ROBOTICS · MICROCONTROLLERS · COMPUTER CONTROL · LASERS

Nuts & Volts

The Preferred Magazine Of The Electronics Hobbyist/Engineer
www.nutsvolts.com

October 2002
Vol. 23 No. 10

Houston, we have a ... PIC Project?

LAST CALL
Enter The MSP430 Gadget-O-Rama 2002 Design Contest!
Cash Prizes Totaling $10,000!
Entry Deadline Oct. 31st!

Using X-10 to Control Christmas Light Displays

Build the Electronic Music Box

Build an Ultra-low Power TV Remote Control Transmitter

Technology Update on Cell Phones

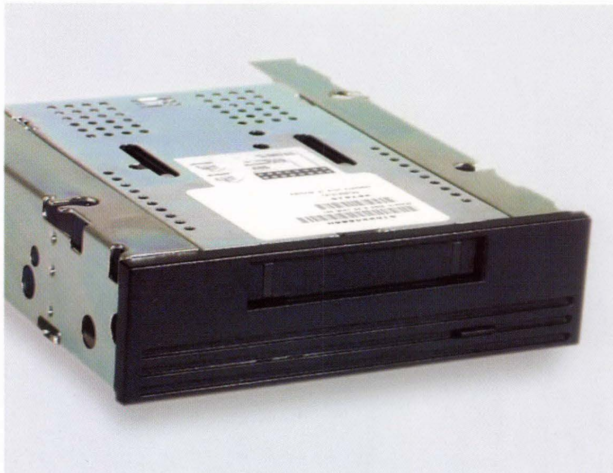
Amateur Robotics
Electronics Q & A
Laser Insight

U.S. $5

0 74470 89295 3

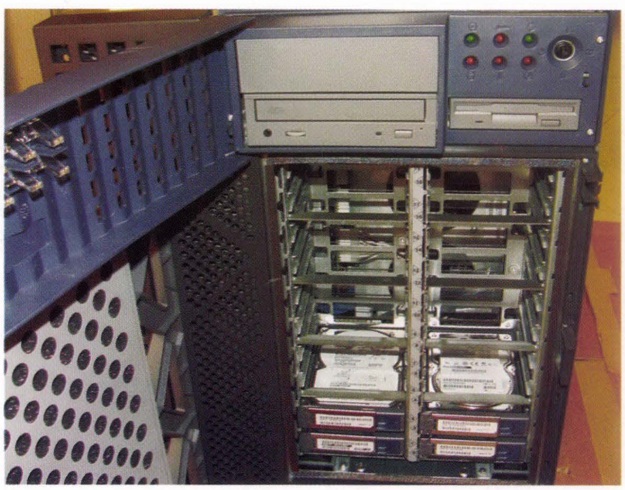
AUCTION BLOWOUT!

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
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Circle #81 on the Reader Service Card.

Adaptec ISA SCSI Cntlr.
- AHA-1535/1535A - SCSI1 & SCSI2 conn.
- Special!! - $17.50 with any SCSI HD!
- New units, OEM pkg, 90-day warranty

HSC#19397 $24.95!

Disk Drive Deals!
9.1GB ULTRA SCSI
- Seagate ST19171WC, 80-pin
- 7200RPM, 4.6mS av. latency
- Wide to std. SCSI adapters - $7.50!!
- HSC 90-day warranty

HSC# 18753 $19.95!

4.3 GB SCSI 1/2 HEIGHT
- ST15150N hard drive
- 21 Hds, 11 Disks, 3,711 Cyl.
- 7,200 RPM, 9.0 mS avg. seek
- HSC 90-day warranty

HSC# 18412 $14.95!

Rack Mount Cabinet
- 1U (1-3/4") high 19" quality-made
- 15-5/8"W x 16"D - outside dimensions
- Reversable mounting flange
- Pulls from working svc. some scratches

HSC#19437 $19.95!

SCA to SCSI 1 Adptr
- Converts SCSI1 to SCA wide
- Standard 4-pin power connector
- Jumpers for LED, SYN, DLY, MTF, ID0-3
- Jumpers & config sheet incl.
- New, 90-day warranty

Special!!...just $7.50 with any SCSI Hard Drive

HSC#SCS3700 $12.50!

Cat5 Patch Cable
Just under $.50 each by the case!!
- 'Foxconn' #CT88B12T88-A17
- Yellow, 12 ft. - 80 cables/case
- New, sold by case only

HSC#19234 $39.95/case

Win-based Terminal
- WYSE 'Winterm 2315SE'
- Virus-proof - high security
- Easy access to server apps.
- Up to 32 users/servers, tiny footprint
- VT220, VT100 and VT52 emulation
- Mouse, keyboard power supply included!

HSC#19346 $89.50

USB Network Adapter!
- Compact - perfect for notebook PCs
- Dual-speed 10/100 RJ45 jack
- Plug 'n play with Win 98, 2000
- Powered by USB port
- Compatible w/LinkSys,other USB hubs
- New, w/cable, manual, 90-day warranty

HSC# 19335 $19.95

12VDC Fan Bargain !!
- Nidec 'Beta SL', Mod. No. D08A-12TL
- 12VDC @ 0.06A, std. 2-pin pwr conn.
- Measures: 80 x 25mm (3.125" x 1.0")
- Buy 'em by the case and save!

Std. PC power supply fan.

New... 90-day warranty

HSC# 80153 $1.95!
HSC# 19422(#80 CASE)$99.00

PCMCIA Card Reader
- SSP Argus 2000 ISA-type reader/writer
- Dual PCMCIA Type I/II, or one Type III
- DOS/W3.1 driver diskette included
- Win95/98/NT ready
- New, w/interface, manual & cables

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You can find these in the "Specials" area of our on-line shopping pages at **www.halted.com...**
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- 7-bay tower cabinet — HSC#80544 $29.50
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- AT Mid-Tower Cab. — HSC# 19327 $14.95
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- DVM, w/flip-up LCD — HSC#AEEC2890 $39.95
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- Table Top Solder Pot — HSC#AEEC10P $32.00
- Compact Power Supply — HSC# 18415 $12.50
- Server Cabinet, ATX — HSC# 80541 $149.95
- Bargain DMM — HSC#AEEC1504 $14.95
- 12V,3.4A Power Supply — HSC# 19312 $9.95
- ATX 200W Power Supply — HSC# 18665 $14.95

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SmartCard Reader
- Fits in PCMICA slot
- For sensitive files/databases
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- Restricts unauthorized access
- Comes with 2 cards, diskette, manual
- New, retail-boxed, 90-day warranty

HSC# 19433 $19.95

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50 Ohm cable assemblies
- RG-58 size coax - two lengths avail.
- Male TNC to male SMA connectors

HSC#19438 13" $4.50
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- 1/8" high-quality 50 ohm coax
- Male to male SMA connectors
- 18" long

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- Mini-Circuits Model No. SAT-20
- 20dB atten. - 0 to 1500MHz, 50 ohm
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- Cable assembly pulls, 90-day warr.

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- Multi-platform compatibility
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- 20 char. x 24 display
- 2.36"H x 3.86"W overall, 0.55" max. depth
- Data sheet @ http:www.halted.com/online/index.htm
- New, 90-day warranty

HSC# 19399 $12.95

- 24 char. x 2 display with LED backlight
- Emerging Display Tech. # ED24200GLYU
- 1.406"H x 5.5625"W overall, 0.4375"D
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- New, OEM pack, 90-day warranty

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Compact Keyboard!
- 88/89 enhanced key layout
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- Only 8.5" x 11.28"!
- Free PS/2 connector adapters!
- New, w/mouse driver diskette and manual

HSC# 19328 $14.95!

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12VDC & 120VAC Built-In!
- Model No. VHS-10S player deck
- Std NTSC VHS format, frnt-pnl cntrls
- Perfect for on the road!
- Working pulls, HSC 90-day warranty

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115VAC Unit
- Magnavox video player, working pulls
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- 'Mylex' Model No. 960P-3
- Up to 32MB, 36-bit SIMM, (4MB min.)
- 1 to 45 drives as one logical drive
- Can co-exist with 3 more (180 drives!)
- Pulls, online support info

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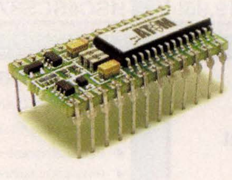
Circle #72 on the Reader Service Card.

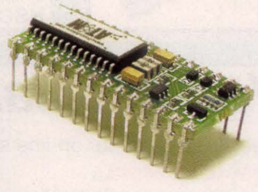
What's in your next project?

COMPLETE DEVELOPMENT KITS AVAILABLE



ATOM 24 MODULE
ONLY $59.95

ATOM 40 MODULE
ONLY $79.95



ATOM 28 MODULE
ONLY $64.95

The Basic Atom is an easy to use self contained microcontroller. Download your program, apply 5 volts and your are up and running. From beginners to professionals, programming microcontrollers has never been easier !

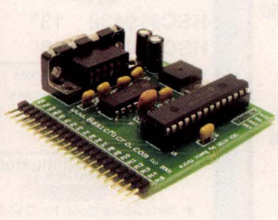
Experiment and test code changes on-the-fly! Bring your projects to life quicker and easier with the Basic Atom IDE ! Stop wasting time strategically planting debug statements throughout your entire program. The Basic Atom software includes a built-in ICD (In Circuit Debugger). Watch your program run on screen with variables, SFRs and RAM values being updated as each line of code executes on the Basic Atom. The Basic Atom's ICD is so easy to use, even a first time user can have it up and running in minutes !

BS2p compatible syntax, with a complete expanded set of powerful and easy to use commands ! Serin, Serout, If..Then..Elseif..Else..Endif, Do..While, While..Wend, OWin, OWout, ADin, Pulsin, Pulsout, PWM, Xin, Xout and more!

32 Bit Floating Point Math. The Basic Atom supports 32 bit floating point and integer math. This includes 32 x 32 bit divides and multiplies. With 32 bit math you can have variables containing values of up to 4 billion.

300 bytes of RAM. No more wasting time trying to save variable space in your program. Plus additional features include a built-in Analog to Digital converter, UART, 2 PWMs and more.

Order your Basic Atom today !



OEM ATOM
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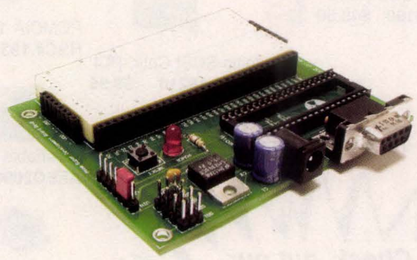

ATOM SUPER DEVELOPMENT BOARD
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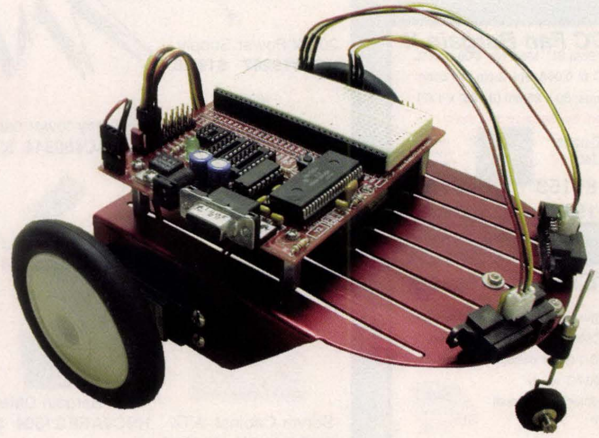
Explorer Robot



Introducing the Explorer Robot. The Explorer Robot is great for the robot enthusiast, educational programs, hobbyist or just about anybody interested in robotics !

The Explorer Robot chassis is made from anodized brushed aluminum. This high quality chassis provides a sturdy base for mounting servo motors, controller board and any number of add-ons. Each chassis includes elongated slots for mounting flexibility. Easily customize the Explorer Robot chassis to suit your needs.

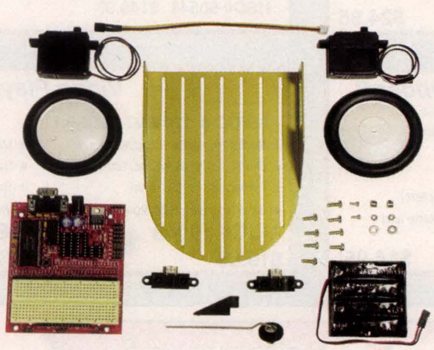
Each Explorer Robot comes complete with two infrared obstacle sensors, ARC controller board (Based on the new Atom Pro), front caster wheel, chassis, modified servos, wiring, battery holder, software and manual. Plus the book "Expirenmenting with the Explorer Robot", which ontains several useful projects for your new Explorer Robot.

Several Add-ons such as, Ni-Cad Cable adapter, Line Follower and more are available for the Explorer Robot.

The brains of the Explorer Robot, the ARC controller board, includes a socket for an I2C eeprom to give your robot memory, L293D motor driver to replace the servo motors or add DC motors. The ARC controller board is designed as the ideal robotics controller board. (The ARC controller board can also be purchased separately)

Order your Explorer Robot Today !

PARTS ALSO AVAILABLE SEPARATELY



EXPLORER ROBOT KIT
ONLY $199.95

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Nuts & Volts

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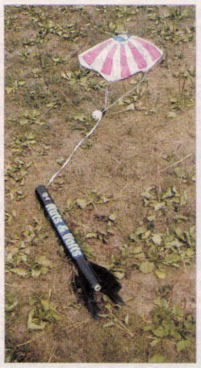
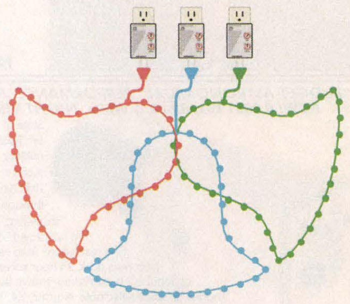
OCTOBER 2002



COVER STORY



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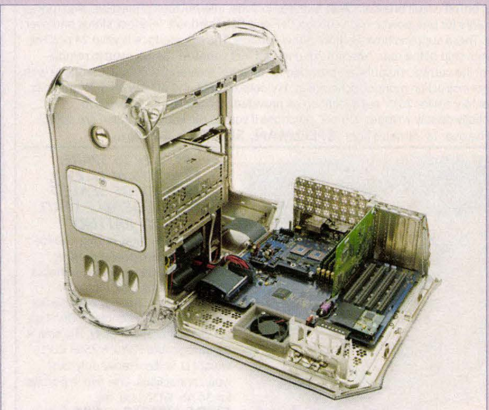
DEPARTMENTS

COLUMNS



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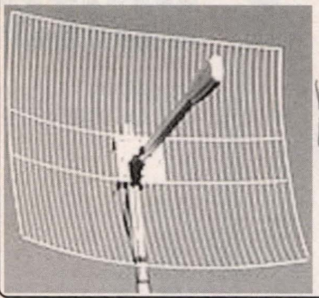
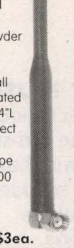
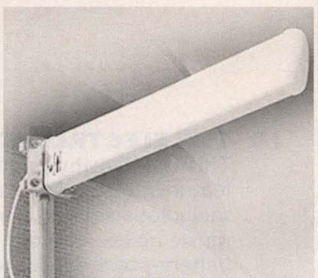


Choose from the LARGE, 24dB, 10 deg. beam width or the MEDIUM, 20dB, 13 deg. beam width PARABOLIC DISH. (shown far left) each provides an environmentally sealed "N" type male termination attached to a 30" long cable. Large size is 27" x 30" and weighs 5.3 lbs, the medium size is 20" x 24" and weighs 3.6 lbs. Can be either horizontal or vertical polarization. Quasi Log Periodic end fire array feed. Both have a commercial quality, light grey, powder coat finish. California Amplifier part no's are: 130135 and 130120. The two omnidirectional offerings, shown left and right are "Rubber Duck" style, the surface mount (shown near left) offers a black, 1/4 wave radiator. The overall size is 3.5"H x 2.7" diam. base. A five foot long RG58-AU cable is terminated with a gold, SMA female connector. The straight 1/2 wave whip is 4.4"L and features a right angle mounted, female SMA connector. Perfect for portable applications. Both omnis are black and very rugged. A UV stable, polycarbonate, radome protects the 13.9dB YAGI, type PC2415N from Cushcraft. (shown far right) Max. input power is 500 Watts, the 15 element, one piece radiating design is extremely rugged. Size is 26" L, weight is 1 pound. Antenna is terminated through a pigtail connector to a "N" type female connector..



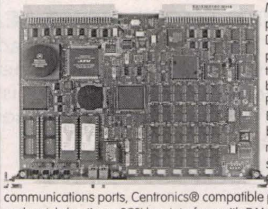


PARABOLIC 24dB.......$129ea., PARABOLIC, 20dB......$99ea., DESK OMNI.......$5ea., WHIP OMNI......$3ea.

"BUDGET ASTRONOMICAL" PERFORMANCE, 600 Lines Resolution. NEW! 0.0001 Lux, Black & White, NIGHT VISION CAMERA!

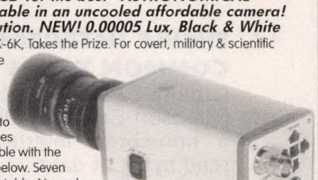
State of the Art Video, Our GMV-6K, Takes the Prize. For covert, military & scientific applications, this is it. Unbelievable 0.0001Lux @ f0.8 performance is enhanced through low speed electronic shuttering, digital frame integration and advanced DSP. Did we mention 600 Line resolution? Auto sensitivity 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/off BLC, S/N >52dB, Mirror on/off, Gain on/off, auto electronic shutter 1/60 to 1/120,000 sec., Alum. housing, dual 1/4x20 mtg. Specs: 1/2" CCD, 768(H) X 494(V), with 380K pixels, 12VDC ±1V@200mA, Std. video out on BNC. Size: 51mm x 51mm x115mm long. Regulated power adapter included. All functions externally controlled. C-mount lens not included.
GMV-6K...$449ea. High performance auto iris lens, 12mm, f1.4..$129

MOTOROLA, MVME 147, SINGLE BOARD COMPUTER



FEATURES: 33.33 MHz MC68030 enhanced 32-bit microprocessor, MHz MC68882 floating point co-processor,16 MB of shared DRAM, with programmable parity, 4K x 8 SRAM and time-of-day clock with battery backup, Four 28/32-pin ROM/PROM/EPROM/ EEPROM sockets, 16 bits wide A32/D32 VMEbus master/slave interface with system controller function, Four EIA-232-D serial communications ports, Centronics® compatible printer port, Two 16-bit timers and watchdog timer, SCSI bus interface with DMA, Ethernet transceiver interface, 4-level requester, 7-level interrupter, and 7-level interrupt handler for VMEbus, On-board debugger and diagnostic firmware.
COMPLETE SPECS: http://mcg.motorola.com/us/ds/pdf/ds0037.pdf
MVME147-023A 33 MHz, 16MB, Ethernet & SCSI..$1495ea.

SONY EX-VIEW CCD for the best "ASTRONOMICAL" PERFORMANCE available in an uncooled affordable camera! With 600 Lines Resolution. NEW! 0.00005 Lux, Black & White

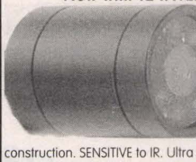


State of the Art Video, Our GMV-EX-6K, Takes the Prize. For covert, military & scientific applications, this is it. Unbelievable 0.00005Lux @ f0.8 performance is enhanced through low speed electronic shuttering, digital frame integration and advanced DSP. Auto sensitivity mode starts as it becomes dark. 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/off BLC, S/N >52dB, Mirror on/off, Gain on/off, auto electronic shutter 1/60 to 1/120,000 sec., Alum. housing, dual 1/4x20 mtg. Specs: 1/2" CCD, 768(H) X 494(V), with 380K pixels, 12VDC ±1V@200mA, Std. video out on BNC. Size: 51mm x 51mm x115mm long. Regulated power adapter included. All functions externally controlled. C-mount lens not included.
GMV-EX6K...$529 High performance 6mm, f1.2 Manual Iris Lens...$69

NEW, GM-DVR100, DIGITAL VIDEO RECORDER,

Digital Recording provides superior quality images, Hard disk hot-swapping capability, Pre-Alarm image recording, Compatible with most multiplexers, Time lapse and real time recording, Refresh rate up to 60 Fields, Quick Search by date/time, alarm events & recording list, playback of recorded video at various speeds, On-screen setup menu and system timer, Password protection, Stable Non-PC based proprietary system, Built-in M-JPEG compression/decompression, Audio recording capability, Selectable time-lapse speeds, Data can be stored in CompactFlash, Operation status record log, Continuous, Alarm, Pre-Alarm & Scheduled Recording Modes, User-selectable settings for image rate, quality and resolution, NTSC
GM-DVR100, DIGITAL VIDEO RECORDER.........$679ea.

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



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

NEW, 2.4GHz VIDEO + STEREO AUDIO TRANSMITTER and RECEIVER PAIR

Simply connect ANY VIDEO SOURCE to the completely self contained 2.4GHz transmitter. All cables supplied. You can transmit up to 700 feet clear line of sight! Companion matching receiver works with any TV or VCR. Internal patch antennas. 12DC. (all pwr. adapters and cables included) Can also be used to transmit VCR or camcorder output to another TV for remote viewing. Brand new, boxed set. **OCTOBER SPECIAL, AST-1.........$89 set.**

BRAND NEW, SPELLMAN +25,000 VDC POWER SUPPLY SL Series, 250Watts, and it's only 1/34"HIGH !

These new, boxed units are the type: SL25P250. Utilizing resonant topology, the proprietary control system maintains high frequency over the entire operation output range. High Frequency operation allows dynamic response time of less than 5 milliseconds and one of the lowest ripple specifications available.
Providing +25000VDC @ 10ma with low ripple of 0.02% rms, line and load regulation is 0.005%. Current load regulation: 0.05% of full current for voltage changes and Current line regulation ± 0.05% of full current over the specified input voltage range. 115VAC powered. Size: 1/34"H x 19"W X 19"D rack mountable. Weight is: 17 lbs. Stability of 0.01% per hour after 1/2 hour warm up. 0.02% per 8 hours typical. Temperature coefficient: 100ppm per deg C. Ambient operating temperature: -20C to +40C. Front panel on/off circuit breaker. Other features include, Internal fault protection, front panel indicators for Line power, High voltage OFF and ON, Overload, Interlock status and over temp. These supplies have no front panel controls. The I/O interface is via a 24 position terminal strip at the rear. External 20Kohm pot, not supplied can be used to remote control the current. Outputs are provided for external metering of output. Complete with original instruction manual, schematics, HV output cable and AC line cord. These units are factory set for 25KV out instant on as provided. These are hazardous and potentially deadly voltages. Do not purchase if you do not know what you are doing. Must be over 18. All sales final. **SPELLMAN, SL25KV.....$499ea.**

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QTY SPECIALS.... 5 for $220......10 for $390
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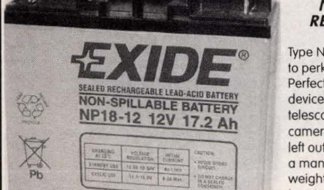
POWER to SPARE, 12 VOLTS at 17.2 Ah, NEW EXIDE SEALED RECHARGEABLE LEAD ACID BATTERY



Type NP-18-12, Now is your chance to perk up those power projects. Perfect for powering many portable devices such as GPS, laptop or telescope, fish finder or underwater camera. The list is endless. Don't be left out of this opportunity. The size is a manageable 7"W x 6.75"H x 3"D, weight is 14 lbs. Heavy duty post type connections. Use two in parallel for 34 Ah WOW! Ltd. qty.
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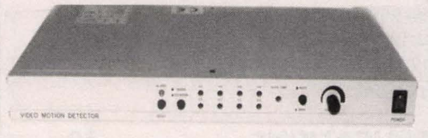

The model VM-10 connect to any standard video signal and you've got an electronic "watchman" diligently watching the entire scene. Or any adjustable sized area within the scene. Such as a doorway or even a drawer or cabinet. A state of the art security aid. The unit will close a contact when it senses 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. **VM10....$179ea.**

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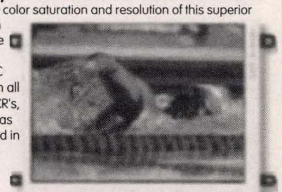

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For covert, military & scientific applications that must be color, this is it. Unbelievable 0.005Lux @ f1.2 performance is enhanced through low speed electronic shuttering, digital frame integration and advanced DSP. Auto sensitivity mode starts as it becomes dark. 24 hour surveillance is possible with the optional f1.2 auto iris lens shown below. Seven Gain/Shutter modes are user selectable. Normal, X4, X8, X16, X24, X32, X64. These provide frame rates of 60, 15, 8, 4, 3, 2 and 1 per second. Auto/Man. white balance 3200° to 10000°K, auto/man BLC, S/N >52dB, Mirror on/off, Gain on/off, auto electronic shutter 1/60 to 1/120,000 sec., Alum. housing, dual 1/4x20 mtg. Specs: 1/2" CCD, 768(H) X 494(V), with 380K pixels, 470 Lines, 12VDC ±1V@200mA, Std. video out on BNC. Size: 51mm x 51mm x115mm long. Regulated power adapter included. All functions can be externally controlled. C-mount lens not included.
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SPECIAL, BWMONITOR-9HR....$94 ea.
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TechKnowledgy 2002

by Jeff Eckert

Advanced Technologies

Mind Over Matter Becoming a Reality

For many years, the concept of wiring a human brain to external machinery has provided great raw material for science fiction writers, but it was pretty much assumed to be too complicated for practical application. But research at Arizona State University (**www.asu.edu**) tends to indicate otherwise.

Prof. Andrew Schwartz, of the College of Engineering and Applied Sciences, is looking into ways to interface the brain with the outside world to, for example, allow a paralyzed person to control mechanical devices. Schwartz is the principal investigator of a team of faculty members, post-doctoral fellows, graduate students, and research technicians working on "Advanced Neuroprosthetic Systems," a three-year, $6 million grant project underwritten by the US Defense Advanced Research Project Agency.

Describing the research, Prof. Schwartz said, "Arrays of electrodes implanted in the cerebral cortex of monkeys record the electrical discharges of 50 to 80 individual brain cells as a small sample of the billions of neurons that communicate with each other during movement. The signals intercepted by these electrodes are sent to a computer where they are 'decoded' or matched to different arm movements. This code is saved in the computer and used by the animal to move a ball or spherical cursor through a virtual space to a specified target when its arms are restrained."

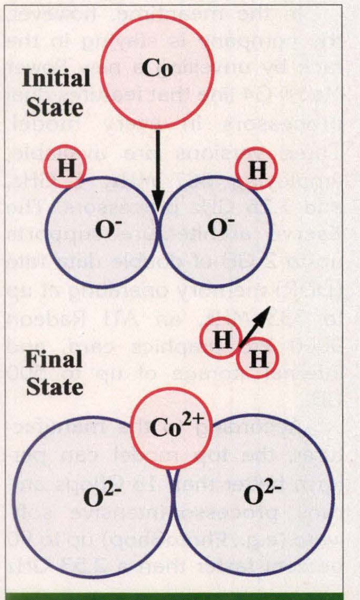
Apparently, monkeys learn to perform the task by changing the way the neurons code for movement direction. By tracking these changes with an adaptive decoding algorithm, both the subject and the computer program learn together. This approach leads to very good performance, allowing subjects to move the cursor with direct "brain control" almost as well as they can with their free hands.

The research team plans to replace the virtual cursor with a robot arm that will be used by a monkey to reach and retrieve food while its own arms are restrained. Through a sort of "neural bypass," the team hopes this approach might help human patients with paralyzed arms. With further progress, the technique might be used not only to activate external devices, but to provide functional electrical stimulation of the patients' own muscles, allowing them to bypass the paralysis and use their own limbs again.

Unfortunately, perhaps, other research has shown that the process can be reversed; that is, computer signals can be used to control the brain. Last May, Dr. John Chapin, working with colleagues at the SUNY Health Science Center at Brooklyn (**www.sunybklynem.org/**), inserted an implant into a rat's brain that allowed him to instruct a trained rat to turn right or left or move forward in response to keystrokes on a laptop computer. Test rats were rewarded with stimulation to a pleasure center when they made the right decision. A projected application is to create armies of "robo-rats" that are equipped with small video cameras and linked via wireless Ethernet. This may be a useful concept while we're talking about rats, but if your employer or spouse hears about it, you could be in for trouble.

"Atomic Anchors" Promise Improved MRAM

A patented technique developed at Sandia Labs (**www.sandia.gov**) allows manufacturers to deposit flat, ultra-thin metallic layers on thin oxide layers, and the process promises to bring improvements in the size and performance of magnetoresistive random access memory (MRAM). One of the nice applications would be to allow computers to boot up almost immediately from the MRAM storage rather than slowly loading the operating system and associated software from a hard drive. According to Sandia, the process reduces material cost, requires less electricity, and can be implemented on equipment that is already in place in chip manufacturing plants.



In the new Sandia process, cobalt atoms cause the release of hydrogen gas molecules then link with oxygen atoms to form "anchors" on oxide surfaces, thus producing a very thin layer. Illustration courtesy of Sandia National Laboratories.

MRAMs use magnetic tunnel junctions in which an ultra-thin layer or insulator (typically aluminum oxide about 1 nm thick) is sandwiched between layers of a magnetic metal. When current flows through the device, the magnetic orientation of the metal layers can be switched, which results in different tunneling current values. These different values are used to represent bits of computer memory. Eliminating the bumps makes it much easier to grow thinner layers, which can operate with lower switching currents.

Working with cobalt as the magnetic metal, researchers have determined that, by incorporating hydroxyls on the surface of the oxide, the cobalt atoms can cause the release of a hydrogen gas molecule, and the cobalt atoms then become oxidized and link up with newly available oxygen atoms to form "anchors" on the top layer of the oxide (see figure). These embedded metal atoms are scattered at points that amount to about one anchor for every 10 oxygen atoms in the top layer. This eliminates the problem of metal atoms clustering together as bumps on oxide surfaces. Such bumps produce poorly crystallized metal films, which offer lower performance.

According to Sandia, although the experiment was conducted using cobalt, the method also should be effective for iron and nickel — two other metals under consideration for MRAM, as well as metals such as copper, ruthenium, and rhodium.

Computers and Networking

Dude, You're Gettin' a Dell (Even If You Don't Know It)

In the US and elsewhere, many cheap, unbranded PCs (known as "white box" computers) are sold by local companies to small businesses, schools, and government agencies. About 40 percent of them are built by the vendors themselves (e.g., Mexican computer vendor Alaska, a subsidiary of Mexmal Mayorista SA de CV, and Brazil's Tropcom). But 60 percent are actually purchased from other manufacturers, and Dell Computer Corp. (**www.dell.com**) recently was reported to have its eye on that market. Its first offering is the "White Box 510D" machine, which is sold only to registered dealers. A company can buy a generically-packaged 510D from Dell, slap on its own brand name, and sell it for whatever price it can get. The base configuration of the machine includes a 1.7 GHz Celeron processor, 128 MB of RAM, a CD drive, and a 20 GB drive. It also comes with Windows XP, but not with a monitor. At $499.00, it may be cheaper than building your own.

This may seem like a relatively insignificant "cottage industry," but according to market research firm IDC (**www.idc.com**), the white box market is doing well in comparison to slumping sales by big-name suppliers. In 2001, 13.7 million unbranded units were sold in the US, and the number is expected to climb to 16.7 million in 2005.

Mac Line-up Moves to Dual-Processor Models

For a brief time, the PowerPC chip — built by both IBM and Motorola — was the fastest PC microprocessor in the world. But as processing technology approached the 1 GHz level, Intel and AMD took over leadership in the clock rate race. As a result, Apple Computer Corp. (**www.apple.com**), which uses the PowerPC chip in its Macintosh machines, has had to resort to some fairly exotic technologies to maintain performance parity. In fact, recent (unconfirmed) rumors have surfaced that Apple has long-range plans to convert its machines to Intel chips.

In the meantime, however, the company is staying in the race by unveiling a new Power Mac® G4 line that features dual processors in every model. Three versions are available, employing 867 MHz, 1 GHz, and 1.26 GHz processors. The Xserve architecture supports up to 2 GB of double data rate (DDR) memory operating at up to 333 MHz, an ATI Radeon 9000 Pro graphics card, and internal storage of up to 500 GB.

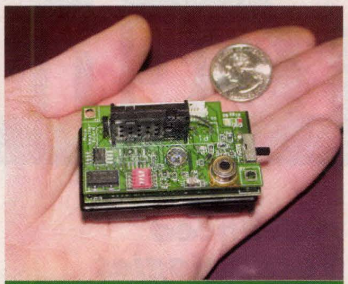
According to the manufacturer, the top model can perform better than 18 Gflops and runs processor-intensive software (e.g., PhotoShop) up to 90 percent faster than a 2.53 GHz Pentium 4-based PC. Performance is also enhanced with the Velocity Engine and up to 1 MB of DDR backside level 3 cache per processor. (The Velocity Engine concept is based on a single-instruction, multiple-data function that allows several calculations to be performed in the same instruction, which enhances the performance of complex calculations.) Shipping with the OS X version 10.2 ("Jaguar") preinstalled, the machines also include two FireWire ports and four 12 Mbps USB ports, built-in 10/100/1000Base-T Ethernet, AirPort® wireless network capability, and a range of other features. Suggested retail prices for the machines are $1,699.00, $2,499.00, and $3,299.00, depending on processor speed and other features.

Apple stays in the performance race with a line-up of dual-processor Macintosh models. Photo courtesy of Apple.

Circuits and Devices

Studying Sea Birds by Remote Control

If you've been lying awake nights wondering why the Leach's Storm petrel (Oceanodroma leucorhoa) — a small seabird — prefers to live and breed on Great Duck Island rather than any of the other thousands of islands that lie off the coast of Maine, you needn't fret much longer. This summer, researchers from the University of California, Berkeley (**www.berkeley.edu**), with the aid of the Intel Research Berkeley laboratory, installed a network of about two dozen sensors to keep track of the birds' activities. The sensors, referred to as "motes," detect light levels, barometric pressure, temperature, and relative humidity. The motes relay collected data to a single above-ground "gateway sensor," which relays the information at a 40 kB/s rate to a laptop computer located in the island's lighthouse. The motes can operate for six months on two AA cells, while the laptop — which is connected to the Internet via satellite — is powered by photoelectric cells.



Miniaturized wireless sensor motes, such as the one pictured above, are now sending back raw data on the microclimate of a petrel seabird colony in Maine. Photo courtesy of Intel Research Laboratory at Berkeley.

The 237-acre Great Duck Island is located in Maine, 12 miles from the Acadia National Park, believed to be one of the largest petrel breeding locations in the eastern US. The bird spends most of its life offshore, though, and only returns to land for the May through

October breeding season. During that period, the birds stay hidden to avoid predators and typically come out only after 10:00 PM, so you aren't likely to see one in person. But you can see photos and track the birds' activities by logging onto **www.greatduckisland.net**.

Betamax: Rest in Peace

Something of a milestone was reached late in August, when Sony Corp. (**www.sony.com**) announced that it will discontinue the Betamax video product line, sending it to the technological graveyard to join eight-track audio tapes and Timex computers. Over the past 27 years, Sony sold 18 million of them, but only 2800 were shipped during Sony's last fiscal year. Reportedly, 2000 more units will be coming off the assembly line before it stops forever, after which Matsushita's VHS format can be officially declared the winner in the long-running video format battle.

The victory is likely to be short lived, however, as VHS continues to lose ground to the DVD format. Electronics retailer Circuit City recently announced that it will be phasing out VHS equipment from its shelves. Various sources have reported that DVD players are the fastest-selling consumer electronics products of all time, and rentals of DVD-format movies grew 126 percent in the first quarter of 2002, to a level of $633 million.

Industry and the Profession

Chip Sales Grow 5.8 in Second Quarter 2002

According to the Semiconductor Industry Association (**www.semichips.org**), quarterly sales of semiconductors increased 5.8 percent to a quarterly average of $11.35 billion in the April-through-June quarter from a quarterly average of $10.73 in the previous quarter. According to SIA president George Scalise, "The semiconductor industry is continuing the recovery that started late last year, and we are encouraged by the progress we have made pulling out of the 2001 downturn." He added, "While computer and computer-related sector demand is lagging, wireless and consumer sectors continue to strengthen. These two leading sectors are stimulating strong sales in flash, digital signal processors, application specific products, discretes and analog, all of which increased by double digits rates in the June quarter."

In June, the SIA released its mid-year market forecast providing an overview of an industry-wide recovery that is currently underway. Sales in 2002 are still expected to result in approximately three percent growth from 2001, and the SIA continues to expect the growth rate to accelerate to 23.2 percent in 2003 and 20.9 percent in 2004, with wireless and digital consumer products leading the growth of sales. **NV**

The Electronic Music Box

By Richard Panosh

This note-worthy project employs a low-end, eight-pin Microchip microprocessor with only an eight-bit timer, and can be used in battery-powered or AC-powered applications such as music boxes or doorbells.

Many hobbyists avoid construction projects that employ microprocessors because they do not have the capability to write the programs or to burn a canned program into memory. In many cases, however, a microprocessor may provide the most eloquent solution to a design. This project employs a Microchip PIC12C509, eight-pin minidip, that is uniquely designed to reduce the number of components to a minimum to masquerade as a music box or door annunciator.

The first music boxes are credited to Swiss watch makers in the 10th century. They produced two types that employed either a disc or a cylinder to store the sequence of notes. The cylinder type is most common and has tiny pins that lift the teeth in the comb to produce a note much like a tiny tuning fork. Today, the precision craftsmanship of mechanical devices is giving way to electronics. There are currently many integrated circuits available that play music. The simplest of these are the tiny chips sealed with epoxy in greeting cards, to the more expensive and sophisticated electronic keyboards. While these circuits produce music, they do not replace the more melodious music box.

Two features of the mechanical music box differentiates it from electronic music chips. In a mechanical music box, the first note is somewhat random depending upon where the drum has stopped. Another feature is that the melody is repeated several times as the cylinder revolves, but as the spring weakens, the tempo slows and a person's thoughts are magically transported to another time. This article employs a low-end, eight-pin Microchip microprocessor with only an eight-bit timer. The program incorporates features to simulate a mechanical music box. It can be battery-powered for applications in music boxes or AC-powered for applications as a doorbell.

Briefly, this microprocessor contains an internal 4 MHz RC oscillator, internal pull-up resistors, low-power consumption, sleep mode, and a 1,024 word memory. These features will be discussed later when we describe the construction. The Microchip microprocessor is an excellent choice for beginners. Microchip Technology, Inc., at their web site (www.microchip.com) provides many application notes for their product line, as well as a complete development software called MPLAB. Alternately, you can request a CD disc of their product line that contains data sheets, application notes, and the MPLAB software. MPLAB can be installed on your computer for free to write, edit, and simulate your code in software for debugging. The simulator allows you to run the code you write and step through it line-by-line to make sure it executes properly. It also allows you to alter canned programs for your specific application. The Microchip microprocessors can execute code at a speed as high as 200 nsec per instruction, if required, and the simplified instructions consist of as little as 33 words.

