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Nuts & Volts

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

May 2002
Vol. 23 No.5

Enter The MSP430 Gadget-O-Rama!
Cash Prizes Totaling
$10,000

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ENTER THE MSP430 GADGET-O-RAMA!

PAGE 10

Cash Prizes totaling $10,000.00 will be awarded!!

Nuts & Volts

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Events, Advances, and News From the Electronics World by Jeff Eckert

TechKnowledgy 2002

Advanced Technologies

Implantable Heart Patient Survives First Six Months

The AbioCor Implantable Replacement Heart. Photo courtesy of ABIOMED, Inc.

Heart failure remains the world's foremost cause of death. In the USA, it kills more than 700,000 people annually. Engineers have tried for many years to develop a practical electromechanical artificial heart, but recipients have had an unpleasant tendency to experience blood clots, strokes, and relatively quick deaths. But there are signs that the technology has improved to a higher level, as Tom Christerson has now survived more than six months with an AbioCor Replacement Heart in his chest. As of this writing, the 71-year-old Christerson has been discharged from Jewish Hospital, in Louisville, KY, and seems to be regaining a bit more strength and independence with each passing day.

The AbioCor heart consists of a thoracic unit (shown in photo), an internal rechargeable battery, a miniaturized electronics package, and an external battery pack. Blood is moved through the lungs and the rest of the body by a motor-driven hydraulic system that is designed to simulate the rhythm of a normal heartbeat. Pumping speed is varied according to the patient's needs under the control of the electronic circuitry. The hydraulics are powered by the internal lithium batteries, and these are constantly recharged by the external battery pack. Recharging occurs via a clever energy transfer device called the transcutaneous energy transmission (TET) unit. The TET consists of two coils — one internal and one external — that transmit power across the skin without actually piercing the surface. The internal batteries can operate for about 30 minutes without a recharge, so the patient can take a shower or engage in other short-term activities independent of the external battery pack. The AbioCor unit is built primarily of titanium and Angioflex, a specially formulated polyurethane that can withstand the required 100,000 beats per day.

ABIOMED has projected that implantation of the AbioCor device will ultimately cost only about one-third as much as obtaining a human heart transplant. The bad news is that we are still looking at about $126,000.00, so maybe you should still go easy on the bacon, cigarettes, and hard liquor. More information is available at the ABIOMED, Inc., web site (**www.abiomed.com**) and at **www.heartpioneers.com**.

Computers and Networking

Alternative Browser Available

Let's imagine that you have been using Netscape as your web browser for years but have concluded that anything beyond Version 4 or so is junk. Let's also assume that you don't want to be part of the Microsoft Internet Explorer (IE) empire and risk all of the associated privacy and security compromises. The National Center for Supercomputing Applications (**www.ncsa.uiuc.edu/**) stopped development of its Mosaic browser in 1997, so you can forget about that. Do you have any options?

Yes, there is at least one. Earlier this year, Opera Software ASA (**www.opera.com**) released version 6.01 of its Opera browser for Windows. Mac users can download the final version of Opera 5.0 for Mac OS 7.5.3 through 9.2, which is billed as the world's fastest browser for the Mac OS. (However, we tested it here, and it seemed a bit slower than Netscape 4.7 and IE 4.5.) Versions are also available for Linux/Solaris, Symbian OS, and QNX, and there is a beta test version for Mac OS X. While Opera hasn't exactly swept over the world, the Norwegian company claims that its product currently has a 5.8 percent market share in Russia, a substantial presence in Germany and Scandinavia, and a fast-growing user base in Europe. The total installed base is said to be three million users.

Opera offers a "completely customizable" user interface, a multiple document interface feature, and a lot of other nice features. Most important for people who are concerned about privacy issues, Opera says that it does not "monitor or provide information to any external parties about what our users do." The downside is that, because many web sites are specifically designed with the requirements of Netscape and IE in mind, they may look strange in Opera, which is designed to comply strictly with standards published by the World Wide Web Consortium (**www.w3c.org**).

Opera is a free download but, of course, nothing is truly free. A 468 by 60 pixel chunk of the user interface is dedicated to banner advertisements, and it is not possible to scroll away from an ad or go to another page. If you want the noncommercial version, it will cost you $39.00.

Program Tracks Money Laundering

In late February, Searchspace® (**www.searchspace.com**) introduced the latest version of its Anti-Money Laundering (AML) software, designed to combat increasingly complex and ever-evolving new money laundering schemes. The new upgrade, AML Sentinel Version 3.0, works with the Searchspace Intelligent Enterprise Framework (IEF), which captures and uses all transactions that flow through a financial institution to provide continuously adaptive profiles of all individuals in the system. In this way, every transaction that flows through the organization is monitored, analyzed, and assessed for risk. The process is fully automated and runs 24 hours per day.

Searchspace systems currently manage over one trillion dollars per day, and clients include the Bank of New York, Archipelago, Barclays, Royal Bank of Scotland, Bank of Scotland, London Stock Exchange, Lloyds TSB, and Lloyd's of London. So, if you are involved in money laundering (or handle your funds in any manner that might be deemed unusual by the authorities), you may need to try a more primitive system, like burying the money in your back yard.

Apple Computer Resists the Trends

Apple's Redesigned iMac. Photo courtesy of Apple Computer.

The PC industry has not provided much exciting news in the last few months, with the main trends being price wars, product stagnation, and disappointing sales. But as of late March, Apple Computer seemed to have headed in the opposite direction by raising the price on the radically different iMac model while having to ramp up production capabilities to keep up with the demand. In the first three months after the new iMac was introduced, the company sold more than 125,000 of the machines, and at last report it was shipping more than 5,000 units per day.

The price of all models has been increased by $100.00, with the bump being blamed on increases in the cost of memory and LCD flat-panel displays. The new retail price for all three models will be $1,399.00 for the 700 MHz G4 with CD-RW drive; $1,599.00 for the 700 MHz G4 with Combo drive; and $1,899.00 for the 800 MHz G4 with SuperDrive. All models include Mac® OS X and Apple's suite of software for creating digital photos, movies, and music, and burning them on CDs and DVDs (models with SuperDrive), and all come with an infinitely adjustable 15-inch LCD display.

Circuits and Devices

CRTs for Rugged Environments

The CyberResearch CRY-Series Displays for Industrial-Grade Applications. Courtesy of CyberResearch, Inc.

If your latest project requires an industrial-strength monitor, you may like the CRY-series displays from CyberResearch, Inc. (**www.cyberresearch.com**). Designed and built for rugged environments such as factories, they are bright enough to be used in full sunlight. The displays are built on a 19-inch aluminum and steel rack-mount chassis and feature a corrosion-resistant aluminum front panel. The front panel and handles have a scratch-resistant black finish, and the fully enclosed frame provides shielding against electromagnetic interference. The 17-inch GRY 1017 is just 14 inches high, and the 15-inch GRY 1015 is only 12.25 inches high. On-screen display controls let you adjust geometry and fine-tune color values. These controls can be set to any of five languages. Both 17" and 15" displays offer a resolution of 1280 x 1024 pixels at 60 Hz and withstand ambient temperatures as high as 131°F (55°C). The GRY 1015 has a dot pitch of 0.28 mm, while the GRY 1017 offers a dot pitch of 0.27 mm. Each operates on 90 to 246 Vac at 50 to 60 Hz, autoranging.

The GRY 1015 sells for $995.00, and the 1017 is priced at $1,295.00. You can also get versions with a capacitive or resistive touch screen for $1,995.00 and $2,295.00, respectively. Data sheets can be downloaded from the company's web site, and you can also find some good application tutorials on PC systems, data acquisition, and motion control at **www.cyberresearch.com/tutorials/techtut.htm**.

Folding Keyboard Available for Palms

One of the apparently insurmountable problems of computer engineering is that, while electronic circuitry keeps getting smaller, human fingers are stubbornly staying the same size. Therefore, for people who are used to touch typing on a standard keyboard, laptop and smaller devices can be very difficult to use. A solution for Palm handhelds is now offered by Logitech in the form of its TypeAway folding aluminum keyboard. The device offers a full key layout with a tactile response that touch typists expect, but it weighs only 150g and is only 12.4 mm thick. The keys feature a "scissor" technology, also used in some notebook computers, to allow for its low-profile typing plane. Navigation keys provide quick access to handheld applications.

The Logitech TypeAway keyboard is compatible with Palm OS® 4.1 and Palm OS® 4.0 for the Palm m125, Palm m500, Palm m505, and future handhelds with the Palm Universal Connector. The Logitech software used to configure the Palm for the keyboard is compatible with Windows® NT, 95, 98, Me, and XP. The application is also compatible with Macintosh® OS. The keyboard ships with a free trial version of the Palm OS based word processor, WordSmith®, and lists for $79.95.

The Logitech TypeAway™ keyboard extends input capabilities of Palm handhelds via the Palm Universal Connector. Photo courtesy of Logitech International.

NAVAID Phase-Out Delayed

For several years, the US Department of Transportation (DOT) and Department of Defense (DOD) have planned to phase out land-based navigation aids in favor of the global positioning system (GPS). However, it was recently announced that radio navigation systems such as very-high-frequency omnidirectional radio range (VOR) transmitters and nondirectional beacons (NDBs) will be left in place at least until 2010. The primary reason is that the authorities are concerned about the risk of GPS signals being blocked or jammed. The verdict is not yet in with regard to Loran systems, which are still under evaluation. Once the studies on its long-term viability are completed, probably later this year, an announcement will follow.

Industry and the Profession

Earthlink Co-founder Pleads Guilty

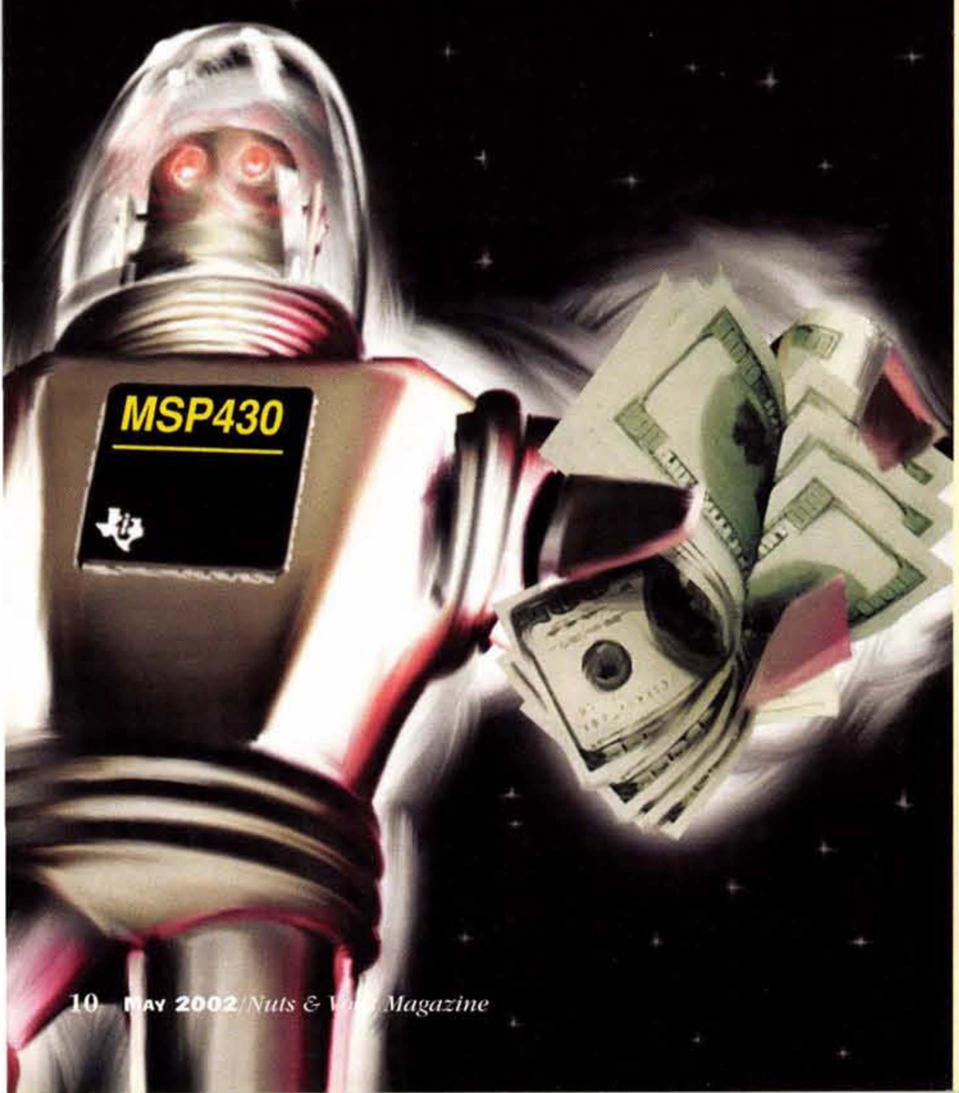
Late in March, Reed Slatkin, one of the founders of Internet service provider Earthlink, pleaded guilty to more than a dozen felony charges. Apparently, Slatkin defrauded 800 investors of more than $593 million in a complex "Ponzi scheme." According to a spokesman for the US attorney's office, Slatkin "admits that he portrayed himself as a successful financial adviser and provided investors with account statements which purported to show that investors were achieving above-market returns on their investments. However, Slatkin generally did not buy securities as he told investors. Instead, he provided victims with false account statements that showed fabricated returns." In the classic Ponzi manner, Slatkin paid investors with money that he obtained from other investors. He could be sentenced to as many as 105 years in jail and fines of up to $3.75 million.

Dell-Philips Deal Worth $5 Billion

A recently signed agreement between Dell Computer Corp. and Koninklijke Philips Electronics NV is reported to be worth as much as $5 billion to Philips, based on an annual growth rate of 25 percent. Under the agreement, Philips will provide Dell with CRT and flat-panel monitors, storage devices, and other components that will be incorporated in Dell products. In addition, Dell will become a "preferred worldwide supplier" to Philips of servers, workstations, PCs, etc. This is a major increase in commerce between the two companies, which conducted about $600 million in business with each other in 2001. **NV**

Texas Instruments and *Nuts & Volts* To Host 2002 MSP430 Ultra-low Power Flash MCU Design Contest

Cash Prizes totaling $10,000.00 will be awarded!!



Do you

have a great idea for a project that could really utilize the amazing features of the Texas Instruments MSP430 family of ultra-low power Flash microcontrollers? Then submit your design. You could participate in over $10,000.00 of prize money including a $5,500.00 award to the winning design!

Beginning May 1, 2002 through October 31, 2002, individuals or teams are invited to submit entries that incorporate an ultra-low-power MSP430 Flash microcontroller into a design.

Projects will be judged on technical merit, originality, usefulness, power efficiency, development, and design process optimization.

The MSP430 family of ultra-low-power 16-bit RISC mixed-signal processors from Texas Instruments provide the ultimate solution for battery-powered applications. For low-power applications where both analog and digital signal processing are required, the MSP430 line provides a range of exceptional cost/performance options. The MSP430 family enables system designers to simultaneously interface to analog signals, sensors, and digital components while maintaining unmatched low power.

"We know that low power, high performance, and analog integration are key customer careabouts, and hope this contest will propel designers to realize applications dreams that they had previously only envisioned," explains Mark Buccini, MSP430 Americas strategic marketing manager, TI. "TI is committed to delivering the best combination of compelling, cost-effective MCU solutions for power-sensitive applications."

When battery life, processing power, and hardware flexibility are major design concerns, the TI MSP430 family offers a myriad of features, including:

- Ultra-low-power architecture that stretches battery life.
- High-performance integrated analog functions, ideal for precise measurement applications.
- A modern 16-bit RISC CPU that enables new applications at a fraction of the code size.
- In-system, programmable Flash that permits flexible code changes, field upgrades, and data logging.
- A complete integrated development environment starting at only ***$49.00*** (MSP-430FETX110).
- Hundreds of downloadable code examples and application reports to jump-start your design effort available from TI at: **www.ti.com/sc/msp430**.

Possible Applications

The list of applications for contest entries is virtually limitless. MSP430 microcontrollers are ideal for applications such as:

- Instrumentation — *thermometers, sports watches, multi-meters, weight scales.*
- Intelligent Sensing — security systems, remote control, robotics, smoke detectors, electronic tags.
- Metering — *gas, water electric, heat allocators, thermostats.*

ENTER THE MSP430

GADGET-O-RAMA!

Overall Contest Guidelines

Each project must be the original work and property of the person or team who submits it. Contestants may enter more than one project, but must submit each design as a separate entry.

All core hardware must be Texas Instruments brand. Sources for development kits and individual chips are available via the MSP430 Design Contest website at

www.ti.com/sc/gadgetorama2002

Projects must be submitted in hardcopy form and must be written in English. The postal and email address for submitting contest entries is:

MSP430 Design Contest
Nuts & Volts

430 Princeland Court, Corona, CA 92879
Attn: Robin Lemieux
gadgetorama2002@nutsvolts.com

Basic Entry Requirements

- A completed entry form.
- A publishable, technically descriptive, abstract in Microsoft Word or ASCII test, including a hardcopy (approx. 500 words) and block diagram of the design. Every entry must contain an abstract with either a block diagram or a schematic in digital format.
- Complete and legible schematics of the hardware used.
- Complete documentation of the project and its operation, including software, flowcharts, and diagrams (where appropriate). In addition, entrants must submit fully compilable source code digitally.
- Four (4) copies of all documentation.
- Four (4) identical photographs of the completed project. All entries must include a photo of the project. Digital submissions need to contain a digital image of the project or a note stating the photographic prints have been sent via mail. Submissions must contain four copies of any prints that are sent.

A complete set of entry instructions is available at **www.ti.com/sc/gadgetorama2002** for download and must be strictly adhered to in order to avoid disqualification. Entries received after the October 31, 2002 deadline will be deemed ineligible. Winners will be notified by mail, email, and/or telephone on or about December 15, 2002. The judges' decision is final. If a winner fails to respond within 30 days of notification, an alternate winner will be selected. Prizes are non-transferrable.

Don't miss out on this great opportunity to flex your creative muscles and possibly get paid in the process!

For information and answers to frequently asked questions, check the FAQ section on the website.

Good luck and good designing!!

MSP430 Architecture

Using a von-Neumann common memory address bus (MAB) and memory data bus (MDB), a 16-bit RISC CPU, peripherals, and flexible clock system are combined.

Memory Options
- Flash, ROM, OTP versions (from 1 kB to 60 kB)
- RAM up to 2 kB

Analog Peripherals
- High-performance ADC
- Comparator
- LCD driver
- Supply Voltage Supervisor (SVS)

Digital Peripherals
- USART
- Hardware multiplier
- 16-bit and 8-bit timers

Modern 16-bit RISC CPU
- Large register file eliminates accumulator bottleneck
- Optimized for C and assembler programming
- Compact core design reduces power and cost
- Up to 8 MIPS of performance available

The MSP430's orthogonal architecture provides the flexibility of 16 fully addressable single-cycle 16-bit CPU registers and the power of an RISC instruction set.

Flexible Clock System
- Low-frequency auxiliary clock — ultra-low-power stand-by mode
- High-speed master clock — high-performance processing
- Stability over time and temperature

The MSP430 clock system is designed specifically for battery-power applications. Multiple oscillators are utilized to support event-driven burst activity.

High-Performance Analog
- 12-bit or 10-bit fast SAR ADC
- 14-bit hi-res SAR ADC
- 16-bit slope ADC

MSP-FET430 Flash Emulation Tool
- JTAG based real-time in-system emulation.
- Target board, interface box, cable, and samples.
- CD-ROM includes Kickstart IDE, assembler, linker, simulator, and 2-kB C-compiler.

The Flash Emulation Tool (FET) supports complete in-system development and is available for all MSP430F1xx and MSP430F4xx Flash devices. Programming, assembler/C-source level debug, single stepping, multiple hardware breakpoints, full-speed operation, and peripheral access are all fully supported in-system using JTAG. The FET comes complete with everything required to complete an entire project.

SPECIAL! TAKE 10% OFF PRICES SHOWN. ENDS MAY 30th! Phone orders ONLY, Not on WEB

SUPER HIGH ENERGY CAPACITORS, PERFECT for EMP EXPERIMENTS, FLASHLAMP PUMPING, CAN CRUSHER or RAIL GUN APPLICATIONS. WOW!

Two models from which to choose. Both are brand new. NO PCB's.

First shown left: made by RFI Corp., their P/N: 10001SOCN3254884-1, rated at 0.5uF @21000VDC, that's 21KVDC!, +20%, -0%, HV connection via 3/8" stud on a 2.6"H ceramic stand off. Size: 4.3"D x 7.5"W x 13"H, Weight: 17Lbs. Welded metal can construction. Original cost over $700 ea. Ltd. Qty.
OUR PRICE, RFICAP-21KV......$119ea.

Second shown right: made by AXEL Corp. their P/N: 13058-17511W-2 rated at 1.75uF @33000VDC, that's 33KVDC!, +20%, -0%, HV Connection via 3/8" stud on a 5" high ceramic standoff. Size: 5"D x 10.25"W x 27"H, Weight: 65Lbs. Welded metal can construction. Original cost over $800 ea. Very limited quantity.
OUR PRICE, AXEL-33KV......$129ea.

SERIOUSLY SIZED SERVOMOTOR SLIDE, provides 21" of precise travel. But Wait...There's More!

These heavy duty, motorized linear slides, do their sliding on 3/4" diam. Thompson steel rail. The X axis is motivated by a substantial 3.4" diam. EG&G servomotor type: ME3515-191B with an EG&G 1000 count encoder driving a flex coupled 1/2" pulley which belt drives 2.2" diam. transfer pulley which direct drives the 1.5" final drive pulley which moves the 0.6" wide toothed belt which moves the carriage. The X axis carriage contains a motorized rotary unit with the same type EG&G servomotor driving a 5.5" diam. 1/4" thick aluminum platter mounted at about a 20 degrees angle to the base. Rotation is via an anti backlash gearing system directly driven by the motor. Supporting all these goodies is a welded, 3" wide steel channel frame. The system overall size is: 45"L x 14.25"W x 8.75"H. These units must ship via truck. Very limited quantity. These are used in good condition.
XSLIDE-ROTARY....... $229 ea. or 2 for $399

SUPERB SLIDE, TRAVERSES 2" with STEPPER DRIVE

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

INCREMENTAL OPTICAL ENCODER, LUCAS/LEDEX TYPE: S-10208A-1386. Provides 1386 counts per rev! That's 5544 counts per rev in quadrature!

5VDC powered. TTL compatible outputs of: A A, B B and M M, 1/4"diam. x 1/2"L, ball bearing shaft. Size: 2.3"diam x 1.9"deep Removed from equipment. A super value.
LUCAS-ENC1368...........$39ea.

WE ARE LOOKING for UNIQUE ELECTRO-OPTICAL, MOTION CONTROL DEVICES and RELATED. PLEASE FAX US YOUR LIST of AVAILABLE MATERIAL.

NIKON, 105mm, f2.8D AF MACRO LENS! BRAND NEW, U.S. WARRANTY, BOXED

The legendary, close-focusing 105mm f/2.8D AF Micro-Nikkor offers images with stunning detail. Its 105mm focal length adds extra working distance. Now you can accommodate several different lighting techniques with one lens. The exclusive Close-Range Correction System allows focusing as near as 12 inches with a 1:1 reproduction ratio! The super sharp, 105mm focal length is an excellent choice as a portrait lens. SPECS: Construction: 9 elements in 8 groups, Picture Angle: 23° 20', Minimum Focus Distance: 1 foot, Maximum Reproduction Ratio (Macro Setting): 1:1, Filter Size: 52mm, Dimensions: 3" diam. x 4.1"L, Weight: 19.6 oz. This product is brand new in std. NIKON box. Original MANUFACTURERS USA warranty IS included. Nikon 105/2.8 Micro AFD #1988N Ltd. Qty. **NIKON-105.....$429ea.**

A SECOND SERIOUSLY SIZED SERVOMOTOR SLIDE, By ANORAD, Provides 23.5" of Precise Travel. But Wait...There's a Z AXIS BONUS!

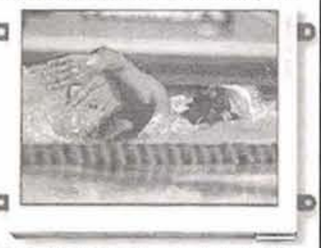
These SUPER HEAVY DUTY, motorized linear slides, do their sliding on crossed roller bearings. The X axis is motivated by a 2.25" diam. EG&G servomotor type: MT-2130-012BE or similar with encoder driving a flex coupled 0.75" diam. ball screw drive. The huge carriage is: 28" L x 5.5" Wx 1.1" Thick. The X axis is a massive precision machined (Mehanite) casting. Mounted to the carriage is a substantial Z axis unit sporting dual THK, YH2218, 0.6"H x 0.5"W rails or similar. Riding the rails are four recirculating ball carriages attached to a 1/4" thick aluminum plate. (Two carriages on each side) Running down the center is a 1/2" diam. ball screw driven by a size 23 stepper motor. This motor provides the drive for the 10.5" travel, Z axis. These units were originally designed to be used in a "gantry" configuration. ie. suspended over the workpiece with the workpiece moving in the Y axis. Overall size is 48"L x 17"W x 20"H. This is the perfect setup for heavy duty cutting or engraving. Slides of this quality don't come around very often. Don't miss out. We have a very limited quantity. These units must ship via truck. These are used in good condition removed from optical equipment. **ANORAD SLIDE.. $349 ea. or 2 for $649**

SPECIALTY HIGH VOLTAGE CAPACITORS, from JENNINGS and CORNELL DUBILIER

First, we have a Jennings , CLFI-50-0030, (shown left), vacuum capacitor, rated at 50pf ± 10% @ 30KV, Size: 2.2" Diam. x 6.5"L, if that's to much for you, we have the CD, type 4CM #10-26620-01 Aluminum electrolytic, rated at 560uF @ 400VDC, Size: 1.7" Diam. x 3.1"H, vertical PC board style mounting. Both are brand new. Limited quantity.
Special, JENNING-CLFI.....$69ea.
Special, CD-560/400...........$3ea.

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

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



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SUPER SLUETH, SPY BORESCOPES, NOW TWO MODELS AVAILABLE!

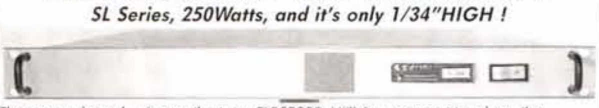
Actually a doctor would call them anrithroscopic borescopes. Super high quality medical grade, stainless, construction. Both models have a direct view eyepiece and a standard 90 degree external light port. The unit pictured above is constructed with a 6.5" long X 7.5mm diameter tube with the objective end optic angled at a 30 degrees for easy viewing of surrounding area. The second style, shown below offers a 9.75" long tube with an amazingly small, 2.2mm in diameter with a flat objective end. That could really get you into some tight spots. Reg price: $800ea.

BORESCOPE-6.5"..............$229ea.
BORESCOPE-9.75"............$249ea.
BORE-PAIR-6.5"+ 9.75".....$450 per set.

THOMPSON PRECISION STEEL BALL BUSHING, type A162536

These are new, boxed, general purpose closed LINEAR BEARINGS. Size: 2.25"L x 1.56"OD with a 1" diam. bore. Rated for dynamic loads of up to 350lbs. Ltd. qty. **THOMP-BB536........$22ea.**

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.....$399ea.**

CROSS-HAIR RETICLES,

New precision ruled glass. 1.8" diam. x .125" thick. Give your projects a proffessional touch. Usually quite pricey. **Special..........5 for $10**

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

These are brand new, very rugged, right angle drive, gearmotors originally intended as car window motors. They are very substantial, weighing over 2 pounds each! They offer a 0.9" diameter x 0.3"H, 9 tooth steel gear drive, located centered between three 0.28" diameter cast aluminum "spider" mounting points. Each offset 120° and on a diameter of 2.5". Overall size: 37"W x 7.25"L x 2"H (including the gear) with std. automotive style 2 pin connector. Motor will operate with good torque with as little as 3VDC, nominal is 12VDC @ 850mA no load, with an RPM of 70/minute. Also it is of course, reversible.
WINMTR-248...$20ea. or 4 for $69

HEAVY DUTY, INDUSTRIAL FOOT SWITCH, USA MADE!

Manufactured by Linemaster Switch, their model: 635-S. UL approved. Rated for 15A @ 125VAC, 10A @ 250VAC or 1/2HP. Made for rugged use with all cast metal construction. The foot pedal is surrounded by a steel guard on four sides to prevent accidental activation. Guard can be removed with two screws. Ten foot log, four conductor cable attached. Very nice, superior quality intended for use with medical laser systems. Two independent S.P.S.T. micro switches. One closes at about 50% pedal travel and the other closes at 90%. They are both closed at 90% Overall size including shield: 6"W x 6"D x 4.5"H, Pedal size: 3.5"W x 5"L x 1.75"H Pedal finished in black powder coat. Shield is "putty" color. Weight is 7lbs. No Slip pad on bottom. Limited quantity. **PRICE.....$24ea. or 2 for $45**

NEW, SECURITY MONITOR. NOW YOU HAVE THREE CHOICES!

Commercial quality, Hi-resolution B&W and Color monitors. Brand new, 90 day warranty. BNC video in and loop through. Rugged black steel case. Three models are available: choose a 9" or 15" Black and White with 1000 lines of resolution or a 14" color with 450 lines of resolution. You will be amazed at how much better they will make your video look! There is no substitute for a real monitor. With UL, FCC and FDA approvals.
SPECIAL, BWMONITOR-9HR........$94 ea.
BWMONITOR-15HR.....$159ea.
COLORMON-14HR......$219ea.

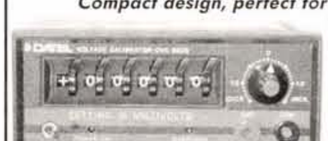
NEWPORT, LC-075, 10X COLLIMATING TELESCOPE

The LC-075 is a general purpose laser collimator optimized for low wave front distortion at infinity. Oversized entrance aperture of 7mm for ease of alignment. Wavelength: 400-700nm, Exit aperture: 18.8mm, wavefront distortion at infinity less than 1/10 wave. Transmission: 90%. Used in excellent condition. Ltd. qty.
Newport price: $775. OUR PRICE.....$289ea.

POWER to SPARE, 12 VOLTS at 17.2 Ah, NEW EXIDE SEALED RECHARGEABLE LEAD ACID BATTERY

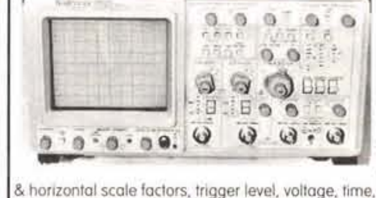
Type NP-18-12, Now is your chance to perk up those power projects. Perfect for powering many portable devices such as GPS, laptop or telescope, fish finder or underwater camera. The list is endless. Don't be left out of this opportunity. The size is a manageable 7"W x 6.75"H x 3"D, weight is 14 lbs. Heavy duty post type connections. Use two in parallel for 34 Ah WOW! Ltd. qty.
EXIDE-NP1812.....$24ea.
Case of 4, EXIDE-NP1812-4.....$89
1amp Charger, EX-CHGR....$15ea.

DATEL DVC8500, DIGITAL VOLTAGE CALIBRATOR Compact design, perfect for travel or bench.



This is one of those items that you won't know how you got along without for so long. Provides ± 10VDC @ 20ma in 1mV steps. Lerver type, thumbwheel controls. Vernier adjustment. Overload protection. Size: 6"W x 6"D x 2.5"H. Used in excellent condition. LIMITED QUANTITY.
Orig Price: $995ea. DATEL-8500.....$289ea.

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



Displays intermittent variations as they happen. Captures the slowest one shot events with 4ns per division a 100 fold increase in the visual writing rate over conventional CRT. Features: 1 ns rise time, 500ps/Div time base, 2mV/Div. vertical sensitivity at 350MHz, 20ps time interval resolution, 1Mohm / 50-ohm input, 500Mhz trigger bandwidth, four channels. On-screen waveform cursors provide vertical & horizontal scale factors, trigger level, voltage, time, freq., phase, ratio values and mode indication. With 2 probes, pouch and manual. EX. cond. 90 day warranty.
New..$12K Now SALE, TEK 2467........$1995.

Circle #49 on the Reader Service Card.

SPECIAL! TAKE 10% OFF PRICES SHOWN. ENDS MAY 30th! Phone orders ONLY, Not on WEB

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

Sleek black anodized, BRASS, housing. O-Ring sealed & WATERPROOF down to 60 feet. Adjustabe mount included. Specs: 1/3" CCD, 400 Lines res.,super 0.003 Lux sensitivity, AGC, Auto Shutter. 12VDC @220mA, 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. **GM300KX-12.......$179**

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

Sleek black anodized, BRASS, housing. O-Ring sealed & WATERPROOF. Adjustabe mount incl. Specs: 1/4" CCD, 350 Lines res., 0.5 Lux sensitivity, AGC, Auto Shutter. 12VDC @220mA, 4mm, 78° FOV lens. A real glass lens. NTSC video out. Superior construction. Ultra small Size only: 1.25"diam. X 2" long. With 60 ft. cable. Perfect as a COLOR remote area inspection camera. Now with TWELVE, super bright, white LED'S! BRAND NEW.
GM400K-12 with LEDs..........$229ea. or GM400K-N without LEDs.........$199ea.

NEW! 0.0001 Lux, Black & White, NIGHT VISION CAMERA! Near "Starlight" PERFORMANCE and 600 Lines Resolution. State of the Art Video, Our GMV-6K, Takes the Prize.

For covert, military & scientific applications, this is it. Unbelievable 0.0001Lux @ f1.2 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 f1.4 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, 470 Lines, 12VDC ±1V@200mA, Std. video out on BNC. Size: 51mm x 51mm x115mm long. Regulated power adapter included. All functions can be externally controlled. Use standard c-mount lens not included.
SPECIAL, GMV-6K....$449ea. High performance auto iris lens, 12mm, f1.4...$199ea.

WE ARE LOOKING for UNIQUE ELECTRO-OPTICAL, MOTION CONTROL DEVICES and RELATED. PLEASE FAX US YOUR LIST

B&W QUAD PROCESOR,

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

SUPER, f1.8, 10x SURVEILLANCE LENS, Perfect for long range observation.

New, Fujinon, 11mm to 110mm ZOOM optics, standard C-Mount. Make any of our C-Mount cameras a long range stealth-cam! WOW! Provides 20X on a 1/3" CCD camera. A super lens. Edmunds' price $800
11-110ZM-1......$249ea.

MICRO LENSES for B&W BOARD CAM

2.9mm, 130° f2
3.6mm, 105° f2
3.3mm, 110° f2
4.3mm, 78° f1.8
3.3mm, 105° f2
6 mm, 65° f2 **YOUR CHOICE...$20ea.**

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

For those applications that must work from dawn 'till dusk, this is it. Rugged aluminum housing with dual mounting sockets. Specs: 1/3" CCD, 420 lines resolution, 0.1 Lux sens., AGC, Auto shutter. 12VDC @120mA. Take full advantage of camera sensitivity with the super, 4mm, f1.4, 78° FOV Auto Iris lens included. Video out on BNC. Size: 50mm sq. X 65mm long. Power adapter included. Ready to go!
SPECIAL, GM-510-A/I....$199ea. or 2 for $369

PRICE BUSTER, DSP, COLOR, MINI C-MOUNT

New, model GM859. Size only: 2" x 2" x2.5"L, Latest 1/4" CCD technology. Res. 350 lines, sens., <3lux, auto white balance, AGC. Auto iris connector. 9-12VDC @150ma power. BNC video out. Switchable gain. Superior cast aluminum housing with top and bottom mounting. Perfect for general surveillance. Less lens.
Special, GM859....$139ea.

NEW! TRIPLEX, COLOR or B&W, DIGITAL VIDEO MULTIPLEXER, OUTPUTS up to 16 FULL SCREEN IMAGES at the SAME TIME! Records ALL Simultaneously!

The GMUX-16 is a feature rich Triplex multiplexer. Triplex gives the ability to Watch, Record or Replay, all at the same time! The GMUX-16 offers stunning performance and flexibility in a feature packed piece of industrial strength video equipment. The self contained unit is compact and can handle up to 16 channels in color or black and white. Both of which can be freely mixed. It's high performance allows you to dispense with two 8 way quads or multiplexers at a stroke, simply leave the unwanted channels unplugged until expansion is required. Simple On-Screen, menu driven set up. 720 X 240 pixels at a refresh rate of 30 fps in full screen mode and 2 fps in complex or 16 way mode from its 60MHz processors. Alarm management is comprehensive with day/night options, up to 100 log entries, and that's for each camera! Dual monitor outputs, dual VCR input/output. Standard composite and S-Video I/O for VCRs, N.C/N.O. Relay alarm outputs. 16 channels of alarm input. Time and date. Front panel mounted switches are tactile and easy to operate. Don't miss this one.
NEW, GMUX-16................$829ea.

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

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

COMPLETE SELECTION of COVERT CAMERAS, all available with audio,

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

NEW, 470 LINE, DSP COLOR Micro CAM The HIGHEST PERFORMANCE available. MICRO SIZED PACKAGE too!

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

NEW! 0.001 Lux, COLOR NIGHT VISION CAMERA! UNBELIEVABLE LOW LIGHT PERFORMANCE. State of the Art Video, Exclusive ON SCREEN, menu driven setup of all camera parameters!

For covert, military & scientific applications that must be color, this is it. Unbelievable 0.001Lux @ f1.2 performance is enhanced through low speed electronic shuttering, digital frame integration and advanced DSP. Auto sensitivity mode starts as it becomes dark. 24 hour surveillance is possible with the optional f1.2 auto iris lens shown below. Seven Gain/Shutter modes are user selectable. Normal, X4, X8, X16, X24, X32, X64. These provide frame rates of 60, 15, 8, 4, 3, 2 and 1 per second. Auto/Man. white balance 3200° to 10000°K, auto/man BLC, S/N >52dB, Mirror on/off, Gain on/off, auto electronic shutter 1/60 to 1/120,000 sec., Alum. housing, dual 1/4x20 mtg. Specs: 1/2" CCD, 768(H) X 494(V), with 380K pixels, 470 Lines, 12VDC ±1V@200mA, Std. video out on BNC. Size: 51mm x 51mm x115mm long. Regulated power adapter included. All functions can be externally controlled. Use standard c-mount lens not included.
GMV-3K-OSD..........$449ea.
High performance auto iris lens, 12mm, f1.2...$199ea.

