (Access door open)

IC1 socket and the LCD and expansion connectors have copper traces running between pins that are spaced 0.1" apart and can easily be shorted by sloppy soldering. The holes on the circuit board from Source 2 are plated through and require only the smallest amount of solder.

Next, proceed with adding all diodes, LEDs, crystal, capacitors, LCD, and expansion connectors as shown in Figure 11. Add the transistors, potentiometers, and power components to the board. Next, add the BCD switch, S2, being careful to orient it as shown in Figure 8. Complete the assembly by connecting the transformer and plugging the LCD to the LCD connector. Note the orientation of the LCD connector in Figure 12. You may want to add indexing pins at unused pin locations 4 and 6 to avoid incorrectly connecting the plug.

2-Channel 20 MS/s Scope

US\$ 199.-



Options
PC Software V2.0 incl. Adapter Cable..... 69.00
Signal Probe 1:1/10:1 60MHz 14.90
Rubber Protection Boot..... 19.90
AC Adapter 9.90
hard-shell anti-static carry case..... 39.90
Complete Set Scope + options (2 Probes) ... 349.00

Wittig Technologies

Wittig Technologies, Inc.
266 East Meadow Avenue
East Meadow, NY 11554
Phone (516) 794 4080, Fax (516) 794 1855
www.wittigtechnologies.com

Subscribe today!

Call toll-free at 1-800-
783-4624 or go online at
www.nutsvolts.com

DesignNotes.com

Your Design Resource on the Web

Improve Your Design
Skills, Find Project
Advice and More

JUST RELEASED

Velleman's PCS500



PC
Oscilloscope
50 MHz
Up to 1 GHz
Repetitive
\$399.95

For complete specs, visit:
www.designnotes.com

Visit Our Online Forum

On-Line Circuit Archive

Hundreds of Circuits.
Over 23 Different Topics

Designing for Dollars

- 1) Submit your favorite circuit or program.
- 2) Each month the best design entry (Judged by your peers) wins \$100
- 3) Monthly winners are eligible for the yearly \$1200 Grand Prizel

NEXT GRAND PRIZE DRAWING IS
OCT. 2002

Share What You Know and
Learn What You Don't

Visit Us at
www.designnotes.com



WIN with Nuts & Volts

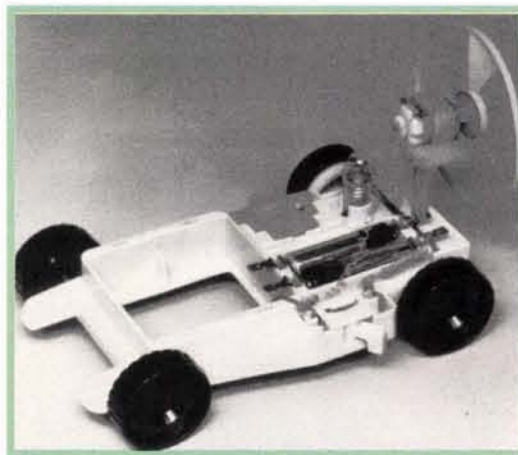
PAID SUBSCRIBERS ARE AUTOMATICALLY
ENTERED EACH MONTH!

This month's sponsor ...

Unicorn Electronics

Scoot Car

Check out
Unicorn's ad
on Page 57
for more
great stuff!!



This month's winners ...

John Jennette of Middleborough, MA
Jaime Herrera of Hackensack, NJ
Stan Neuhausen of Madison, CT

To Subscribe — Just fill in and mail the card supplied in the magazine or call our toll free order line at (800) 783-4624 with a Visa or MasterCard. If you do not wish to order a subscription, but would like to be entered in our drawing, simply send or email your name, address, and telephone number to *Nuts & Volts*, 430 Princeland Ct., Corona, CA 92879 or drawing@nutsvolts.com. No phone entries accepted. All orders/entries must be received by the last day of the month to be included in that particular month's drawing.

Computer Desktop Encyclopedia

Experience it today at the Nuts & Volts website.

For Experts and Novices —

The Encyclopedia contains more than 15,000 definitions, illustrations, photos, charts and diagrams, and covers the field from micro to mainframe.