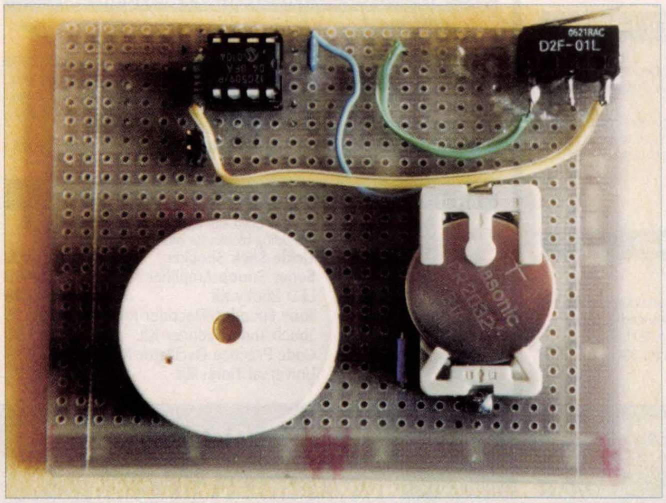
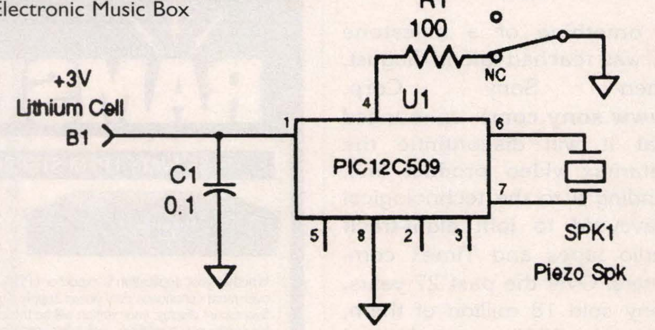


Figure 2. Typical Board Layout of the Electronic Music Box

Figure 1. Circuit Diagram of the Electronic Music Box



While Microchip also supplies hardware burners to program their microprocessors, individual suppliers can provide the hobbyist that programs infrequently greater savings. MicroEngineering Labs, Inc. (www.melabs.com), for example, sells the EPIC Plus programmer assembled for about $60.00 and provides the board with software for as little as $35.00 (you supply the parts).

If you begin programming your own microprocessors, you have the choice of installing your program into a windowed EPROM memory microprocessor, an OTP (One Time Program), or an EEPROM memory version (such as the 16C84). Both the windowed EPROM and OTP are electrically programmed. The windowed version is reusable by erasing the memory, whereas the OTP cannot be reused. The EEPROM version is both programmed and erased electrically. So if you plan to use the quartz windowed EPROM version, you will also require a bright ultraviolet light source that is used to erase this version. Several companies including Digi-Key produce EPROM erasers for about $40.00.

While we are discussing programming, it should be mentioned that the Microchip microprocessors like the 12C509 that contain a 4-MHz RC oscillator are also supplied from the manufacturer with a calibration factor for these oscillators. An external quartz crystal can be used that is extremely accurate, but requires more components and cost. A ceramic resonator is also an option that is less expensive, but also requires another part. The internal RC oscillator is the least expensive and simplest solution for this project.

Since the RC oscillator is the least accurate clock, the manufacturer provides a calibration factor that can be used to trim the frequency. This calibration factor is installed in the last memory location at the time of manufacture. If you read an empty microprocessor from the manufacturer — like the 12C509 — all memory locations will read h'0FFF' (hexadecimal or all 1's in binary) except the last memory location at h'3FF' that will contain a value like h'0C50'. The h'0C' is the instruction MOVLW (move literal to W) when the microprocessor either powers up or wakes up. This instruction places the calibration h'50' in the W register where it can be used, if desired, by moving it into the OSCCAL (Oscillator Calibration) register to trim the RC oscillator frequency. For this reason, a windowed EPROM version with an internal RC oscillator option should not be erased before reading this value. The best method is to read the microprocessor memory and save it to a file such as CAL509.hex for future use. Later, if the EPROM memory is erased, the calibration factor can be reinstalled by programming it with the CAL509.hex file.

One additional caveat to mention if you program an expensive quartz windowed EPROM, is to never enable code protection. The code protection option was provided to protect your intellectual property from being pirated from unscrupulous people and works well with OTP microprocessors. If enabled with the erasable EPROM version, it will make the part unusable and worthless.

The simple circuit is illustrated in Figure 1. The microprocessor — U1 (PIC12C509) — can operate from 2.5 to 5 volts, so that power can be supplied from either one lithium coin cell (3V), a pair of silver oxide coin cells, a nine-volt battery with regulator, or maybe even be powered from a wall wart transformer with a regulator, depending upon the application. The simplest power source is the lithium coin cell and is suitable for an application as a music box. The microprocessor draws about 550 microamps during play and, at the end of the song, goes into sleep mode. In the sleep mode with the box open, it draws about 30 microamps and when the box is closed, it draws less than one microamp.

The difference in current draw in the sleep mode is due to the internal pull-up resistor associated with the microswitch. A CR2025 lithium coin cell is rated at three volts and a service capacity of 155 mAh (milliamp-hrs). This would power the circuit in the sleep mode for the shelf life of the battery (10 years) when the box is closed, 200 days with the box open, play the song about 9,000 times (two minutes long), or a more reasonable time combination of the two. If you plan to use a nine-volt battery and regulator, remember to include the voltage regulator power consumption in your calculations. The commonly available 78L05 regulator idles at about 2 mA current.

Microswitch SW1 activates the play or sleep mode of the microprocessor in an application as a music box. It is wired so that when the box is opened, the normally-closed contact pulls pin 4 low to begin the song. When the box is closed, the switch is in the open state and pin 4 is high. This arrangement was chosen because the box is normally closed and the microprocessor current drain is the lowest. As mentioned earlier, the current drain is different in these two modes because when pin 4 is in the low state, current is conducted through the internal pull-up resistor. The use of the internal pull-up resistors eliminates the use of an external resistor. R1 is installed to provide protection from possible static electric discharge to this pin from the open microswitch.

Since the microprocessor consumes such little power in the sleep mode, it is never turned off or powered down. For this reason, when the box is closed and the song stops playing, the last note to be played is still resident in memory and the song will begin again where the song ended just like a mechanical music box. The song contained in the memory is Edelweiss that consists of 55 notes plus a repeat song indicator written into the Notes table. The last note in the table is always zero that is the repeat song indicator. The Notes table is located between the program instructions. As a result, all Call routines occur within the upper half page of the program memory. This is required, since the Call instruction is limited to an eight-bit word or to the first 256 memory locations. The program instructions occupy about 200 words. The Notes table ends at line 229 and leaves room for an additional 26 notes or a song that contains 82 notes.

Figure 3. Typical Music Box Construction

The length of the note determines the tempo of the song and is defined in another table called Duration. The Duration table consists of two eight-bit words. The first word is the Lo-order byte followed by the Hi-order byte. The Duration table is located in the upper half page of memory page 1. Since two words are stored for each note length, each time the Timer (TMR0) is reloaded, the Hi and Lo byte are suitably decremented to determine how long the note will be played. Since the period of each note varies, the Duration table must be adjusted accordingly to hold the note for the correct tempo. The Duration table ends with two zeros that are detected to repeat the song over again.

A note is generated by toggling two output pins differentially (pins 6 and 7) at twice the frequency of the note. This creates a squarewave with a 50% duty cycle at the desired frequency of the note. Each time the timer (TMR0) counts up and rolls over to zero, it is reloaded with the required number of Ticks to generate the proper tone. The number of Ticks is defined in the program as:

$$\text{Ticks} = 256 - \left(\frac{125\text{kHz}}{2 * \text{Note}} - 1\right)$$

where the Note is the desired Note frequency in Hertz. For example, C above middle C has a frequency of 523 Hz that requires 137 Ticks entered into the timer each toggle of the output pin. Thus, additional notes can be added and defined, as required. For Edelweiss, seven notes have been defined plus a Rest (pause). The rest consists of a one-millisec delay times the Duration to generate a Rest time.

Each time a new note is entered, a 16-bit counter is decremented to keep track of the total number of notes played in the song. When this count becomes zero, the microprocessor powers down in its sleep mode. The count is set in the program to play 145 notes. This counter also estab-

Parts List for the Electronic Music Box

1	B1	3V Lithium Coin Cell Panasonic CR2032, Digi-Key P-189
1		Battery Holder Memory Protection Devices, Digi-Key BA20323
1	SPK1	Piezo Speaker Projects Unlimited, AT006 (0.3-5kHz). Marlin P. Jones & Assoc., 9123-SP (0.3-4kHz)
1	R1	100 ohm, 1/4W carbon resistor
1	C1	0.1uFd, ceramic capacitor
1	SW1	Microswitch Omron D2F lever, Digi-Key SW154
1		Eight-pin DIP socket
1	U1	Microchip 12C509 microprocessor OTP version, Digi-Key PIC12C509-04/P

Preprogrammed version is available from **Vista, P.O. Box 125, Bolingbrook, IL 60440**.

Order Music Box IC by mail. Include a check or money order for a total of $7.50 (postage included).

Miscellaneous perf board, solder, case, audio amplifier, and parts depending upon the application.

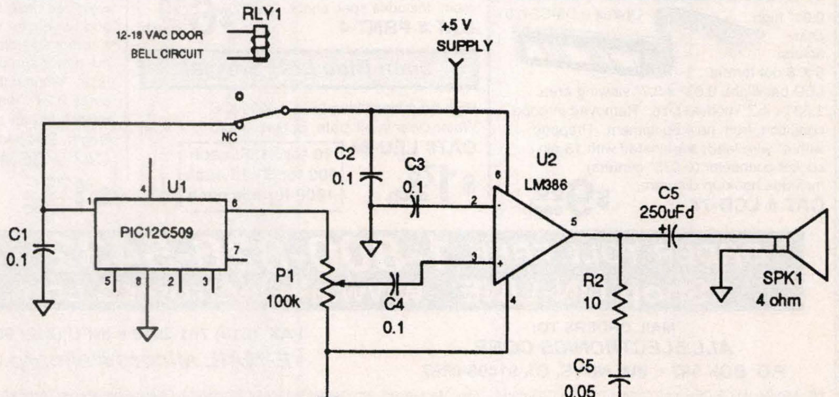


Figure 4. Circuit Diagram of the Electronic Door Annunciator

lishes the approach of the end of the song and begins increasing the pause between notes to slow the tempo as the electronic spring winds down. This pause increases when the last 30 notes are to be played and increases geometrically.

The layout is not critical and the prototype was constructed on a perf board for coin cell battery operation. Figure 2 illustrates the completed circuit. The microswitch was affixed to the corner of the perf board with five-minute epoxy after roughening the surfaces with sandpaper. The microprocessor should be installed in a socket. Carefully check your wiring for errors and install the microprocessor in the socket before connecting the battery.

One application for the music box is illustrated in Figure 3. The board slides into the end of a wooden box purchased from a hobby craft store such as Hobby Lobby, Michael's, or Pier 1 Imports. Small 1/4" square wooded rails were glued inside the box to receive the board and hold it vertically at the left end of the box. A piece of thin cardboard was also glued between two rails to prevent the contents of the box from shorting the circuitry out. A small 1/4" square block of wood was glued to the front and rear edges of the cover. The rear block prevents the board from creeping up when the box is closed and the front block activates the microswitch when the box is opened. Perhaps a better design would have been to install the circuit board in the top of the box. Essentially, the top of the box is not used and the lower compartment would be completely available to store your items.

Do not use a piezo electric alarm element for the piezoelectric speaker. An alarm element is resonate at one zero sharp frequency to provide a large amount of audio efficiency and the different squarewave notes can excite these modes to produce a very displeasing sound. Use only a piezo electric element designated for speaker applications that provide a flatter frequency response and high impedance. Such elements are available from many electronic parts suppliers.

The microprocessor and program can also be utilized (as illustrated in Figure 4) as a doorbell annunciator. In this application, the microprocessor power can be obtained by rectifying, filtering, and regulating the bell transformer power. Alternately, power can be obtained independently from a 5V wall wart. If you use a wall-wart supply, verify that it provides no more than five volts or regulate the output. The power to the microprocessor is supplied by means of the normally-closed contacts of a relay. When the doorbell button is pressed, the relay opens up. When the button is released, the relay applies power to the microprocessor and, upon power-up, it begins playing the song from the first note through to completion. When the song is completed, the microprocessor goes back to sleep. Pin 4 must be left open in this application for the power-up to begin playing the song.

For the doorbell application, the audio output can be amplified as illustrated in Figure 4 by means of a LM386 audio amplifier driving a small 4-8 ohm speaker. The input attenuator is used to adjust the speaker volume.

The assembly level program and compiled hex file are available on the *Nuts & Volts* website. As indicated in the parts list, we will sell a preprogrammed microprocessor to those who wish to purchase a programmed chip.

Many happy tunes to you. **NV**

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- PCI/AGP bus graphics card (24 bit high color or 64 bit
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Reader Feedback

Dear Nuts & Volts:

I just wanted to take the time to say I enjoyed the article by Walt Noon on his Halloween animation project in your September issue. I would usually like an article with a little more detail in it (such as mechanical dimensions, since I am by no means a mechanical person) than this one had, but I have concluded that it had enough information that I can play around until I get it right, which is what most of us *Nuts & Volts* readers like to do, anyway.

I have been wanting to do some animated Halloween decorations using pneumatics for a number of years, but thought the complexity would be too much. This article has convinced me that this is the year to actually do it!

Thanks for your continuing excellence in your magazine!

Dave Clarke
Melbourne, FL

Dear Nuts & Volts:

I just wanted to thank you for the "Avoiding PIC-falls" article by John Patrick in the Sept. 2002 issue. I have been using PIC microprocessors for about two years. When I saw the article I thought to myself, "I have to sit down and really study this."

Many of the pitfalls sounded very familiar — especially the RA3 pullup resistor, table reads across boundaries, and stack overflow. I wish I had the article two years ago! Thanks again for the good article.

Bob Lang
via Internet

Dear Nuts & Volts:

Loved Walt Noon's 'Bait and Switch' article in this month's issue.

Articles of this type are very appealing, and Walt both knows his stuff and presents it in a very readable fashion.

Keep it going! I hope to see more articles from him.

John
via Internet

Dear Nuts & Volts:

The premier issue of "The Nuts & Volts of Amateur Robotics" is fantastic! I enjoyed reading every detail and felt the layout and content were expertly accomplished. The color is excellent and fine paper quality plus good font size makes reading enjoyable. I greatly look forward to future issues.

Mike Otis
via Internet

Dear Nuts & Volts:

As you know, since you sell my books, I am not exactly a beginner in electronics. However, having concentrated for 40+ years on the broadcast side of things, I have limited knowledge in many areas. This is why I love *Nuts & Volts*. Having retired from broadcast engineering a few years ago, I have had the opportunity to venture into new areas of study.

I say all that to say this: The robotics insert was fascinating and, even though I am not currently into robotics, I have carefully filed it away for reference.

If you are an inventor and experimenter, you never know where the next project may lead you. I just worked a deal to design a series of interactive arcade games for a company in Canada. Who knows what they may ask me to make these games do?

I would also like to comment on the critic of the regen circuit. I have always told my students, and stress it in my books, that you learn the most basic circuits and then let your creativity use these to create new, more complex, things. There may be a use for regen that none of us have ever thought of before.

Keep up the good work. Even an old codger is learning a lot.

George Whitaker
Arlington, TX

Dear Nuts & Volts:

I don't know if you'll get similar mail about the cover of Robotics Supplement #1, but when my wife and 10th-grade son looked at the cover, the first thing noticed was the hand gesture. It doesn't appear to be

Continued on Page 64

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Simple Interface Uses Common Tools

By Mark Van Steenburgh

Making use of a BASIC Stamp, InByte, and Microsoft Excel to read a byte.

This article is intended to demonstrate how to make use of some of the tools many of us already have available in our office, lab, or hobby shop. I am a firm believer in making full use (sometimes even over-use) of the tools available to me before investing in additional tools. This sometimes requires a step or two "out of the box" as they say. We will be making use of Microsoft Excel, a BASIC Stamp, and InByte (a simple serial interface program that is freely distributed on the web). Many would argue that Excel is not the best choice as an interface program. However, the beauty of the ideas and concepts demonstrated in this article are that they do not require special programming skills or access to a copy of Visual Basic.

For clarity sake, the examples used for this article will be kept simple. This application will make use of a single byte of information transmitted from a BASIC Stamp (or Hyper Terminal for testing, if you don't have access to a BASIC Stamp). We will use serial communication to get the byte of information into our computer via InByte and we will use DDE (Dynamic Data Exchange) to get our byte of information from InByte to Excel. For those of you that need to know, a byte of data is eight bits of binary data, that is a maximum of 255 in decimal, and FF in Hex. ASCII characters are each assigned a byte value. For example, when you use Hyper Terminal to send data to another source via a serial connection, typing the letter "A" transmits a byte of data via the serial port. The decimal equivalent value of "A" is 65 and "a" is 97. Many sources are available that list the entire ASCII code table from 0 to 255. For the sake of space conservation, I will end this discussion here.

Getting back to the application at hand, a byte of data representing either eight discrete inputs or one analog input will be transmitted from a BS1 (BASIC Stamp 1) to a PC serial port using 2400 N81 (2400bps, no Parity, 8 data bits, 1 stop bit) settings. InByte will receive the byte and make it available to other applications via DDE. In our case, we will use Excel to read the byte from InByte.

For the purpose of our example, let's take a basic look at the format we will need to make use of DDE. To establish the DDE link, the following format will be used: ProgramName|TopicName!DataName. Look closely at the separators. The separator between the ProgramName and TopicName is "pipe" and the separator between TopicName and DataName is "exclamation point." InByte will make the data available to other programs. We will use Excel to link with the data. See Excel help for more information on DDE.

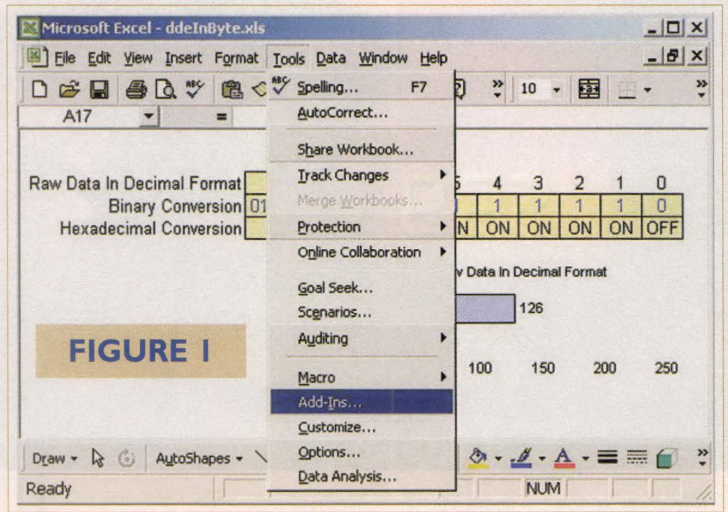

FIGURE 1

InByte

InByte is a simple interface program that has been compiled using Visual Basic. To keep things simple, and to focus on the use of the DDE interface, we will not be discussing the development details of InByte. InByte receives data on the user-selected serial port at 2400 N81. Once running, InByte monitors the selected comm port of the computer and displays and makes available — via DDE — the most recent byte of information received in decimal format. As mentioned earlier, this value will range from 0 to 255. For DDE communication, the ProgramName is "InByte," the TopicName is "Byte," the DataName is "byteVal." InByte is available for free download at **http://emergingtech-llc.com/downloads**. InByte will run under Win 98/NT/2K.

The Excel Interface

Moving on to the Excel interface, a few things need to be said. I used

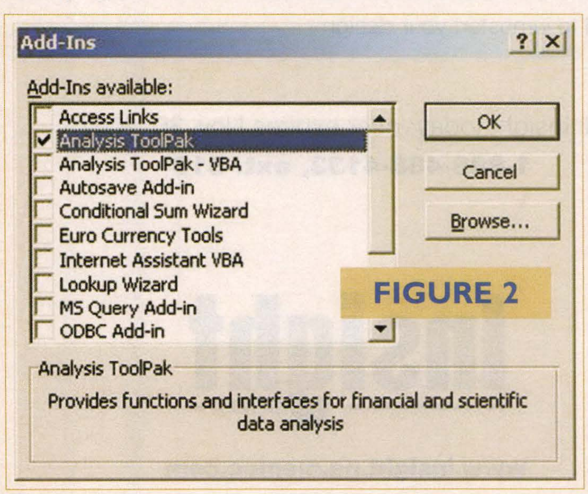

FIGURE 2

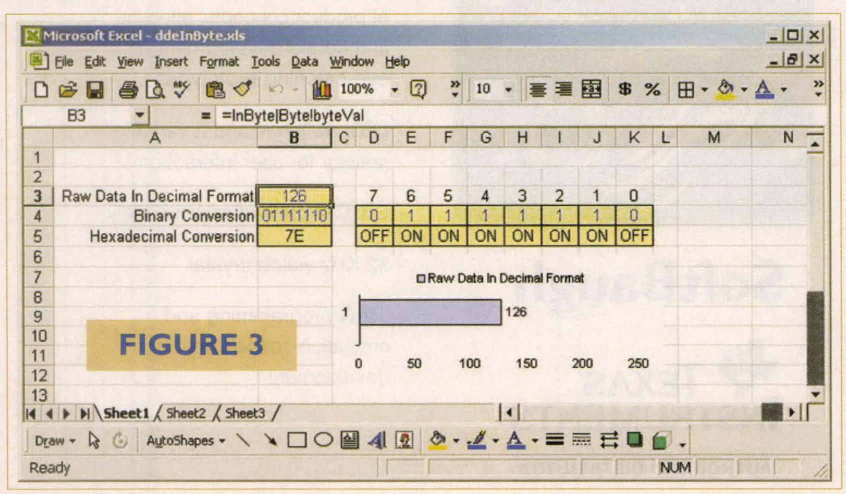

FIGURE 3

Excel 2000 for this example and found that the standard install works fine for the DDE portion of the example. Although a couple of additional functions used on the spreadsheet (dec2bin & bin2hex) will require enabling and/or installing the Analysis ToolPak add-in, if this has not previously been done. Figures 1 and 2 show the steps to enable the add-in. Excel will prompt for the install disk in the event the add-in needs to be installed.

I have used a simple convention on the spreadsheet. Cells with yellow background have formulas entered in them. Cells containing blue text indicates those values are used by another cell. Figures 3 and 4 show the spreadsheet in normal mode and again with the formulas displayed.

The DDE communication formula is shown in cell B3 and looks like this: =InByte|Byte!byteVal. Before entering this formula, you may want to have InByte running. Excel will look for it once you press the enter key. Cell B4 contains the function to convert a decimal number to a binary number. This function only supports numbers up to 10 bits with the 10th bit as the sign. This is not a problem for our application since only eight bits are required.

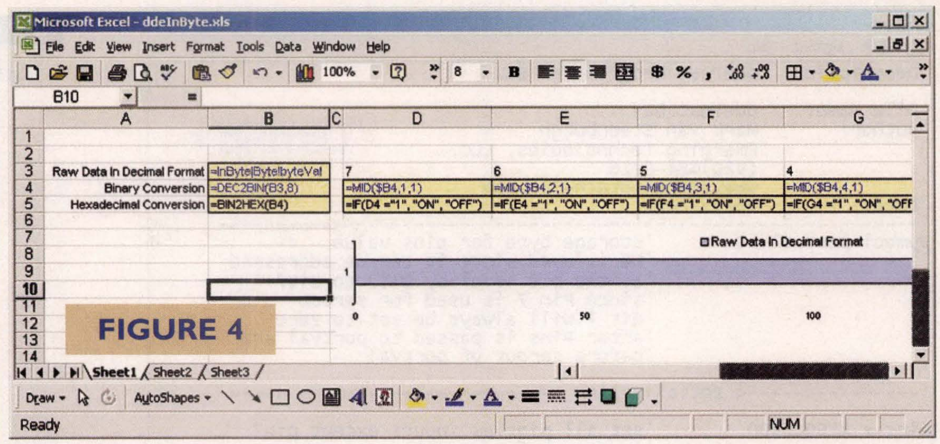

FIGURE 4

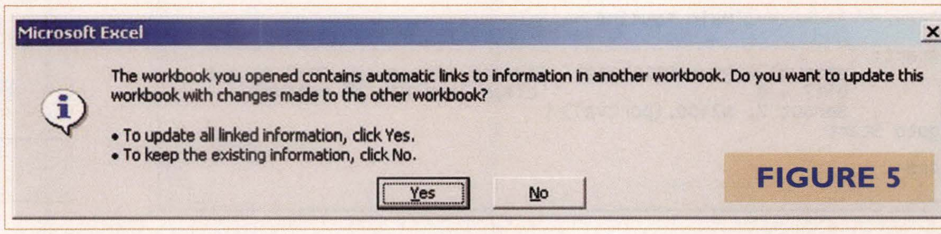

FIGURE 5

Cell B5 contains the function to convert a binary number to hexadecimal format. This function has the same 10-bit limitation. See Excel help for additional information on these functions. Cells D through K in row four are using the MID function. I have used the MID function to break out the individual bits from the byte. Of course, there are a number of different ways to do this; this is just one. This is valuable for monitoring of discrete inputs. The way I have used the MID function, it takes the eight-bit binary value and returns a single character from the position specified, starting from the left. For example, the formula in cell E4 takes a single character from the second position from the left of the value of cell B4. This happens to be discrete input 6 of our example. Additionally, cells D through K in row five are using the IF function. I have used the IF function to turn the ones and zeros into information that makes more sense. I have used the words "OFF" and "ON" to indicate the state of the input.

FIGURE 7

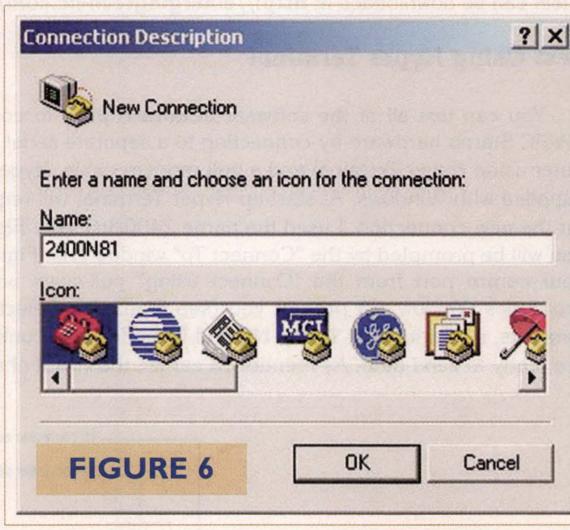

FIGURE 6

Since I have used the MID function, the values in cells D through K of row four are now in text format. The IF function logically tests the target value and returns a representation for a true or false result. I have set a true result to return the word "ON" and a false result to return the word "OFF." For additional information regarding the MID and IF functions, see Excel help.

Additionally, I have placed a bar graph on the sheet to represent the byte value in decimal. This can be valuable for monitoring when the byte represents an analog input. To create the bar graph, I simply selected cell B3 (the byte value in decimal format) and used the chart wizard to set up a bar graph and add it to the sheet.

When starting the ddeInByte.xls spreadsheet, a message will be displayed (see Figure 5) asking you if you would like to update the links in the sheet. Answer yes to this question to start the DDE link to InByte (of course, InByte must be running to establish the link).

Lastly, with regards to the spreadsheet, I made adjustments to the chart format and the sheet options to get the look I wanted. Chart formats are accessible by right clicking on the chart and selecting the format option. Sheet options are available by selecting TOOLS, then OPTIONS from the main spreadsheet menu. The ddeInByte.xls spread-

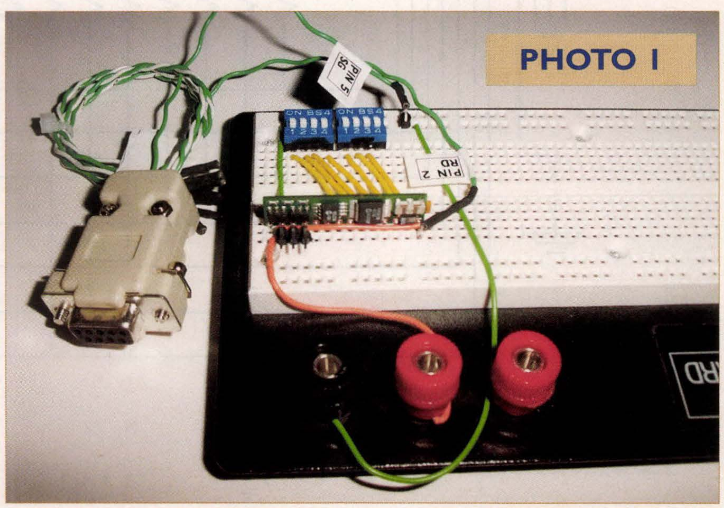

PHOTO 1

DDETEST.BAS - Notepad

```
'Description:  ddeTest Program for BS1

'File Name:    ddeTest.bas
'Author:       Mark Van Steenburgh
'              Emerging Technologies, LLC.
'              (920)684-0216
'              www.emergingtech-llc.com
'Date:         06/05/2002
'-------------------------------------------------------------------
Symbol portVal=b0         'storage byte for pins value
'                         'b0 is used since it can be addressed
'                         'at the bit level by Bit0 to Bit7
'                         'since Pin 7 is used for serout
'                         'Bit 7 will always be set to zero
'                         'after Pins is passed to portVal and
'                         'before serout of portVal
'
'---------------< Intialization >-----------------------------
'
Dirs = %10000000          'set all pins as inputs except pin7
'                         'is output for serout
'
'---------------< Main Routine >------------------------------
'
Start:
       portVal = Pins^%11111111  'invert pins so sw "ON" is a 1
       bit7 = 0                  'clear last bit of portVal
       Serout 7, N2400,(portVal)
goto Start

End
```

LISTING 1

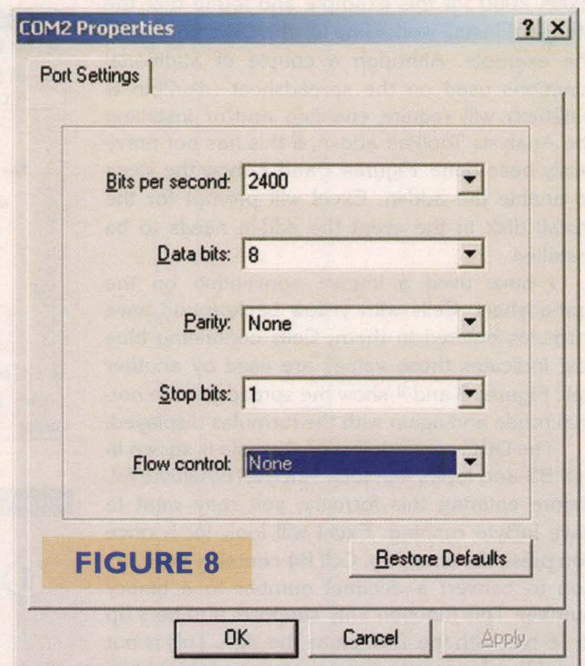

FIGURE 8

sheet can be downloaded at **http://emergingtech-llc.com/downloads**.

Test Using Hyper Terminal

You can test all of the software discussed prior to connecting the BASIC Stamp hardware by connecting to a separate serial port or computer using Hyper Terminal and a null modem cable. Hyper Terminal is supplied with Windows. At start-up Hyper Terminal will request a name for the new connection. I used the name 2400N81 (see Figure 6). Next you will be prompted by the "Connect To" window (see Figure 7). Select your comm port from the "Connect using" pull-down box. Then the Properties Window will prompt you (see Figure 8). Select 2400bps, 8 data bits, no Parity bits, 1 stop bit, and None for flow control. Now you are ready to send data. As mentioned earlier, the ASCII character "A" is represented by the decimal value of 65. With InByte and ddeInByte.xls running and Hyper Terminal connected, when the letter "A" is typed into Hyper Terminal, the number 65 is displayed on InByte and in cell B3 of ddeInByte.xls. Now that we have tested InByte and ddeInByte.xls, we can add our BASIC Stamp hardware.

The BASIC Stamp Application

In an effort to keep things simple, the example BASIC Stamp hardware (see Photo 1 and Figure 9) is set up for seven switch inputs and a serial output. Pin 7 is used for serial output functionality, therefore only pins 0 through 6 are available for discrete input. The maximum byte value with all seven inputs on will be 127. See Listing 1 for the BS1 program listing. Connect the BS1 to the PC comm port selected on InByte. Run the BS1 program, and with InByte and ddeInByte.xls running, you can switch the switches and watch the display update.

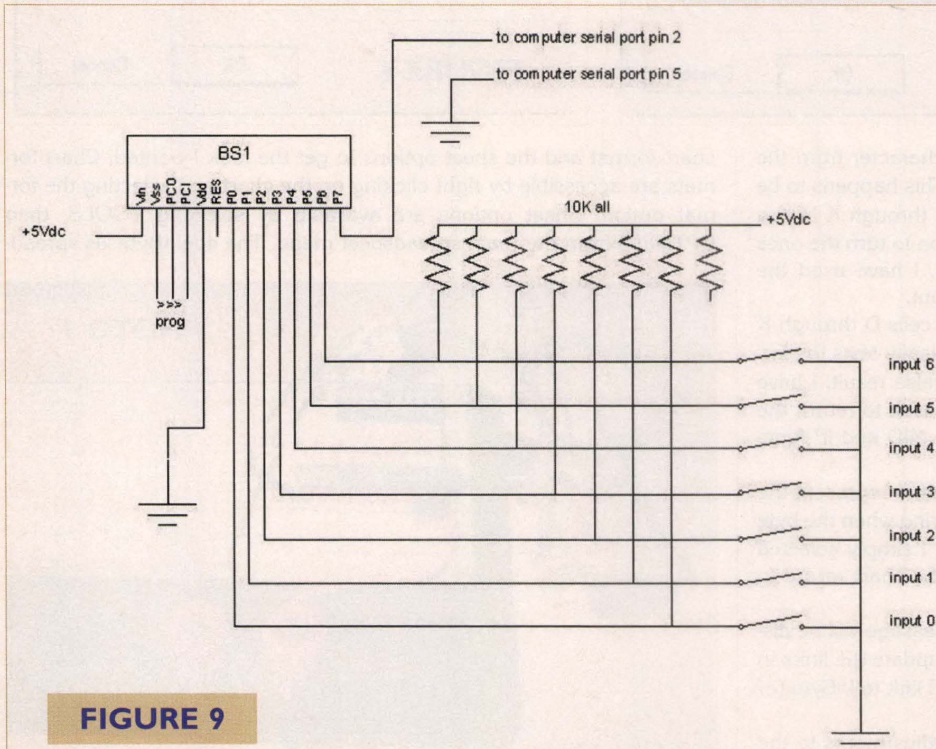

FIGURE 9

In Conclusion

All of the examples here should be fairly easy for the average *Nuts & Volts* reader to put together. InByte, ddeInByte.xls, and the BS1 listings can be downloaded from the Emerging Technologies, LLC., downloads web page. This should make it easy to get things up and running on your bench in short order.

For more information on the BASIC Stamp, visit the Parallax web site at **www.parallaxinc.com**. If you are interested in testing the analog bar graph, you can set up the circuit described in the BASIC Stamp Application Note #2 available for download from the Parallax downloads page. Application Note #2 is part of their 126 page BASIC Stamp 1 Application Notes download. If you set this up, you will need to change the serout code from "Serout S_out,N2400, (#b0,13,10)" to "Serout S_out,N2400,(b0)." **NV**

Mark Van Steenburgh is the founder of Emerging Technologies, LLC. Mark has been a part of the automation industry since 1986. He can be reached at **mvansteenburgh@emergingtech-llc.com** or **(920) 684-0216**.

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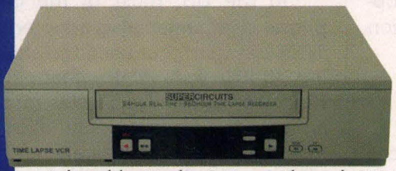

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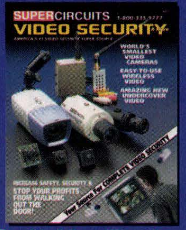

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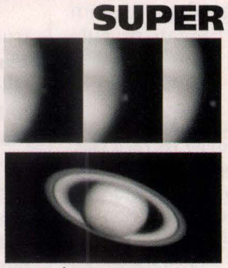

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The Most Complex Two-Way Radio Ever Built

by Louis E. Frenzel

Open Communication

Due to circumstances beyond my control, Part 2 of my column "How to Put 10 Pounds in a Five-pound Bag Or Squeezing Higher Data Rates Into Narrower Bandwidths" will appear in the December issue rather than this month. Instead, we'll be looking at the most complex two-way radio ever built — the cell phone.

Cell phones. Another sophisticated technology we take for granted. Over 60% of US households have a cell phone and that percentage is continuing to grow. The percentage is even higher in Europe where practically everyone has a cell phone. But do you know anything about your cell phone? Do you know what type you have and how it works? Probably not if you are an average user. Who cares about the technical details? But if you are an electronics communications wonk like me, you may want to know more about what has to be absolutely the most complicated two-way radio system ever invented. On top of that, you really should know about the significant changes that are taking place in the cell phone industry. If you have a cell phone, you will be impacted. Here is an overview to bring you up-to-date.

The First Generation

The cell phone concept was actually invented by Motorola back in the 1980s. The idea was to use many limited-range cell sites with overlapping coverage and frequency channel reuse to permit as many subscribers as possible to use the system reliably.

This concept works great. The earliest cell phones were better referred to as car phones as they were big and bulky and installed in the trunk of the car. But over the years, the cell phone evolved into a handheld unit. By the early 1990s, these popular portable units became the cell phone standard. While you can still get a car cell phone, few have them since the handheld units have become smaller, cheaper, and more reliable than ever.

The first generation cell phones were based upon analog technology and referred to as AMPS (Advanced Mobile Phone System). It used radio spectrum in the 800 to 900 MHz range that was freed up when the FCC (Federal Communications Commission) took away channels 69-83 in the upper UHF TV allocation because they were rarely used. There are actually 832 duplex (simultaneous two-way) channels each 30 kHz wide. The modulation is FM. The early car radios operated with a maximum power of three watts, but the handheld units use up to 600 mW.

While this analog system worked well, the growth in subscribers had the cell phone companies scrambling for more radio spectrum to expand. The total number of subscribers was overwhelming the systems, especially in the big metro areas. Since spectrum space is scarce if available at all, the cell phone companies began to resort to technical solutions that would make more efficient use of the existing spectrum. The result was the development of the second generation cell phones.

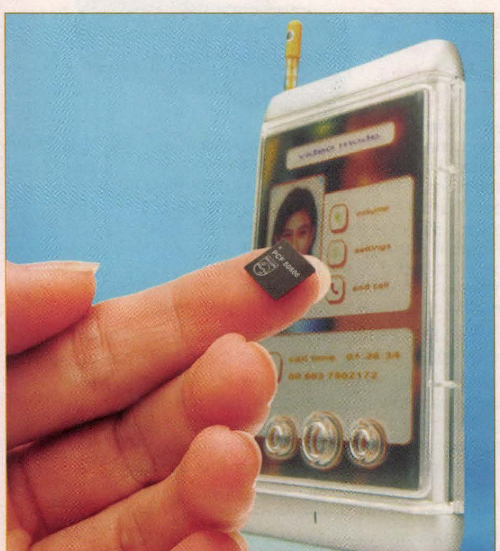


FIGURE 1. Extending battery life is a key issue for new wireless handheld devices. Power-hungry features such as color displays, support for streaming media, and multiple modes of wireless connectivity require a new approach to power management. Philips' single-chip power management unit reduces power consumption by up to 70% in smart phones and wireless. Courtesy Philips Semiconductor.