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

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

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

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

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

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

NEW! 4 or 8 CHANNEL, VIDEO AUTO SWITCHERS

Connect four or eight std. video signals and they will be sequentially output to the dual rear panel BNC outputs. Front panel user adjustable, variable dwell 1 to 15 sec per channel. Auto/manual switching with channel bypass. Compact only 8.6"W x 3.7" D x 1.75" H, ac powered. Video loop through. **GM-34, 4 Chan...$65, GM38, 8 Chan...$75**

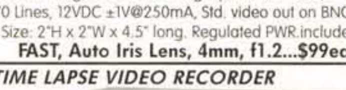
NEW, DAY/NIGHT TECHNOLOGY, OPTIMIZED COLOR / IR OPTICS DSP technology and 10 Automatic LED's. Weather Tight GM450K-IR Makes it Happen

Features include: Interactive infrared illuminator with 10 high power, wide angle LEDs @ 880nm . See objects 60 feet away during total darkness. A super quality 5 element, glass lens, specially coated with a 100 layer optical coating. For perfect focus with white light and a crisp image under infrared. Normally impossible due to the different focal point for IR and visible light. Solid state infrared optical switch provides day time IR cut filter for excellent color. At night infrared filter will turn off to allow infrared to pass. Also, night time IR LEDs will gradually turn on with proper amount of illumination. You can also see color images such as lights and signs at night. Fog free cover glass. Specs: 0.5 lux color sensitivity. 60dB S/n ratio typical. 12" I/O cable with BNC video and DC barrel jack. 120 dB smear rejection ratio. Adjustable mount and C power adapter included. **GM450K-IR.........$199ea.**

NEW! 0.01 Lux, COLOR NIGHT VISION CAMERA! FANTASTIC LOW LIGHT PERFORMANCE, ON SCREEN, menu driven setup of all camera parameters. STATE of the ART, GMV-35KOSD,

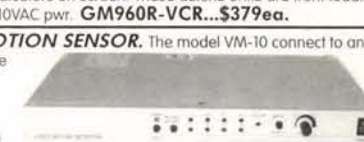
Perfect for covert, military & scientific work that must be color. Unbelievable 0.01Lux @ f1.2 performance is enhanced through low speed electronic shuttering, digital frame integration & advanced DSP. Auto sensitivity mode starts as it becomes dark. 24 hour surveillance is possible with the optional f1.2 lens shown below. Specs: Shutter speed auto or manual, 1/60 to 1/120,000, 60dB S/N ratio!, 154dB Smear rejection!, AGC gain 0 dB to 18 dB. Digital gain 0dB to 12dB. Digital zoom continuous from up to 2X in 0.1X steps. Masking mode allows hiding 4 programmable zones for privacy protection. Camera on screen name. White balance modes: Auto tracking, one push or selection from 3200k, 4800k, 5600k, 7800k, and "double white balance" independent white balance circuit for both bright and dark zone, maintains correct white balance even with combined indoor & outdoor lighting. Programmable 48 zone back light compensation mode for difficult lighting situation. Negative mode. Mirror image & up/down selection. Seven, selectable Gain/Shutter modes. Normal, X2, X4, X8, X16, X24, X32, X64. These provide frame rates of 60, 30, 15, 8, 4, 3, 2, and 1 per second. Alum. housing, dual 1/4x20 mtg. Specs: 1/3" CCD, 811(H) X 508(V), with 412K pixels, 470 Lines, 12VDC ±1V@250mA, Std. video out on BNC. Std S-Video out on 4Pin connector. Size: 2"H x 2"W x 4.5" long. Regulated PWR.included.
GMV-35KOSD...$399ea. FAST, Auto Iris Lens, 4mm, f1.2...$99ea.

NEW, GM960R TIME LAPSE VIDEO RECORDER



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

BRAND NEW, VIDEO MOTION SENSOR.



The model VM-10 connect to any standard video signal and you've got an electronic "watchman" diligently watching the entire scene. Or any adjustable sized area within the scene. Such as a doorway or even a drawer or cabinet. A state of the art security aid. The unit will close a contact when it senses a change. Auto or manual reset. Internal buzzer with volume control and adjustable on time. VCR record and VCR stop output. (use with time lapse VCR.) 110VAC powered. Adjustable sensitivity. Video loop through. **VM10....$179ea.**

Circle #49 on the Reader Service Card.

Moving?

Be sure and submit your address change to *Nuts & Volts* at least six weeks prior to moving. Unfortunately, we aren't able to replace missed issues due to unreported address changes or changes received after our mailing cut-off date.

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Reader Feedback

Dear Nuts & Volts:

I've been a subscriber for a little over a year now and have enjoyed your magazine. I know enough about electronics to be dangerous, and I have to admit that most of the articles are over my head. After reading last month's article on Computer Interfacing: Part 1, I just had to contact you.

I cannot put this article down! I have been wanting to build an electronics project for a long time now, but have not found a project that was interesting enough to me. This article, and project, was the one to get me fired up. The functionality of the project is something that I can really make use of, the design is simple enough for a novice to understand, and it all just makes sense. I have never built anything using ICs, but this project really has me interested.

Not knowing much about the topic, I've spent hours rereading the article and following the circuits, each time amazed when some facet of the design finally clicks in my head. I've learned so much about IC technology from this one article that it is hard to explain the impact it has had on me.

Thanks to you and Mr. Ward for providing this terrific article. Please know it has inspired at least one would-be electronics hobbyist to jump in and start building. I can't wait for Part 2!

Ted Gerutta
via email

News Bytes

Privacy Corps Helps Protect Consumers From Telemarketers

Privacy Corps has launched a new website, http://www.privacycorps.com/.

Created for the benefit of consumers who are tired of intrusive and unwanted telemarketers, Privacy Corps provides consumer ratings and product comparisons of the latest privacy-protection equipment, allowing customers to beat telemarketers at their own game.

Savvy citizens can arm themselves with an arsenal of products and take control of a previously unmanageable problem. Providing constant vigilance, these products, ranging from a mere $17.00 to an affordable $70.00, are all designed with a single purpose — to stop telemarketing calls.

"Consumers have to be

Continued on Page 18

90 DAY WARRANTY PARTS AND LABOR • 10 DAY INSPECTION

TEST EQUIPMENT WANTED CALL OR FAX LIST • OPEN ACCOUNTS

HP R85026A WR28 Detector, 26.5-40 GHz, for HP 8757 series **$1200.00**

SIGNAL GENERATORS

FLUKE 6060B/AK Signal Generator, 0.1-1050 MHz, 10 Hz res. **$1250.00**
FLUKE 6060B-130,830 Signal Generator, 0.1-1050 MHz, 10 Hz res., GPIB **$1600.00**
GIGATRONICS 1018 Signal/Sweep Gen., 0.05-18 GHz, 1 kHz res., +8 dBm **$5000.00**
GIGATRONICS 600/6-12 Synthesized Source, 6-12 GHz, 1 MHz res., GPIB **$1500.00**
GIGATRONICS 6000/8-16 Synthesized Source, 8-16 GHz, 1MHz res., GPIB **$2250.00**
GIGATRONICS 6061A-830 Signal Generator, 0.1-1050 MHz, 10 Hz res., AM, FM, GPIB **$1900.00**
HP 11707A Test Plug-in, for HP 8660 series **$400.00**
HP 11720A Pulse Modulator, 2-18 GHz, 80 dB on/off ratio **$450.00**
HP 8642M Signal Generator, 0.1-2100 MHz, 1 Hz res., HPIB **$3750.00**
HP 8656B-001 Signal Generator, 0.1-990 MHz, 10 Hz res., HPIB, OCXO **$2750.00**
HP 8657A Signal Generator, 0.1-1040 MHz, 10 Hz res., AM, FM, HPIB **$3000.00**
HP 8660C/603A/633B Signal Generator, 1-2600 MHz, 1 or 2 Hz res., AM, FM **$3250.00**
HP 8660D/86603A-002 Signal Generator, 1-2600 MHz, 1 or 2 Hz res., phase modulation **$6000.00**
HP 8671A Signal Gen., 2.0-6.2 GHz, 1 kHz res., CW, FM, +8 dBm, HPIB **$2750.00**
HP 8671B Synthesized Signal Generator, 2-18 GHz **$4000.00**
HP 8672A Signal Generator, 2-18 GHz, 1-3 kHz res., AM, FM, +3 dBm **$4500.00**
HP 8672A-008 Signal Generator, 2-18 GHz, 1-3 kHz res., AM, FM, +8 dBm **$5000.00**
HP 8673C Signal Gen., 0.05-18.6 GHz, 1 kHz res., AM, FM, Pulse, HPIB **$14000.00**
HP 8673D-H15 Signal Gen., 0.05-26 GHz, 1 kHz res., AM, FM, HPIB **$15000.00**
HP 8673H-212 Signal Generator, 2.0-12.4 GHz, 1 kHz res., AM, FM, +8 dBm **$8500.00**
HP 8673M Signal Generator, 2-18 GHz, 1 kHz res., AM, FM, +8 dBm **$9500.00**
HP 8683B Signal Generator, 2.3-6.5 GHz, cavity tuned, AM/WBFM/Pulse **$2250.00**
HP 8683D Signal Generator, 2.3-13.0 GHz, cavity tuned, AM/WBFM/Pulse **$3750.00**
HP 8684B Signal Generator, 5.4-12.5 GHz, cavity tuned, AM/WBFM/Pulse **$2250.00**
MARCONI 2019 Signal Generator, 80 kHz-1040 MHz, 10 or 20 Hz res **$850.00**
WAVETEK 955 Signal Generator, 7.5-12.4 GHz, +7 dBm, AM, FM **$750.00**
WAVETEK 957 Signal Generator, 12-18 GHz, +7 dBm, AM, FM **$750.00**

SWEEP GENERATORS

HP 8350B/83522A Sweep Oscillator, 10-2400 MHz, +13 dBm levelled **$3750.00**
HP 8350B/83525A Sweep Oscillator, 10 MHz-8.4 GHz, +13 dBm levelled **$5000.00**
HP 8350B/83540A-002 Sweep Oscillator, 2.0-8.4 GHz, 70 dB step atten. **$3250.00**
HP 8350B/83545A-002 Sweep Oscillator, 5.9-12.4 GHz, 70 dB step atten. **$3750.00**
HP 8350B/83570A Sweep Oscillator, 18.0-26.5 GHz, +10 dBm levelled **$7000.00**
HP 8350B/83570A-H22 Sweep Oscillator, 17-24 GHz, +10 dBm levelled **$5000.00**
HP 8620C Sweep Oscillator Frame **$500.00**
HP 86222B-002 RF Plug-in, 10-2400 MHz, +13 dBm, 70 dB step atten. **$1250.00**
HP 86222B-E69/8620C Sweep Osc. & frame, 0.01-2 GHz & 2-4 GHz bands **$1200.00**
HP 86240B RF Plug-in, 2.0-8.4 GHz, +13 dBm levelled **$450.00**
HP 86241A RF Plug-in, 3.2-6.5 GHz, +8 dBm levelled **$300.00**
HP 86245A RF Plug-in, 5.9-12.4 GHz, +16 dBm unlevelled **$350.00**
HP 86251A RF Plug-in, 7.5-18.6 GHz, +10 dBm levelled **$500.00**
HP 86260A RF Plug-in, 12-18 GHz, +10 dBm unlevelled **$400.00**
HP 86260A-H04 RF Plug-in, 10-15 GHz, +10 dBm unlevelled **$400.00**
HP 86290B RF Plug-in, 2.0-18.6 GHz, +10 dBm levelled **$1500.00**
HP 86290C RF Plug-in, 2.0-18.6 GHz, +13 dBm levelled **$1750.00**
WAVETEK 2001 Sweep Generator, 1-1400 MHz, +10 dBm, 70 dB atten. **$750.00**
WAVETEK 2002B Sweep Generator, 1-2500 MHz, +13 dBm, GPIB **$1750.00**
WILTRON 6647M Sweep Generator, 10 MHz-20 GHz, +10 dBm, GPIB **$4500.00**
WILTRON 6669B-02,03 Sweep Gen., 0.01-26.5 GHz/K conn.& 26-40 GHz/WR28 .... **$7500.00**
WILTRON 6717B-20 Synthesizer/Sweeper, 10 MHz-8.4 GHz, +13 dBm,GPIB **$6000.00**

POWER METERS

BOONTON 42B/41-4E Analog Power Meter, with 1 MHz-18 GHz sensor **$400.00**
HP 11683A Range Calibrator, for HP 435/6/7/8 .... **$750.00**
HP 435B/8481A Power Meter, -30 to +20 dBm, 10 MHz-18 GHz **$900.00**
HP 436A-022/8481A Power Meter, -30 to +20 dBm, 10 MHz-18 GHz, HPIB **$1200.00**
HP 436A-022/8482A Power Meter, -30 to +20 dBm, 100 kHz-4.2 GHz, HPIB **$1200.00**
HP 436A-022/8484A Power Meter, -70 to -20 dBm, 10 MHz-18 GHz, HPIB **$1200.00**
HP 436A-022/8485A Power Meter, -30 to +20 dBm, 50 MHz-26.5 GHz, HPIB **$1500.00**
HP 436A-022/8485D Power Meter, -70 to -20 dBm, 50 MHz-26.5 GHz, HPIB **$1700.00**
HP 438A Dual Channel Power Meter **$3000.00**
HP 8477A Power Meter Calibtator, for HP 432 series **$400.00**
HP 8487D High Sensitivity Sensor, -70 to -20 dBm, 50 MHz-50 GHz, 2.4mm **$1850.00**
HP 8900D/84811A Peak Power Meter, 0.1-18 GHz, 0-20 dBm peak **$2500.00**
HP Q8486A Power Sensor, 33-50 GHz, -30 to +20 dBm, for 435/6/7/8 .... **$1500.00**
HP R8486A Power Sensor, 26.5-40 GHz, -30 to +20 dBm, for 435/6/7/8 .... **$1500.00**

RF MILLIVOLTMETERS

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

AMPLIFIERS, MISCELLANEOUS

AMPLIFIER RESEARCH 4W1000 Amplifier, 40 dB gain, 4 Watts, 1-1000 MHz **$950.00**
BOONTON 82AD Modulation Meter, AM/FM, 10-1200 MHz **$500.00**
C.P.I. VZC6961K1 TWT Amplifier, 35 dB gain, 4-8 GHz, 20 Watts **$3500.00**
ENI 525LA Amplifier, 50 dB gain, 1-500 MHz, 25 Watts **$3250.00**
HP 11713A Switch/Attenuator Driver, HPIB **$800.00**
HP 11729B-003 Carrier Noise Test Set, 5 MHz-3.2 GHz **$1900.00**
HP 3730B/3738B Downconverter, 5.9-8.9 GHz & 8.7-11.7 GHz **$1200.00**
HP 415E SWR Meter **$200.00**
HP 8347A RF Amplifier, 25 dB gain, 100 kHz-3 GHz, +20 dBm, HPIB **$2750.00**
HP 8349A Amplifier, 15 dB gain, 2-20 GHz, +20 dBm output **$1650.00**
HP 8403A-002 Pulse Modulator, 0.8-2.4 GHz, 80 dB dynamic range **$450.00**
HP 8406A Comb Generator, 1/10/100 MHz increments, to 5GHz **$500.00**
HP 8447A-001 Dual Amplifier, 20 dB, 0.1-400 MHz, +6 dBm Po, NF <7 dB **$650.00**
HP 8447D-010 Preamplifier, 25 dB gain, 0.1-1300 MHz, <8.5 dB NF **$750.00**
HP 8447E Amplifier, 22 dB, 0.1-1300 MHz, +13 dBm output **$650.00**
HP 8447F-H64 Dual Amp., 0.01-50 MHz 28 dB & 0.1-1300 MHz 25 dB **$900.00**
HP 8901A Modulation Analyzer, 150 kHz-1300 MHz, HPIB **$1350.00**
HP 8901B-001 Modulation Analyzer, 150 kHz-1300 MHz, HPIB **$1900.00**
MPD LAB-1-510-10 Amplifier, 48 dB gain, 500-1000 MHz, 10 Watts **$750.00**
RACAL 9009 Modulation Meter, 30-1500 MHz, AM, 1.5-100 kHz pk FM **$350.00**
RF POWER LABS ML50 Amplifier, 2-30 MHz, 47 dB gain, 50 Watts, metered, 28 V **$200.00**
ROHDE&SCHWARZ ESH2 Test Receiver, 9 kHz-30 MHz **$3250.00**

COAXIAL & WAVEGUIDE

AEROWAVE 28-3000/10 WR28 Directional Coupler, 10 dB, 26.5-40 GHz **$300.00**
AMERICAN NUC. AM-432 Cavity Backed Spiral Antenna, LHC, 2-18 GHz, TNC(f) *NEW* **$95.00**
AVANTEK AMT-400X2 WR28 Active Doubler, +10 dBm in & out **$450.00**
BIRD 8201 500 Watt Oil Dielectric Load, DC-2.5 GHz **$350.00**
FXR/MICROLAB SL-03N Stub Stretcher, 0.3-6.0 GHz, 100 Watts max., N(m/f) **$75.00**
GENERAL RADIO 874-LTL Constant Impedance Trombone Line, 0-44 cm, DC-2 GHz **$400.00**
HP 11590A-001 Bias Network, 1.0-18.0 GHz, APC7 .... **$450.00**
HP 11691D Directional Coupler, 22 dB, 2-18 GHz, N connectors **$450.00**
HP 11692D Dual Directional Coupler, 22 dB, 2-18 GHz **$800.00**
HP 33327L-006 Prog. Step Attenuator, 0-70 dB, DC-40 GHz, 2.9mm **$1000.00**
HP 778D-011 Dual Dir. Coupler, 20 dB, 0.1-2.0 GHz, APC7 .... **$450.00**
HP 8498A-030 30 dB Attenuator, 25 Watts, DC-18 GHz **$500.00**
HP 87300C-020 Directional Coupler, 20 dB, 1.0-26.5 GHz, 3.5mm **$475.00**
HP K422A WR42 Flat Broadband Detector, 18.0-26.5 GHz **$350.00**
HP K532A WR42 Frequency Meter, 18.0-26.5 GHz **$450.00**
HP K752A WR42 Directional Coupler, 3 dB, 18.0-26.5 GHz **$450.00**
HP K752C WR42 Directional Coupler, 10 dB, 18.0-26.5 GHz **$450.00**
HP K752D WR42 Directional Coupler, 20 dB, 18.0-26.5 GHz **$450.00**
HP K870A WR42 Slide Screw Tuner, 18.0-26.5 GHz **$275.00**
HP K914B WR42 Moving Load, 18.0-26.5 GHz **$250.00**
HP Q752D WR22 Directional Coupler, 20 dB, 33-50 GHz **$650.00**
HP R281A WR28 x 2.4mm(f) Adapter **$600.00**
HP R422A WR28 Crystal Detector, 26.5-40 GHz **$400.00**
HP R752A WR28 Directional Coupler, 3 dB, 26.5-40 GHz **$450.00**
HP R752D WR28 Directional Coupler, 20 dB, 26.5-40 GHz **$450.00**
HP R914B WR28 Moving Load, 26.5-40 GHz **$250.00**
HP V365A WR15 Isolator, 25 dB, 50-75 GHz **$750.00**
HP V752D WR15 Directional Coupler, 20 dB, 50-75 GHz **$650.00**
HP X870A WR90 Slide Screw Tuner **$150.00**
HUGHES 45322H-1110/1120 WR22 Directional Couplers, 10 or 20 dB, 33-50 GHz **$350.00**
HUGHES 45712H-1000 WR22 Frequency Meter, 33-50 GHz **$750.00**
HUGHES 45714H-1000 WR15 Frequency Meter, 50-75 GHz **$900.00**
HUGHES 45722H-1000 WR22 Direct Reading Attenuator, 0-50 dB, 33-50 GHz **$1000.00**
HUGHES 45724H-1000 WR15 Direct Reading Attenuator, 0-50 dB, 50-75 GHz **$1000.00**
HUGHES 45732H-1200 WR22 Level Set Attenuator, 0-25 dB, 33-50 GHz **$250.00**
HUGHES 45752H-1000 WR22 Direct Reading Phase Shifter 0-360, 33-50 GHz **$1400.00**
HUGHES 45772H-1100 WR22 Thermistor Mount, -20 to +10 dBm, 33-50 GHz **$400.00**
HUGHES 47316H-1111 WR10 Tunable Detector, 75-110 GHz, pos. polarity **$600.00**
HUGHES 47741H-2310 WR28 Phase Locked Gunn Osc., 32 GHz, +18 dBm **$2000.00**
HUGHES 47742H-1210 WR22 Phase Locked Gunn Osc., 42 GHz, +18 dBm **$2750.00**
KRYTAR 201020010 Directional Detector, 1-20 GHz, SMA(f/f)/SMC **$200.00**
KRYTAR 2616S Directional Detector, 1.7-26.5 GHz, K(f/m)/SMC **$200.00**
M/A-COM 3-19-300/10 WR19 Directional Coupler, 10 dB, 40-60 GHz **$450.00**
NARDA 3000-series Octave Band Directional Couplers, N connectors **$150.00**
NARDA 3020A Bi-Directional Coupler, 50-1000 MHz **$500.00**
NARDA 3024 Bi-Directional Coupler, 20 dB, 4-8 GHz **$375.00**
NARDA 3090 Precision High Directivity Couplers **$225.00**
NARDA 368BNM Coaxial Hih Power Load, 500 Watts, 2-18 GHz, N(m) **$500.00**
NARDA 3752 Coaxial Phase Shifter, 0-180 deg./GHz, 1-5 GHz **$900.00**
NARDA 3753B Coaxial Phase Shifter, 0-55 deg./GHz, 3.5-12.4 GHz **$950.00**
NARDA 4000-series Octave Band Directional Couplers, SMA connectors **$75.00**
NARDA 4247-20 Directional Coupler, 20 dB, 6.0-26.5 GHz, 3.5mm(f) **$200.00**
NARDA 5070-series Precision Reflectometer Couplers **$300.00**
NARDA 562 DC Block, 10 MHz-12.4 GHz, 100 V max., N(m/f) **$65.00**
NARDA 765-10 10 dB Attenuator, 50 Watts, DC-5 GHz, N(m/f) **$165.00**
NARDA 791FM Variable Attenuator, 0-37 dB, 2.0-12.4 GHz **$500.00**
NARDA 792FF Variable Attenuator, 0-20 dB, 2.0-12.4 GHz **$375.00**
NARDA 793FM Direct Reading Variable Attenuator, 0-20 dB,4-8GHz **$225.00**
NARDA 794FM Direct Reading Variable Attenuator, 0-40 dB,4-8GHz **$375.00**
OMNI-SPECTRA 2085-6010-00 Crystal Detector, 1-18 GHz, neg. polarity, SMA m/f **$50.00**
PAMTECH KYG1014 WR42 Junction Circulator, 18.0-26.5 GHz **$250.00**
SONOMA SCI. 21A3 WR42 Circulator, 20 dB, 20.6-24.8 GHz **$75.00**
TEKTRONIX 2701 Step Attenuator, 0-79 dB, DC-1 GHz **$150.00**
TRG B510 WR22 Direct Reading Attenuator, 0-50 dB, 33-50 GHz **$900.00**
TRG V551 WR15 Frequency Meter, 50-75 GHz **$600.00**
TRG W510 WR10 Direct Reading Attenuator, 0-50 dB, 75-110 GHz **$1000.00**
TRG W551 WR10 Frequency Meter, 75-110 GHz **$750.00**
WAVELINE 100080 WR28 Terminated Crossguide Coupler, 30 dB **$200.00**
WEINSCHEL 150-110 Programmable Step Atten., DC-18 GHz, SMA **$450.00**
WEINSCHEL DS109 Double Stub Tuner, 1-13 GHz, N(m/f) **$150.00**
WEINSCHEL DS109LL Double Stub Tuner, 0.2-2.0 GHz, N(m/f) **$150.00**

COMMUNICATIONS

HP 37204A-003 HPIB Extender, fiber-optic connection *unused* **$250.00**
HP 4934A-J02 TIMS; CCITT option; battery power **$1650.00**
HP 59401A HPIB Bus Analyzer **$375.00**
TAMPA MW. LAB BUC1W-02W-CST Ku band Upconverter, 1 Watt 14.0-14.5 GHz WR75 *NEW* **$150.00**
TEKTRONIX 1411R-opt.04 PAL Test Gen., w/SPG12,TSG11,TSP11,TSG13,15,16 .... **$1400.00**
TEKTRONIX 147A NTSC Test Signal Generator, with noise test signal **$800.00**

MISCELLANEOUS

EG&G/P.A.R. 5302/5316 Lock-in Amplifier, 100 mHz-1 MHz, GPIB/RS232C **$2250.00**
FLUKE 2180A RTD Digital Thermometer **$500.00**
HP 59307A HPIB VHF Switch **$200.00**
P.A.R. 5206-95.98 Two-Phase Lock-in Amp., 2 Hz-100 kHz, GPIB **$1250.00**
TEKTRONIX TM5003 TM5000-series 3-slot Programmable Power Module **$450.00**
TEKTRONIX TM5006 TM5000-series 6-slot Programmable Power Module **$500.00**
TEKTRONIX TM503 TM500-series 3-slot Power Module **$150.00**
TEKTRONIX TM504 TM500-series 4-slot Power Module **$175.00**
TEKTRONIX TM506 TM500-series 6-slot Power Module **$250.00**
TEKTRONIX TM515 TM500-series 5-slot Portable Power Module **$250.00**

Circle #48 on the Reader Service Card.

News Bytes
Continued from Page 15

proactive when it comes to privacy issues," states Ken Chase, president of Privacy Corps. "The first course of action is to insulate yourself from intrusive marketing by equipping your telephone with one of these nifty devices."

Call-screening devices require no monthly fees, unlike those telephone companies charge for caller ID and call blocking, services proven to do nothing except aggravate the people who you do want to talk to — and drain your budget of $10.00 to $12.00 per month. Call-screening devices are an effective and inexpensive way to block telemarketing calls and remove your phone number from direct marketing call lists.

Privacy Corps searches out and tests privacy-protection devices, rating each for ease of use and effectiveness and selling only those deemed worthy of their money-back guarantee. Top products include the TeleZapper, an extremely popular call-screening device, and the Call Screener, Phone Butler, EZ Hang-up, and TriVOX units.

"By offering a varied selection of privacy-protection products at different price points," adds Chase, "we hope to appeal to a wide range of customers, ensuring Privacy Corps's message is broadcast loud and clear: you must wage war against those who want to exploit your privacy!"

by Edward B. Driscoll, Jr.

Micro Memories

In 1977, the Tandy Corporation (aka., RadioShack) found itself at a crossroads. Coming off the enormous hype of the CB radio craze — which it benefited from by selling truckloads of CB radios — it found itself wanting to replace the declining profits from those once hot radios.

A Tandy executive named John Roach found one in-house, when he noticed a number of Tandy engineers ordering something called a MITS Altair 8800.

As a result of a cover story in the January 1975 issue of *Popular Electronics*, The Altair was the first microcomputer to achieve any sort of popular success. But it was a kit, which required serious soldering skills to assemble. And even then, it was basically a box with lights and switches on the front. It also needed fairly healthy programming skills, a spare teletypewriter, paper tape reader, and a spare TV monitor to really make it work.

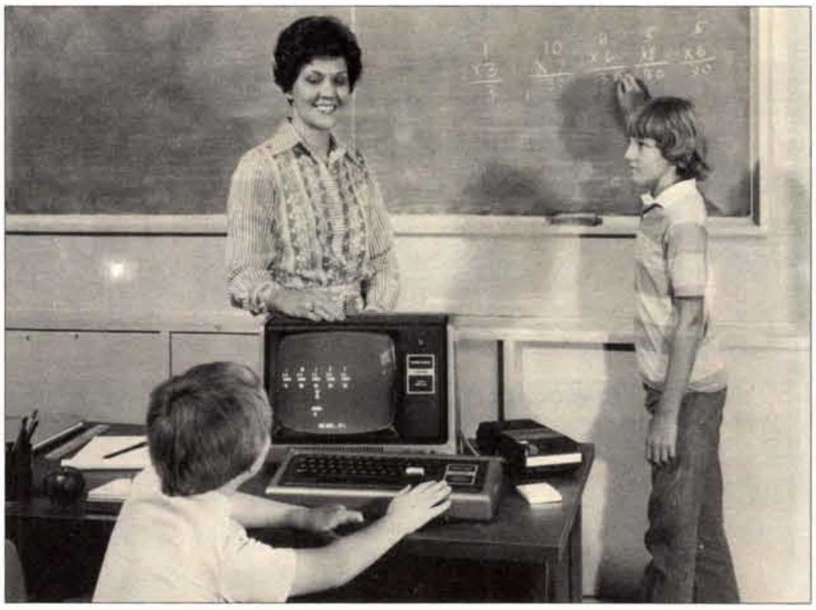
Seeing an electronics niche to exploit, Roach hired Steve Leininger, the head of the Homebrew Computer Club of Palo Alto, CA, to design what eventually became the TRS-80 Microcomputer System Model I. (Those TRS initials came, of course, from Tandy RadioShack. The 80 referred to the unit's 1.77 MHz Zilog Z-80 processor. The Model I designation didn't arrive until the summer of 1979, when Tandy introduced TRS-80 Model II.)

Only Leininger thought it would succeed. He told Roach, Charles Tandy himself, and Lewis Kornfeld, president of RadioShack that the TRS-80 would probably sell 50,000 units. Tandy and Kornfeld were thinking it would sell somewhere closer to the neighborhood of 3,000. Roach's response to Leininger's estimate was unprintable in a family magazine, but euphemistically referred to an equestrian methane emission.

55,000 Sold the First Year

On Wednesday, August 3, 1977, at a press conference at Manhattan's Warwick Hotel, Tandy released the TRS-80, with a retail price of $599.95. Despite the previous success of the Altair, despite the high-tech buzz that Star Wars was generating at the box office that summer, the press response — as usual when presented with something revolutionary — was a collective yawn.

Fortunately, the public response was 180 degrees different. They flooded RadioShack stores with orders, selling 10,000 units in the first month, and a total of 55,000 in the first year — even more than Leininger's prediction. The TRS-80 was the most expensive single item RadioShack had ever carried to that date, and RadioShack even required a $100.00 deposit to order the computer. Even so, they couldn't keep up with the demand, resulting in the units being backordered for several months.



The Model I was finally discontinued in January of 1981 due to its failure to meet the FCC's Radio Frequency Interference rules. By the time it was discontinued, it had sold over 200,000 units.

Aesthetics Be Damned

Compared to the Apple II, released just a few months earlier that same year, the TRS-80's aesthetics left much to be desired. The Apple II was a much more elegant piece of engineering. Whereas the Apple II came in a sleek white case, and screamed simplicity and ease of use (right down to the "A is for Apple" name), the TRS-80's aesthetics were basically non-existent. The monitor was simply a recycled black and white TV with its tuner removed, the CPU board of the computer was contained in the keyboard unit, and it first shipped with only four or 16 kilobytes of RAM. (Compare that to the 512 megabytes of RAM inside the computer I'm writing this on.)

Originally, the TRS-80 shipped with a very limited form of the computer language BASIC. Eventually, the ROM on the Model I was upgraded to allow for a 12K-sized Level 2 BASIC, which allowed for more sophisticated programming, although the TRS-80s it ran on saved those programs to a cassette recorder. (RadioShack would eventually make floppy disks available for the unit, which would sell for a staggering $500.00 each.) Level 2 BASIC and 16K of RAM would become the standard configuration for Model Is.

The Expansion Interface

Not long after releasing the Model I, Tandy created a $299.00 Expansion Interface for the unit, basically a squat case that fit under the monitor, molded in the same battleship gray that the rest of the TRS-80 came in. The Expansion Interface allowed the RAM to be upgraded to a bitchin' 32 or even 48K capacity. It also allowed for the use of two cassette tape units, a printer port, a floppy disk controller (which controlled up to four floppy disk drives), and a serial port.

One problem with the Expansion Interface was that the connectors on its 40-conductor ribbon cable — which interconnected with the CPU/keyboard — easily attracted dirt. On his "TRS-80 Home Page" site http://www.kjsl.com/trs80/index.html), Pete Cervasio wrote, "There was nothing more frustrating than to have a large program typed in only to have the machine decide it wanted to reset itself. The other problem was flaky connections at the serial port board. All these contributed to the name 'TRaSh-80.' The interconnect problem was bad enough to give rise to several companies that sold gold-plated connectors that could be soldered to the machine."

The Expansion Interface also allowed a modem to be plugged into the unit. I'll never forget going online to my first BBSs and even CompuServe in its early days of offering services to individual computer users. (Like many of the TRS-80 customers that Tandy originally marketed to, I had a CB radio in the mid-1970s. The thought of "online CB," which CompuServe was promoting — and to this day, typing "GO CB" in CompuServe will take you to their chat rooms — was just irresistible.)

Adventures in Computing

Besides BASIC, programs to drive modems, and early spreadsheet and word processing programs (all of which printed out to a dot matrix printer), a hugely popular series of games for the TRS-80 were Scott Adam's Adventure series. These text-based games were the direct successors to the text-based adventure games that ran on large university mainframes in the 1970s, and amazingly enough, up until the late-1990s, on CompuServe. Adams' original TRS-80 Adventure games can all be downloaded in versions playable on Windows PCs from his web site **www.msadams.com/**.

Speaking of web sites, for those who want to use their PCs to emulate a TRS-80, several emulators are available at Ira Goldklang's TRS-80 Revived site, with the entirely coincidentally named URL of **www.trs-80.com/**. For those who want to do more than emulate a TRS-80, working Model Is occasionally turn up on Ebay, as well as computer swap meets.

Pioneering Silicon Spadework

There's a Model I (with

Expansion Interface and Floppy Drives) currently housed in the American History Museum at the Smithsonian Institute, which speaks volumes about its pioneering silicon spadework in the late 1970s. I'd say it's probably a tie between how many of today's computer users cut their teeth on the TRS-80 as compared to the Apple II. The TRS-80s that came out of Fort Worth, TX weren't as sophisticated or flashy as their West Coast cousins, but they could provide an amazing amount of computing power to a neophyte. And they could be souped up to provide even more.

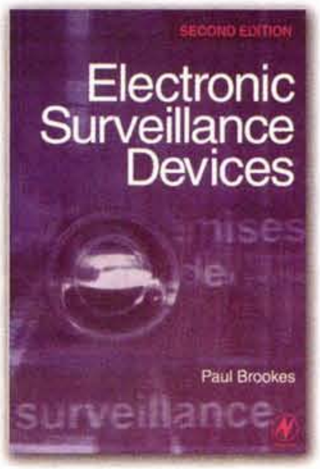
They really weren't TRaSh — for their day, they were terrific! **NV**

Keep your electronics library up-to-date with these latest reads —

New Books

Electronic Surveillance Devices
by Paul Brookes

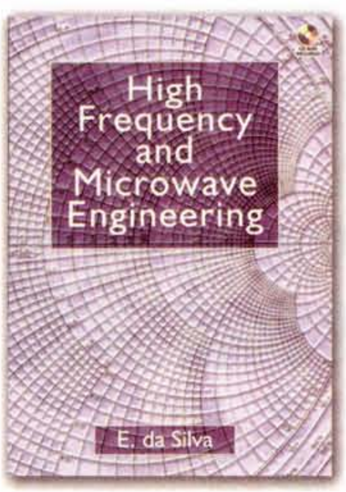
$39.99



This is the book that security professionals, security system installers and hobbyists have been waiting for. Paul Brookes launches straight into the practicalities of electronic surveillance with plenty of clear, detailed information on building the devices that are at the heart of surveillance and counter-surveillance. Self-build electronics projects are supported by principles and a brief survey of each type of device.

High Frequency and Microwave Engineering by E. da Silva

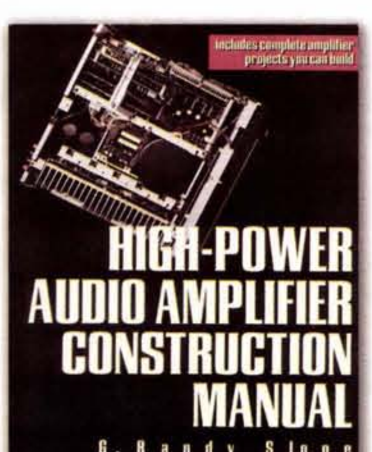
$52.95



With the increased use of mobile phones and computer wireless techniques, a need has developed for a book which provides students and industry with expertise in radio and microwave engineering. This text provides a comprehensive course in radio and microwave engineering. It also includes a CD-ROM containing the CAD package PUFF 2.1 for construction and evaluation of circuits and a comprehensive section on practical aspects of design.

High-Power Audio Amplifier Construction Manual
by Randy Sloan

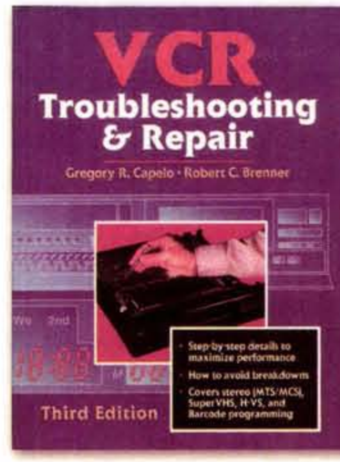
$34.95



Serious About Sound? Build showcase amplifiers that outperform store-bought models—at a fraction of the cost. Ideal for audiophiles, electronics hobbyists, and audio engineers, here is the ultimate audio amplifier dream-to-reality book, giving you leading-edge electronics tools for designing every detail of a superior high-power amplifier. Using Randy Slone's ready-to-construct recipes, you can—in less time than you think—put together an amplifier that's a major step up from commercial offerings. And you'll save hundreds, even thousands, of dollars doing it. The Best In Do-It-Yourself Audio Amplification. 12 complete designs, ready to build; Theory and principles for designing your own world-class amplifier.

VCR Troubleshooting & Repair
by Gregory Capelo & Robert Brenner

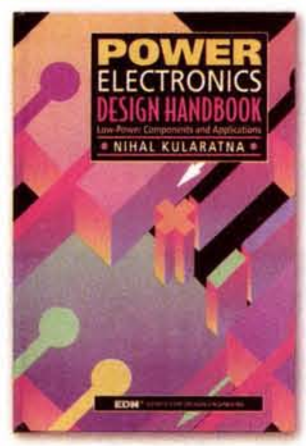
$29.99



The labor costs of even a minor VCR repair are very high, and warranties typically only cover the first 90 days of ownership. The first four chapters of this practical guide allow do-it-yourselfers to take charge of maintaining and repairing their own VCRs for optimum performance. Basic VCR and recording principles are explained so you can gain a better understanding of how your machine operates.

Power Electronics Design Handbook
Low Power Components and Applications

$65.00

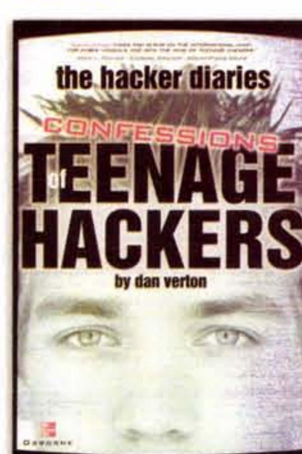


by Nihal Kularatna

Power Electronics Design Handbook covers the basics of power electronics theory and components while emphasizing modern low-power components and applications. Coverage includes power semiconductors, converters, power supplies, batteries, protection systems, and power ICs.

The Hacker Diaries: Confessions of Teenage Hackers
by Dan Verton

$24.99



On February 7, 2000, Yahoo.com was the first victim of the biggest distributed denial-of-service attack ever to hit the Internet. On May 8th, Buy.com was battling a massive denial-of-service attack. Later that afternoon, eBay.com also reported significant outages of service, as did Amazon.com. Then CNN's global online news operation started to grind to a crawl. By the following day, Datek and E-Trade entered crisis mode...all thanks to an ordinary fourteen-year-old-kid.

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.

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Learning RVK-Basic

Part 5

By Bob Vun Kannon

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

In this article, we will take up the subject of program structure.

In the good old days of programming, the only way to alter sequential code flow was to put in a jump instruction, also known as a GOTO in Basic. Code can be written using this statement and made to work, but when the program exceeds about one page in length, it becomes very cumbersome to keep track of what the program is doing. Generally, for solving real problems, it is better to avoid the GOTO statement. RVK-Basic has several ways to handle program flow without using a GOTO.