Everyone Needs This — You can't escape computer and telecom lingo in this day and age. The Encyclopedia covers only the high-tech world, but makes it interesting for everyone.

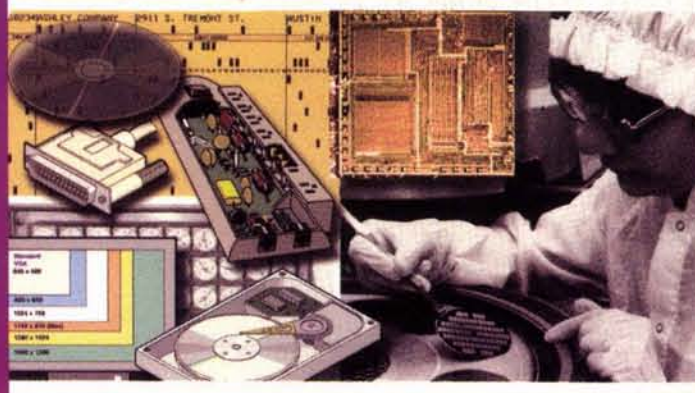
Twenty Years in the Making —

Starting as The Computer Glossary in 1980, the Encyclopedia is the longest-running computer dictionary. Edited by Alan Freedman, noted computer lexicographer with 40 years of experience in the industry, the Encyclopedia is the most comprehensive reference of its kind.

Computer Desktop Encyclopedia

The indispensable
reference on
computers.

Version
14.1



If computer terminology or high tech mumbo jumbo seems to leave you on the outside looking in, you need to check out this cool feature available now at
www.nutsvolts.com

Check it out. It's informative, it's here now ...

New Product News



SCOPE + SCOPEALYZER™ = LOGIC ANALYZER

Did you ever wish you could use your existing 20 MHz oscilloscope as a high-performance logic analyzer? Now you can with the highly affordable Barrett Instruments ScopeAlyzer™.

Just attach one vertical channel and the external trigger to the ScopeAlyzer and you now have a professional-grade logic analyzer with these specs: 16 channels, 100 MHz sample rate (1-2-5 sequence), 128K memo-

ry, trigger (0,1,x, edges), and tracepoint.

The ScopeAlyzer emphasizes ease of use since one of the most frustrating aspects of logic analyzers is that they are difficult to use and set up.

Want to take a snapshot of data? With the ScopeAlyzer, you only need to press one key.

The ScopeAlyzer is small — measuring only 3" x 5" — and fits conveniently in the toolkit and on the bench. When you need it add it to the oscilloscope without disturbing the rest of your workbench.

The ScopeAlyzer is offered in two models: Model 61050, eight channels, 50 MHz \$395.00; Model 61100, eight channels, 100 MHz \$595.00.

For more information, contact:

BARRETT INSTRUMENTS
P.O. BOX 3390, DEPT. NV
SARATOGA, CA 95070
1-800-272-1936

EMAIL: sales@BarrettInstruments.com
WEB: www.BarrettInstruments.com

MOBILE RADIO PROTECTION AGAINST THEFT AND TAMPERING

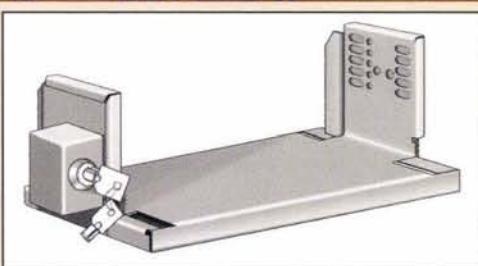
Availability of the ET-850 Locking Slide Mount for amateur and commercial two-way mobile radios is announced by Hugh Goulding, President of E TIP, Inc.

Designed to help prevent theft and tampering, the ET-850 provides a standardized radio-mounting platform for vehicles and other equipment applications while allowing the operator to remove the radio easily and quickly. The attractive and durable black powder-coat finish makes the ET-850 at home in the work vehicle or the luxury automobile.

