Nuts & Volts

Exploring Electronics And Technology For The Hobbyist And Professional

www.nutsvolts.com

January 2000 Vol. 21 No. 1

CLOSED CAPTIONS, V-CHIP, AND OTHER VBI DATA

There's more in your TV signal than just video and audio. Closed captions, V-chip information, time of day, program and network information, Internet links, and more lurk within the broadcast signal just waiting for you to pull it all out.

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- For *single* non-bootable SCSI2 peripheral
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HSC#80504 — $39.95

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- 0.5% Basic Accuracy, 19 scales, battery included!
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- Diode Tester, Transistor checker
- With test leads, instructions
- New, 30 day warranty

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- V.42 Error Correction, V.42bis Data Compression
- Will work as speakerphone and answering device with TI Extensa 600, 650 0r 900 notebook computers!
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- Windows 95, Windows for Workgroups v3.11 drivers
- New -- 90 day warranty.

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- 107 keys, (101 plus 1 mouse key, 5 special function)

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Write in 64 on Reader Service Card.

Write in 59 on Reader Service Card.

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NUTS & VOLTS MAGAZINE (ISSN 1065-2035) IS PUBLISHED MONTHLY FOR $19.00 PER YEAR BY T & L PUBLICATIONS, INC., 430 PRINCELAND COURT, CORONA, CA 92879. APPLICATION TO MAIL AT PERIODICALS POSTAGE RATES IS PENDING AT CORONA, CA AND AT ADDITIONAL MAILING OFFICES. POSTMASTER: SEND ADDRESS CHANGES TO NUTS & VOLTS MAGAZINE, 430 PRINCELAND COURT, CORONA, CA 92879-1300.

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DISPLAY ADS
Mary Gamar

by Gordon West

COLOR IMAGING ON MOST ANY RADIO SYSTEM

Hams call it "slow scan television." Public safety officials call it "photo facsimile" when they might send a mug shot over the airwaves. The more generic term might simply be "color video imaging over radio system frequencies."

"When the Orange County (California) chapter of the American Red Cross wanted to see a still color picture of where they would stage their emergency response vehicles, it took only a half minute to send the color video image from the Costa Mesa staging site back to the Red Cross emergency operations center in Santa Ana," comments Julian Frost N3JF, a licensed ham and a communications leader for his local Red Cross unit.

"It took us 36 seconds to send a medium-resolution picture with our completely handheld equipment through our local Costa Mesa city ham repeater," adds Frost. The picture was received clear as a bell and displayed on the big EOC television at the Red Cross Chapter. Nothing more than the visual communicator converter tied into a simple ham radio handheld was all that was necessary to bring in the shot.

Two well-respected companies are bringing in the handheld, battery-operated visual communicators. Kenwood Corporation offers the VC-H1 interactive visual communicator, and AOR USA offers the AR-300 image picture communicator. Both sets look almost identical, but Kenwood builds in multiple slow-can television formats including Robot, AVT, Scottie, Martin, and their proprietary fast FM mode. The Kenwood fast FM mode is a little bit like ham slow-scan television Robot C36, but it can send a color picture in 17 seconds instead of 36 seconds. In the fast FM mode, the Kenwood visual communicator operates at 9600 bps which is compatible with bandwidth rules on ham VHF and UHF frequencies.

The AOR AR-300 and its AR-570 base station uses its own FM format and protocol which occupies less bandwidth but takes about 30 seconds for a standard-resolution color image, and 69 seconds for a high-resolution color image. Black-and-white imaging is also available in about half the time.

"During a recent "My Camera" demonstration with the City of Costa Mesa Disaster Preparedness Committee, city officials were amazed that this type of imaging was available at relatively low cost for their volunteer ham radio operators.

"It sounds like we aren't talking about thousands of dollars in the budget necessary for visual communications over radio, but rather only hundreds of dollars for each visual communicator set," comments one of the city disaster team members, marveling at the clarity of the color imagine sent over the ham radio repeater system.

"I could see our ham volunteers using this equipment to bring color still pictures into our city emergency operations center, and allowing everyone to see first hand a still color picture with just a little ham radio handheld transceiver coupled to this lightweight, battery-operated visual communicator."

The 30-second actual radio transmission sounds like what you might hear when you pick up your FAX phone in the middle of a transmission. High and low tones, along with a rhythmical timing click, correspond to the visual image as it is scanned from top to bottom. Kenwood Corporation, best known for its amateur radio and commercial radio products, sells their visual communicator VC-H1 into the ham market because of its full capabilities to decode, as well as send out all of ham radio slow-scan television formats. This could allow the Kenwood visual communicator to work over both high frequen-

Close-up of the Visual Communicator's color LCD screen image of Gordo's ham station.

City of Costa Mesa Emergency Response Radio Amateurs test the video sender system during a drill.

You do not necessarily need to be a licensed amateur radio operator to take advantage of the latest breed of add-on radio technology: color video imaging.

As long as you do not exceed your radio system's legal band-width limits, and don't cover up voice traffic on the air, almost all two-way radio networks could benefit from the transmission of still color images over the airwaves.

cies, as well as VHF and UHF with almost any type of ham radio imaging system. While you cannot select which ham radio mode you are about to receive or send, the reception of an image will automatically cue the equipment into the proper compatible picture exchange mode.

The AOR AR-300 works on its proprietary mode, and a similar video communicator can decode the picture, as well as the AOR stand-alone color image "trans view" black box, Model AR-570.

So one of the first decisions to be made for any radio operator is whether or not they need ham radio compatibility, which they would get with the Kenwood equipment, or the AOR system that can work in both ham, as well as *any* radio set-up, but only among AOR-compatible systems.

The handheld device that takes video images and transforms them into a digital signal processed stream of tones, along with its built-in receiver that digital signal processes these tones over the air, is a simple-looking handset with a detachable CCD camera mounted on the top. The monitor display is 1.8 inches diagonal, and is a thin-film-transistor, color LCD with anti-glare coating on the surface. It's swell for seeing at night, great for seeing in the dark, somewhat viewable in bright light, and totally non-viewable out in the sunlight. But this is true with any color LCD screen — they wash out in direct sunlight.

Both the Kenwood and the AOR handheld video sender/receiver systems can hold up to 10 images stored in a compressed JPEG format. This could allow you to capture 10 color video images in the field in the direct sunlight, and then take the equipment into the shade and see which ones you want to send over the airwaves. The little CCD camera on the top swivels 360 degrees and, if you really want to squeeze every bit of resolution out of the system, you could even substitute a more elaborate CCD camera system for the little one on the top.

WARNING: NEVER LET THE CAMERA SWEEP THE SUN — TO DO SO WILL PERMANENTLY BURN THE SENSITIVE CAMERA IMAGING SYSTEM, and you will forever see a bleach mark right in the middle of the shot. Always keep the camera pointing away from the sun at all times when turned on!

The visual communicator handheld equipment runs on four AA batteries, and draws about one-half amp of current when completely turned on. Needless to say, you don't turn it on until you want to either capture an image or see it or send it.

You don't need to turn it on to have it double as a speaker microphone. You order the handheld video unit with the appropriate curly mike cord that is going to plug into your particular type of handheld transceiver. Keep in mind that the radio is not built into the handheld video unit, but the video unit CAN double as a handheld speaker and microphone along with the push-to-talk.

Make sure and order the right interconnect cable that matches your particular style handheld!

The built-in microphone is an electret condenser mike, and this requires just a couple of

This is a close-up view of the battery-operated video sender from AOR.

Both Kenwood & AOR visual communicators run on AA batteries.

milliamps of current to operate which is supplied by your transceiver. The speaker is 16 ohms output, and the video image is sent down the supplied curly cord to your particular style handheld

Ham Operator Byron Grams KC6YNG prepares to send a radio photo with his handheld system.

with the proper impedance match to impress it on your handheld audio circuit.

The tones are sent out on the FM carrier, or over single sideband, as analog audio tones. The portable video imaging unit measures 6-3/4" high, 2-5/8" wide, and 1-3/8" deep. A proprietary plug is inserted in the bottom of the equipment that will then terminate to the proper microphone and speaker plugs that will plug into your specific handheld equipment.

Remember — every handheld is slightly different on its external microphone and speaker output jack, so you must order the right plug for the equipment. An exception would be the Kenwood video unit which comes with the common Kenwood speaker microphone plug as part of the package.