IF ... THEN ... ELSE ... END IF

In the previous article in this series, we already used the structured IF statement, but it will be good to state here how it works. The IF statement begins with an IF statement. The IF keyword must be followed by a comparison of some kind. For example, if we want to test whether a variable is zero,

```
IF x = 0 THEN
```

would work. Please note well that a space is required on either side of the equal sign. Also be aware that the THEN keyword is entirely optional.

If the test proves to be true, statements immediately following the IF statement will be executed next. If the test turns out false, program flow will continue with statements following the ELSE statement (if there is one) or the END IF statement. This could look something like the following.

```
IF x = 0 THEN
        ' statements here are executed if true
ELSE
        ' statements here are executed if false
END IF
```

There are four types of comparisons allowed in RVK-Basic.

=	equal
|	not equal
>	greater than
<	less than

Each of these symbols will require a space on either side of it for the compiler to recognize it. RVK-Basic does not allow more than one test per IF statement. You may not link multiple tests together with logic statements. You may not put expressions in the IF statement. Use only constants and variables. I highly recommend indenting executable code inside IF statements.

By all means, do indent other IF statements that may be nested inside an IF. For example, if you wanted to set bit B,2 only when x was 0 and y% was greater than z%, you could write:

```
IF x = 0 THEN
  IF y% > z% THEN
        SETBIT B,2
  ELSE
        CLRBIT B,2
  END IF
ELSE
  CLRBIT B,2
END IF
```

Once you try indenting your code to keep track of what is controlled by what, you will find it really does help you to read the code later.

GOSUB and RETURN

Often there may be a task that needs to be done in several places in your code. This can be handled by the GOSUB statement. The idea of this construction is easily seen with an example. Suppose we want to turn on B,2 and turn off B,1 and toggle B,3. We will write a subroutine (I'll call it DOIT2B). This subroutine will contain the instructions to do all these things we need. It will begin with a line label "DOIT2B:" and it will end with a RETURN statement.

This routine could be placed almost anywhere in the program, but I generally find it convenient to put the subroutines at the bottom of a program, after the main code. Now suppose that we wanted to execute this DOIT2B code if x was a 1, a 3, or a 6. We could write:

```
    IF x = 1 THEN
      GOSUB DOIT2B
    END IF
    IF x = 3 THEN
      GOSUB DOIT2B
    END IF
    IF x = 6 THEN
      GOSUB DOIT2B
    END IF
    END

DOIT2B:    SETBIT B,2
           CLRBIT B,1
           TOGGLE B,3
RETURN
```

You can see that the use of the GOSUB can reduce the size of your program. Also note well that DOIT2B: is a line label and must begin in the first column. Labels may never be indented in RVK-Basic.

THE CASE STATEMENT

The CASE statement is an excellent way to handle decisions based on a value. In the following code example, I do exactly the same job as we did above with multiple IF statements plus I've added a new subroutine to undo what DOIT2B does whenever none of the conditions are met.

```
    BEGIN CASE x
        CASE 1, 3
            GOSUB DOIT2B
        CASE 6
            GOSUB DOIT2B
        CASE ELSE
            GOSUB UNDOB
    END CASE

DOIT2B:  SETBIT B,2
         CLRBIT B,1
         TOGGLE B,3
RETURN

UNDOB:   CLRBIT B,2
         SETBIT B,1
         TOGGLE B,3
RETURN
```

Please note well that the CASE 6 and the following line are not needed if you simply add a ", 6" to the end of the first CASE statement. I wrote the code above just to show you that you can put multiple CASE statements inside a BEGIN CASE.

PROCEDURES

The only real problem with a GOSUB/RETURN is that the subroutine may modify variables used in the main program. This leads to real complications keeping track of which subroutines use which variables. This problem can be solved by the use of a procedure. In a procedure, the values of specific variables are passed to the procedure when it is called. When the program returns from the procedure, only the variables in the main program – which were explicitly named as outputs from the procedure when the procedure was called – are modified. Any other variables used inside the procedure are invisible to the main program. All of this is handled by a CALL statement, which calls the procedure. The SUB and END SUB statements begin and end the procedure. In the following example program, I will calculate

```
Z% = Y% / X%
```

as well as

```
P% = Q% / R%
```

and then I will convert P% from a binary number to a BCD (Binary Coded Decimal) format. For those not familiar with BCD, each nibble of an integer is used to represent one decimal digit. For example, 123 decimal is &H76 in hexadecimal, but it is also &H123 in BCD. The BCD form can be very useful when you need to write digits to a display.

```
CALL IDIVI(y%,x%)(z%)
CALL IDIVI(q%,r%)(p%)
CALL INT2BCD(p%)(p%)
```

```
'====INTEGER TO BCD PROCEDURE==========================
'= CONVERTS a% to n% in packed BCD format            =
'=====================================================
SUB INT2BCD(a%)(n%)
    n% = 0
    WHILE a% > 999
      a% = a% - 1000
      n% = n% + &H1000
    WEND
    WHILE a% > 99
      a% = a% - 100
      n% = n% + &H100
    WEND
    WHILE a% > 9
      a% = a% - 10
      n% = n% + &H10
    WEND
    n% = n% + a%
END SUB
'====END SUB INT2BCD==================================

'=======INTEGER BY INTEGER DIVISION===================
'= Performs an unsigned ineger division             =
'= answer% = top% \ bot%
'= NOTE: MSB of top% must be zero                   =
'=====================================================
'..tested OK 7/14/2000 - rvk
SUB IDIVI(top%,bot%)(answer%)
    IF bot% = 0
      answer% = &HFFFF
      EXIT SUB
    END IF
    answer% = 0
    ctr~ = 0
    WHILE bot% < top%
      IF bot% < &H8000
        INCR ctr~
        SHIFT bot%,1,LEFT
      ELSE
        EXIT WHILE
      END IF
    WEND
    INCR ctr~
    WHILE ctr~ | 0
      SHIFT answer%,1,LEFT
      IF top% < bot%
      ELSE
        top% = top% - bot%
        INCR answer%
      END IF
      SHIFT bot%,1,RIGHT
      DECR ctr~
    WEND
END SUB
'====END SUB IDIVI====================================
```

I strongly urge you to read the section of RB.TXT concerning the use of procedures. Note well that the number and type of parameters in the CALL statement must match the parameters in the SUB statement.

In our next article, we will continue the presentation of program structure as we take up the topic of loops. **NV**

New Product News

THE ZAP CHECKER — A "RECEIVER METER"

Alan Broadband Company announces the Zap Checker — a high-quality, hand-held instrument that detects and displays transmitted electronic energy. This new electronic device is comparable to a sensitive wide-band receiver with signal strength indicators.

The useable bandwidth of the Zap Checker extends from less than 10MHz to over 4.50GHz. This bandwidth includes cellular and wireless phones, microwave ovens, computer wireless devices, UHF, VHF, service band and ham radio transmitters, hidden "bugs" and surveillance equipment, baby and security monitors, FM and TV broadcasts, and even electronic car keys, and garage door openers.

The sensitivity of the Zap Checker is high — detecting cellular phones and covert "bugs" at more than 20 feet, transmissions from "sealed" microwave ovens at 40+ feet, and from VHF and UHF transceivers at more than 80 feet. The detection of transmitted signals on the Zap Checker is limited by the background level of radiated signals — usually determined by baseline FM and TV transmissions in the area.

The high sensitivity enables one to tune-up low power QRP transmitters and determine antenna radiation patterns from a distance (avoiding detuning effects) — to measure RFI signals and pinpoint RF leakage in cables, to locate hidden transmitters during "fox hunting," to determine the optimum placement of computer wireless equipment, to monitor the radiation level at the baby's crib, to detect hidden cameras, and audio bugs, etc.

The Zap Checker also has unique detection and display systems. Detection is in Logarithmic or Linear modalities. Display of the transmitted signal readings are either by an analog meter or by illumination of colored LEDs. The LED display allows the measurements to be viewed from a distance or at nighttime. A switch enabled silent vibrator mode is included for situations where it is undesirable to directly view the displays (such as at the top of a utility pole, or when monitoring covert transmissions at a meeting site).

The durable, portable Zap Checker operates on two AA alkaline batteries for more than 80 hours, weighs less than 5 oz with batteries, and readily slips into a pocket or purse.

The introductory price of the Zap Checker is $89.00, including shipping and handling in the USA. California residents add 8% sales tax.

ALAN BROADBAND CO., INC.
93 ARCH ST., DEPT. NV
REDWOOD CITY, CA 94062
650-369-9627 • 1-888-369-9627
WEB: **www.zapchecker.com**

SOLAR-POWERED MICRO-RADIO STATION KITS

Kenneke Communications releases several complete Solar-Powered Radio Station kits. These complete radio stations include everything to get on the air — from anywhere.

The solar power system allows the stations to be operated where no "mains" power is available. Stations are available in FM, AM, and short-wave versions.

These self-contained kits include all gear required to get on the air. A typical kit includes audio sources, microphones, mixer, transmitter,

New Product News

antenna, and solar charging set-up.

Basic electronics skill is required to build and install a solar radio station kit.

Solar powered radio stations are ideal for remote, rough, or undeveloped locations. These self-contained stations can be used for local entertainment, information, and political persuasion. Our solar stations can also be used for remote transmitter and translator sites.

Several different versions of the solar powered broadcast radio stations are available. For the US, a complete (FCC) Part-15 license-free kit is available. Outside the US, and for licensed US stations, full power solar radio station kits are offered. Custom built kits are also available.

For more information contact:

KENNEKE COMMUNICATIONS
829 WASHINGTON S.W., DEPT. NV
ALBANY, OR 97321
(541) 928-4552
EMAIL: **jon@kenneke.com**
WEB: **www.kenneke.com**

32-SEGMENT ADDRESSABLE SERIAL LCD CONTROLLER

Emerging Technologies, LLC announces the introduction of the 32SSLCD (32-Segment Serial LCD Controller). Order the controller only to use with your unique LCD display or order with a four-digit LCD already plugged onto the controller.

The 32SSLCD provides a simple interface to the control of LCD displays. The input is asynchronous serial communication and it outputs the required waveforms for LCD segment drive. Serial data is displayed on the LCD and is latched until new data is received. The input is a simple single wire serial interface. The serial communication requires a baud rate of 2400 bps, no parity bit, eight data bits, and one stop bit (2400N81).

The address and mode are user configurable using dip switches on the controller. The address is made up of a three bit sub-nibble (A0, A1, & A2) and eight addresses are available (0-7) so multiple 32SSLCDs can be used together on one serial line. The display mode (Md) is either 32-Segment mode (default) or Standard mode. The 32-Segment mode allows control of each of the 32 segments of the display via four bytes of serial data (plus ID and address bytes). The Standard mode is used to drive four digit displays with numbers (0 through 9) only.

Controller only is $34.95.

Data Sheets and additional technical information are available on the website. Visit www.emergingtech-llc.com and click on "Products."

EMERGING TECHNOLOGIES, LLC
MANITOWOC, WI 54220
920-694-0216
EMAIL: **info@emergingtech-llc.com**
WEB: **www.emergingtech-llc.com**

US232

US232 is a ready-made cable-and-software solution for enabling RS232 serial devices to talk to newer USB PCs.

The cost-effective US232 is based on FTDI's single chip FT8U232AM USB UART IC for transferring serial data over the USB.

US232 cable can be used on its own to instantly upgrade RS232 devices to USB without development time, and at very little unit cost.

FTDI's US232 cable solution with its royalty-free software drivers functions like a dream, and makes updating an old device a piece of cake — just ship the legacy device with an extra part — US232 cable.

US232 is a compact USB <=> RS232 0.5m cable in an attractive ice-blue translucent enclosure which uses the enhanced Sipex SP213EHCA as its RS232 level converter, so it can support RS232 baud rates of up to 460 kbaud.

US232 is available now from stock from $39.00 (qty. 1) including free Windows 98/2000/xP, Linux, and iMac drivers.

For more information, contact:

SAELIG COMPANY, INC.
1 CABERNET CIR., DEPT. NV
FAIRPORT, NY 14450
716-425-3753 FAX: **716-425-3835**
EMAIL: **saelig@aol.com**

VOICE-ACTIVATED REMOTE CONTROL

The Voice-Activated Remote Control is multi-lingual, and can learn the voices of up to four different users, so each of your family members can program their own commands. This is especially helpful for family members with different accents or different voice pitches who can't register the same voice commands as the primary user.

The remote has a pull-down extension that contains the buttons you need to control specific functions on your equipment, while the most commonly used buttons are on the surface, simplifying the process of locating the button you need, and streamlining the look of the remote.

Model #8167 can control up to four home theater devices. Model #8169 can control up to eight home theater devices, and features an LCD display. Both remotes use four AAA batteries (included).

Model #8167 Voice-Activated Remote Control $53.96.

Model #8169 Voice-Activated Remote Control w/LCD Screen $69.95. Please add $7.95 S/H. NY residents add sales tax.

For more information, contact:

LORD & WYATT COMMUNICATIONS
DEPT. VRC
147 HALSEY ST.
BROOKLYN, NY 11216-2103
718-789-7329

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:
Not everyone is into building robots. There's still plenty of interest in EV and RC projects, particularly "electric" gas gauges. A unique antique "non-gasoline" engine gets a tachometer, and baby quails are given a chance at life in a homemade incubator. Lots of information on ferrite, potted, and toroid magnetics. And the never-ending quest for missing parts — this time the spotlight is on Heathkit.

"Baby You Can Drive My Car"

Q. I am currently in the middle of a small electric vehicle project, and I have a couple of nagging questions in the back of my mind. My EV is built around a homemade recumbent bicycle frame and a small 90VDC motor. The motor was made by RAE Corporation (McHenry, IL), and the attached label says 1960 RPM at 1.3 amps. I don't know if this is running or stall current.

When I hook my multimeter in series with the motor and a 12-volt car battery, the running current (no load) is just under one amp. If I grab hold of the shaft, and stall the motor, the current jumps up to 1.6 amps. What perplexes me is that I would think that the current should be much, much higher — or at least that is what I have been led to believe. While surfing various web sites on EVs, I have come across a current measuring method that uses a "shunt." Should I be using one of these instead of the method I am using to see the true current?

I ask this because I need to know approximately how much power I'm taking from the batteries and how much further I can travel before my batteries (which will be lead-acid gel cells) drop below a safe operating point. Basically, I need a "gas gauge" for my batteries. If I knew exactly how much amperage my motor was drawing and knew how much power was left in my batteries, it would go a long way toward the construction of my vehicle.

Andrew L. Ayers
Phoenix, AZ

A. To answer your first question, the reason for the rather small current jump at stall has to do with the applied voltage. A 90-volt motor won't develop much torque at 12 volts, so a lot of that "running" current you are measuring is used trying to get the motor up to speed. At 90 volts, the current difference between running and stall will be more noticeable.

As for the a gas gauge, let's start with the current monitoring method you ask about. Whether you know it or not, you already have a shunt device inside your multimeter. But I think you'd find it rather cumbersome to have a multimeter dangling from the dash of your vehicle, so an external current shunt is definitely a must. The shunt works using Ohm's Law, where the shunt is a resistance through which a current flows, which develops a voltage across the shunt proportional to the current flow. For example, if the shunt resistance is 0.1 ohms and the current is one amp, the voltage across the shunt will be 0.1 volts ($E = IR = 1 \times 0.1 = 0.1V$).

Now to translate that voltage into something useful. This is easily done using an INA168 chip made by Texas Instruments and available from **Digi-Key (800-344-4539; www.digikey.com)**. The INA168 is a unipolar shunt current monitor housed in a space-saving SOT-23 plastic package. Using a single external resistor, the INA168 can monitor hundreds of amps in systems up to 60 volts. Figure 1 is a diagram of a 10-amp monitor.

As the motor current increases, so does the voltage across the shunt resistor. The resistance has been selected so that 10 amps equal 100 mV. The INA168 senses the voltage, multiplies it by 50, and outputs it to the LM339 ladder comparator. Each time the output voltage increases by one volt (about two amps), another LED is lighted until, at full throttle or stall, all four LEDs are lit. Notice that the voltage limit across the IC is 60 volts. If you want to monitor systems of higher voltage, unground the five-volt power supply (pin 2) so that it and the rest of the electronics float free of the system (motor) voltage — or you'll fry the chip. A floating power supply can be created using a battery of four 'D' dry cells. The INA168 doesn't need a motor ground to work.

But you're only halfway to creating a complete gas gauge. The above monitor will tell you how fast the power is being removed, but it won't tell you how much power is left in the batteries. For that you need a voltage monitor, like the one in Figure 2.

Again, a ladder comparator is used to light stacked LEDs as the power is drained from the battery. This time, the variable input (non-inverting) is held constant and the reference voltage is allowed to follow the Vcc supply voltage. The ladder has also been weighted for an expanded scale, where the LEDs span the range of 13.6 to 11.5 — the healthy working range of a deep discharge lead-acid battery. The LEDs are labeled Full to Empty in 1/4 increments; calibrate the LEDs using your multimeter (i.e., the 1/2 LED triggers at 12.5 volts) by adjusting the 2k pot. For other system voltages, drive the gauge via a resistor voltage divider.

To answer your final question: If the voltage gauge shows just 1/4 full, you want to go light on the gas (current) pedal — unless you feel like pushing your vehicle to the nearest electric "filling" station.

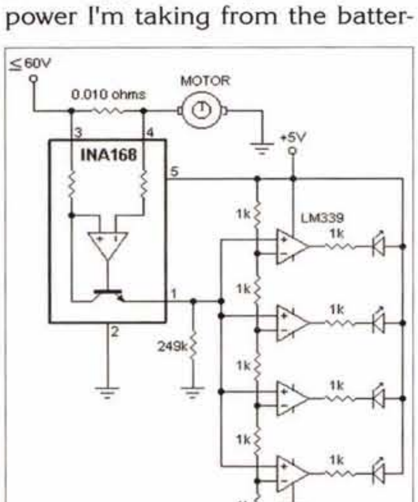


Figure 1

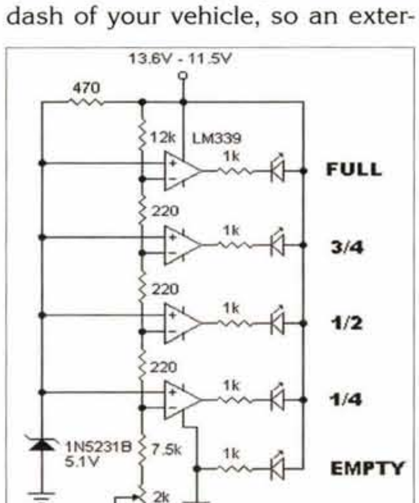


Figure 2

"Trains and Boats and Planes"

Q. I'm looking for a circuit that can measure high-currents which average 30 amps, but could surge up to 60 amps. The power source is NiCd batteries with a voltage range between 5 and 12 volts, and the load is an electric motor commonly used to power indoor RC model airplanes. The output will be processed by a serial A/D converter, like an ADC0831 or LTC1298, then input to one of the small PIC computers to monitor current over a short time. Can you help?

Don Jenkins
via Internet

A. I think so. What you need to do is break one of the power source lines and insert an "ammeter" — which is nothing more than a series resistor (R1) that generates a small voltage. The value of the shunt is selected to provide a usable input voltage to the A/D converter, which until recently, was done using op amps. But like the question above, "Baby You Can Drive My Car," TI's introduction of the current shunt monitor IC has simplified a lot of the design work. This time the INA138 in Figure 3 is the perfect chip for the job.

A 50-mV shunt is preferred for this application because of power dissipation concerns. For example, a 30A shunt (.0017 ohms) only dissipates 1.5 watts at 50 mV, as opposed to 3 watts at 100 mV, which leaves gives you more flying time. You can buy 50mV shunts with 1% accuracy from **Newark Electronics (800-463-9275; www.newark.com)**.

Next the gain of the INA138 has to be set; the gain depends on the voltage input range of the ADC. Let's take an arbitrary value of 2.5 volts — a common ADC input range. With a 50 mV shunt, the gain is 50 which requires a 249k resistor. Check out the table below for other gains.

Voltage Gain	Exact RL	Nearest 1% RL
1	5k	4.99k
2	10k	10k
5	25k	24.9k
10	50k	49.9k
20	100k	100k
50	250k	249k
100	500k	499k

Because the value of RL is so high (249k), a buffer op amp is required to prevent gain error caused by the input impedance of the ADC. Any rail-to-rail op amp will work, but for this application, I suggest one that works off a single supply, like the LM6132 or OPA340 — both available from Digi-Key. Running through the design, R1 generates a 50mV signal, which is detected by the INA138. That generates a voltage across RL, which is buffered by the op amp. After this, you're on your own to provide the reference voltage and input range you want for your PIC data logger. You must understand that I've never actually built this circuit — only ran it through the formulas — so you may need to adjust for offset and other variables that exist in the real world.

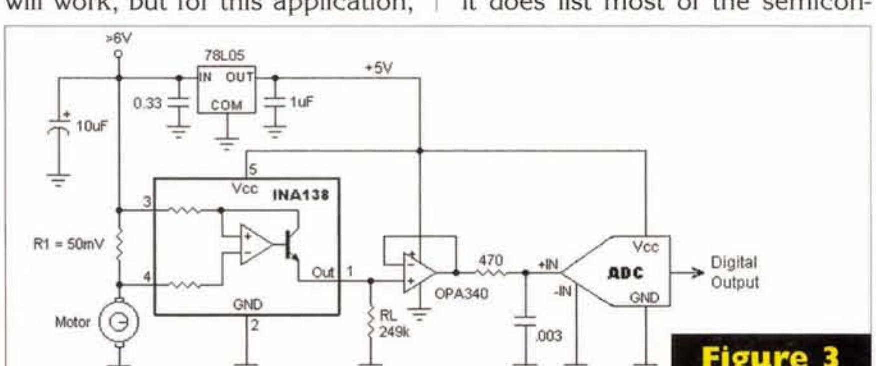


Figure 3

"I've Been Searching ..."

Q. I have a Reset Time Totalizer (Model C5) made by Industrial Timer Corp. that operates on 115 volts/60 Hertz. I want to build a Smart Outlet Box similar to the Heathkit Model GD-1295, which I will use to monitor the hours of use on an LCD projector lamp. I have a schematic, but it only refers to Heathkit part numbers. Do you know of a Heathkit parts cross reference?

Charlie Moore
OC IBM PC Users' Group

A. Despite the fact that Heathkit closed its doors 25 years ago, interest still runs high for its products — for good reason. At a time (shortly after WWII) when interest in electronics was high but money rather short, Heathkit provided the hobbyist with affordable radios and test equipment in the form of kits. So hardy was the breed that many of those kits are still in use today. You'd think Heathkit parts would be hard to come by, but surprisingly they too weathered the test of time. Here's a good cross-reference directory.

www.d8apro.com/heath3.htm

While this directory doesn't include all Heathkit part numbers, it does list most of the semiconductors. I've done the research for you, and annotated the Heathkit parts on the GD-1295 schematic in Figure 4. R1, listed as 9-150, is a positive temperature coefficient (PTC) thermistor, like the kind used in TV set degaussing coils. You can purchase this part from any TV repair shop.

Before you guys start yelling and screaming, "Where did you find that schematic?," let me tell you I took it off my Heathkit CD disk that I purchased at **www.ebay.com**. You can have one, too, by searching under the heading "Vintage Heathkit Schematics on CD - NEW!" or at the seller's web site — **te@usol.com**. The price is $9.95, plus $3.00 shipping. Another excellent source of Heathkit schematic diagrams can be found for free at **www.circuitarchive.co.uk/heath.htm**

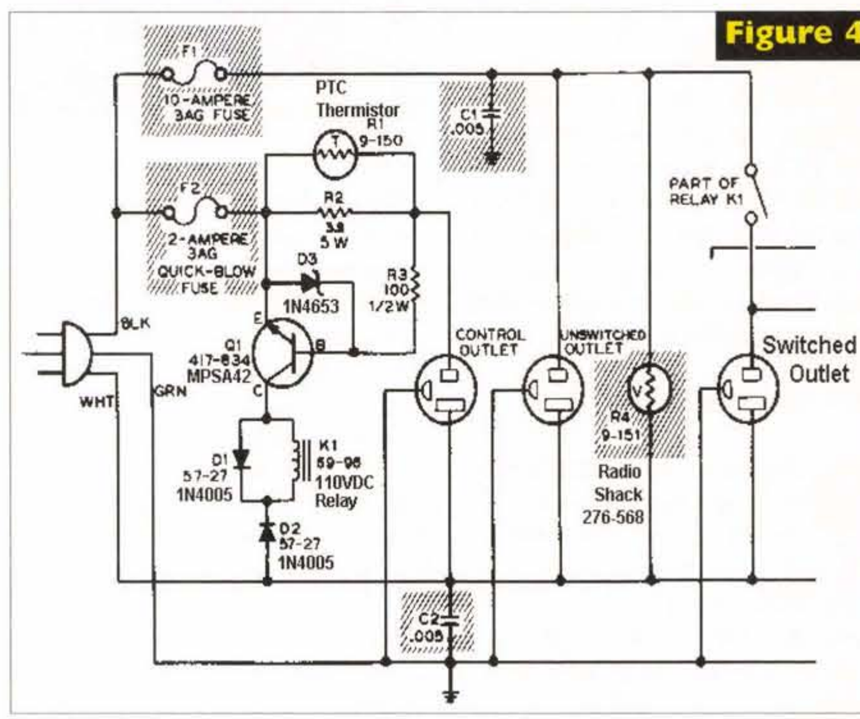
"Do You Hear What I Hear?"

Q. Where can I find a 24-inch-long (approx.) ferrite rod, like the kind used in AM radio antennas? I'm trying to build a really long ferrite loopstick antenna for my computer-controlled radio. I have seen several postings on the Internet describing a long ferrite rod, but have not been able to find a supplier. Preferably surplus (i.e., low cost). Also, where can I buy a metal can transformer (either RF or IF) to match the impedance of the ferrite loopstick to the receiver input?

Greg Kim
via Internet

A. As far as I know, they're not available on the surplus or retail market ... but you can special order them for a lot more

Figure 4



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www.webopedia.com/DidYouKnow/_index.html

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Interested in finding white papers, case studies, and research information on ASICs, DSPs, and much more? — The EDTN Networks e-library allows you to search for the latest information based on topic, keyword, or company name.

http://edtn.bitpipe.com

money than you're willing to pay for such a fragile item. Fortunately, you don't need one, long continuous rod; you can make one using segments of smaller rods, like the kind salvaged from old portable radios. The trick is to polish the ends of the rods so that the ends match up smoothly with no gaps.

Snub these pieces together as tightly as possible and secure in place, keeping the rod straight. I've never tried it, but I assume you can slide them into a long, cardboard tube such as the kind you can make by rolling kraft paper around a 1/4-inch wooden dowel and lacquered to hold its form. The individual rods are then inserted into the tube, pushed tightly together, and held in place with hot glue. Then wrap the coil windings around the assembly.

As for the matching transformer, this can be done using the rod, too. After all, the rod is nothing more than the core of a transformer. Before you remove the windings from the old rods, count the number of turns on a single rod that go to the radio's input and try that first. By sliding this winding up and down the rod, you can change the coupling and impedance match.

"Pinball Wizard"

Q. I recently purchased a new computer with Windows XP, but it doesn't have a game port for my old RadioShack joystick — only USB, serial, and parallel ports. Is there an adapter that can convert the USB port to a game port?

Patrick Szulczewski
Merrill, WI

A. Yes, RockFire makes one, as does Radio Shack. Prices range from $17.00 to $26.00. An alternative is to plug in an adapter card with a game port, which is a common component of 3D video gaming boards.

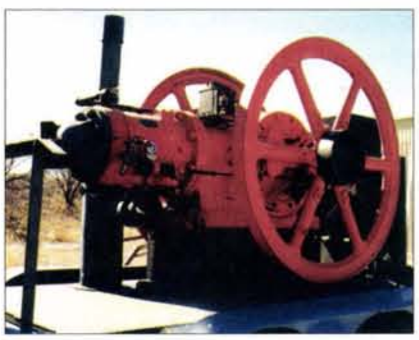
RadioShack 260-0164 — $16.99
www.radioshack.com

PC Cables — $19.00
www.pccables.com/70609.htm

USB|gear — $25.99
www.usbgear.com/usa/item_9.html

USBMax — $25.99
www.usbmax.com/usb-max/Products/view-item-detail.cfm?id=9

"Spinnin' Wheel Got To Go 'Round"



Q. I have a 1920 model Fairbanks-Morse semi-diesel oil engine (see photo above), mounted on a three-axle utility trailer, that I frequently display at antique equipment shows and other exhibitions. This particular engine was once used to drive a river bank irrigation pump. It runs on almost anything — except gasoline (I use kerosene), hence there is no spark plug, magneto, or electrical ignition system.

Now the question: Can you draw up a circuit that would add a tachometer to this thing? The engine is rated at 325 RPM, which I usually run at 160 RPM so as not to strain anything, which is far below the range of anything I can find commercially. I'm not fussy. The readout can be LCD, LED, or an analog meter — whatever works. And the sensor can be of any type. However, I don't want to mount anything (such as a magnet) on or near the flywheel rim because it travels 35 to 40 MPH at full speed.

Thomas Earnest
San Angelo, TX

A. After looking carefully at the four photos you sent me, I decided that an opto-tach would be your best solution. The circuit — Figure 5 — consists of a one-shot, monostable multivibrator (upper two 4001 gates) that's triggered by a phototransistor. Each time the multivibrator is triggered, it outputs a fixed-width pulse, that's conditioned by the lower 4001 gates. This signal is then processed by an integrating circuit made up of the 1N32A diode, 5.1k resistor, and 47uF capacitor. The output of the integrator is proportional to the width of the pulse and its repetition rate. The faster the pulse rate, the higher the output voltage, which is displayed on an analog panel meter. The meter can be any 0-1 mA panel meter, including a RadioShack 22-410 voltmeter (sans the 15k resistor). Of course, you'll need to either create a new scale with art supplies or use a multiplication factor for the original scale. For example, in the case of the RadioShack meter, you can set full scale at 300 RMP and use a 2X multiplier to read the correct value.

There are a number of places the phototransistor sensor can be mounted, but I had in mind mounting it behind the spokes and letting the ambient light (sunlight or incandescent lamp) act as the light source. (Don't use a fluorescent lamp for the source because its flicker will give you false readings.) As the flywheel spins, the spokes interrupt the light source six times per revolution, or about 16 times a second (16 Hz). The CAL pot adjusts the width of the one-shot pulse, and is used to calibrate the meter. The SENSITIVITY control is set so that the transistor is off when the spoke blocks the light from the source. Alternatively, you can place strips of reflective tape on the outer rim (or inner hub) of the flywheel and have the phototransistor monitor the reflected light for its trigger, thereby making the sensor less dependent on an ambient light source.

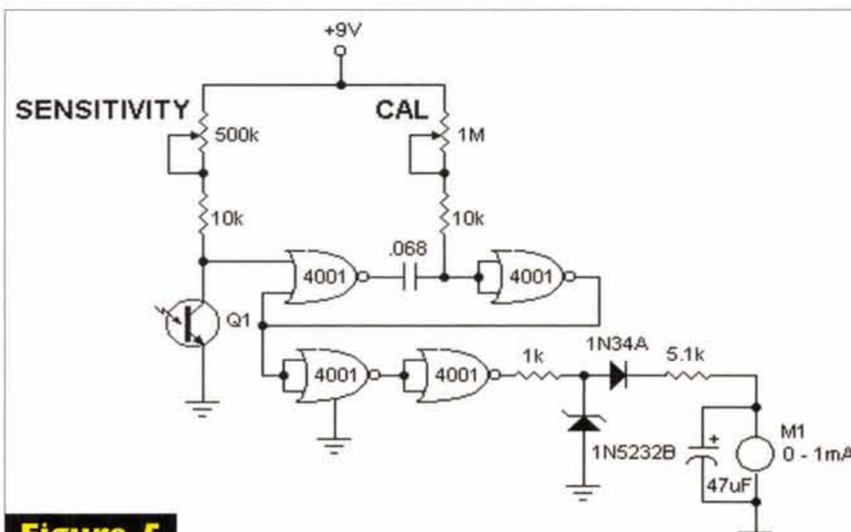


Figure 5

"A 'Bobbin' and a 'Weavin'"

Q. Can the small bobbin- and cylinder-shaped inductors found in abundance in computer monitors and present day TVs be used as "RF chokes" in radio receiver/transmitter construction projects? These small inductors (about 1/4" to 5/8" OD to about 3/8" to 1" long) measure less than 1 uH to over 15 mH and are wound on a non-metallic (ferrite?) core, with DC coil resistance of milliohms to several ohms. With a lab full of equipment, including a research grade Q-meter, how do you test the usefulness of these inductors for radio projects? Also, what is the purpose of the small permanent magnets glued to one end of some of these inductors? My LCR meter shows that the inductance increases when the magnet is removed.

Ted Roubal, PhD, KC7ZEO
Seattle, WA

A. These inductors perform two duties, depending on where they're located in the circuit. Mostly, you'll find them in the switching power supply where they serve as filter chokes. That is, they smooth out the ripple in the DC power supply outputs. They usually have fairly low DC resistance with high current capacity, and can serve the same purpose in RF designs.

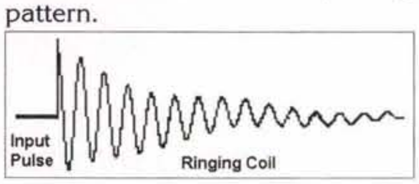
Those inductors that you see with attached magnets are generally used in a tuned tank circuit, where the magnet does exactly what you observed. It lowers the inductance to fine tune the monitor sweep oscillators. These, too, can be used in low-frequency filtering or resonant circuits. As for their use in the antenna or other power tuning parts of a receiver or transmitter, it's debatable. The inductors are more closely matched to 100-kHz than to MHz operation. Best you earmark them for power supply use.

"Ring My Bell"

Q. I bought a box of assorted toroids at a junk sale. How can I determine which are ferrite toroids and which are powdered iron type?

John Hassell VK6JAH
via Internet

A. A tricky way to determine the core content of a coil is to ring it with a pulse. Originally designed to test flyback transformers in tube-type TV sets for shorted turns, this test would ring a coil with a sharply-rising pulse then count the number of rings. A good coil would ring about 10 times before dying out, whereas a shorted coil would not ring at all. However, it was noted that the type of core material also affected the number of rings the coil would support. As the core metal "softens," the number of rings decrease — typically three rings for powdered iron. There's an array of core materials that exist between powdered iron and ferrite, each with its own unique ring pattern.



Generally, the test is performed using a pulse generator and an oscilloscope. However, I was able to run across this novel flyback tester (Figure 6), made by **Dick Smith Electronics (www.dse.com.au/)**, and sells for $48.80 (Australian) in kit form — model K7205.

In place of an oscilloscope, the tester uses LEDs to count the number of rings that occur after the coil is pulsed. The best way to test for the toroid core type is to ring a coil that you know the core material and note the LED pattern. As a rule, soft powdered iron will only light the first three LEDS, whereas a ferrite will light up to eight.

"Welcome To My World ..."

Q. I'm building my own incubator for hatching quail eggs. The temperature needs to be adjustable and maintained at

Editor's Tip: Reverse Battery Protection

A problem with battery-operated devices is that the electronics can be damaged if the battery is inserted backwards. Traditional solutions use a single diode or bridge configuration ahead of the circuit — both of which are voltage and power wasters.

A nifty alternative solution is the MAX4636 from **Maxim (800-998-9872; www.maxim-ic.com)** — the silicon equivalent of two single-pole, double-throw relays. Unlike a DPDT relay, each SPDT section is controlled individually. By properly cross-wiring these "relays," the backward-battery scenario can be prevented.

When you insert the battery with the correct polarity as shown, the upper switch, S1, is in its normally closed state, because its control pin is LOW. Consequently, the connection from pin 2 to pin 10 provides a path from the battery to the Vcc terminal. Conversely, the lower switch, S2, closes its normally open terminal (not as shown) because its control pin is HIGH. Hence, the path from pin 7 to pin 6 connects the battery's negative terminal to ground. Reverse the battery, and the logic gates flip. Tada!

P.S. All Maxim semiconductors can be purchased directly from Maxim.

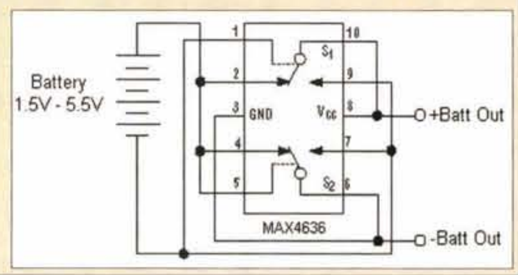
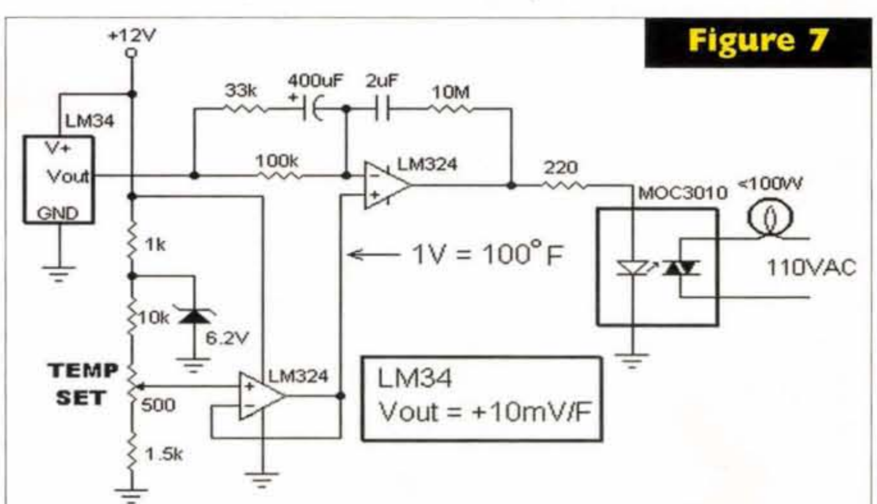


Figure 7



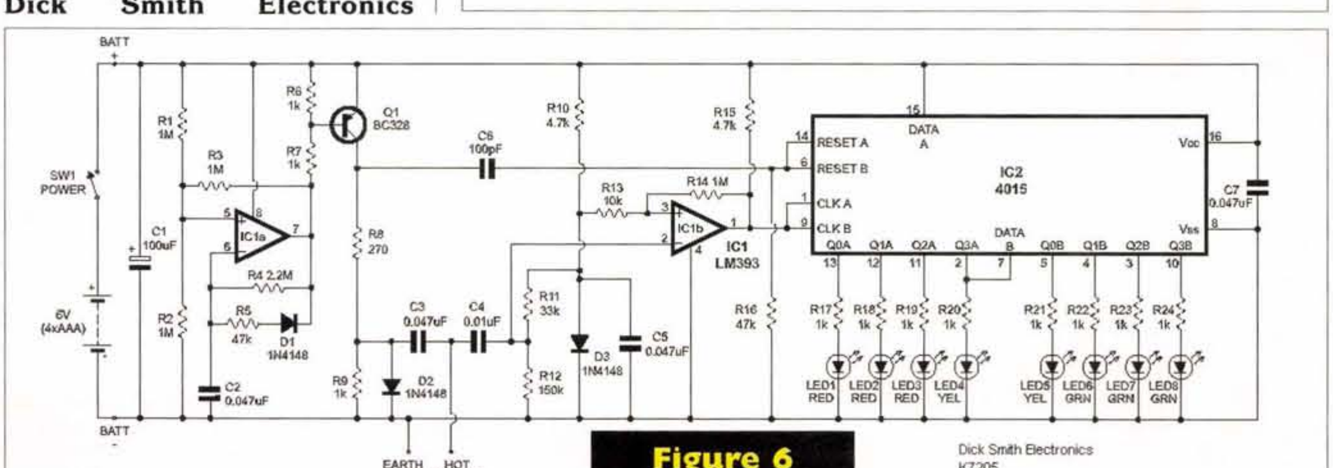


Figure 6

about 100 degrees, plus or minus no more than one degree. I plan on using a 60-watt light bulb for the heat source. What type of controller circuit would you use to do this?