Because the radio is mounted to the slide for easy removal and the base stays in the vehicle, blind fumbling with tools to release hidden fasteners is eliminated. Technicians save labor wherever the ET-850 is installed. Transfer of radios between vehicles becomes easy and straightforward.

The ET-850 locking slide mount with an independent tubular key system provides a higher level of security that helps control unauthorized removal and transfers, tampering, and thefts of opportunity.

Many fleet organizations such as fire, law enforcement, utilities, schools, marine operations, trucking, contractors, service, and commercial organizations, etc., encounter expensive and disruptive loss of communications



because of crimes aimed at the two-way radio. Fleet communications are an important infrastructure component that is vital to providing superior service. Protecting mobile two-way radios with the ET-850 locking slide mount lessens the potential for disruption of a fleet communications network. Increased awareness of the importance of fleet communications and the vulnerability of radios is especially important now.

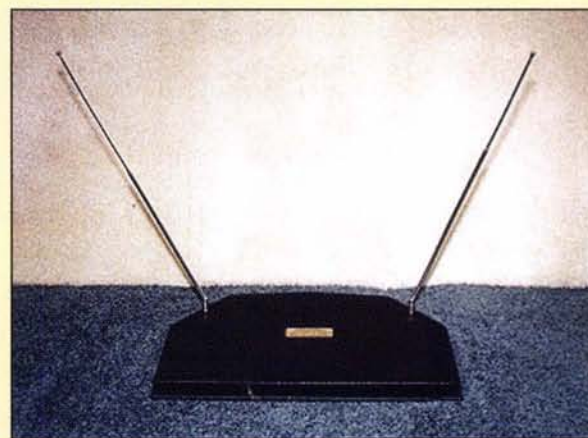
The ET-850 locking slide mount fits most of the available mobile two-way radios on the market today including but not limited to: Kenwood, Motorola, Johnson, Uniden, Vertex, Ericsson, M/A Com.

Ask about the new double-stack locking slide mount that secures two mobile radios and the high-security radio cage.

For more information, contact:

E TIP, INC.
P.O. BOX 571
29 S. IOWA AVE.
DEPT. NV
ADDISON, IL 60101
630-530-8393
FAX: 630-530-5019
EMAIL: sales@etipinc.com
WEB: www.etipinc.com

SUPER ANTENNA MODEL 1



Godar Electronics introduces Super Antenna Model 1 for high definition television. This is the world's first compact rabbit ear incorporating rods with a 14 element yagi antenna. This combination gives stable digital HDTV, and standard VHF/UHF reception.

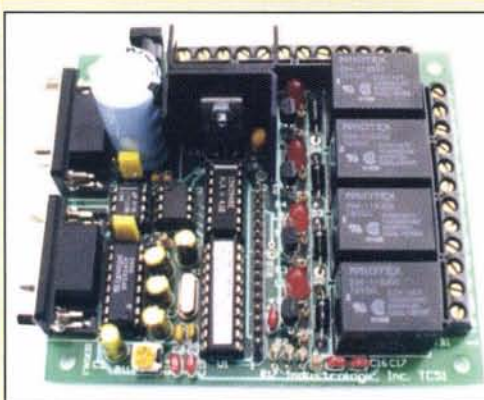
Model 1 is a passive non-amplified broadband antenna requiring no electronic amplifier. In addition, there are no controls or switches. This will add to the product's longevity.

Model 1's sleek flat design affords a better looking antenna over other indoor TV antennas. The base is made of indestructible ABS plastic. A six-foot detachable coax cable is included.

Price is \$59.95, made in the USA.

For more information, contact:

GODAR ELECTRONICS
339 N. GILBERT RD., DEPT. NV
GILBERT, AZ 85234
480-892-8207



TC51 SINGLE BOARD COMPUTER

Industrologic, Inc., announces the release of their TC51 Single Board Computer.

The Industrologic TC51 is a microcontroller-based single board computer designed to be a complete industrial controller assembly that is easy to program and connect to external signals. It includes a versatile complement of input and output circuitry needed by many common control applications.

The board can be programmed as a stand-alone controller using its on-board Tiny Machine Basic programming language, or it can be used as an RS-232 serial data acquisition board.