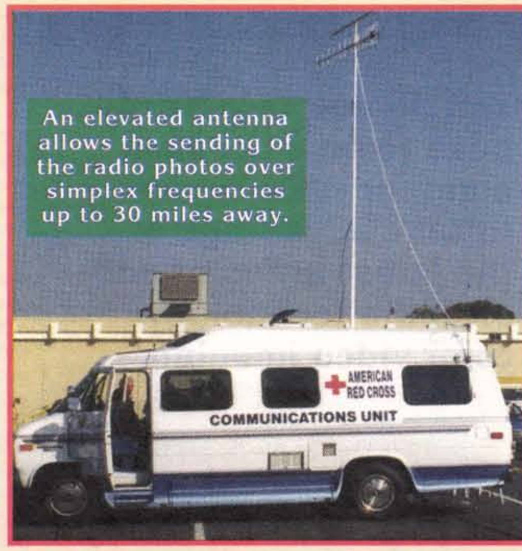
The video output is 75 ohms, one-volt, peak-to-peak, and the built-in digital signal processor modulates the tone by the video-controlled oscillator. On the AOR unit, demodulation is accomplished by arctangent angle by DSP.

The whole handset, including batteries, weighs under two pounds; and if you are cautious about how long you leave the equipment turned on, it should play for at least a day full of color imaging.

You can also internally generate characters to give important information to any sent image. These characters include the full alphabet, and numbers 1 to 9, plus zero, and the slant bar.

The handheld video imaging device also has external jacks for six-volts input, external video output, and a comm port for use with a PC. A TX/RX lamp will illuminate when you push the send button to send an image you have captured on the screen, or any one of 10 stored images. To send an image, aim the camera, press a single button to freeze the shot and store it into memory, and then send the memorized picture over the airwaves taking about 30 seconds for the AOR equipment, and 16 seconds for the Kenwood equipment. For more detailed AOR resolution, this may be programmed ahead of time and the one-minute picture will have some outstanding resolution to be best appreciated on a large screen television.

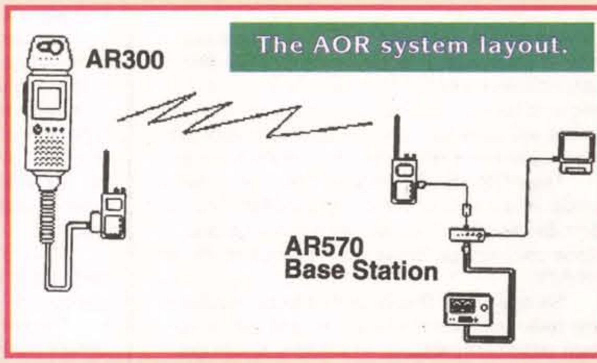
To decode the images, AOR offers a stand-alone color image base or mobile system that can transmit and receive full color television-quality still images over your normal radio circuit, or even off of telephone and cellular lines. The AR-570 from AOR features DSP technology for clear pictures and there is absolutely no external computer required for the entire transmission or reception of the still color images. Image frame memory, telephone line interface, built-in microphone relay, computer interface, DAT/MD compatible recorder jack, and the rugged metal case are some standard features of the AOR AR-570. There is even a network control unit function that could provide for full automatic dialing and reception over telephone line networks, too.



An elevated antenna allows the sending of the radio photos over simplex frequencies up to 30 miles away.

This means you could mount an unattended AOR system at a remote location, and have the received images come out over a normal telephone system to a companion AR-570 decoder.

Most interesting were the capabilities of this equipment to work off of normal radio circuits. You at first want to insure that the radio system owner and control operator are familiar with the type of modulation they are soon to hear over the airwaves. Even the ham radio operators who really knew their stuff were surprised that all of this racket was presenting wonderful color imagery at another receiving point. During our tests with the American Red Cross, as well as the



The AOR system layout.

city of Costa Mesa, we sent images over a variety of different radio systems.

Ham operators wanting to blend in with other video artists would probably choose the Kenwood equipment because of its multiple SSTV formats. But if you're building your own new video system, AOR indicates their proprietary signaling is an excellent way to go to insure commonality between agencies. In an emergency, you'd want to be able to send pictures to other agencies that may have the same AOR equipment.

Some of the uses by different agencies might be a police department that could send a mug shot to a distant officer in the field who may be holding a suspect that may match the description. Fire personnel could take a unit aloft and send down an image of the fire storm so ground personnel could better see exactly where the boundaries are. During our American Red Cross demonstrations, we would send many images showing the layout of our different stations at a mass meeting exercise, and this gave Red Cross staff members a much better idea of where everything was located when they planned to come down that night for a visit.

City employees could also shoot some pictures of new cracks in certain structures after one of our numerous Southern California earthquakes. Nothing beats the capability of seeing exactly what they are seeing.

Best of all is the capability of sending these images over a regular radio system. Just as long as the radio service is allowing 30 seconds of audio tones to come over their circuit, things should work swell. We found that all amateur radio repeaters could easily pass these tones, including those repeaters that had certain types of filters to drop out DTMF tones. And, if someone should accidentally key up for a second to disturb your 30-second transmission, all you might see is a few lines in the middle of the received photo.

But probably the biggest thing to work out ahead of time is letting everybody know on channel that you are about to tie up the frequency for 15 seconds, or 30 seconds, or maybe 60 seconds for a high-resolution image transfer. When you're sending, the frequency is dominated by the tones that are coming over your video system. When you've completed sending the picture, give your FCC call sign, and get on with business on the channel.

I would strongly suggest a copy of the Federal Communications Commission Code of Federal Regulations, CFR 47, specifically covering Part 80 marine, Part 87 air services, Part 90 land mobile radio, Part 95 personal radio, and Part 97 amateur radio services. Read carefully whether or not analog tones may or may not be superimposed on your carrier within the band limits specified in the rules. If necessary, check with your local frequency coordinator. Since this is a relatively new concept in the land mobile radio service, there may be interpretations in the law as to whether or not tones may be permitted on a channel that would normally carry only voice FM emissions.

Both Kenwood Corporation, as well as AOR promise *Nuts & Volts* readers plenty of information about their visual communicators. For Kenwood amateur radio products, log on to www.kenwood.net. Then look up their VC-H1 SSTV visual communicator.

For AOR product information, go to www.aorusa.com, and look up AR-300 and AR-570 color image facsimile systems.

AOR also indicates they would like to hear from commercial users who may have specific applications for their video radio senders. Contact Taka at AOR in Torrance, CA, at 310-787-8615, or FAX 310-787-8619.

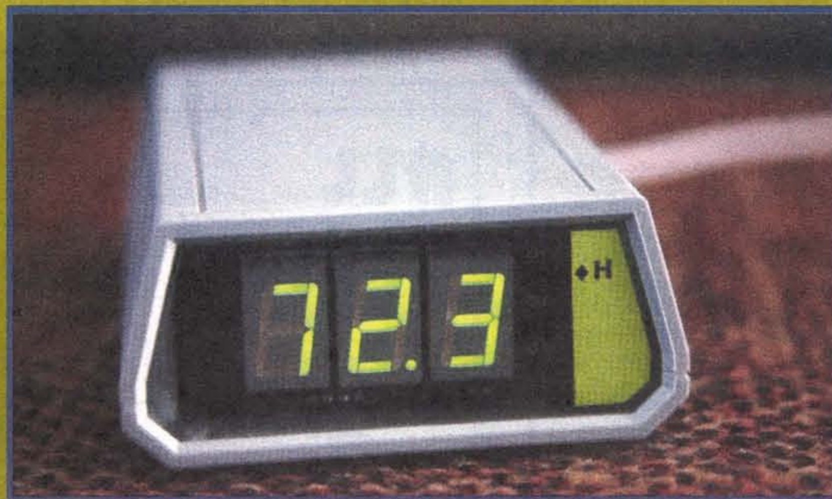
So next time you hear some strange sounds coming over your local radio channel, or even over high-frequency marine radio or ham radio, chances are it is some form of still color photograph sending and receiving. Go to the web sites and see all that you can see with these under-$900.00, handheld, add-on visual communication devices. **NV**

INDOOR DIGITAL HUMIDITY METER

by Richard Panosh

You can build a digital indoor humidity meter that displays the relative humidity on a green 0.56" LED display.

The display can be easily read from a distance of 20 feet and employs a Philips capacitance humidity sensor.



Indoor comfort is governed both by temperature and humidity. During the winter, the cold outdoor air contains little humidity and when it is warmed indoors, the humidity is further reduced. During the summer, air-conditioning also reduces the humidity when the air is cooled by the evaporator. A few household activities like cooking, laundry, and bathing will add moisture to the air.

The importance of the relative humidity can be very significant. A resting individual will lose approximately one quart of water ever 24 hours at a room temperature of 70°F and relative humidity of 50%. Indoor house plants will also lose water due to low humidity.

You can build a digital indoor humidity meter that displays the relative humidity on a green 0.56" LED display. The display can be easily read from a distance of 20 feet and employs a Philips capacitance humidity sensor.