Clyde.H.Timms
via Internet

A. Many years ago, I remember buying one of those inexpensive quail egg incubator kits. It was a small plastic dome with a night light for heat, no humidifier or temperature controller. Needless to say, none of the eggs hatched so I know the need for precise temperature control. I also know that temperature controllers can be very expensive. Fortunately, the price of IC temperature sensors has dropped down to the level of thermistors, which simplifies the design considerable — as shown in Figure 7.

The key component of this controller is the LM34 temperature sensor. It outputs a linear voltage that's equal to 10 mV per degree Fahrenheit. For example, 1.000 volts represents 100° F. This voltage is input to an op amp and compared to a reference voltage set by the TEMP SET potentiometer. If the sensor voltage is lower than the reference voltage, the triac optoisolator lights the lamp. When the sensor voltage equals the reference voltage, the lamp goes out. The temperature range of the control is 77° F to 123° F. The feedback capacitors and resistors around the op amp provide a time constant that prevents the circuit from oscillating. Don't forget to maintain the humidity at 60% during the incubation period.

MAILBAG

Dear TJ:

After reading your Mar. 2002 column, I felt I should write to you about "clamps." You describe them as voltage limiters, but that is not my understanding of the term "clamp" at all. In video and pulse electronics, a clamp is also called a "DC restorer." Its purpose is to restore a DC reference to a signal that has been AC coupled.

For example, a clamp may be as simple as a diode connected to a reference voltage (often ground) downstream of a capacitor, which "clamps" the (for example) most negative excursions of the AC-coupled signal to the reference voltage, causing all positive excursions to be positive from the reference level. This in no way changes the peak-to-peak level of the signal, but simply fixes one peak excursion to the reference voltage.

A more complex clamp is the "keyed clamp," which is structured as a switch driven by a pulse ("key") input during times when the AC-coupled input should be at a reference level. In video systems, the negative tip of the horizontal sync pulse is commonly used for the "key."

In both of these cases, the amplitude of the clamped signal is not limited in any way, but a fixed DC reference is restored. I believe that the proper name for the circuits you presented is "limiter" or, if limit thresholds are soft, "compressor."

Michael Mahon
via Internet

Build Your Own Multi-Frequency Digital Signal Generator

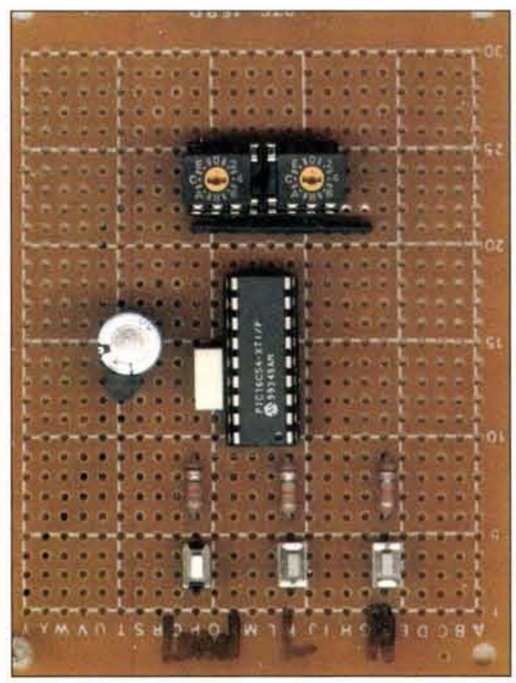
By Dennis Shepard

Someone once said that everything electronic could be reduced to a combination of three fundamental circuits: an amplifier, oscillator, or switch. To me, an oscillator or signal generator has been one of the most fascinating of these circuits. And one that has so many uses, as well.

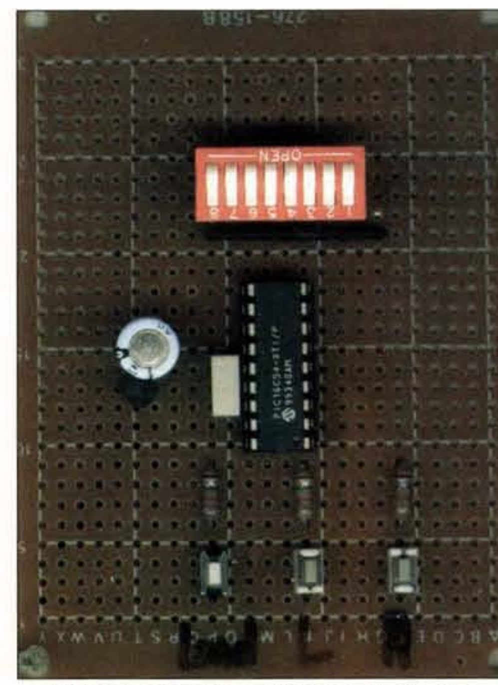
I'll never forget when I was a youngster living in Corona (where *Nuts & Volts* is located). A friend's father brought home some Unijunction Transistors (UJTs). He wired up a variable frequency oscillator using two resistors, one capacitor, and a potentiometer. I found it incredible that a single turn pot could sweep the entire range of audible frequencies!

With the dawning of the 'digital age,' many classic analog circuits fell to the wayside in the interests of more stable and accurate signal generation using Phased Lock Loops (PLLs) and other digital circuitry. One of the major drawbacks of digital was it was fairly expensive. Now, with the advent of microcontroller circuits, we no longer have that problem.

I have designed a multi-frequency digital signal generator capable of generating many thousands of frequencies using a row of eight DIP switches and three push-button switches. And it's as accurate as the crystal's accuracy used on the PIC's oscillator. In other words, a lab grade signal generator based on a PIC is now available for your own personal use and enjoyment!



HexaDecimal version breadboard.



DIP version breadboard. Note the SIP resistor pak instead of individual resistors.

Time and Frequency

It seems prudent to start this project off with the basics. We can define a 'cycle' as that period of time it takes a signal from the waveform's beginning until it repeats itself. For example, a 60 Hz sinewave starts at 0 degrees, progresses to 90 degrees for the peak of the positive portion, returns to 0 at 180 degrees, progresses to 270 degrees for the peak of the negative portion, and returns to 0 at 360 degrees completing the cycle.

Since 60 Hz is the same as 60 cycles per second, one cycle occurs in 1/60th of a second or approximately 8.33 msec. Now with squarewaves, the timing interval is the same regardless of the waveform. However, the rise and fall times are fairly instantaneous in this project as in one microsecond! So, to generate a squarewave, you would turn on the output, wait a period of half the cycle time, turn off the output, wait another half the cycle time and repeat the process continuously. That's essentially all it takes to digitally generate a squarewave.

Since the PIC we're using can execute instructions in one microsecond, all we have to do is calculate the number of cycles for a given frequency. We can do this by the formulae:

Frequency=1/Cycles and Cycles=1/Frequency

For example, a 50 Hz signal would require 20,000 cycles per second. So we would want to turn on the output for half that time, or 10,000 cycles. Then we'd want to turn off the output for another 10,000 cycles and repeat the process.

Nesting Loops as Counters

It would be tempting to tell you that we use a digital timing, but that's not really accurate. Instead, we actually 'count' the number of cycles that the processor runs. Since the PIC is an eight-bit machine, a counter would only be able to count from 0-255 and then roll over. While it's possible to monitor for rollover bits, there's a more efficient way to do it. Most of you are probably familiar with the BASIC Stamp made by Parallax. What some of you may not know is that Parallax wrote their own assembly language for the earlier PICs and included some enhanced instructions based on several of Microchip's original instructions.

Scott Edwards wrote and published a book five years ago on PIC source code which included many of the Parallax instructions. One of these is DJNZ, which stands for Decrease and Jump if Not Zero. Basically, it decrements the counter and jumps back to a location when the result is Not Zero. This instruction takes three or four microseconds to execute, depending on whether it's jumping to another location or not. Here's what the nested loop looks like with comments:

```
        mov   LO,#LoByte    ;move contents of LoByte into LO
                            ;register
        mov   HI,#HiByte    ;move contents of HiByte into HI
                            ;register

:loop   djnz  LO,:loop      ;decrease LO...if not 0...jump to :loop
        djnz  HI,:loop      ;decrease HI...if not 0...jump to :loop
        ret                 ;return from subroutine
```

We can see from this piece of code that LoByte is loaded into LO register and HiByte is loaded into HI register. These moves are necessary each time because once the looping begins, the values in the HI and LO registers are decremented until they reach zero. And we have to reload the correct values each time we call this subroutine to get the same cycle time. This loop will work with any value from eight to 197,128 cycles. Parallax has derived the following formula in one of their technical notes to calculate the values for the HiByte and LoByte values. Those formulas are:

Cycles=1/(2 x Frequency) x 1,000,000

HI=FLOOR(Cycles + 765)/770

LO=FLOOR((Cycles - (770 x HI) + 765)/3) - 2

Now let me explain a new mathematical term to some of you. FLOOR (x) evaluates to the nearest whole number (or integer) less than (x). If we used integer, the number would round up if the fractional value was more than half. And that would introduce an error. So we can say that FLOOR essentially strips the fractional value off the number.

Cycles are calculated as the number of one microsecond instructions to be counted before changing the output. So to calculate the values to program the signal generator for a given frequency, you will have to go through the following steps:

1) Determine the Frequency you want to generate
2) Calculate the number of Cycles required
3) Calculate the HI numerical value
4) Calculate the LO numerical value
5) Enter these values into the registers

Programming the Signal Generator

Now that we understand how to calculate the proper values, the next step is setting it up. We use another Parallax instruction known as XOR, which stands for eXclusive OR. We have selected RA.0 for our output pin. We use the XOR instruction to toggle that pin by executing the command XOR RA,#1. What this does is toggle or change states of the output of this one pin each time the program executes it. It takes up two cycles of time to execute this, so that's why we subtract two from the LO register to compensate for the time to execute this instruction. This also gives us an exact 50% duty cycle or equal on/off times.

Looking at the schematic, you'll notice that all three push buttons are Normally Open with pull-up resistors. The way we program the unit is to input the correct value on the DIP switches and then press either HiByte Load or LoByte Load and simultaneously press the Load/Run pushbutton. By the way, the signal generator defaults to 1KHz on start-up, which is a standard test frequency. You can program whatever other frequencies you want and keep a table of values if you want to change them often.

Multi-Frequency Digital Signal Generator Parts List

C1	47 uF 35 WVDC Electrolytic capacitor *(RadioShack #272-1027 or equal)*
***CR1**	4.00 MHz Ceramic Resonator *(Digi-Key #PX400-ND or equal)*
DIP1	Eight-position DIP switch *(RadioShack #275-1301)*
HEX1	Optional HexaDecimal DIP rotary switches *(Digi-Key #SW217-ND or equal)*
***IC1**	Microchip Technology PIC 16C54-XT/P microcontroller *(Digi-Key #PIC 16C54-XT/P-ND [requires programming])*
R1-R11	10K Ohm 1/4 watt 5 % resistors *(RadioShack #271-1335 or equal)*
S1-S3	SPST momentary contact push-button switch *(RadioShack #275-1547 or equal)*
Misc.	Hook-up wire, power supply, etc.

* The following items are available directly from **Shepard Engineering Concepts.** A kit of programmed IC1, CR1, and VR1 are available for $15.00 ppd. These prices are for the continental US only. **Please make payment to:** Dennis Shepard, 9309 Coulter Court, Bakersfield, CA 93311; (661) 665-1465. Preferred payment methods are money orders, certified checks, or Western Union.

Since the DIP switches represent a binary eight-bit number, you'll probably need a calculator that changes number bases. RadioShack, among others, carries them at a reasonable price. You can also replace the DIP switches with two HexaDecimal switches (RB.0-RB.3 for the lower nibble and RB.4-RB.7 for the higher nibble) and enter the code as 00-FF for the eight-bit range. If you're doing much frequency changing, it would be well worth your effort since you'll only have to change two rotary switches per register.

Excel to the Rescue

The sig gen object code for programming your own PIC, frequency settings chart, and calculator files are downloadable from the Nuts & Volts website at www.nutsvolts.com

I'm sure everyone who owns a computer knows what Excel is. It's a spreadsheet program that is widely used in business. One of the nice things about Excel is its Function option, which let's you put mathematical FORMULAS in a cell location. So what I've done is written an Excel worksheet that works on all versions from Windows 95 to their most recent release. You simply enter the frequency required, and the formulas will automatically generates the values for HI and LO, as well as displaying the Cycles required. Then all you have to do is program the switches, and you're in business!

Multi-Freq Digital Signal Generator Calculator

Frequency =	15,000.00
Cycles =	33
High Byte =	1
Low Byte =	7

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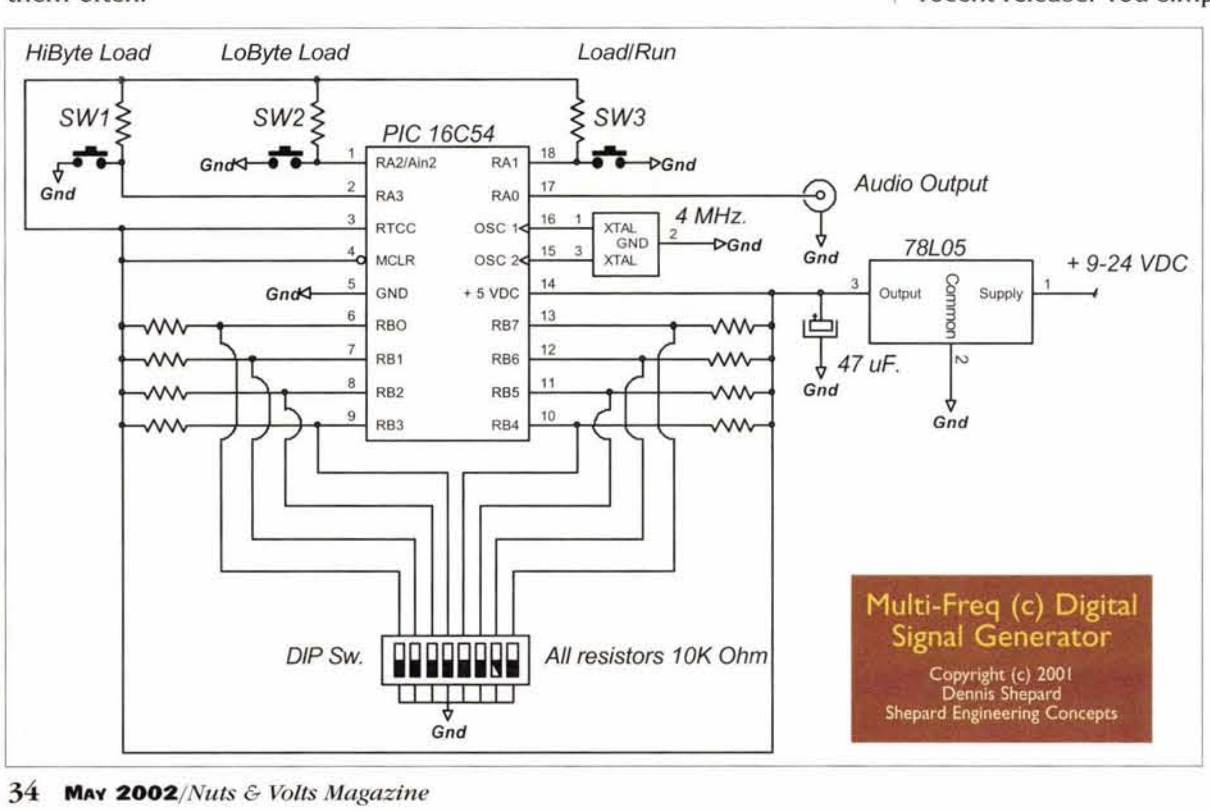

How Accurate is it Really?

I personally checked every frequency in the switch setting table provided and every frequency was within 1%. However, as the frequency increases, the resolution decreases. At the bottom end (~ 5Hz), you can calculate and generate values in the 1/100th of a Hertz range, but at the upper end above 10 KHz, the resolution drops off to hundreds of Hz. That's because as the frequency gets higher, you can only discern a few cycle's difference.

For example, 10 KHz is 50 cycles while 11 KHz is 45 cycles. So the resolution in this range is only about 200 Hz. That's the limitation of the eight-bit and integer math that the PIC is capable of. But for the price of about $25.00 in parts, you can't beat it! Enjoy! **NV**

by Robert Nansel

Amateur Robotics

It takes three or more unrelated ideas bumping together to make a cool robot project. Getting ideas to rub against one another is the heart of invention. It can't be forced. It relies as much on serendipity — on being in the right place at the time — as it does on skill or knowledge. Knowledge can even hinder invention when what you think you know ain't so (or, more subtly, when what you know is correct but irrelevant to the problem).

As a case in point, the idea for this month's project came last spring from browsing at my local hardware store and ignoring some of my well-intentioned engineering knowledge (the low mechanical efficiency of V-threads vs. Acme threads for power transmission).

The Inspiration Aisle

Hardware stores are well-loved by robot builders. Catalogs can't compare with being where you can see and touch the things that will become parts of your robot. I've always thought that the better part of engineering is intuiting when a design looks or feels right, with number crunching to back up the intuition.

Anyway, I was browsing in my local hardware store. I'm the type of customer who gives overly helpful sales' clerks fits because often I go to a hardware store for inspiration. I have no idea what I'm looking for, just that I'm certain I will recognize it when I see it.

My favorite places in the store are the aisles with things like fasteners, hinges, springs, and metal stock. This particular visit, I found my store carried much smaller threaded rod stock than I'd previously noticed, clear down to #6-32 thread in 12-inch lengths. Just 69 cents.

I spun a nut onto the threaded rod and twirled the shaft between my fingers to see how fast the nut advanced. I mulled that over and then thought of the spools of rubber tubing in the previous aisle and the tiny Namiki pager vibrator motors I'd just bought the week before. Might there be a linear actuator in such a combination of parts?

Linear Actuator

At the time, I was writing about BEAM-style robotics. I had in the back of my mind to find some way to get useful work out of surplus Namiki motors, which are very popular among the BEAM crowd because they're cheap and tiny (less than a quarter inch diameter). Only the difficulty of devising tiny, precise gearboxes for Namiki had stopped me from designing a robot around them. I'd need at least a watchmaker's lathe — and a watchmaker's skill — to even attempt it.

But what if I could couple the Namiki's shaft to a threaded rod and drive a follower nut? The 6-32 rod was too big, but a 4-40 or 2-56 would work. I could couple the

FIGURE 1: Experimental linear actuator design.

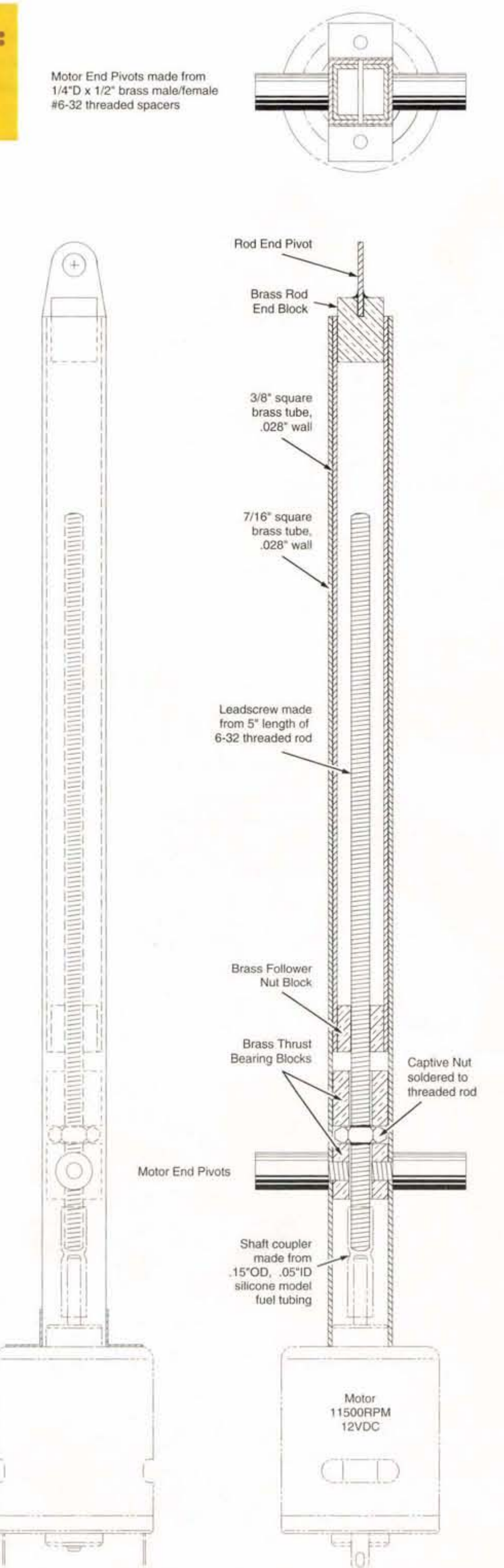

PHOTO 1: The essential elements.

FIGURE 2: Slide blocks.

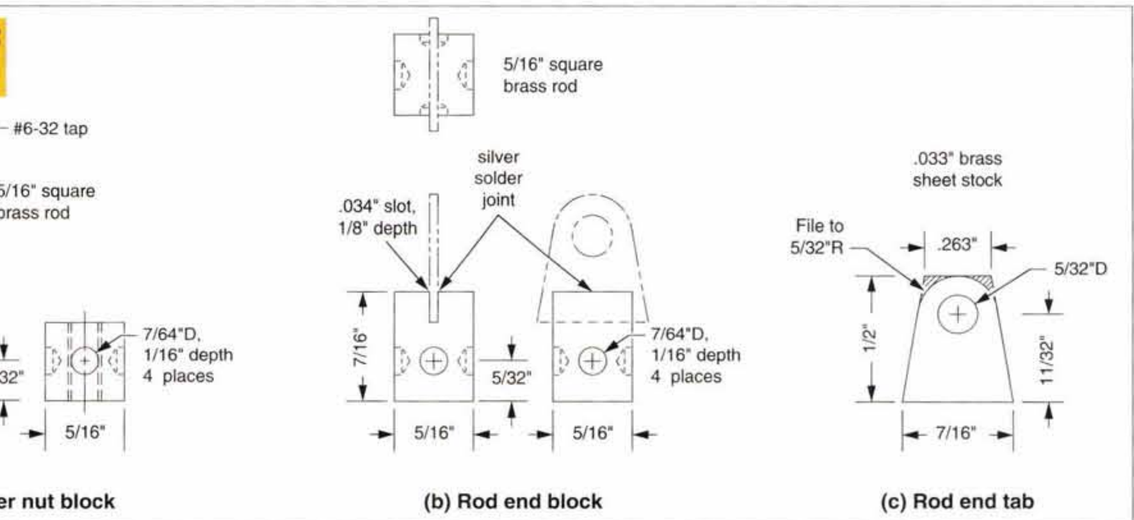

PHOTO 2: One more block to make and several holes to drill.

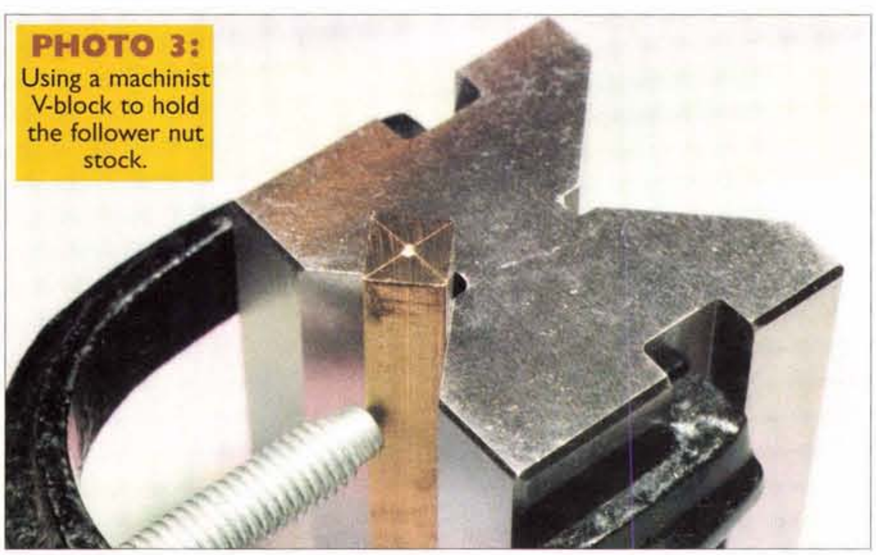

PHOTO 3: Using a machinist V-block to hold the follower nut stock.

PHOTO 4: V-block clamped to drill press table for drilling the follower nut.

threaded rod to the motor shaft with silicone surgical tubing, friction fit, and the tubing would absorb some of the inevitable shaft misalignment.

Even though the 6-32 was too big, I bought it anyway. I knew the idea should work with most any small motor, including the cheapie Mabuchi motors at RadioShack, my next stop.

Duct Tape Proof Of Principle

Any time you can spend less than $3.49 to do a proof-of-principle experiment, do it. I knew that standard V-thread screws aren't an efficient way to convert rotary to linear motion — that's why machine tools use Acme threads instead. The number I had in the back of my brain was about 50% efficiency. Hang the efficiency, though, if I could build a simple linear actuator with no gear reduction. It would be fast, small, and certainly cheap.

You couldn't dream of directly coupling a large motor to a heavier threaded rod simply because the surface speed of the rod threads would be too high. It would burn up the nut in short order. But a 6-32 threaded rod has a maximum diameter of .138" (usually more like .125") and thus a circumference of .434". If you rotate the rod at 11,500 RPM, the surface speed would be about 415 feet/min, tolerable for intermittent duty. The follower nut should travel a zippy six inches per second.

I tried the simplest experiment I could to get a feel for the speeds and forces possible. RadioShack's #273-255 12VDC motor has a .09" shaft, so coupling that to the 6-32 threaded rod was no problem with a bit of silicone hobby fuel tubing. A plain hex nut with no lubrication served as the follower. I taped the motor to my bench, and I held the lead screw in alignment by grasping the follower nut. With 12V, the nut scooted smartly the 12" length of the lead screw in just under two seconds. The nut pushed hard enough that I had to hold the motor with my other hand to keep it from breaking free of the duct tape. The set-up worked fine pushing or pulling, and none of the parts seemed harmed or stressed at all.

If I had looked up the efficiency formula for V-thread screws in my engineering manual and plugged in the numbers, I would have been appalled to discover the theoretical efficiency for a 6-32 screw should be in the 13% to 30% range. I probably wouldn't have tried my proof-of-principle experiment.

By ignoring that knowledge, I was able to convince myself the core principles were sound, despite the low theoretical efficiency. Converting that conviction into a practical system with proper mechanical slides, motor mount, limit switches, and the like would take a lot more work, so that's where I left it until now.

Now To Build It Without Duct Tape

What I want is a fast, cheap linear actuator for my robots. All machining must be do-able with a drill press and simple hand tools. It would be nice to use Namiki pager motors, but my first priority is a system using cheap, high-speed hobby motors.

A hexapod walker — a good candidate for linear actuators — could require 12 or more actuators, so the design needs to be quick to assemble. This rules out mounting screws for the blocks. Brass is soft, so punching is an option, and brass solders well, so I would try that method, too.

Figure 1 shows my basic design. Though it works, sort of, it isn't yet a complete design (it's missing limit switches, among other things). I also ran into some minor hitches while building it which I'll talk about later. For now, think of it as an experiment in progress.

The mechanical slides are made from telescoping brass tubing and square brass stock from the Small Parts catalog. The 7/16" sq. tube in Figure 1 is 7" long, and the 3/8" sq. inner tube is 5" long; this combination allows a 3" stroke without binding. The square tubing resists torques from both the motor and the load and simplifies mounting. Both the tubes and the solid stock are easily cut with an X-ACTO™ razor saw and miter box.

After I first cut the tubes, they telescoped all right, but it took several pounds of force to move them. I filed and scraped the surface of the 3/8" tube and the openings of the 7/16" tube until the smaller tube slipped freely in the larger tube. Now the smaller tube slides out with no more force than its own weight.

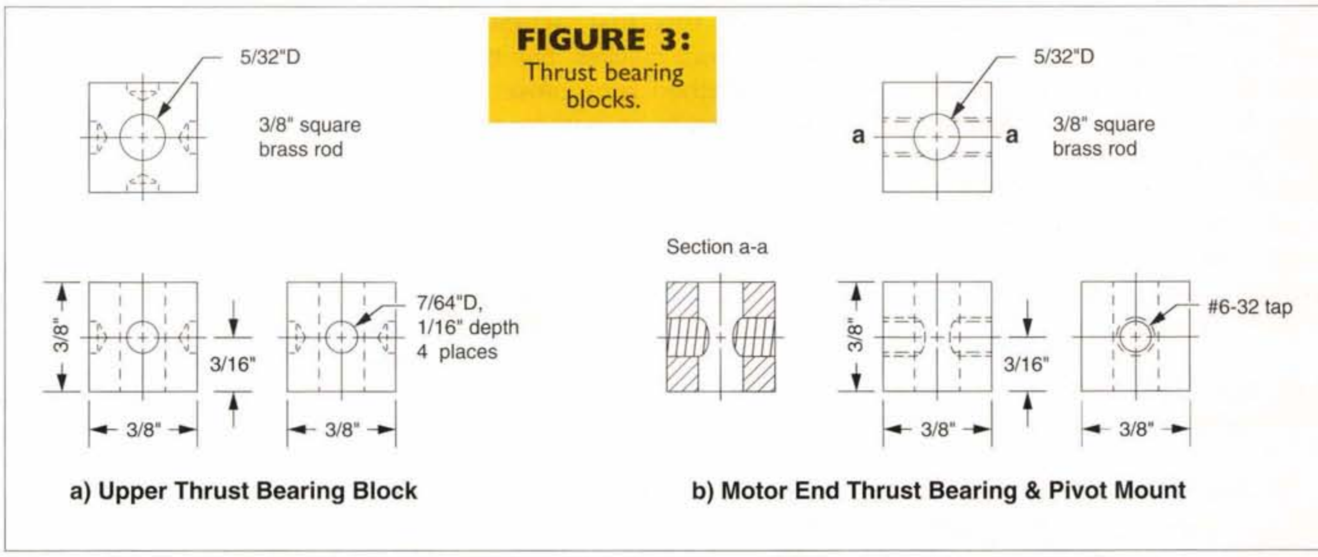

FIGURE 3: Thrust bearing blocks.

Machining And Mounting The Blocks

The parts shown in Figures 2 and 3 are small, and holding them with pliers while you machine them isn't precise enough. Properly speaking, a lathe is the right tool for this job. Most of the troubles I had building it stem from not having a lathe. I figure most of you don't have lathes either, so I'm working to perfect methods to reliably build it without a lathe.

A C-clamp works fine for rough-cutting the blocks in the miter box, but to finish the blocks — especially to drill the through holes and tap threads — you'll need a V-block and step clamps or a machinist vise to hold them (Photos 3 and 4).

I couldn't use the miter box for the slot of the rod end block, so I first cut a starting slot 1/8" deep freehand with the razor saw, which makes a kerf about .01" wide (Photo 5). I then enlarged the slot with an 18T hacksaw and smoothed the rough sides with a Dremel abrasive disk (Photos 6 and 7).

The shallow 7/64" holes on the faces of the blocks are used to help fasten the blocks by either of two methods. Either solder through matching holes in the tube or center punch "dimples" through the tube walls into the shallow holes. In either case, mark the tubes to match, but don't center punch them yet.

To secure a block with the solder method, first drill matching holes through the tube walls. Do this with a length of square steel bar inside the tube so center punching and drilling the holes won't deform the tube walls so much that you can't slide the brass block or tube through it. You may need to use the steel bar to deburr the holes by running the

Stock Description

Qty.	Part Dimensions	Vender	P/N
	Square brass tube, .028" wall, 7/16" x 36"	Small Parts	SBT-28/7
1	7" x 7/16" x 7/16"		
	Square brass tube, .028" wall, 3/8" x 36"	Small Parts	SBT-28/6
1	5" x 3/8" x 3/8"		
	Square brass, 5/16 x 12"	Small Parts	ZSB-5-12
1	5/16" x 5/16" x 5/16"		
1	7/16" x 5/16" x 5/16"		
	Square brass, 3/8 x 12"	Small Parts	ZSB-6-12
2	3/8" x 3/8" x 3/8"		
	Brass angle, 1/4" x 1/4" x 12", .014" thick	Small Parts	BAA-4-12
2	7/16" x 1/4" x 1/4"		
1	Steel 6-32 threaded rod, 5"		
1	Steel 6-32 hex nut		
1	Motor, 12VDC, 11,500 RPM	RadioShack	273-255

Small Parts, Inc.,
13980 N.W. 58th Court, P.O. Box 4650, Miami Lakes, FL 33014-0650
tel: **(800) 220-4242**, **(305) 557-8222**; fax: **(800) 423-9009**
URL: **www.smallparts.com**

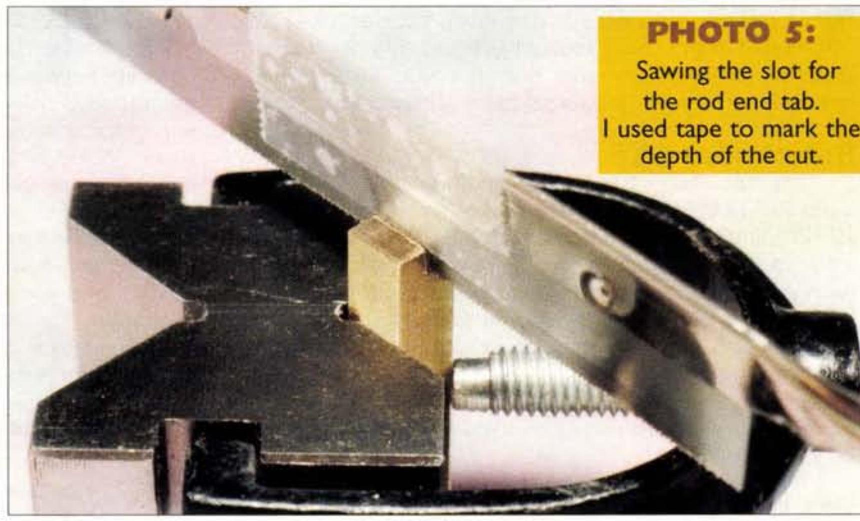

PHOTO 5: Sawing the slot for the rod end tab. I used tape to mark the depth of the cut.

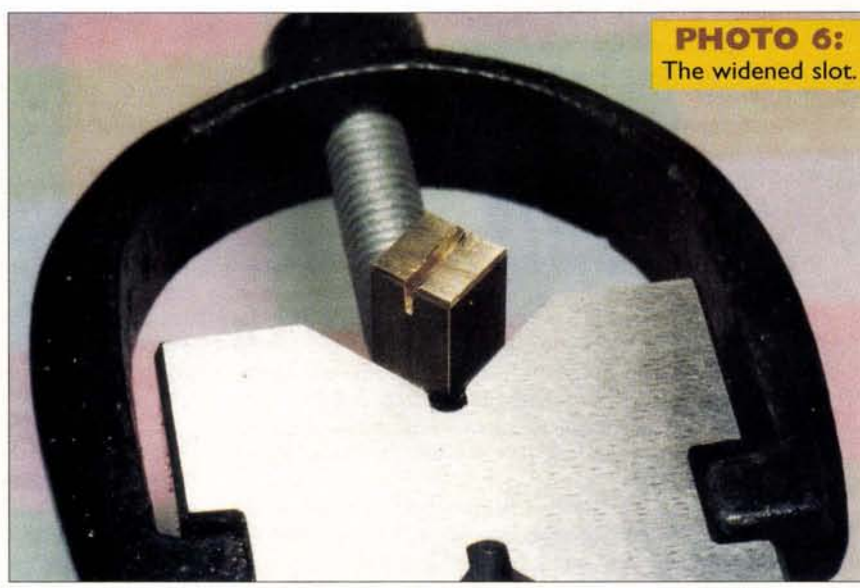

PHOTO 6: The widened slot.

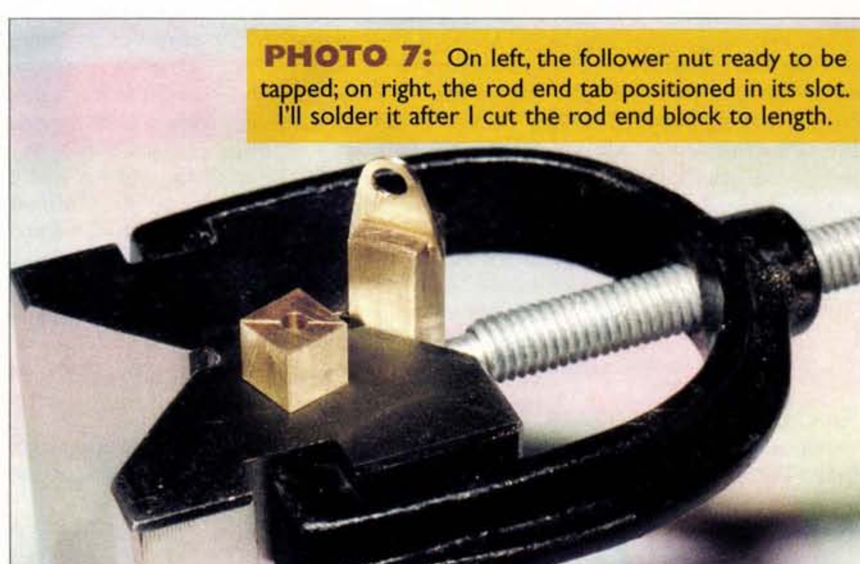

PHOTO 7: On left, the follower nut ready to be tapped; on right, the rod end tab positioned in its slot. I'll solder it after I cut the rod end block to length.

steel bar through the tube, tapping out any brass chips, and repeating the process until the brass block or tube slides freely.

Soldering a block is just a matter of lining up the solder holes of the tube with those of the block, applying flux, and heating the joint with a small butane torch to melt the solder.

Let Me Get This Straight ...

I used the center punch method rather than the solder method for this first actuator because it was quicker, but the soldering method may prove to be more accurate, at least for the follower nut block. If all the holes and dimple locations aren't perfectly lined up when you whack the center punch, it's possible for the block to end up canted in the tube. This is most critical with the follower nut.

In this first attempt, the threaded rod deviated from the centerline of the 3/8" tube enough to touch the tube's wall 4.85" from the nut. This means the threaded rod is at a 1.5 degree angle from the centerline of the tube.