The TC51 is based on the Atmel AT89C4051 microcontroller chip with EEPROM program memory, and can be reprogrammed using any number of software development tools and device pro-

grammers available for Atmel microcontrollers.

Communication with the TC51 is accomplished via two serial RS-232 ports with true RS-232 drivers and DB9 connectors matching PC compatible serial port pinouts.

Convenient screw terminal block connections are used for all of the digital, analog, and relay connections, which include four 10 amp Form "C" relays, four logic levels signals usable as inputs or outputs, and two 12-bit analog-to-digital inputs.

Its on-board power supply has a wide input range and includes +5 and +12 volt outputs for use by external devices.

The TC51 package is shipped complete with all items necessary to immediately begin application development, including a serial port cable for connection to a PC compatible computer, a wall block power supply, host computer software, and programming examples, and hardware and software reference manuals.

For more information, contact:

INDUSTROLOGIC, INC.
3201 HIGHGATE LN.
DEPT. NV
ST. CHARLES, MO 63301
314-707-8818
EMAIL: info@industrologic.com
WEB: www.industrologic.com

High Tech Video system w Audio

Includes TWO B/W Cameras w sound & I.R. (night vision) ONE 5.5" B/W Monitor with Built-In adjustable Switching (from 2 to 20 seconds) & two 60 ft. pre-wired cables. Everything you need to set up a high tech video monitoring system at home, office, restaurant warehouse or use it as a baby monitor. Easily hooks into VCR for



Video Recording also

item # Dual View

Fantastic Price!

\$119.00 ea
(\$109.00 ea. qty 4)

view extensive details @ web site

2GHz RF
Field
Strength
Analyzer

ONLY

\$1699

Best Price!

• Frequency Range: 100kHz to 2.060MHz
• Narrow Band FM (NFM), Wide Band FM (WFM), AM and Single Side Band (SSB) Modulated Signals May Be Measured
• PLL Tuning System for Precise Frequency Measurement and Tuning
• LED Backlight LCD (192x192 dots)
• Built-In Frequency Counter
• Hand-Held and Battery Operated
• All Functions are Menu Selected
• RS232C for PC Interface and Printer

#3201

See the web site for details

Removable Hard Drive Rack

We Sold Over 18,000 in 2000!

For IDE/Ultra DMA Hard Drives
This product can be used with any 3-1/2 IDE hard drive up to 1" high. It includes an electronic keylock for safe removal and insertion. Made of ABS 707 fireproof plastic. Use this product to protect sensitive hard drive data, take your hard drive between work and home or even set up different users with their own hard drives that they physically insert every time they use a PC. Other models available from C.S.I. include RH10 series and RH20 series, which are interchangeable within the same interface design (IDE or SCSI). Other Models are Available. See www.web-tronics.com under "hard drive and accessories" for more details and pictures.



RH-10C-IDE

ONLY
\$14.95
any qty.

Dual Output Bench Power Supply

with four 3 1/2 digit LCD Displays



Output: 0-30VDC x 2 @ 2 AMPS
Source Effect: <0.02%+1mV
Load Effect: <0.01%+5mV
Ripple & Noise: <1mVrms
Dimensions: 365 x 265 x 164 mm
Input Voltage: 110VAC +/- 10%

CSI3002D-2.....\$159.00

(qty 5+...\$149.00) Details at www.web-tronics.com

Auto-Temp Solder Station with Ceramic Element

- With Ceramic Heating Element for More Accurate Temp Adjustment
- 3 Conductor Grounded Power Cord
- 250°C-480°C (470°F-900°F)
- Fast Heating Feature



SR-976

Extra Tip Options Available. See Web!

ONLY
\$39

CTRL - D
to bookmark
this site

www.web-tronics.com

Don't forget
the dash

Circuit
Specialists
Inc.

In Business
Since 1971

- Easy to Navigate
- Includes a Search Engine That Really Works
- New Items Added Constantly

For More Info See www.web-tronics.com

CCD B&W Board Cameras

- ASIC CCD Area Image Sensor
- Extremely Low Power Consumption
- 0.5 Lux Min Illumination
- Built-In Electronic Auto Iris for Auto Light Compensation

Detailed Specs on the Web

VM1030PA-B 30mmx30mmx25mm, Pinhole lens, 12V \$39.00 any qty.