Circuit Description

The schematic diagram for the humidity meter is shown in Figure 1. The circuit is powered from a 5-9VDC wall transformer. Internally, this voltage is dropped and regulated to +5V by IC1, a Maxim Max738A switching regulator (max. DC input 16 volts). The switching regulator operates at better than 85% efficiency to convert the input power. Since each segment of the LED display is operated at 15 mA for high brightness, a 0 display with six elements active will require about 90 mA total current. If a linear regulator was used, it would dissipate nearly half a watt, dropping 9V to

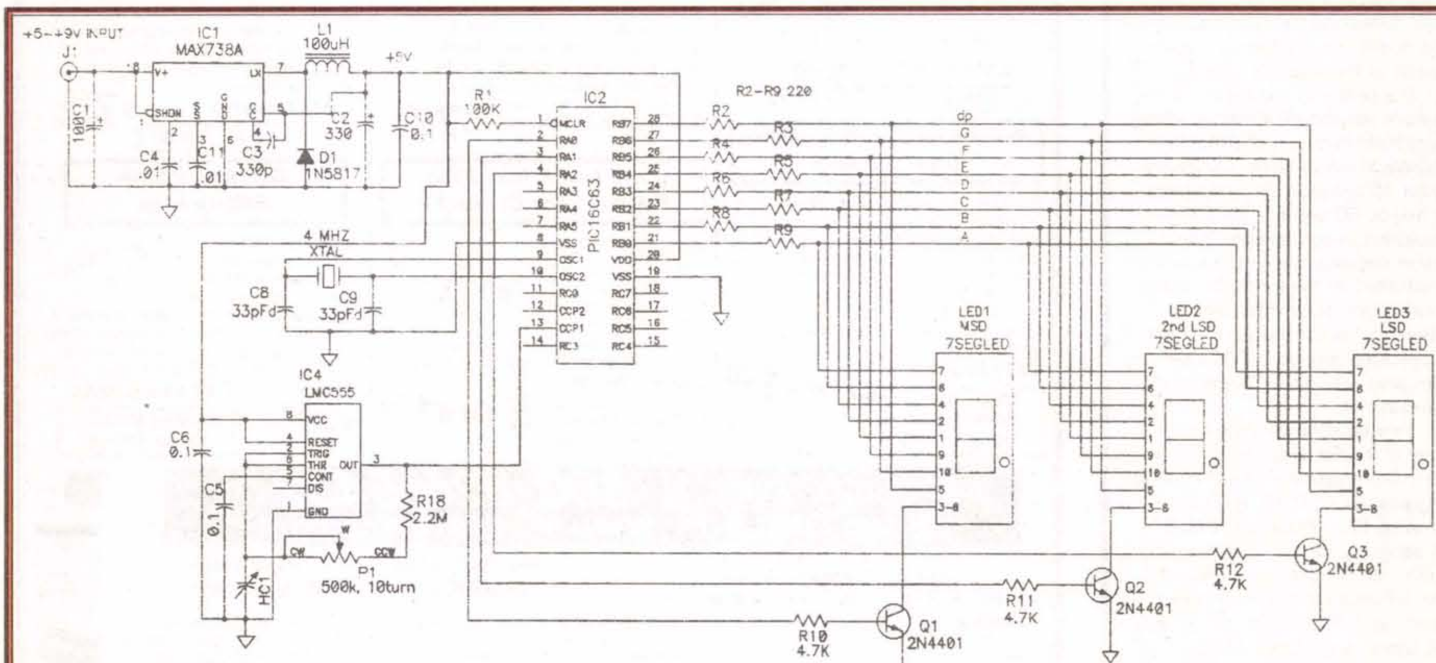
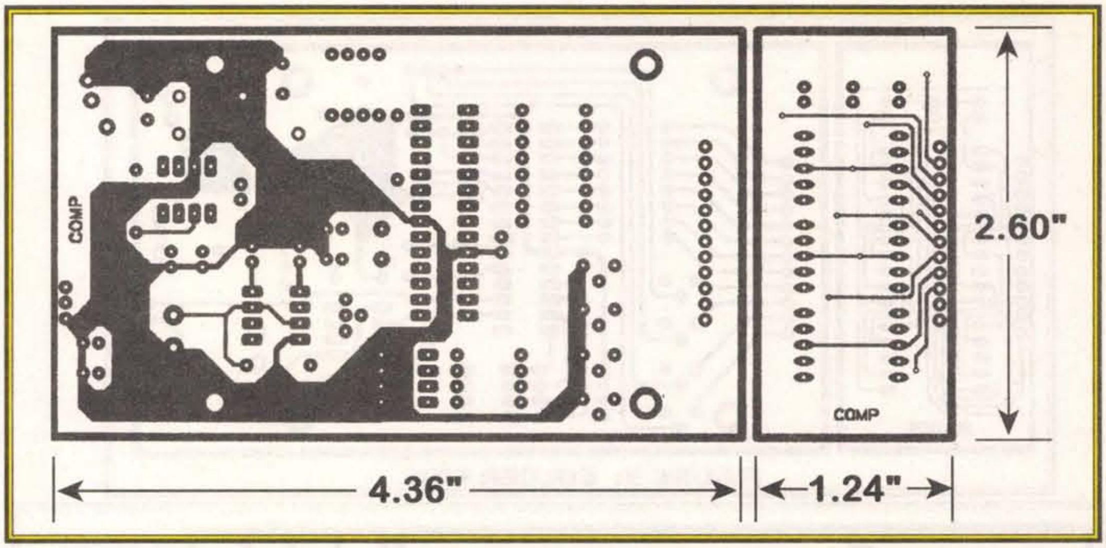


FIGURE 1: SCHEMATIC

FIGURE 2: COMPONENT SIDE

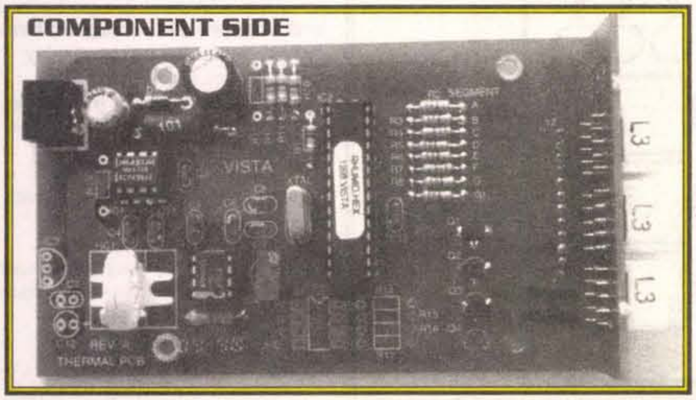


5V.

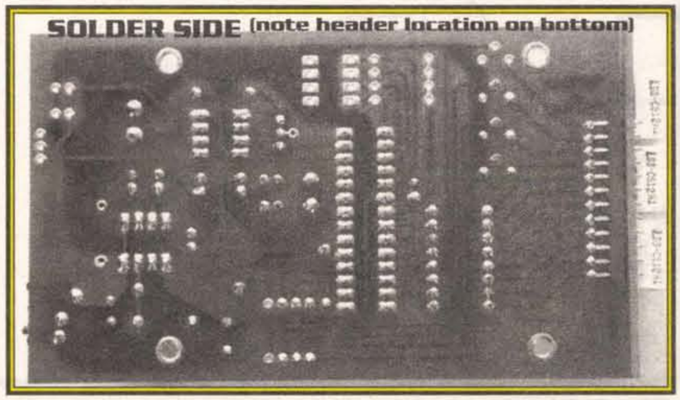
HC1 is the Philips capacitance humidity sensor. The dielectric constant of the sensor changes as a function of relative humidity. The sensor is connected with the CMOS version of the 555 timer to form an oscillator. The resulting frequency produced is a function of the relative humidity which allows a microprocessor to calculate and display the value.