The Second Generation

Second generation (2G) cell phones are digital. Your voice is digitized by an analog-to-digital converter (ADC), then digitally compressed and used to modulate the radio carrier. Digital voice is far more immune to noise than analog voice, and more reliable. In addition, digital circuits are far more power-efficient, so they make the handhelds smaller and the batteries last longer. As 2G and later generation phones get more complex, the power consumption and battery life become key design issues. New power management chips have come to the rescue. See Figure 1.

But the biggest benefit of digital cell phones is that they incorporate multiplexing methods that permit more subscribers to share the limited number of radio channels available.

Europe experienced the spectrum crowding problem first and really developed the earliest 2G cell phones. Their system — originally called Groupe Special Mobile — is now better known as the Global System for Mobile communications or just GSM. The GSM system uses 200 kHz wide channels, but time multiplexes eight subscribers per channel. This technique is known as time division multiple access (TDMA). The serial digital data from eight subscribers modulates the carrier by Gaussian minimum shift keying (GMSK).

GMSK is a form of frequency shift keying where the binary 0s and 1s to be transmitted are used to shift between two distinct carrier frequencies. GMSK first filters the binary data to minimize its bandwidth, then uses only a small shift in frequency to further minimize bandwidth. The result is a very spectrally-efficient form of modulation. What that means is that the modulation allows you to transmit very fast digital data in minimum bandwidth. In GSM, the basic serial data rate is about 270 kbps and that is occurring in a 200 kHz channel. We say that there are 270/200 = 1.35 bits/Hz.

In the US, most of the cell phone companies also adopted a TDMA system that used the existing 30 kHz wide AMPS channels. Because the bandwidth was more limited, the system only allows three subscribers to share a 30 kHz channel. But that still permits a threefold increase in system capacity. And the new digital signals easily co-exist with the analog signals. Not a bad deal at all.

The US TDMA digital system was called by its Telecommunications Industry Association (TIA) standard IS-54. Later, this standard was updated and called IS-136. It uses differential quadrature phase shift keying (DQPSK) modulation which has to be one of the most spectrally-efficient modulation methods around as it transmits at a rate of 48.6 kbps in the 30 kHz channel for an extremely efficient 1.62 bits/Hz.

Another second generation cell phone is based upon the modulation and multiplexing method generally known as spread spectrum. Developed primarily by the company Qualcomm, this spread spectrum system is called code division multiple access (CDMA). The relevant TIA standard is IS-95.

In CDMA, the digital voice signal is given a unique pseudorandom code to identify it and then modify it by what is called a chipping signal that effectively spreads the information over a 1.25 MHz chunk of spectrum. Up to 64 subscribers can use the channel simultaneously. Because the signals are encoded and spread, they each appear to be low-level background noise to one another. A complex correlation receiver sorts all the signals out.

Despite its complexity, CDMA has grown in popularity because it provides more users per bandwidth making it a real money-maker for the carriers who use it.

FIGURE 2. Many 3G and even 2.5G phones have built-in digital camera and/or video capability. The camera eye at the top of the unit digitizes your picture and transmits it while you can display the caller's photo on your color LCD screen. This is Motorola's A820 3G phone. Courtesy Motorola.

And it offers the advantage of good performance in fading conditions with mulitpath signals so common in mobile applications.

The chances are that you currently have a 2G phone. What kind? It is hard to tell by just looking at one. You typically have to go by what carrier you use. AT & T Wireless and Cingular mostly use IS-136 TDMA phones and both carriers are switching over to GSM. Sprint is a CDMA carrier. Verizon uses CDMA while Voice Stream uses GSM.

In some cases, a carrier may use all three types because of various mergers and acquisitions that have been common in this field. If you have a PCS phone it is probably Sprint and operates in the 1900 MHz (1.9 GHz) band. Most TDMA and CDMA phones are also dual mode phones meaning they typically have an analog phone built in. If you happen to be roaming in an area where there is no 2G CDMA or TDMA coverage, the phone automatically reverts to analog operation. Analog operations are still supported throughout the US, despite the fact that few new phones contain it.

The Next Generation

The cell phone manufacturers and the carriers have been working on the next generation systems called third generation (3G). The goal has been to expand upon the digital capabilities of the 2G phones by including packet data transmission that can be used to send emails and access the Internet.

To help in this regard, the ITU (International Telecommunications Union) established a basic set of definitions and standards for 3G. Known as IMT-2000 or the Universal Mobile Telecommunications Standard (UMTS), it outlines a high-speed wideband CDMA (WCDMA) system that uses 5-MHz channels. It is designed to make upgrades from GSM systems fairly simple.

The objective has been to provide data transmission rates up to 2.048 Mbps in a fixed position, 384 kbps in a slow moving pedestrian environment, and 144 kbps in a fast mobile environment. That, of course, is much faster than any standard dial-up modem and even faster that some of the DSL and cable modem connections available today.

As it has turned out, no one has yet built a fully functioning UMTS 3G system. There are numerous test sites in Europe and one in Japan, but none in the US. The level of technical complexity and the very high cost of implementation has delayed 3G systems.

In the US, the lack of sufficient spectrum has essentially put 3G off for the time being. On top of that, many US carriers are still trying to amortize the cost of their 2G systems and recent upgrades. What is happening is that carriers have decided to make upgrades to existing systems that provide an interim step to 3G known as 2.5G.

2.5G Phones

The basic approach has been to take an existing TDMA or CDMA 2G system and make minimum modifications to give them packet data handling capability. Carriers using IS-136 TDMA have essentially decided to switch over to GSM then add the popular European upgrade called General Packet Radio System (GPRS).

What GPRS does is to steal up to four of the eight time slots in a GSM data frame and put packet data in it instead of voice signals. The change is minimal in the cell phones and the base stations, as it is more of a software upgrade than new hardware. The result is a data capability of about 56 kbps. Already, many US carriers have adopted it and are offering GSM/GPRS phones that can access the Internet and send emails among other data applications.

Another somewhat more complex upgrade to a GSM/GPRS system is known as Enhanced Data for GSM Evolution (EDGE). It uses an eight level phase shift keying (8PSK) modulation to squeeze more speed from the available bandwidth. Speeds up to 384 kbps are possible. That's close to 3G standards. EDGE is not yet available most places, but it is in the works in those carriers that have adopted GSM/GPRS.

CDMA carriers and phone vendors also have developed 2.5G phones. Qualcomm's new cdma2000 phones contain a data capability called 1XRTT that gives packet data transmissions up to 144 kbps. It can be upgraded to something called EV-DO which is a higher speed version of cdma2000 that can reach 2.4 Mbps.

Clearly, this is in 3G territory, but it is not the UMTS WCDMA system defined by the ITU. Already some cdma2000 systems are fully operational and carriers are rolling them out across the country.

So while 3G isn't really with us yet, you can enjoy the benefits of data capability today with available 2.5G phones. Some are asking whether we really need 3G. The big question is not so much when as what will we do with it?

3G Apps

Okay, so you have a data capable phone. Now what? Do you really want to access the Internet from your cell phone? In fact, it doesn't really make sense since you have no keyboard and the screen is so small as to be ridiculous. You could add a keyboard, of course, and enlarge the screen, but it still won't be as good as a laptop or regular PC.

But you can send and receive emails if they are short and don't contain attachments.

Emails and Internet access have been made easier by a new class of cell phone that is a combination of a personal digital assistant (PDA) like those from Palm and Handspring. They have bigger color screens and keyboards, so they do a reasonable job of email. So does the special email-optimized Blackberry handheld by RIM. It has a good, but small full keyboard and a pretty big screen.

But, unless you are a real gung-ho road warrior, your cell phone still has one main function: voice. Digital data capability aside, the killer app for cell phones is still talking on the phone. Big deal ...

Yet, it looks like we are going to get other applications whether we want or need them. After all, that is the way of the electronics industry to give us stuff we don't really want or need, but that we get hooked on like 2-GHz Pentium PCs and MP3 players. One of the potential applications is called location services.

The US government has mandated that all cell phone manufacturers and carriers include technology so that any cell phone user can be located within 100 yards. This is called the Enhanced 911 program. It is designed to provide location data so that 911 emergency response units can find a caller who can't say where they are.

E911 is turning out to be a big headache for the cell phone manufacturers and carriers. Providing such location information is extremely difficult and expensive. One system chosen by most of the carriers is Enhanced Observed Time Difference (EOTD) that uses a triangulation scheme.

The cell phone signal is picked up by two or three cell sites and the time of arrival of the signals is used as a measure of distance and location. While the system works, it has not yet provided the accuracy specified by the government.

Another more accurate, but very expensive scheme is based upon the Global Positioning System (GPS). This is the government satellite system used by the military and now others for navigation. Modern IC GPS receivers can be built into each cell phone, but the cost is very high. CDMA carriers are using a version of such an arrangement called SnapTrack developed by Qualcomm. The government is allowing carriers to phase in their location systems because of the cost and complexity problems. But all are required to have it by the end of 2005.

What do you do with it? Well, besides providing 911 units with location data, the carriers are trying to figure out a way to make money selling your location information to others. For example, restaurants, parking lots, and others may send you ads for their services to your cell phone as you pass by. Most people will appreciate this.

Or maybe there will be a service that you can access when you wish to locate some nearby fast food place, a post office, or whatever. In fact, some subscribers are a bit nervous about their cell phone carrier knowing exactly where they are when using their phones. Whatever happened to privacy?

It is anyone's guess just what might be the real popular applications for 3G phones once they arrive. In Japan and Europe, games are popular, but that is not true in the US. A neat feature that is getting some attention is a built-in still digital camera. See Figure 2. You can point the built-in camera at yourself and take a still color photo that can be sent to another phone and seen on a small color screen. This works so well that it is expected to be one of the more popular features of 2.5G and 3G phones. It is doubtful that full video will be an application. It would be expensive. And besides, who wants to watch a movie on a two-inch screen in a moving car?

If you are a techie, you can start taking advantage of all this digital data stuff from your cell phone right now. In the larger cities, GSM/GPRS and cdma2000 are already available. If not, it soon will be. Most of the carriers will be using their experiences with 2.5G phones to find out what applications might be best for 3G. Who knows when we might get those, if ever. In the meantime, just realize that the technology we take for granted only increases our expectations for even more spectacular applications. I can't wait. **NV**

An Internet Enabled Strip Chart

By Jim Sky KH6SKY

While Radio-SkyPipe software was initially designed to facilitate amateur radio astronomy observations, there is no reason that you could not use the system for a host of other purposes. Seismographs, remote weather monitors, radio-based meteor detectors, and Geiger counters are obvious possibilities.

The computer-based strip chart has almost completely replaced its mechanical ancestor. Gone are the clogged pens and paper jams that so often spoiled our observations in years past. The project described here marries the computer-based strip chart with the Internet. Using this software with a simple analog-to-digital converter (ADC) or your computer sound card allows you to share strip chart information across a network in near real-time.

The Software Concept

Radio-SkyPipe is Windows 95/98/Me/NT/200/Xp software written in Microsoft Visual Basic 6. The program has three primary modes of operation: Stand Alone, Server, and Client Mode. In Stand Alone Mode, the program simply acts as a data collection program, accepting data via the sound card or an ADC connected to the parallel port. The attainable sampling rate depends on the computer speed and how busy the CPU is maintaining other processes. Typically, the sampling rate will not be faster than 10 to 20 samples per second. You may average a number of samples for each data point, if you so desire.

In Server Mode, Radio-SkyPipe can pass data over a local network or the Internet to another Radio-SkyPipe equipped PC. Because each data sample contains its own time stamp, brief Internet delays are inconsequential. The strip chart is recreated on the Client Mode PC as it is produced on the Server Mode PC along with the appropriate time markers on the chart.

Public Observations

Most of us are not blessed with permanent IP addresses on the Internet. Usually, you will receive a new IP address each time you log on to your Internet Service Provider (ISP). To get around this, I installed a proprietary Internet Locator Service (ILS) on my website. If you so elect, when in Server Mode, you may have Radio-SkyPipe publish your current IP address on the ILS. Client mode users will then see a brief description of your observatory in their list of available servers. The client mode user can simply double click on your observatory listing and the connection will be established directly between the server and client computers. The serving computer may be configured for as many client connections as can be adequately handled by the computer.

Privacy Please

If the connection is to occur inside a private network where IP addresses are fixed, then there is no need to make the server public. Server addresses can be set up in a private list on the Client PCs. I use this method to monitor receivers out in my workshop while I am in my office. You may also maintain a private connection between two PCs over the Internet, but in order to do so, you must still know the IP addresses of the two PCs. This is easy to accomplish if the PCs have fixed addresses, otherwise each time the addresses change, they must be manually entered into the Radio-SkyPipe program.

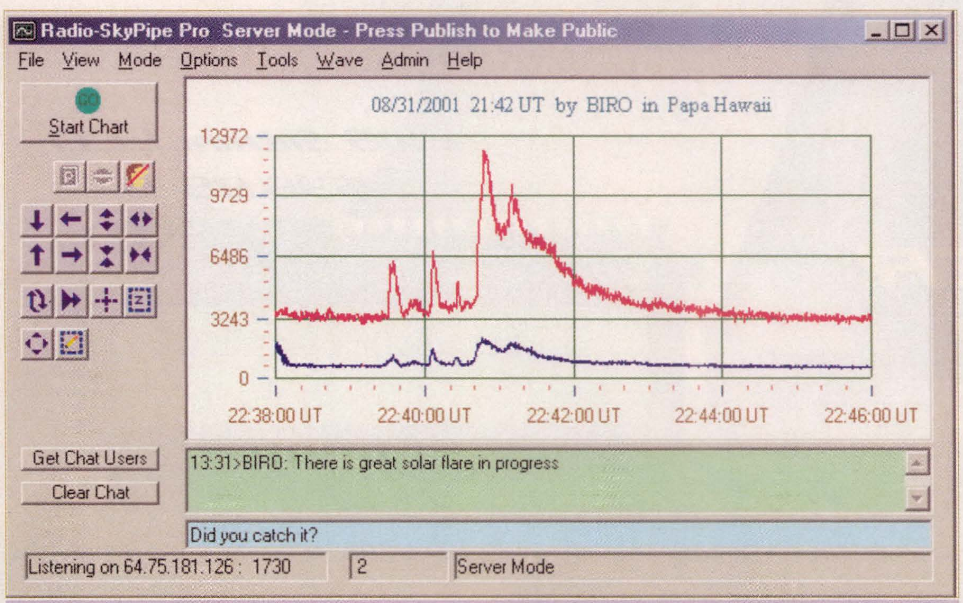


Figure 1. Strip chart of a solar flare observed on 8/31/2001 using Radio-SkyPipe software and two short-wave receivers set to different frequencies. Note the chat window that allows remote observers to exchange comments during observations.

Two-Way Usage

A separate Client-only window can be summoned while in Server or Stand Alone Modes thus allowing the user to act as both a Server and a Client. This allows simultaneous two-way exchanges of charts between users. This was one of the primary goals in writing Radio-SkyPipe. There has always been a need among amateur scientists to correlate observations in order to exclude the effects of noise or equipment glitches. We have been using this system to share radio astronomy observations for well over a year now (see Jupiter's Mysterious Radio Noise Storms in the sidebar). If we see a solar flare or Jupiter signature, we pretty much know it is real and not our neighbor's neon beer sign emitting a burst of static.

Chart Features

You may scroll around in the chart even as it continues to collect data. Charts may be repositioned and resized in most any useful manner.

While the free Standard Version of Radio-SkyPipe is limited to creating new charts with only a single channel, you may still use the free version to receive multiple channel charts from Pro Version users. Pro Version users can record and serve up to eight simultaneous channels using the analog-to-digital converter, or two channels of data derived from the sound card. Both versions have a chat window so you can communicate with any of the users connected to a given Radio-SkyPipe server. Not only is this feature fun, it has proven to be very helpful during group observations. Using chat, it is possible to clarify the nature of chart events that might otherwise be misinterpreted.

Sound Card Usage

Audio sources such as radios and microphones can be fed to the Line In or Microphone input of the sound card. Radio-SkyPipe can detect and record averaged peaks from these signals and present them to the strip chart. You cannot use the sound card to record steady or very slowly varying DC signals, but if your source to be measured produces an audio output, you may use this method of input to the computer. We use this method for recording solar flares and Jupiter noise storms by directly taking the output from a short-wave receiver and running it to the Line Input jack of the sound card. The method is appropriate wherever the averaged value of the sound is the desired information.

When using the sound card for data collection, it is important not to overdrive the sound card input. It might be possible to damage the circuitry if too much voltage is applied to the input. You should also familiarize yourself with the sound mixer panel of your computer. The mixer panel has an input and output side, sometimes referred to as record and playback panels. On a "standard" Windows mixer panel, you may toggle back and forth between these panels by selecting Options and then Properties. Adjust the recording panel's line input or microphone volume control to adjust the level detected by Radio-SkyPipe.

Analog-to-Digital Converters

There are presently two analog-to-digital converter circuits supported directly by Radio-SkyPipe. A single-channel circuit based on the MAX187 integrated circuit or an eight-channel device based on the MAX186 may be used. Both circuits are easy to build and provide accurate 12-bit data to the computer via the parallel port. A schematic for the eight-channel unit is provided here, as it is probably the one you will want to build. Plans for the single channel unit are available on my website (http://radiosky.com).

The circuit is simple enough that it may be built on an integrated circuit breadboard like the ones available from RadioShack. You can also purchase bare boards from my website. I suggest you go ahead and use an IC socket for the ADC chip. The wiring isn't that critical and you could spare the IC from overheating. It might be possible to power the circuit from the parallel port, but I never recommend this. A small wall-wart type 9V DC supply will work fine if it is fairly well filtered. Even a 9V battery will last quite a while. The current draw is quite low.

Note that although they are not shown in the schematic, each of the eight analog inputs to the MAX186 (pins 1 through 8) are brought to ground via a 100-kilohm resistor. I have found this necessary to reduce noise on these high impedance inputs, especially the ones that are left floating, that is, not connected to a voltage source for measurements.

The 12-bit resolution of the ADC gives you the ability to measure

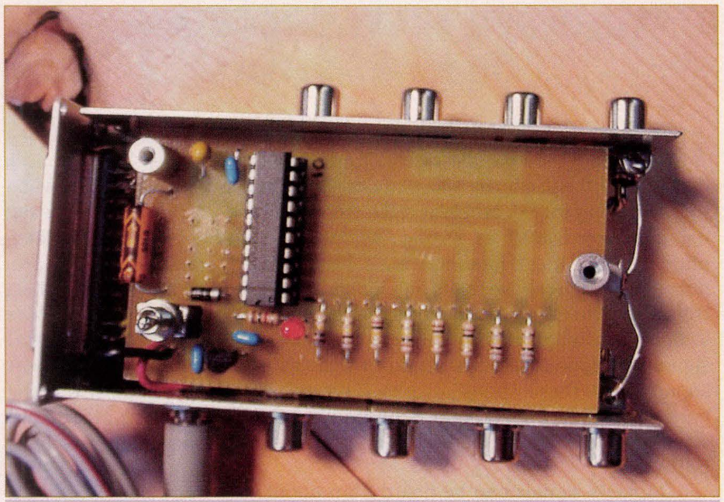


Figure 2. The eight-channel ADC built up on a printed circuit board and installed in a compact metal enclosure. The circuit is simple enough that it could be built on a small piece of protoboard instead.

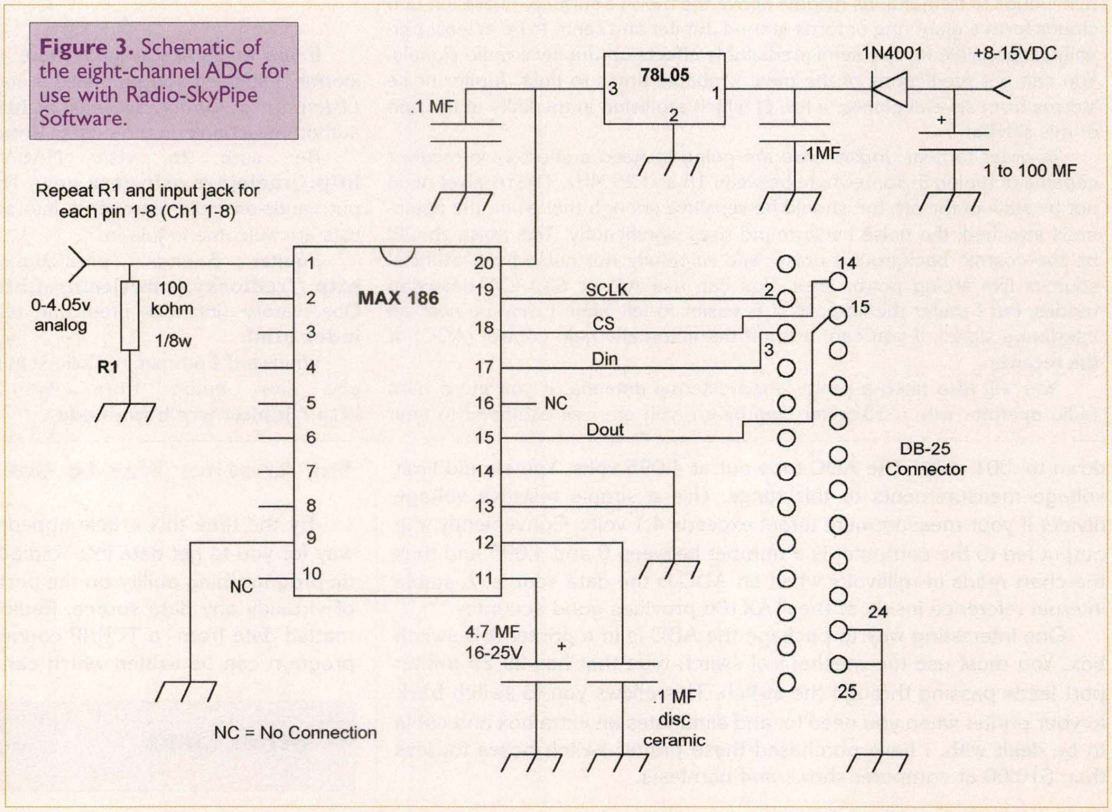


Figure 3. Schematic of the eight-channel ADC for use with Radio-SkyPipe Software.

Parts List

8 ea. — 100 kilohm 1/8W resistors (R1 is repeated for each of the data inputs pins 1-8 of the MAX186).
3 ea. — .1 mF disc ceramic 25V capacitors
1 ea. — 4.7 mF 16-25V electrolytic capacitor
1 ea. — 78L05 voltage regulator IC
1 ea. — MAX186 analog-to-digital converter IC by Maxim Integrated Circuits

All parts are available from **Digi-Key** at **www.digikey.com.** The MAX186 IC is also available from Radio-Sky Publishing at **http://radiosky.com** for $18.00 plus shipping. A partial kit, including a bare board, IC, and various components is also available.

Jupiter's Mysterious Radio Noise Storms

If you are a short-wave radio listener or a ham radio operator, you may have already heard radio signals from the planet Jupiter. The first time that I heard these signals was early one morning in the early 1980s when I was listening for DX amateur radio stations in the 21 MHz band. The signal manifested itself as strong "whoosh-whoosh-whoosh" in my headphones. What I was hearing were L-Bursts (the L stands for long), produced by electrons spiraling in Jupiter's tremendous magnetic field. L-Bursts sometimes sound much like waves crashing on a beach. Later, I was to find that Jupiter also produces a short burst (you guessed it, S-Bursts) signal that sounds like sputtering or pebbles on a tin roof. You can hear sound files of these noises at some of the websites listed below. Next to the huge radio bursts sometimes produced by the Sun, Jupiter's radio emissions are the strongest natural cosmic radio emissions we can hear from Earth.

Jupiter's signals can be heard from about 14 MHz to almost 40 MHz here on our planet's surface. The low frequency limit is set by the Earth's ionosphere which usually blocks extra-terrestrial radio signals below this frequency. The high frequency limit is imposed by Jupiter's own magnetic field. This natural upper cut-off to Jupiter radio storm emissions actually allowed us to predict the strength of Jupiter's magnetic field long before the Voyager space probes arrived at the planet to measure the field directly. Experience has shown that the best frequencies to listen for Jupiter actually run from about 18 to 24 MHz. Jupiter's emissions are broad in nature and so may be detected over regions hundreds of kiloHertz or even many MegaHertz wide. Thus, there is no set frequency on which to listen. You simply tune around a bit for a clear area close to the frequency for which you have designed your antenna.

Though I have been referring to these "decametric" emissions of Jupiter as "storms," the analogy is only partially correct. Like weather storms on Earth, these signals are not totally predictable. You can never be exactly sure when you might receive these signals, however, because the signals arrive here in a beamed fashion — somewhat like a lighthouse beacon — we can say when the signals are more likely to be heard. Actually, Jupiter acts a bit like a lighthouse with three separate beacons. Imaginatively enough, we call these emission modes A, B, and C. Emissions from the A, B, and C regions can also be affected by the position of Jupiter's inner-most moon, Io. You may have seen some of the dramatic NASA pictures of Io, with its active volcanoes spewing sulfurous, ion-rich clouds to tremendous heights above the moon's surface. These ion-rich clouds form a giant ring or torus around Jupiter and seem to be at least partially responsible for Io's semi-predictable effects on Jupiter's radio signals. You can get predictions of the most probable times to hear Jupiter noise storms from several places, a few of which are listed in the links at the end of this sidebar.

In order to hear Jupiter, you are going to need a short-wave receiver capable of tuning in somewhere between 18 and 25 MHz. The receiver need not be state-of-the-art, but should be sensitive enough that when the antenna is attached, the noise background rises significantly. This noise should be the cosmic background noise, and hopefully not noise from artificial sources like arcing power lines. You can use AM or SSB/CW detection modes, but I prefer the latter as it is easier to tell when I may be near an interfering signal. If you can, turn off the automatic gain control (AGC) of the receiver.

You will also need a pretty good external antenna. If you are a ham radio operator with a 15-meter Yagi beam, you are well equipped to hear

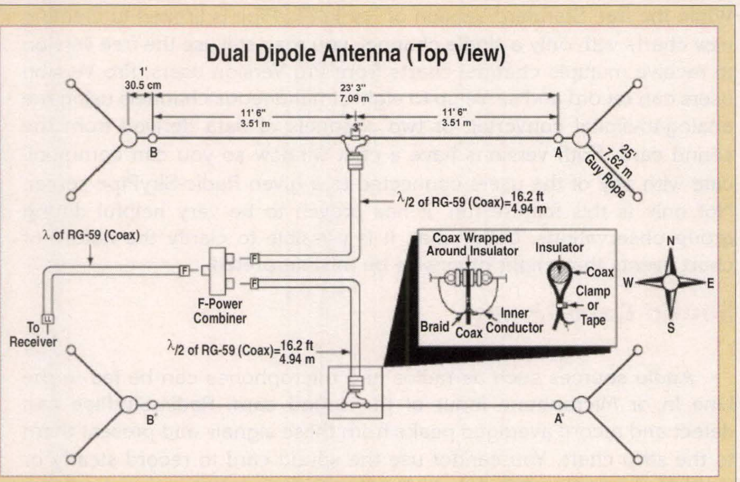


Figure 4. Dual dipole antenna used by many Jupiter radio listeners. The V's shown at each corner are not part of the antenna, but are guy ropes used to support the 10-foot sections of 2" PVC pipe which serve as a support at the end of each dipole. The dimensions here are for an antenna that operates at 20.1 MHz.

Jupiter noise storms when they occur while Jupiter is low in the sky. However, when Jupiter is overhead, you will need to either point the beam upwards or use a different type of antenna. The simplest antenna on which Jupiter might be heard is a half wave dipole set about 1/8 to 1/4 wavelength above ground. Participants in NASA's Radio Jove project most often use a dual dipole arrangement, shown here in Figure 4. This antenna is simple to construct and has proven to be sensitive enough to pick up plenty of Jupiter activity. The dual dipole has about twice the gain of the ordinary dipole. Placing the antenna at a height of about 10 feet, (three meters), above ground helps concentrate the sensitivity to an area directly overhead. This means the antenna will best receive Jupiter when it is within 30 degrees of the "zenith." The arrangement also reduces sensitivity to terrestrial station interference. You can get plans for the Jove Project dual dipole antenna at the Jove Project website listed below.

Observing Jupiter's radio noise storms is a challenging and educational activity. If you ever wanted to get involved with radio astronomy, this is an excellent first step, and now that we have a tool like Radio-SkyPipe software, you don't have be alone when you are observing!

Jupiter Resources

If you would like to learn more about observing Jupiter's radio noise storms, I suggest you purchase a copy of Richard Flagg's excellent book *Listening to Jupiter,* available at **http://radiosky.com**. This is the only authoritative book on the subject written with the amateur observer in mind.

Be sure to visit NASA's Jove Project website at **http://radiojove.gsfc.nasa.gov/**. The Jove Project was developed to help put hands-on radio astronomy into schools, but individual amateur scientists are welcome to join in.

Jupiter Sounds, predictions, and more information — **http://radiosky.com/rjcentral.htm**. University of Florida Radio Observatory (includes prediction tables) — **www.astro.ufl.edu/radio/index.html**.

Windward Community College in Hawaii streams Radio-SkyPipe charts and live audio from its Jupiter/Solar radiotelescope — **http://jupiter.wcc.hawaii.edu/**.

down to .001 volts. The ADC tops out at 4.095 volts. You should limit voltage measurements to this range. Use a simple resistive voltage divider if your measurement target exceeds 4.1 volts. Conveniently, the output fed to the computer is a number between 0 and 4,095 and thus the chart reads in millivolts when an ADC is the data source. A stable internal reference inside of the MAX186 provides good accuracy.

One interesting way to package the ADC is in a printer A-B switch box. You must use the mechanical switch type that has all 25 printer port leads passing through the switch. This allows you to switch back to your printer when you need to, and eliminates an extra box and cable to be dealt with. I have purchased these printer switch boxes for less than $10.00 at computer shows and hamfests.

Yet Another Way to Get Data In

By the time this article appears in print, there will be yet another way for you to get data into Radio-SkyPipe. This method requires a little programming ability on the part of the user, but it will allow the use of virtually any data source. Radio-SkyPipe will be able to accept formatted data from a TCP/IP connection. The idea here is that a small program can be written which can read voltages from any ADC. This

Other Links

Radio-SkyPipe Help Pages
http://radiosky.com/skypipehelp/skypipehelpindex.html

small custom program passes the data to Radio-SkyPipe via a LAN or Internet connection using the appropriate formatting and the TCP/IP protocol. The custom program thus acts as a go between, overcoming the inherent problem of requiring the data collection program — Radio-SkyPipe — to understand the workings of a particular ADC. A skeleton program in Visual Basic will be provided to make the job of writing your interface program easier, however, if you are happier writing in C, Delphi, Java, or any other language, you are free to do so. It is my hope that people will donate their SkyPipe interface programs for others to use. One nice thing about this scheme is that the actual ADC does not have to be connected to the PC on which SkyPipe is running. In fact, there is no reason that the machine has to be Windows based! A Linux box or Mac could do the interfacing job just as well.

Obtaining the Software

You can download Radio-SkyPipe software from my website at **http://radiosky.com**. The software comes in a self-extracting executable zipped file. The Standard version will provide you with loads of functionality. It is free to all non-commercial users. There are no time limits or annoying nag screens. If you wish to upgrade to the Pro version, you will get a key to unlock many great features like triggered wave file recording, observer log, remote administration, eight-channel serving capability, time server synchronization, automatic FTP of charts to your website, and more. New versions come out fairly often, so I have included a feature under Help that will check the webite for the latest version.

Possible Applications

While the software was initially designed to facilitate amateur radio astronomy observations, there is no reason that you could not use the system for a host of other purposes. Seismographs, remote weather monitors, radio-based meteor detectors, and Geiger counters are obvious possibilities. You could also use the system to monitor equipment temperatures and voltages at remote installations such as amateur radio repeaters. Any detector that produces a voltage or a sound signal will work with Radio-SkyPipe. If enough interest develops in any one area to warrant a special ILS, I will be happy to implement one. That way, observations of a particular type will not appear in everyone's available servers list. **NV**

Jim Sky — Author's Bio

Confronted with starvation after receiving my degree in biology in 1976, I worked for the next 22 years in the technological end of the banking industry in Kentucky. Lately, I have struck out on my own as a software developer and publisher in Hawaii. My interests include radio astronomy, electronics, and aquatic biology. I hold an Amateur Extra Class license K4SKY/KH6.

See Page 40 for info!

by Jon Williams

Stamp Applications

Play It Again, Stamp!

One evening, we were strolling the famous Las Vegas strip and stopped in front of the Bellagio hotel to watch an incredible fountain display. While my friends and the thousands gathered on the sidewalk that evening were in awe of the beauty of it all, the only thing I could think about was the control system required to create such an incredible display. Honestly, I think I was salivating — it was just that awesome.

In August, I made a quick trip to Las Vegas to visit friends. I love that city. It never sleeps and no matter how wacky you think you are, there's a good chance you'll encounter someone even wackier in Las Vegas.

One evening, we were strolling the famous Las Vegas strip and stopped in front of the Bellagio hotel to watch an incredible fountain display. Those of you who have seen it know what I'm talking about; it's nothing short of spectacular. In front of the hotel is a pond that I would guess covers about three acres of ground. In the pond are hundreds of water jets that are synchronized to music. The jets move and modulate the water in seemingly magical ways.

While my friends and the thousands gathered on the sidewalk that evening were in awe of the beauty of it all, the only thing I could think about was the control system required to create such an incredible display. Honestly, I think I was salivating — it was just that awesome.

On returning to Dallas, I got an email from a customer in California. He was looking to make a programmable sequencer with the BASIC Stamp. With the thoughts of the fountain fresh in my mind, I jumped right on it. He was just looking for guidance, but I couldn't help myself — I wrote a whole program.

So that's what our project is this month. A programmable sequencer using the BASIC Stamp. My outputs are going to be LEDs (see Figure 2). If you want to control something else, you'll need to add appropriate conditioning circuitry to drive your loads. By the way, my new friend in California? ... his outputs are connected to electronically-controlled flame throwers. I can't wait to see that in action!

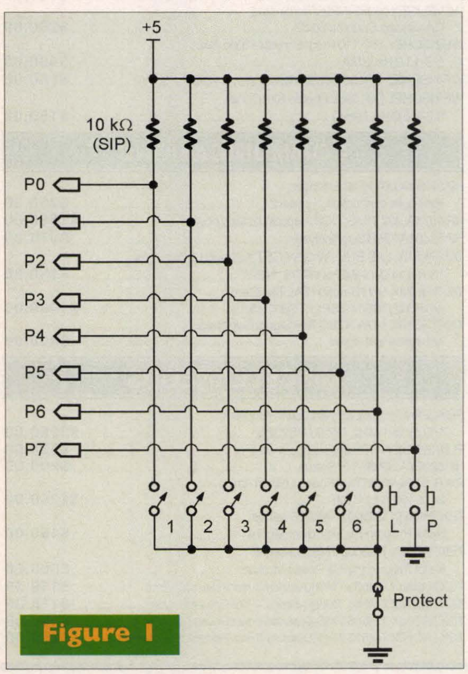


Figure 1

With Halloween this month and the holiday season right around the corner, this is a useful little project. And for those of you in the film or theater special-effects business, this little controller can be used for anything from lights to flash pots to squibs.

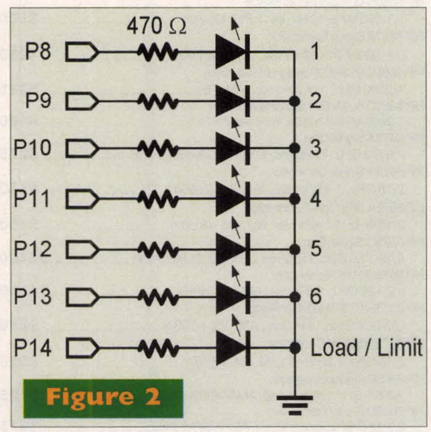


Figure 2

How It Works

The concept is very simple. After reset, we will set the channel input switches for a given step and then press the Load button (for us "old timers" this is reminicent of the way we programmed computers way back when ...). If the step is good, the Load/Limit LED will blink. So long as we don't press Play, the sequence will continue to build up to our defined step limit. Once we do press Play, the sequence will be run on our outputs at a rate determined by the StepTime potentiometer.

Pressing Play also resets the step counter and allows us to reprogram a new sequence. If you want to protect your current sequence, it's a simple matter of breaking the ground connection to the channel switches and Load input button (see Figure 1).

Let's go ahead and jump into the details. Once the I/O pins are initialized, the program waits for a Load or Play input and takes action.

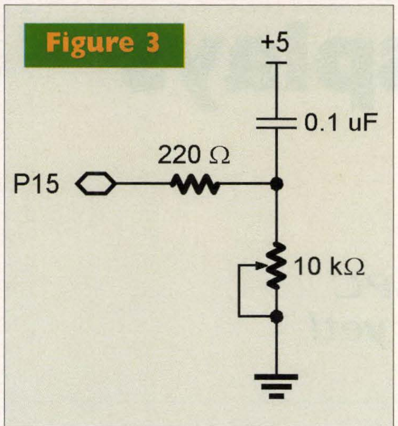
```
Main:
  GOSUB Scan_Inputs                          ' check switches & buttons
  IF (play = Yes) THEN Play_Back             ' play current sequence
  IF (load = No) THEN Main                   ' nothing to do, scan again
```

Most of the time we're going to be waiting for an input. Let's take a look at the code than actually handles the button and switch inputs.

```
Scan_Inputs:
  swInputs = %11111111                       ' assume all are active
  FOR idx = 1 TO 10
   swInputs = swInputs & ~Inputs             ' get current inputs
   PAUSE 5                                   ' delay between readings
  NEXT

Check_Channel_Count:
  numChans = 0
  FOR idx = 0 TO 5
   numChans = numChans + swInputs.LowBit(idx)   ' add channel value
  NEXT
  IF (numChans <= MaxChannels) THEN Scan_Exit   ' count okay
  swInputs = swInputs & %10000000               ' mask out channel inputs

Scan_Exit:
  RETURN
```



Most of this code should look familiar as we've used it in the past. The first part of the subroutine scans and debounces the input switches and buttons. This is done by starting with the assumption that all are active, then using a loop to AND the current inputs with our result value. Since the inputs are active low, the inversion operator (~) is used. If at any point during the loop a button or switch opens (bounces), that bit will become zero in the ***swInputs*** variable. Since zero ANDed with anything is zero, the channel will be excluded from the current scan. We can fine-tune the debounce performance by changing the number of loops and the delay time between each.

The second section of the subroutine is used to control the number of simultaneous outputs when we playback the sequence. On some devices, we may not want to allow all six output channels to be on at the same time. This bit of code counts the switch bits that are set by taking advantage of the LowBit modifier. LowBit allows us to specify an index so we can cycle through the switch bits with our loop control variable, ***idx***. If the number is less than or equal to the MaxChannels limit, the scan will be allowed. If there are too many inputs, all switch channels are cleared — as if they'd never been closed. The Load input is also masked out so that we don't create a blank spot in our sequence. The Play button is still available for the scan.