VM1030A 30mmx30mmx26mm, Standard lens, 12V \$39.00 any qty.

VM1035A 42mmx42mmx25mm, Standard lens, 12V with back light compensation \$49.00 any qty.

VMCB21 44mmx38.5mmx28mm, with 6 infra-red LEDs, 12V \$49.00 any qty.

VM1036A 32mmx32mmx25mm, Standard lens 12V, reverse mirror image feature \$49.00 any qty.



Detailed Specs
on the Web

B&W, Color & Powerful Night Vision Model

- Smart Rugged Metal Housing
- Extremely Low Power Consumption
- 12 Volt
- CCD Area Image Sensor for Long Camera Life
- Built-In Electronic Auto Iris for Auto Light Compensation
- No Blooming, No Burning
- 0.1 Min Lux Illumination (B&W), 1 Lux Min Lux Illumination (color)

Bullet CCD Cameras

Detailed Specs on the Web



VMBLT1020 B&W, 21mm(D)x55mm(L) \$49.00 any qty.

VMBLT1020W B&W Weatherproof, 21mm(D)x58.5mm(L) \$69.00 any qty.

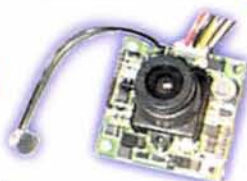
VMBLTJC19BW COLOR! Weatherproof, 17mm(D)x88mm(L) \$109.00 any qty.

WDB-5007S Powerful night vision camera (56 IR LEDs) \$159.00 (\$139.00/ 5+)

COLOR CCD Mini Board Cameras

- Low Power Consumption
- 1 Lux Illumination
- Built-In Electronic Auto Iris for Auto Light Compensation
- Internal Synchronization
- 12Volts
- 400 TV Lines

Detailed Specs
on the Web



VM3010PA 33mmx33mmx18mm, Pinhole lens with audio \$99.00 any qty.

VM3010-A 33mmx33mmx32mm, Standard lens with audio \$99.00 any qty.

DC to AC Power Inverters!

150 watt up to 3000 watt models!

150w modified sine wave: \$29.95 (G-12-015B) Check Our Low Prices!

300w modified sine wave: \$39.95 (G-12-030)

150w pure sine wave: \$69.00 (G-12-150S)

300w pure sine wave: \$109.00 (G-12-300S)

800w modified sine wave: \$139.00 (G-12-800)

1000w modified sine wave: \$179.00 (G-12-100)

3000w modified sine wave (phase corrected), (G-12-300).....\$489.00

See Our web site for DETAILED Specs.!



G-12-030 300W

Our Most Sophisticated DMM We Sold Over 800 Last Year! with RS-232 Interface & Software, 3-3/4 Digit, 4000 Count, Auto-Ranging with Analog Bargraph

- True RMS Mode
- 10MHz Frequency Counter
- Time Mode with Alarm, Clock, and Stop Watch
- Dual Display
- 10 Location Memory
- Min, Max, Avg and Relative Mode
- Decibel Measurement
- Cap and Ind. Measurement
- Temperature Mode (C/F)
- K Type Temperature Probe Included
- Pulse Signal for Logic & Audible Test
- Continuity/Diode Test
- Logic Test
- Auto Power OFF/Keep ON Mode
- Fused 20A Input with Warning Buzzer
- Back Light
- Data Hold/Run Mode
- Safety Design UL1244 & VDE-0411
- Protective Holster
- Silicon Test Leads



NOW
ONLY
\$149

Reg. \$169

More Details
on our
Web Site

PROTEK 506

\$129.00 ea. qty 10

Bench Digital Multimeter w RS232C

\$99.00 !