The total change of capacitance over the range of humidity is only about 40 pFd and the sensor capacitance tolerance is on the order of ±15% which requires

COMPONENT SIDE



SOLDER SIDE (note header location on bottom)



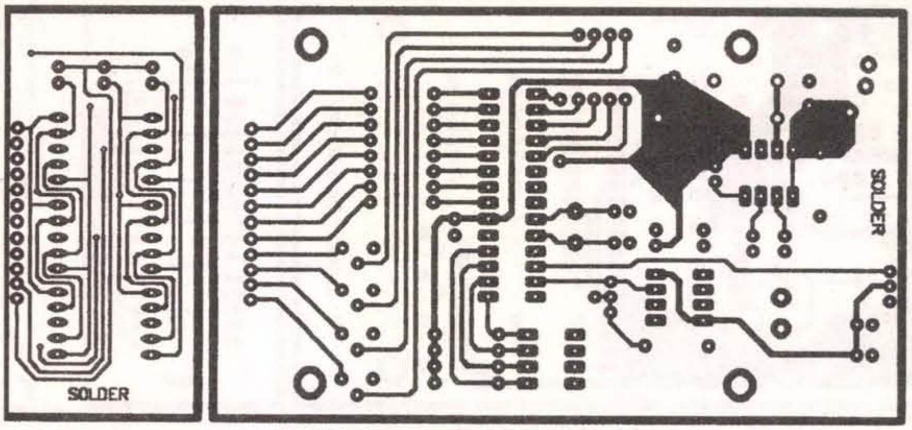


FIGURE 3: SOLDER SIDE

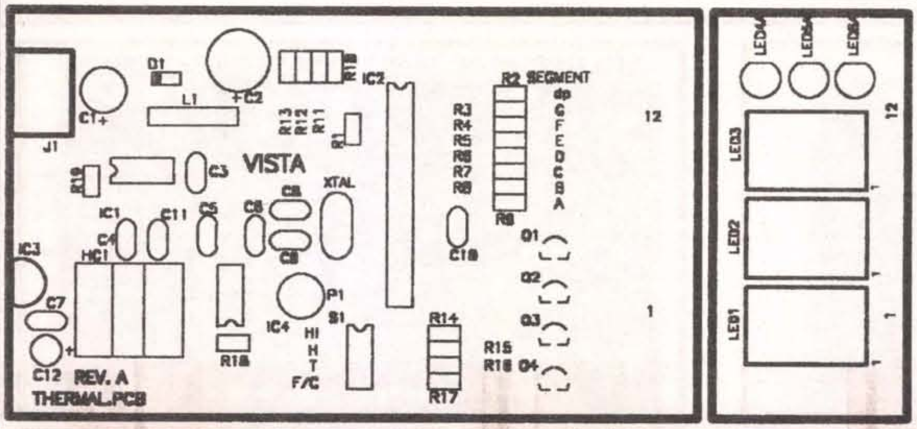


FIGURE 4: PARTS LOCATION

careful calibration for accurate results. For these reasons, P1 should be a 10-turn trim pot. The humidity sensor response is not linear and the curve has been approximated by two line segments for accuracy.

The brains of the thermometer are provided by a Microchip PIC16C63 microprocessor. This microprocessor is equipped with a 16-bit timer and a capture/compare module.

The capture feature is used as an interrupt to capture the 16th edge of the squarewave to calculate the period of the humidity sensor and solve for the relative humidity. In addition, the microprocessor is interrupted every 6.5 milliseconds to refresh the LED display digits.

All calculations are performed in double precision unsigned binary arithmetic (16 bit) to display the humidity from 0° to 99.9°. Values above or below this range will display a "HI" or "LO" on the display.

Multiplication and division routines which may require several hundred reiterations are still executed in about one-half millisecond since the microprocessor is running close to one instruction per microsecond. This would allow for a humidity update of nearly 20 readings per second.

Instead, the display routine is

slowed down by an update loop to sample only once every five seconds. The binary number is converted to BCD and then to the required bit pattern to light the individual seven-segment LED display. The display is multiplexed with all the a-elements wired together, all the b-elements, etc., to reduce the number of drive signals to eight (this includes the decimal point) which are sourced by port B.

The resultant high current produced by driving multiple segments of a digit are current-sinked by transistors Q1-Q3. These transistors are switched by a portion of port A. Port C contains the capture input pin.

Program

The source and object code for the microprocessor is available, or a completely preprogrammed microprocessor is available from the parts list.

Construction

The author's prototype humidity meter was built on a double-sided printed circuit board. A pre-etched board, drilled with plated holes and silkscreen, is available from the parts list.

This board has been designed with the placement of additional components which are not required in this project.

If you wish to make your own, Figure 2 and Figure 3 provide the artwork for a double-sided printed circuit board. The board is sized to fit a Serpac A-27 style enclosure with a clear lens. Parts layout for the prototype is shown in Figure 4.

The digital design is, in general, not critical, but special care may be required if an alternate construction method is used with the Maxim switching regulator since it operates at about 160 kHz and consideration should be given to the effects of different stray capacitance that will affect the oscillator frequency.

Start by soldering the sockets to the main board. Next, mount the resistors, diodes, inductor, capacitors, and transistors. Observe polarities on the diode, transistors, and electrolytic capacitors. The inductor should be made with a ferrite core (not powdered iron). In addition, the inductor should be rated for about 150 mA. Mount the crystal a little bit above the board so that the metal case doesn't touch any of the board traces.

Mount the three seven-segment LEDs to the display board and make sure that the decimal points of each display are at the bottom edge (closest to the edge connector). The display element's pin out must correspond to the board layout (Digi-Key LU94025 common cathode). Green display elements are preferred because they are easier on the eyes, although any color may be used.

The display board is made to attach to the main board by means of a 12 terminal 0.156" spaced right angle header (Digi-Key WM4110).

The straight section with the plastic bar should be mounted to the solder side of the display board and soldered from the component side.

The curved portion of the header is then inserted through the holes of the main board from below (the solder side) and soldered from the silkscreen side. This will result in the proper display height and set back for the Serpac A-27 case.

If a suitable header is not available, you may connect the two boards together with a ribbon cable or bare wire leads. To prevent the leads from breaking from fatigue, the front display board may be mechanically attached with a bracket or epoxy glue.

After completing the assembly, carefully check your work for cold solder joints and/or solder bridges. If you make your own board, make sure that both sides of a lead are soldered for continuity from the top traces to the bottom traces where required. This is especially important on the display board where the plated hole vias are used to transfer the signals from one side of the board to the other side of the board without a component lead present.

The DC wall transformer can supply from 6V to 15V and must be capable of at least 100 mA continuous rating. Voltages above 15V will exceed the rating of the

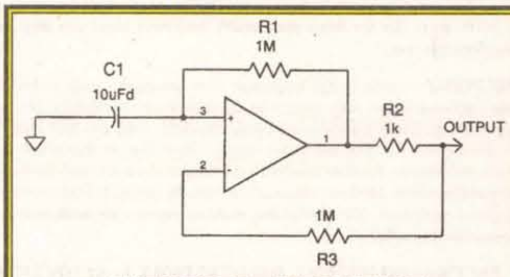


FIGURE 6: NEGATIVE CAPACITANCE MULTIPLIER

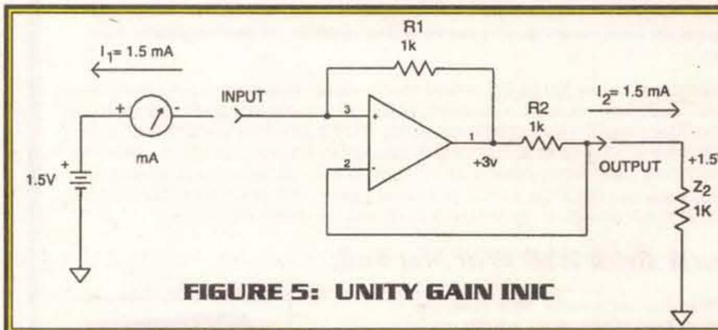


FIGURE 5: UNITY GAIN INIC

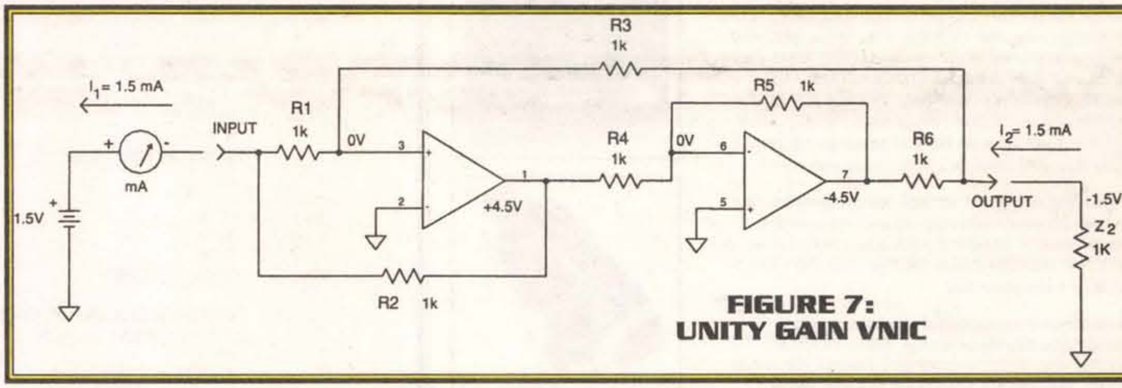


FIGURE 7: UNITY GAIN VNIC

MAX738A switching regulator. The power connector at the rear of the main board is designed for a 2.5 mm hollow barrel plug with the center pin positive.