Would such a small angle matter? I did a quick test to find out. I assembled the motor, telescoping tubes, follower nut, and surgical tubing, but left out the thrust bearings. The thrust bearings would have reduced the maximum misalignment of the shafts, but the threaded rod would then be rubbing on the clearance holes of the bearings, something they weren't designed for. Not only that, the threaded rod would flex with each revolution. Friction would be high, and it would be a race between the bearing and the threaded rod to see which would fail first.

My prototype worked great without the thrust bearings — for a few seconds. As long as the slide tube was mostly retracted, the ends of the threaded rod and motor shaft stayed in close alignment. On extension, though, the increasing misalignment caused the silicone coupler tubing to tear. You could use stronger, stiffer tubing, such as Tygon, but it's better to get the alignment closer in the first place.

By eye, the block looked centered and square with the tube, but the block itself may not have been perfectly square (it's hard to tell with such a small part). The block measured .310" on a side, but the inside dimension of the 3/8" tube was .318", so the block could have tilted as much as .008" in .310".

Doing the trig, this comes out suspiciously close to the 1.5 degree misalignment mentioned above. Doubling the length of the follower nut to .620" would cut in half the possible misalignment angle.

Another source of misalignment is the nut's drilled and tapped hole. Next time, I'll lay out the hole location under a magnifying glass to be sure it's accurately centered on the block face. Then, too, I tapped the follower nut threads of my prototype freehand and, in starting the tap, I may have angled it slightly.

Better Ways For Next Time

I should have left the nut block in the drilling set-up of Photo 4, then chucked up the tap in place of the drill bit, and used the chuck to hold the tap. Do not turn the drill press on to tap the threads; this will instantly shatter the tap (and your composure).

Instead, unplug the drill press and turn the drive pulley by hand to start the first few critical threads.

I should also have kept the follower nut in alignment while center punching the dimples. This could have been done by threading a section of the rod through the nut and holding the end of the rod centered with the

---

The last couple weeks I've received several new robot-related items that I haven't yet had time to evaluate. You'll be hearing lots more over the next three months, but for now I'll just give some quick summaries.

Solarbotics BEP

The Solarbotics Bicore Experimenter's PCB — "BEP" — is a set of 12 BEAM function modules or tiles on one 7.75" x 10.125" double-sided printed circuit board. BEP is based on a 40mm x 40mm modular grid of pre-scored, snap-apart tiles (with some half-size 20mm x 40mm, and quarter size 20mm x 20mm tiles). Each tile allows you to build a single BEAM function module for use alone or with other BEP tiles.

The functions include:

- A generic Bicore breadboard (BC1, three each) and two kinds of prewired Bicore oscillators (BC2, six each, and BC3, three each).
- Two kinds of solar engine circuits on half-size tiles (PM3, four each, and MSE1, six each).
- An inverting multiplexor (IMx, three each) for routing enable signals. These are useful for motor-reversing logic.
- An eight-channel motor driver (MD2, two each).
- A motor driver meant for unmodified hobby servos (SC1, two each.
- Half-size tiles with solderable leg mounting pads to simplify mounting wire legs to hobby servos (LMP1, 10 each).
- Quarter-size charging jack/power switch modules (CHG, three each).
- Two different quarter-size generic breadboard tiles (BB1, nine each, and eight-pin, two each).

Altogether, you get 51 separate tiles. The BEP sells for $35.00 US, so that makes the average price per tile just 69 cents. You could easily spend an hour or two hand-wiring and debugging any one of these functions. With a BEP, tile it would take maybe as much as 15 minutes to do the same job. I'd say 69 cents to save an hour or more of labor is a darn good deal.

What takes the BEP beyond being a mere bargain is that the folks at Solarbotics grouped most of the function tiles into arrays that allow you to build several entire BEAM robots. For instance, they've grouped a BC1, an IMx, two BC2s, and a PM3 on a strip to form the core of a solar-powered, two-motor reversing walker with tactile sensors. Next to that array is an almost identical one, but with quarter-size CHG and BB1 tiles instead of the PM3 solar engine tile. This would let you build a battery-powered walker. Or you could combine the two strips to make a four-motor walker electronically equivalent to the Solarbotics ScoutWalker 2. Yowza!

Solarbotics
179 Harvest Glen Way NE
Calgary, Alberta
Canada T3K 4J4
(403) 818-3374
www.solarbotics.com

TAOS Color Sensors

The TSLx257 series of color light-to-voltage sensors from TAOS, Inc., include a photodiode, transimpedance amplifier, and integral color filter in a three-pin package. You connect ground and +5V to pins 1 and 2 and read the sensed light intensity as a 0 to 5V analog voltage on pin 3.

The TSLR257 senses red, the TSLG257 green, and the TSLB257 blue. Despite the integral color filters, all three parts still have substantial response in the near infrared, so to get true RGB color measurements, you need to add an external optical filter to block IR. The data sheet shows that with a Hoya CM500 IR-blocking filter that the TSLR257 peaks at about 611 nm, the TSLG257 at 540 nm, and the TSLB257 at 480 nm.

Combine these three parts with eight-bit A/D converters (and perhaps some voltage-scaling op-amps to equalize sensitivity), and you have a simple 24-bit RGB color sensor for your robot. Or use their analog sensors with a Solarbotics SC1 ServoCore driver and a couple BB1 breadboards to make a color-sensitive light tracker. Hmmm ...

Texas Advanced Optoelectronic Solutions, Inc.
800 Jupiter Road, Suite 205
Plano, TX 75074
(972) 673-0759
www.taosinc.com/products.htm#tslx257

CMUcam Color Vision Board

The CMUcam combines a 75MHz SX28 microcontroller board with an OV6620 Omnivision CMOS single-chip camera. Together they make the world's first under $100.00 robot color vision system.

CMUcam was developed at Carnegie Mellon — the user manual is copyrighted by Anthony Rowe and CMU. It has also been licensed by start-up company Seattle Robotics, not to be confused with the Seattle Robotics Society. (Seattle Robotics has a nifty preassembled robot platform that's worth a look, too. It's called Easybot and sells for $175.00. Check it out.)

The system has a modest 80 x 143 resolution, but, unlike higher-resolution NTSC-type cameras, CMUcam gives full software control over the camera's contrast and brightness settings, as well as selectable YCrCB and RGB color modes, with and without auto white balance.

The CMUcam can track and output to its RS232 port the centroid of a user-defined color region at up to 17 frames per second. It can also gather image mean color and variance statistics, output a real-time binary bitmap of the tracked pixels in an image, and automatically detect a color and drive a servo to track that color. A standard three-pin servo connector is even provided for that purpose. And the thing is tiny; it weighs about an ounce, and two of them could sit comfortably side-by-side on my palm.

The CMUcam has so many features I don't have the space to list them all here. Note that it can usefully be interfaced to low-end controllers (such as BASIC Stamps). Look forward to several robot projects using this little beauty.

More on CMUcam can be found at:

URL: **www.cs.cmu.edu/~cmucam**
Email: **cmucam@cs.cmu.edu.**

To buy an assembled and tested CMUcam or Easybot, contact Seattle Robotics at:

URL: **www.seattlerobotics.com**
Email: **support@seattlerobotics.com**

slide axis. On making the dimples, it would be easy to check for alignment.

I'll tell y'all next time how well these proposed fixes work. I also hope to show you a modified actuator design that avoids the need for tapping threads. If I have room, I'll also take a closer look at the Solarbotics BEP and maybe the TAOS color sensors, too. See you then! **NV**

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

Robert Nansel
Box 228
Ambridge, PA 15003
E-Mail:
bnansel@nauticom.net

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TECH FORUM

QUESTIONS

I am looking for a circuit that uses a 12-volt source input and can generate an 80 Hz sinewave with an adjustable amplitude. The amplitude needs to be adjustable from 0 to 150 Vpp with no DC offset. I also need the output capable of 16 watts. Any ideas?

#5021 **Paul Shoytush**
Washington, MI

I need a circuit to convert component video (Y,Pb,Pr) to standard NTSC output. I've got an HDTV display in the living room and a standard analog color TV in the kitchen. I'd like to have the kitchen TV display whatever is showing on the HD display, via its component video inputs. By the way, the component video is always at 1080i resolution.

I've looked at the Motorola MC1377, but don't think it will work in my application, because it appears its inputs are analog (480i) component video.

I'm looking for something I can build myself or purchase to do this.

#5022 **Joe Jaworski**
Asheville, NC

I need to make a graph on a computer of a potentiometer's resistance against time as it is turned. I tried a RadioShack digital multimeter cat #22-805 with PC interface as an ADC to input the resistance. It works except it's too slow. Are there converters about 15 times faster?

#5023 **Dennis Gunst**
via Internet

What's the best way to switch video inputs? I have a number of security cameras and would like to be able to switch from one to another using a PIC such as a BASIC Stamp.

There are commercial products, but they are expensive.

Maxim makes a chip that should work, but it's SMT, so I cannot use it.

I could use a bank of relays, it's simple but primitive.

#5024 **James L. Jones**
via Internet

What about surge protection for AV equipment? None of the surge protectors I've seen accept a video input. I'd like to protect my expensive home-theatre system from a lightning strike on the camera that I use to watch the pool. I could go wireless, but that seems a little much.

#5025 **James L. Jones**
via Internet

I have an old router that uses a CGA/EGA monitor which has gone bad.

Is there any way to adapt a VGA monitor to this system. The computer is a VME custom system so changing the video card is not an option.

#5026 **Anonymous**

My niece has a Win 98 computer that lets her see for only a moment — safe mode shortly after getting her system to run using a scanner then hangs into a black screen.

She tried removing the scanner. She also said characters do appear when she types. She said there is not much time during safe mode before it locks into a black screen.

Do her IRQ or CMOS settings need to be checked or is her hard drive crashed?

I am a component level, mostly analog electronic repair technician. I know some DOS commands and I recall my dad's PC CMOS settings needed to have the IRQ changed to fix his scanner.

#5027 **Bob**
via Internet

Is there a way to connect a terminal with a female 25-pin parallel printer port to a printer with a "B" USB connector?

#5028 **Ivan Rodriguez**
via Internet

I am looking for a 230V circuit that would slowly raise the current into a lamp at dusk, and also remove the current surge into the filament and prolong its life.

#5029 **P. Montaron**
Tahiti — French Polynesia

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

[2021 - FEB. 2002]

Does any company still support the mini-oscilloscopes made (15 years ago) by NonLinear Systems? My 30 MHz model MS-230 appears to need a new CRT.

You might try contacting NLS directly and seeing if they can help you.

I have several of their pieces of equipment, and several years ago, I had a problem with my TT-20. Even though they no longer made it, they still repaired it for me. All this will cost you is a phone call.

Their information is as follows:

Non-Linear Systems
4174 Sorrento Valley
San Diego, CA 92121
Telephone **858-535-2161**
FAX **858-535-2169**
www.nonlinearsystems.com
General Information:
sales@nonlinearsystems.com

Craig Kielhofer
via Internet

[12016 - DEC. 2001]

I am trying to integrate a Piezo Gyroscope – like the Cirrus MPG-10 Micro Piezo Gyro – into my home-robotics project for dead-reckoning navigation. Would it be possible to use one in such an application?

Piezo Gyroscopes work on Newton's "Three Laws of Motion" [or physics] in that **[1]** a body at rest will want to remain at rest and a moving body will want to remain moving, requiring energy **[2]** to interdict or change that state. When a mass is at rest for example, **[3]** changing that state requires a force upon the general mass of that object and this change or force can be measured by the use of piezo elements. If you hold a weight out with your arm, on the end of a string, and then you move you body forward slowly or quickly you will notice that the weight on the string will resist momentarily being moved and it will swing backwards towards you as your body accelerates.

If you attach a sensing method to this weight, like a piezo crystal placed behind the object, you will have a single axis accelerometer that measures forward movement, turning this information into an electrical signal, instead of the swinging motion of its tendency to resist movement. If the piezo element is glued to the object as it decelerates, a equal but opposite voltage will be produced by the stretching of that piezo element. Compressing the piezo on acceleration will produce a positive voltage for example, and stretching that element upon deceleration will produce the opposite or negative value in volts. Both can be counted and both can be processed into a value to "make changes" by the use of a microprocessor or amplifier.

Instead of a string, if you add a given fixed axis or fulcrum lever to the system, you can measure acceleration or deceleration of any angle or motion. Piezo gyros use a fixed "proof mass" attached to a spring and piezo element which compresses or stretches as its fixed state of motion or rest, is attempted to be altered [and other factors]. As the motion or change takes place, the mass forces it self against the piezo element and creates electrical changes in the element in the form of a small electrical potential or signal.

In RC situations this signal is fed back into the servo action [like a rudder] to "self correct error conditions" like oversteer or tail spin of a helicopter, where the boom wants to counter rotate to the main prop. Instead of your RC input to the tail rudder control or prop to keep the helicopter flying straight with its boom following directly to the rear, the gyro senses movement if the tail moves out of its fixed or proper axis, then feeds this to the control unit instead of manual corrections by you which, in turn, increases or decreases the force needed to keep the helicopter in a straight or true running attitude.

As far as your use, in a robotic arm for example, to dead reckon, I don't know the absolute resolution that can be achieved by a given unit, or what you want, or how to increase that resolution off hand other than to extend its [the gyro] motion into a given exaggerated direction [at the end of a long boom for turns?].

If you were to incorporate a microprocessor into several gyros and calculate "time" as one of the factors to the equation, you should be able to "dead reckon" quite accurately. This is a crude version of what munitions and air planes use to figure out where they are.

[3021 - MAR. 2002]

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

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

#1 If you are using a TV flyback transformer, the easiest way to measure the frequency is at the base or gate of the driver transistor. Once you know the frequency, apply a low-voltage signal to the primary and measure the secondary using a 10X probe on the o'scope. This will give you the ratio of input to output so you can measure the primary voltage when it is operating and multiply by the ratio.

Russell Kincaid
Milford, NH

#2 Measuring the frequency will be the easy part. You said you have access to a frequency counter. Find the power transistor which drives the primary of the Tesla coil and connect the input to the counter to the base, and the ground from the counter to the emitter. Stay clear of the collector – it will have high voltage present. Before you connect the counter make sure the Tesla coil uses an isolation transformer in the power supply. If it does not, line voltage could be present on the emitter.

Measuring the voltage will be tricky. A Tesla coil has such a low current output that the input divider network in a multimeter (even with a high-voltage probe attached) will draw the voltage down to almost nothing.

You will have to build a simple, low-tech instrument called a "sphere gap voltmeter" to measure the voltage. This is a device which takes advantage of the fact that a given voltage will jump a known distance between two spheres of known diameter.

You can get more information by doing a search on the Internet for "sphere gap" (in quotes). I turned up a dozen or so hits using www.altavista.com. You can find a picture of a sphere gap at **www.voncorp.com**.

If you should decide to build one, you can use a couple of doorknobs from the hardware store as your spheres. Make sure to choose a couple of spherical ones without fancy ornamentation. Use some fine sandpaper to remove any plastic protective coating which may act as an insulator.

Rick Curl
Birmingham, AL

A given force or signal can be used to determine what speed your traveling at, and/or accelerating or decelerating at [don't forget the spin of the earth and the Coriolis effect], while the microprocessor can add in time to calculate how far you have traveled, and a math program can figure out where this is in the world compared to where it started.

Other gyro inputs can account for turns to the left or right, up and down, and all other axis that you might need to determine your relevant position.

This is a simplified explanation as to how it works. Should you wish to study in more detail, one simplified version can be found at: **www.imi-mems.com/closegyro.htm**.

Chris
Bieber, CA

[3027 - MAR. 2002]

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

Clamp DC ammeters sense the magnetic field created by the current. Different tricks are used

[12013 - DEC. 2001]

Using a potentiometer, I want to vary the speed of a 130V, 18A conventional DC motor.

Would pulse width modulation be the best method, maybe starting with a simple 555 oscillator?

What "gate" components would be best: bipolar transistors, FETs, or what? Would an H-bridge be necessary?

This circuit uses an LM556 dual timer configured as a pulse width modulator, running at 20 kHz. The 556 drives an IR2110 voltage translator/switch driver which can drive both high side and low side switches, but only the high side drive is used.

R11 serves to limit the peak current from the driver and prevents the drive line from ringing.

Transformer T2 provides power for the driver, it has to float at the Q1 switch source voltage. The drive power could be self-generated if the PWM duty cycle was limited, but I chose not to limit it.

The only purpose of L1 is to limit the rise time of the current. If the Q1 switch was turned on with a stopped motor, it would try to supply hundreds of amps and poof! Also, if the AC power is applied with the speed control at max, the Q1 switch is on all the time and L1 is ineffective.

For that reason, T4, a current transformer is used to feedback to the shut-down pin of the IR2110. Once it is shut down, it stays down until the next pulse comes along. The polarity of the current transformer must be such that it puts out a positive pulse when the current increases. Please! Test this with a 100-watt lamp before connecting the motor.

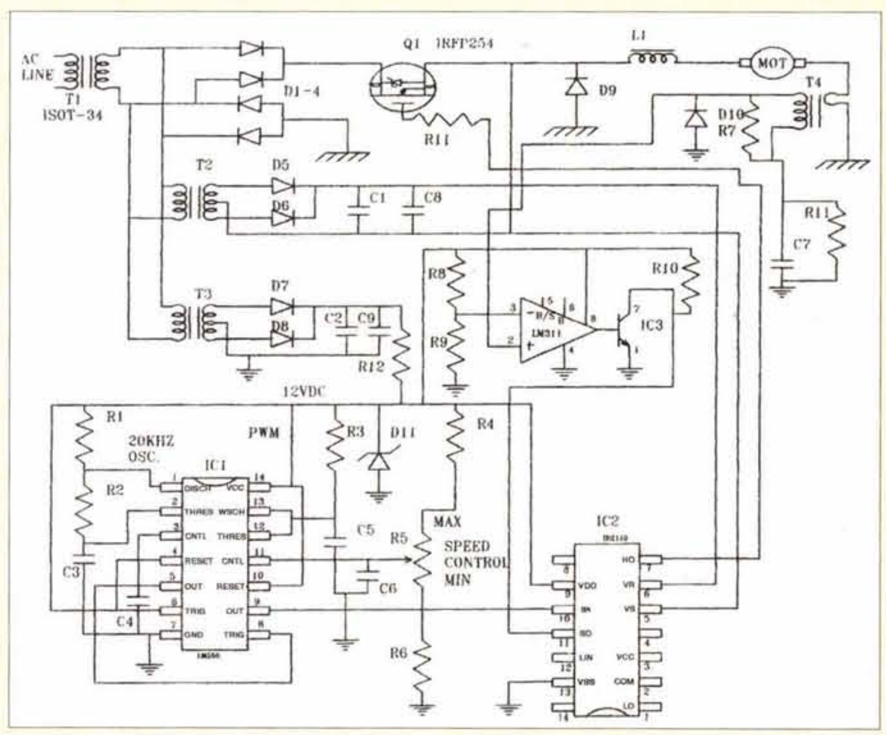
Two kinds of ground symbols are used to emphasize that the motor ground currents should not mix with the logic ground, although the two grounds should be common at some point.

It is possible to build this circuit without the isolation transformer, T1, but in that case, no part of the circuit can be grounded. The circuit must be in a metal grounded box and the speed control pot shaft must either be plastic or recessed so that if anyone pulls the knob off, he will not get zapped. The motor frame must be grounded in any case.

Russell Kincaid
Milford, NH

PARTS LIST

Part	Value	Digi-Key P. N.
Q1	IRFP254 250V, 23A	IRFP254-ND
IC1	LM556	LM556CN-ND
IC2	IR2110	IR2110-ND
IC3	LM311	296-1389-5-ND
D1-4	200V, 35 amp	GBPC3502WIR-ND
D5, D6, D7, D8	N4003	1N4003DICT-ND
D9	200V 6 amp	FR603CT-ND
D10	1N4148	1N4148MSCT-ND
D11	12V, 500mW	1N5242BDICT-ND
T1	ISOT-34 2,500W, available from Electronic Specialists, Inc., Natic, MA 01760. 1-800-225-4876.	
T2, T3	24VCT, 100mA	MT2218-ND
T4	25 amp, 200 turns	237-1108-ND
L1	10uH min, 100uH max, 20 amps M5701-ND, 10 amp rated Connect 4 units in series & parallel to get 20 amp rating.	
C1, C2	10uF, 35V	P922-ND
C3, C5	.01uF, 50V, 2%	PS1H103G-ND
C4, C6, C7, C8, C9	.01uF, 50V	PS1H103J-ND
R1, R2	2.4K, 1/4W, 1%	BC2.43KYCT-ND
R3, R11, R10	4.7K	BC4.75KYCT-ND
R4, R6	10K	BC10.0KYCT-ND
R5	10K pot, linear	RV4NJ103C-ND
R5	10K pot, plastic shaft	392JB103-ND
R7	82 ohms, 1%	BC82.0YCT-ND
R8	4.3K, 1%	BC4.32KYCT-ND
R9	7.5K, 1%	BC7.50KYCT-ND
R12	270 ohms	BC274YCT-ND



to make the DC measurement.

A slip-on "inductive ammeter" measures the field directly. Two low reluctance (high permeability) flux concentators slip over the wire to measure. The low reluctance magnetic path brings most of the current's magnetic field to a measurement gap. On my slip-on meter, that measurement gap is part of an ordinary analog meter movement. Increasing the current in the wire increases the magnetic field in the gap, the larger field creates more torque, and increased torque deflects the meter needle more against the restoring spring. My inductive ammeter cost about $10.00 (new) 20 years ago.

Alternatively, a meter could use the Hall-Effect to measure the magnetic field in the gap. Microswitch used to sell linear Hall-Effect sensors (with an amplifier) on a leaded ceramic substrate; I don't know if they still do.

The Hall-Effect sensors in Digi-Key's catalog are on-off (i.e., not linear) and therefore not suitable. BTW, it is just the Hall-Effect; it is not a Hall-Effect transistor. The Hall-Effect occurs in semiconductors as a consequence of Lenz's Law: moving charges deflect in a magnetic field. The generated voltages are small. An off-brand DC ammeter or DMM probe will run $80.00 to $250.00.

Other methods of measuring DC currents are also used. At one point, HP used a variable reluctance core. Changing the reluctance of core changes the flux, so Faraday's Law kicks in to produce an output voltage whose amplitude is proportional to the DC current.

Sometimes the non-linearity of the magnetic material is used. A bias oscillator and winding drives the material around its BH loop. The DC current to measure offsets the BH loop and introduces even harmonic distortion. The instrument measures the second harmonic to determine the DC current. Flux-gate magnetometers and compasses use this method.

Good meters involve more twists on the basic measuring idea. Instead of measuring the magnetic field directly, they may employ a buck winding to oppose (and null) the current to measure. The buck winding not only keeps the magnetic core from saturating, but it also improves the linearity and drift performance. The construction details of the clamp are also non-trivial; the mating faces must make good and repeatable contact; the faces are often lapped. I don't know the mechanical details of the gap, and I suspect that measurement gap does not completely cut the magnetic path.

Gerald Roylance
Mountain View, CA

[3026 - MAR. 2002]

I am in my second year of GCSE electronics and as a main project have decided to make an airband radio. I am having a problem finding a circuit and would appreciate any help.

#1 Building an aircraft radio receiver is a good but involved project. *Nuts & Volts* had an aircraft receiver a couple months ago, but it had no image rejection and distorted audio. Most current VHF receiver designs focus on FM designs for the amateur bands, and those designs can ignore the ugly issues of AGC.

Many simple AM receiver designs employ an NE602 mixer and MC1350 IF amplifiers. The front end performance isn't great, but the goal isn't building the world's best receiver. I don't know your project or course requirements, but here's a possible approach.

Purchase an aircraft band receiver kit from Ramsey. For $30.00 or $40.00 you will get a schematic and most of the parts you need. You won't have to chase down a supplier for the exotic ICs or varactor. In addition, you get a PC board to simplify the construction. Build the receiver as the kit instructs, and try it out.

When you get it working, experiment using different antennas. Choose a nearby NAV station for a reference (it will have reasonably stable output).

Cut some folded dipole antennas to different lengths (say four antennas that cover a 30% change in length) and measure their effectiveness by looking at the receiver's AGC voltage for the reference channel. Try both horizontal and vertical polarizations. Do the measurements outside in the open (the receiver is battery powered). Can you explain the measurements?

Examine the circuit design and understand what the different pieces do.

Then start looking for ways to improve the design. Here are some possibilities.

Ramsey probably uses an inexpensive ($0.50) 10.7MHz FM ceramic filter in the IF. FM band filters have very wide bandwidths (e.g., 180kHz), but aircraft channels are spaced at 50kHz for NAV and 25kHz (or 12.5kHz) for COM.

Digi-Key sells some narrowband monolithic crystal filters (ECS, about $8.00). Try replacing the ceramic filter (probably 300 ohm) with the crystal filter (probably 1500 ohm). Do you notice any differences?

Answer the question why a 10.7MHz IF with a fixed tuned front end is a poor design choice to cover the entire COM/NAV band (108-136MHz; hint: image rejection). Consider the benefits of a 21.4MHz or a 45MHz first IF.

Learn how to design a coupled resonator filter (see, for example, *Hayward's Introduction to Radio Frequency Design*). Design a preselector (input) filter. Then compare and contrast it with the Ramsey preselector design.

Consider receiver designs that switch in different preselectors (band switching) or designs that simultaneously tune the front end resonators and the local oscillator.

You could spend a significant amount of time with any one of these options, and the exploration would take you beyond just building a kit.

Gerald Roylance
Mountain View, CA

#2 The air band is 118MHz to 137 MHz, AM modulation. It should not be difficult to construct or modify a single conversion superhetrodyne receiver.

You will find more information in this book: Air Band Radio Guide, by Graham Duke, ISBN 0711027870, Ian Allan Publishing.

Russell Kincaid
Milford, NH

by Stanley York

Laser Insight

Last month, we began to put together a nitrogen laser power supply. This month, I will describe the construction of the laser in detail.

But before I go too far, I feel I should repeat the warnings I gave in the last column.

DANGER ... DANGER ... DANGER

The laser about to be described should not be constructed by anyone unfamiliar with safe high-voltage working procedures.

The laser to be described here is experimental. There have been many designs similar to this, and most of them have reported some measure of success. But the laser does require some careful adjustments and a good deal of insight to make it work reliably, or even at all!

We will also be working with dangerously high voltages, *so if you are not familiar with the precautions required when dealing with high voltages, then perhaps this article is not for you.*

The charged capacitor used to fire the laser can discharge in the pump chamber in about 5-6 nSec. If you calculate the peak power of the pulse, it is in the order of 100 Megawatts or more, and it has a kick like two mules. Therefore, it will give you a very nasty shock if you are not careful. So if you decide to build this laser, **PLEASE** be very careful, and remember, if you show it to anyone, keep them away from the assembly altogether, especially your younger audience. **You** are supposed to know what you are doing and what parts you can touch. **They** do not.

So again, if you are not yet familiar with high-voltage working procedures, then perhaps you should save this article until you get more experience. The power supply is dangerous, and you will be working at your own risk, so be careful, I cannot emphasize this enough!! This is not a plaything, the charged capacitor is lethal!!

Okay, now let's get on with the fun stuff!

Nitrogen laser

The nitrogen laser described here (actually, it's more of an air laser, since we are using ambient air rather than pure nitrogen) produces a short-lived, high-intensity pulse in the ultraviolet, and as such, finds widespread use in another laser system — the dye laser.

Later in this series, I intend to write about the dye laser, and describe a fairly simple set-up that I built many years ago, when I first came to the US.

The nitrogen (N2) laser is often used in conjunction with dye lasers as a pump source. Dye lasers can be pumped with a flashlamp, but are not as efficient as when pumped with a N2 laser. The reason being that only part of the flashlamp output is in the ultraviolet, whereas the radiation from the N2 laser is purely ultraviolet. (Being in the ultraviolet, this laser does pose other safety concerns that you should be aware of. But more on this later.)

The dyes used in laser applications are best pumped with UV from a nitrogen source. They are typically toxic, and are sometimes mixed with nasty solvents that are not easily available or cheap! If you wish later to experiment with a dye laser, you should try to build the N2 laser first, as described here, and do some comparative studies with it later.

The nitrogen laser is probably the simplest gas laser you can make. For one thing, it doesn't use any mirrors. However, by adding a mirror to one end of the pump chamber, you can double the power output. The laser is excited by an electric arc discharge through the gas, and produces a high-intensity coherent light output pulse of approximately the same duration as the arc discharge. The laser is also self-quenching. In other words, the laser will not continue to produce laser light after the initial burst, even if there are excited gas molecules still present in the pump chamber. The laser to be discussed puts out a light pulse of around 5-8 nSec, depending a little on the dimensions of the pump chamber and discharge capacitor. Although the laser itself is simple, the power supply and discharge capacitor are very dangerous. When fully charged to the maximum voltage of my supply (33,000 volts), my capacitor held an energy level of 1.6 Joules (1/2CV2). If discharged in 6nSec into the central gap of the laser pump chamber, it would release over 250 Mwatts of peak power (that's not a misprint, 250,000,000

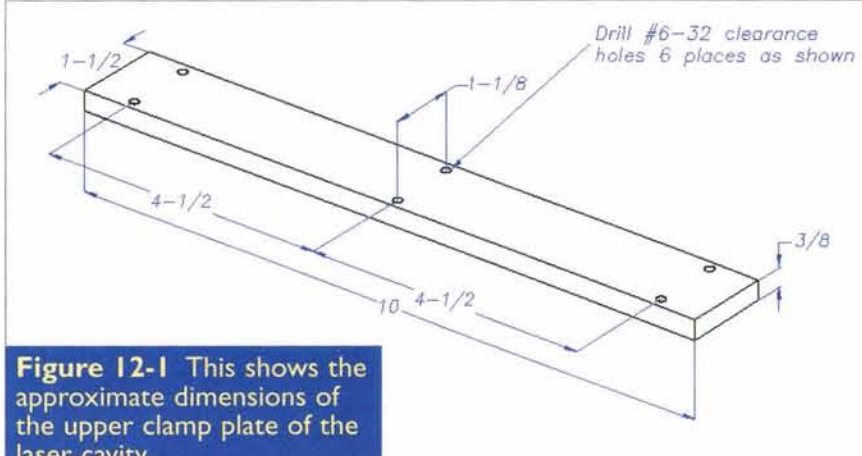


Figure 12-1 This shows the approximate dimensions of the upper clamp plate of the laser cavity.

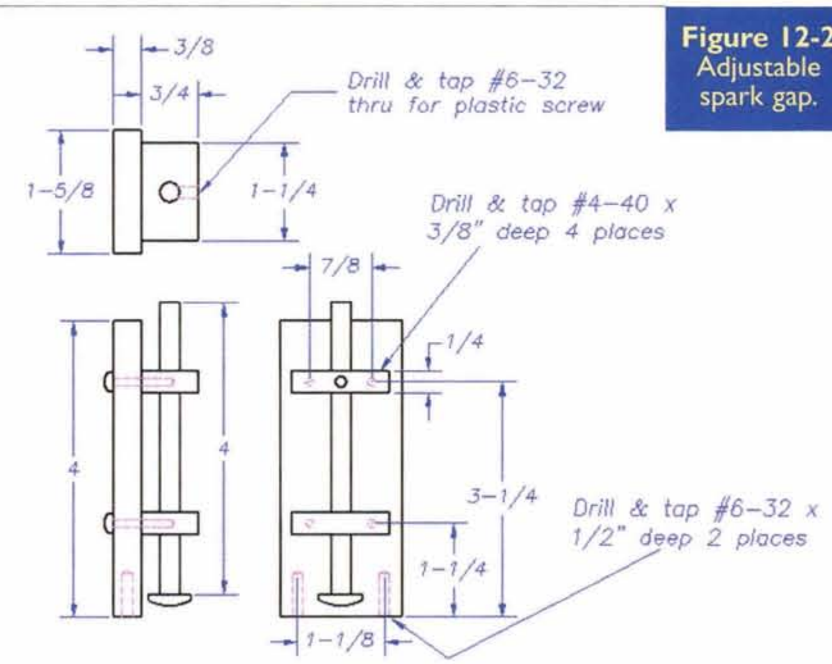


Figure 12-2 Adjustable spark gap.

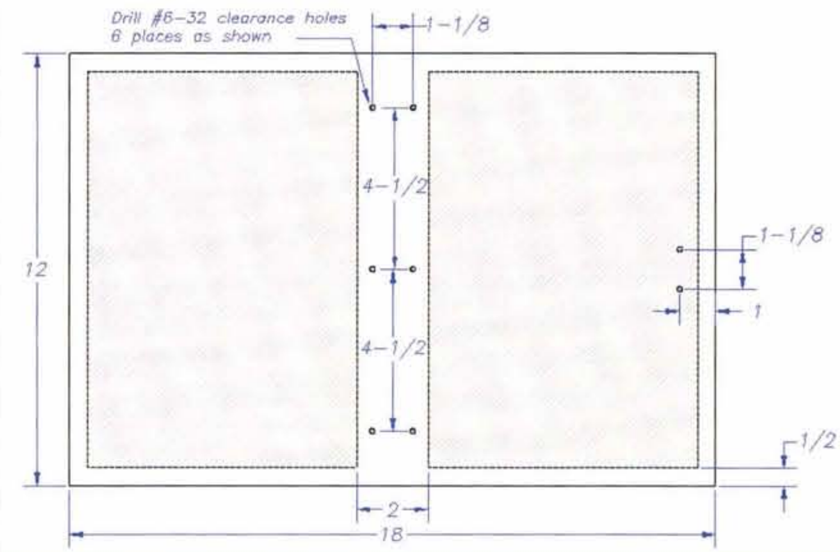


Figure 12-3 Construction of the high voltage capacitor.

watts!!!). So, please, keep this in mind and exercise extreme caution if you decide to build this laser.

Making the parts

Figure 12-1 shows a Plexiglas bar that is used as the top clamp in the laser chamber. This bar holds down the two aluminum bars that serve as the electrodes in this laser. I chose clear Plexiglas so that I could watch the discharge, but you can use whatever you have available.

After the Plexiglas is cut to size, drill #6-32 clearance holes for plastic screws. There will be very high voltage in the vicinity of the laser channel when it fires, and you must make every effort to prevent unwanted discharges and leakage paths. The dimensions given are not chiseled in stone, so if you can't get exactly what is specified, don't worry too much, after all, this is an experimental laser! There will be a few fine adjustments to make before the laser runs reliably.

Figure 12-2 shows the spark gap assembly. Make the body of the assembly from Plexiglas or polystyrene, and again, use plastic screws only or glue to join the parts together. When assembled, the spark gap should have at least 3/4"-1" clearance between the upper contact and the base when the gap is fully open. Use a plastic screw through the side of the upper horizontal block to just pinch the gap adjustment rod at a preset height. This makes it relatively easy to reposition the gap (with the power off, of course).

To make the contacts in the spark gap, I formed a well-rounded pad of solder onto a copper disk (penny) as one of the contacts. A corresponding solder pad was formed on the capacitor plate after the assembly was put into position.

Use a loosely-braided copper wire, as wide as you can get it, and solder it to the upper side of the penny before you epoxy the upper contact to the plastic shaft. The braid has to carry a large current when the gap arcs over, and it must also be low inductance. So be sure to make a good solder connection here. A fast discharge current is important to the success of the laser as a whole.

Figure 12-3 shows my version of the discharge capacitor that makes this laser possible. Start with a sheet of double-sided PCB material at least 12" x 18". The larger the piece you start with, the more energy you can discharge into the pump chamber. Start making the capacitor by removing a strip of copper from the edge about 1/2" wide all around on both sides. This gives a long non-conductive path to the high voltage, minimizing leakage currents that could rob energy from the capacitor. Be careful not to score too deeply with your knife when marking out the trim line.

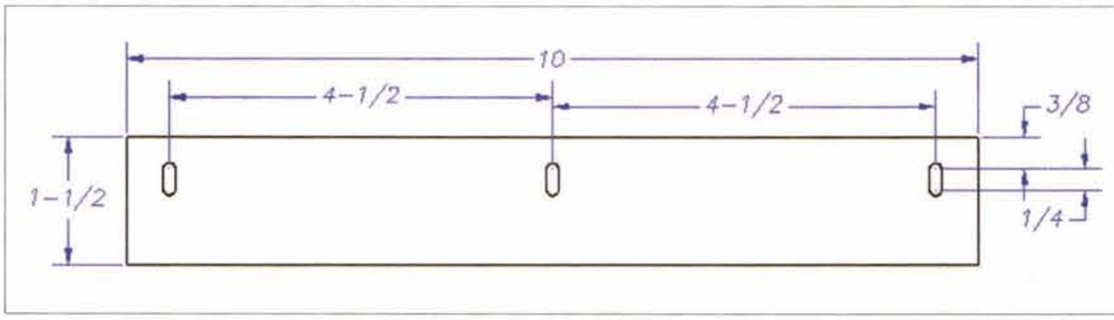


Figure 12-4 One of the discharge electrodes. You'll need to make two of these from 1/4" aluminum bar.

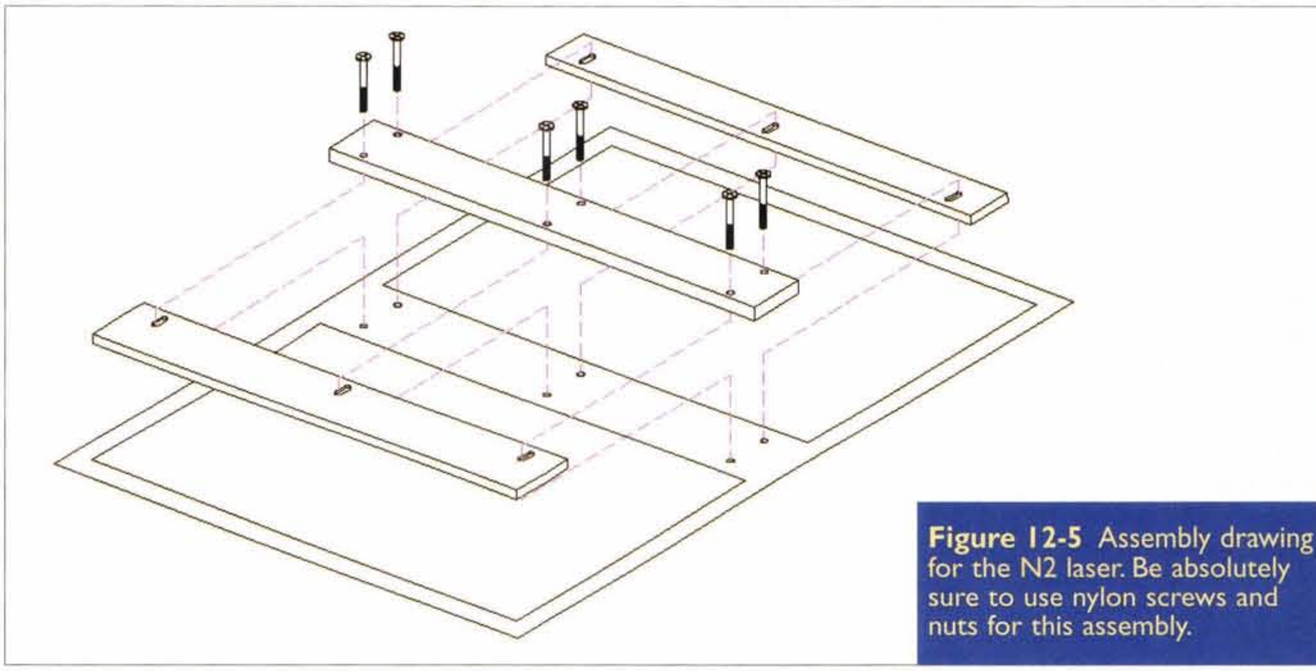


Figure 12-5 Assembly drawing for the N2 laser. Be absolutely sure to use nylon screws and nuts for this assembly.