Item#
CSI9803R



- *Digital & Analog Display, 3999 counts & 42 segment bar graph.
- *Autorange & Manualrange
- *DATA HOLD, Min/Max Relative Measurement
- *Storage Data DISPLAY/RECALL
- *True RMS f AC voltage & current
- *Back Light
- *ADP Measurement: 400mV +/- 3%
- *Continuity & Diode test
- *Power Source: AC or DC

See details @ web site

O'Scope Offer

30MHz! ONLY \$299!

ONLY
\$299



- Dual Channel
- Dual Trace
- Vert Trigger
- 1 Year C.S.I. Warranty!

Includes 1 oscilloscope probe
Manufactured for CSI by a leading O.E.M. manufacturer. See our website for detailed specifications!

#OSC-1030

Digital Read Out 3Amp Bench Power Supplies

Available in 0-30 volt & 0-50 volt versions

High stability digital read-out bench power supplies featuring constant voltage and current outputs. Short-circuit protection and current limiting protection is provided. Highly accurate LED accuracy and stable line regulation make the 3000 series the perfect choice for lab and educational use.

Line Regulation: $2 \times 10^{-4} + 1 \text{ma}$
LED Accuracy: Voltage $\pm 1\% + 2 \text{ digits}$
Current $\pm 1.5\% + 2 \text{ digits}$
Wave Line Noise: $\leq 1 \text{mVrms}$
Dimensions: 291mm x 158mm x 136mm

New!
Lower Prices

CSI3003: 0-30v/0-3amp 1-4 / \$89.00 5+ / \$85.00

CSI5003: 0-50v/0-3amps 1-4 / \$109.00 5+ / \$99.00

Bookmark our WEB Site! Many more Power Supplies are Available. Look Under Test Equipment



AS
LOW AS
\$85

Selected Titles For The Electronic Hobbyist and Technician —

The NV Hobbyist Bookstore

Robotics

The Robot Builder's Bonanza by Gordon McComb

A major revision of the bestselling "bible" of amateur robotics building — packed with the latest in servo motor technology, microcontrolled robots, remote control, Lego Mindstorms Kits, and other commercial kits. **\$24.95**



Microcontrollers

Handbook Of Microcontrollers by Myke Predko

This reference is the first guide to cover all the most common types of microcontrollers. With its from-the-bottom-up approach, this book/CD-ROM package gives you all the information you need to simplify the job of selecting the right microcontroller and writing an application for it. **\$54.95**



Programming & Customizing the 8051 Microcontroller by Myke Predko

Programming and Customizing the 8051 Microcontroller puts you in control of the 8051's architecture and instruction set — and even supplies a baker's dozen of ready-to-build example applications, programs, and circuits. Best of all, the included CD-ROM supplies source code for the book's experiments and applications. **\$39.95**



Programming & Customizing the HC11 Microcontroller by Tom Fox

Applications bazaar for the 68HC11 microcontroller. Squeeze every last drop of power out of Motorola's wildly popular family of 68HC11 true 8-bit single chip computers! From basics to complete applications. **\$39.95**



Programming & Customizing PICmicro Microcontrollers 2nd Edition by Myke Predko

This book is a fully updated and revised compendium of PIC programming information. Comprehensive coverage of the PICMicro's hardware architecture and software schemes complement the host of experiments and projects making this a true, "learn as you go" tutorial. **\$49.95**



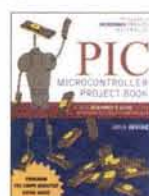
Programming & Customizing the BASIC Stamp Microcontroller by Scott Edwards

This edition moves you briskly from electronic foundations through BASIC Stamp "Boot Camps" and an intelligent traffic signal simulation to build a robotic bug with whisker sensors, a time/temperature display, and a data-logging thermometer. **\$39.95**



PIC Microcontroller Project Book by John Iovine

This project-oriented guide gives you 12 complete projects, including: using transistors to control DC and AC motors, DTMF phone number logger and distinct ring detector and router ... home automation using X-10 communications ... digital oscilloscope ... simulations of fuzzy logic and neural networks ... and many other applications. **\$29.95**