It is always good practice to clean the printed circuit board thoroughly. This is especially true for the high impedance around the CMOS oscillator. Install the integrated circuits into their sockets and power the humidity meter up.

If everything is correct, the unit should operate and display a reading. Sensor calibration can be accomplished at a single point by trimming P1 for a similar reading by comparing it to another relative humidity meter that is known to be accurate.

Response times of different meters will vary and adjustments should only be made under somewhat stable conditions. In general, the electronic relative humidity meters respond more quickly than the mechanical types.

Alternately, the relative humidity meter can be calibrated in a standard salt solution. Several saturated aqueous solutions of inorganic salts provide a suitable calibration reference. The simplest and safest among these is a saturated solution of sodium chloride — common table salt — which provides a relative humidity point at 75.3 around 75°F.

To be accurate, the salt solution must be saturated (more salt available than will go into the distilled water) and sealed in a container such as a Corning Ware baking dish with putty around the glass cover to form a seal.

Place the relative humidity meter on a support above the solution so it will not be immersed in the solution. Allow 24 hours for the solution and sensor to equilibriate before making any adjustments.

That completes the Indoor Digital Humidity Meter project. No sweat! **NV**

Bill of Materials Quantity Type	Value	HUMID.PCB Ref Designators
	CAPACITORS	
2	33pFd	C8,C9
1	330pFd	C3
2	0.01uFd	C4,C11
3	0.1uFd	C5,C6,C10
1	100uFd/16V	C1
1	330uFd/High freq.	C2
1	PHILIPS HUMID. SENSOR (part #2322 691 90001)	HC1
	SEMICONDUCTORS	
1	1N5817	D1
3	2N4401	Q1,Q2,Q3
3	7-SEG NUM. DISPLAY (Digi-Key LU94025 Common Cathode)	LED1,LED2 LED3
1	MAX738A	IC1
1	PIC16C63	IC2
1	LMC555	IC4
	RESISTORS	
8	220	R2,R3,R4,R5,R6 R7,R8,R9
3	4.7k	R10,R11,R12
1	100k	R1
1	2.2M	R18
1	500k, 10 TURN	P1
	MISCELLANEOUS	
1	2.5 mm POWER JACK	J1
1	4MHz	XTAL
1	100uH ,150mA ferrite core	L1
1	VISTA TEMP.PCB	
1	VISTA DISPLAY.PCB	
1	+5V WALL XFORMER/100MA	
1	28-PIN DIP SOCKET	
2	8-PIN DIP SOCKET	
1	SERPAC A27 CASE	
1	12 Position 0.1" HEADER (Digi-Key WM4110)	
1	KESTER 331 SOLDER	
	TOTAL 46 PARTS	

The following parts are available from Vista, P.O. Box 1425, Bolingbrook, IL 60440-1532, (630)-378-5534.

- Complete Digital **HUMID-ASSEM** and tested for **$89.00**
- Complete Digital **HUMID-KIT** containing all parts with case for **$72.00**
- **HUMID-SOFTWARE** source program on 3.5" floppy for **$19.95**
- **PIC16C63** Pre-programmed microprocessor for **$15.00**
- **PHILIPS HUMID. SENSOR** for **$12.50**
- **MAX738A** IC for **$7.50**
- Vista Digital **HUMID-BRD** board for **$13.00**

All mail orders will be shipped by first class U.S. mail with a shipping and handling charge of $3.00. All phone orders will be shipped by U.S. priority mail with a shipping and handling charge of $6.00. Illinois residents must include 7.5% sales tax.

Dear Nuts & Volts:

This is concerning the answer you published for #99912.

The answer you published is good if the only password you are trying to bypass is the Windows password. There is a procedure that has to be done to erase the password out of the CMOS set up.

Some computers have a jumper that has to be set with the power off, then turned on for a second or two, then turned off again and the jumper set to the original configuration. This requires that the computer be opened for access to the motherboard.

MicroHouse out of Boulder, CO is a good source for computer board configurations. Also the manufacturer should be contacted first.

There is another procedure that requires some electronics knowledge. It can be done two different ways.

The first requires that the CMOS battery be disconnected and the computer let sit for a day or two with the power turned off (time consuming).

The second and quickest requires that the CMOS battery be removed and the battery connections on the circuit board be shorted out. If this does not work, then there are a couple of diodes in the circuit that have to be shorted also.

I have had to do this procedure to save a system when a used motherboard was used for repairs or to access a system when the password was forgotten and no records were kept. This procedure requires caution so that the motherboard is not damaged.

If possible, while you have the computer open, determine the hard drive type/configuration, once you have reset the CMOS password you are going to have to reset all of the setup configuration information.

Once again, caution should be used.

Gary A. Floyd, Vacaville, CA

Dear Nuts & Volts:

I am a long time subscriber of *Nuts and Volts* magazine and have enjoyed your publication for many years. I ran across an interesting product that I believe would be of interest to many of your readers.

The product is Liberty Basic. It is a Basic Language that enables individuals to easily write fully functioning Windows applications. This package has it all. Graphical user interface, easy to use syntax, and all the hooks, bells, and whistles to automate anything.

It would make a great control system for a home automation project or to interface with BASIC Stamps.

The shareware version of the software, complete with tutorials and samples programs, can be downloaded from www.libertybasic.com. There is also a link to the author at that address. Registration is only $40.00 and enables the distribution of software using a run time engine.

Please take a look. I am very excited about this project. I am sure many of your readers will be too.

Kim J. White
kjwhite@looksmart.com

Newsbytes

The Character Computer Mouse for Children

Aguila Enterprises of Worcester, MA has introduced to the US computer marketplace, the original children's Character Computer Mouse.

This unique new children's accessory hit the toy and computer industry this fall. Each character mouse is ergonomically designed for a child's hand and features luminous indicators in their eyes. A complete product line of character mice will include a turtle mouse, sneaker, lady bug, snail and, of course, a mouse!

All mice are serial PC compatible. Aguila Enterprises — a privately held company — will implement and manage a comprehensive distribution program for US computer superstores, software retailers, and mass distributors.

Tested and proven in Europe, the turtle mouse has already captured a Gold Medal in the category of Novelty-toys and Best Educational Item at Inpex 14, Americas Largest Invention Show.

The turtle mouse can also boast of International recognition in the categories of Foreign Invention and Teaching Methods.

An exciting new door of opportunity has been opened for the computer industry with this patent-pending invention, retailing at $33.99. Now possible is the ability for software manufacturers to custom design any mouse through Aguila Enterprises.

For more information and pictures of the character mouse check out the websites at:

http://www.harb.net/aguilaenterprises or http://www.lobotronic.com

All inquiries should be made to:

Michael Smith
36 Bowdoin St.
Worcester, MA 01609
Ph: 508-363-3951
Fax: 508-791-9756
E-Mail: aguila36@flash.net

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Quickly Diagnose Your Internet Connection Using DOCTORZ

Zugg Software has released version 1.20 of DoctorZ, a Windows-based software package that tests your connection to the Internet and pinpoints any problems. DoctorZ is the fastest Internet tester available for Windows, and uses an expert system which learns about your network connection over time to improve it's speed and diagnostic abilities. An easy-to-use graphical interface reports results in plain text without the jargon used by most other troubleshooting programs. Extensive tutorials teach novice network users about the Internet, how problems occur, and how they can be detected with DoctorZ.

DoctorZ is not a simple "ping" or "traceroute" program, but can test any network service, such as E-Mail or world-wide-web servers. DoctorZ can perform tests in the background at a specified interval. Results can be logged to a file, sent via E-Mail, or generate alarms. Information about domain name registrations, E-Mail accounts, and web page source and headers can also be examined. All settings in DoctorZ are saved across multiple sessions, including previous testing results.

DoctorZ is available for Windows 95/98/NT/2000. Proxy servers are supported for specific network service tests. DoctorZ is Y2K compliant.

DoctorZ costs $10.00, with all future versions and upgrades available for free. DoctorZ is available for immediate download from Zugg Software at:

http://www.zuggsoft.com/

For more information, contact:

Zugg Software
681 43rd St.
Los Alamos, NM 87544
E-Mail: zugg@zuggsoft.com
Voice: (505) 662-0798.