When you remove the copper, make sure to remove all the small shards of copper that remain. Use sandpaper or steel wool to remove the fine copper splinters. Finally, go over the sanded edges with a damp cloth to remove all traces of steel wool or copper dust.

On one side of the board only, remove a strip of copper from the center about 2" wide as shown. You will then finish up with two capacitors with a common negative terminal. Depending on the thickness of your board, you should finish up with a capacitance in the range of 2-3 nF.

For most material types used in PCB manufacturing, you can reckon on about 1kV per mil thickness as the voltage rating before you get arc-through in the board.

In my unit, the fiberglass material itself (not including the copper) was 0.030" thick. This gives it a maximum voltage rating of about 30,000 volts. Finally, drill the holes in the center part of the board to accept the pump chamber. At this time, you should also remove a circle (or square, whichever is easier to cut) of copper from around the screw holes on the bottom of the board. This will prevent premature arc-over through the holes. In fact, all holes through the board should have at least 3/4" of copper removed to prevent leakage paths and arcing. This applies to the pump chamber and the spark gap assembly area. When you are satisfied the board is clean and there are no copper whiskers left, it may be a good idea to paint around the cut areas with clear polyurethane varnish to seal and further insulate the cut edges of copper. This will prevent the loss of energy through corona and surface leakage.

The discharge terminals are shown in Figure 12-4 and should be made next. These can be made with aluminum bar about 1/8"-1/4" thick and 1-1/2 to 2 inches wide. The width is not really important, although it must be wide enough so that at the narrowest gap setting, the bars are still in good contact with the copper on the PCB capacitor. Cut these to size making sure you have straight edges on each long side and cut the slots shown on one edge to match the holes in the Plexiglas pump chamber top.

Final assembly of the laser

Assemble the parts as indicated in Figure 12-5. Before you tighten the plastic screws to secure the discharge chamber to the capacitor, space the terminals so that there is a gap of about 1/4" between them for the whole length. This will give us a starting point for the discharge. The gap may require adjusting once we try to fire the laser. The finished laser should look something like that shown in Figure 12-6.

The spark gap assembly should be mounted approximately in the middle of one of the outside edges, as shown.

Next, take a piece of 1/2" schedule 40 PVC pipe about 4" long and wind about 20-30 turns of 32-34 AWG insulated wire in a single layer. Cut a narrow slot about 1/8" deep across the center of each end to hold a piece of heavier gauge wire that will act as a termination for the smaller wire, and also serve to attach the coil to the capacitor.

When completed, cover the whole winding with two coats of clear polyurethane varnish. When dry, solder the ends of the heavy wire to the two upper capacitor plates as shown in Figure 12-6; the positioning is not important. This inductor is almost a short circuit at the charging current rates, and serves to charge both plates of the capacitor during the charge period, but since the discharge is so fast (about 4-5nSec), the inductor acts as an open circuit. There will be a tiny charging current through this wire during the charging phase, but during the rapid discharge, the inductance of the wire presents very high impedance to current flow, and almost all of the discharge energy is dissipated in the gap.

Last, take a high-voltage, high-

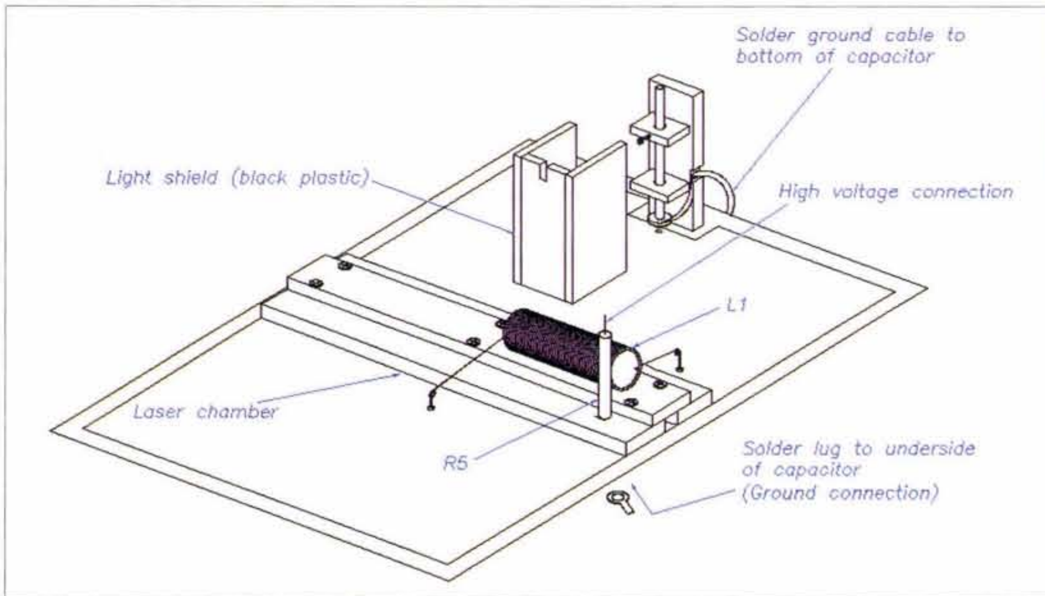


Figure 12-6 Final assembly, mounting spark gap, inductor, and charge resistor.

value resistor (R5, 100Mohm) and mount it vertically near the coil as shown in Figure 12-6. This resistor limits the charge current during the testing stage, and can be left permanently attached as I did, or you can remove it and substitute it for a lower value. It prevents the power supply from being shorted and stalling during a discharge.

Firing the laser — watch your eyes!

Since the power supply issues a fixed output voltage, the capacitor energy may be adjusted by setting the spark gap closer to or further away from the top surface of the capacitor. Closer spacing results in a lower voltage before arc-over, and consequently, a faster charge time and lower discharge energy. There have been reports of laser action as low as 6-7 kilovolts on the capacitor, so you should start fairly low and see how your version performs.

Connect the grounded side of the power supply to the solder lug on the bottom plate of the capacitor, and connect the high-voltage output to the vertically-mounted high-voltage resistor. Set the upper contact of the spark gap about 1/8" above the surface of the capacitor and turn on the supply. There will be a very short delay, during which the capacitor is charging. You will hear the bristling sounds associated with high voltage and then sparks will appear at the gap, and in the space between the discharge terminals of the laser.

The discharges will be quite loud and spectacular, and one important thing to remember is to avoid looking directly at the arcs. The arcs are rich in ultraviolet light, and prolonged viewing will damage your eyes.

Plexiglas will absorb some UV radiation, but play it safe. To prevent eye damage, make a simple box from opaque plastic to slip over the spark gap assembly once the gap is set. No dimensions are given for this, because it will depend somewhat on how you fashioned the spark gap assembly. But the general idea is shown in Figure 12-6.

If you used clear Plexiglas for the pump chamber top clamp, you may want to cover this also. I used a thin black plastic sheet draped over the chamber. When finished with the adjustments, secure the plastic with double-sided tape or hot-melt glue, in case you need to adjust anything later on. If you don't have a plastic sheet, use a couple of layers of thick paper or cardboard.

You may or may not be getting any laser output at this stage. One way of checking laser output is by putting a white handkerchief a few inches away from one end of the laser channel, and see what happens when the laser fires. If you see a brief flash of blue/white light, then you are getting a pulse of ultraviolet light. The bright flash you see is fluorescence from dyes held in the handkerchief from washing. The flash won't seem to be really bright, because it only lasts for a few nanoseconds, but you'll know it when you see it.

To optimize the laser output, you will have to change the spark gap distance to alter the volume of the discharge. Various reports that I have seen indicate that laser action can begin as low as 5-6KV. I didn't see it that low myself, but my design is a little different. You may also need to alter the gap in the laser discharge channel. Always try to keep the gap parallel in the channel, because you don't want a localized discharge down one end, but rather a discharge that is spread out down the length of the channel.

Big, fat sparks in the laser discharge gap are to be avoided. These are not producing a laser pulse. It is tricky to set up and get lasing in the first place, but you'll be well rewarded when you see the ultraviolet output.

If you have problems getting the laser to run, don't be disconcerted, because this laser can be tricky to get good results. The size and shape of the discharge electrodes, discharge voltage, air pressure, temperature, and humidity are just a few things that can affect the performance. Using air as the lasing medium is at best, not very efficient. Using pure nitrogen instead will give better results, and be easier. If you are able to find a source of nitrogen, this would give good results, and definitely better for the dye laser project coming soon. Above all, don't be hasty and you should be okay. I didn't show a mirror in these drawings, but if you place a surface-silvered mirror close to one end of the laser chamber, you will increase the power output.

But positioning the mirror and aligning it correctly become another problem. Too close to the laser and the discharge will attack the reflective surface and very quickly destroy it. I know because it happened to me, and I destroyed a mirror on the first pulse! Too far away, and the feedback from the mirror is reduced, and the less effective it becomes. Presenting the mirror at the wrong angle to the discharge path also reduces feedback; it must be perfectly perpendicular to the discharge channel to be effective.

As always, if you have any questions regarding lasers or optics, or if you have any suggestions for future articles, please feel free to contact me through this magazine, or directly at **stanley.york@att.net**. **NV**

Events Calendar

The Events Calendar is a free service for publicizing electronic events such as amateur radio hamfests, flea markets, etc. If your organization is sponsoring an event and would like a free listing, contact us at least 60 days in advance. Include your flyer, estimated attendance, name of the person to contact, and phone number.
While we strive for accuracy in our calendar, we can not be responsible for errors or cancellations. The information contained in this column is for the use of the readers of *Nuts & Volts* and may not be republished in any form without the written permission of T & L Publications, Inc.

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Events Calendar
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Corona, CA 92879
Phone 909-371-8497
Fax 909-371-3052
E-mail
events@nutsvolts.com

May-July

MAY 2002

MAY 3-4

MO - LEBANON - State Convention. Lebanon ARC, 417-532-4642. Email: bwheeler@advertisnet.com
NH - HOPKINTON - Hamfest. Hosstraders, email: k1rqg@aol.com

MAY 4

AZ - SIERRA VISTA - Hamfest. Cochise ARA, 520-336-5216. Email: mcnab@c2i2.com Web: www.qsl.net/k7rdg
KY - LOUISA - Hamfest. Big Sandy ARC, 606-638-9049. Email: wa4swf@arrl.net Web: http://www.bsarc.org
NY - OWEGO - Hamfest. Binghamton ARA, 607-748-5232. Email: n2bc@arrl.net
SC - SPARTANBURG - Hamfest. Blue Ridge ARS, 864-833-2204. Email: w4rgw@arrl.net Web: www.brars.org
WI - CEDARBURG - Hamfest. Ozaukee RC, 262-377-6792. Web: http://www.qsl.net/orc

MAY 4-5

AL - BIRMINGHAM - Hamfest. Birmingham ARC, 205-681-5019. Email: ke4yzk@bellsouth.net Web: http://www.w4cue.com
NJ - EDISON - Trenton Computer Festival. Raritan Center, Rt. 514 NJ Tpke., Exit 10. KGP Productions, 1-800-631-0062. Email: kgp@mail.com Web: www.tcfshow.com/
NJ - WEST ORANGE - Special Event. Edison Historical Labs. Send SASE to: Nutley ARS, 169 Chestnut St., Nutley, NJ 07110
TX - ABILENE - Hamfest. Abilene Civic Center. Key City ARC, 915-672-8889. Email: ka4upa@arrl.net

MAY 5

IL - SANDWICH - Hamfest. Sandwich Fairgrounds. KARC, 815-895-3310. Email: bob@w9icu.com Web: http://www.qsl.net/wa9cjn
PA - WRIGHTSTOWN (BUCKS COUNTY) - Hamfest. Warminster ARC, 215-822-0749. Email: k3zma@aol.com Web: http://www.k3dn.org

MAY 11

NV - RENO - Hamfest. Reno Area Metro Simplex, 775-673-6401. Email: glen@kk7ih.net Web: www.nvrams.org
PA - FREDERICKSBURG - Hamfest. AARG, 717-534-2945. Email: info@aa3rg.net Web: www.aa3rg.org
WA - STANWOOD - Hamfest. Stanwood-Camano ARC, 360-629-2921. Email: huppert@whidbey.net

MAY 17-18-19

OH - DAYTON - Hamvention. Hara Arena. Dayton ARA, general information call 937-276-6930, email: info@hamvention.org Web: www.hamvention.org/

MAY 19

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

MAY 26

MD - WEST FRIENDSHIP - Hamfest. Howard Co. Fairgrounds. MFMA, 410-923-3829
OH - HILLIARD - Hamfest. Franklin County Fairgrounds. 614-267-7779. Email: clind2@juno.com

MAY 31, JUNE 1-2

NY - ROCHESTER (HENRIETTA) - Convention. Rochester ARA, 716-424-7184. Email: harold@rochesterhamfest.org Web: www.rochesterhamfest.org
OR - SEASIDE - Convention. Seaside Convention Center. SEA-PAC, 503-297-1175. Web: www.seapac.org

JUNE 2002

JUNE 1

IL - SPRINGFIELD - Hamfest. Sangamon Valley RC, 217-628-3697. Email: egaffney@family-net.net
GA - MARIETTA - Hamfest. Jim Miller Park. Atlanta RC, 770-995-6446, johnka4vqh@aol.com Web: www.saf.com/arc/atlfest.htm
MI - GRAND RAPIDS - Hamfest. Hudsonville Fairgrounds. Independent Repeater Assn., Inc., 616-698-6627 after 4pm EST. Web: www.w8hvg.org
NJ - WASHINGTON TWP - Hamfest. Westwood Regional Jr/Sr High School, 701 Ridgewood Rd. BARA, 201-664-6725. Email: K2ZO@arrl.net

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http://www.agishows.com

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www.supercomputersale.com

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

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Fax 630-834-2594
E-Mail: cc@gats.com
www.computercentralshows.com

Computer Country Expo
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Web: www.ccxpo.com

Five Star Productions
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E-Mail: jeff@fivestar
www.fivestarshows.com

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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

Web: www.bara.org

JUNE 2

IL - PRINCETON - Hamfest. Starved Rock RC, 815-433-2117. Email: bk9vzh_gov@yahoo.com

PA - PITTSBURGH (BUTLER) - Hamfest. Breezeshooters ARC, 412-221-3806. Email: n3ue@arrl.net Web: http://www.breezeshooters.net

VA - MANASSAS - Hamfest. Ole Virginia Hams ARC, 703-335-9139. Email: n4yic@arrl.net Web: http://www.qsl.net/olevahams

JUNE 7-8

MS - PASCAGOULA - Hamfest. Jackson County Fairgrounds Civic Center. Jackson County ARC, 228-826-5095. Email: nn5af@arr.net Web: www.angelfire.com/ms3/jcarc

JUNE 8

MO - MACON - Hamfest. Macon County, Nemo, Schuyler, & Tri-County ARCs, 660-385-3629. Email: n0pr@arrl.net Web: www.qsl.net/n0pr/hamfest.html

PA - BLOOMSBURG - Convention. Columbia Montour ARC, 570-784-2299. Email: n3kyz@jlink.net Web: http://www.qsl.net/cm-arc

TN - KNOXVILLE - Hamfest. Cokesbury Center, 9915 Kingston Pike. Knoxville RAC, 865-670-1503. Email: d.bower@ieee.org Web: www.w4bbb.org

JUNE 9

IL - EFFINGHAM - Hamfest. National Trail ARC, 217-342-3054 (M-F 9am-5pm).

IL - GRANITE - Hamfest. Southwestern IL College Campus, IL Rt. 203. The Egyptian RC, 618-655-1232, email: w9pat@arrl.net. 618-667-4592, email: kb9ail@arrl.net. 618-656-0905, email: k2kfw@arrl.net Web: www.w9aiu.org

IL - WHEATON - Hamfest. Six Meter Club of Chicago, 708-442-4961. Email: wa9fih@arrl.net http://cyberconnect.com/orion/hamfest.htm

KY - INDEPENDENCE - Hamfest. Northern Kentucky ARC, 513-797-7252. Email: n8jmv@arrl.net

JUNE 14-15

NE - SOUTH SIOUX CITY - Convention. 3900 Club, 712-252-4107 (10am-5:30pm). Email: tands@pionet.net Web: http://www.3900club.com

JUNE 15

NJ - DUNELLEN - Hamfest. Columbia Park. Raritan Valley RC, Inc., 732-469-9009, email: wb2njh@aol.com, or 732-968-7789

NJ - LAWRENCEVILLE - Hamfest. NJ National Guard Armory, Eggerts Cross Rd. Delaware Valley Radio Assn., 609-882-2240, email: abbott0903@aol.com Web: www.w2zq.com

OH - MILFORD - Hamfest. Milford ARC, 513-753-5066. Email: kb8snh@cs.com

JUNE 16

IN - CROWN POINT - Hamfest. Lake County Fairgrounds. Lake County ARC, PO Box 90, Crown Point, IN 46308

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

MI - MONROE - Hamfest. County Fairgrounds. Monroe County Radio Communications, Assn., 734-242-9487 after 5pm. Email: ka8ebi@arrl.net Web: mcrca.org/hamfest.htm

JUNE 28-29-30

CA - FERNDALE - Convention. Humboldt ARC, Redwood ARC, Farwest Repeater Assn., & Southern Humboldt ARC, 707-442-3866. Email: conven@humboldt-arc.org Web: www.humboldt-arc.org

JUNE 30

NY - QUEENS - Hamfest. NY Hall of Science parking lot, Flushing Meadow Corona Park, 47-01 111th St. The Hall of Science Amateur Radio Club, 718-898-5599. Email: WB2KDG@Bigfoot.com

JULY 2002

JULY 4

PA - HARRISBURG (BRESSLER) - Hamfest. Harrisburg RAC, 717-938-8249. Email: k3pd@arrl.net Web: http://hrac.tripod.com/July4.htm

JULY 6

WI - OAK CREEK - Hamfest. American Legion Post 434, 9327 S. Shepard Ave. South Milwaukee ARC, Inc., 414-762-3235, email: ryatex@aol.com

JULY 7

IL - PEOTONE - Hamfest. Kankakee Area Radio Society, 815-933-1323. Email: karsfest@yahoo.com Web: www.w9az.com

PA - WILKES-BARRE - Hamfest. Murgas ARC, 570-824-7579. Email: n3wpg@juno.com Web: http://www.qsl.net/k3ytl

JULY 12-13-14

UT - BRYCE - Convention. Utah Hamfest Committee, 801-547-9218. Email: jimkatpa@aol.com Web: www.utahhamfest.org

JULY 13

GA - GAINESVILLE - Hamfest. Lanierland ARC, 770-967-6364. Email: w4tl@arrl.net Web: www.lanierlandarc.org/hamfest.htm

TN - CLEVELAND - Hamfest. Cleveland ARC, 423-472-1660. Email: bgault@wingnet.net

JULY 14

PA - KIMBERTON - Hamfest. Mid-Atlantic ARC, 610-667-1650. Email: sflink@juno.com Web: www.marc-radio.org/hamfest.html

PA - PITTSBURGH (NORTH HILLS) - Hamfest. Northland Public Library. North Hills ARC, 412-486-1681. Email: aa3ta@bellatlantic.net Web: www.nharc.pgh.pa.us

JULY 19-20

OK - OKLAHOMA CITY - Oklahoma State Fair Park, Oklahoma Bldg., intersection I-40 & I-44. Central Oklahoma Radio Amateurs, Inc., www.geocities.com/heartland/7332

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Build a Radio Frequency Field Strength Meter

By Fred Blechman

You can detect signals within a broad range of radio frequencies with this device, which can be built from a kit or from the information in this article. Although not as sensitive as security devices for detecting low-power "bugs," this unit can be very useful for determining if transmitting devices are operating. Radio amateurs and experimenters can use the RF Meter for tuning oscillators, transmitters, and antennas for maximum output.

It's all around us. You can't feel it, you can't see it, and you can't hear it, yet we are figuratively swimming in a sea of radio frequency (RF) energy! Well, with the right equipment you CAN actually SEE it — with a television set, for example. Or at an Air Control Tower or Center on cathode ray tubes. Or on a Global Positioning Satellite (GPS) receiver's screen.

And you can certainly HEAR it on an AM or FM standard broadcast radio receiver — and even more on a shortwave or amateur radio receiver. And a radar detector can let you know you're being scanned with high-frequency for possible speeding in your car.

However, without some sort of detecting and display or output device, the radio frequencies that constantly invade, penetrate, and pass through our bodies are not noticeable. Of course, in EXTREME exposure the effects can be harmful, and even the radiation from cell phones held against your ear are suspect. Generally, however, we are neither aware of, nor harmed by, RF signals.

RF Field Strength Meter

It is handy — in building or testing equipment that produces radio frequencies — to have a device that will indicate the relative strength of the signal. For example, one very practical application is tuning a transmitter and its antenna for maximum radiation.

The RF Field Strength Meter described here is a wide-band detector that indicates field strength in the 100KHz to 500MHz range at relatively low levels. The RF power reading — shown on an analog meter — is not linear, and simply indicates relative strength. The circuit has an adjustable attenuator to handle fields of different levels.

Every part needed is furnished with the RF Meter Kit from LNS Technologies.

The Kit

I've written before about LNS Technologies' kits. They are exceptionally well designed, and come complete with all the necessary parts and detailed assembly and operational instructions. The LNS "RFMETER-KIT" includes an etched and drilled circuit board, all the necessary components (except for a nine-volt battery), a pre-drilled bakelite cabinet, a tubular antenna, and a large analog meter.

All the information is provided here — including a printed circuit board layout and parts layout — so that you can build this RF Meter from scratch. The Parts List uses mostly common parts, but you might have some trouble finding the TLC272CP Dual Op-Amp IC (integrated circuit). It is specially designed for high-frequency capability, and getting it from a catalog house could mean paying for a minimum order plus shipping. The same applies to the 50 microampere panel-mounted analog meter. For this reason, the Parts List also offers some of the special parts separately.

Theory of Operation

Figure 1 is the schematic of the RF Meter. The circuit consists of a power supply, a current-to-voltage converter, a detector, and a moving coil meter.

The circuit is powered from a single battery and the switch, S1, mounted on VR1, and stabilized by capacitors C3 and C5. When the switch is closed, resistors R3 and R4 form a high impedance voltage divider to provide a reference voltage of half the supply voltage. With a nine-volt battery, the reference voltage is 4.5 volts. (This reference was

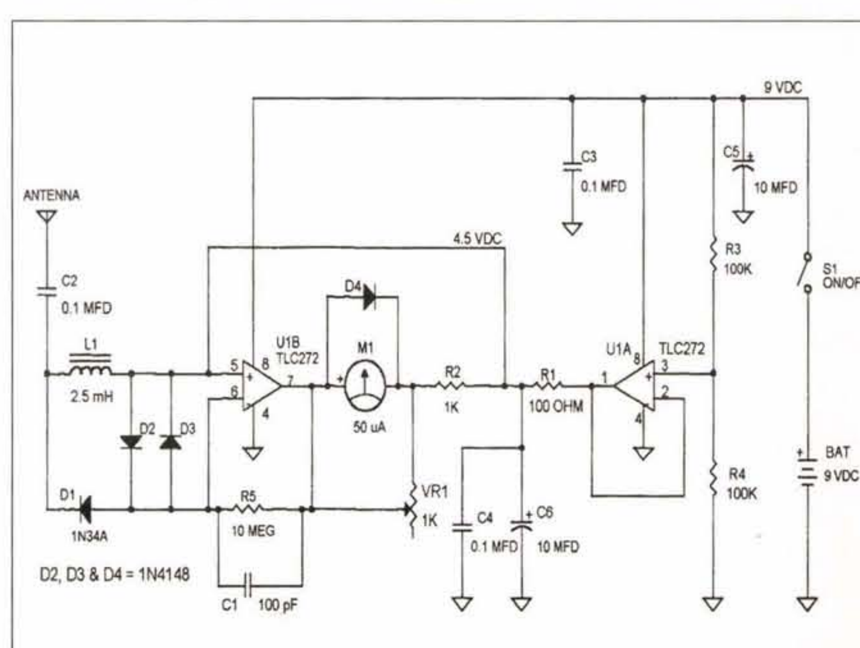


Figure 1 - RF Meter Schematic

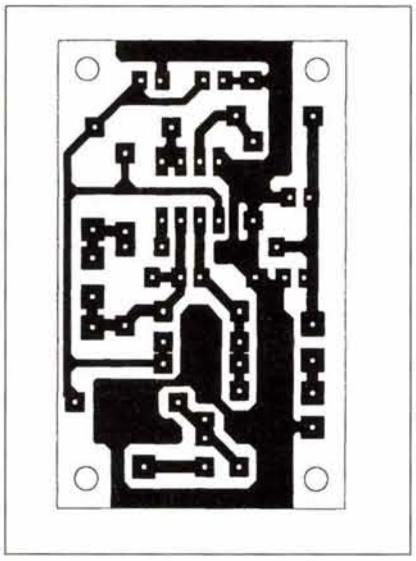


Figure 2 - RF Meter Printed Circuit Board Pattern

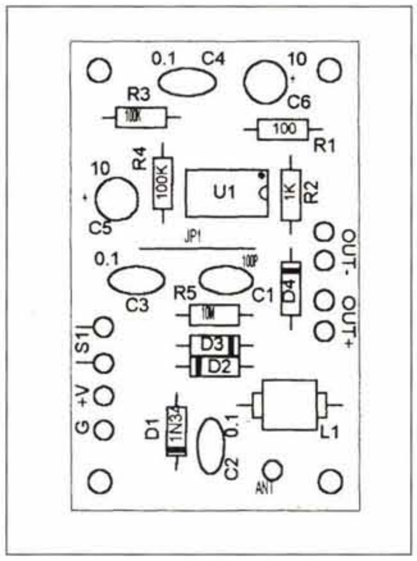
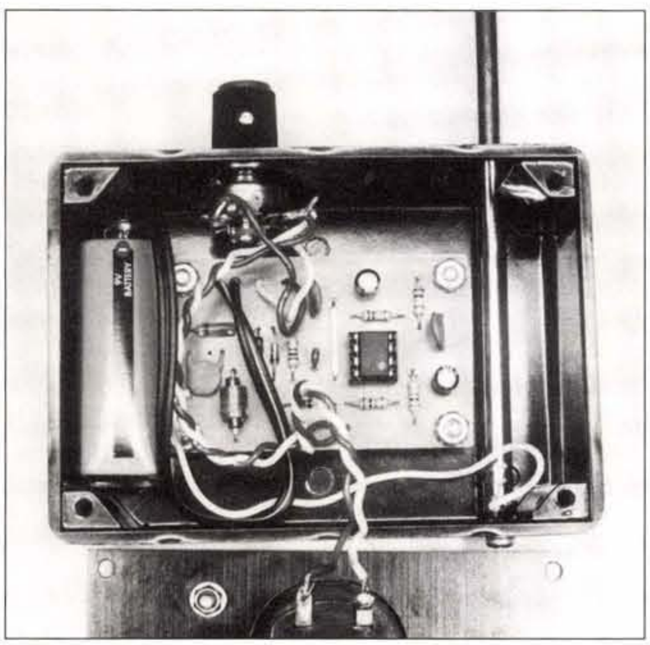


Figure 3 - RF Meter Parts Location and Orientation



The assembled unit is enclosed in a pre-drilled plastic cabinet.

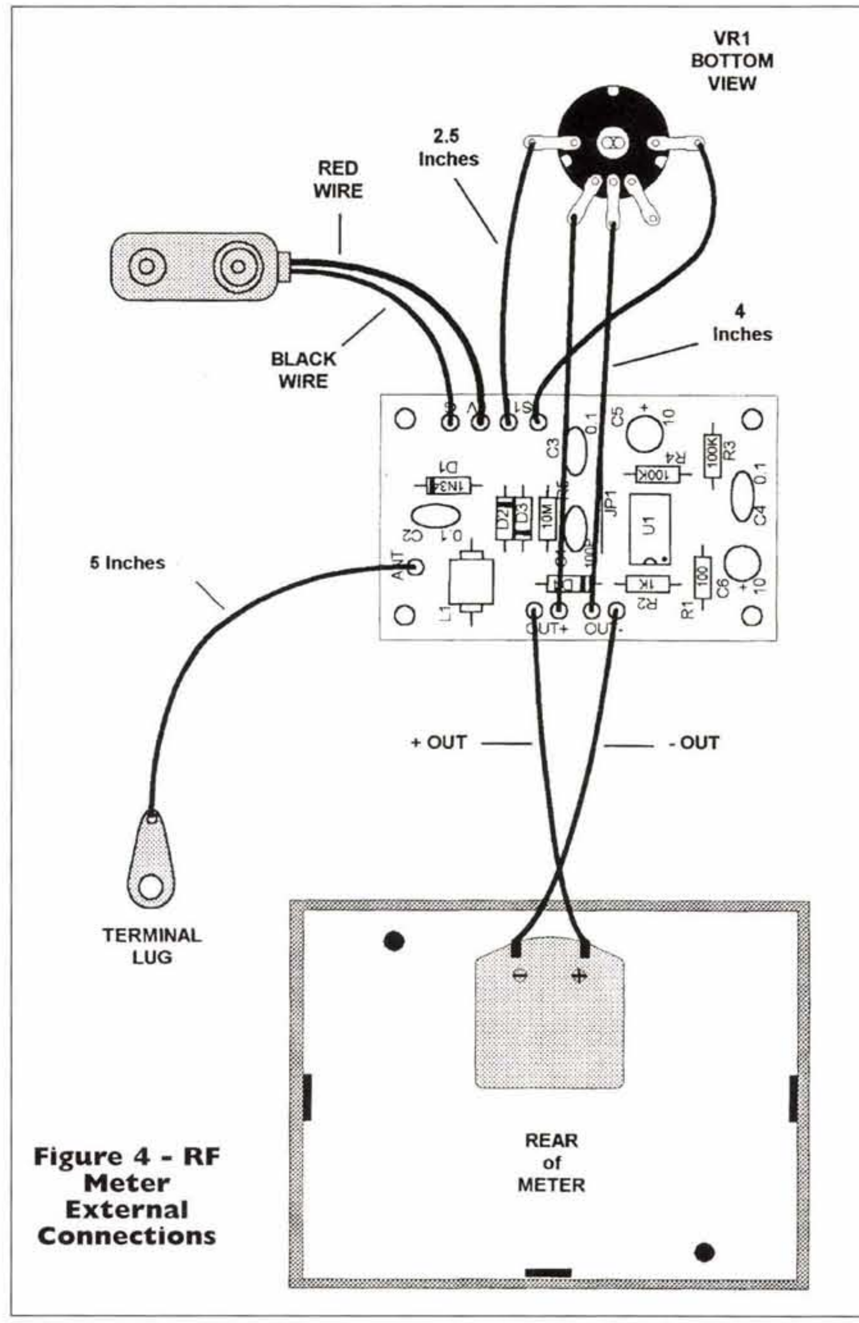


Figure 4 - RF Meter External Connections

originally intended to allow a zero-center meter to be used in this circuit, but a zero-left meter can also be used, as it is here.)

Operational amplifier U1A is configured for unity gain and buffers the 4.5 volt reference voltage for operational amplifier U1B and the meter. Resistors R1 and R2 prevent the op-amp from becoming unstable due to the load of capacitors C4 and C6.

Radio frequency signals arriving at the antenna are coupled by capacitor C2 to the detector circuit, with the combination of C2 and inductor L1 forming a high-pass filter to eliminate low frequencies.

Detection of the RF signal is done by D1, a 1N34A germanium diode, with diodes D2 and D3 protecting the inputs of operational amplifier U1B from large field strengths. With feedback through the combination of resistor R5 and capacitor C1, the amplification of U1B is very high. The output of U1B at pin 7 drives the analog meter, M1, with potentiometer VR1 acting as a variable shunt so the meter can handle a wide range of signal levels.

Construction

As with other LNS kits, the parts are supplied in several plastic bags, each with its own contents list, and ALL the required parts are provided, except for solder.

The printed circuit board is shown in Figure 2, and the parts layout using this board is shown in Figure 3. When placing the parts into the printed circuit board, don't be surprised if you find "extra" holes joined by circuit pads. The holes are there to accommodate different sized parts, since some same-value component leads are closer than others.

Install the jumper, JP1, first, so you don't forget it. Then the resistors, being careful to place the proper values in the proper locations. When installing the diodes, note not only that the marked ends (cathodes) are oriented properly, but that D1, the germanium diode, is different from the other three in appearance.

Use an eight-pin socket for the integrated circuit (U1), and orient it so the notch is properly placed. Since U1 can be installed in the socket facing either way, the notch in the socket is a reminder to face U1 properly when it is inserted into the socket.

Install the inductor, L1, and then the disk capacitors. When installing the cylindrical electrolytic capacitors, C5 and C6, be certain the positive lead is located as shown in Figure 3. Be aware that the lead marked with a bar symbol is the NEGATIVE lead; the OTHER lead is positive.

Insert U1 into its socket, observing polarity, and you are ready for the external connections.

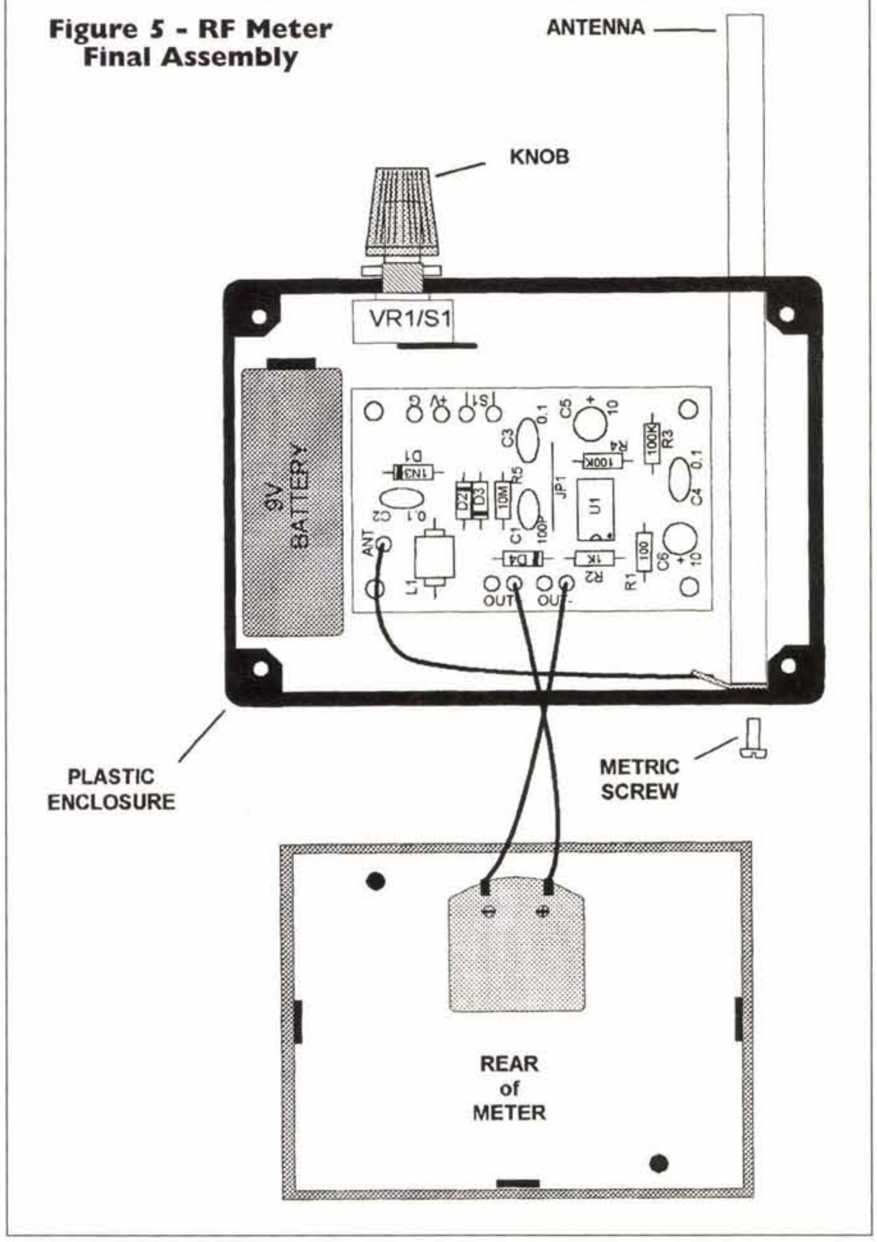
External Connections

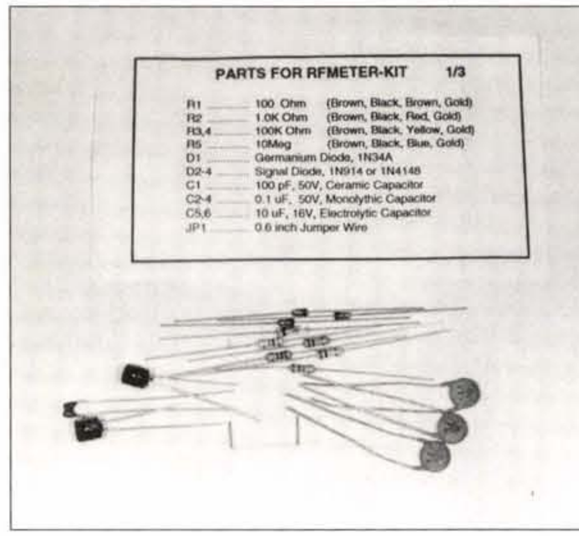
Once all components are placed on the printed circuit board, you'll need to refer to Figure 4 for the external connections.

When installing the nine-volt battery connector, if the leads are red and black, the red goes to the "+V" positive voltage point on the printed circuit board, and the black lead to "G" (ground). However, if the connector leads are both black, you'll find that one of the black leads has a white stripe. In this case, the solid black lead is positive, and the white-striped lead is negative.

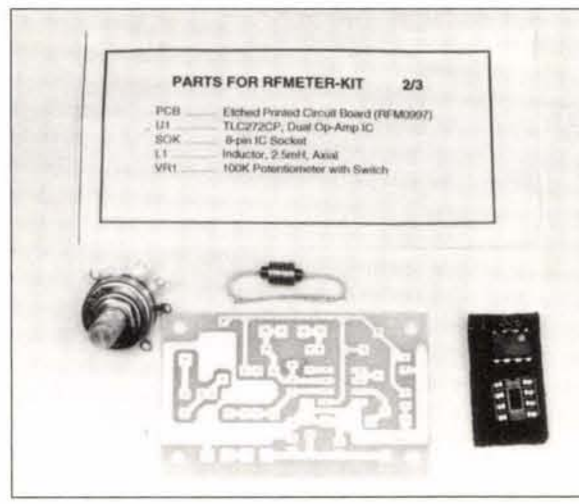
If you are assembling the RF Meter from the kit, you may find a length of two different colored wires twisted together. Cut the lengths needed as shown in Figure 4. (The length to the meter, not shown, is

Figure 5 - RF Meter Final Assembly

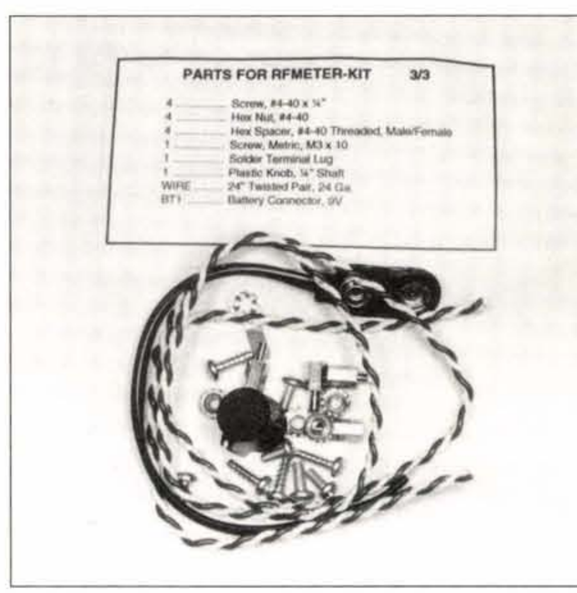




Parts Bag #1 has resistors, diodes, and capacitors.