The Nuts & Volts of BASIC Stamps Vol. 1 & 2

In 1995, Scott Edwards began authoring a column on BASIC Stamp projects in *Nuts & Volts Magazine*. The column quickly became a favorite of *Nuts & Volts* readers and continues today with Jon Williams at the helm. *The Nuts and Volts of BASIC Stamps* is a collection of about 75 of these columns. **\$29.95 each**



Radio & RF

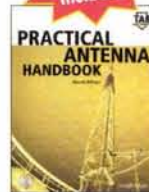
Secrets of RF Circuit Design 3rd Edition by Joe Carr

This revised and updated guide gives you the best ways to design, build, and test today's radio frequency circuits. It's filled with projects and experiments that make it easy to apply RF principles to real-life applications. **\$39.95**



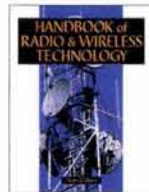
Practical Antenna Handbook 4th Edition by Joe Carr

The most popular book on antennas ever written. This edition blends "theoretical concepts that engineers and others need to design practical antennas, and the hard-learned practical lessons derived from actually building and using antennas." **\$49.95**



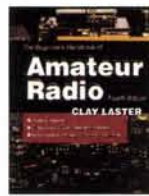
Handbook of Radio & Wireless Technology by Stan Gibilisco

Containing more than 1,000 concise articles, this one-stop source of user-friendly insight provides blanket coverage of one of the fastest-growing areas in communications from antennas and transmission lines, to analog and digital modulation techniques, to satellite, space, and laser communications. **\$44.95**



Beginners Handbook of Amateur Radio 4th Edition by Clay Laster

The revised edition of the most trusted guide in ham radio is here. This edition delivers all the guidance you need — from radio and electronics fundamentals needed to set up a transmitter to the newest equipment to revisions to the FCC rules and tests. **\$34.95**



Electronics

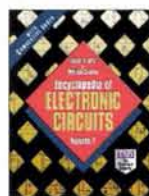
Practical Electronics For Inventors by Paul Scherz

This experiment-oriented guide is loaded with over 750 hand-drawn images that support author Paul Scherz's crystal-clear, fully detailed instructions, showing you how to turn theoretical ideas into real-life gadgets. **\$39.95**



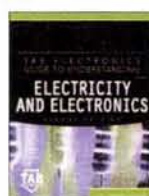
Encyclopedia of Electronic Circuits Vol. 7 by Rudy Graff

Designed for quick reference and on-the-job use, the *Encyclopedia of Electronic Circuits*, Volume 7, puts over 1,000 state-of-the-art electronic and integrated circuit designs at your fingertips. This collection includes the latest designs from industry giants such as Advanced Micro Devices, Motorola, Teledyne, GE, and others, as well as your favorite publications, including *Nuts & Volts*! **\$39.95**



Guide To Understanding Electricity & Electronics by Randy Slone

For the true beginner, there's no better introduction to electricity and electronics. You'll also find 25 complete projects that enhance your electricity/electronics mastery, including 15 new to this edition, and appendices packed with commonly used equations, symbols, and supply sources. **\$24.95**



Digital Electronics Guidebook: With Projects by Myke Predko

Perfect for electronics hobbyists and students — even complete beginners — who want to understand digital logic and build their own low-cost logic circuits. Featuring more than 20 projects with step-by-step directions for designing, constructing, and interfacing easy-to-do TTL (Transistor-Transistor Logic) circuits. **\$34.95**



High Voltage

Homemade Lightning: Creative Experiments in Electricity by R.A. Ford

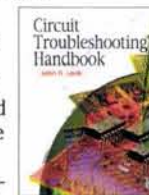
Enter the wide-open frontier of high-voltage electrostatics with this fascinating, experiment-filled guide. You'll discover how to make your own equipment, how electricity is used in healing, and the workings of many experiments in high potential physics! **\$24.95**



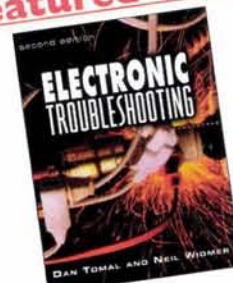
Troubleshooting

Circuit Troubleshooting Handbook by John D. Lenk

Heavily illustrated with diagrams and schematics, it uses a standard, easy-to-follow format to help readers understand and troubleshoot a wide range of circuit types, and provides proven circuit testing techniques for all levels of instrumentation. **\$39.95**