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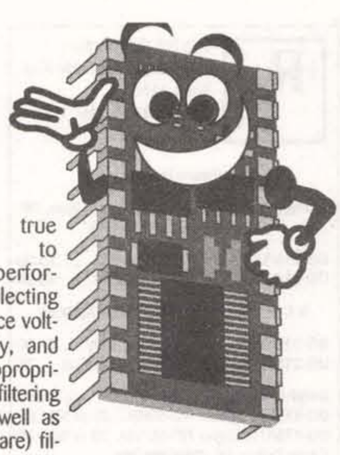
Continued on page 92

STAMP APPLICATIONS

by Lon Glazner



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

Getting the Most Out of Your 12-Bit ADC

In this installment of Stamp Applications, we'll take a look at a couple of simple circuits that allow you to make the most of your ADC.

Overview

Analog-to-digital converters (ADC) are ubiquitous components in the world of embedded control design these days. Many microcontrollers have on-board ADCs, and the resolution of these ADCs is increasing on a regular basis. But an increase in resolution does not necessarily translate to an increase in measurement accuracy.

A Bit About Analog-to-Digital Converters

There's a little bit of ground to cover in discussing ADCs in general. I'm not going to go into a dissertation on analog conversion technologies but, for those of you that have never used one before, some of the basics may be helpful.

ADCs come in a wide variety of flavors. When interfacing to a BASIC Stamp, I lean towards those that have serial interfaces. This reduces the number of pins required to control the ADC, and I/O pins are like gold in a BASIC Stamp design. The Serial Peripheral Interface (SPI) seems to provide the simplest interface software, and requires only three I/O lines from the BASIC Stamp.

ADCs also come with a variety of "channels." The term channel refers to the number of ADC measurement points on a specific IC. For instance, a four-channel ADC would have four pins where analog voltages may be measured. The digital interface software determines which channel is being measured for any given data sample.

ADCs also come with a variety of resolution ratings. An eight-bit ADC can return 256 different values for any given sample (including a result of 0); a 10-bit ADC has 1,024 different values; and a 12-bit ADC has 4,096 values. Virtually all ADCs have reference voltage inputs, usually labeled VREF or REF. The voltage at this point determines the full-scale value associated with an ADC measurement. For instance, an eight-bit ADC with a reference voltage of 5.0VDC would return a 255 (binary %11111111, or hex $FF) if 5.0VDC were present at the channel being sampled.

So, what is the voltage resolution in our eight-bit ADC with a 5.0VDC reference? This can be determined by dividing 5 by the number of possible values the ADC can provide.

Or... 5.0V / 256 possible values
= .01953V / value

Our eight-bit A/D has a resolution of 19.53mV per bit. The accuracy is usually ±1 least significant bit (LSB), which means that your measurement can be expected to be off by ±19.53mV for any given measurement (ADC measurements are often called "samples").

Engineers will often be required to design analog measurement devices which require greater resolution and better accuracy than described above. For the novice, there is a desire to select a 10- or 12-bit ADC and call it good. This can be a dreadful mistake. After all, even if your ADC has a resolution of 1mV per bit, if there is 8mV of noise on your ADC input, you've effectively reduced your ADC to nine bits of resolution. In other words, you've paid for the 12-bit device, but your performance is only a little better than an eight-bit ADC.

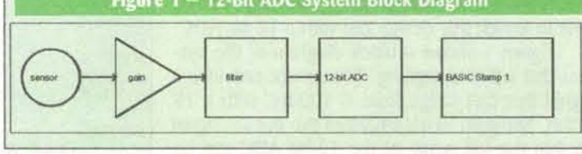
Don't throw out the ADC though, there are a few tried and true methods to increase performance. Selecting your reference voltage correctly, and providing appropriate gain and filtering circuits, as well as digital (software) filtering can produce respectable results.

Defining the Design

A good way to get a grasp on some of the particulars of making accurate ADC measurements is by walking through a design. Consider this article ADC-101. There will be areas specific to certain input voltages or signal types that we'll not concern ourselves with, there will also be certain types of noise that we'll ignore for the most part. A great example of this is PCB layout. Poor physical PCB layout, as well as improper grounding, de-coupling, and bypassing techniques have much greater effects on your ADC performance than the improvements granted by the filter circuits we'll cover here. I can't cover all of these issues in one article, but I'll be sure to point out some references for those aspects of ADC measurements that are being omitted.

One last warning before we're off and running. Highly accurate analog measurement systems often have to be calibrated to make full use of the circuitry associated with them. We'll touch on calibration in software, but we won't go into a complete analysis of how to design out component offsets and other error factors through software or hardware calibration.

Figure 1 — 12-Bit ADC System Block Diagram



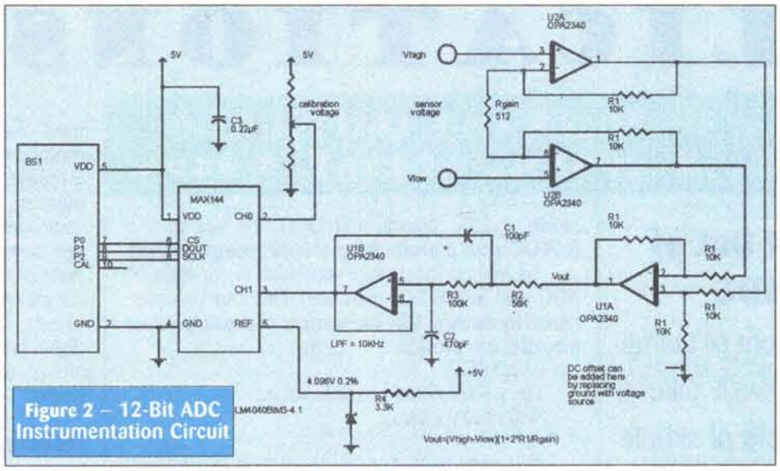


Figure 2 – 12-Bit ADC Instrumentation Circuit

Design Statement

We've been presented with a sensor that outputs a minimum voltage of 1VDC. The full-scale value of the sensor is limited to only 1.1VDC (full-scale is the largest value that will come out of the sensor). It's our job to provide a circuit that can accurately measure the voltage provided by this sensor. To complicate matters, our boss – the grand Pooh-Bah – wants a resolution of 50uV, and an accuracy of ±50uV in our measurements. There may also be some noise at about 100kHz coming from a component near where our circuit is being placed. We weren't given any specifics on this device, just a heads-up on the potential for some noise at this frequency.

It is pretty clear that just hooking up a 12-bit ADC to the sensor would not provide the kind of resolution that our slave-driver boss requires. But if we provide an amplifier block (or gain block) and some analog filtering, we might just be able to knock this design out with a 12-bit ADC.

Figure 1 shows a block diagram of the system that we're designing. The sensor provides a signal that can range from 0-100mV, with a 1V offset. The gain block amplifies the sensor signal so that the full range of the 12-bit ADC can be used. The filter block is a simple two-pole, low pass filter with a cut-off frequency in the area of 10kHz.

The Hardware

For the hardware design, we'll tackle first-things-first. A two-channel, 12-bit, SPI-ADC would be ideal for this design. The MAX144 (from MAXIM Integrated Products, www.maxim-ic.com) seems to fit the bill, as far as ADCs go. We'll be using a precision voltage reference – the LM4040BIM3-4.1 – from National Semiconductor to provide a voltage reference of 4.096V for the MAX144. There is a significant benefit to making this choice. The 4.096V reference voltage means that every bit measured relates to exactly 1mV (from 4.096V / 4096 possible values).

The gain block and filtering can be done with op-amp circuits. It's a good idea to select op-amps that were designed specifically for instrumentation and ADC interfacing. The OPA2340 from Burr-Brown provides a solid dual op-amp for our purpose. The OPA2340 provides rail-to-rail outputs (to within 1mV) and operates on a single +5V supply. These parts also have a low offset voltage (less than 1mV) which can help reduce measurement errors.

The complete circuit schematic is displayed in Figure 2. The gain block is made up of the two op-amps in the U2 package. The gain for this circuit is set to 40. A gain of 40 applied to a full-scale sensor output would generate a 100mV*40 = 4.0V output. The additional 0.096V provides us with a little headroom. We can expect the total voltage output to the low-pass filter to remain less than 4.00V, which is less than the full-scale measurement range of the MAX144.

We know that each bit returned by our ADC is related to a 1mV measurement. Since this 1mV resolution is gained up by 40, the actual value per bit is 1mV / 40 = 25uV, which meets the criteria for this design. From the design needs, we were allowed ±50uV accuracy, and that translates into a little room for error.

There are a couple of loose strings that should be tied up at this point. The first relates to the OPA2340 parts. I did not show the power or ground pins in the schematic, nor did I show the 0.22uF bypass capacitors which should be located as close as possible to the power pin and connected between the power and ground connections for each op-amp. These capacitors are important and should not be omitted.