When a valid input is accepted and it was not the play button, the new step will be recorded.

```
Check_Limit:
 IF (numSteps < maxSteps) THEN Record_Input      ' room for this step?
 LoadLED = On                                    ' - no Load LED on solid
 GOTO Main

Record_Input:
 numSteps = numSteps + 1                ' update count
 WRITE SeqLen, numSteps                 ' write events count to EEPROM
 swInputs = swInputs & %00111111        ' mask out Load & Play buttons
 WRITE (Sequence + numSteps - 1), swInputs ' write step data to EEPROM

 LoadLED = On                           ' show good load
 PAUSE 50
 LoadLED = Off
```

Before we record a step, we need to make sure we haven't hit the step limit. If we have, the Load/Limit LED will be lit solid and the program will cycle back to main to wait for another input. This will let us detect the Play button.

If can record a new step, the events counter is incremented and saved to the EEPROM. The input channels are also saved to the EEPROM. The reason for this is that we can have longer sequences than could be stored in RAM and we won't lose them on reset. The Load/Limit LED will blink to let us know that the step was accepted.

With the current step recorded, we need to make sure that the Load button is released before looking for another step. This will prevent us from filling our step memory with the same data, no matter how long we hold the Load button.

```
Wait_For_Clear:
 GOSUB Scan_Inputs
 IF (Load = Yes) THEN Wait_For_Clear    ' force release of Load button
 GOTO Main
```

There's no magic here — we simply scan the inputs again and check the Load button. If we want to create a longer section with the same channel data, we'll just press and release that Load button multiple times. There is no blanking between steps unless we deliberately insert it.

Okay, now that we have our steps in memory, we can play them back. Pressing the Play button runs this bit of code:

```
Play_Back:
 READ SeqLen, numSteps                          ' get length of sequence
 IF (numSteps = 0) THEN Main                    ' nothing to play back
 FOR idx = 0 TO (numSteps - 1)
  READ (Sequence + idx), LEDs                   ' put step data on LEDs
  GOSUB Play_Delay                              ' delay between steps
 NEXT

 GOTO Initialize                                ' reset everything
```

We start by reading the length of the sequence from EEPROM. This lets us run a previously-stored sequence after a reset or power-up. Then it's just a matter of reading the events table to the outputs and inserting our step delay. At the end of the sequence, we jump back to the initialization code where the outputs and step counter are cleared. We can create a repeating sequence by holding the Play button or placing a SPST switch in parallel with it.

The delay between steps during playback is controlled by a potentiometer and read using **RCTIME**.

```
Play_Delay:
 HIGH StepTime                                  ' discharge RCTIME cap
 PAUSE 1
 RCTIME StepTime, 1, stepDelay                  ' read pot value
 stepDelay = (stepDelay */ $013C) + 100         ' convert to 100 - 1000
 PAUSE stepDelay
 RETURN
```

Figure 3 shows a standard **RCTIME** circuit. When using **RCTIME**, we start by discharging the capacitor. Since the other end of the capacitor is tied to Vdd, we'll make the StepTime pot pin high. With a 0.1 uF cap and a 220-ohm resistor, it doesn't take long to discharge the capacitor, so the one millisecond **PAUSE** is plenty of time to get the job done.

The pot position is read using **RCTIME** and the raw value is placed in ***stepDelay***. On my prototype, the maximum **RCTIME** value returned was 728. What I wanted to have was a step delay that was a minimum of 100 milliseconds and a maximum of one second (1,000 milliseconds). What I need to do is scale 728 to 900. I needed a scaling factor for the ***stepDelay*** value. This is done by dividing 900 by 728 — the result is 1.236.

Now we all know that the BASIC Stamp doesn't do floating-point math, but it does have that tricky */ (star-slash) operator. The */ operator multiplies by a fractional value expressed in units of 1/256. To find our */ parameter, then, we simply multiply our fractional value by 256. In our case, the result is 316 (1.236 x 256). My habit is to convert this value to hex ($013C) because the upper byte represents the whole part of the value. The Stamp doesn't care and will happily work with any numeric format you choose. In our delay conversion code, we add 100 to guarantee a minimum step delay when the pot is turned all the way down to zero. **PAUSE** takes care of creating the delay.

Taking It Further

This project is really simple, yet incredibly useful and an excellent candidate for further development. Here are a few ideas that you could incorporate to stretch the project and your Stamp programming skills.

- By using our old favorites, the 74HC165 and 75HC595, we could monitor eight inputs and control eight outputs using only five Stamp pins. This frees a lot of Stamp I/O.
- With enough free I/O pins, you could add an LCD display and a couple of control buttons (i.e., Step Forward, Step Back). This would be especially useful for long sequences and making adjustments without reprogramming the whole series.
- Need really long sequences? Add an I2C memory like we did with the data logger project.
- Want to get really fancy? Read the pot when you press Load and store the timing with the step data.

I hope you find this project as fun and useful as I did; it really can be adapted for a wide variety of applications. Please let me know if you do something interesting with it. Well, that's enough for this month. Have a safe, sane, and happy Halloween. Until next time, Happy Stamping. **NV**

Using X-10 to Control Christmas Light Displays

By Richard Haendel

Combine X-10 technology and a PC to create your best holiday display yet!

Take some inexpensive X-10 lamp modules, mix in the appropriate power line interface, stir with a simple hardware controller, sprinkle lightly with Visual Basic programming, add a heavy dose of imagination, and what do you have? A recipe for the best Christmas light displays on the block!

'Tis the season

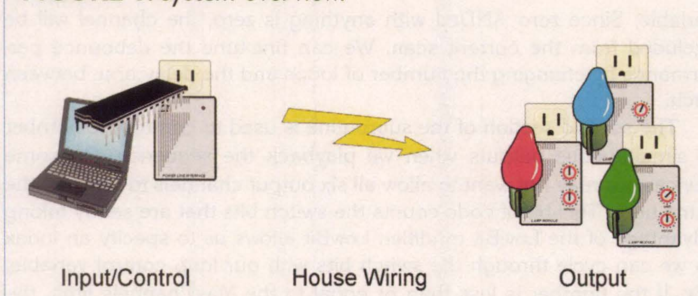
In recent years, decorating houses, bushes, trees, and almost anything else you can imagine with lights at Christmas time has become quite a popular pastime. Even I have been guilty of participating in this annual ritual. However, my display has been so lame that I'm almost ashamed of it. Aside from the fact that I have an extremely large yard, I prefer motion lights. Lights, that is, that blink, flash, or dim in some predetermined order, pattern, or sequence. Another problem is that I really don't like the small, low voltage bulbs that are almost always used in motion displays. I prefer the larger, C-9 bulbs, especially for outlining the house. These, of course, rarely ever blink, chase, or what have you since they don't come with built-in controllers. In other words, they're dumb lights. For the last few years, I've had this idea that X-10 could turn my dumb lights into smart lights. So this year, finally, is going to be an X-10 Christmas!

X-what?

X-10, short for experiment number 10, has been around since the late 70s. It was developed for BSR as a wireless control method for their audio equipment. It was so popular that it quickly became more important than the equipment it was supposed to control.

My first X-10 system (circa 1979) was really high tech! It consisted of a light switch module, an appliance module, and a desktop controller. It was really just a curiosity to me since, at the time, I didn't have a home automation budget, or even a home — just an apartment. Therefore, my X-10 system wound-up on the shelf and was, for the most part, forgotten. Besides, the most important element was missing — the personal computer!

FIGURE 1. System overview.



X-10 from the PC

The PC is the perfect X-10 companion. After all, who wants to automate their home manually? Of course, there are already several good systems that combine hardware and software into a total home control solution. And, although I've never tried any of them, I assume they are excellent packages and quite good at what they do. I'm sure that some, if not all, could even be used to create the kind of display I'll describe later in this article.

However, if you only want to blink a few lights, the above systems might be overkill. My system, on the other hand, is simple and cheap (I wouldn't use it if it weren't). If you want to expand on it, you can. But you certainly don't have to. It won't cost so much that you have to feel

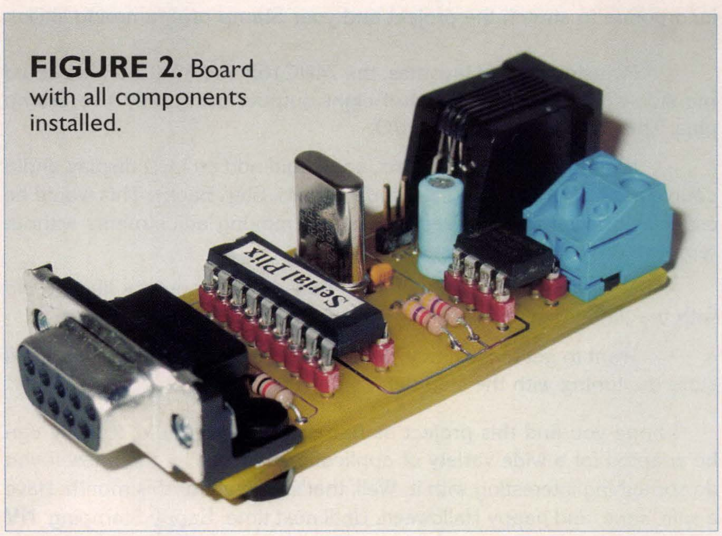


FIGURE 2. Board with all components installed.

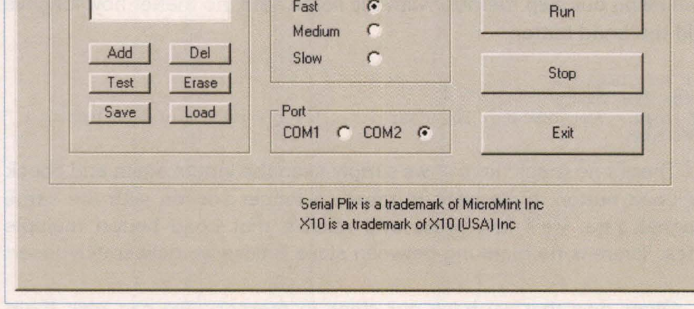


FIGURE 3. PC to X-10 control program.

bad about tossing it into the same box as the other decorations and storing it away in the attic.

How do they?

So much X-10 information is already floating about the Internet, that I won't talk about the details here. Nor will I describe how the Plix chip works. Micromint's website (**www.micromint.com**) has all the information you need for that. What I am going to talk about, however, is the PC to X-10 system I've designed and built. This system consists of a hardware interface board based on the Serial Plix chip and a software program I call PCX to control it. I'm also going to describe one simple — yet interesting — way to use it.

Requirements

To control lights with my PC to X-10 system, you need the following (shown symbolically in Figure 1):

Input and control: A Windows 95 (or better) PC; a special program to create/edit/send X-10 commands; a Serial Plix chip with support circuitry; and a PL513/TW523 power line interface module.

House wiring: Something for the signals to travel through (not real lightning).

Output: At least one X-10 lamp module for each channel/color and Christmas lights.

The easy way

Because X-10 has some critical timing requirements, it's much easier to use a custom device of some sort. Of all the ones available, I chose Micromint's Plix chip mostly because it's simple to interface and easy to program. Micromint has two versions: one that's parallel and one that's serial. For some reason, they offer a demonstration board that plugs into the printer port for the parallel version, but not for the serial version. I really wanted to use the serial version. Not just because it's easier to program from Visual Basic, but also because, these days, you're much more likely to have an extra serial port hanging around than you are an extra printer port.

Just DIY it ...

I did. It wasn't difficult (see schematic). The circuit is derived mostly from the Serial Plix data sheet. Jumper J4 was added so you can use the (uni-directional) PL513 instead of the (bi-directional) TW523. U2 is simply a MAX667, low-power regulator for the +5 volt supply. Since current drain is very low — about 1.6 mA when idling and roughly twice that when processing commands — an ordinary nine-volt battery lasts a long time. In fact, I was unable to fully exhaust one during all of my testing.

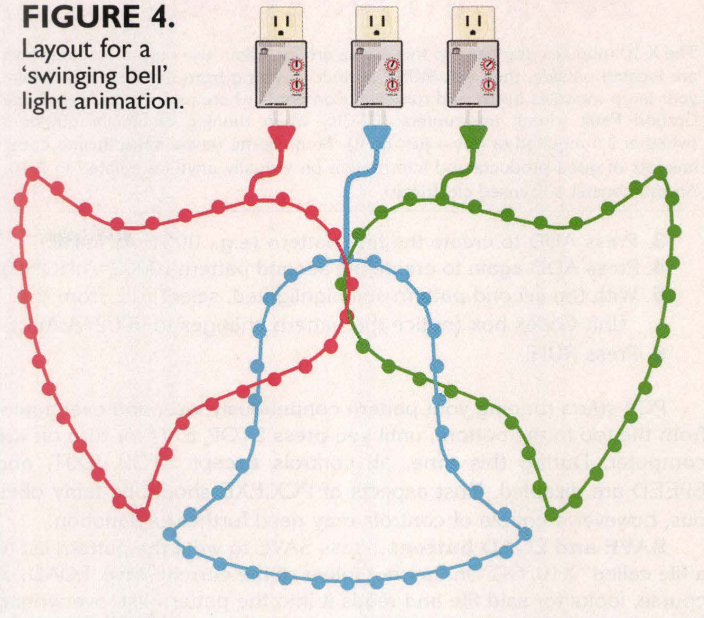
Construction

The easiest way to build the Serial Plix interface board is to purchase a complete kit from me (see the parts list for ordering information). Note that I offer (professionally manufactured) bare boards and fully assembled units, as well. In any event, be aware that only my assembled and tested units include the Plix chip. All products, however, include extensive documentation and full source code to the PCX.EXE program. You must be extremely careful when inserting integrated circuits into their sockets. Be sure to ground yourself and make sure the pins are straight. Carefully line them up with the holes and gently, but steadily, push the IC into its socket. Visually inspect the installation to be sure no pins were accidentally bent during the insertion.

Check-out and set-up

The completed board should look similar to Figure 2. A nine-volt battery connects to the blue terminal block. Note that the inside pin (the one closest to the phone jack) is positive. The only way to check out the board is to use it. The only set-up required is jumper J4, as previously discussed. The best way to get it running is to be patient and read on.

FIGURE 4. Layout for a 'swinging bell' light animation.



Control freak

With the Serial Plix interface board designed, built, and working, it was now time to control it. I wrote the program you see in Figure 3 to do just that. It was written in Visual Basic because VB includes the MSComm control, making serial communications (especially one-way) almost trivial. This program, called PCX, allows you to create, edit, and run control sequences that I call patterns. Patterns are X-10 like instructions stored in a list box that is cycled through, from the top to the bottom, over and over again. Creating a pattern is just a matter of pressing buttons and checking boxes in PCX.EXE. For example, if we wanted to blink all lights that are plugged into an X-10 lamp module, we'd do the following:

1. Press ERASE to clear any previous pattern.
2. Choose a house letter from the House Codes box.

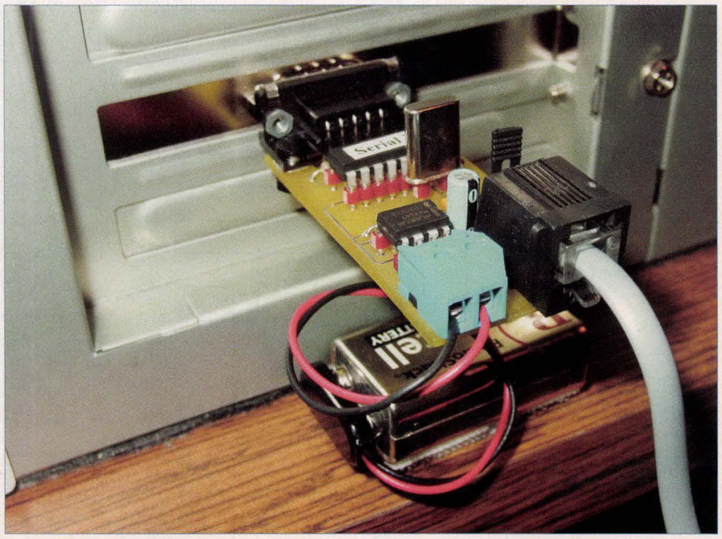


FIGURE 5. Typical installation. Note the use of Velcro to hold the battery securely.

IMPORTANT SAFETY NOTICE

The X-10 modules described in this article are for indoor use only. If your displays are located outside, then you MUST protect all wiring from the elements. Leave your lamp modules inside and run extension cords where necessary. Always use Ground Fault Circuit Interrupters (GFCIs) when running electricity outdoors (whether it's required or not — just do it). SmartHome (**www.smarthome.com**) has lots of good products and information on virtually anything related to X-10. Always consult a licensed electrician.

3. Press ADD to create the first pattern (e.g., 0001=A:NONE).
4. Press ADD again to create the second pattern (0002=A:NONE).
5. With the second pattern still highlighted, select ALL from the Unit Codes box (notice the pattern changes to 0002=A:ALL).
6. Press RUN.

PCX starts running your pattern continuously, over and over again, from the top to the bottom, until you press STOP, EXIT, or turn off the computer. During this time, all controls except STOP, EXIT, and SPEED are disabled. Most aspects of PCX.EXE should be fairly obvious, however a couple of controls may need further explanation.

SAVE and LOAD buttons. Press SAVE to write the pattern list to a file called "X10.TXT" in the root folder of the current drive. LOAD, of course, looks for said file and reads it into the pattern list, overwriting the current one, if any. This not only allows you to save complicated patterns, but also to use a text editor to create new ones.

SPEED (Fast, Medium, Slow). What can I say? X-10 is slow! Painfully slow. Of course, that's not usually a problem for everyday control of coffeepots and garage doors. For blinking lights, however, it could be. Chasing lights? Out of the question, in my opinion. I think it's fast enough for animations, though.

Note: I consider my PC to be somewhat typical (i.e., Pentium III, 1000MHz, 512 meg RAM, Windows 98) — not too old and not too new. I've been using this set-up to run lights on my desk for the entire time I've been writing this article. Although the constant blink, blink, blink is about to drive me bonkers; my computer has not been affected at all. Don't worry about tying up your computer while running displays. Just press the minimize button and you probably won't even know it's there.

Ready, set, animate

Okay, so you've got a power line interface and some lamp modules, the Serial Plix interface board, and an assortment of Christmas lights. You've also got a Windows PC with PCX.EXE installed and you're asking yourself — now what? Let's animate.

Whoa Nelly — a little background first ...

The type of animation I'll be describing is called "frame" animation. That is, each time an object is displayed, its position changes slightly. Therefore, viewing the object, frame after frame in rapid succession, makes it appear to have become animated. Ergo animation.

Also, construction of the forthcoming display will be covered in complete detail next month. Showing you how to animate something that hasn't been built yet might appear to be out of sequence. However, the main purpose of this month's article has been to get you started with the electronics portion of a Christmas display. Perhaps you don't need my help in building it, or maybe you've already got one? In that case, great, you can sit-out next month. Otherwise, you'll have plenty of time to get your (electronic) ducks lined up before we build the real thing.

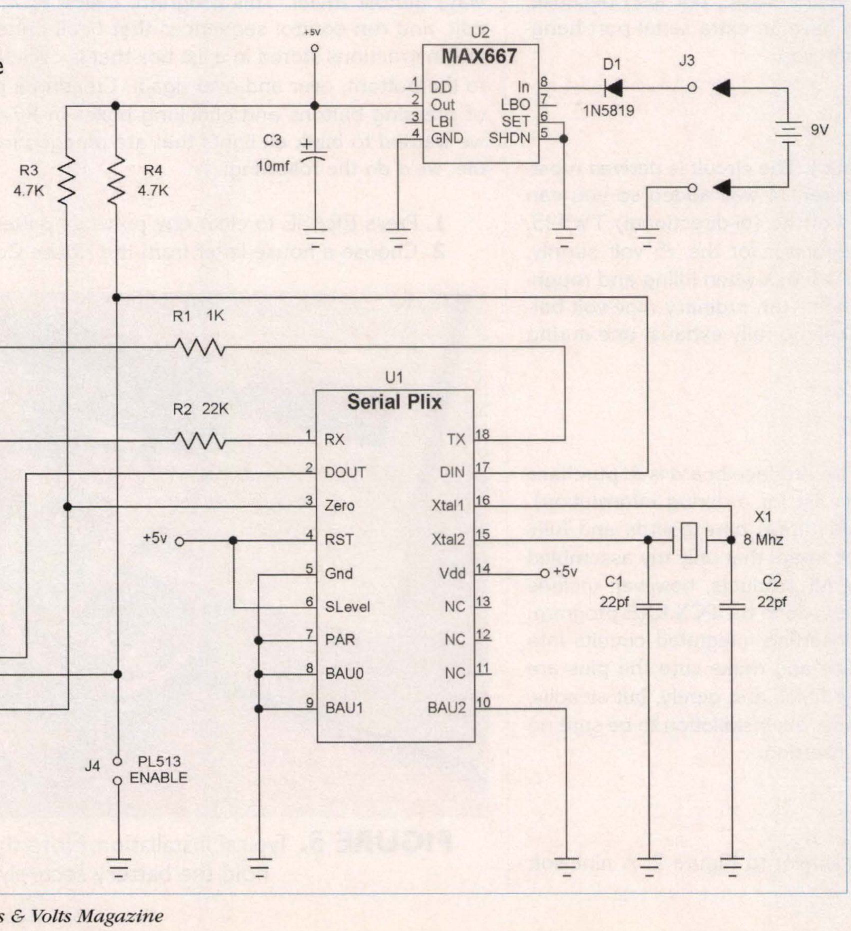
Christmas bells

That said, let's look at what might be considered, by some, to be a classic: the swinging bell (shown graphically in Figure 4). This particular animation requires three separate strands of lights: red, blue, and green. It also requires three X-10 lamp modules, all of which should have their house codes set to A and their unit codes set to 1, 2, and 3. Plug each lamp module into a separate electrical outlet. Plug the red lights into the first lamp module, the blue lights into the second, and the green lights into the third lamp module.

Elsewhere, close to your PC, plug a PL module into some nearby outlet. If you're using the PL513, don't forget to install the jumper at J4. Next, connect a nine-volt battery snap to the interface board's power terminals (watch that polarity!). Plug the board directly into your computer's COM1 or COM2 port (see Figure 5). If it doesn't fit, simply lay it on the table and use an ordinary RS-232 cable to make the connection. Whatever you do, NEVER allow the board to touch anything metallic! If you do, it could be seriously damaged or even destroyed.

Next, connect the board's modular phone jack to the power line interface's modular jack. You must use a phone cord that is wired straight through (i.e., 1-to-1, 2-to-2, etc.). Note that not all phone cords are like this. Some use only two wires and some, when they do use four, actually reverse two of them. If you're unsure, do a continuity check or just make your own. Finally, connect a nine-volt battery to the snap. Since the board has no power switch, you'll have to disconnect the battery anytime you wish to turn it off. Velcro® is good for holding the battery

SCHEMATIC. Serial Plix interface board.



securely in place (see Figure 5, again). Next, start PCX.EXE and create the following pattern:

0001=A:01ON	1st, turn the red lights on
0002=A:01OFF	2nd, turn the red lights off
0003=A:02ON	3rd, turn the blue lights on
0004=A:02OFF	4th, turn the blue lights off
0005=A:03ON	5th, turn the green lights on
0006=A:03OFF	6th, turn the green lights off
0007=A:02ON	7th, turn the blue lights on again
0008=A:02OFF	8th, turn the blue lights off again

Press the SAVE button to store your pattern. Finally, press RUN, sit back, relax, and watch your lights start blinking. Notice that the red lights blink first, then the blue ones, and then the green ones. Finally, the blue ones blink again and the pattern starts over. It's this blinking action that makes the bell appear to swing back and forth. You can always add some Christmas music, and a few "ding-dong" sounds to improve the effect. Now, just mix in a generous amount of imagination to create that killer display which will drive your neighbors wild with envy.

Conclusion

For the last few pages, I've touted the virtues of X-10 so much that you might think (that I think) it's the only way to do Christmas animations. Well it isn't. You could do the same thing by building special dimmers, flashers, chasers, blinkers, and so on. They undoubtedly could make the lights blink faster and the total cost might even be less. However, you'll have to deal with the dangerous, possibly lethal, 120 volts AC flowing through your house. Also, you may or may not, have other uses for that special hardware.

The system I've presented here avoids those pitfalls. All you have to build is a simple, inexpensive, and safe, low-voltage interface board. The grunt work is done by the PCX program that could be modified (see parts list for a note about the source code) to perform other tasks. Expand it to handle more house codes and/or unit codes. Make your patterns start or stop automatically. Or don't! The choice is yours.

Merry Christmas and Happy Animating! **NV**

Parts List

Resistors (1/4W, 5%):
R1 — 1K
R2 — 22K
R3,R4 — 4.7K

Capacitors:
C1,C2 — 22 pF ceramic
C3 — 10 mF electrolytic
C4 — .01 mF ceramic (U1 bypass cap, not shown on schematic)

Crystal:
X1 — 8 MHz

Semiconductors:
D1 — 1N5819
U1 — Serial Plix chip
U2 — MAX667 low-power voltage regulator

Jacks:
J1 — DB9, female
J2 — Modular phone
J3 — .197" (5mm) two-pin terminal block
J4 — Jumper, .1" header and shorting block

Misc.:
Circuit board, IC sockets, nine-volt battery and snap, Velcro.

Note 1:
All parts (except U1) are available either from **Jameco** (www.jameco.com) or **Digi-Key** (www.digikey.com). U1 is a custom IC available from **Micromint, Inc.**, (www.micromint.com).

Note 2:
The following items are available from:

Richard Haendel
6002 Covey Run Drive
Edmond, OK 73034

1. Custom-manufactured, double-sided, circuit board only $19.95.
2. Complete kit of all parts, except U1, only $49.95.
3. Fully assembled and tested unit, including U1, only $79.95.

Each is shipped postpaid to the 48 contiguous United States and includes full documentation with the Visual Basic source code to PCX.EXE on diskette. All prices are in US dollars. Sorry, no credit cards.

See **http://rhtools.home.att.net** for more information.

Electronics Q&A

With TJ Byers

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

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

*You can reach me at: **TJBYERS@aol.com** or by snail mail at Nuts & Volts Magazine, 430 Princeland Ct., Corona, CA 92879.*

What's Up:

Solar power, battery power, and PC power put to work. Got a grab bag of components you need to identify? Here's two hints. The nemesis of the remote-controlled world (broken keypads) finally fixed. And a challenge for the inventor and/or shuttle bug.

Ozone Conscious

Q. How hard would it be to come up with a project for an ozone meter with an LCD readout, to measure the level of smog? I realize that ozone is only one component, but nonetheless it would be interesting to measure it.

Derek Casari IV
via Internet

A. It's not easy because the air is a mixture of many gases and particles, and sorting out just the ozone molecules in this slurry can be a daunting task. There are basically two methods in common use. The first is the UV absorption method, where a UV light source is passed through an air sample and the ozone level calculated. The light is emitted by a low-pressure sodium lamp with a principal spectrum line at 253.7 nm (nanometers), and passed through a tube containing the air sample (Figure 1). The amount of UV passing through the sample is detected by a sensor and compared to a reference. The difference between the two figures is processed by an algorithm and displayed as micrograms per cubic meter – typically in the range of .01 to 0.12 uG. To obtain a zero reference and compensate for lamp aging, the sample chamber is periodically purged and replaced with fresh air drawn through an ozone absorbing charcoal filter.

The second uses an electrochemical reaction, typically of potassium iodide. The ozone sensor is made of two platinum electrodes immersed in potassium iodide solutions of different concentrations contained in separate cathode and anode chambers. The chambers are linked with an ion bridge. Air is then pumped from the outside and allowed to flow through the cell. When the ozone in the air enters the cathode half of the sensor, it produces a small electron flow, which is proportional to the amount of ozone present. Unfortunately, the sensor becomes contaminated over time and wears out, which forces replacement of the sensor or replenishment of the chemicals, depending on the design. These ozone sensors are commonly used in high-altitude weather balloons called ozonesondes.

A similar technology — not yet in full production — is based on colorimetric chemical changes. The ozone sensor consists of a transparent substrate (e.g., a glass or plastic slide) coated with an organic dye that changes color when it reacts chemically with ozone. The coated substrate is then illuminated by one or more LEDs of the appropriate wave-length(s), and the portion of incident light transmitted through the coated substrate is measured by a photodiode. The color change manifests itself as a change in absorbance, and thus a change in the amount of transmitted light at each wavelength of interest. A change in absorbance at each wavelength is then related to the degree of reaction and thus to the ozone dosage (Figure 2). A related technology, developed by Environics (860-872-1111; **www.epa.gov/region1/steward/ceit_iti/tech_cos/envi.html**) uses a treated rubber strip that develops micron-sized surface cracks in proportion to ozone exposure, which can be measured as a function of opacity.

Figure 1

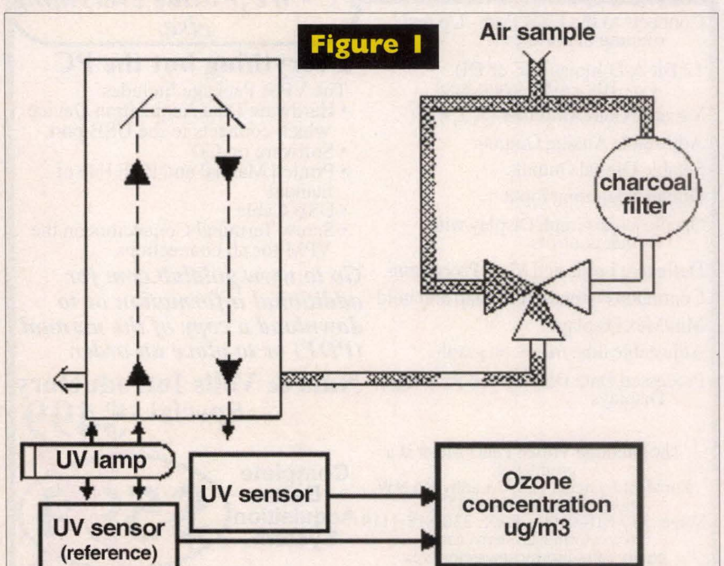
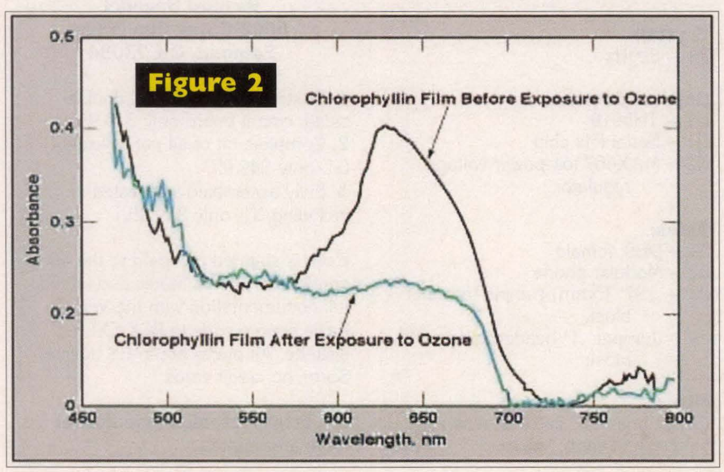


Figure 2



Solar Powered

Q. I have a small design that I want to power from a 12-volt, wet-cell battery. In normal operation, the system draws about 0.6 watts — except for a short period of about 0.5 seconds twice per day that requires 200 watts to activate a solenoid. I need information on how to figure out the power needed from a solar battery charger. I assume I will also need something like an LM317 regulator to prevent over-charging of the battery. I am currently operating on such a regulator powered by a transformer from the AC outlet, which charges 24/7. So I will need to allow for periods of darkness when the solar panel will not be charging.

Jack Mickelson
Santa Ana, CA

A. First you have to put the numbers into their proper prospective — i.e., convert the watts to amp-hours (Ah). Let's start with 0.6 watts first. Using the equation P = EI, we see that the current at 12 volts is 50 mA. Now that has to be multiplied by 24 hours (because your system draws power 24/7) to arrive at the figure of 1.2 Ah. Using the same procedure, the 200-amp pulse comes to 16.6 amps at .05 Ah. Adding them together produces 1.25 Ah per day.

The next step is to calculate the size of the solar panel. Since you live in southern California, you can assume that you'll receive a yearly total of six hours of sunlight per day. If we divide six hours into 1.25 Ah, we get a charging current of 208 mA. To be on the safe side, I'd recommend a 250 mA solar panel — three watts. You can buy these panels from several sources, including Read Goods (800-762-7325; **www.realgoods.com**), for about $70.00.

The charge controller, which prevents the battery from overcharging, can be made very simply using a comparator and a relay (Figure 3). The inverting input of the comparator is referenced at 6.2 volts via the 1N753 zener diode. The positive input monitors the charge in the battery, and should be set at 6.2 volts via the 50k pot with 13.2 volts applied to the positive battery line using a variable power supply. Now connect the battery and PV panels and you're in business. If the battery voltage drops below 13.2 volts, the relay engages and connects the solar panel to the battery for charging. Because the circuit is powered only by the solar panel (due to the 1N4001 blocking diode), it draws no current from the battery and becomes inactive at night.

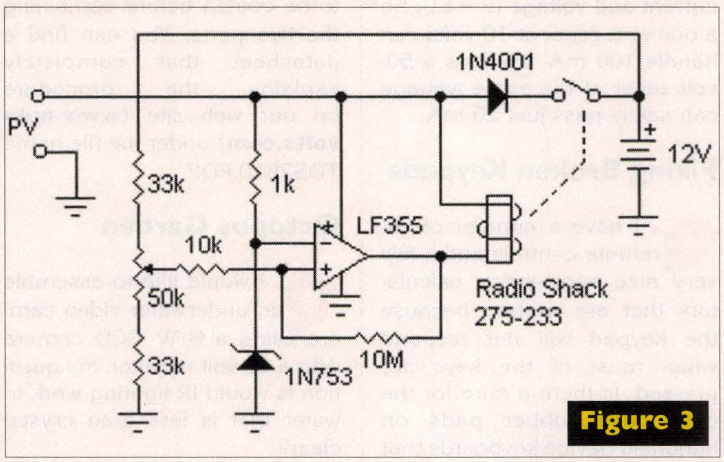


Figure 3

Battery Powered

Q. I want to convert the power of two AA batteries or two AAA batteries to 12 volts DC with at least one amp output current. If you have any suggestions or any references, please let me know.

Amir Khezrnejat
via Internet

A. Getting the 12 volts out from a three-volt input is rather easy. It's the one-amp part that's the clinker — for two reasons. First, it pushes the limit of most single IC upverter designs. Second, to get one amp from the 12-volt output, you have to put in at least four amps from the batteries — and that's assuming 100% efficiency. This is no small feat for even a D-cell battery. That said, here's your circuit (Figure 4).

The voltage booster is built around a Maxim MAX1774 step-up DC-DC controller with a 12-volt preset output. While the circuit is relatively simple, the components are critical — especially the inductor and capacitors, which should be purchased from the manufacturers listed in Table 1 included here.

Supplier	Phone
AVX	803-448-9411
Central Semiconductor	516-435-1110
Coilcraft	708-639-6400
Coiltronics	407-241-7876
Matsuo	714-969-2491
Motorola	800-521-6274
Nichicon	708-843-7500
Nihon	805-867-2555
Sanyo	619-661-6835
Siliconix	800-554-5565
Sprague	603-224-1961
Sumita	708-956-0666

Table 1

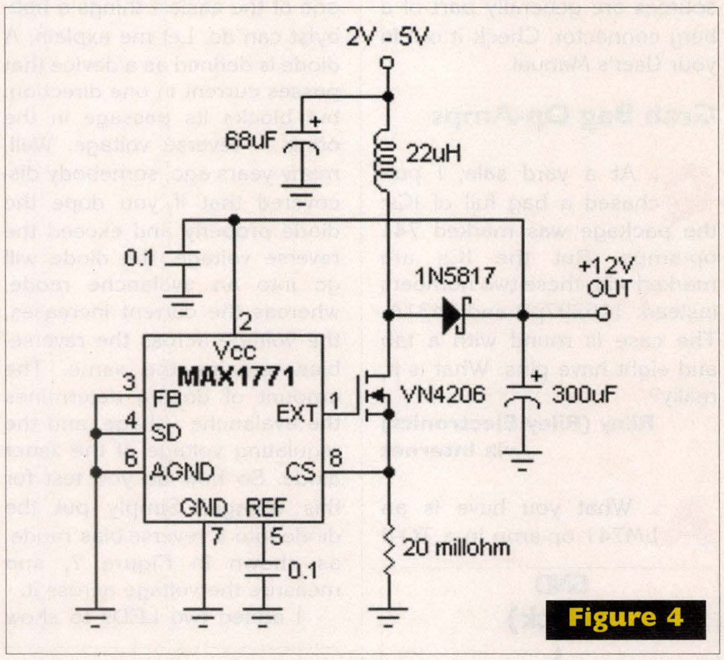


Figure 4

PC Powered

Q. In the Aug. '02 issue, under Cool Web Sites, you mention an article on stealing USB-port power. I tried the site, and found it has nothing to offer me. What I am really looking for is five volts to power a small, low-current relay only when the computer is turned on.

Pete Wilson K4CAV
via Internet

A. You can pick off a steady source of power from several PC external ports, including the keyboard, mouse, and game ports. However, your best bet for a project this simple is to obtain the five volts from inside the PC, either from a disk drive power connector or from the motherboard itself. I'd try the disk drive power plug first because most PCs have one that goes unused — if not, you can always buy a cable splitter (Jameco #72303) to create one. The plug is wired accordingly (Figure 5).

There are several locations on the motherboard where you can tap into the 5- or 12-volt lines. For example, an auxiliary fan output (FAN 2) can provide 12 volts or use the Power-On LED connector for five volts. The connections to these sources are generally part of a berg connector. Check it out in your User's Manual.

Grab Bag Op-Amps

Q. At a yard sale, I purchased a bag full of ICs; the package was marked 741 op-amps. But the ICs are marked with these two numbers instead: 116297p2 and 7431A. The case is round with a tab and eight have pins. What is it, really?

Riley (Riley Electronics)
via Internet

A. What you have is an LM741 op-amp in a TO-8 metal can. The op-amp was made for an OEM (original equipment manufacturer) and it bears their individual part number (116297p2). The second number is the manufacturing date, the 31st week of 1974, lot A. Here's a pin-out of your device (Figure 6).

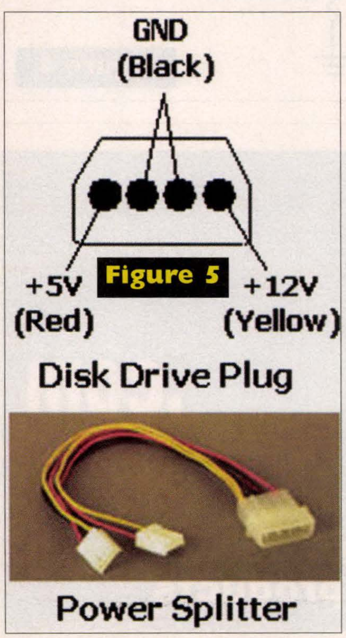


Figure 5

Grab Bag Zeners

Q. I recently acquired a lot of zener diodes of all shapes and sizes. Some have numbers that I can cross-reference to a voltage, but many have no marking or markings that make no sense at all. Is there a way to identify them?

Robert (Bob) Smyth
via Internet

A. Fortunately, identifying a zener diode voltage is one of the easiest things a hobbyist can do. Let me explain. A diode is defined as a device that passes current in one direction, but blocks its passage in the other — reverse voltage. Well, many years ago, somebody discovered that if you dope the diode properly and exceed the reverse voltage, the diode will go into an avalanche mode, whereas the current increases, the voltage across the reverse-bias remains the same. The amount of doping determines the avalanche voltage, and the regulating voltage of the zener diode. So how do you test for this voltage? Simply put the diode into a reverse-bias mode, as shown in Figure 7, and measure the voltage across it.