Parts Bag #2 has the PC board, IC, socket, choke, and potentiometer



Parts Bag #3 has wire, miscellaneous hardware, knob, and a nine-volt battery connector.

four inches.)

Having two wires of different colors twisted together makes it easy to maintain the required polarity between the printed circuit board, the meter, and the active terminals of the potentiometer.

The wire to the antenna is a single wire with a lug soldered to the antenna end, and the wiring from the potentiometer switch terminals to the printed circuit board is not polarity-sensitive.

Packaging

Once again, if you are building the RF Meter from the kit, the packaging is provided in the form of a 4-inch wide, 3-inch high, 1.5-inch deep plastic box with the large meter already attached to the front panel. The front view of the final assembly in the supplied cabinet is shown in Figure 5.

All necessary holes are pre-drilled in the cabinet. All hardware is provided for mounting the printed circuit board onto spacers at the back of the box. Since the spacer mounting holes pre-drilled in the back of the box may not EXACTLY match the corner mounting holes in the printed circuit board, you may need to enlarge the printed circuit board holes.

The potentiometer is mounted at the top of the box, and the fixed-length antenna is installed through a hole in the top of the box, and held with a screw into the bottom of the box, with the antenna solder lug sandwiched between the antenna and the inside of the box.

A switch on the potentiometer turns the unit ON or OFF. Install a pointer knob on the potentiometer shaft positioned so you know when the switch is OFF.

A regular nine-volt battery powers the unit. It is not necessary to use a long-life or alkaline battery since the current drain when the meter is ON and in standby operation is only a little over one milliampere. But remember to turn it OFF when not in use.

Snap the battery connector onto a nine-volt battery and install the battery as shown in Figure 5. Be sure the potentiometer is rotated fully counter-clockwise and clicks to the OFF position.

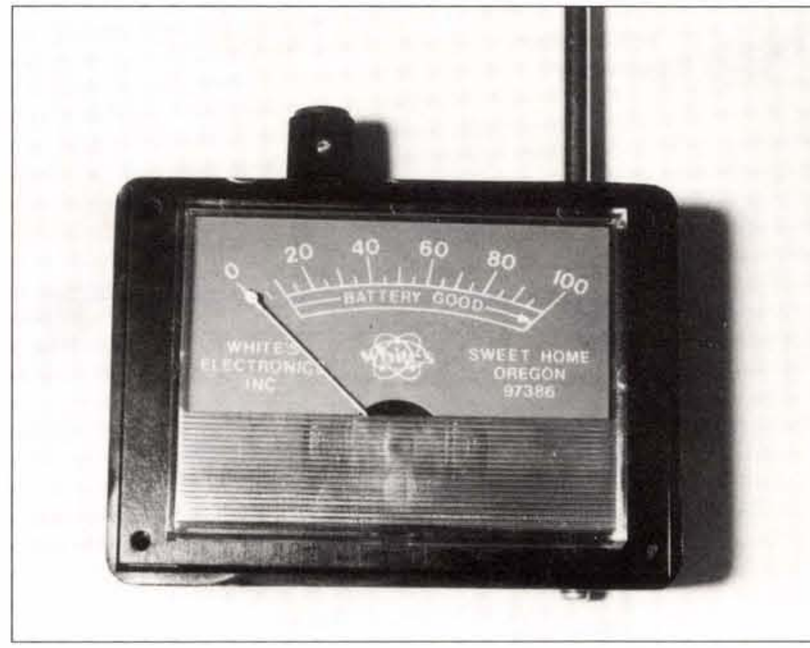
Now it's just a matter of placing the front panel with its meter onto the front of the box and holding it in place with the four screws provided.

Testing

Testing the completed RF Meter is just a matter of putting its antenna near a good source of radio frequency. Any television screen or computer monitor screen (even most laptops) will do — color or black and white.

With the RF Meter antenna well away from the TV or monitor, turn the potentiometer knob of the RF Meter clockwise until it clicks. This turns on the power and sets it to maximum sensitivity. The meter nee-

The completed RF Meter sensitivity is controlled by a top-mounted knob.



The 50 microampere analog meter included with the kit, originally intended for use with a battery tester, is mounted on the cabinet lid.

Parts List

Resistors: Carbon film, 1/8 watt
R1..........100 ohm
R2..........1K ohm
R3, R4......100K ohm
R5..........10 megohm
VR1.........1K ohm panel-mount potentiometer with S1 switch.

Capacitors:
C1..........100pF, 50V, ceramic
C2,C3, C4...0.1uF, 50V, monolythic or ceramic
C5, C6......10uF, 16V, electrolytic

Semiconductors:
U1..........TLC272CP dual op-amp intergrated circuit
D1..........1N34A germanium diode.
D2, D3, D4..1N914 or 1N4148 signal diode

Miscellaneous Items:
L1..........2.5mH axial inductor
JP1.........Wire jumper 0.6-inch
M1..........50uA DC panel mount analog meter
Antenna.....Eight-inch metal antenna
PCB.........Etched and drilled printed circuit board
Socket......Eight-pin integrated circuit socket
BAT.........Nine-volt battery connector
Solder terminal lug, knob for potentiometer, plastic cabinet, hardware, hook-up wire.

All the parts above, plus assembly instructions, are available from **LNS Technologies**, P.O. Box 67423, Scotts Valley, CA 95067. Phone: (831) 438-2028 8AM-5PM Pacific Time. **Website: http://www.techkits.com.** RFMETER-KIT is $39.00 plus $5.00 shipping USA, $7.00 Canada/Mexico. CA residents add 8% sales tax.

For those desiring to build partly or fully from scratch, here are the parts most difficult to find (address, shipping, and tax as above):

RFM-PCB.......Printed circuit board...........$7.00
RFM-METER.....50uA DC analog panel meter......$10.00
TLC272CP......Dual op-amp integrated circuit.....$4.00
ANTENNA.......Antenna and mounting screw......$3.50
ENCLRFM.......Drilled plastic cabinet.........$10.00

dle will dip negative from zero. This is normal. As you turn the potentiometer fully clockwise, the needle will return to zero.

Now, as you bring the Meter antenna close to the TV or monitor screen, the needle will rise. Adjusting the proximity of the Meter antenna to the screen, and adjusting the potentiometer rotation, controls the needle swing.

Troubleshooting

What? You get NO meter needle action? Time to check various things:

(1) Battery okay, and connector snaps secure?

(2) Printed circuit board parts in the correct place, and properly oriented?

(3) Solder joints good?

(4) Make sure external connections to the printed circuit board are as shown in Figure 5, especially polarities for the meter and battery.

(5) With the potentiometer switch ON, using a voltmeter, you should have battery voltage at pin 8 of U1, and half that voltage at pin 5, with pin 4 as ground (battery negative terminal).

Using

There are a broad range of uses for the RF Meter, just so long as you are not intending to try to detect very low frequencies or very low RF power. Actually, it will even detect and read the signal from a 900MHz wireless telphone if thr RF Meter antenna is held close to the 900MHz phone antenna.

Most uses will involve detecting an RF signal, or tuning the output of a radio frequency device for maximun strength.

Some of the devices that show respectable RF Meter readings when operating in close proximity to the RF Meter antenna are microwave ovens, cordless telephones, walkie-talkies operating on various civilian bands, Citizen Band transmitters, and most amateur radio handy-talkies and transmitters. The stronger the signal, of course, the greater the

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detection range.

Slight Modification?

If you find the RF Meter is not sensitive enough for your application, you can at least double the sensitivity by using a telescoping antenna instead of the nine-inch fixed-length antenna provided with the kit or offered separately.

For example, the RadioShack Catalog Number 270-1401B Replacement Telescoping Antenna ($3.49) has five sections and extends to 30.5 inches. However, be aware that if you use this antenna, you'll have to adapt its base for mounting from below instead of the side.

Summary

Don't expect to use this RF Meter for ham "fox hunts" of low-power hidden transmitters, or to discover "bugs" in your home or office. A considerably more sophisticated (read: "expensive") design would be needed for security sweeping. But for general use around the ham or experimenter's shack, this does a credible job. **NV**

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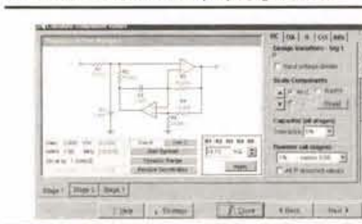

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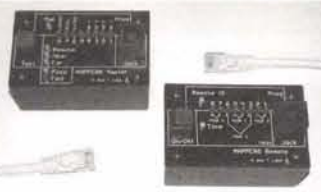

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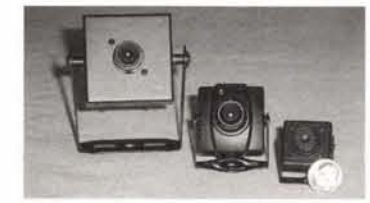

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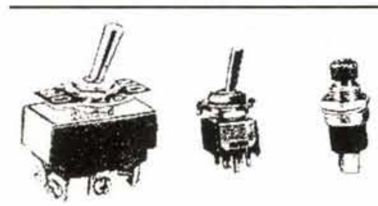

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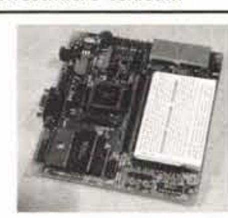

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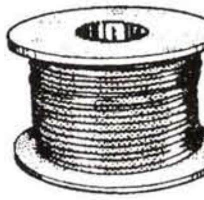

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Computer Interfacing: Part 2

Getting Your Computer "GUI"
Incorporating Visual BASIC in Computer Interfacing

By David A. Ward

This is the second article in a series of five articles about computer interfacing. The first part "Getting In and Out of The Box" introduced an eight-bit 32 address interfacing card and an eight-bit input port and eight-bit output port, and gave a couple of simple QBASIC software examples to test the circuits. It was mentioned in that article that Visual BASIC examples would be forthcoming. This article will introduce building a Visual BASIC "GUI" (graphical user interface) application for your interfacing circuitry.

The software demonstrated in this article is Microsoft's Visual BASIC 6.0 Professional Edition which typically retails for around $100.00. If, however, you buy a Visual BASIC 6.0 text book it may also come with a CD-ROM containing a "working model" of Visual BASIC. Typically, the main difference between the working model edition and the professional edition is that the working model edition will not allow you to compile an executable application or package that application for installation on other computers.

I would recommend *Programming with Microsoft Visual Basic 6.0* by Diane Zak published by Course Technology, International Thomson Publishing Company (www.course.com), as a great place to begin learning how to program in Visual BASIC. Although this book does not have any input or output programming in it — and I doubt that you'll find a programming book that does — it does a great job getting you up and going in Visual BASIC in a short time.

First off, you should understand that Visual BASIC does not support the I/O commands of "OUT" and "INP" that are supported in QBASIC. However, there is a software patch, if you will, available that does allow Visual BASIC to support the "OUT" and "INP" commands that is free and easy to use. Jan Axelson has written a program in Delphi 2 called "Inpout32.dll" that is available at her Lakeview Research web site; www.lvr.com.

The Inpout32.dll works in Windows 95/98, but will not work in Windows versions beyond that. To get a copy of Inpout32.dll, go to www.lvr.com and select "Resource Pages," then select "Parallel Port." From there, scroll down to "Programming Tools for Port I/O and Interrupts" and finally you'll find a download for "Inpout32.zip." After you have downloaded and unzipped the file, copy the "Inpout32.dll" file into your Windows\System directory. Now all that is needed are two lines of code added to your Visual BASIC application to allow your application to perform I/O operations.

Let's begin by building the simplest Visual BASIC application we can to allow us to type in an address and data to output, as well as an input address and a box to show us the input data. After this application is running and everything works we can then enhance the form to look like the one shown in Figure 1.

To begin, start Visual BASIC 6.0 and begin a "new project standard EXE" from the choices shown to you. You should now see a project named "project1" with a blank form called "form1." We will need to add two lines of code in a separate module to get the "Inpout32.dll" code to function. Select "Project" from the top menu and then "Add Module," you should now have a "Project1 module1 (code)" window available for you to type in the code listed below:

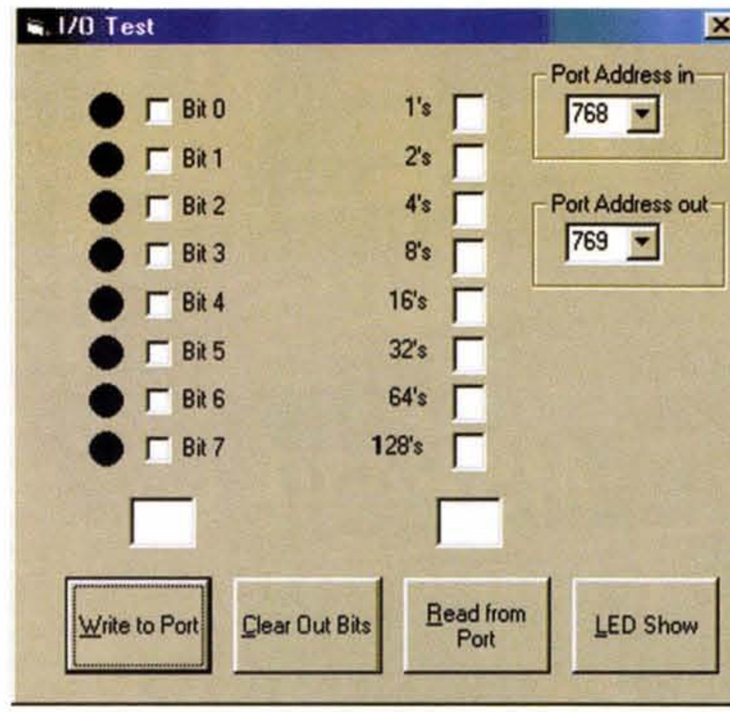


Figure 1

```
Public Declare Function Inp Lib "inpout32.dll" Alias "Inp32" (ByVal
PortAddress As Integer) As Integer
Public Declare Sub Out Lib "inpout32.dll" Alias "Out32" (ByVal
PortAddress As Integer, ByVal Value As Integer)
```

Although the code wraps around onto two lines here, be sure to have each "Public Declare ..." on one line in the module code window. You can extend a line in Visual BASIC to the next line by using an underscore "_" at the end of the first line. Normally, Visual BASIC is not too particular about spaces, etc., and usually prompts you when it doesn't like something that you type incorrectly. However, in these module code windows, it may not be of much help prompting you of errors and being picky about punctuation, etc. If you have troubles getting your program to work correctly, the problem is most likely here in this module code window. This extra module with these two lines of code will need to be added to any Visual BASIC project that uses the "INP" and "OUT" commands or you'll get an error.

Now we are ready to make a simple testing application to make sure that everything is going to function properly. Go back to the "form1

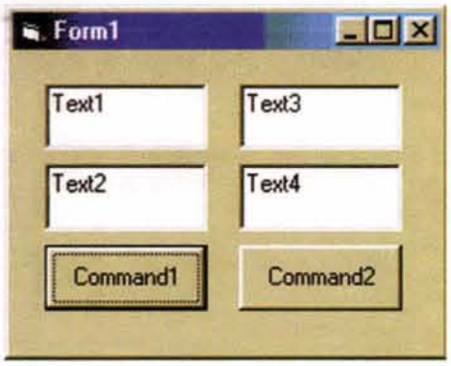


Figure 2

(form1)" and use the "Project1 - Project 1" folder menu located in the upper right hand corner of the screen. You should now have a blank form in front of you named form1. You can now place two command buttons and four text boxes from the left hand tool box on the form as shown in Figure 2.

Text1 will be where the output address is entered by the user; Text2 will be where the data to be output is placed and clicking on Command1 will send the data out to that address. Text3 will be where the input address is entered and Text4 will show what data was read in from that address; clicking on Command2 will cause the input operation to take place. To make the application easier to use, change the "Text" properties of each text box to the following and the "Caption" properties of the command buttons as shown in Figure 3.

Now all that is necessary is to add the code that will execute when each command button is clicked. Double clicking on a Visual BASIC object will take you into a code window where you can enter the appropriate code. Double click on Command1 "Output" and type in the following code:

```
Private Sub Command1_Click()
  Out Text1.Text, Text2.Text
End Sub
```

Double click on Command2 "Input" and type in the following code:

```
Private Sub Command2_Click()
Text4.Text = INP(Text3.Text)
End Sub
```

Now run the application by clicking on the "Run" menu choice at the top of the screen and then the "Start" choice or click on the "Play"

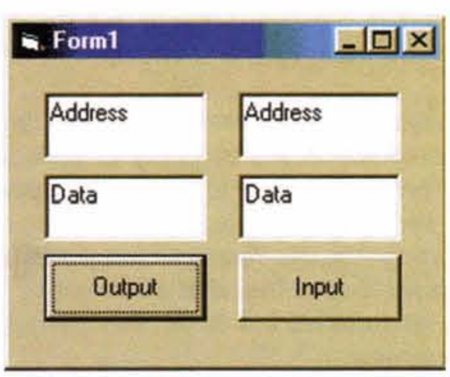


Figure 3

icon. Before you press either command button, be sure to type addresses and data to be output or you'll get an error. It is best to enter addresses in the prototyping range of 768 (decimal) through 799 (decimal) and a data number from 0 to 255 (decimal). Outputting numbers to addresses outside of the designated prototyping area may cause problems with other devices in your computer. Since the ports are only eight bits wide, outputting numbers greater than 255 cannot be done. If all goes well, you should be able to turn LEDs off and on on your interfacing protoboard and read the settings of your DIP switches. If you get error messages from Visual BASIC, the problem is most likely in the module1 code module containing the "Public Declare Function ..." code. Remember that the LEDs are connected in reverse logic; outputting a "1" turns them off. You can correct this by changing your Command1 code to the following:

```
Private Sub Command1_Click()
  Out Text1.Text, 255 - Text2.Text
End Sub
```

If you still are having troubles getting things to function, go back to QBASIC and see if everything works correctly there. If it does, then your hardware is fine and the problem is in the Visual BASIC software. Another problem may be that you are outputting or inputting to the wrong address.

Now let's build the advanced Visual BASIC I/O Test application shown in Figure 4.

Let's take a minute and go through how the application works before getting into the details of building it. Along the left hand side are eight black circles or shapes which represent the eight LEDs on the proto-board. They will turn to a red color when the box next to them is checked and then output, or they will remain black in color if their bit is turned off. Each check box to the immediate right of the circles is where the user can select which bits he or she desires to turn off or on. They are labeled Bit 0 through Bit 7; a bit can be turned on or off by clicking one time in the check box.

When the "Write to Port" command button is clicked, the data that is selected in these eight check boxes is output to the address shown in the "Port Address out" combo box on the right hand side of the form. The text box directly above the "Write to Port" command button will show the decimal value of the number that was just output. The "Clear Out Bits" command button will clear out all of the check boxes for both the output side and the input side, as well as their text boxes located at the bottom of their check boxes.

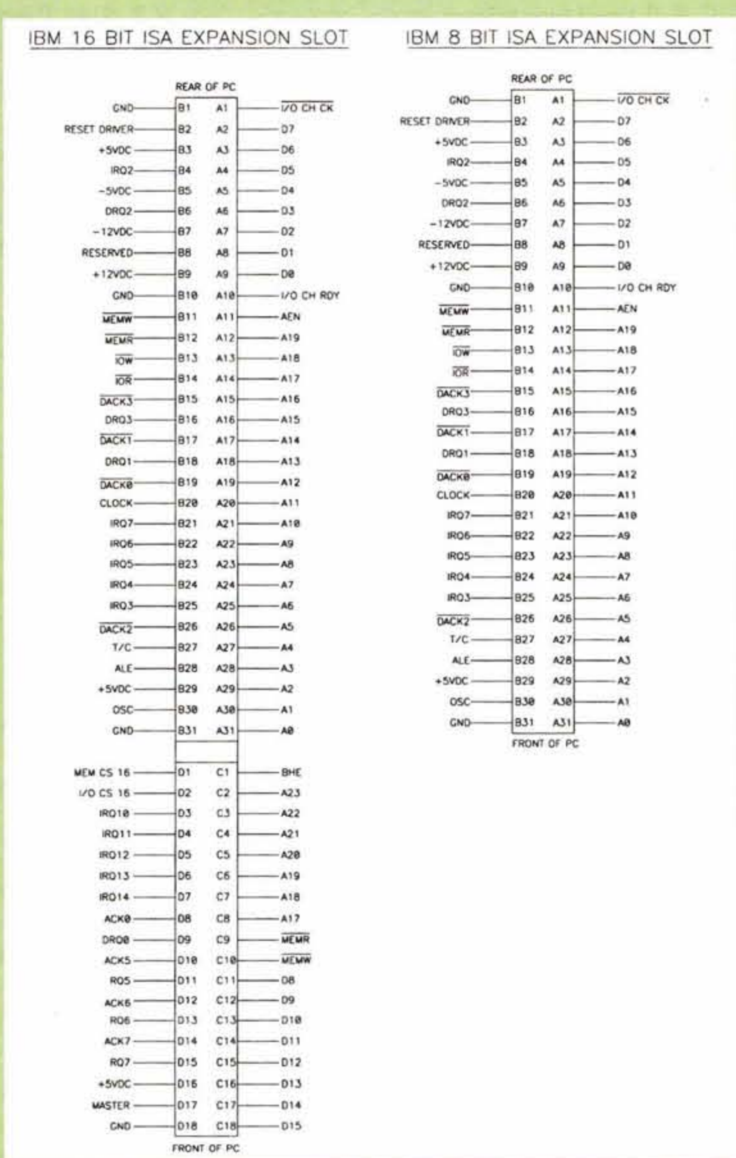
Clicking on the "Read from Port" command button will cause the program to input eight bits from the address displayed in the "Port Address in" combo box in the upper right hand corner and display each bit as a "1" or a "0" in the appropriate text box. The binary weighting of each bit is labeled on the left side of each box and the decimal value that was input will be displayed in the text box located immediately above the "Read from Port" command button. The "LED Show" command button will turn LEDs off and on in patterns for several seconds at the address shown in the "Port Address out" combo box.

Finally, the two combo boxes labeled "Port Address in" and Port Address out" allow the user to click on the down arrow on the right side of the box and activate a pull down list of addresses — 768 (decimal) through 799 (decimal) — and select the particular address wanted. The application begins with a default input address of 768 (decimal) and an output address of 769 (decimal) which can be easily changed when building the application.

Let's begin building the form now. Begin Visual BASIC 6.0 and start a "New Standard EXE" project. Add the module with the "Public Declare ..." code lines as explained earlier and then get back to the new blank form. First, place the eight circles on the form by placing one shape from the shape icon on the left hand tool box (the shape will be a rectangle at first). The shape will be named "Shape1." In its properties window, change its fill style to "0-solid" and its shape property to "3-circle." Now select Shape1 and right click on it; from the pull down menu that appears, select "copy." Now right click on the form and from the pull down menu select "paste." A window should now appear to let you know that there is already an object named Shape1 and asking you if you would like to create a control array. Select yes, and each time you paste, you will get another circle, each one being named Shape1(1), then Shape1(2), and so on.

Continue pasting until you have eight circles, Shape1(0) through Shape1(7). Note that the shapes will be pasted on top of each other in the upper left hand corner of the form and that you will need to select each one and move them to their proper place on the form. Place them on the form as shown on the sample form with Shape1(0) at the top and Shape1(7) at the bottom. Now go through the same process for the eight check boxes located just to the right of the circles.

A note about the ISA expansion slots: Please refer to the ISA expansion slot figure in this sidebar. Many newer PCs do not have eight-bit ISA expansion slots, but have the expanded 16-bit ISA expansion slots. Note that the eight-bit ISA expansion slot and the first part of the 16-bit ISA expansion are completely compatible. Therefore, the interfacing PCB will work in either an eight-bit slot or the first part of the expanded 16-bit slot.



First place checkbox1 down and then copy an array of check boxes, checkbox1(0) through checkbox1(7), and place them on the form with checkbox1(0) at the top and checkbox1(7) at the bottom. Next, change the "caption" properties on the check boxes to read "bit 0," "bit 1," etc. Now place two text boxes down on the form, text box 1 directly under the output check boxes and text box 2 to its right below where the input text boxes will be located. Now place a text box, textbox3, where the "1's" text box should be, then copy an array of text boxes, textbox3(0)

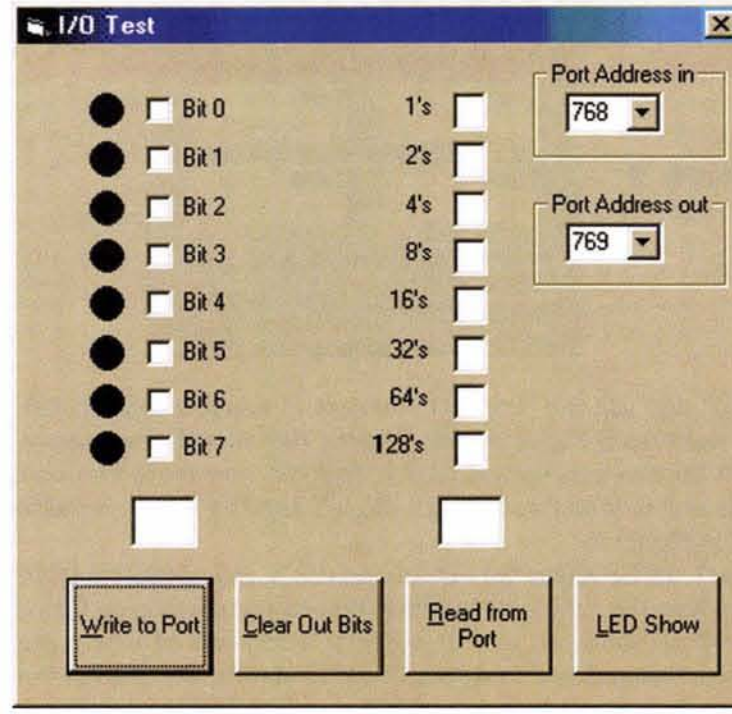


Figure 4

through textbox3(7), down to display the input bits. To the left of each of these text boxes place a "label" indicating its binary weighting, 1s through 128s. Now place four command buttons along the bottom of the form and change their captions and names in their properties window as follows: "Write to Port" as its caption, and "cmdWriteToPort" as its name; next "Clear Out Bits" as its caption, and "cmdClear" as its name; next "Read from Port" as its caption, and "cmdRead" as its name; and finally, "LED Show" as its caption, and "cmdShow" as its name.

To get the first caption letter in each command button to become underlined, place an "&" in front of the letter you want underlined in the caption properties. An underlined letter in a command box is an access key so that when you press the "ALT" key and that underlined letter, it is the same as clicking on the key. For example, pressing the "ALT + W" keys is the same as clicking on the "Write to Port" command button. Next place two frames down for the port selection combo boxes to be placed on and change their caption properties to read "Port Address in" and "Port Address out." Now place two combo boxes, one on each frame, and change their names to "Port_in" and "Port_out." In the combo box properties, you can change their text properties to the default addresses you want them to come up with when the application first runs.

Now you can type in the addresses you want the user to be able to select from these combo boxes by going to their properties windows and to their "List" properties. Type in the numbers you want listed — 768 through 799 — and press "Control + Enter" after each number to progress down through the list. You can change what is displayed on the top of the form from "Form1" to what you want by selecting the form itself, clicking on the form but not on another control, and changing the form's caption property.

Finally, notice that the sample form shown only has the "X" or close choice available to close the window and cannot be resized or minimized by the user. This can be set in the form's properties under "border style." Change the border style to "1-fixed single." Now all that is needed is to type in the code to make it all work. I have tried to document the code with comments so that it is easy to follow. Notice that in Visual BASIC placing a single quotation mark (') in front of anything changes everything after that to a comment that is ignored by the computer when executing the code. Also note that it doesn't matter what order the sub routines are placed in the program. Most of the objects that you see on the sample form had to have their sizes changed from the default sizes that Visual BASIC sets down. You can change their sizes by selecting them and clicking and dragging on their resizing handles located along their outer edges after they are selected. Also, some of the font sizes and/or

PCB Purchasing Information

Bare PCB doublesided with plated through holes, includes two break-off cable adapter PCBs for proto-boarding. **$25.00 includes shipping and handling.**
Parts kit for PCB and I/O ports, includes: eight IC sockets, 11 ICs, 11 capacitors, one eight-position DIP switch, eight LEDs, 16 resistors, 2-26 wire ribbon cables each 2-½ feet long (cables are made with IDC sockets installed), four male headers for the cables, and proto-boarding pins for the cable adapter PCBs. All parts are included to build the interfacing circuitry on the PCB and the eight-bit I/O ports excluding the proto-board. **$25.00 includes shipping and handling.**

Send a check or money order to:
David A. Ward
2261 West Skyview Dr., Cedar City, UT 84720
Phone: 435-586-7235 • Email: ward@suu.edu
(I am unable to accept credit cards.)

styles might have been changed from their defaults under their font properties.

Good luck. I hope it all runs well for you without any problems. But there are usually some typos and other small items in a program this long that you'll need to find and fix before it all comes together. Watch for spelling differences in control names between the code itself and what the control is actually named. The next article in this series will deal with inputting and outputting to non-TTL compatible level devices. TTL level devices (+5VDC and 0VDC) are not always available outside of the computer itself and it often becomes necessary to convert the TTL level signals that we have been dealing with so far to higher DC voltages and even to AC voltages. **NV**

Listing 1

```
'I/O test program
'David A. Ward June 2001
'For use with the 32 address 8 bit I/O card
'inpout32.dll must be in the Windows\Systems directory
'for the INP and OUT commands to work.

'the following code must also be located in a separate module:
'Public Declare Function Inp Lib "inpout32.dll" Alias "Inp32" (ByVal PortAddress As
Integer) As Integer
'Public Declare Sub Out Lib "inpout32.dll" Alias "Out32" (ByVal PortAddress As
Integer, ByVal Value)

Option Explicit
Dim X, Y, T, Z, PortAddress_in, PortAddress_out, Number, Total As Integer

'Flashing LED show
Private Sub cmdShow_Click()
 MousePointer = 13 'change cursor to indicate the program is busy
  'shift LED's from LSB up through MSB
  Z = 0
   While Z < 10
    X = 0
     While X < 8
       Out PortAddress_out, 255 - 2 ^ X
       Call Delay
       X = X + 1
     Wend
    'Shift LED's from MSB down through LSB
     X = 7
     While X > -1
       Out PortAddress_out, 255 - 2 ^ X
       Call Delay
       X = X - 1
      Wend
    Z = Z + 1
   Wend
   'turn every other LED off and on
Z = 0
While Z < 10
Out PortAddress_out, 0
  Out PortAddress_out, 170
  Call Delay
  Out PortAddress_out, 85
  Call Delay
  Z = Z + 1
Wend
'turn all LED's off
  Out PortAddress_out, 255
  MousePointer = 0
End Sub

'Delay subroutine
Private Sub Delay()
  Dim PauseTime, Start
  PauseTime = 0.01 ' Set duration at 10mS.
  Start = Timer     ' Set start time.
  Do While Timer < Start + PauseTime
    DoEvents       ' Yield to other processes.
  Loop
End Sub

'Write check box data to the output port
'change checked box circles from black to red or red to black if unchecked
Private Sub cmdWriteToPort_Click()
  If Check1(0).Value = vbChecked Then Number = 1: Shape1(0).FillColor = &HFF&
_
      Else Shape1(0).FillColor = &H0&
    If Check1(1).Value = vbChecked Then Number = Number + 2:
Shape1(1).FillColor = &HFF& _
    Else Shape1(1).FillColor = &H0&
    If Check1(2).Value = vbChecked Then Number = Number + 4:
Shape1(2).FillColor = &HFF& _
    Else Shape1(2).FillColor = &H0&
    If Check1(3).Value = vbChecked Then Number = Number + 8:
Shape1(3).FillColor = &HFF& _
    Else Shape1(3).FillColor = &H0&
    If Check1(4).Value = vbChecked Then Number = Number + 16:
Shape1(4).FillColor = &HFF& _
    Else Shape1(4).FillColor = &H0&
    If Check1(5).Value = vbChecked Then Number = Number + 32:
Shape1(5).FillColor = &HFF& _
    Else Shape1(5).FillColor = &H0&
    If Check1(6).Value = vbChecked Then Number = Number + 64:
Shape1(6).FillColor = &HFF& _
    Else Shape1(6).FillColor = &H0&
    If Check1(7).Value = vbChecked Then Number = Number + 128:
Shape1(7).FillColor = &HFF& _
    Else Shape1(7).FillColor = &H0&

Out PortAddress_out, 255 - Number
Text1.Text = Number
Number = 0
End Sub

'Read binary data from the input port
Private Sub CmdRead_Click()
  Total = Inp(PortAddress_in)
  Text2.Text = Total
  If Total And 1 Then Text3(0).Text = "1" _
    Else: Text3(0) = "0"
  If Total And 2 Then Text3(1).Text = "1" _
    Else: Text3(1) = "0"
  If Total And 4 Then Text3(2).Text = "1" _
    Else: Text3(2) = "0"
  If Total And 8 Then Text3(3).Text = "1" _
    Else: Text3(3) = "0"
  If Total And 16 Then Text3(4).Text = "1" _
    Else: Text3(4) = "0"
  If Total And 32 Then Text3(5).Text = "1" _
    Else: Text3(5) = "0"
  If Total And 64 Then Text3(6).Text = "1" _
    Else: Text3(6) = "0"
  If Total And 128 Then Text3(7).Text = "1" _
    Else: Text3(7) = "0"
 End Sub
'Clear out bits on form and set all port bits to 0
Private Sub CmdClear_Click()
  For X = 0 To 7
  Check1(X).Value = False
  Shape1(X).FillColor = &H0&
  Text3(X) = ""
  Next X
  Number = 0
Out PortAddress_out, 255 - Number
Text1.Text = ""
Text2.Text = ""
End Sub

Private Sub Port_in_Click()
  PortAddress_in = Port_in.Text
End Sub

Private Sub Port_out_Click()
  PortAddress_out = Port_out.Text
End Sub

Private Sub Form_Load()
'set up port addresses
PortAddress_in = Port_in.Text
PortAddress_out = Port_out.Text
End Sub
```

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

by Jon Williams

Stamp Applications

I²C Fun For Everyone

Honestly, I don't know what I was thinking. I²C has been around for over 20 years and I was certainly aware of it, I just never paid much attention. Silly me. Since I can't turn back the clock, I've spent the last couple weeks making up for lost time and I have to say, I'm having a blast. And with my growing interest in robotics, I²C is a fantastic way to expand the Stamp's capabilities without chewing up a bunch of pins.

For those of you who are old enough to do it, do you remember the last time you bought a new car? It feels great, doesn't it? Then, as you hit the open road, proud of your shiny new machine and loving that new-car smell ... you notice that just about every second human on the planet is driving the exact same model ...

I went through that recently, but not with a car. I did it with the I²C (Inter-integrated Circuit) bus (I've also just recently discovered how useful crock pots are ... but I'll talk about that when I connect a BASIC Stamp to one).

There are a couple pieces of great news concerning I²C for us Stamp users: **(1)** There are literally hundreds of I²C parts available that we can connect to and, **(2)** The protocol is simple enough to implement on any Stamp — I've even heard of Stampers implementing it on the BS1!

As you know, the BS2p has built-in I²C capability with its **I2COUT** and **I2CIN** commands. We've covered those commands in a couple past articles, so this month we're going to give I²C to the rest of the BS2 family.

I²C Basics

The I²C-bus is a two-wire, synchronous bus that uses a Master-Slave relationship between components. The Master initiates communication with the Slave and is responsible for generating the clock signal. If requested to do so, the Slave can send data back to the Master. This means the data pin (SDA) is bi-directional and the clock pin (SCL) is [usually] controlled only by the Master.

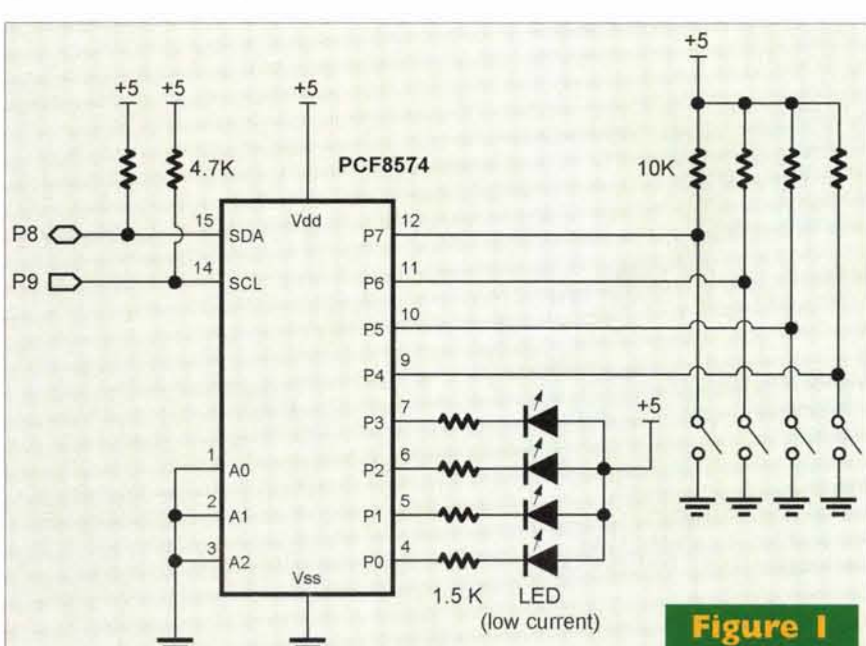


Figure I

The transfer of data between the Master and Slave works like this:

Master sending data

- Master initiates transfer
- Master addresses Slave
- Master sends data to Slave
- Master terminates transfer

Master receiving data

- Master initiates transfer
- Master addresses Slave
- Master receives data from Slave
- Master terminates transfer

The I²C specification actually allows for multiple Masters to exist on a common bus and provides a method for arbitrating between them. That's a bit beyond the scope of what we need to do, so we're going to keep things simple. In our set-up, the BS2 (or BS2e or BS2sx) will be the Master and anything connected to it will be a Slave.

You'll notice in I²C schematics that the SDA and SCL lines are pulled up to Vdd (usually through 4.7K). The specification calls for device bus pins to be open drain. To put a high on either line, the associated bus pin is made an input (floats) and the pull-up takes the line to Vdd. To make a line low, the bus pin pulls it to Vss (ground).