Along the same lines, the MAX144 data sheet specifies some layout requirements, which should be read, and adhered to, if you intend to place the MAX144 into any of

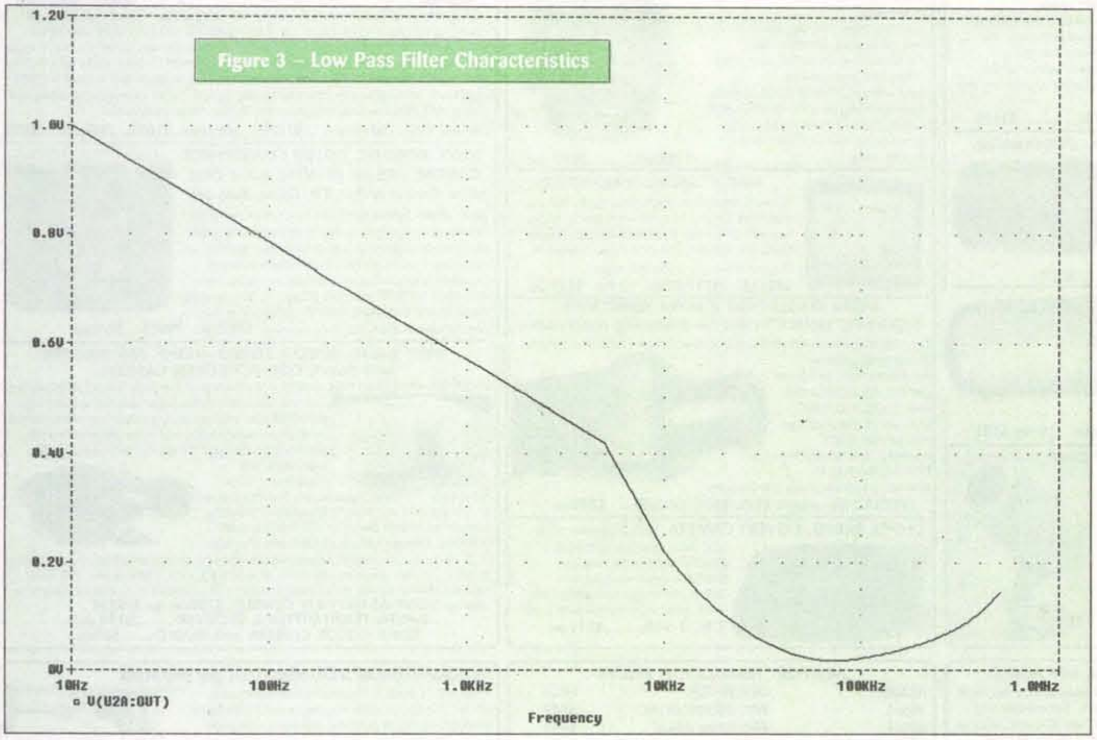
Code Listing: NV100.BAS Interfacing to the MAX144 12-Bit ADC

```
SYMBOL      CS_AD        = 0
SYMBOL      SDATA        = 1
SYMBOL      CLK          = 2
SYMBOL      DATpin       = pin1
SYMBOL      Ad_flag           = bit12

SYMBOL      CLOCKS       = B2
SYMBOL      SAMPLES      = B3
SYMBOL      AD0_CAL      = W0
SYMBOL      AD1_IN            = W2
SYMBOL      WORK         = W3
SYMBOL      AD_RESULT    = W4

BEGIN:
      LET DIRS = %11111101
      PAUSE 1000
MAIN:
      GOSUB ANALOG
      GOTO  MAIN

'*****************************************************
ANALOG:
      HIGH  CS_AD
      HIGH  CLK
      AD_RESULT = 0
      FOR SAMPLES = 1 TO 16
            LOW   CLK
            LOW   CS_AD
            LET AD0_CAL = 0
            FOR CLOCKS = 1 TO 16
                  LET AD0_CAL = AD0_CAL * 2
                  LET AD0_CAL = AD0_CAL + DATpin
                  PULSOUT CLK,10
            NEXT
            IF    BIT12 = 1 THEN ANALOG
            AD0_CAL = AD0_CAL&$0FFF
            HIGH  CS_AD
            HIGH  CLK
            LOW   CLK
            LOW   CS_AD
            LET AD1_IN = 0
            FOR CLOCKS = 1 TO 16
                  LET AD1_IN = AD1_IN * 2
                  LET AD1_IN = AD1_IN + DATpin
                  PULSOUT CLK,10
            NEXT
            AD1_IN = AD1_IN&$0FFF
            HIGH  CS_AD
            HIGH  CLK
            WORK = AD1_IN + 2500 - AD0_CAL
            AD_RESULT = AD_RESULT + WORK
      NEXT
      AD_RESULT = AD_RESULT/16
      DEBUG AD_RESULT,CR,CR
      RETURN
'*****************************************************8
END:
```

your designs. Finally, the channel 0 connection was used to measure a calibration voltage provided by a 1K potentiometer configured as a voltage divider. While this is not strictly necessary, it made calibration much easier during initial testing.

To finish up the hardware design, a simulation of the filter circuit was completed to ensure that it would adequately cut off any 100kHz noise that might be coupled onto our sensor signal lines from the noise source our boss had mentioned earlier. The filter output versus frequency is displayed in Figure 3.

The Software

The software is pretty straightforward for this system. Although, there are a few "gotchas" that I need to mention. One issue of concern is the manner in which the two channels of the ADC are selected. The MAX144 alternates channel 0 and channel 1 with each sample operation that you perform. It starts with channel 0 selected at power-up. This can create some problems.

If you're like me, you might make a modification to your BASIC Stamp code and then download the software to your Stamp without cycling the power off and then on. This could place your software out of sync with the MAX144. You would be reading channel 1 when you expect to read channel 0.

A simple way around this is to sample the MAX144, and then test the 12th bit in the returned word. If the bit is clear ("0"), then you have just read channel 0. If it is not clear, then you should set the chip select and clock lines high and attempt to read the MAX144 again. The second attempt will provide the sample from channel 0. You only need to do this as part of a software routine for reading channel 0. Once you have successfully read channel, 0 your BASIC Stamp will be in sync with the MAX144.

You'll notice in the software that the highest nibble of each returned sample is cleared by ANDing the sample result with $0FFF. This clears the channel information returned with each sample. The resulting data can be summed with other samples to provide a simple averaging routine. In the software listing for this design, there is a 16 sample averaging function being performed. Summing any additional samples would run the risk of overflowing the storage register AD_RESULT. Also keep in mind that any routines that manipulate the data will have some effect on both your accuracy and your measurement resolution. Averaging, in particular, has a tendency to reduce the value of the data that you are manipulating.

In this design, channel 1 of the ADC is actually measuring the sensor-input voltage. Channel 0 is used to read the voltage from a calibration potentiometer. With each pass through the program, the results from channel 1 are added to 2500 (2500mV) and then the result from channel 0 is subtracted from channel 1 + 2500mV. In a system with no errors, you would set your potentiometer to 2500mV. If you found that your system was outputting voltage readings 10mV too high, you would set the potentiometer to 2510mV.

A simple way to get a ball-park calibration value is to tie both sensor inputs to the same point and adjust your calibration potentiometer until the AD_RESULT register reads a "0." This is a very simple calibration technique that could be adversely affected by component aging, vibration, and temperature, among other things. But it does present one of the more powerful aspects of designing with embedded controllers.

In Closing

In the lab, I was able to calibrate this system and achieve an accuracy of ±50uV, as well as reach the target resolution of 50uV. In fact, the sample resolution was good down to 25uV steps. I did have some trouble reading values lower than about 300uV but, when I got above that threshold, the system was doing its job well.

This circuit was built on a solderless breadboard, which is about the most unforgiving place that you can test a design that is highly susceptible to noise. I had intended to work out the basics and move the circuit to a copper board for "dead-bugging" (a prototyping technique where the parts are soldered to a copper ground plane), but the circuit performance was adequate for the testing that I required.

To summarize the techniques used to build accurate ADC-based systems, I think the following five points cover most concerns …

1. Define your accuracy and resolution requirements before selecting a specific ADC.
2. Select accurate voltage references that are compatible with your ADC.
3. Add gain blocks to make use of the full span of your ADC's measurement range.
4. Provide analog filtering for the signals that you intend to measure.
5. Read the manufacturer's data sheets for layout recommendations and other important insights into any ICs that you expect to use.