I added two LEDs to show that the zener diode under test is good and not open or shorted. If both LEDs are lit, the zener diode is good — provided the DMM measures a voltage less than 50 volts. If LED1 is lit and LED2 isn't, then you have the zener backwards or it's shorted.

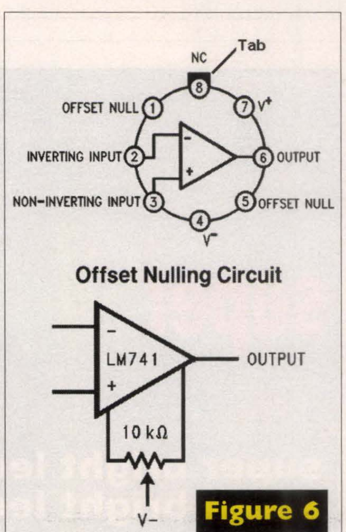


Figure 6

All diodes go into an avalanche mode when the breakdown voltage is exceeded, and that's what usually destroys them. But zeners are special in that they can handle the reverse current without burning up. So one of the parameters that must be observed when testing for zener characteristics is limiting the current via a series resistor. As a rule, 20 mA will test any zener for breakover voltage without burning it up. The resistance value I chose for this tester will limit the test current to 20 mA, even if the diode is shorted. For zener voltages higher than 50 volts, you'll have to increase the voltage and adjust R1 accordingly. Just remember, zeners are rated by wattage, which is a product of current and voltage (P = EI). So a one-watt zener at 10 volts can handle 100 mA, whereas a 50-volt zener at the same wattage can safely pass just 20 mA.

Fixing Broken Keypads

Q. I have a number of TV remote controls and a few very nice engineering calculators that are useless because the keypad will not respond when most of the keys are pressed. Is there a cure for the conductive rubber pads on handheld device keyboards that lose their conductivity?

Ed Strahan
via Internet

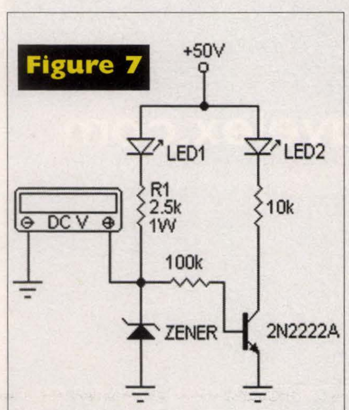


Figure 7

A. Chemtronics makes a very nice CircuitWorks rubber keypad repair kit that will solve your problem. It comes in two versions: the CW2605 which contains 3.3oz of repair material and CW2610 which contains 11oz of repair material. They sell for about $10.00 and $26.00, respectively (depending on the retailer). You can buy the kits from Digi-Key (800-344-4539; **www.digikey.com**), Future Active (800-655-0006; **www.future-active.com**), and Newark Electronics (800-463-9275; **www.newark.com**).

However, the working time of this "epoxy" mix is short enough that you need to have all your pads in place and ready to be coated before combining the two parts. You can find a datasheet that completely explains the procedure on our web site (**www.nutsvolts.com**) under the file name TDS2610.PDF.

Octopus Garden

Q. I would like to assemble an underwater video camera using a B/W CCD camera with a 12-volt monitor. My question is would IR lighting work in water that is less than crystal clear?

Ken Gott
via Internet

A. The greater the distance light travels in water, the more color is lost. Red is most affected because of its long wavelength. Even a few cm of water attenuates it considerabley, and by 30 feet, red is all but gone! IR — with its longer yet wavelength — is even more affected. Most deep sea work is done using halogen lamps. Here are a few web sites that will help you with your new hobby. Please keep me informed as to your progress, I'm most interested.

Science Master
www.sciencemaster.com/columns/nyi/nyi_current.php#

SAA Photography: *Lighting the underwater world*
www.saa.org.uk/photography/Lightingtheunderwaterworld.htm

ikelite
www.ikelite.com

Finding Obsolete Parts

Q. I have a problem that is quite common. I repair laboratory equipment for a commercial laboratory specializing in quality assurance for the coal industry. Most of our equipment is state-of-the-art, but a few are getting along in age. For example, one particular instrument contains an Intel 8741 controller that has an EPROM, which has a limited life expectancy, and the chip is no longer supported by Intel. (We have 10 of these instruments valued at about $20,000.00 each, so they aren't exactly disposable.) I have an EPROM burner that can program and read a 2716 or a 2716B. What I need is the information for simulating the 2716 with the 8741. I'm sure there are other repair persons with similar problems.

James Fetterly
via Internet

A. Got good news and bad news. Bad news: As far as I know, you can't interface an external EPROM to the 8741. Good news: The 8741 and 8742 were commonly used in IBM AT and PS/2 keyboards, so the chance of finding one of those keyboards with a functional chip is very high. Unfortunately, I don't know the serial number sequence, so you may have to ask around. This also leads me to believe this chip is still available through obsolete IC suppliers. Check out PARTFIND.DOC on our web for a list of sources.

MAILBAG

Dear TJ:

I have used your instructions to build three "Kodak Max Strobe" units that you described in the Dec. 2001 issue. They serve well to demonstrate various electronic principles in several of the classes which I teach. For example, no two of the three flash boards were exactly the same. Only two had SMDs, one board had foil on both sides, all three had different trigger transformers, etc. These variations only added to their teaching value.

I would like to see another article on additional uses for these camera carcasses.

Victor Maciejewski
Rochester, NY

You are among several readers who would like to see more on these unique devices. So I'm putting up this challenge to you, dear reader: Submit your original disposable camera design to me, and for each one I publish, you will receive a one-year subscription (or extension) to Nuts & Volts. I eagerly await your ideas.

TJ Byers
Q & A Editor

Dear TJ:

Reading through your July 2002 column, I noticed your response to David Keefe regarding how to build a 12-volt power supply for a desktop PC. You rightly advised him of the enormity of the task. What you didn't advise him to do, probably because you didn't know about it (and is something worth mentioning), is to buy a 12VDC desktop PC power supply. They do indeed exist, and look essentially the same as a regular ATX power supply. However, they are difficult to find. I only know of one source, actually, and I fear they are now out of business. Just to let you know.

Andrew L. Ayers
Phoenix, AZ

No, I wasn't aware of 12-volt power supplies for desktop PCs. And yes, the company you cited, Key Power, Inc., seems to be out of business. Hopefully, one of our readers knows of a supplier for these devices.

TJ Byers
Q & A Editor

Last chance to enter the MSP430 Gadget-O-Rama — See page 40.

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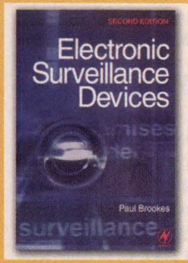

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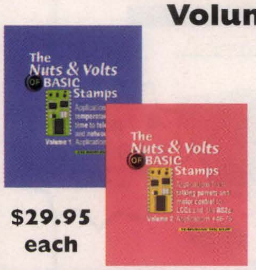

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Ultra-low Power TV Remote Control Transmitter — Part 2

By Mark Buccini

This month's project allows direct control of a Sony-type TV using serial infrared control (SIRC) encoding.

Ready to go wireless? This month, we'll expand on September's project — Build a TV Infrared Remote Control Decoder — and build a remote control encoder. This month's project allows direct control of a Sony-type TV using serial infrared control (SIRC) encoding. This solution also boasts the potential for an extremely low stand-by mode of less than two micro-amps. With this kind of low current consumption, your project may never need battery replacement! And it doesn't have to stop there. With an understanding of the decoder from last month and the encoder this month, a complete IR connection can be made for true wireless communication and control. The complete encoder or transmitter is built using a 20-pin MSP430F1121 Flash-MCU and a few discrete components as shown in Figure 1.

Circuit Description

In order to encode SIRC information packets, SIRC key code function commands must be passed to the MCU. In typical hand-held transmitters, this is done with a keypad. For our project, to keep things simple we will use the MSP-FET430X110 Flash emulator as the MCU target and pass SIRC commands via the debugger. The FET includes a voltage regulator and bypass capacitors installed on the target board. Using an FET, all that is needed to complete the circuit in Figure 1 is the IR LED driver section. An IR LED is required and I used RadioShack part number 276-143. The circuit also shows a NPN transistor amplifier. A common 2N2222 transistor is fine. The transistor amplifier is connected directly to the MSP430F1121 output P1.2. P1.2 is configured by software as a capture/compare 1 (CCR1) output for timer_A3. This is done using the port 1 option select (P1SEL) register. This same pin must be put into an output direction using the port 1 direction register (P1DIR). The LED on P1.0 installed on the FET will be used for visible feedback that everything is operating properly.

The circuit uses the 32,768Hz watch crystal installed on the FET as the source for the MCU auxiliary clock (ACLK). The MSP430's on-chip digitally-controlled oscillator (DCO) will be used for the CPU master clock (MCLK) and peripheral sub-master clock (SMCLK).

SIRC Protocol Review

The SIRC protocol described last month uses 12-bit data packets comprised of a five-bit device code (D4 to D0) and seven-bit command code (C6 to C0). A variable bit-length or pulse width determines a bit. The start bit is 2.4mS, a "0" 600uS and a "1" 1.2mS. All data bits, excluding the start bit, also include a 600uS sync pulse, or lack of IR presence. The SIRC protocol sends data LSB first, so following the start bit, C0 is the first bit transmitted. Figure 2 shows the format of a complete SIRC data packet. Keep in mind that a bit is on if a 38-40kHz modulated IR carrier is present — modulation must be preset, not a digital level.

SIRC Packet Encoding Example

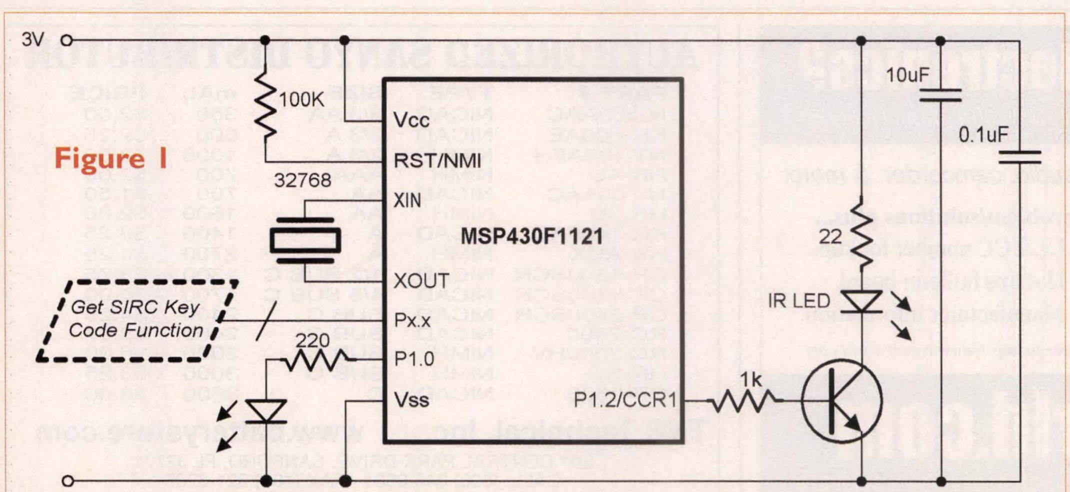
Looking at Table 1 and Table 2, we can construct a 12-bit SIRC packet. For example, to turn on a Sony TV, "1" is the device code, "21" the command code. Adding the device and command code with the start bit disregarded the 0095h value for a SIRC packet. This would be the value loaded into a 16-bit MCU register — or in last month's case — the packet received from a Sony TV remote if the power on key is pressed. To increment a channel on a Sony TV, the device code remains "1," and the command code "16," and the SIRC packet would be 0090h. If volume-up were intended for a Sony CD player, the SIRC packet would be 0892h.

How to Generate 40kHz Modulation

One of the more challenging aspects of building a TV IR transmitter is the 40kHz modulation. A total transmitter solution must have the ability to output a 40kHz pulse stream (25uS period) and be able to perform other functions simultaneously. A common approach is a two-chip solution using an external multivibrator like the venerable TLC555 to output 40kHz in combination with a controlling MCU. The MCU then enables or disables the TLC555 to turn on or off the 40kHz-pulse stream. As an alternative, it is also possible to "bit-bang" 40kHz output on an MCU port pin with software in a tight CPU cycle counting loop. But these types of pure software timed loops force the entire CPU to "spin" on a single simple function, which is not efficient and is a practice that should be avoided.

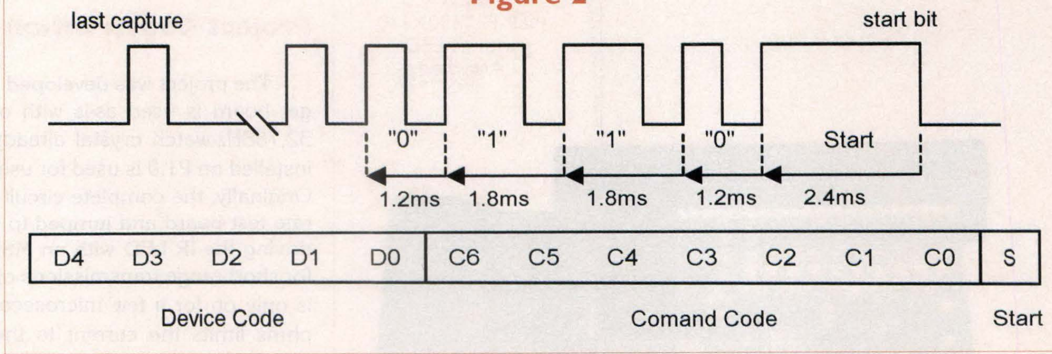
A more effective approach is to use a hardware pulse-width output from an MCU to generate the 40kHz modulation, leaving CPU resources free for other tasks. The MSP430F1121's multi-function 16-bit timer_A3, in combination with capture compare register 1 CCR1 and capture compare registers 0 CCR0, can be used to generate the 40kHz modulated output function completely with timer

Figure 1



hardware. As coded using timer_A3 output mode 3, the value in CCR0 defines the modulation period (25uS) and CCR1 the duty cycle. The 40kHz modulated PWM pulse pattern on P1.2 will set high when timer_A3 equals CCR1 and reset at CCR0, as seen in Figure 2. This pattern repeats with no CPU overhead. The software is used only to turn on or off the timer_A3 40kHz modulated output function.

Figure 2



Clocks Everywhere

With the decision to use timer_A3 as the 40kHz modulator, you must determine which clock source to use for timer_A3. Just about any external crystal (XTAL) can be used as a clock source for the MCU and associated timer_A3. The modulation period loaded into CCR0 could simply be the XTAL / 40k. But if ultra-low power is a goal, using any XTAL is not an option. To provide ultra-low power, the MCU must often be placed in a low power stand-by mode 3 (LPM3) with only the XTAL and a wake-up timer active. The problem is that a high-speed XTAL may use up to 1mA of current just to oscillate. And when shut off, an XTAL may take 20mS to start up. Both of these conditions are not tolerable for applications that need to conserve power and respond quickly.

A better solution for the MCU clocking may not be so obvious. The MCU architecture allows the use of a low-power 32kHz-watch crystal to source the ALCK auxiliary clock. And in LPM3 stand-by with the CPU off, and only ACLK and a wake-up timer active, the device consumes less than 2uA. This will do the trick, and a 32kHz-watch crystal is already installed on the MSP-FET430X110.

Current consumption now looks good, but the problem remains that a 32kHz ACLK could never generate a 40kHz modulation period. Fortunately, the MCU offers an independent on-chip DCO (digitally controlled oscillator) that can be configured with normal software to oscillate from 100kHz to 8MHz. The DCO also starts extremely fast in less than six microseconds. Fast start-up is ideal for low power applications by allowing an extended amount of time in stand-by mode LPM3. Applications can burst to active only when required, with no additional power-consuming time in a start-up mode.

Frequency Locked Loop

Just one last problem to tackle — like all semiconductor-based devices — the DCO has a strong temperature coefficient. Over temperature, the DCO frequency drifts double-digit percentages that would cause errors in the 40kHz modulation. But the DCO can be calibrated. With digital control and the presence of a 32kHz ACLK, a frequency locked loop (FLL) function can be implemented in software. The FLL function periodically re-configures the DCO, integrating the frequency of the DCO clock over the period of the stable crystal-generated 32kHz ACLK. The FLL function calibrates the DCO with software to a multiple of ACLK. For example, the DCO could be locked to 1048576, 32 x 32768 (ACLK). ACLK can still be used for stand-by, and the DCO for the CPU MCLK master clock and peripheral SMCLK sub-master clock. The calibrated DCO-generated SMCLK is used in this project as the source for Timer_A3.

Remote Control — Example fet110_sirc_tx.s43

The software example fet110_sirc_tx.s43 is available from the *Nuts & Volts* website at **www.nutsvolts.com** and transmits a SIRC TV power on/off command and then TV channel + command in a loop. The example software first initializes the MSP430's software stack to the top of RAM and the watchdog is disabled. The basic clock is configured to divide the 32kHz XTAL / 4, and the ACLK is now 4096Hz. This reduced-frequency ACLK is useful as a FLL function by providing a longer FLL integration interval. The slower ACLK will also increase the interval of the watchdog wake-up interrupt, which also uses ACLK. The DCO is then calibrated to 256000Hz by calling the Set_DCO subroutine. Timer_A3 is configured in up-mode with CCR0 equals 62 defining a PWM period of 25uS. CCR1 = 48 for a PWM pulse duty cycle of 62-48. The CCR0-CCR1 generated pulse on P1.2 is then 12/256000 or approximately 5.5uS. During this time, the IR LED is on during every 25uS during the modulation output.

Three variables are defined for timing purposes: IR_600 is the required number of 25uS intervals for a 600uS total delay period used when the subroutine D_600 is called. IR_2400, when combined with IR_600, is the number of 25uS required for a total delay of 1200uS. Inspecting the software carefully shows that the subroutine D_2400 is always called above D_600 with return and thus "falls through" D_600. The total delay when D_2400 is called is always a combination of D_2400 and D_600. This is called "fall through" programming and is used often in modern embedded programming applications to deduce the code size. IR_45000 is used for a 45mS delay.

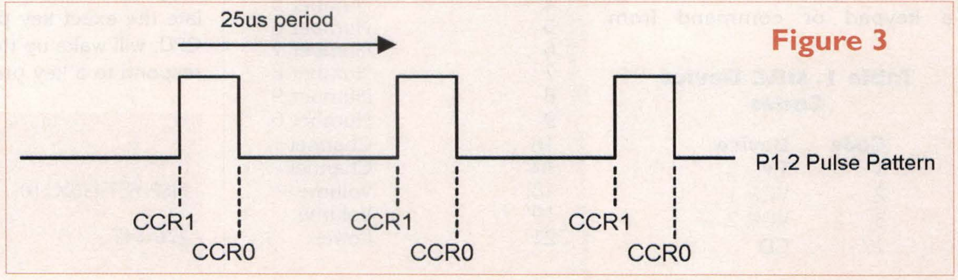
```
IR_600    equ  24     ; 600us @ 62/(2560000)
IR_2400   equ  72     ; 2400us effective (72+24 counts)
IR_45000  equ  1800   ; 45ms @ 62/(2560000)
```

Four CPU registers are used in the example fet110_SIRC_tx.s43: IRData (R4) holds the SIRC packet data to transmit. IRBit (R5) is used to track bits as transmitted. IRCnt (R6) is used as a countdown timer of 25uS pulses for 600uS and 1200uS intervals. IR45mS is used also as a 25uS-pulse countdown timer, indicating when a delay of 45mS has expired.

```
#define  IRData R4
#define  IRBit  R5
#define  IRCnt  R6
#define  IR45ms R7
```

The selection of the above registers is not important; any CPU register or even RAM words can be used. If available in an application, often-used software registers should be allocated to CPU registers. CPU registers are single-cycle, reducing code execution time and code space.

Figure 3



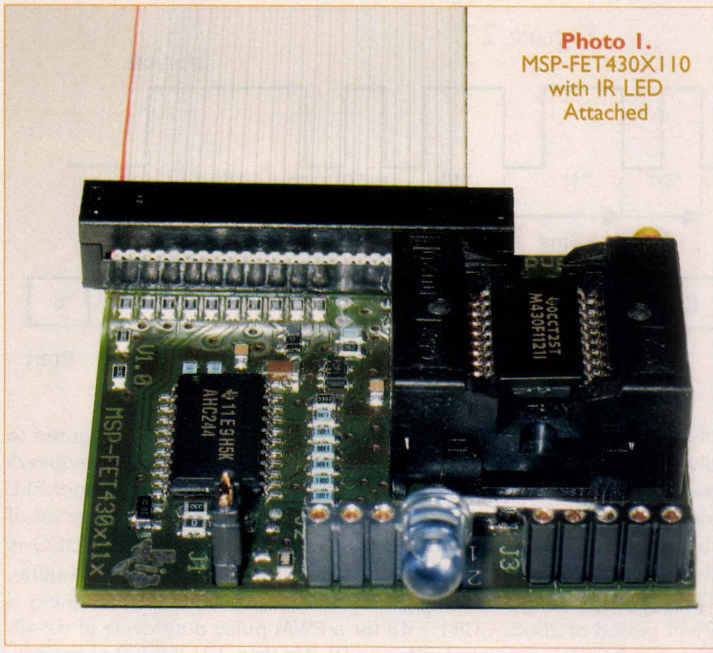


Photo 1. MSP-FET430X110 with IR LED Attached

The Mainloop is short with an activity burst enabled by the watchdog interrupt WDT_ISR every four seconds. This interrupt will wake the MCU from LPM3 returning activity to the Mainloop:

```
Mainloop mov.w  #0095h,IRData   ; Power-on SIRC command
         call   #IRTX_SIRC3     ; TX packet
Chan_UP  bis.w  #LPM3,SR        ; Enter LPMx, stop, save power
         mov.w  #0090h,IRData   ; Chan + SIRC command
         call   #IRTX_SIRC3     ; TX packet
         jmp    Mainloop
```

Initially, IRData is loaded with the power on/off command 0095h; calling IRTX_SIRC3 sends the command to the TV three times, spaced 45mS apart. This is done because most TVs require that the same command be received at least three times as a kind of error detection. After the power on/off command is sent, a Sony TV will power up. From here, the Chan_UP loop sends the channel + command to the TV three times every four seconds. The TV channel can be seen to increment.

For user feedback, the LED installed on the FET port pin P1.0 is toggled during the IRTX_SIRC subroutine just to let you know everything is operating correctly. The subroutine IRTX_SIRC will transmit the 12-bit data from IRData register. The length of time the modulated output on P1.2 is on for each bit is calculated by counting down 25uS iterations in IRCnt inside of the CCR0_ISR interrupt. IR45mS is also counted down inside of CCR0_ISR to define the 45mS spacing between transmissions. Remember the Mainloop calls IRTX_SIRC3 which itself calls IRTX_SIRC twice and falls through for a third transmission.

The Mainloop repeats, waiting in LPM3 for the next WDT_ISR to wake up the system and repeat the loop. The WDT_ISR is only used to simulate an actual SIRC key code input function. Normally, a keypad or command from another source would pass the request for SIRC transmission.

Table 1. SIRC Device Codes

Code	Device
1	TV
2	VCR 1
3	VCR 2
17	CD

Table 2. SIRC TV Command Codes

Command	Function
0	Number 1
1	Number 2
2	Number 3
3	Number 4
4	Number 5
5	Number 6
6	Number 7
7	Number 8
8	Number 9
9	Number 0
16	Channel +
17	Channel -
18	Volume +
19	Volume -
21	Power

Project Construction

The project was developed with an MSP-FET430X110. The FET target board is used as-is with only headers added to J2 and J3. The 32,768Hz-watch crystal already installed is used for ACLK. The LED installed on P1.0 is used for user feedback during each IR transmission. Originally, the complete circuit in Figure 1 was constructed on a separate test board and jumped to the FET. It was later found that directly driving the IR LED with an MSP430 port pin provided enough current for short-range transmissions of up to three meters or so. As the IR LED is only on for a few microseconds, the MCU port pin RDSon of ~150 ohms limits the current to the IR diode. The IR diode cathode was attached directly to P1.2 and the anode to ground. The FET is powered directly from the PC parallel port. (See Photo 1.)

Operation

Operation is very simple.

1. Insert an MSP430F1121 into the FET socket.
2. Attach the IR LED directly to the FET as described earlier.
3. Connect the FET to a PC installed with the FET software.
4. Create a new assembler project.
5. Add FET110_sirc_TX.s43 to the project.
6. Make the project.
7. Launch the C-spy debugger — this programs the MSP430 Flash also.
8. Point LED and FET toward a Sony-type TV.
9. Press Go in the C-spy debugger.
10. Your TV will turn on and scan up through channels.

Going Further

The project presented here is very easy to construct using only an MSP-FET430X110 and an IR LED. Using the proven software, your Sony TV can be under the control of your FET in minutes.

For experimentation, try running the demonstration program fet110_sirc_TX.s43. Use the C-spy debugger with a breakpoint set in the Mainloop of the program on the following line:

```
call #IRTX_SIRC3   ; TX packet
```

After the breakpoint is hit, try changing the CPU register from R4, IRData from 0090h to another value such as 0091h. Running again to the breakpoint, the MCU will transmit a channel-down command. The TV will increment down a channel. Experiment from there.

An important point of the project is low power. Because the FET-based solution is normally in LPM3, stand-by power consumption is very low, less than 2uA. In a stand-alone transmitter project, the bulk of application time is stand-by with the transmitter just waiting for a key press command request. In a stand-alone transmitter, the WDT_ISR we used to simulate a command request would most likely be replaced by a regular keypad. Plenty of MCU port pins are available for this task.

To maintain a low-power stand-by, the keypad change would need to be communicated with port pin interrupts, not power-wasting software "polling." Every MSP430 F1121 port pin has interrupt capability. Only after an interrupt request would the MCU scan the port pins to isolate the exact key pressed. Remember the DCO, which will clock the CPU, will wake up the system in less than 6uS — which is plenty fast to respond to a key press interrupt. **NV**

Parts List

MSP-FET430X110	MSP430x11x1 Flash Emulation Tool, available from Texas Instruments
276-143	IR LED, available from RadioShack

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Exploring and Experimenting With Lasers and Their Properties

by Stanley York

Laser Insight

Last month, we looked at a couple of ways of aligning or realigning a simple laser system.

If you are lucky enough to have picked up a laser system from one of the many surplus sources, you should now have enough information to realign your laser after taking the mirrors and laser rod out for cleaning.

Very often, complex laser systems are offered for sale at very low prices. Laser marking systems, welding systems, and scribers are frequently found in magazines such as *Nuts & Volts*, and there are many websites that offer these systems for sale at very good prices. With a little care, and a few spare parts, one of these surplus or discarded machines can be put into useful service.

Aligning a more complex laser system

Realigning these systems is a little more involved than the simple lasers we have looked at so far, and I would like to pass on a few more tips this month regarding additional optical elements found on some of these lasers.

Basically, all lasers can be reduced to the simple type of system we looked at last month. Additional optical components enhance or modify the basic laser beam in some way, to give it properties the basic beam does not have. Some of these properties may be high-frequency pulsing ("Q" switching), or wavelength changing (frequency doubling the basic beam), or changing the spatial profile of the beam to reduce the divergence and improve the quality of the beam (TEM00). Some of these properties we have briefly mentioned in the past, but without a lot of detail.

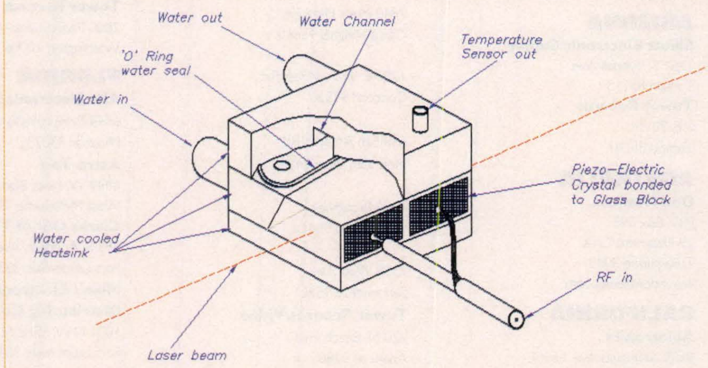
A laser marker is an interesting machine. They are sometimes offered for sale, but are fairly complex, and perhaps a little beyond the pockets of the hobbyist. It usually has a combination of single-mode operation (TEM00) and an AO-Q switch. There is also a dual galvanometer mirror assembly that moves the focused laser beam over the part to be marked. We looked at the essential components of a laser marker in the Feb. 2002 issue of *Nuts & Volts*, and some of these items were briefly discussed.

The AO-Q switch is essentially a quartz glass block with a piezo-electric transducer bonded to one side. If you missed the February issue, the drawing of the Q switch assembly is reproduced here as Figure 17-1.

In operation, the piezo-electric transducer is fed from an RF source of around 25-100W output at typically 24-27MHz. When the device is active (i.e., being fed with RF energy), the glass block vibrates at ultrasonic frequency, forming a standing acoustic wave within the block. The wave fronts in the block essentially form a diffraction grating that splits up the laser beam into a number of weaker beams, traveling off the axis to the optical centerline. This phenomena very effectively reduces the intracavity gain of the laser, making it fall below lasing threshold.

With a lower than required gain, there is insufficient optical feedback to sustain oscillation, so the laser cannot produce any stimulated emission. When the RF energy is switched off, the excess energy built up in the rod is released in a so-called 'giant pulse,' releasing all the optical energy as a pulse of short duration (50-200nSec), but of high peak power.

Figure 17-1. This drawing shows the general form of an AO Q switch as used on a laser marker.



The AO-Q switch is normally activated again with RF after a short delay (approximately 10-20 microseconds) before the steady state level resumes, and so the laser output appears as a series of short, high-peak power pulses. These high-power pulses can reach several hundred kilowatts (peak), but because of the switching nature of the beam, and the duty cycle imposed, the average power level is usually much lower than the steady state power level.

The high-peak power is sufficient to ablate the surface of almost any material placed at the focal point, thus leaving a permanent mark. The beam would typically mark a metal surface to a depth of perhaps 0.0005"-0.002" depending on power level and writing speed.

Aligning the spatial filter

The spatial filter reduces the number of active spatial modes present in a laser beam. By removing the higher-order modes, the beam purity is improved. The beam divergence is also improved, and this means that the beam can be focused down to a very small spot, much smaller than a multimode beam. Of course, there is a price to pay for the improved beam quality ... you lose some power from the beam. This is not so bad though, depending on what you need the laser for.

In a welding application, for instance, you need raw power hitting the target, and a multimode beam is fine. However, in the case of a laser marker, you need a small focused spot for best detail and smallest engraved characters. In this case, the spatial filter is a must. Here's how you set it up.

With the basic laser alignment done, install the spatial filter and record the power level. The level will be much lower than previously seen. Adjust the X and Y position of the filter until maximum power is found. This usually happens when the filter is positioned on the laser rod centerline. If you now take some burn patterns as described last month, you'll see that the beam is a lot smaller, the divergence has reduced considerably, and the beam has a more uniform energy density.

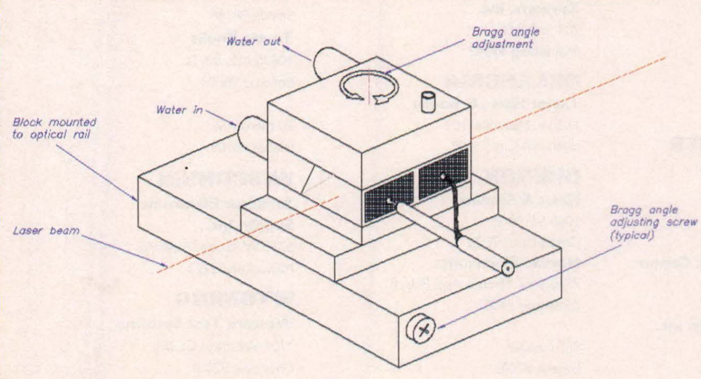
If you have a number of different sizes of filter, you may find it easier to 'zero-in' on the right size by starting out with a larger size until you have a feel for the adjustment.

Aligning the AO-Q switch

If you are lucky enough to get a laser marker, you can align the system pretty much as described last month, with the exception of the AO-Q switch. To set this device up, you have to follow another procedure:

Begin by setting the laser up in a normal mode, i.e., with just the

Figure 17-2.
This drawing shows a typical Bragg angle adjustment scheme.



mirrors on the optical rail. You can add the mechanical shutter if you wish, it doesn't make any difference to the alignment, but it really should be included for safety.

When the alignment of the basic laser is satisfactory, put the AO-Q switch onto the rail and secure it. Make sure you have the cooling water lines connected, otherwise, you run the risk of overheating the Q-switch, damaging it beyond simple repair. Turn on the laser and the RF supply to the Q-switch. If you have some means of detecting the laser beam output, place the collecting head on the rail and turn up the laser power.

Make sure you wear safety goggles when you use any working laser. Remember, you only get one set of eyes!

Watch the laser power meter as you increase the output. You may see that the power comes up normally, or at some reduced level. Set the power level at some convenient figure about a quarter of full power.

The laser power supply will have some kind of control for the Q-switch modulation. This may be a simple toggle switch, or a rotary, selector-type switch for changing the modulation source, etc.

At this stage, turn the modulation off. If the laser power stays on, or reduces just slightly, then the Q switch needs adjusting. The AO-Q switch mount will have an adjustment screw on it for adjusting the Bragg angle of the Q-switch (see Figure 17-2).

The Bragg angle is the angle the Q-switch presents to the direction of propagation of the laser beam. The angle is normally adjusted in a horizontal plane (i.e., about a vertical axis). With the RF power on, and with no modulation applied to the RF power, the laser output should be zero. If you already turned off the Q-switch modulation, you should adjust the Bragg angle on the Q-switch for minimum laser output.

Increase the pump power to the lamp (i.e., turn the lamp current up). You may now see some laser power on the power meter. If you do, continue adjusting the Bragg angle until the power drops to minimum. Continue in this manner until you reach full power. When minimum laser leakage is achieved, you will get optimum Q switching when activated normally.

Typical Q-switched pulses will be from 50-200nSec in width, and may be up to 100kW in peak power. Much depends on the gain of the cavity, pump power, and Q-switch frequency.

Beam expander

If your system has a beam expander, you may align it easily by setting the focus to infinity, and then position the expander on the rail so that the laser beam enters the expander in the input side, as indicated in Figure 17-3. Here's how:

If you look through the beam expander, you see that it very closely resembles a telescope. In fact, that's all the beam expander is. A telescope used in reverse.

In a normal telescope, light enters the larger of the two lenses, and is focused down to the eyepiece. In the beam expander, the beam enters through the eyepiece, and emerges through the larger lens. When you set the beam expander on the optical rail, you must make sure the laser beam enters what would be the eyepiece lens (in a telescope).

To set the focus to infinity, you should look at some distant object and adjust the focus until you bring the object into focus. Then lock the tube in position using the locking ring. There are more precise ways to set the focus to infinity, but the margin of error will be small following the above procedure. Another method uses an autocollimator, and I'll explain the process during the discussion on that device.

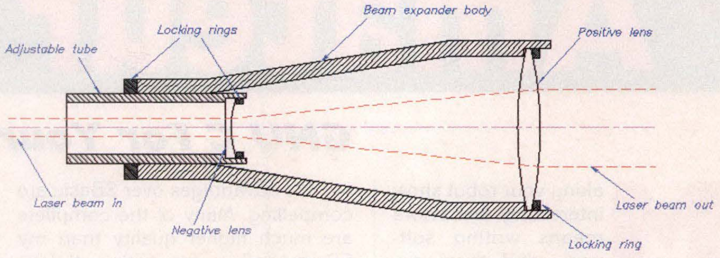
The key to setting the beam expander is that the focal point of the negative lens and the focal point of the positive lens must coincide. When the focus is set, you can put the beam expander back on the optical rail, and use the HeNe laser to adjust the position and attitude of the beam expander, so that the HeNe beam goes in through the center of the input lens, and out through the center of the output lens.

Because of the expansion of the beam, it may be more difficult to determine the edges of the HeNe beam, depending upon the expansion rate. The beam expansion ratio may be in the range of 1.5:1 to 10:1, depending on the application. For a laser marker, the expansion is normally around 1.5:1 to 3:1.

When the expander is placed on the optical rail, you have to adjust the X-Y position, and the Yaw and Pitch adjustments to get the laser beam to track precisely through the center of the input and output lenses.

In making these adjustments, the output beam will change its position on the external optics, so you have to watch this also. If the laser beam leaving the beam expander is hitting any part of an optical mount, it will reduce the power to the focused beam, and will also damage the optical mount and any lens or mirror it contains.

Figure 17-3. This drawing shows a cross section of a typical laser beam expander, and the parts that go into it.



Any other external optical devices that came with your laser system can now be set up using the HeNe laser. Any mirrors, lenses, or prisms should be aligned, preferably with the incident laser beam hitting the optical device squarely in the center of the input face. In the case of the laser marker, there is a set of mirrors mounted to galvanometer scanners.

These mirrors usually follow the beam expander, and the output from these mirrors goes directly through the F-theta lens and then focuses onto the workpiece. Aligning these can be a bit tricky, depending on how much space you have to work in, but as long as the laser beam is squarely in the center of the mirrors, you should be okay.

These mirrors are small because they have to move fast to be able to reach the high writing speeds that these machines can achieve, so any errors in aligning these mirrors means that you may not catch all of the expanded laser beam.

Be especially careful about this situation, because the part of the beam that escapes is going to go somewhere, and it might hit something flammable!

If the alignment is not perfect through the mirrors and the F-theta lens, the marking field will be distorted. If you confine the marking to the center area of the field though, you probably wouldn't notice the error. As the marking field expands, it will get progressively more difficult to mark a straight line, and the outer reaches will typically show pincushion distortion in one axis, and barrel distortion in the other (see also the notes on this in the February issue).

Well, I seem to have run out of space again. I was hoping to cover the autocollimator in some depth this month, but the alignment procedure took all the space. Next month, I will deal with the autocollimator, and explain how it works, and see if we can't come up with a design for a simple one you can make. This tool will make laser mirror alignment easy.

As always, if you have any questions regarding lasers or optics in general, or if you have any suggestions for future columns, please send me some email. I always answer everyone who contacts me, even though it sometimes takes a while.

My email address is: stanley.york@att.net. **NV**

GNU C For Your 68HC12 Robots

Making your robot show interesting behaviors means writing software, and there are plenty of options for programming your 'bot. Commercial compilers exist for languages such as C, Basic, Forth, and just about every assembly language known. You can also find freeware and shareware programming tools for every language from the very common to the most obscure.

When I was writing the Amateur Robotics column for this magazine, I often wrote my robot code in SBasic. SB is a dialect of Basic that I developed to help beginners get started programming their machines. The 'S' in SBasic stands for "simple," and the hundreds of emails I've received over the years show that a small army of robot builders got their start writing SBasic programs.

I still consider SB a valuable programming tool, and use it for many of my projects. In fact, it is heavily featured in my book — *Build Your Own Robot!* (A. K. Peters, 2000) — since SB makes it easy to show programming techniques without getting bogged down in arcane syntax. It also hides many of the subtleties of configuring your 68hc11, 68hc12, or 68332 program. You can focus on what you want the program to do, and not worry so much about where the code will reside, how the computer will access your program out of reset, or most of the other mysteries of embedded control programming.