This scheme is designed to protect devices on the bus from a short to ground. Since neither line is driven high, there is no danger. We're going to cheat a bit. Instead of writing code to pull a line low or release it (certainly possible — I did it), we're going to use **SHIFTOUT** and **SHIFTIN** to move data back and forth. Using **SHIFTOUT** and **SHIFTIN** is faster and saves precious code space. If you're concerned about a bus short damaging the Stamp's SDA or SCL pins during **SHIFTOUT** and **SHIFTIN**, you can protect each of them with a 220-ohm resistor. I've been careful with my wiring and code and haven't found this necessary.

Low Level I²C Code

At its lowest level, the I²C Master needs to do four things:

- Generate a Start condition
- Transmit eight-bit data to the Slave
- Receive eight-bit data from Slave — with or without Acknowledge
- Generate Stop condition

A Start condition is defined as a HIGH to LOW transition on the SDA line while the SCL line is HIGH. All transmissions begin with a Start condition. A Stop condition is defined as a LOW to HIGH transition of the SDA line while the clock line is HIGH. A Stop condition terminates a transfer and can be used to abort it, as well.

There is a brief period when the Slave can take control of the SCL line. If a Slave is not ready to transmit or receive data, it can hold the SCL line low after the Start condition. The Master can monitor this to wait for the Slave to be ready. At the speed of the BS2, monitoring the clock line usually isn't necessary but I've built the clock-hold test into the I2C_Start subroutine just to be safe.

Data is transferred eight bits at a time, sending the MSB first. After each byte, the I²C specification calls for the receiving device to acknowledge the transmission by bringing the bus low for the ninth clock. The exception to this is when the Master is the receiver and is receiving the final byte from the Slave. In this case, there is no Acknowledge bit sent from

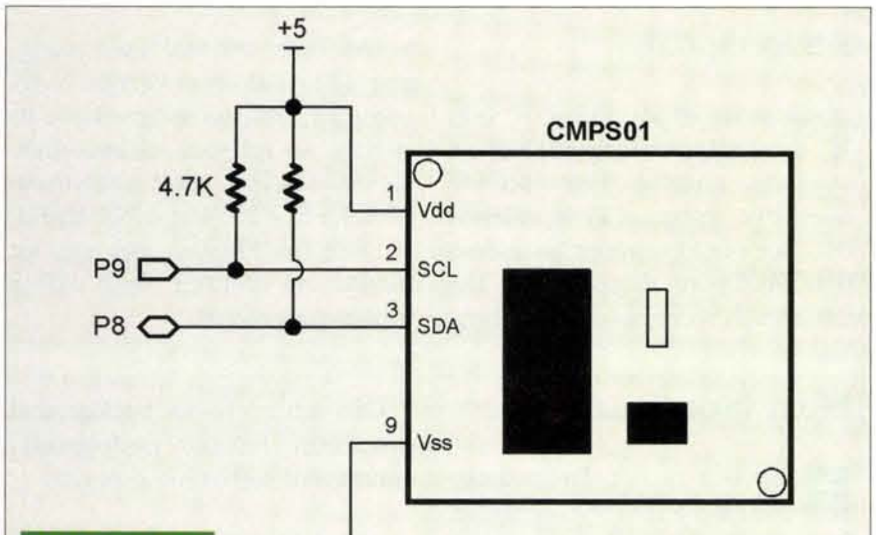


Figure 2

Master to Slave.

Sending and receiving data from a specific slave always requires a Start condition, sending the Slave address and finally, the Stop condition. What happens between the Slave address and the Stop are dependent on the device and what we're doing.

What you'll need to do is get the data sheet for the I²C device you want to connect to. I have found, without exception, that data sheets for I²C-compatible parts have very clear protocol definitions — usually in graphic form — that makes implementing our low-level I²C routines very simple.

Let's Make It Work

Now, I'd love to have you all believe that I'm the sharpest knife in the drawer ... but we all know that isn't the case and I've just admitted to being a Jonny-come-lately as far as I²C is concerned. So let me tell you that the working I²C code I'm presenting here is my version of similar code that I have obtained from several sources. A quick web search will turn up many sites that use I²C devices with the BS2, BS2e, and BS2sx.

To demonstrate the use of I²C, we'll work with two components — one very simple and the other a little more sophisticated — but no more difficult to use. Both are useful in robotics projects.

The first is the Philips PCF8574 I/O port expander. I've used it with the BS2p and bring it up again because of its utility and how easy it is to communicate with. The PCF8574 has eight I/O pins that can be used either as input, outputs, or in combination. The spec sheet calls for the pins — whether inputs or outputs — to be active low. Inputs, then, should be pulled up to Vdd and taken to Vss when active. For outputs, the device will sink current — but not very much. Only three milliamps per pin, actually. So use low current LEDs or a buffer if you need more current from a PCF8574 output.

The PCF8574 has no data direction register and we must always write or read the full eight bits. When using it only for outputs or only for inputs, this isn't a problem. But when mixing I/O, things get just a bit tricky. You see, if we write a zero to a pin that is being used as an input, the next read cycle can read back that zero and make it look like a false input. The way to avoid this problem is to mask any input pins (with a one) when we do a write.

Listing 1, on page 76, is the program that goes along with the schematic in Figure 1. In this program, we will use a single PCF8574 to display a four-bit counter and read back four switch inputs. To prevent the counter write cycle from creating false inputs, the counter (inverted for active-low outputs) is ORed with a constant called MixDDR. In this constant, a one represents an input pin, zero an output since inputs are pulled-up and outputs are active low.

The subroutine called Write_PCF8574 takes care of the details and, as you can see, it is very straightforward. First, the Start condition is generated. The next step is to send the Slave address. The upper four bits of the Slave address define the device type. Bits two, three, and four are the physical device address. With three address bits, we can have up to eight PCF8574 chips on the same bus, giving us up to 64 bits of I/O (you'll need to make the Slave address a variable to do this). Bit zero of the Slave address defines write (when zero) or read (when one).

I2C_TX_Byte is used to send eight bits to the Slave device and to read back the acknowledge bit. Notice how simple this is using **SHIFTOUT** and **SHIFTIN**. There may be times when you'll want to check the received ACK bit to make sure everything is working. The PCF8574 is a simple device, so this won't be necessary. One other thing that I should point out is that both **SHIFTOUT** and **SHIFTIN** take care of setting the specified data and clock pins as required, so it doesn't matter that we enter into I2C_TX_Byte with the SCL line set as an input.

You may wonder why the data byte (masked counter) is transmitted twice. The reason is that the PCF8574 behaves like a shift register. The first write places data into an internal holding register and subsequent writes force the holding register to the output pins. For programs that may not be refreshing the PCF8574 as frequently as we are here, writing twice ensures that the outputs reflect their proper state. After the second write, we must generate a Stop condition to terminate the transfer and free the bus.

Reading data back from the PCF8574 is just as straightforward. Read_ PCF8574 generates a Start, transmits the Slave address (this time with bit zero set to one for read), reads from the device, then generates a Stop. Remember what I mentioned earlier, that the final read — when the Master is receiver — does not send an ACK (low) bit. Since we're only reading one byte, we'll use I2C_RX_Byte_Nak.

Notice that this is really just an entry point for I2C_RX and sets the i2cAck variable to a one. I2C_RX does the work by shifting in eight bits, starting with the MSB. **SHIFTOUT** is used to send i2cAck. In this case, it's a one, so the bus is high (NAK) during the ninth clock pulse.

Read_ PCF8574 returns data to the main code in a variable called i2cData. To make things easy, the variable called switches is aliased to the upper four bits of i2cData (since the inputs on the PCF8574 are P4 .. P7). A few **DEBUG** statements are used in the main body to update the display. All-in-all, this one is pretty easy, and demonstrates the utility of the PCF8574.

Next up is another neat device from those cool guys across the pond at Devantech. This one is the CMPS01 compass module (available from Acroname). The CMPS01 is an electronic compass that will give us readings in Brads (0 to 255) or in tenths of Degrees (0.0 to 359.9). To make it compatible with other I²C devices, the engineers at Devantech designed the CMPS01 to behave like a typical memory device.

This program (Listing 2 on page 74), like the PCF8574, is very easy so I'm not going to cover it line-by-line. I just want to go over a couple of the high-level subroutines because they demonstrate techniques that will be used in many other I²C devices.

The first subroutine to look at is called Write_Word. This routine writes a 16-bit variable to the CMPS01, starting at the locations specified by i2cReg. Notice that after the high byte is written, the low byte is written without worry of the register number. The reason is that the register number is automatically incremented after each write. This allows us to send a stream of contiguous bytes to the device. For the CMPS01, we only need to send two bytes, but for other devices (like an RTC), it might be convenient to write several bytes without having to set the address for each.

Now we'll look at the routines for reading from the CMPSO1. To read from a location, we will actually begin what looks like a write cycle. We need to do this to set

Resources:

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Parallax
599 Menlo Drive, Suite 100
Rocklin, CA 95756
(888) 512-1024
www.parallaxinc.com
www.javelinstamp.com

Acroname
www.acroname.com

Devantech
www.robot-electronics.co.uk

the register address. Once the register address is sent, another Start condition is generated. This is what actually sets the register number and then allows us to do the read from it. As with writes, the register number is incremented with each read cycle. This allows us to read a 16-bit variable (as in Read_Word) by specifying the address of the high byte.

I really like the CMPS01 and have it designed into a little robot I'm working on to collect empty soda cans as part of the Dallas Personal Robotics Group's Roborama contest.

Mixing And Matching ... Sort Of

As you've seen, it's pretty simple to write code for I²C devices with the core subroutines developed in our demo programs. One thing that I haven't yet discussed is the use of a variable for the SDA pin. The reason is this: You will find devices that have no internal addresses (PCF8574), some with less than 256 locations so they use a single address byte (CMPS01), and some with enough locations to require two address bytes (24LC32 EEPROM).

I made the SDA line a variable because it is possible that a particular application will require more than one SDA line to prevent devices from stepping on each other. I spent a frustrating day swapping out RTC chips that I thought were bad only to find that an EEPROM was stepping on the RTC's transmissions. The SCL line can be shared with all devices since we can only talk to one device at a time. If your own project uses just one device, or devices are compatible, you can simplify the code a bit by using the SDA constant in the low-level I²C routines. Otherwise, set the value of i2cSDA to the bus pin you want to use, then call the routines.

You'll find the code and schematic for that RTC (PCF8583) in the ZIP file that goes along with this article. There's also code for a couple of EEPROMs and the PCF8591 four-channel A2D.

Until next month, have fun with I²C devices and Happy Stamping. **NV**

BS2p Update

For those of you using I²C with the BS2p, an upgrade will be available shortly. The upgrade does two things: **(1)** It extends the clock-hold timeout period so that intelligent devices (like the Devantech compass) have time to do their internal processing, and **(2)** With the Version 1.33 compiler, you no longer have to specify an internal address byte for devices that don't need them (like the PCF8574 and PCF8591).

See the Parallax web site for details on getting your BS2p module upgraded.

Next Month ...

Believe it or not, I'm actually thinking ahead for a change. So, what's up? Well next month, we'll spear our embedded control problems with the new Javelin Stamp. Can you say Object Oriented Programming in a BS2-sized module? If you haven't heard the news yet, this new module from Parallax is physically and electrically identical to the BS2sx and has these features:

- Programs in (a subset of) Sun's Java language
- Has 32K of flat program space
- Has 32K of RAM (space not used by program is available for variables)
- Can run up to six background processes (virtual peripherals) concurrent with main program

The background processes are particularly exciting. With the Javelin, you can receive or send serial data, control servos or motors with PWM, measure an analog voltage or even spit one out, have precise timer functions — all without affecting the foreground program.

To be fair, the Javelin is a very sophisticated beast, but once you get used to it, it's a heck of a lot of fun. If you want to get a jump on next month's article, be sure to visit the Javelin web site and download the documentation.

Listing 2

```
' =========================================================================
'
'   File...... CMPS01.BS2
'   Purpose... Daventech CMPS01 Electronic Compass Demo
'   Author.... Jon Williams
'   E-mail.... jonwms@aol.com
'   Started... 10 MAR 2002
'   Updated... 29 MAR 2002
'
'   {$STAMP BS2}
'
'
' =========================================================================


' -------------------------------------------------------------------------
' Program Description
' -------------------------------------------------------------------------
'
' This program demonstrates essential I2C routines and communication with the
' Daventech CMPS01 electronic compass.  The Daventech compass behaves very
' like a typical I2C memory device and the routines to read from and write to
' it are identical to those used with EEPROMs.


' -------------------------------------------------------------------------
' Revision History
' -------------------------------------------------------------------------


' -------------------------------------------------------------------------
' I/O Definitions
' -------------------------------------------------------------------------

SDA             CON     8                       ' I2C serial data line
SCL             CON     9                       ' I2C serial clock line


' -------------------------------------------------------------------------
' Constants
' -------------------------------------------------------------------------

WrCMPS01        CON     $C0                     ' write to compass
RdCMPS01        CON     $C1                     ' read from compass

Ack             CON     0                       ' acknowledge bit
Nak             CON     1                       ' no ack bit

' Compass registers
'
CMPS01_Rev      CON     0
CMPS01_Brads    CON     1                       ' bearing, 0 - 255
CMPS01_DegHi    CON     2                       ' degrees, high byte
CMPS01_DegLo    CON     3                       ' degrees, low byte
CMPS01_S1THi    CON     4                       ' sensor 1 test, high
CMPS01_S1TLo    CON     5                       ' sensor 1 test, low
CMPS01_S2THi    CON     6                       ' sensor 2 test, high
CMPS01_S2TLo    CON     7                       ' sensor 2 test, low
CMPS01_S1CHi    CON     8                       ' sensor 1 cal, high
CMPS01_S1CLo    CON     9                       ' sensor 1 cal, low
CMPS01_S2CHi    CON     10                      ' sensor 2 cal, high
CMPS01_S2CLo    CON     11                      ' sensor 2 cal, low
CMPS01_X1       CON     12                      ' not used
CMPS01_X2       CON     13                      ' not used
CMPS01_CalDone  CON     14                      ' calibration done flag
CMPS01_CalCmd   CON     15                      ' calibration cmd register

CrsrXY          CON     2                       ' DEBUG Position Control


' -------------------------------------------------------------------------
' Variables
' -------------------------------------------------------------------------

i2cSDA          VAR     Nib                     ' I2C serial data pin
i2cData         VAR     Word                    ' data to/from device
i2cReg          VAR     Byte                    ' register address
i2cWork         VAR     Byte                    ' work byte for TX routine
i2cAck          VAR     Bit                     ' Ack bit from device

temp            VAR     Word                    ' for rj printing
digits          VAR     Nib
width           VAR     Nib


' -------------------------------------------------------------------------
' EEPROM Data
' -------------------------------------------------------------------------


' -------------------------------------------------------------------------
' Initialization
' -------------------------------------------------------------------------

Init:
```

```
  PAUSE 250
  DEBUG CLS
  DEBUG CrsrXY, 0, 0, "Devantech CMPS01 Compass Demo"
  DEBUG CrsrXY, 0, 1, "-----------------------------"

  i2cSDA = SDA                              ' define SDA pin
  i2cReg = CMPS01_Rev                       ' compass revision number
  GOSUB Read_Byte
  DEBUG CrsrXY, 0, 3, "Rev Num... "
  temp = i2cData
  width = 3
  GOSUB RJ_Print

  DEBUG CrsrXY, 0, 5, "Brads..... "
  DEBUG CrsrXY, 0, 6, "Degrees... "


' ---------------------------------------------------------------------------
' Program Code
' ---------------------------------------------------------------------------

Main:
  i2cReg = CMPS01_Brads                     ' get brads, 0 - 255
  GOSUB Read_Byte
  DEBUG CrsrXY, 11, 5
  temp = i2cData
  GOSUB RJ_Print

  i2cReg = CMPS01_DegHi                     ' get degrees, 0.0 - 359.9
  GOSUB Read_Word
  DEBUG CrsrXY, 11, 6
  temp = i2cData / 10
  GOSUB RJ_Print
  DEBUG ".", DEC1 i2cData, "  "

  PAUSE 250
  GOTO Main
  END


' ---------------------------------------------------------------------------
' Subroutines
' ---------------------------------------------------------------------------

RJ_Print:                                   ' right justify
  digits = width
  LOOKDOWN temp, <[0,10,100,1000,65535], digits
  DEBUG REP " "\(width - digits), DEC temp
  RETURN


' ---------------------------------------------------------------------------
' Compass Access Subroutines
' ---------------------------------------------------------------------------

' Writes low byte of i2cData to i2cReg

Write_Byte:
  GOSUB I2C_Start
  i2cWork = WrCMPS01
  GOSUB I2C_TX_Byte                         ' send device address
  i2cWork = i2cReg
  GOSUB I2C_TX_Byte                         ' send register number
  i2cWork = i2cData.LowByte
  GOSUB I2C_TX_Byte                         ' send the data
  GOSUB I2C_Stop
  RETURN


' Writes i2cData to i2cReg

Write_Word:
  GOSUB I2C_Start
  i2cWork = WrCMPS01
  GOSUB I2C_TX_Byte                         ' send device address
  i2cWork = i2cReg
  GOSUB I2C_TX_Byte                         ' send register number
  i2cWork = i2cData.HighByte
  GOSUB I2C_TX_Byte                         ' send the data - high byte
  i2cWork = i2cData.LowByte
  GOSUB I2C_TX_Byte                         ' send the data - low byte
  GOSUB I2C_Stop
  RETURN


' Read i2cData (8 bits) from i2cReg

Read_Byte:
  GOSUB I2C_Start
  i2cWork = WrCMPS01
  GOSUB I2C_TX_Byte                         ' send compass address
  i2cWork = i2cReg
  GOSUB I2C_TX_Byte                         ' send register number
  GOSUB I2C_Start                           ' repeat start (sets register)
  i2cWork = RdCMPS01
  GOSUB I2C_TX_Byte                         ' send read command
  GOSUB I2C_RX_Byte_Nak
  GOSUB I2C_Stop
  i2cData = i2cWork                         ' return the data
  RETURN


' Read i2cData (16 bits) from i2cReg

Read_Word:
  GOSUB I2C_Start
  i2cWork = WrCMPS01
  GOSUB I2C_TX_Byte                         ' send compass address
  i2cWork = i2cReg
  GOSUB I2C_TX_Byte                         ' send register number
  GOSUB I2C_Start                           ' repeat start (sets register)
  i2cWork = RdCMPS01
  GOSUB I2C_TX_Byte                         ' send read command
  GOSUB I2C_RX_Byte
  i2cData.HighByte = i2cWork                ' read high byte of data
  GOSUB I2C_RX_Byte_Nak
  GOSUB I2C_Stop
  i2cData.LowByte = i2cWork                 ' read low byte of data
  RETURN


' ---------------------------------------------------------------------------
-
' Low Level I2C Subroutines
' ---------------------------------------------------------------------------
-

' --- Start ---

I2C_Start:                                  ' I2C start bit sequence
  INPUT i2cSDA
  INPUT SCL
  LOW i2cSDA                                ' SDA -> low while SCL high

Clock_Hold:
  IF (Ins.LowBit(SCL) = 0) THEN Clock_Hold  ' device ready?
  RETURN


' --- Transmit ---

I2C_TX_Byte:
  SHIFTOUT i2cSDA,SCL,MSBFIRST,[i2cWork\8]  ' send byte to device
  SHIFTIN i2cSDA,SCL,MSBPRE,[i2cAck\1]      ' get acknowledge bit
  RETURN


' --- Receive ---

I2C_RX_Byte_Nak:
  i2cAck = Nak                              ' no Ack = high
  GOTO I2C_RX

I2C_RX_Byte:
  i2cAck = Ack                              ' Ack = low

I2C_RX:
  SHIFTIN i2cSDA,SCL,MSBPRE,[i2cWork\8]     ' get byte from device
  SHIFTOUT i2cSDA,SCL,LSBFIRST,[i2cAck\1]   ' send ack or nak
  RETURN


' --- Stop ---

I2C_Stop:                                   ' I2C stop bit sequence
  LOW i2cSDA
  INPUT SCL
  INPUT i2cSDA                              ' SDA --> high while SCL high
  RETURN
```

Listing 1

```
'
'===========================================================================
'
'   File...... PCF8574.BS2
'   Purpose... PCF8574 control via I2C
'   Author.... Jon Williams
'   E-mail.... jonwms@aol.com
'   Started... 20 MAR 2002
'   Updated... 29 MAR 2002
'
'   {$STAMP BS2}
'
'
'===========================================================================


' -------------------------------------------------------------------------
' Program Description
' -------------------------------------------------------------------------
'
' This program demonstrates essential I2C routines and communication with the
' Philips PCF8574 port expander. The expander is a quasi-bidirectional device;
' you can write to outputs or read from inputs no data direction register.
'
' Inputs and outputs are active low. When writing to the device, a "1"
' should be written to any pin that is used an input.


' -------------------------------------------------------------------------
' Revision History
' -------------------------------------------------------------------------


' -------------------------------------------------------------------------
' I/O Definitions
' -------------------------------------------------------------------------
'
SDA             CON     8                       ' I2C serial data line
SCL             CON     9                       ' I2C serial clock line


' -------------------------------------------------------------------------
' Constants
' -------------------------------------------------------------------------
'
DevType         CON     %0100 << 4              ' device type
DevAddr         CON     %000 << 1               ' address = %000 -> %111
Wr8574          CON     DevType | DevAddr | 0   ' write to PCF8574
Rd8574          CON     DevType | DevAddr | 1   ' read from PCF8574

ACK             CON     0                       ' acknowledge bit
NAK             CON     1                       ' no ack bit

MixDDR          CON     %11110000               ' 1 = input for mixed I/O

Yes             CON     0
No              CON     1

CrsrXY          CON     2                       ' DEBUG Position Control


' -------------------------------------------------------------------------
' Variables
' -------------------------------------------------------------------------

i2cSDA          VAR     Nib                     ' I2C serial data pin
i2cData         VAR     Byte                    ' data to/from I2C device
i2cWork         VAR     Byte                    ' work byte for I2C TX code
i2cAck          VAR     Bit                     ' ACK bit from device

counter         VAR     Nib
switches        VAR     i2cData.HighNib         ' from PCF8574


' -------------------------------------------------------------------------
' EEPROM Data
' -------------------------------------------------------------------------


' -------------------------------------------------------------------------
' Initialization
' -------------------------------------------------------------------------

Initialize:
  PAUSE 250                                     ' let DEBUG open
  DEBUG CLS, "PCF8574 Demo"
  DEBUG CrsrXY, 0, 2, "Counter:  ", BIN4 counter
  DEBUG CrsrXY, 0, 3, "Switches: ", BIN4 switches

  i2cSDA = SDA                                  ' define SDA pin
  i2cData = %11111111                           ' clear outputs
  GOSUB Write_PCF8574
  IF (i2cAck = ACK) THEN Main                   ' device is present

  DEBUG CLS, "Error: No ACK from PCF8574"
  END

' -------------------------------------------------------------------------
' Program Code
' -------------------------------------------------------------------------

Main:
  FOR counter = 0 TO 15
    DEBUG CrsrXY, 10, 2, BIN4 counter           ' display counter on screen
    i2cData = MixDDR | ~counter                 ' mask inputs
    GOSUB Write_PCF8574                         ' display counter on LEDs
    GOSUB Read_PCF8574                          ' get data from PCF8574
    DEBUG CrsrXY, 10, 3, BIN4 switches          ' display switch inputs
    PAUSE 100
  NEXT
  GOTO Main

  END


' -------------------------------------------------------------------------
' Subroutines
' -------------------------------------------------------------------------

' Data to be sent is passed in i2cData

Write_PCF8574:
  GOSUB I2C_Start                               ' send Start
  i2cWork = Wr8574                              ' send address
  GOSUB I2C_TX_Byte
  i2cWork = i2cData
  GOSUB I2C_TX_Byte                             ' send i2cData to device
  GOSUB I2C_TX_Byte                             ' force to pins
  GOSUB I2C_Stop                                ' send Stop
  RETURN


' Data received is returned in i2cData

Read_PCF8574:
  GOSUB I2C_Start                               ' send Start
  i2cWork = Rd8574                              ' send address
  GOSUB I2C_TX_Byte
  GOSUB I2C_RX_Byte_Nak                         ' get byte from device
  i2cData = i2cWork
  GOSUB I2C_Stop                                ' send Stop
  RETURN


' -------------------------------------------------------------------------
' Low Level I2C Subroutines
' -------------------------------------------------------------------------

' --- Start ---

I2C_Start:                                      ' I2C start bit sequence
  INPUT i2cSDA
  INPUT SCL
  LOW i2cSDA                                    ' SDA -> low while SCL high

Clock_Hold:
  IF (Ins.LowBit(SCL) = 0) THEN Clock_Hold      ' device ready?
  RETURN


' --- Transmit ---

I2C_TX_Byte:
  SHIFTOUT i2cSDA,SCL,MSBFIRST,[i2cWork\8]      ' send byte to device
  SHIFTIN i2cSDA,SCL,MSBPRE,[i2cAck\1]          ' get acknowledge bit
  RETURN


' --- Receive ---

I2C_RX_Byte_Nak:
  i2cAck = NAK                                  ' no ACK = high
  GOTO I2C_RX

I2C_RX_Byte:
  i2cAck = ACK                                  ' ACK = low

I2C_RX:
  SHIFTIN i2cSDA,SCL,MSBPRE,[i2cWork\8]         ' get byte from device
  SHIFTOUT i2cSDA,SCL,LSBFIRST,[i2cAck\1]       ' send ack or nak
  RETURN


' --- Stop ---

I2C_Stop:                                       ' I2C stop bit sequence
  LOW i2cSDA
  INPUT SCL
  INPUT i2cSDA                                  ' SDA --> high while SCL high
  RETURN
```

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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

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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***

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2nd Edition

by Myke Predko

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by Scott Edwards

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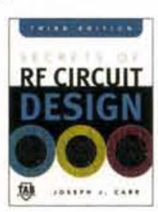
In 1995, Scott Edwards began authoring a column on BASIC Stamp projects in *Nuts & Volts Magazine*. The column quickly became a favorite of *Nuts & Volts* readers and continues today with Jon Williams at the helm. *The Nuts and Volts of BASIC Stamps* is a collection of about 75 of these columns.

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***

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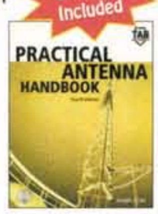
by Joe Carr



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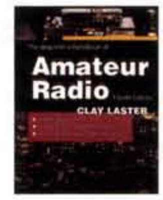
Beginners Handbook of Amateur Radio *4th Edition*

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***

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***

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Practical Electronics For Inventors

by Paul Scherz

This experiment-oriented guide is loaded with over 750 hand-drawn images that support author Paul Scherz's crystal-clear, fully detailed instructions, showing you how to turn theoretical ideas into real-life gadgets. ***$39.95***

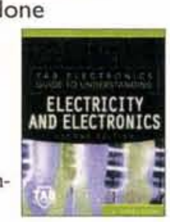
Encyclopedia of Electronic Circuits Vol. 7

by Rudy Graff

Designed for quick reference and on-the-job use, the *Encyclopedia of Electronic Circuits*, Volume 7, puts over 1,000 state-of-the-art electronic and integrated circuit designs at your fingertips. This collection includes the latest designs from industry giants such as Advanced Micro Devices, Motorola, Teledyne, GE, and others, as well as your favorite publications, including *Nuts & Volts*! ***$39.95***

Guide To Understanding Electricity & Electronics

by Randy Slone



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

Digital Electronics Guidebook: With Projects

by Myke Predko

Perfect for electronics hobbyists and students — even complete beginners — who want to understand digital logic and build their own low-cost logic circuits. Featuring more than 20 projects with step-by-step directions for designing, constructing, and interfacing easy-to-do TTL (Transistor-Transistor Logic) circuits. ***$34.95***

Troubleshooting

Circuit Troubleshooting Handbook

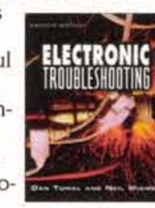
by John D. Lenk

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

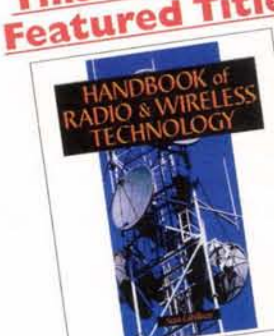
2nd Edition

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***

This Month's Featured Title



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***

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DAYTON HAMVENTION® NEWS BREAK: ENTRY TECHNICIAN TEST MAY UNDERGO MAJOR CHANGES

By Gordon West

In 60 days — July 1, 2002 — the amateur radio Element 4 Extra class examination will change.

This is part of the yearly review and rotation schedule to keep amateur radio examinations fresh, current with present technology, and up-to-date with changing ham practices. "The questions being administered by 30,000 VEs are far more comprehensive than were those on the FCC examinations," comments John Johnston W3BE, formerly with the Federal Communications Commission (FCC).

"Today's questions not only cover in greater depth the same topics, they also include contemporary technology and interests. For example, in 1972, a grand total of only 160 questions were in use," adds Johnston.

FCC rules 97.523 now require a public question pool for each of the three written examination elements:

Element 2 Entry-level Technician
Element 3 Intermediate-level General
Element 4 Extra class

"Each pool must contain at least 10 times the number of questions required for a single examination," continues Johnston. "Section 97.523 says that all of the VECs must cooperate in maintaining one set of question pools," comments Johnston.

The work of maintaining, reviewing, and updating the question pools is accomplished by the Question Pool Committee (QPC). The Question Pool Committee is composed of four volunteers, none receiving a penny for their extraordinary updating efforts.

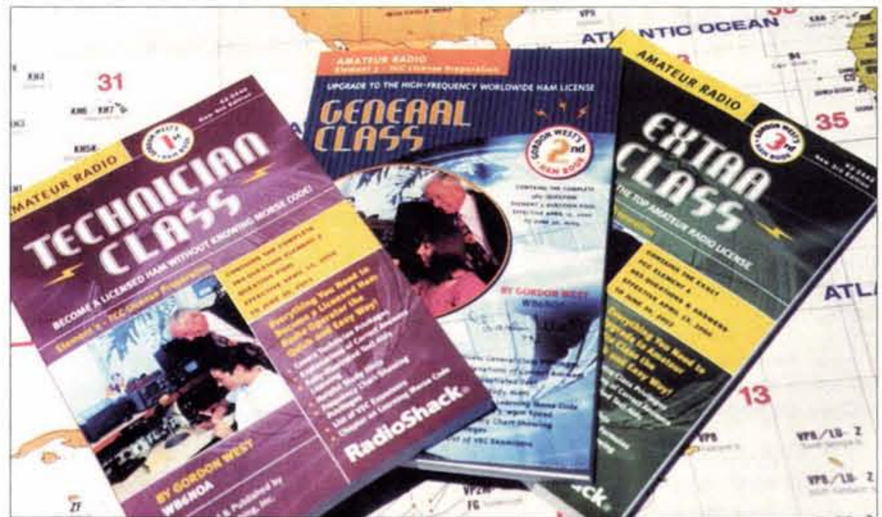
QPC Chairman Scotty Neustadter W4WW
ARRL Bart Jahnke K9JJ
Fred Maia W5YI
Retired FCC Johnny Johnston W3BE

Johnston points out that the question pools may be downloaded off the web at http://www.arrl.org/arrlvec/pools.html. The pool update schedule, as reported by Johnston, is as follows:

Element 4, Extra Class	July 1, 2002 (In 60 days!)
Element 2, Technician Class	July 1, 2003 (Next year)
Element 3, General Class	July 1, 2004
All pools remain unchanged	2005
Element 1, 5 wpm code test	May be phased out in 2006

OLD EXTRA RUSH

The brand new Extra class test goes into effect July of this year, swelling from the present 665 total questions in the pool (50 on the test) to 801 questions in the pool. General class and grandfathered Advanced class hams are presently preparing for the test before the July 1 changeover date, saving themselves from the "new" 136 Extra pool questions that would need to be studied on top of the present



Next year, the Technician class question pool may get a complete rewrite!


Questions are needed on how to send email to another ham.


Questions are needed on how to check VHF loading coils.

More questions needed for fuses and holders.

Questions are needed on setting up your first station.

665 questions. Current Extra class test preparation materials are selling like hotcakes, and volunteer examiners are indicating packed exam sessions with everyone wishing to get the present Extra class test out of the way.

But as I pointed out a few months ago in this same publication, the "new and much harder" Extra class test is really nothing more than the resurrection of old Advanced class and Extra class questions, tabled during test restructuring in 2000, added to the present questions. But I am happy to report some new refreshing questions from Johnny Johnston, former FCC G-man, specifically on rules and regulations. Johnston is new to the QPC team, and has sparked some enthusiasm among the QPC to maybe take a step back and see whether or not the entire question pool is on target.

COMPLETE TECHNICIAN TEST REWRITE FOR NEXT YEAR?

When the "new" Extra class question pool was released to the public and book publishers, I gave it a thorough checkout and dropped a note to all QPC members extending thanks for their volunteer efforts in their rewrite efforts. I further indicated that much of the "new" questions added to the present Extra class pool appeared to be "not so new," resurrected from older shelved questions and answers. No doubt I hit a sensitive nerve among the QPC — an all-volunteer committee who pleads with hams to submit Q&As and generally get nothing. Not only are they sensitive that every year they ask for new questions and get few, but this year someone (me) raises an issue on the continuous use of older shelved questions that are now back in the "new" Extra class pool.

I also asked whether or not the Technician class examination — due for rewrite this summer and fall — would end up much like Extra class where the majority of the present Technician entry-level questions remain the same, and only a handful of present entry-level Tech questions would get massaged, deleted, or would be added. I also pointed out that the present Technician class exam covered many areas of amateur radio circuitry which few beginner ham operators would ever come in contact with as they get started with their new hobby.

- Inductors
- Capacitors
- Coils and capacitors in series and parallel
- Ohm's Law mathematical calculations
- Double-pole, single-throw and single-pole, single-throw switches
- Potentiometer
- Resistor tolerance ratings
- P N P transistor
- Schematics of transistor and tube identification
- Schematic of capacitor, variable inductor, variable capacitor, and iron core inductor
- Knowledge of inductance
- Factors that determine capacitance of a capacitor
- Block diagrams
- Power density proportional to the inverse square of the distance
- Rote memorization of bands for those operators passing a code test
- Whole body specific absorption rate

The QPC chairman was quick to point out that "knowing all about the inside workings of the equipment ... we do not do any such thing" referring to the present Technician questions not necessarily requiring the applicant to know all about the inside of their radio.

But to properly teach these questions and relate them to the real world of ham radio, a question asking about what iron does when inserted in the coil of an inductor, I need to spend several hours demonstrating inductors which, last time I took a radio apart, are still on the inside of the equipment.

After the smoke cleared, an amazing thing happened ... a *complete new syllabus rewrite suggested by QPC members Johnny Johnston and Fred Maia*. Their proposal is still under consideration, and if adopted, will lead to a completely rewritten Technician class examination that would go into effect a year from this July.

AN EASIER TECHNICIAN TEST NEXT YEAR?

Not necessarily so — same approximate 385 questions in the

Questions are needed on how to establish a satellite FM contact (on two meters/440MHz).

Questions are needed on how to safely mount your mobile radio (this is too low for safe driving).

pool, 35 on the test, but questions that may be brand new and ultra-fresh for the new amateur operator learning Q&As that will better prepare him or her on skywave bands like six meters, repeater and satellite bands like two-meter and 440, linking bands like 222 MHz, and microwave bands like 1270 MHz and up.

SUGGESTED TECHNICIAN CLASS SYLLABUS:

T1 - Six questions on rules and regs

T2 - Five questions on how to operate your Technician class station

T3 - Three questions on how to make a radio contact, good amateur practice, and reducing telephone interference

T4 - Three questions about no-math elementary electronic principles, analog vs. digital, Hertz, topical function of a diode, transformer, and the definition of Ohm's Law

T5 - Six questions about how equipment works, operation and tuning of a radio, making frequency measurements, power supplies, mike gain, simple antenna basics, how coax works, and selecting equipment for desired communications

Questions are needed on where to find CW practice on the air (not here).

T6 - Two questions on how radio waves actually travel through the air, velocity, and Technician class frequency allocations for those radio waves

T7 - Two questions on radio phenomena including groundwaves and skywaves, longer range via tropo ducting, sunspots, and the solar cycle

T8 - Two questions about repeaters and good repeater operating skills; also included would be simplex autopath, closed repeaters, satellite operation, radio control, and crossband operation

T9 - One question about public service operations including emergency communications, health and welfare traffic, stations in distress, and emergency communication skills

T0 - Five questions about RF safety, including routine station evaluation for RF exposure limits, RF safety fundamentals around Technician class equipment, antenna installation safety, safety belts, hard hats, amplifier interlock switches, and good station wiring

SO WHO WILL WRITE 385 Q&As?

Ham operators throughout the country will have an opportunity to submit as many questions for the new Technician class pool as they would like — in almost any format, either paper submissions or over the internet.

With each question, there needs to be a brief correct answer, and hopefully three incorrect answers, called distractors, that won't intentionally try to trick the applicant into answering a question wrong.

If the question is on a subject that has written back-up — such as from an operating manual published by the American Radio Relay League (ARRL), page numbers would be helpful.

If the response to our call for questions and answers is just a fraction of one percent of the entire ham community, the Question Pool Committee will have more than enough questions to choose from.

Amateur operators submitting questions will have the opportunity to help shape the knowledge an applicant must learn about ham radio in order to prepare for the upcoming test next year.

If a ham has a pet peeve regarding new operators not knowing how to operate properly on the two-meter band, address those problem areas with logical questions. Maybe you are a repeater control operator on a system that outputs on 147.960 MHz, 600 kHz split. You are frustrated by the new ham that tries to access your repeater with a positive split, rather than -600 kHz. A good question for beginner operators is how to calculate a positive or negative offset when operating near the top band edge.

Or maybe you come up with a simple question about what "ENC" or the letter "T" mean on the LCD readout of a handheld. Or maybe ask a question about CTCSS to determine whether an applicant knows this is the same thing as "ENC" or "T" on the LCD readout of their brand new mobile or HT VHF/UHF transceiver.

When the Technician class syllabus is finalized, it will appear in several publications including this one, along with a printed Q&A form to give us your best Tech question. Or a bunch of Tech questions. You will also be given an address to submit your questions on-line with screen prompts to help you compose the Q&A.

Each question submitted will also go into a special pool developed by the ham industry. For every question you submit, you gain one additional chance to win selected prizes which the industry has agreed to give away in support of increased amateur radio operator participation in the development of new entry-level Technician class questions. The more questions you submit, the greater chance of winning everything from a handheld transceiver to a full-featured mobile. Look for details soon.

So stay tuned to the new entry-level Technician class question pool rewrite. The new Technician syllabus will make BIG NEWS, and there will be multiple locations that you can log on or write in with your submissions that could very well change the way we train and test new applicants entering our hobby. From satellites to digital, I guarantee there will be a topic you can really get behind.

Let's see your new Technician class questions based on the brand new Technician class question pool syllabus. **NV**

The proposed draft syllabus for the new Element 2 Amateur Radio Examination is posted on the *Nuts & Volts* website at **www.nutsvolts.com** if you'd like to check it out. The period for public comment is set to close on May 9, 2002.

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