This Month's Featured Title



Electronic Troubleshooting 2nd Edition

by Dan Tomal and Neil Widmer
This updated tool gives all the fundamentals needed to do successful servicing and repair work, blending traditional theory with the very latest insight into modern electronics technology. Time-saving tables, charts, and illustrations pinpoint equipment problems in a snap. Numerous reference guides, rules of thumb, and tricks of the trade all combine to assist in troubleshooting the full spectrum of devices and products more easily than ever before. **\$39.95**

Call 1-800-783-4624 today! or order online at www.nutsvolts.com WE ACCEPT VISA, MASTERCARD, AMERICAN EXPRESS

Prices do not include shipping and may be subject to change. Ask about our 10% subscriber discount on selected titles.

Grow Your Library

Parallax offers
an entire library
of books on the
BASIC Stamp.

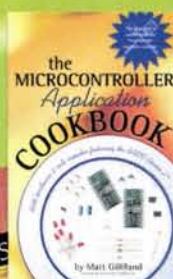
StampWorks (\$49 - #27220)

Includes 31 experiments for
the NX-1000 board and the
entire BASIC Stamp Manual.

Build Your Own Combat Robot (\$25 - #28166)

Essentials of combat
robot construction,
motors, microcontrollers
and contents.

Nuts and Volts of BASIC Stamps
(\$49 for both - #28163/28164)
75 BASIC Stamp applications as
published in Nuts and Volts Magazine.
Everything from motors to modems and
LCDs and Visual BASIC.



Microcontroller Application

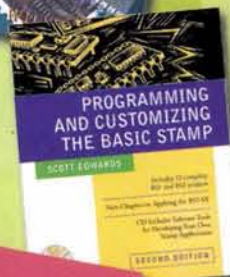
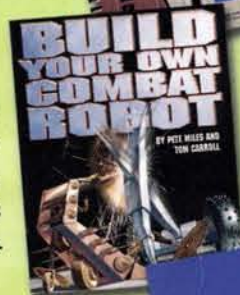
Cookbook (\$29.95 - #28111)

Popular bestseller includes usable BASIC
Stamp code snippets for many sensors,
motors, I/O buffering and high voltage.



Microcontroller Projects Using the BASIC Stamp (\$44.95 - #27952)

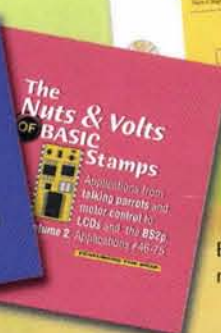
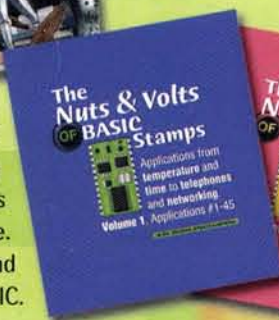
Second edition features
BS2p examples, motor
control section and well-
designed PBASIC reference.



Programming and Customizing the BASIC Stamp

(\$34.95 - #27956)

Second edition features
new chapter on the
BASIC Stamp 2sx,
functional introduction
to BASIC Stamps and
assorted applications.



BASIC Stamp and the Parallax logo are
registered trademarks of Parallax, Inc.

Title	Author	Pages	Published
Microcontroller Cookbook	Matt Gilliland	248	2001
Microcontroller Projects	Al Williams	407	2002
Programming and Customizing...	Scott Edwards	330	2001
Nuts & Volts of BASIC Stamps	Edwards/Glazner/Williams	968	2001
Build Your Own Combat Robot	Miles/Carroll	350	2002
StampWorks Manual	Parallax, Inc.	505	2001

PARALLAX

To order visit www.parallaxinc.com or call toll-free
(in the U.S.) 888-512-1024 (M-F, 7 am - 5 pm, PST).

Circle 154 on Reader Service Card.

NUTS & VOLTS MAGAZINE
430 PRINCELAND COURT
CORONA, CA 92879-1300