If you would like to check out SBasic, you can download a complete distribution kit, with 60+ page manual, from my website at **www.seanet.com/~karllunt**. Note that two versions of SBasic exist; one is dedicated to 68hc11 and 68hc12 processors, while the other version handles the 68332 device.

The need for C

Even though I have heard of some large and powerful projects being done in SBasic, it was always intended to be a tool for beginners. I've long felt that to move on to larger, more sophisticated robots, you must move to the C programming language. I use C in my professional life, and do a lot of C programming at home for projects such as my X-10 home control system.

C's advantages over SBasic are compelling. Many of the compilers are much higher quality than my SB compiler, generating tighter code and giving you greater control over where the various parts of your program are placed. The language is mature and widely used as both a cross-platform assembler and as a pseudo-code for conveying program designs. There is a good demand for accomplished C programmers in the embedded control job market, but much less demand, I fear, for good SBasic programmers.

But the ultimate reason for switching to C is the flexibility and power built into the language. Everything from the preprocessor and macros to pointers and structures serve as tools you can use to streamline your code and make it easy to maintain.

Many companies offer good C compilers for the 68hc12, which is my chip of choice for new robot designs. A bit of web searching will turn up several vendors, such as ImageCraft or Cosmic, and you can prowl through listservers and newsgroups dedicated to the 68hc12 or to embedded control for comments on these products.

But I like my tools free, and the hands-down best value for a free C compiler is the GNU toolset. More than just the C compiler, the GNU suite includes tools such as a linker, a librarian for maintaining libraries of working object modules, and utilites for converting and disassembling object files. Note that the same GNU compiler can generate code for both the 68hc11 and 68hc12 chips, though this article will focus on the 68hc12.

However, getting the GNU toolset up and running to the point that you can write your first robot program can be a daunting task. The entire operation is 'way more difficult than installing SBasic, so I'll walk you through the steps. When finished, you will have an incredibly powerful programming tool at your fingertips, and access to programs previously beyond your reach with SBasic.

One word of caution, however. This article will show you how to install the 68hc11/12 GNU C compiler on your PC; it will not teach you how to program in C. If you do not already know how to program in C, head to your local bookstore and get a copy of one of the books that teaches you how to program in C in N weeks, days, or hours. I've liked some of the *Sams* books I've looked through, but there are many good ones out there.

Be sure to get one that includes a working C compiler that you can use for doing the book's exercises. Also look for one that teaches you the basics of C, not how to write visual or Windows-based C programs. Your robot program won't have any drop-down menus or text boxes on it (at least, your first programs won't). You can always learn the graphical features later; for now, focus on the low-level concepts of the language.

Let's get started

Begin this project by hitting the GNU website dedicated to the 68hc11 and 68hc12 C compiler suite at **www.gnu-m68hc11.org**. Click on the Download link to get to the download page. Here you can download several different packages, including the full source for the GNU C compiler. That's right, you can get the source and completely rebuild the compiler, if you choose. 'Way cool, and those who are heavily into embedded control programming should probably do this at least once, but that is a subject for another article.

At this point, click the EXE link to get to the page containing the Windows binaries. This will take you to the Inno packages, which are very similar to the Setup files you are used to seeing in the Windows world. Click on links to download the following packages of files:

GNU Binutils 2.11.2
binutils-68hc1x-win32-2.11.2-1.1.1.i386.exe (2363Kb)

GNU Gcc 2.95.3
gcc-68hc1x-win32-2.95.3-1.1.1.i386.exe (3275Kb)

Examples 1.2.1
m68hc11-examples-1.2.1.zip (139 Kb)

newlib 1.1.1
newlib-68hc1x-win32-1_9_0-1_1_1_i386.exe

The binutils package contains supporting utilities, such as the linker, the librarian, and the tools for manipulating compiled object files. The gcc package is the 2.95.3 release of the GNU C compiler proper. The examples package contains several interesting sample projects written in 68hc12 C. The newlib package contains an archive of C object modules for the 68hc11/12, suitable for linking into your programs. Execute the .exe files to install the binutils, newlib archive, and the gcc compiler into a home directory; I used c:\68hc11\gcc. Unzip the examples package and stick them in a folder underneath this home directory; I used c:\68hc11\gcc\examples.

The installed packages contain executables for the compiler and its support utilities, make files for controlling the compilation of your programs, example programs, object libraries, and documentation for using all of the utilities in the form of HTML pages you can view with your web browser.

You will also need a copy of the GNU (or equivalent) make utility. This powerful utility controls the building of programs using a text file of commands called the makefile. There are many places on the web to download a make utility; I pulled my copy from **http://ring.qgpop.net/archives/graphics/freetype/contrib/win32/**. Download the file **gnumake-win32.zip** and unzip this package into a directory on your execution path. To test your installation, go to a DOS prompt and enter:

```
NAME = blinky

BINDIR = c:/68hc11/gcc/bin
CC = $(BINDIR)/m6811-elf-gcc
AS = $(BINDIR)/m6811-elf-as
LD = $(BINDIR)/m6811-elf-ld
OC = $(BINDIR)/m6811-elf-
    objcopy

CFLAGS = -O3 -m68hc12 -fno-ident
    -fno-common
AFLAGS = -m68hc12
LFLAGS = -Map $(NAME).map
OCFLAGS = -O srec
ARCHIVES = -lgcc
OBJS = $(NAME).o crt0.o isr.o
    vectors.o

.c.o:
$(CC) $(CFLAGS) -S $<
$(CC) $(CFLAGS) -c $<

.s.o:
$(AS) $(AFLAGS) -a=$*.lst -
    o $@ $<

all: $(OBJS)
$(LD) -T$(NAME).ld
    $(LFLAGS) -o$(NAME).obj
    $(OBJS) $(ARCHIVES)
$(OC) $(OCFLAGS)
    $(NAME).obj $(NAME).s19
```

Listing 1: The blinky.mak makefile.

make -v

You should see some version information for the GNU make utility. Make sure you are using version 3.75 or greater.

All of the above tools are intended to run from a command-line prompt or a batch file. I have used PFE-32 for years as my program editor, and it includes a button for launching a DOS command from a drop-down list. This makes it easy for me to edit a program in PFE-32, then compile and view the results with a single click. If you don't have a similar tool, you can use just about any text editor, including WordPad or Notepad. Another option is to browse the web and pick up a generic Windows IDE (interactive development environment) tool that you can customize.

Your first project

The first C program you typically write for a PC is called hello.c, and it displays the phrase "Hello, world!" on your monitor. The equivalent program in the embedded control or robotics world is called blinky.c and blinks an LED. The following paragraphs will show you how to set up your GNU tools to compile and build the blinky program.

All of this supposes you have an actual 68hc12 computer board available, on which to run your blinky program. I am using the Technological Arts Adapt912b32 board, which contains a Motorola 68hc912b32 device and assorted support circuitry. This one chip gives me 32K of flash for program storage, 1K of RAM for variables and stack, and 768 bytes of EEPROM for holding non-volatile data. I've used Technological Arts boards before, and like the quality and pricing.

As a little extra touch, this board already has an available LED, hooked to port P, bit 7. I can turn on the LED by writing a one to PORTP bit 7, or turn it off by writing a zero to that bit.

This board also includes a bootloader, installed in the top 2K of flash. This bootloader accepts standard S19 records from the serial port and burns them into the proper areas of flash. I activate the bootloader by moving a couple of jumpers and resetting the board. After transferring my program's S19 records via a communications program such as Hyperterm, I move the jumpers back to their normal position and reset the board. If I did my job correctly, my new program runs automatically.

The make file

In the GNU world, you build a program by invoking the make utility. This is a powerful tool that controls how your program is built by invoking other tools, handling command-line arguments, and evaluating results of the operations. It completely automates the process, provided you give it the right instructions. These instructions appear in a text file called the makefile. Typically, there is only

```
/* Linker script for 68HC12 object file (ld -r). */
OUTPUT_FORMAT("elf32-m68hc12",              "elf32-
m68hc12",
              "elf32-m68hc12")
OUTPUT_ARCH(m68hc12)
ENTRY(_start)
SEARCH_DIR(C:/68hc11/gcc/lib/gcc-lib/m6811-
elf/2.95.3/m68hc12)

/*
 * Use the MEMORY command to define the types of
memory available on
 * the target system. This is how you describe the sys-
tem's memory
 * map to the linker.
 *
 * On the 68hc912b32, the memory map looks like
this:
 *
 * Address range     Memory type
 * -------           ------
 *   0 - $01ff       I/O ports
 * $0800 - $0bff     static RAM
 * $0d00 - $0fff     EEPROM
 * $8000 - $ff7f     flash EEPROM, less vectors
 * $ff80 - $ffff     flash EEPROM vector area
 *
 * Note that some 68hc12 development boards may
include
 *  a firmware downloader in their 68hc12 chip that
overrides
 *  the normal memory map. For example, the
Technological
 * Arts Adapt912b32 board contains a downloader that
takes
 * control of the normal vector area. In this case, the
TA
 * downloader moves the vector area to $f780 - $f7ff.
 */

MEMORY
{
 IOPORTS (!x)  : org = 0x0000, l = 0x0200
 RAM   (wx)  : org = 0x0800, l = 0x0400
 EEPROM (!i)  : org = 0x0d00, l = 0x0300
 ROM   (rx)  : org = 0x8000, l = 0x7f80
 VECTORS (rx)  : org = 0xf780, l = 0x0080    /* spe-
cial for Adapt912b32 board */
}

PROVIDE (_stack = 0x0c00);


SECTIONS
{
/*
 * Declare the I/O ports section.
 *
 * On the 68hc912b32, this starts at address 0x0000.
 */

 IOPORTS :
 {
 } >IOPORTS

/*
 * Declare the EEPROM section.
 *
 * On the 68hc912b32, this starts at address 0x0d00.
 */

EEPROM :
{
PROVIDE (_start_of_eeprom = .);
} >EEPROM

/*
 * Declare the VECTORS section.
 *
 * On the 68hc912b32, this starts at 0xff80.
 */

VECTORS :
{
PROVIDE (_start_of_vectors = .);
vectors.o
} >VECTORS

/*
 * Declare the start of general-purpose RAM.
 *
 * This is where most variables and arrays will appear.
 * On the 68hc912b32, this is normally at $800.
 */

RAM :
{
 PROVIDE (_start_of_ram = .);
 *(.sdata)
 *(.sbss)
 *(.scommon)
 *(.dynbss)
 PROVIDE (_start_of_bss = .);
 *(.bss)
 PROVIDE (_end_of_bss = .);
 *(COMMON)
 PROVIDE (_end_of_ram = .);
} >RAM

/*
 * Start of text section.
 *
 * The .text section typically holds ROMmed code.
_start usually
 * appears at the beginning of this section. On the
68hc912b32,
 * this is normally at $8000.
 */

ROM :
{
 PROVIDE (_start_of_rom = .);
 *(.text)
 *(.gnu.warning)
 PROVIDE (_start_of_rodata = .);
 *(.rodata)
 PROVIDE (_end_of_rodata = .);
 PROVIDE (_start_of_rodata1 = .);
 *(.rodata1)
 PROVIDE (_end_of_rodata1 = .);
 *(.stab)
 *(.stabstr)
 *(.stab.excl)
 *(.stab.exclstr)
 *(.stab.index)
 *(.stab.indexstr)
 *(.comment)
 _end_of_rom1 = .;
 PROVIDE (_start_of_init = .);
} >ROM


.init : AT (_end_of_rom1)
{
 _start_of_data = .;
 PROVIDE (_start_of_data = .);
 *(.data)
 *(.data1)
 _end_of_data = .;
 PROVIDE (_end_of_data = .);
} >RAM


/*
  DWARF debug sections.
  Symbols in the DWARF debugging sections are rela-
tive
  to the beginning of the section so we begin them at
0.
  Treatment of DWARF debug section must be at end
of the
  linker script to avoid problems when there are unde-
fined
  symbols. It's necessary to avoid that the DWARF sec-
tion is
  relocated before such undefined symbols are found.
*/
/* DWARF 1 */
.debug    0 : { *(.debug) }
.line          . : { *(.line) }
/* GNU DWARF 1 extensions */
.debug_srcinfo . : { *(.debug_srcinfo) }
.debug_sfnames . : { *(.debug_sfnames) }
/* DWARF 1.1 and DWARF 2 */
.debug_aranges . : { *(.debug_aranges) }
.debug_pubnames . : { *(.debug_pubnames) }
/* DWARF 2 */
.debug_info  . : { *(.debug_info) *(.gnu.linkonce.wi.*)
}
.debug_abbrev  . : { *(.debug_abbrev) }
.debug_line  . : { *(.debug_line) }
.debug_frame  . : { *(.debug_frame) }
.debug_str  . : { *(.debug_str) }
.debug_loc  . : { *(.debug_loc) }
.debug_macinfo . : { *(.debug_macinfo) }
}
```

Listing 2: The blinky.ld linker script.

one makefile called, oddly enough, makefile. I generally use a separate makefile for each project, and name the file <project>.mak. For example, I would use a file named blinky.mak to control the building of my blinky.c program.

I will not go into the details of makefile syntax here. It is very arcane and itself could be the subject of an entire article. Instead, I will walk you through my blinky.mak file, tell you what the statements do, and provide pointers on editing them. If you want more info on the make utility, consult the make utility documentation, available from many sites on the web. Begin by creating a project directory for holding your blinky project. For my examples, I've used c:\projects\gcc_play.

The blinky.mak file, used to build the blinky program, appears in Listing 1. Note that the line numbers in the left column are for reference only; they do not appear in the blinky.mak file.

Line 1 simply defines the name of the project. This sets up a variable called NAME that can be used to reference the project by name, without having to include the word "blinky" everywhere the reference appears. This helps me reuse this makefile for other projects; I just change the NAME variable to the new project, save the file by its new name, and most of my editing is done.

Lines 2 through 6 define variables for the binutils directory and several tools used in actually building the blinky program. For example, the variable CC expands to c:\68hc11\gcc\bin\m6811-elf-gcc, which is the path to the GCC compiler.

Lines 7 through 10 define variables for command-line flags used in invoking each of the tools. For example, the variable CFLAGS defines the command-line options used when the make utility invokes the GCC compiler to compile a C source file. The option of main interest here is -m68hc12, which appears in the CFLAGS and AFLAGS variables; this option tells GCC to create code for a Motorola 68hc12 processor. A full list of options for all utilities shown here is available in the docs folder installed with the GCC packages; in my case, the path to this docs file is C:\68hc11\gcc\m6811-elf\doc.

The ARCHIVES variable — defined in line 11 — specifies archives to search when the make utility invokes the linker. The linker searches libraries of previously-compiled object files, attempting to resolve references you might have used in your program. For example, if you invoked the C library routine strcpy() in your program, the linker will search the archives called out in this option, trying to find an object module containing strcpy(). I'll provide more info on the linker later.

Line 12 defines the OBJS variable, which lists all object modules associated with this project that won't be found in existing archives. In order for the make utility to compile and link your program properly, it must be able to create all of these object files. Instructions to the make utility on how to compile or assemble the source for these files must appear later in this makefile.

Lines 13 through 15 define a rule for translating a .c file into an .o (or object) file. When the make utility needs to create an .o file, such as blinky.o, it will use this rule to compile blinky.c into blinky.o. The actual steps needed to invoke the compiler appear in lines 14 and 15. Technically, you only need line 15. The options on line 14 tell the GCC compiler to stop compilation after creating an assembly language source file named blinky.s, while line 15 performs the full compilation. The .s file is educational, however, as it shows the assembly language source the compiler created for each line of C code.

Lines 16 and 17 provide a similar rule for assembling an .s file. By convention, assembly language source files in the GNU world carry an .s extension; the rule in line 17 tells make to invoke the assembler, using the flags defined in variable AFLAGS, and to generate a listing file and an object file. The listing file will be named with the same base name as the original source file, but with a .lst extension. By default, the object file will carry an .o extension.

Lines 18 through 20 are where the entire project is built. When you invoke make from a command line, it looks for a default task to do; in this case, that task is called all and is defined by these lines. To do this task, the make utility must first have all of the files listed in the OBJS variable. If all of the files needed exist already, make can proceed to build the project. If any of the files in OBJS are missing, or if the corresponding source file changed after its object file was last created, make looks through the rules it knows to figure out how to make the needed files.

Once all of the files in the OBJS variable are current, make executes the commands in lines 19 and 20. Line 19 invokes the linker, passing a large list of options to it. The most important of these options is the -T field, which defines a linker script to be used in assigning the placement of various code and data sections within the program. I'll go into this in greater detail in a moment.

This line also includes a reference to the ARCHIVES variable described earlier. This variable lists any object libraries the linker should search in order to resolve references to functions in your code. Note that the placement of these library names in the linker command line is important. The linker searches libraries and your object files in the order presented, and getting things out of order can cause maddening errors about unresolved references.

For example, if I reversed the order of the OBJS and ARCHIVES variables in the linker command line, the linker would first search all of the archives, then look through my object modules. The object modules would refer to functions in the archives, but those have already been searched and their contents forgotten. Thus, the linker would have references in my object modules to functions it cannot locate, and would error out.

While I'm on the subject of libraries ... the ARCHIVES variable lists a library apparently named gcc. This is really a kind of shorthand in the GNU world. Arguments that specify library names are usually understood to mean libraries with a name of the form libname.a, where the field name is all that appears in the argument. Thus, an argument of -l gcc implies a library named libgcc.a.

The arguments passed to the linker in variable LDFLAGS causes the linker to write a map file named blinky.map. This text file tells you where every major component of

```
1. #include <stdio.h>
2. #include <string.h>
3. #include "ioregs12.h"

4. int        main(void);

5. int        v = 1234;
6. char       b[32];
7. short int     c[10];
8. char       a[] = "12345";

9. extern char      _start_of_data;
10. extern char      _end_of_data;
11. extern const char    _start_of_init;

12. unsigned short int    start =
   0x0000;
13. unsigned short int    end = 0xffff;

14. int main()
15. {
16.        unsigned short int     n;

17.        COPCTL = 0x08;
18.        COPCTL = 0x08;
19.        DDRP = 0x80;

20.        memcpy(&_start_of_data,
   &_start_of_init, &_end_of_data -
   &_start_of_data);
21.
22.        while (1)
23.        {
24.                for (n=start; n<end;
   n++)
25.                {
26.                }
27.                PORTP ^= 0x80;
28.        }
29.        return 0;
30. }
```

Listing 3: The source file for blinky.c.

your program is placed in memory, including all variables, all function entry points, the stack, and all vectors. This is a very valuable debugging resource, and nice to have for reference.

The linker collects all the object modules in your project, plus all the needed library functions from the various archives, and packs them into a single ELF object file; in this example, the file will be named blinky.obj. But you typically want an .s19 file for burning into flash on a 68hc12. Line 20 causes make to invoke the objcopy tool, used to translate an ELF file into a Motorola S19 file. This is a simple utility compared to the linker, and requires only a few options. I won't go into details here; consult the document files on objcopy for more information.

NOTE: The GNU make syntax requires that each line inside a rule starts with a tab character; leading spaces will not work! For example, lines 14, 15, and 17 above all start with a hard tab.

Also note that in the GNU world, directory names are separated with slash characters, not backslashes. This matters whenever you define a directory path. As you see, lines 2 through 6 all use slash characters in the directory names, since these lines define paths to executables run by make.

I'll mention one other interesting tool not used in the above makefile. The objdump utility will generate a disassembly of an ELF object file, complete with assembly language source statements, labels, and memory assignments. This can be handy when debugging your working program. To get a disassembly of the blinky.obj file, you would enter the following line at the command prompt:

```
objdump -S -d blinky.obj
>blinky.dis
```

This will save the disassembly to a text file named blinky.dis.

The linker script

The GNU linker collects various object modules, including those created by compiling or assembling your source files, and packs these modules into a single large object file. During this process, the linker assigns addresses in RAM and ROM to the various sections of your program, based on instructions you provide in a linker script. You have to get the linker script correct to have a hope of creating a useable S19 file for your program.

My linker scripts all have the name of the project with a .ld extension; the linker script for the blinky program is blinky.ld. The linker script is a text file, created with nearly any ASCII text editor. I've included a copy of my blinky.ld file for discussion; refer to Listing 2.

The following discussion is limited to options you see in this file, but the linker script is a powerful tool and capable of far more than you see here. As always, consult the documentation files included with the GNU installation for more details.

The first block of lines in my linker script provides general information, such as the name of the entry point to the blinky program (_start), the type of target machine (68hc12), and the main search library where the linker should look for object libraries. I've set SEARCH_DIR to point to the newlib directory installed earlier; the linker will search here when it tries to find the libgcc.a archive called out in the makefile.

The next block of lines forms a MEMORY command, used to define the various types of memory found on the target system. Here, you see statements that define types of memory called IOPORTS, RAM, EEPROM, ROM, and VECTORS. Each memory type includes options describing what kind of accesses are permitted, where the memory type starts, and its total length in bytes.

For example, the RAM memory type is marked as writeable and executable, while the IOPORTS memory type is marked as not executable. The linker will use these memory type descriptors to test where it tries to put portions of your executable. Thus, if you try to assign initial values to a variable assigned to the EEPROM memory type, the linker will throw an error, since that memory type is declared not to be initializable (!i descriptor).

At the bottom of the MEMORY command, you see a line that defines the label _stack, marking the top of the program stack. PROVIDE statements appear throughout this script, and allow the linker to resolve addresses that appear in my source files, but are not defined in them. Here, the linker is told to create a label called _stack with a value of $0c00. When the linker needs to resolve references to _stack, it uses the value defined in this PROVIDE statement.

Following the PROVIDE statement is a very large SECTIONS command. This command defines the placement for all of the sections of code and variables defined in my program. In nearly all cases, elements of your programs will be assigned to sections automatically during compilation, and you normally don't need to know what goes where. However, it is a good idea to understand how this works in general, so I'll hit the high points here. For more details, look through the docs for the GCC compiler and for the linker.

For example, variables that need initial values other than zero as your program starts up appear in the .data and .data1 sections. Variables that need to be initialized to zero at startup appear in sections such as .sdata and .sbss. Read-only portions of your program — such as executable code or constants — are assigned to sections such as .text or .rodata.

The SECTIONS command shown here tells the linker what memory type to assign to each of the possible sections in the program. As you can see, I've used ROM for the read-only sections and RAM for most of the data sections. Two sections, however, are worth noting.

The SECTIONS command assigns one entire object module — vectors.o — to the memory type VECTORS. This tells the linker that if it finds a module named vectors.o, it must place it at the addresses reserved for VECTORS in the MEMORY command discussed above. If I make a mistake and make the vectors.o file too large to fit in this assigned space, the linker will generate an error.

The .init section holds the initial values for those variables that must appear in RAM, but must be initialized to a value other than zero at startup. Here you see that I have placed the .init section in ROM at the end of my read-only sections, but told the linker to translate all references to items in the .init section to an area starting at the last referenced address in RAM. This use of the AT operator is a powerful element of the linker script; for more details, look through the linker docs.

The last major block of statements sets up debugging information, should you choose to use the GNU debugger on your target system. These sections were defined in the original example script that I

```
1. .section        .text
2. .globl _start
3. _start:
4.        lds      #_stack
5.        jsr      main
6. $1:
7.        bra      $1

8. .section        .bss

9. .globl _.frame
10. .comm          _.frame,4,1

11. .globl         _.d1
12. .comm          _.d1,2,1

13. .globl         _.d2
14. .comm          _.d2,2,1

15. .globl         _.xy
16. .comm          _.xy,4,1

17. .global        _.z
18. .comm          _.z,2,1

19. .global        _.tmp
20. .comm          _.tmp,16,1
```

Listing 4: My crt0.s file.

```
/*
 * vectors.c   vector table for the
68hc12
 */

#include "isr.h"

extern void ISR_Empty(void);
extern void _start(void);

/*
 * This is not a routine but a table that
the linker can use to assign
 * vectors to the various interrupt service routines (ISRs). This
 * table must ultimately appear in the
68hc12's vector area starting
 * at 0xff80.
 */

void ( * const vector[])() = {
  ISR_Empty,      // $ff80
  ISR_Empty,      // $ff82
  ISR_Empty,      // $ff84
  ISR_Empty,      // $ff86
  ISR_Empty,      // $ff88
  ISR_Empty,      // $ff8a
  ISR_Empty,      // $ff8c
  ISR_Empty,      // $ff8e
  ISR_Empty,      // $ff90
  ISR_Empty,      // $ff92
  ISR_Empty,      // $ff94
  ISR_Empty,      // $ff96
  ISR_Empty,      // $ff98
  ISR_Empty,      // $ff9a
  ISR_Empty,      // $ff9c
  ISR_Empty,      // $ff9e
  ISR_Empty,      // $ffa0
  ISR_Empty,      // $ffa2
  ISR_Empty,      // $ffa4
  ISR_Empty,      // $ffa6
  ISR_Empty,      // $ffa8
  ISR_Empty,      // $ffaa
  ISR_Empty,      // $ffac
  ISR_Empty,      // $ffae
  ISR_Empty,      // $ffb0
  ISR_Empty,      // $ffb2
  ISR_Empty,      // $ffb4
  ISR_Empty,      // $ffb6
  ISR_Empty,      // $ffb8
  ISR_Empty,      // $ffba
  ISR_Empty,      // $ffbc
  ISR_Empty,      // $ffbe
  ISR_Empty,      // $ffc0
  ISR_Empty,      // $ffc2
  ISR_Empty,      // $ffc4
  ISR_Empty,      // $ffc6
  ISR_Empty,      // $ffc8
  ISR_Empty,      // $ffca
  ISR_Empty,      // $ffcc
  ISR_Empty,      // $ffce
  ISR_Empty,      // $ffd0
  ISR_Empty,      // $ffd2
  ISR_Empty,      // $ffd4
  ISR_Empty,      // $ffd6
  ISR_Empty,      // $ffd8
  ISR_Empty,      // $ffda
  ISR_Empty,      // $ffdc
  ISR_Empty,      // $ffde
  ISR_Empty,      // $ffe0
  ISR_Empty,      // $ffe2
  ISR_Empty,      // $ffe4
  ISR_Empty,      // $ffe6
  ISR_Empty,      // $ffe8
  ISR_Empty,      // $ffea
  ISR_Empty,      // $ffec
  ISR_Empty,      // $ffee
  ISR_Empty,      // $fff0
  ISR_Empty,      // $fff2
  ISR_Empty,      // $fff4
  ISR_Empty,      // $fff6
  ISR_Empty,      // $fff8
  ISR_Empty,      // $fffa
  ISR_Empty,      // $fffc
  _start        // $fffe
};
```

Listing 5: The vectors.c source file.

```
/*
 * isr.c
 */

#include "isr.h"

void __attribute__ ((interrupt))
ISR_Empty(void)
{
}
```

Listing 6: The isr.c file.

edited, and I simply left them in place.

The blinky program

Now that you have the makefile and linker script behind you, we can take a look at the blinky.c source file. Refer to Listing 3. Again, the line numbers do not appear in the source file; they are for reference only. You will notice that this file contains a bit more than is really necessary to blink an LED. I included some extra elements so you can compare the source file to the generated map and disassembly. This provides valuable insights into how the compiler and linker assign addresses to each of the program elements.

Lines 1 through 3 specify include files to process during compilation. In particular, the file ioregs12.h is a file I created that defines the address of each 68hc12 I/O register. This lets me refer to a port by its accepted Motorola name, rather than an address.

Line 4 is the formal prototype of the main() function. This prototype indicates that main() returns a value, which is normal in the PC world, but largely useless in the embedded control world. Control should never leave main() in a robot program, as there is almost never anything outside of main(). I'll discuss this more in a bit.

Lines 5 through 8 define variables that aren't actually used in the program, but I added these so you could look through the disassembly and map files to see how the linker treats each of these different types of variables.

Lines 9 through 11 actually refer to addresses known only to the linker. The linker script discussed above uses PROVIDE statements to force the linker to assign addresses to these variables, based on where important sections of the program appear in memory. For example, the variable _start_of_data will be assigned to the first byte of RAM that must be initialized when the program starts up. You'll see how these variables are used in a moment.

Lines 12 and 13 define two variables used to control the length of the timing loop for blinking the LED. At startup, they are initialized to the values shown here. Lines 14 through 16 are the start of the main() function, including the creation of a local variable n.

Lines 17 through 19 show how to access I/O ports directly in C. Here, I am sending the byte $08 to the COPCTL register twice, followed by writing the value $80 to DDRP. The write to DDRP makes bit 7 of PORTP an output line, so I can control the LED tied to that port. Those of you familiar with SBasic will notice immediately that accessing I/O ports in C takes much less source and is more readable.

Line 20 invokes a C library routine called memcpy() to initialize the RAM variables in the .init section described above. This function copies the bytes starting at address _start_of_init to the address _start_of_data, until it has copied the number of bytes calculated as its third argument. Recall that the linker placed the initial values of RAM variables in ROM starting at address _start_of_init, but placed the actual variables in RAM starting at address _start_of_data. This invocation of memcpy() moves the ROMmed initial values to the RAM variables.

Note that this operation is normally handled by custom assembly language code that appears in a module named crt0.s (crt stands for C Run-Time). Rather than drag you through the intricacies of such operations in 68hc12 assembly language, I thought I'd reduce the entire operation to a C function. However, the crt0.s file is the customary method of doing this operation, and you should look through the examples to understand how crt0 does this.

Lines 22 through 28 define a large WHILE loop that repeatedly counts from the value in start to the value in end, then toggles bit 7 of PORTP. Again, SBasic users should note how simple and readable the C code is for accessing and changing a bit in PORTP. If you are new to C, line 27 reads PORTP, exclusive-ORs the value read with $80, then writes the result back to PORTP. Note that control cannot reach line 29, since there is no way to exit the WHILE loop. However, the function main() was defined as returning a value, so the return statement shown here keeps the compiler happy.

The crt0.s file

Next up is my crt0.s file. This file typically holds the start-up code, executed following reset of the target machine. Usually, it holds the address of the start of the program and includes code that initializes all RAM variables before invoking the function main().

The file you see here is very nearly the smallest possible crt0.s file. As mentioned above, I have moved the code normally found in crt0.s that copies initial values from ROM to RAM at progam start-up into the blinky.c file. Refer to Listing 4 for details. Again, the line numbers do not appear in the source file, but are included only for reference. Line 1 assigns the following code to the .text section, so the linker will know where to place it in memory. Line 2 defines a global variable named _start, which marks the starting point of the entire program and is created in line 3.

Lines 4 through 7 are the entire code for the crt0.s file. Line 4 initializes the 68hc12 stack pointer to the address _stack, created by the linker through a PROVIDE statement in the linker script. Line 5 invokes the function main() to run the program. Lines 6 and 7 serve as a safety net; should control ever return from main(), the computer will lock up in an endless loop.

The remainder of this file creates global RAM variables that might be needed, depending on the functions your program invokes and the option flags you pass to the GCC compiler. Refer to the GCC documentation for details on controlling the frame pointer _.frame and other dedicated soft registers.

```
/*
 * isr.h
 */

#ifndef ISR_H
#define ISR_H

void __attribute__ ((interrupt))
ISR_Empty(void);

#endif
```

Listing 7: The isr.h file.

The vectors.c file

Next up is the vectors.c file, which controls the contents of the 68hc12 vector area. Refer to Listing

5, which shows my vectors.c file.

Those familiar with 68hc12 MCUs already know that this reserved area of memory holds interrupt vectors for various subsystems. The most important of these vectors is the reset vector, which normally appears at addresses $fffe and $ffff. Following reset, the MCU fetches the 16-bit value in this address and uses it as the start of the program to run.

The comments in this file refer to the vector table in its normal location starting at $ff80. Since the Adapt912 board I'm using covers the normal vector area with its own vectors, I have to move my vectors to a reserved area starting at $f780. Regardless of where your target board needs the vectors, the assignment of these addresses occurs in the linker script described above. The SECTIONS command refers to the VECTORS area of memory, and assigns the object file vectors.o to this area. Thus, when the file created by compiling vectors.c is linked, the linker will place the vector table in the address range assigned for it.

Note that the last label in the vector table is _start. This puts the address of the beginning of the program, defined in crt0.s above, into the location reserved for the 68hc12 reset vector. Forcing _start to appear here ensures that the linker will build a final executable with the reset vector properly initialized.

Most of the vectors in this table refer to a function called ISR_Empty(). This is a dummy function that consists of a RTI (return from interrupt) instruction. Any function you include in the vectors table must be defined as an interrupt handler. You can see how I did this by examining the files isr.c (Listing 6) and isr.h (Listing 7).

The file isr.c shows you how to declare an interrupt handler in GNU C, a technique you will need to use extensively in robotics code. The function ISR_Empty() is just a stub routine, an empty function that ends with an RTI instruction. When you need to write more sophisticated interrupt handlers, declare your function as I have declared ISR_Empty(). Then, edit the table in vectors.c to insert the name of your interrupt handler into the appropriate vector location. The linker will create the vector table with the address of your function properly placed.

Build and load

To build the blinky program, you must invoke the make utility from a DOS command prompt, batch file, or Windows shortcut icon. Change your working directory to be your C source directory — such as c:\projects\gcc_play — and enter the following command line:

```
make -f blinky.mak
```

After you have successfully compiled blinky.c and the support files, you will be left with a file named blinky.s19. This file contains the Motorola S19 records that make up your program's executable. How you get this S19 file into your target 68hc12 machine will vary. Some boards include a background debug mode (BDM) connector and associated software, while others — like the Adapt912 board I used — rely on a PC serial port and a comm program like Hyperterminal.

When you have successfully copied your executable into flash, you should be able to reset the board and watch the LED blink. With a stock 16-MHz crystal, you should see the LED blink on and off several times per second. The GCC compiler can generate fairly tight code, and it will only take a split second for the 68hc12 to run through the 65,000+ iterations in the blinking delay loop in main().

That's a wrap

I know this can all look a bit intimidating, especially if you are used to the simplicity of SBasic. But remember that many of these files won't change for other projects, and I've worked to make the ones that do need to change — such as blinky.mak — as easy to edit as possible.

Note also that what you see here is not the way to build C programs with the GNU tools, it is a way. Others who use the GNU tools will use different techniques, and will have good reasons for doing so. You can learn by looking at other people's projects, and at the example files included in the GCC toolset you downloaded. Plus, the web offers a treasure trove of examples and documentation for your GCC projects.

The porting of the GNU C compiler to the 68hc11 and 68hc12 was done in large part by Stéphane Carrez of France. His work and the efforts of the Free Software Foundation, which distributes the compiler and utilities, have given the 68hc12 community access to a powerful toolset for program development.

Look on this move to C as the start of the next phase in your robotics hobby. Whether you use the 68hc11, 68hc12, or an unrelated device, C gives you an excellent tool for creating robot code. If you don't yet know how to write C programs, take the time to teach yourself, using one of the popular books available. Using C may be the most important move you make in your efforts to build a better 'bot. **NV**

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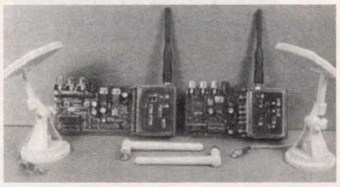

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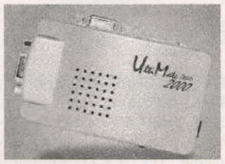

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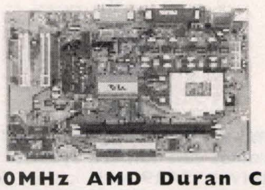

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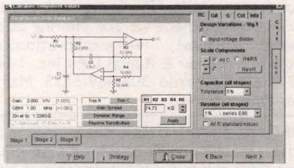

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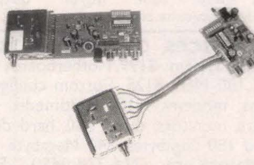
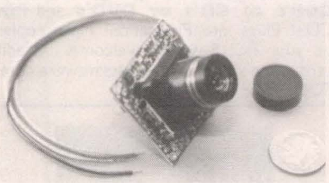


2.4GHz WIRELESS transmitter /receiver kit. ASK-2008-TR, 8 frequencies uP controlled 2.300 to 2.481 MHz, video NTSC/PAL with 2 channels of audio for development testing. 12VDC/100 mA for both transmitter and receiver. Includes 2 rubber duck antennas. **$125**. Matco, Inc., Schaumburg, IL, 1-800-719-9605, 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

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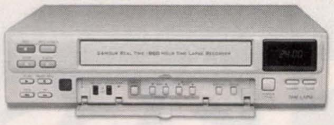

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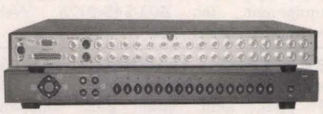
SEE THE NEW MATCO PRODUCT FEATURES AND PRICES in the color center spread on page 43.

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



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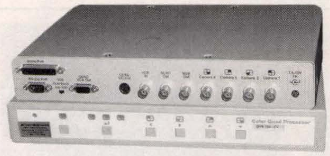
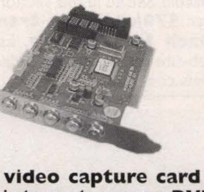
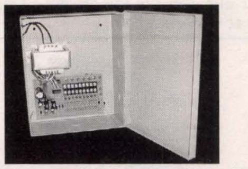
14" COLOR — high resolution SECURITY MONITOR w/4 channel switcher. High impact enclosure with modern front panel 4 channel video and audio switcher. High quality speaker built-in. Components purchased separately would exceed $500. Price slashed to **$249/each**. Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com



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



4 PORT video capture card with remote internet access, DVRC-4; $339. Remotely view any 4 NTSC video cameras over your internet connection. Sophisticated motion sensing option allows camera to be activated by motion or time. 500 MHz or higher; 98/2000/XP, NT compatible. Installation time under 10 minutes. 16 channel unit is also available, bundled with PC. **Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com**



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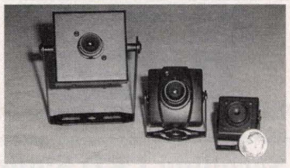

COLOR & B/W board cameras w/cases, BX-120-LC (350 lines color) $89; BX-125-LC (380 lines color) $99, sub-miniature BX-123-AU (420 lines B/W with audio) $69. Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com

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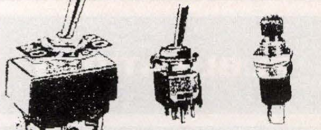

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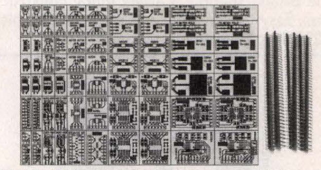

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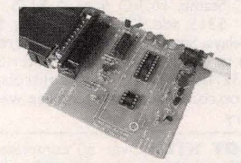

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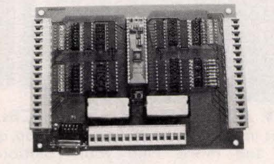

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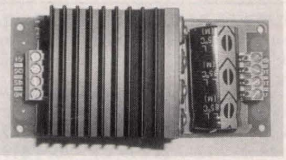

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ELECTRONIC KITS: Hundreds of electronic kits and projects. Where else except www.electronickits.com

HI-TECH SURVIVAL: Electronics, computers, internet, energy, phones, medical, financial, security, physical survival, electronic harassment, many more! **CONSUMERTRONICS**. **www.tsc-global.com** Catalog $3: PO 23097, Albuquerque, NM 87192.

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APOGEEKITS High quality electronic kits. Detailed illustrated assembly instructions. 4 inch high digital clock, animated LED bell display and FREE download plans make unique holiday gifts! SECURE on-line ordering. **<http://www.apogeekits.com/>**

DIGITAL TACHOMETER KIT: IR microcontrolled. As seen in the September 2002 **"Poptronics"** article. Info at Design Specialties, 4444 County Hwy. 16, Delhi, NY 13753. **www.dsgnspec.com**

MISCELLANEOUS ELECTRONICS FOR SALE

2 AXIS SOLAR TRACKER PCB assembly $73. Add your 12VDC source & drive system to track the sun. Info: http://members.shaw.ca/theanalogguy

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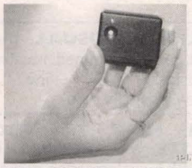

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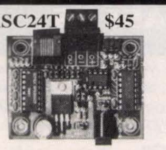
RS485/422/232/TTL

ASC24T $45



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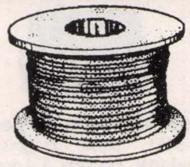

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HARD-TO-find parts: PTV screens, modules, chassis, flybacks, tuners, tubes, for all brands. Manuals. 478-272-6561. Scarborough TV, 1422 Old River Road, East Dublin, GA 31027. scarboroughstv@pcnow.net

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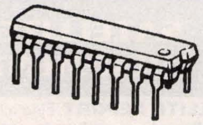
DEC EQUIPMENT WANTED!!! We are buying DEC systems, boards, terminals, drives and peripherals. Also Scientific Micro Systems (SMS), CMD, Datability, Dilog, DSD, EMULEX, other DEC compatibles. Please contact us for a quote or fax/email your equipment list. We buy, sell, and trade. **KEYWAYS, INC.**, 937-847-2300 or fax 937-847-2350 or email buyer@keyways.com



WANTED: EXCESS ELECTRONIC COMPONENTS, BOARD-LEVEL COMPONENTS; MILITARY COMPONENTS; ICs, MEMORY, TRANSISTORS, DIODES, CAPS, RELAYS, ETC. CALL LPS 562-439-2453 FAX 562-439-0453.

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. 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

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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.

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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

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.

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	130. Antique Electronics
20. Batteries/Chargers	135. Aviation Electronics
30. CB/Scanners	140. Publications
40. Music & Accessories	145. Robotics
50. Computer Hardware	148. CNC
60. Computer Software	150. Plans/Kits/Schematics
70. Computer Equipment Wanted	155. Manuals/Schematics Wanted
80. Test Equipment	160. Misc. Electronics For Sale
85. Security	170. Misc. Electronics Wanted
90. Satellite Equipment	175. Online Services
95. Military Surplus Electronics	180. Education
100. Audio/Video/Lasers	190. Business Opportunities
110. Cable TV	200. Repairs/Services
115. Telephone/Fax	
120. Components	
125. Microcontrollers	

WANTED: **TUBES** & sockets. All kinds and quantities. A/B carbon resistors. Sprague black beauties/vit Q caps. Western Electric audio equipment & tubes. Contact Charlie 760-955-8279, fax 760-245-4760. cdlske60@earthlink.net

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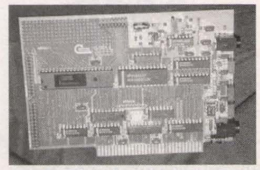

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HI-TECH HARDWARE, CONSULTING, PLANS: Unique, original, made-to-order, special needs, controversial **SPECIAL PROJECTS, TECHNICAL COACHING, WEBSITE DESIGNS**. Electronics, computers, internet, energy meters, phones, radionics, security, physical survival, electronic harassment. Design, create, modify, repair, consult! **LONE STAR CONSULTING, INC**. Catalog online: **www.lonestartek.net**, 915-474-0334.

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Events Calendar

The Events Calendar is a free service for publicizing electronic events such as amateur radio hamfests, flea markets, etc. If your organization is sponsoring an event and would like a free listing, contact us at least 60 days in advance. Include your flyer, name of the person to contact, and phone number. While we strive for accuracy in our calendar, we cannot 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
Email
events@nutsvolts.com

Oct-Nov

OCTOBER 2002

OCTOBER 5

FL - JACKSONVILLE - Hamfest. Email: n4uf@nofars.org Web: www.nofars.org
TX - TEMPLE - Hamfest. Temple ARC, 254-773-3590, email: hamexpo@tarc.org

OCTOBER 6

IA - WEST LIBERTY - Hamfest. ICARC, 309-537-3678. Email: kc0aqs@qsl.net Web: www.qsl.net/kc0aqs
IN - BEDFORD - Hamfest. 812-849-0095. Email: chairman@hoosierhillshamfest.org Web: www.hoosierhillshamfest.org
OH - MEDINA - Hamfest. Medina Hamfest Committee, 330-273-1519 after 7pm. Email: n8tzy@m3net.net

OCTOBER 12

GA - AUGUSTA - Hamfest & Computer Show. The ARA of Augusta, 706-651-9504, email kg4ley@hotmail.com
NJ - WASHINGTON TOWNSHIP - Hamfest. BARA, 201-664-6725. Email: k2zo@arrl.net Web: www.bara.org
NY - LAKE PLACID - Hamfest. 518-827-4800, email: valosin@midtel.net
TX - DENTON - Hamfest. Denton County ARA, 940-390-5338. Email: kd5kjz@yahoo.com

OCTOBER 13

CT - WALLINGFORD - Hamfest & Computer show. Email: nutmeghamfest@qsl.net Web: www.qsl.net/nutmeghamfest
MI - EAST LANSING - Hamfest. 989-725-1853, email; kc8dbp@arrl.net

OCTOBER 19

CO - GOLDEN - Hamfest. 303-985-8692, n0mqj@attbi.com
FL - JACKSONVILLE - Hamfest. Greater Jacksonville Hamfest Assn., 907-269-8714. Web: http://www.jaxhamfest.com
FL - ORLANDO - Hamfest. Bahia Shrine, Bob KG4ECC, 407-834-9481
MI - KALAMAZOO - Hamfest. 616-337-7602. Email: hamfest@kalamazoohamradio.com Web: www.kalamazoohamradio.com/hamfest
MI - SAULT STE. MARIE - Hamfest. Eastern Upper Peninsula Amateur Radio, 906-635-0215. Email: wa8old@sault.com
TN - OAK RIDGE - Hamfest. Oak Ridge ARC, 865-670-1503. Email: d.bower@ieee.org

OCTOBER 20

IL - GODFREY - Hamfest. Lewis & Clark RC, 618-462-4212. Email: n9fhh@exi.com
MA - CAMBRIDGE - Hamfest. MIT Radio Society/Harvard Wireless Club/MIT UHF Repeater Assn., email: w1gsl@mit.edu (617-253-3776 9am-5pm.) Web: http://web.mit.edu/w1mx/www/swapfest.html
NY - QUEENS - Hamfest. The Hall of Science Amateur Radio Club, 718-898-5599. Email: WB2KDG@Bigfoot.com
PA - SELLERSVILLE - Hamfest. RH Hill ARC, 215-679-5764. Web: www.rfhill.ampr.org

OCTOBER 24-27

CT - ENFIELD - Conference & Flea Market. Radisson Hotel. Web: www.microwaveupdate.org

OCTOBER 26

MN - ST. PAUL - Hamfest. 763-535-0637. www.hamfestmn.org
MO - KIRKWOOD - Hamfest. St. Louis ARC & Gateway to Ham Radio, 314-638-4959. Email: slw@partyline.net
OR - SALEM - Hamfest. Mid-Valley ARES. 503-540-3270, Email: ki7or@arrl.net Web: www.qsl.net/w7oem/swaptobe.html

OCTOBER 27

MD - WESTMINSTER - Hamfest. Email: n3sb@qis.net Web: www.qis.net/~k3pzn/tailgate.htm
OH - CANTON - Hamfest. Massillon ARC. Web: www.qsl.net/w8np

NOVEMBER 2002

NOVEMBER 1-2

TX - ODESSA - Hamfest. The West Texas ARC, 915-366-4521. Email: w5bu@arrl.net

NOVEMBER 2

OK - ENID - Hamfest. Enid Hamfest Group, 580-233-1470. Email: enidhamfest@yahoo.com

NOVEMBER 2-3

GA - LAWRENCEVILLE -

COMPUTER SHOWS

ACP Computer Show & Swapmeet 714-558-8813
jferguson@acpsuperstore.com
www.acpsuperstore.com

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.fivestarshows.com

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www.gibraltartrade.com

KGP Productions
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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.shownsale.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

Hamfest. Alford Memorial Radio Club, email: kr4nq@bigfoot.com, web: www.totr-radio.org

NOVEMBER 9

AL - MONTGOMERY - Hamfest & Computer Show. Montgomery ARC, Inc., 334-272-7980 after 5pm CST. Email: k4ozn@arrl.net http://jschool.troyst.edu/~w4ap/

MI - KALAMAZOO - Antique Radio Swap. MARC, 734-207-2346, email: moppat@flash.net

OH - GEORGETOWN - Hamfest. Grant ARC, 937-446-2338. Email: WD8CTX@juno.com

NOVEMBER 16

FL - MIAMI - Flea Market. Flamingo/UM ARC, 305-264-4465. Email: wa4tej@beethoven.com

NOVEMBER 16-17

IN - FORT WAYNE - Hamfest & Computer Expo. ACARTS, 260-484-1314. Web: www.fortwayne hamfest.com

NOVEMBER 30

IN - EVANSVILLE - Hamfest. EARS & The Ham Station, 812-333-4116. Email: ears@w9ear.org

Reader Feedback

Continued from Page 14

too friendly. Because of this gesture other things were taken out of context. Like the punk red hair and the clenched fist. Is this a try to be a cover for 'Heavy Metal' (pardon the pun ... even if it was intentional). I even tried to explain that if you counted the actuators in the hand it would be obvious that, since the fourth one is activated, the index finger was the one that was raised.

To that I got a 'yeah right' response.

Just be careful in the future. I just subscribed and am waiting for my first issue. I subscribed for information content not attitude.

You have excellent content with the spirit of the original *Popular Electronics* ... lots of projects from simple on up. *Poptronics* is okay, but I dont't feel that it's up to your level for the general hobbyist.

Thanks for listening to my ravings. The complaints were intended to be tongue-in-cheek since I really believe the cover's appearance was not intentional.

Keep up the good work.

Ray Bedard
via Internet

News Bytes

Strydent Offering Free Software for Back-to-School

Strydent Software will offer 1,000 free downloads of its award-winning software, InkSaver, in an effort to help students, parents, and educators save money on the high cost of inkjet printing during the back-to-school season.

InkSaver is an innovative software product that makes inkjet cartridges last up to four times longer. By working seamlessly with a user's existing printer software and printer, InkSaver gives users control over the amount of ink they use, without compromising print quality.

"Most reports and homework assignments turned in today are printed at home on an inkjet printer," said Bernie Crump, Pinetree Secondary School teacher. "Printer ink is expensive, so InkSaver is a great way to help families control the cost of school supplies."

The free offer is limited to students, parents, and educators. Interested participants are asked to fill out a short eligibility form at http://www.inksaver.com/backtoschool. InkSaver is available in North America and Europe from leading computer retailers, mail order, and online resellers, as well as direct from Strydent Software at http://www.strydent.com/ or 1-800-663-6222 (outside North America +1-604-296-3600). The suggested retail price is $34.99 US.

Charter One Bank Introduces Online Check Imaging

Charter One Bank, a subsidiary of Charter One Financial, Inc. (NYSE:CF), now has available free online check imaging for its online banking customers at www.charterone.com/.

Charter One is the first bank in the nation to offer its customers direct access to check imaging using the Federal Reserve's new FedImage(SM) Services technology.

With check imaging, Charter One's online banking customers now have access to all of their paid or cancelled checks in real time, eliminating the need to receive and store the paper checks that arrive with their monthly statements. In addition to viewing checks, customers will have the ability to print or email their check images.

"Online check imaging is a great tool for our customers and will give them another way to stay on top of important financial transactions," said Dominic J. Salomone, senior vice president and chief bank operations officer at Charter One Bank.

Introduced in May 2002 and being implemented nationwide through 2003, FedImage Services provides a national image archive for check images captured at Federal Reserve offices. Direct archive access is provided to bank customers through the bank's home banking or other customer access systems.

Rostra Precision Controls Makes Safety a Top Priority

This year alone, 52 children have been backed over by a vehicle, often in their own driveway, and last year 116 children died as a result of these accidents, according to the National Highway Traffic Safety Administration. These numbers can drastically be reduced with a new technology available from Rostra Precision Controls.

"The majority of children who are victims of back over accidents are under the age of 14," said Thomas Weiss, vice president, automotive accessories of Rostra Precision Controls. "These accidents occur because many households lack large yards for children to play in and are instead using driveways as a recreational area."

Rostra Precision Controls developed a rear obstacle sensing system that uses microwave technology to detect objects within a 12-foot radius behind the vehicle. It alerts the driver through an in-dash readout display and a series of audible beeps that increases in intensity as an object draws closer.

Rostra's ROSS costs less than $500.00 installed and is available for virtually any vehicle, including RVs and trailers.

"ROSS isn't just for families with small children because most of the drivers from these accidents are a relative," said Weiss. "Rostra's sensing technology provides added piece of mind and ensures safety to both children and family members."

To locate the nearest Rostra dealer, call (800) 782-3379 or visit http://www.rostra.com/.

HSN.com's New Virtual Dressing Room Provides Shoppers With

Personalized 3D Model to 'Try On' Clothes Online

HSN, the world's most widely distributed TV shopping network, has launched My Virtual Model™ Experience on www.hsn.com/, allowing customers to try on clothes online before making a purchase.

Featured as a hotlink on hsn.com's homepage, the My Virtual Model Experience allows women to 'try on' hundreds of different outfits, from a wide variety of designers, in the comfort of their home or any other location with Internet access.

HSN.com is the first Web destination to offer a fully integrated version of My Virtual Model Inc.'s visualization and sizing solutions, known respectively as the My Virtual Model™ Dressing Room and My Virtual Mode™ Fit. Women can build a 3D model of themselves and then see how they look in specific outfits sold on the network and hsn.com. Accurate sizing is guaranteed by matching individual body measurements with various garment specifications.

The simplified sign-in process asks women to provide their own unique information including height, weight, skin tone and hair color, and measurements such as bust, hip, and thigh. Easy-to-use instructions are clearly provided and the entire process takes just minutes to com-

Continued on Page 78

Advertiser INDEX

Your company could be listed here, too. Call us *today* for advertising information. 909-371-8497

IDENTIFY THOSE NOISE LEAKS

By Gordon West

Your first job in eliminating noise and interference to your electronic equipment is to identify where the noise is coming from.

The two-way radio spectrum begins around 3 kHz, and extends all the way up to 300 GHz. Three-hundred GHz is the same as 300,000 MHz, and the top end of the radio spectrum is affectionately known as *microwave*.

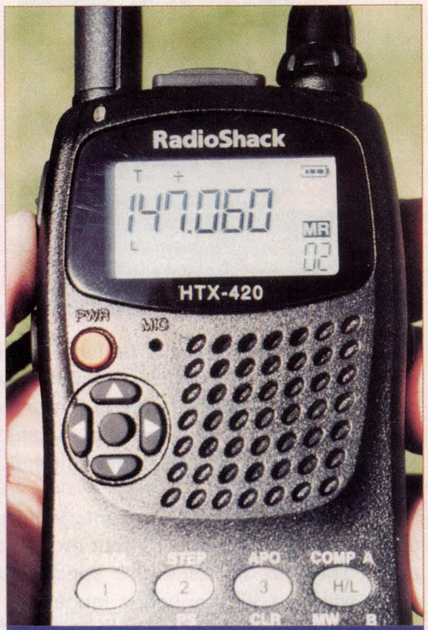
At the bottom of the radio spectrum, *static* is most prevalent from the atmosphere, and there is not much that we can do to minimize this type of electromagnetic interference. Lightning associated with thunderstorms may be picked up 1,000 miles away with a good low-frequency or medium-frequency receiver.

On medium frequency and high frequency, static as well as electrical interference are the big noisemakers. Home appliances like flourescent lights, fans, air conditioner motors, Mixmasters, and the common residential 240 VAC backyard power lines topped with multi-kilovolt bare high-voltage conductors are all potential electrical noise generators!

Up on VHF where frequency modulation helps reduce the effects of amplitude modulated noise interference, birdies are a nuisance. A birdie is a small signal that leaks out of microprocessor circuits found in almost anything electronic at your house. You wouldn't expect a coffee maker to hang a dead carrier on 156.8 MHz, the marine distress channel, would you? But what about your fax machine that also doubles as an inkjet printer, putting out enough signal at 406.025 MHz that could interfere with satellite-based search and rescue operations? Cordless phone machines, auto-dialers, computers, scanners, and even the little pest repellant oscillators might easily lock up a communications receiver 50 feet away.

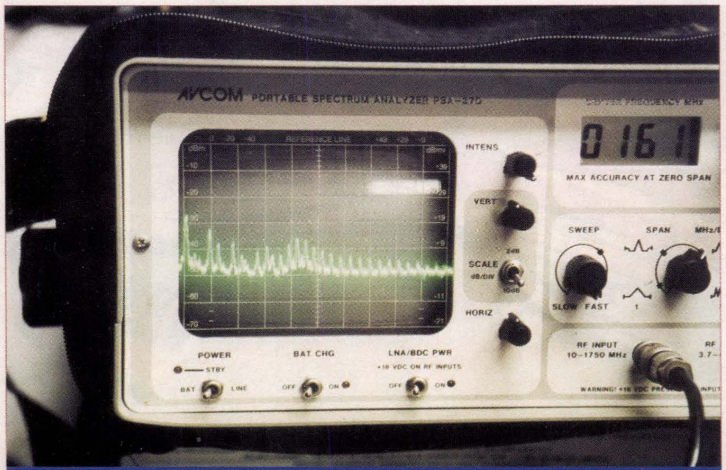
As we get into UHF and SHF frequencies, unintentional radiators might include your microwave oven, microwave burglar alarm, a turned-on cell phone, and that brand new radar detector you just installed in the dash of your sports car.

So throughout the spectrum, the chance of getting your wireless link or communications interrupted with an offending signal must be considered when you set up your new system, and it just doesn't seem to work like it should. Whether it's a wireless LAN, or the new long-range cordless telephones, or a radar detector or CB radio or ham set, there is plenty around you to disturb their normal operation. And even "jamproof" radio receivers like the spread-spectrum Global Positioning System may not be immune from interference. Ask any boater who transmits on marine VHF channel 77, and immediately the Global Positioning System receiver instantly loses satellite signals, due to the tenth harmonic of the 156 MHz signal completely blanking out spread-spectrum reception. And imagine bus drivers that get into downtown cities and find their GPS medium-frequency differential beacon reception konks out every time they parallel a set of power lines. And just last week, a buddy of mine out on the desert was showing me his 2.4 GHz wireless Internet system to a distant mountain-top relay station, and we were instantly off the air when his next door neighbor turned on his home alarm system before leaving for the office.

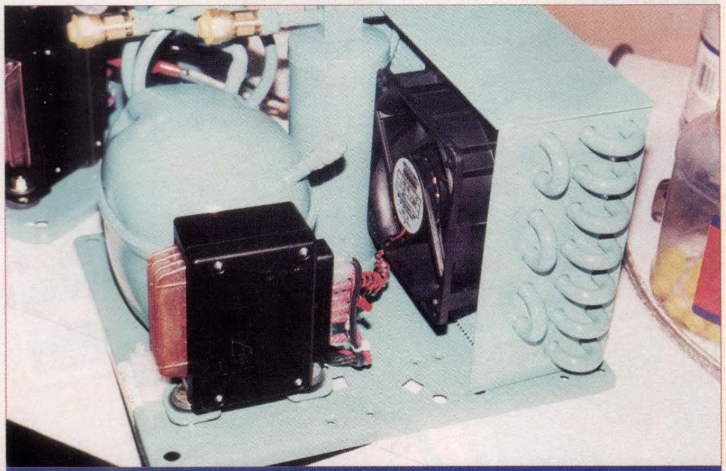


A simple dual band handheld ham radio can also tune into noise "birdies."

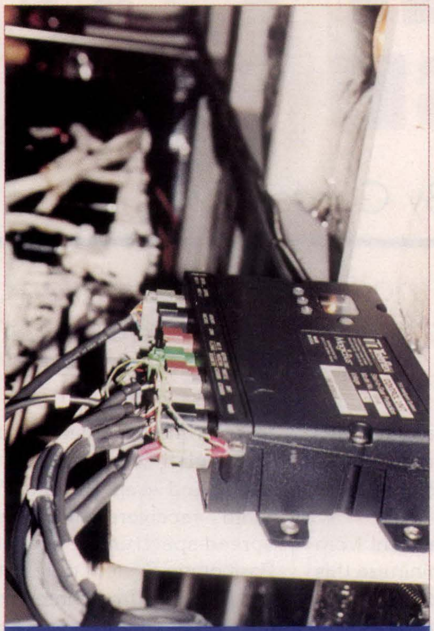
The Federal Communications Commission (FCC) has a specific part in the Code of Federal Regulations, Volume 47, Part 15, which fully describes limits of unintentional radiation that may come off of a product in your home, office, or vehicle. There are also laws about "intentional radiators," such as your garage door opener or that keyless entry



Noise pulses from the refrigeration controller.


The broadband noise was traced to the Danfoss black plastic refrigeration controller.

The AOR "noise sniffer" in action showing noise indications on the LCD display.


Noise from this RV on-board computer system radiated throughout the entire coach.

automobile alarm system. The Part 15 rules will take you weeks, if not months, to read and understand, but nonetheless, get on the FCC web page and take a browse to see how many microvolts per meter at a specific distance your new gizmo can radiate without violating Part 15 rules and without causing interference to other devices picking up your unintentional emission.

Generally, the amount of interference coming off of an "unintentional radiator" should just about drop into the noise level 15 to 30 feet away. The Part 15 rules give specific distances and measurements, along with specific frequency ranges, so go by the Part 15 law when dealing with any device that seems to be causing interference to other electronic devices, like a radio receiver system.

Up on VHF and UHF, the greatest interference comes from "birdies" which are relatively stronger emissions on specific VHF/UHF/SHF frequencies or channels, not necessarily blanking out the entire radio dial. For instance, the next door neighbor added a new flight simulator airplane yoke assembly to his kid's computer, and every time they had the system turned on, it gave me a major spike on a specific ham radio frequency, 145.800, which I continuously monitor for the International Space Station. The signal is coming from an upstairs bedroom five houses away! Luckily, I was able to convince the neighbor down the street that this type of signal leaking out onto the airwaves couldn't be all that healthy for their kids, and they let me put several RF chokes on the leads and the problem all but went away.

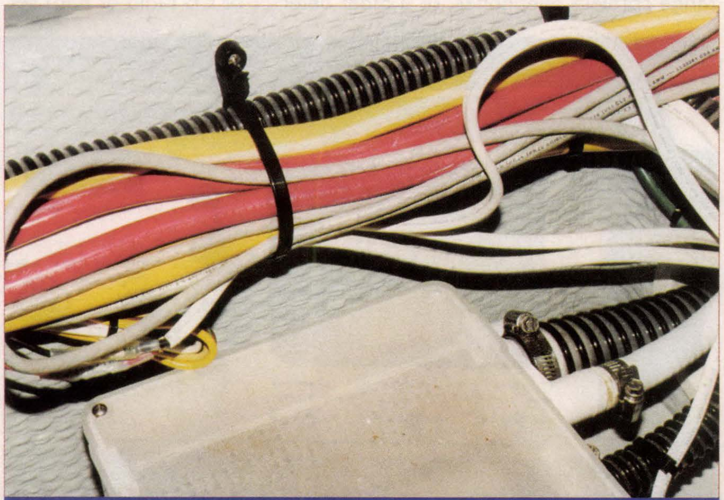
But what about wireless computer or robot links where you don't actually listen to a receiver to detect a clean signal or interference? It takes a not-so-expensive radio receiver capable of scanning frequencies up to 2.4 GHz (2,400 MHz) to detect errant signals coming in on your particular device's frequency. For VHF and UHF "birdie tracking," I use the handheld AOR AR-8200 receiver along with the AR-3000 professional monitor that covers 100 kHz through 2,036 MHz, plus Optoelectronics scanners and noise "sniffers." AOR has a new receiver, the AR-8600 with a versatile band scope display with save-trace memory, too. ICOM America offers the PCR-100-12 computer communications receiver, covering up to 1,300 MHz, and Win Radio has probably the ultimate in computer spectrum analyzers with 2D and 3D waterfall displays. This equipment is offered by Grove Enterprises (www.grove-ent.com), www.universalradio.com, and other radio dealers who specialize in scanning receivers and spectrum analyzers that indeed tune up beyond 2,000 MHz.

For an analysis of the hottest microwave receivers/analyzers, email: **www.fred@dxing.com** with Universal Radio. He is the guru on microwave tracing devices.

You can also use a common ham handheld transceiver capable of VHF/UHF reception, too. Most recently I finished my very positive review of the new RadioShack HTX-420 two-band handheld, and it has a red-hot receiver that offers wide-band reception in the VHF and UHF spectrum. The idea is to lock onto the frequency of interference, and then walk all over the house or all over the neighborhood until the interference gets stronger. You determine the direction of the incoming "birdie" by letting your body shield the signal coming in from behind you. You may look strange standing in the middle of the street and spinning around with your little handheld, but nonetheless you can usually end up on the front door of the neighbor or your own house where the interference is coming from.

Next, substitute the little rubber duck antenna for a paper clip, and get closer to the interference. The new RadioShack handheld has all-aluminum construction so everything within the receiver is shielded. When you get right next to the can opener or fax machine that is likely radiating the noise, pull out the paper clip and see whether or not holding the radio next to the possible noise source elicits some weak reception. If it does, you're right on top of the device creating the interference. Unplug it from the wall and listen to the interference go away. You have now found your culprit. Shielding, RF chokes, and wrapping up any


Noise from the refrigeration controller wiped out this super yacht's long-range radio reception.


Bundled wires can share coupled noise pulses.

excess power cord may help. For one neighbor down the street, I bought them a new cordless phone just to cancel the steady dead carrier on one of my popular VHF marine band channels.

Down on high frequency, noise interference tends to spread out and clobber reception on many bands and many frequencies. Some noise sources are easy to figure out — the "sweeper" associated with flourescent light fixtures, or the incessant broad-band buzz associated with touch lamps. Some broad-band, high-frequency noises come and go with the time of day, more likely fish tank heaters, electric blankets, alarm systems next door, or the really bizarre mobile home that seems to wipe out shortwave reception up to a block away.

What, a mobile home creating broad-band noise? Not the actual mobile home itself, but the aftermarket Danfoss refrigeration system that was installed to keep that new freezing compartment icy cold. The Danfoss controller uses a plastic enclosure as its only surroundings, and of course, the computer-generated phantom signals every 100 kHz freely pass through the plastic, couple onto the wiring, and radiate for up to 300 feet away. Aboard boats down at the local marina, the Danfoss controller is driving everyone from yacht owners to the United States Coast Guard crazy because it completely disrupts medium-frequency radio reception of the all important differential beacon system intended to add correction signals to an onboard Global Positioning System receiver.

When viewed on a spectrum analyzer, the RF signals coming out of the Danfoss controller peak around 10 MHz, and completely fill the band from 2 MHz to 30 MHz and sometimes higher. Special LC filters onto many of the important leads coming into and out of the control's black plastic box didn't help much, but some simple copper screen over the entire control box and grounded to the metal heatsink fins dropped the spurious radiation to nearly zero.

The Danfoss controller was by far the most mysterious sound we have heard in a long time on high frequency. Its patented sampling network of system status gives off a sound almost identical to the short and long signals of Morse Code. Everyone at the RV park and marina was blaming the ham radio operator who didn't even own a radiotelegraph key! But there was no mistaking the dots and dashes heard from 5 MHz to 25 MHz throughout the radio dial! It had to be a ham. But it wasn't — it was the Danfoss controller sending Morse-Code-sounding signals all over the trailer park and down at your local marina.

As we get below 10 MHz, the biggest sources of noise pollution are power lines and atmospherics. Atmospherics we must live with — there is absolutely nothing that will magically take away lightning strikes or the incessant buzz of the ionosphere during a peak in solar-generated charged particles. These are days that oldtimers called "radio blackout" periods, and the best bet for licensed hams is to simply choose a higher band above 10 MHz.

But for power line noise, there are some things that you can do to help mitigate the problem. If you can actually hear the upper-wire insulators frying on a damp evening, you can contact the power line company and give them the pole number — and within a few weeks, they may come out and either replace the insulators or hose them down with a special water solution that is non-conductive.

Never attempt to hose down insulators with regular water — you could be electrocuted.

If the power line noise is constant, dry, or damp, you might try the MFJ-1026 power line noise canceller (**www.mfjenterprises.com**). This little device plugs between your main external antenna and your receiver, with a secondary antenna that has a pre-amp to pick up the same noise, and put them 180 degrees out of phase, hopefully cancelling the undesirable noise from your main antenna coax. It's unbelievable how well this works on certain types of power line interference — and if your main antenna is a rotatable Yagi or loop, rotate your antenna slightly so as to null out the offending power line noise. One of my ham buddies in Florida made up his own multi-band, high-frequency, cubicle-quad antenna, and he can turn it ever so slightly and watch from the local power lines drop to near zero.

But your first job in eliminating noise and interference to your electronic receiver is to identify where the noise is originally coming from. Except for power line and atmospheric noise down on high frequency, most VHF, UHF, SHF, and microwave interference is from something within your own radio or experimental room, or maybe the next building or house away. If you're into radio control of robots or models, and you lose contact over a relatively short distance, there's a good chance you are operating in an area with a strong signal smack dab on your control frequency. But unless you can actually scan this frequency, you might not know that there is some interference right on your frequency. Identify that interference, and deal with it! Shielding, grounding, RF chokes, ferrite beads, and wrapping all those extraneous cables in aluminum foil will many times solve the problem. But to solve the problem, you need to actually listen to the improvements you are working on with a companion radio receiver.

Good success in solving RF interference! **NV**

Houston, we have a ... PIC Project?

By Bill Ruehl

Going NASA-style with a model rocket launcher controller.

Whenever my kids come home with a science project from school, I tend to get a little excited. I love science fairs and any opportunity that a kid might have to reach far beyond the textbook and manipulate real science is a worthy interest in my book.

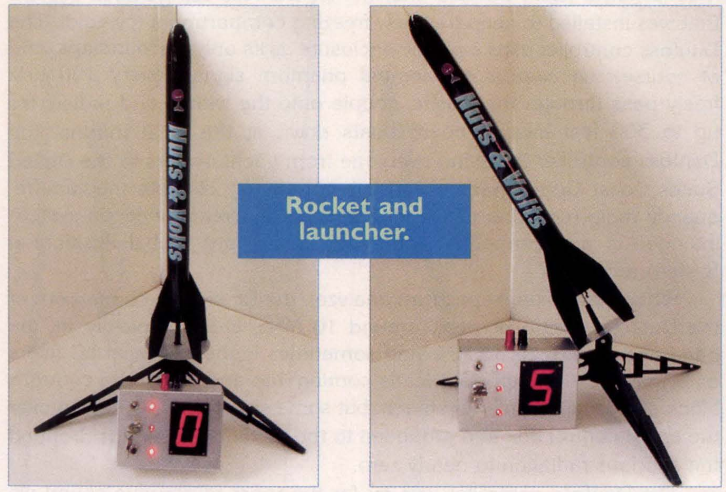
My daughter was looking for a project involving model rockets so off to the hobby store we went. After letting the hobby storeowner abuse my Visa card for a while, we left with a rocket kit, a launch kit, some rocket motors, and some safety tips.

While she was building her sleek new ship, I took a look at our new launch pad and launch controller. The launch pad was neat enough, it folded away quickly into our field box and looked robust enough for our purposes. The launch controller, on the other hand, seemed a little cheesy. You slap in some AA batteries, hook the unit up to the wire filament igniter (placed in the outlet nozzle of the motor), slide the safety "key" (a simple metal rod) into a hole, and provide your own count down. I wanted something that looked a little more "NASA" than that, so into the junk box I went.

Designing something for outdoor use on nice sunny days takes some special consideration regarding viewability. LCDs are great outside during bright conditions, but there wasn't anything available in my price range (cheap!) for the size I wanted. Really big numerals were what I wanted, just like the real countdown clocks at NASA.

I found the answer in the Digi-Key catalog with their (part #67-1493-ND) display from Lumex. Standing a full 2.25" tall, these displays really look impressive. Now, being an LED, you might think they'd be difficult to see under bright conditions, but this unit uses numerous high brightness/efficiency LEDs to make up each element making visibility easy. I used a piece of smoked acrylic plastic over the display and it has worked out very well. The power and launch status LEDs are of the high brightness/efficiency type, as well, putting out 2000mcd each. All this means is you can see the thing in the midday sun.

Function of the device is simple. When power is supplied via the large toggle, it feeds the high side of the display and rocket launch leads directly. The PIC power is provided by a standard issue 7805 on the meLabs 16F84 Protoboard. All the circuits are fed from the same RadioShack 9.6V Radio Control Car pack. This is my preferred method of providing power. Since most of my projects share a common battery pack, I can keep them all running for long periods by sharing packs between them. The PIC runs a simple program written in PBASIC that could, with a little work, be ported to the BASIC Stamp 2. The high current I/O is all handled by two quad Darlington transistor ICs (ULN2065).

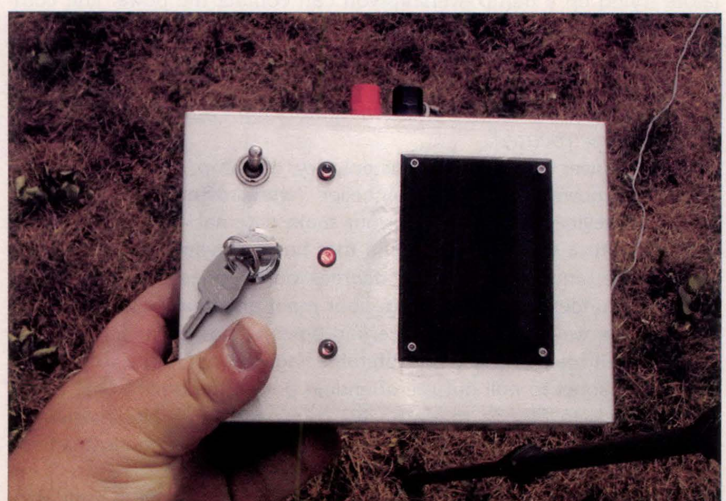


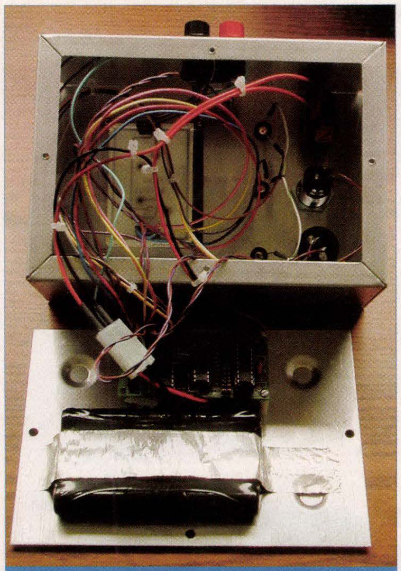
Rocket and launcher.

Each gate is good for 1.5 amps with proper heat-sinking making them ideal for our needs. Many manufacturers have dropped this chip in the past few years, but Mouser still has the ST electronics unit listed. Aside from a handful of capacitors and resistors, that's largely all there is. Each of the first seven Darlington transistors sink current for the display acting as a driver.

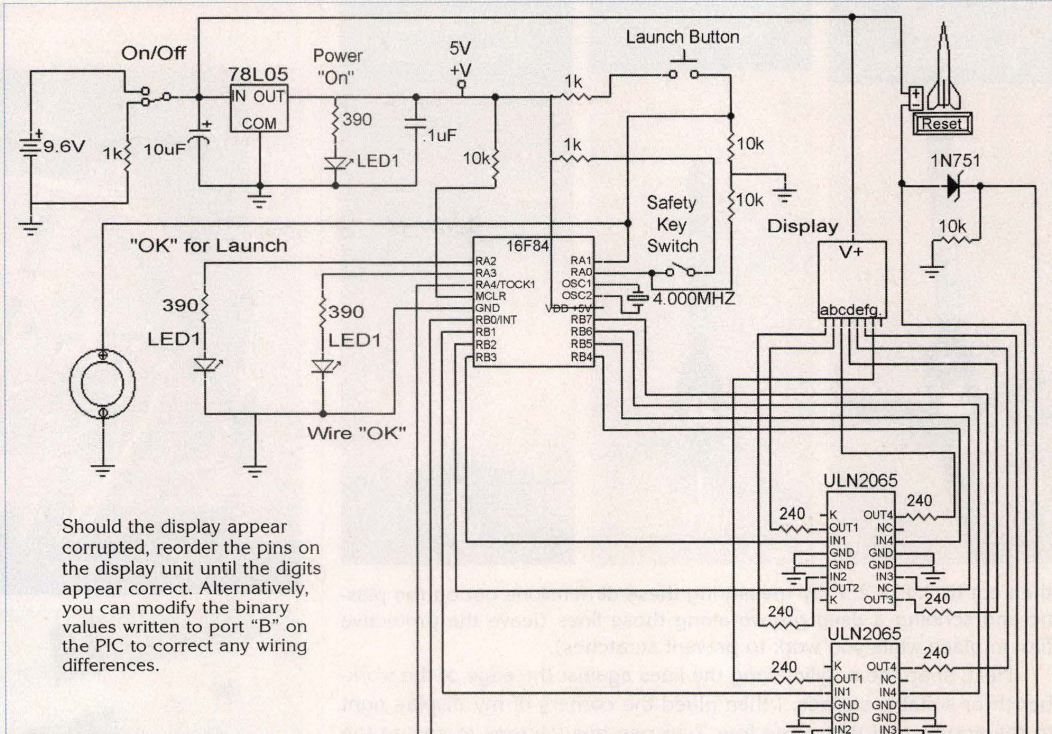
Since I was not using the decimal display pin, I elected to use the eighth transistor pin for the rocket ignition. I did run out of I/O lines so I had one of them do double duty. The launch button (input) and piezo


Igniter connection.


Finger poised on the button.



Unit opened.



Should the display appear corrupted, reorder the pins on the display unit until the digits appear correct. Alternatively, you can modify the binary values written to port "B" on the PIC to correct any wiring differences.

Schematic.

speaker (output) share I/O line RA1 that also gives me the "feature" of audio confirmation of the launch button press. All eight bits of port "B" are used to drive the display and send the rocket on its way. The remaining port "A" pins are used to read user input, drive status LEDs, and check the wiring connections prior to launch.

The "wire check" feature uses a zener diode to clamp the voltage at 5.1V on the low side of the igniter circuit, thus only going high when the leads are properly attached to the rocket igniter. It should be noted that this will only detect an open in the wiring and is not meant to check for unintended shorts.

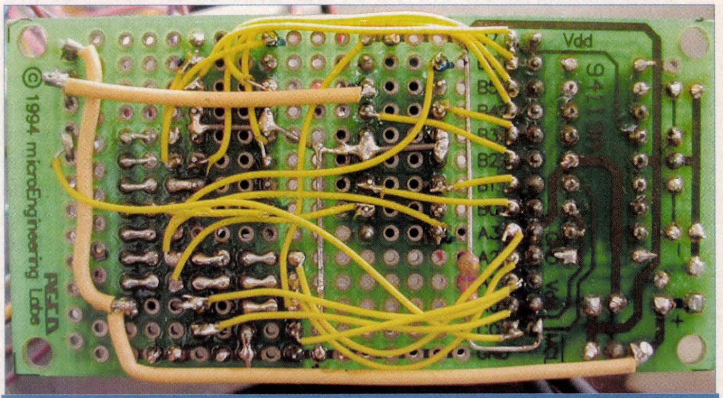
The launch sequence goes like this. Switch on the power; if the key switch is in the launch position, an error is flashed on the big display indicating that the switch needs to be returned to the "safe" position. When this is done, the system waits for the "wire check" (indicated by the middle status LED flashing quickly) to go high, thus allowing the program to proceed to key switch confirmation mode where the LED remains on continuously and the last LED called "Launch Armed" is lit. At this point, the display rapidly flashes a zero and the count down is initiated by pressing the red launch button. After the drama of the countdown plays out, the ignition circuit is shorted to ground and the rocket bursts skyward followed by some animation on the display that no one ever sees because they are too busy looking at the rocket high overhead.

Recovery.

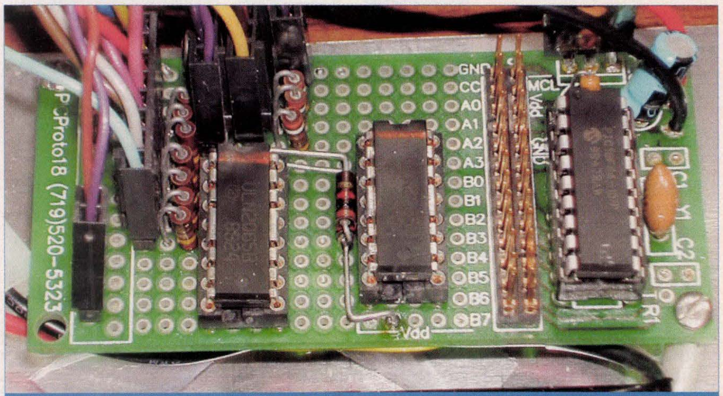
I built mine in an ordinary aluminum Bud box (7" x 5" x 3"). You can use the one listed or another suitable unit. The interconnects on the back side of the PIC protoboard were done with wire-wrap wire soldered point-to-point to link to the I/O lines. Note the large yellow wire on the underside of the same board, which is used to route the 9.6V power to the high side of the display and to the ignition circuit.

The piezo element was bonded with epoxy to the inside of the case with its hole lined up with a .062" hole in the side.

The smoked acrylic can be purchased in small quantities (12" x 12") from McMaster Carr as part number (8505K214) for less than $4.00 (not including shipping). The square hole can be nibbled out of the face of your project box by placing the display against the outside of the box where you want it and marking the perimeter with either a scriber or a pencil. The acrylic is



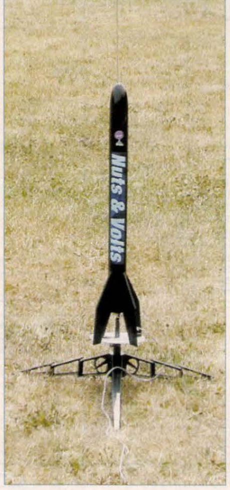
Back side of board.



Board close-up.

Launch preparation.

Prelaunch.

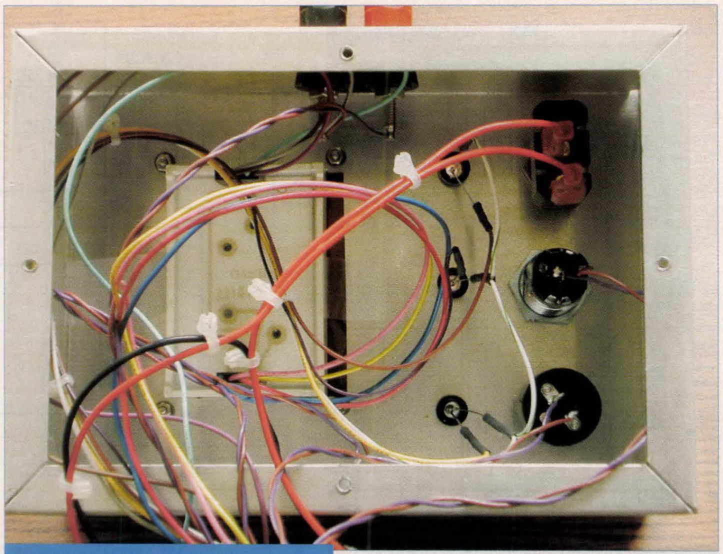


Split second after launch.

then cut to 3.4" x 2.5" by measuring these dimensions out on the plastic and scribing a deep groove along those lines (leave the protective film in place while you work to prevent scratches).

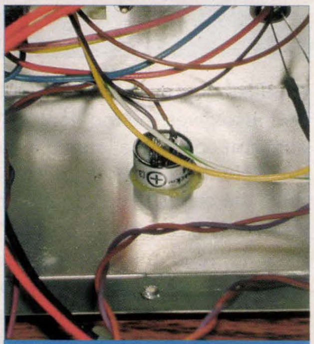
Next, snap the acrylic along the lines against the edge of the workbench or suitable surface. I then glued the corners of my display right to the acrylic and then used four 2-56 pan head screws to secure the acrylic to the face of the box, allowing the display to stick through the square hole. I secured the battery to the inside of the enclosure with heavy tape but Velcro or a nylon tie will work too. I used my launcher for about a year before I needed to recharge the battery, so easy access to the pack is not paramount, hence the tape. I used sockets for all the DIPs and have found this practice very helpful when things don't go as planned. Don't forget to put the pull-up resistor on the MCLR pin of the PIC or you'll go nuts trying to figure out why your project is flaky.

Programming of the PIC 16F84 was done on an Epic plus programmer with PBASIC Pro spinning the code into machine language. I realize that these are not household tools, so for a six-month period, I will sell pre-programmed 16F84s to those that desire a plug-and-play solution for a reasonable fee (see sources sidebar for details). I will also post the code on the *Nuts & Volts* ftp site as hex and assembly files, so you can load it onto your own PIC provided you have the means and the know how. I wholly endorse the products from meLabs and recommend you give them consideration if you are looking for PIC tools. They have served me well both professionally and on my own personal projects. I do not have any fiscal relationship with them, I just really like their products. **NV**



Inside box view.

Launcher.



Piezo speaker mounting.

Qty.	Part Number	Description	Source
1	67-1493-ND	Display	Digi-Key
1	PIC16F84-04/P-ND	PIC 16F84	Digi-Key
1	X902-ND	Resonator ceramic 4.00MHz w/cap	Digi-Key
3	P408-ND	LED red clear high brightness	Digi-Key
1	360-1206-ND	Switch toggle SPST 15A	Digi-Key
1	CKC8010-ND	Switch SPST keylock 4A	Digi-Key
1	EG2035-ND	Switch PB SPST mom 3A red	Digi-Key
1	377-1083-ND	Box alum 7 x 5 x 3 gray	Digi-Key
4	1902CK-ND	.500/4-40 nylon hex thread	Digi-Key
2	J164-ND	Post binding banana insulated red	Digi-Key
7		180 Ohm 1/4 watt resistor	
3		390 Ohm 1/4 watt resistor	
4		1K Ohm 1/4 watt resistor	
4		4.7K Ohm 1/4 watt resistor	
2	511-ULN2065B	Quad Darlington Array	Mouser
*1	ROCKETPIC	Preprogrammed 16F84	Mt. Design

Sources

Mouser Electronics, Inc.
1000 North Main Street
Mansfield, TX 76063
Voice: **(800) 346-6873**
Fax: **(817) 804-3899**
Email: **sales@mouser.com**
Web: **www.mouser.com**

McMaster-Carr
473 Ridge Rd.
Dayton, NJ 08810-0317
Voice: **(732) 329-3200**
Fax: **(732) 329-3772**
Email: **nj.sales@mcmaster.com**
Web: **www.mcmaster.com**

Digi-Key Corporation
701 Brooks Avenue South
Thief River Falls, MN 56701
Voice: **(800) 344-4539**
Fax: **(218) 681-3380**
Email: **sales@digikey.com**
Web: **www.digikey.com**

Mountain Design & Tool, Inc.
225 Burma Rd.
Mountain Top, PA 18707
Email for PayPal purchases and inquiries:
wruehl@hotmail.com
RocketPIC's are $15.95 each (shipping included)
US & Canadian orders only.
Snail Mail (postal money order) and Email (PayPal) orders only.

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Colorado Springs, CO 80960
Voice: **(719) 520-5323**
Fax: **(719) 520-1867**
Web: **www.melabs.com**
Email: **support@melabs.com**

TECH FORUM

QUESTIONS

I've purchased a USB external enclosure for my old EIDE hard drive (Western Digital Caviar) 10 GB and although the driver (OnSpec USB Device) has been installed correctly, and "quick formatted" the hard drive, I'm NOT getting a drive letter under "my computer" (O/S WIN 98 Sec. Ed.) and, therefore can't access it.

I've been told, rather than 'quick formatting it,' to completely and unconditionally format the old hard drive inside the PC, but that could take 78 days continuously (will the formatting take place faster in the SAFE MODE?). Also, what jumper settings (slave, master, single) should I use when HDD is placed in the external enclosure?

Any ideas on how to access this external hard drive?

#10021 **Dan Zillbermann via Internet**

I have two Sony Watchman TVs (model no. FD-10A and FD-2A). I would like to use one of them for a self-contained portable monitor. Is there someplace on the circuit board I can run a video signal from a miniature video camera without using an external modulator?

#10022 **Raymond Capton rcapton@netzero.net**

I am looking for a circuit for a radio-controlled model boat, electronic speed control with reverse capability that will operate in the range of 6-18 volts DC at 20 amps max. I would like to avoid the use of relays.

I also need another circuit that can use one of the proportional channels on the R/C transmitter tied into a separate eight-button keypad that will output distinct signals to control eight different on/off functions on the boat for momentary/latched operation.

#10023 **Marvin A. Harten Los Angeles, CA**

I have an old Sadelco TV signal strength meter with UHF freq coverage. Is there any way to adapt it — internally or externally — to provide level readings for Digital TV signals?

#10024 **David Schoepf via Internet**

I'm planning a fiber optic link to send a small quantity of data (two pressures and one temperature) between two PIC CPUs.

The cable is Optical Cable Corp. DX02-045D-W series, 62.5/125um. Length is less than 250 feet. The cable has two fibers, I would prefer duplex over one fiber, using the second as backup/fault detection.

I'm having problems locating connectors and transceivers. I would prefer board mount tranceivers with TTL in/out to PIC. Connectors should be easy to install and at low cost.

#10025 **Carl Denk via Internet**

I want to build an AC power-line surge and spike detector that will monitor the AC power line and provide a latching output via LED that a spike or surge has occurred, resettable via push-button switch. A circuit with a peak level indicator via a series of LEDs would be even better. Is there a circuit that can do this?

#10026 **Ben Hall Huntsville, AL**

I need a conversion formula to convert amps to horsepower.

#10027 **Anonymous via Internet**

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.

ANSWERS

[9021 - SEP. 2002]

I'm looking for a source for a "soft-start" controller for a 3 hp, three-phase, 240-volt water well pump motor.

I have a 3 hp submersible water well pump hanging on 120 feet of plastic pipe. When it starts, it puts a high torque on the plastic pipe.

#1 Sometimes the best answer is a simple one, forget the soft-start controller. I know this is not the super electronic way of doing things, but in the long run, it will be cheaper.

You need to go to an oil field supply house and pick up some "WOG" hose (water, oil, and gas) and have brass or stainless fittings swaged on, or if you are handy, you can get reusable fittings which really are easy to put on.

If your well is extremely deep, you can go to a wire reinforced hose and you can get one that will be strong enough to handle practically anything and the fittings are the same deal as with the WOG hose.

The great thing about it is, if you have to pull your pump, just pull it and coil up the hose as it comes out of the well, you do not have connections to deal with and it is lighter than pipe. Also, lightning will not blow out expensive soft-start equipment.

My experience with direct drive

pumps (air compressors, too) is that they are usually sized marginally and need the starting torque to get started.

RR Thomas
via Internet

#2 I checked the Internet and found the following sources:

SM Service & Technology, 930 Stuyvesant Avenue, Union, NJ 07083. 908-687-1880. info@smservice.com. **http://smservice.com/**.

They have a device called The Power Commander, which has Soft Start.

Over time, full voltage hard starts can damage motors, as well as equipment. Soft starts prevent unnecessary high starting current by reducing the peak current by as much as 50%. A controlled soft start in the Power Commander limits the inrush of current, prevents unnecessary excess torque, and reduces power line disturbances. The soft-start circuit in the Power Commander senses the motor load and the power to the motor. It then applies only the exact power required to start the motor without reducing the necessary starting torque or RPM. Actual kW demand is reduced and the power factor is improved. Every start is smooth, stepless, and adjustable to the operator's needs.

These other sites sell a wide variety of soft-start controllers:

Galco Industrial Electronics, 26010 Pinehurst, Madison Heights, MI 48071. sales@galco.com, **www.galco.com**, (800) 521-1615.

Linco Power Ltd., 3930 Chesswood Drive, Toronto, ON M3J 2W6 Canada. (416) 630-0658. linco@lincopower.com, **www.lincopower.com/Solcon/solcon.htm**.

Wesley K. Miller
Camp Hill, PA

#3 Most manufacturers of industrial motor control centers (motor starters) such as GE, Square D, Crouse Hinds, and Westinghouse also make soft starters.

The best approach is one with an adjustable current limit to allow you to bring the motor up to speed with the least mechanical stress. Currently, you are starting an induction motor full voltage across the lines, which draws about 500-800% of FLA (full load amps) during start. This translates into severe mechanical stresses just before the motor reaches full speed of up to approximately 250-300% of nominal torque. There are several factors in this equation, such as motor NEMA design, line gauge voltage, line, and length, which can change the numbers up or down.

Walter Heissenberger
Hancock, NH

#4 A three-phase VFD (Variable Frequency Drive) has helped us out in the past. We had to pull in four high-torque motors at the same time and not dip the power source. We used an inexpensive VFD from AC Tech.

The ramp-up voltage was programmed so the motor started out at slow rotation and ramped up to operating speed. It was about a 1.5 second process, but the starting amps went down considerably. You may want to check **www.automationdirect.com**. They have about the most inexpensive PLC and VF Drive components on the market.

Luke J. Barker, EE
Reinke Mfg. Co., Inc.
Deshler, NE

[9026 - SEP. 2002]

I am looking for a way to use my DSL connection on four floors. I have an access point on the third floor and am able to connect okay on the second floor, but no signal in the basement. Would a high-gain antenna help?

Your best bet is to get an external DSL modem from your DSL provider and feed its output into a multiport network router/concentrator. You'll have to install NIC cards in all of your PCs and run CAT5 twisted-pair cabling from each PC to the router/concentrator. This way, the external modem is your "server" and gateway to the DSL service. Windows should detect the installed NIC cards and install the required drivers from the modem install CD. If "done correctly," you should have "plenty of signal" to all four machines — any installation, etc., problems can be handled by your DSL provider.

Ken Simmons
Auburn, WA

[9027 - SEP. 2002]

To get older PCs running, it's sometimes necessary to boot up with a DOS floppy, but the hard drive C: disappears!

What installs the hard drive in DOS?

I'm assuming you're dealing with "AT-class" machines (80286 minimum processor). It looks like the back-up battery for the CMOS configuration memory has died. These batteries were typically small 3.6V NiCad packs located near the 24-pin clock/CMOS chip on the main motherboard. Newer boards use 3 VDC Lithium "coin" cells. Near these packs is a two or four-pin header which you can attach an external battery pack (i.e., 4xAA-size Alkalines) instead. However, you still have to periodically replace these batteries.

There were no "drivers" for the hard drives — you selected the "drive type" from a table of parameters in the BIOS setup (number of heads, number of cylinders, landing zone, etc.) and entered that info into the CMOS via the BIOS set-up routines. Unfortunately, once the CMOS back-up battery dies, all the system information (drive types, clock, etc.) is lost, which is why it's a good idea to write down any/all BIOS configuration info and store it in a safe place.

NOTE: all AT-compatible hard drives have the "drive type" information on their labels. You can also get this information from the drive manufacturer, as long as you know the make and model (located on the drive's ID label). Once the "drive type, etc.," info is entered and stored into the CMOS memory, the system will access the drive (and boot if the drive is system formatted).

NOTE: You need MS-DOS 3.3 and later to properly handle the drives and their controllers, etc., and perform FDISK/FORMAT operations to make the drive usable.

Assuming the drive(s) that keep "disappearing" are already bootable and/or already formatted/readable by DOS, simply putting a fresh battery (or replacing the expired NiCad pack) onto the motherboard, running SETUP from the BIOS, re-entering/saving the "drive type" information to the CMOS, and rebooting the machine is all you need to get that "old iron" back up and running.

XT-class (8088 processor) machines used hard drive controller cards that "did all the work" in handling the drive's parameters (heads, cylinders, etc.) and were used with MS-DOS 3.2 and earlier. You didn't have to enter and CMOS data (XT-class machines didn't use it), but you had to access the hard drive controller BIOS via DEBUG to do the preliminary "low-level" formatting before you could run FDISK/FORMAT and access the drive (make it bootable, etc.). In this case, it's possible the drive got "clobbered" somehow and simply needs reformatting. If the drive has really "died," good luck in finding a replacement!

The book *Upgrading and Repairing PCs* will have all the info needed to get your hard drives "back on-line," regardless of the age of the drives and such. If the current edition (12th or 13th now?) doesn't have this antiquated" info, I'm sure you can find an earlier edition that does.

Ken Simmons
Auburn, WA

[9023 - SEP. 2002]

In a common emitter, BJT amplifier design (four resistors, RC, RE, and the two base resistors/voltage divider), what determines the computed IB static-bias current with respect to known input signal strength?

The first step in biasing a transistor is configuring the bias based on what you want the transistor to do. A switching transistor is biased quite differently than an audio amplifier. From the configuration that you are describing, I am guessing that you are configuring as an audio amplifier. It seems that you are wondering where to set I_B knowing that your input signal current is around 1mA.

First of all, the Q-point I_B that you mentioned (1mA) seems excessively high. Since the β of most amplifying transistors is 150 - 250, your expected collector current would be 150 to 250mA at the Q point, which is far too high for a basic small signal amplifying transistor.

Here is a basic step-by-step method to determine the Q point of a small signal amplifier (common emitter circuit) with your topology.

Since you mentioned that you desire a linear output voltage swing, pick a Q point I_C that will allow a bipolar swing without clipping the positive or negative half of an input sinewave prematurely. This I_C should naturally create a V_C of zero volts at the Q point, allowing maximum signal swing both positive and negative. I am assuming a bipolar power supply is available, typically ±15VDC.

See Figure 1 for the input swing vs. output swing relationship.

Note that the Q point selected allows for a symmetrical swing for the output signal. Another way to look at the Q point is to consider the extremes of transistor operation. Namely "cutoff" and "saturation." Cutoff is when the base current is sufficiently low to effectively turn the transistor off. When the transistor is off, then the collector to emitter voltage is at its maximum (V_{CE}=V_{CC}). The saturation point is the point at which adding more base current does not increase the collector current. The associated collector to emitter voltage for saturation is known as $V_{CE\text{-}SAT}$, and is around 300mV for many bipolar junction transistors. Figure 2 shows this relationship. Note that the Q point is selected so that it is midway between cutoff and saturation. The line between saturation and cutoff is known as the load line.

Now, to do a basic bias, lets pick a transistor, the ubiquitous 2N3904, NPN. It has a typical ß of 200. For simplicity, let's make some assumptions about this amplifier. First, the overall gain desired is 50, I_C is 1mA. Since we wanted the output signal to swing around 0V, then $R_C = V_C/I_C$ or R_C = 15V/1mA = 15KΩ.

Given that your topology was a common emitter with emitter degeneration resistor, then the approximate gain is $A_V = R_C/R_E$ or R_E = 15K/50 = 300Ω.

To determine the bias stick resistor values, work your way back from the emitter. V_{RE} = 300Ω*1mA = 300mV. V_{BE} is about 700mV, so the base voltage is 1V more positive than the negative rail, or at -14VDC in this case. Therefore, VR1 = 29V. Pick an R1 that creates a nominal current. A 100KΩ resistor here will create a current of 290µA. It then follows that R2 needs to drop the remaining 1VDC, so R2 = 1V / 290µA = 3.45KΩ.

I_B at the Q point is just IC/ß or 1mA/200 = 5µA. The complete circuit is shown in Figure 3.

Figure 4 is the same circuit diagram tested on the bench. Note that slight variations are due to resistance tolerances (R_2 was changed to 3.3K, closest match), individual transistor ß, and power supply tolerances. Nonetheless, the overall gain is within 10% of the calculated gain, a pretty good first approximation.

The input signal was a sinusoid of 200mV peak to peak, at 1,000 Hz. The output signal was measured with a scope at 9V peak to peak, no clipping. Just for fun, I increased the input signal and noticed that clipping occurred almost simultaneously on both the positive and negative half of the sinewave, an indication that the Q point was selected appropriately for this type of amplifier.

Hope this helped out.

Robert Most
via Internet

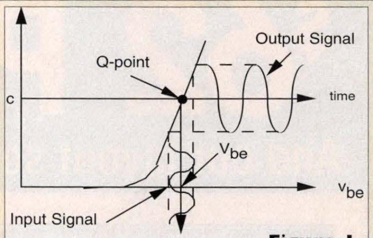


Figure 1

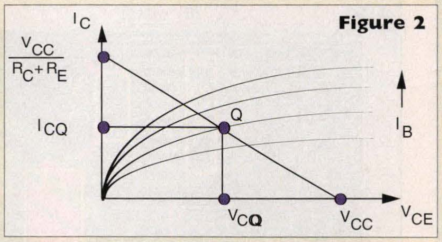


Figure 2

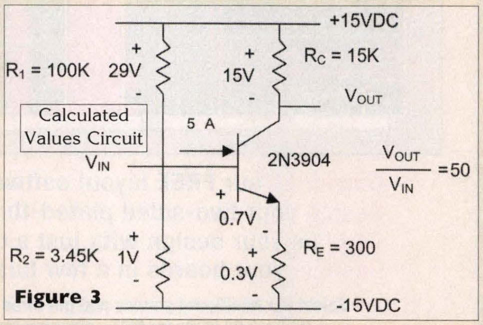


Figure 3

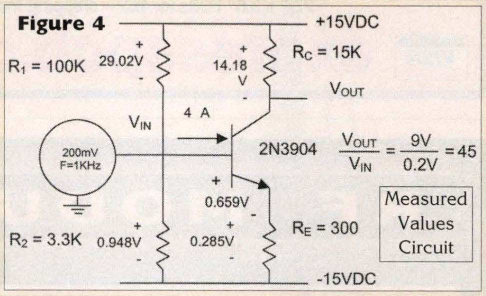
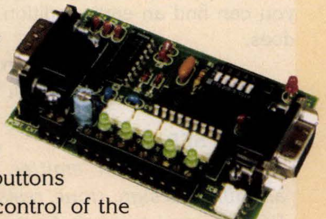


Figure 4

New Product News

SOLID-STATE RELAY MODULE



The WTSSR-M is a member of the new stackable RS-232 data modules available from Weeder Technologies. Five optically isolated solid-state relays can be wired directly in place of — or in parallel with — existing low-current push buttons and toggle switches to enable software control of the switch operation. Relay outputs can also be used to switch external solenoids, actuators, or high-current relays.

A relay can be instructed to open or close and remain at that new state, or switch back to the previous state after a user-defined delay period. Control each relay individually or update all five relays as a group.

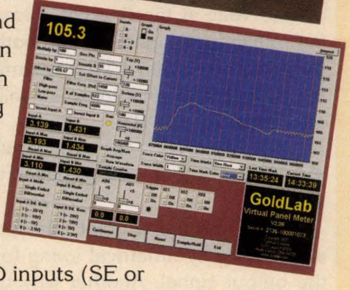
Built-in event sequencer allows user to load a series of relay on/off patterns and time delays which will execute sequentially.

All modules in this series can be plugged end-to-end on a common RS-232 cable attached to the serial port of a PC, laptop, or other host. An on-board 32-position DIP switch sets the address of each module, which is used for identifying data transmitted from it, as well as directing data transmitted by the host. The data bus supports full anti-collision discipline between connected modules and will allow up to 32 modules to share the same communications line. Power is supplied by an external 8 to 30 VDC source (not included) to the first module in the chain and is carried down the RS-232 cable to successive modules.

The WTSSR-M sells for $69.00. A data sheet is available in PDF format on the web site.

WEEDER TECHNOLOGIES
1710-B Brighton Cove
Ft. Walton Beach, FL 32547
850-863-5723
www.weedtech.com

GOLDLAB VIRTUAL PANEL METER (VPM)



ForMost Systems announces the availability of the first of a new breed of Virtual Instrumentation. The GoldLab Virtual Panel Meter (VPM). The VPM was created out of a need for a complete data acquisition and control system with all components in one package from one supplier, which can be installed and up and running in minutes. All at a price lower than the cost of a typical A/D board alone.

Highlights of the VPM capabilities are: Connects to the USB port — up and running in minutes; 12-bit A/D inputs (SE or DI) (±10V, 4096 scans/sec); variable gain amplifier (1, 2, 4, 8); adjustable analog outputs; settable digital outputs; digital triggering input; oscilloscope graph display with format controls; definable logic and math processing; continuous operation or snap and hold; min/max displays; adjustable time marks on graph; processed data display, and raw input displays.

The VPM is perfectly suited for prototyping, testing, demos, laboratory experiments, monitoring, and production.

The VPM package includes a hardware data acquisition device, which connects to the USB port; software on a CD; printed manual and PDF file of manual; USB cable; screw terminal connectors on the VPM for all connections; and complete installation instructions.

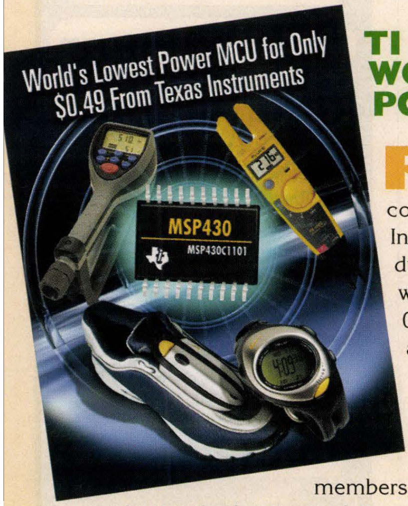
The VPM will run on PCs with Windows 98SE, ME, 2000, XP, or later, and a USB port.

The Virtual Panel Meter is $599.00 complete. There is currently a $100.00 introductory discount.

For more information, contact:

FORMOST SYSTEMS
5377 Lauby Rd., N.W., Dept. NV
North Canton, OH 44720
330-818-0100 Fax: **330-818-1119**
Email: **info@goldlab.com**
Web: **www.goldlab.com**

TI UNVEILS WORLD'S LOWEST POWER MCU



Providing customers power savings up to 10 times more than competitor devices, Texas Instruments (TI) (NYSE: TXN) introduces the world's lowest power MCU with power consumption as low as 0.7 micro-amps in standby mode and 1.3 micro-amps active.

The new MSP430C1101 is available for $0.49 in high-volume and is 100 percent compatible with all existing MSP430 family members. With the introduction of the new device, the family portfolio spans from the low-end $0.49 device to higher-end devices with up to 60kB of program memory, high-performance data converters, and an array of digital peripherals offering true system on chip (SoC) solutions for a wide range of low-power applications.

The new MSP430C1101 includes 1kB of ROM, 128 bytes of RAM, a watchdog timer, three-channel multi-function 16-bit pulse-width modulation (PWM) Timer_A, and an analog comparator that supports high-precision analog-to-digital conversion for cost-sensitive applications. Eliminating the need for software intensive polling commonly used with other low-cost MCUs, the MSP430C1101 like other high-end MSP430 derivatives, also offers vectored interrupt capability on every I/O pin and with every peripheral supporting sophisticated event-driven operation.

"The new MSP430C1101 provides our customers a significant cost-performance advantage," said Mark Buccini, Product Line Marketing Manager. "Despite the MSP430C1101's highly competitive $0.49 price and ultra-low-power, it really packs a punch in terms of performance. By using the 16-bit performance, we see our customers not having to make compromises and embedding features never thought possible from a low-cost MCU in applications ranging from electronic tags to running shoes."

For more information, contact:

TEXAS INSTRUMENTS, INC.
Semiconductor Group, SC-02214
Literature Response Center
P.O. Box 954
Santa Clara, CA 91380
1-800-477-8924, ext. 4500
Web: **www.ti.com**

GPS POSITION AND SENSOR DATALOGGING

TDS2020GDL GPS Datalogging System now features the new small Sapphire GPS module, making it easy to build a custom position datalogger to store location, as well as other sensor information onto compact flash cards for later review. Furthermore, a new software datalogger wizard provided allows non-programmers to easily configure the device to suit individual needs.

Equipment used in agriculture, security, transport, or seagoing vessels often needs to be monitored and correlated with position information.

Pressures, temperatures, rotation rates, doors open/closed, and other information can be collected by this module in Excel PC-compatible format.

Satellite-fed position information on latitude, longitude, date, and time from a GPS receiver can be stored for later importing into a PC spreadsheet program.

After the module has run for minutes or months on a small battery, PCMCIA, or compact flash datastorage cards can be removed for easy data transfer into a PC. Laptop PCs are often inappropriately used in these often remote logging applications, but the ruggedness, very low-power consumption, and low price of the TDS2020GDL GPS Datalogging System makes it a much more useful pocketable solution.

The Sapphire GPS receiver is housed in a small hemisphere with a strong magnetic base, and can easily be placed on a vehicle roof.

The TDS2020F computer beneath it can also turn off the GPS receiver if need be, to save power.

A keypad and graphics display can be added to the setup, so the module can become a complete portable instrument, not just a device to record measurements. Adding other ready-made software modules or custom software can make the system do control work at the same time as data collection.

Interactive design enables an engineer with little programming knowledge to tailor the module to his exact requirements. Supplied high-level Forth programs can be user-customized to meet a user's exact requirements. Data and GPS logging in .csv format is provided as a ready-made program, but sampling rate and sleep times can be changed, or add a keypad and graphics display so that the module becomes a complete portable instrument or controller and not just a device to record measurements. Two serial ports and optional CANbus interface give it real communications capability.

Available from stock, the TDS2020GDL GPS Datalogging Starter Pack is $835.00.

For more information, contact:

SAELIG COMPANY, INC.
1 Cabernet Circle, Dept. NV
Fairport, NY 14450
585-425-3753 Fax: **585-425-3835**
Email: **saelig@aol.com**
Web: **www.saelig.com**

News Bytes

Continued from Page 65

plete. Each profile is saved for unlimited repeat use and confidentiality is protected.

HSN.com represents the first deployment of My Virtual Model Inc.'s fourth generation of photo-realistic 3D bodies, faces and garments, called "E4." Using an intuitive interface, which features separate rows of tops and bottoms, 'mixing & matching' outfits is fast and easy. The 'Rotate' feature allows women to see what they look like from a 360-degree perspective and the 'Larger View' button provides a closer look at garment design details. For consumers, the online shopping experience has never been more efficient, or more fun.

"We feel this will be a great service to our current customers and will help attract new ones as well, "said Christy Clark, senior vice president and general manager of hsn.com.

"The hsn.com application represents the most sophisticated deployment of our technology to date," said Louise Guay, founder and executive vice president of My Virtual Model Inc.

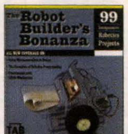
HSN is celebrating its 25th year as the company that originated the television shopping concept in 1977. The idea materialized on a small AM radio station in Florida and has since grown into a global multichannel retailer.

Selected Titles For The Electronic Hobbyist and Technician —

The *Nuts & Volts*

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***

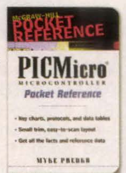
Programming & Customizing the HC11 Microcontroller
by Tom Fox

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***

PICmicro Microcontroller Pocket Reference
by Myke Predko

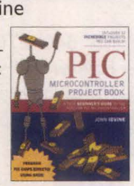


Designed to complement Programming & Customizing the PICMICRO, this book contains a minimum of verbiage and serves as an immediate device, code and circuit look-up for experienced PICMICRO applications designers. **$29.95**

Programming & Customizing the BASIC Stamp Computer
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



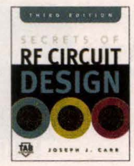
This project-oriented guide gives you 12 complete projects, including: using transistors to control DC and AC motors, DTMF phone number logger and distinct ring detector and router ... home automation using X-10 communications ... digital oscilloscope ... simulations of fuzzy logic and neural networks ... and many other applications. ***$29.95***

The Nuts & Volts of BASIC Stamps Vol. I & 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.

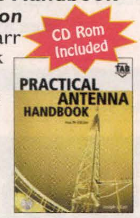
Radio & RF

Secrets of RF Circuit Design
3rd Edition
by Joe Carr



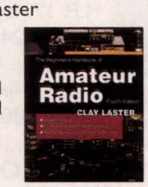
This revised and updated guide gives you the best ways to design, build, and test today's radio frequency circuits. It's filled with projects and experiments that make it easy to apply RF principles to real-life applications. ***$39.95***

Practical Antenna Handbook
4th Edition
by Joe Carr



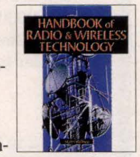
The most popular book on antennas ever written. This edition blends "the theoretical concepts that engineers and others need to design practical antennas, and the hard-learned practical lessons derived from actually building and using antennas." ***$49.95***

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***

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***

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***

Guide To Understanding Electricity & Electronics
by Randy Slone

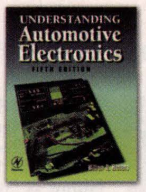
For the true beginner, there's no better introduction to electricity and electronics. You'll also find 25 complete projects that enhance your electricity/electronics mastery, including 15 new to this edition, and appendices packed with commonly used equations, symbols, and supply sources. ***$24.95***

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***

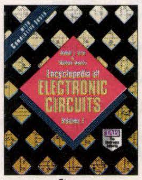
Hobbyist Bookstore

Understanding Automotive Electronics *Fifth Edition*
by William B. Ribbens



This edition of *Understanding Automotive Electronics* covers the most recent technological advances in operation and troubleshooting of electronic systems and components. This is a practical text, suitable for the automotive technician, student or enthusiast. It includes low-emission standards, on-board diagnostics and communications, digital instrumentation, and digital engine control.
$34.99

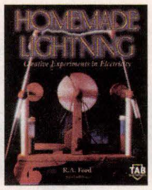
Encyclopedia of Electronic Circuits Vol. 7
by Rudy Graff



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***

High Voltage

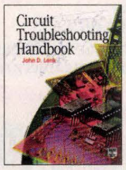
Homemade Lightning: Creative Experiments in Electricity
by R.A. Ford



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

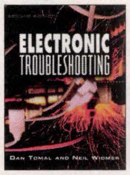
Troubleshooting

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

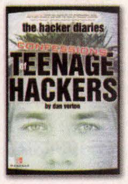
Electronic Troubleshooting *2nd Edition*
by Dan Tomal and Neil Widmer



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***

Miscellaneous

The Hacker Diaries: Confessions of Teenage Hackers
by Dan Verton



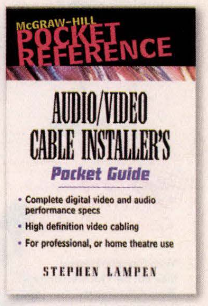
Through fascinating interviews with FBI agents, criminal psychologists, law-enforcement officials—as well as current and former hackers—you'll get a glimpse inside the mind of today's teenage hacker. Learn how they think and understand the internal and external pressures that pushed them deeper and deeper into the hacker underground. ***$24.99***

This Month's *NEW* Titles

Audio/Video Cable Installer's Pocket Guide

$29.95

by Stephen Lampen

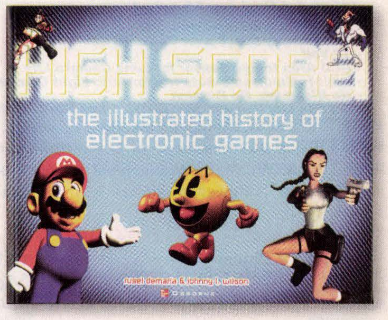


Put complete performance specifications for analog and digital audio and video installations — from professional recording studios to living room theatres — in the palm of your hand! Audio/Video Cable Installer's Pocket Guide packs over 200 illustrations that clarify all the methods, procedures, and tools you need to successfully tackle even the most complex installation job. Great for everyone from home enthusiasts to professional engineers and technicians, the convenient take-along size is as perfect for professionals working out in the field as it is for hobbyists tinkering in the basement. Author Stephen Lampen, an industry pro, anticipates and answers your every question on analog and digital audio, analog and digital video, including high definition video cabling; connectors; using Category 5, 5e, and 6 to carry audio and video; installation; and much more.

High Score! The Illustrated History of Electronic Games

$24.99

by Rusel Demaria & Johnny Wilson



From pinball to PlayStation, this photo-packed "coffee table" volume chronicles the history of electronic games — which has become both a billion dollar industry as well as a cultural phenomenon. Featuring hundreds of interviews with game creators and thousands of never-before-seen photos from the early days, this book honors the games that have captivated youngsters and the young-at-heart for more than 30 years — making this the ultimate tribute to electronic games.

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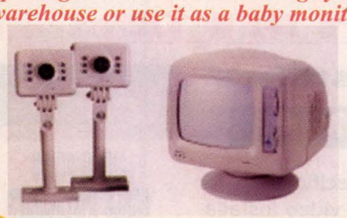

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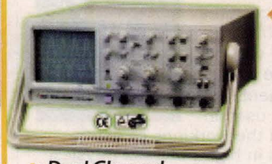

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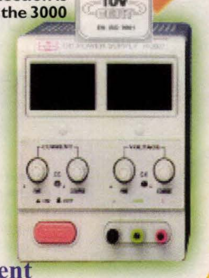

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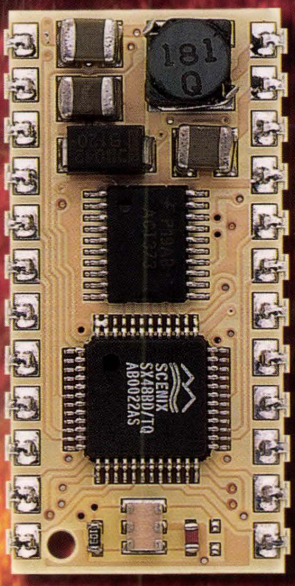

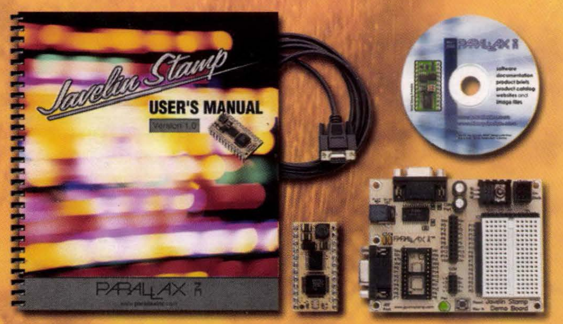

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