For anyone interested in working with this circuit, all of the components mentioned in this article can be purchased from the on-line catalog company **Digi-Key (www.digikey.com)**. See you next month. **NV**

RESOURCES

For more information on the BASIC Stamp, contact:

Solutions Cubed
Lon Glazner
3029 Esplanade Suite F
Chico, CA 95973
E-Mail: **lon@solutions-cubed.com**
www.solutions-cubed.com
Phone: **530-891-8045**
Fax: **530-891-1643**

Parallax, Inc.
3805 Atherton Road, #102
Rocklin, CA 95765
phone **(916) 624-8333**
http://www.parallaxinc.com

Scott Edwards Electronics, Inc.
1939 S. Frontage Rd. Ste. F
Sierra Vista, AZ 85635
phone **520-459-4802**
fax **520-459-0623**
www.seetron.com
info@seetron.com

SUPER VACUUM PUMP, LEYBOLD, TRIVAC B, type D16, #91266-2

Dual stage, oil sealed, rotary vane pump with a 11.7cfm pumping capacity and an ultimate vacuum of $8x10^{-5}$ mbar.

This brand new pump is powered by a three phase, 1HP, AC motor with built in thermal protection. The motor can operate on 200 / 230 or 460 VAC. Completely modular construction for easy maintenance. The unit weighs 78lbs. A super special item only one available.

LEYBOLD D16...............$1695

NEW! NOW YOU HAVE COLOR (down to 60 ft.) UNDERWATER.

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 @120mA, 4mm, 78° FOV lens, A real glass lens. NTSC video out. Superior construction. Ultra small Size only: 1.25"diam. X 2" long. With 60 ft. cable. Perfect as a remote area inspection camera. Great for weatherproof general outdoor use as well. **GM-400KW.......$219**

MINIATURE and, PRECISE, PORTESCAP, SWISS, GEARMOTOR.

State of the art "ironless" type, mini motor type M11-210-54-0 with approx: 40:1 gearbox. Size: 16mm d. x 43mm L Operatir parameters: @6VDC input, 8mA, 141RPM Nc Load, @ 12VDC input, 12mA 290RPM No Load

PORTESCAP, TYPE B: $15ea. 2 for $27, Special....10 for $125

ULTRA MINI and WEATHERPROOF, "LIPSTICK" CAM

Sleek black anodized, alum. housing. O-Ring sealed & RAINPROOF. Adj. tilting mount. 1/3" CCD, 380 Lines, 0.3 Lux, AGC, Auto Shutter. 9-12VDC @100mA, 4mm, f1.8, 78° FOV real glass lens, NTSC video. <1ounce! IR SENSITIVE. 23mmdX50mm, 36" cable with BNC video & DC barrel jack.

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

GM-200K-STD...........$99
GM-200K-PH lens.....$99

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

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

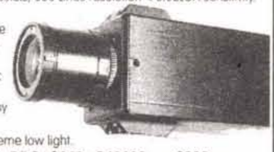
SPECIAL..........$289 set

NEW, 9" SECURITY MONITORS

We were fortunate to obtain these Hi-res 700 Line B&W units. Original manufacturers boxes, 90 day warranty. BNC video in and loop through. Rugged steel case. Current production model. Limited qty. They will make your video look super!

SPECIAL...$119.00ea. 2 for $229.00

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



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

SPECIAL this month REG. $349, GM600.......$299ea.

CLOCK RADIO, COVERT CAMERA, New, Magnavox clock radio with covert low light video camera. Specifications per our GM1000A shown on page one. Connect the output to anything with a "video Input" jack. via RCA style ouput.

CRC-1-STD,........$119.ea

CO2, 120Watt CW, SEALED GLASS LASER HEADS
Integral Hard Sealed Mirrors, NEW!

High quality water cooled heads. Were originally designed for medical application. All models are similar in construction. Size of the model 103: 60"L x 3.2"diam., Model 160: 44"L x 3.2"diam. Model 135: 35"L x 3.2"diam. Power requirement, model 103, 40KV trigger with 25KV @ 10 to 30ma operating current. Model 160 and 135, 30KV trigger with 15-20KV @ 7 to 20mA operating current. These are not toys. They must conform to Class IV CDRH regulations when assembled into a functioning system. Perfect for engraving, cutting and drilling most materials. Only three available. We don't expect any more.

Limited Qty...100+Watts.....$1475., 60Watts...$1095., 35Watts.....$895.

SONY, ROBOTIC, COLOR CONFERENCE CAMERA, 450Line, 8X, NTSC & Y/C OUT, Serial Control of Pan, Tilt, Zoom, Auto Iris and Auto Focus too! Like having your own R2D2. Intended for use in fortune 500 board rooms. The video performance is stunning. Superior to almost anything we have seen. Camera and lens is an integral assembly. Excellent Condition. Rugged black ABS enclosure. 8 pin mini-DIN & Std. SVHS jack. Size: 8"Dx6.5"H. Data on using the serial port is provided. The units self test on power up and the video is active. Reg price over $4K. **SPECIAL PRICE....$249ea.**

NEW, 2.4GHz VIDEO + STEREO AUDIO TRANSMITTER with SONY, CCM-PC5 COLOR CAMERA.

Originally sold for $500! Now available for a fraction of that price. Great looking styling. Camera has a very stable, adjustable tiliting base, front panel LED pwr. indicator and sensitive built in electret mic, providing excellent audio and video performance from one compact package. Simply connect camera to the completely self contained 2.4GHz transmitter. All cables supplied. You can transmit up to 700 feet clear line of sight! Companion matching receiver works with any TV or VCR. Internal patch antennas. Camera has adjustable focus 6mm lens (1" to infinity, macro capable) Auto power off when the privacy shutter is closed. Power is 7-13VDC. (all pwr. adapters and cables included) 1/3" CCD, 330Lines res. 35% better than standard VHS! Can als be used to transmit VCR oputput to another TV for remote viewing. **SONY-ASTROVIEW COMBO..$189ea. or 2/$339**

2.4GHz TRANSMITTER & RECEIVER..........$129 pair.
SONY COLOR CAMERA with AUDIO........$69ea.

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

That's right! COLOR! In the same size package too! Sleek aluminum housing fits like a glove! Removeable mtg. bracket & a 1.3M cable with BNC vid., RCA aud., (internal mic) & DC pwr. jack for, no sweat hook up. Why fool around with an open P.C. board? Now you can have the "COLOR STEALTH CAM"

- 1/3" • 350 Lines
- Auto Shutter
- 270k pixels
- Focus:10mm to inf.
- 1<ounce!
- 0 .7 Lux • AGC
- Pwr. 6-12V @30mA
- Std. 7 mm, 56° FOV lens
- NTSC video
- Size: 31mm sq. x 28mm d.

GM-4000S-STD w/audio, SPECIAL...$89ea.

B & W "STEALTH CAM", MICRO SIZE, with AUDIO!

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

GM-2000S-STANDARD OR PINHOLE, with audio, SPECIAL...$69ea.

NEWPORT TRANSLATION STAGES.

MODEL:	DESCRIPTION:	EACH
605-4	With differential Mic.	$849
605-4	With Screw Adjust	$449
600A-3	W/Micrometer Adj.	$159
270	LAB JACK	$249
RSA-2T	360 deg. Rotary Stage	$129
625A-4	Laser Holder	$149
481A	Rotary Stage	$189
M36	Translation Stage	$249
460A-XY	X-Y Translation Stage	$189
460A-XYZ	X-Y-Z Translation Stage	$299
M37	3 Axis Trans. Stage	$289
415	Vertical Trans. Stage	$129
M360-90	Mnting. Plate 90deg.	$ 29
M436	Translation Stage	$199
M150	Magnetic Mtg. Base	$129
420	Linear Trans. Stage	$119
CYM-2	Square mnt. (Screw)	$ 99
13270	ORIEL Adj. IRIS	$ 99

10V @ 2.5 AH SEALED, LEAD ACID, PACK. Each pack has 5, 2 Volt cells. 'D'size cells are arrainged as 1X5 cells. Enclosed in an ABS outer shell. (removed for photo) Perfect for high drain applications. Make custom packs of any rating. Size: 7.5"L x 2.8"H x 1.5"D

SALE! 6-five packs for $20, 40 for $99

MOTORIZED LINEAR SLIDE, offers 0.001" per step travel.

A THK, LWL-12 series re-circulationg, ball bearing slide with a 4.7" long steel rail is mounted to a 0.2" thick, black anodized, aluminum plate. The slide has a right angle bracket attached to a spring loaded, anti backlash, drive nut. Riding on a 0.37"diam. 10TPI lead screw which is coupled to one end of a dual 1/4" shaft , stepper motor with specs: 1.8° /step, 5V @1Amp, 4 wire. Optical end of travel sensor. **LWL12-2.5........$59ea.**

6V@12AH SEALED, RECHARGEABLE, BATTERY New Panasonic, LCR6V12P1. Tough to get at a discount. Very compact. Two top mounted 1/4" faston connectors. Perfect for high drain projects. Size: 5.9"L x 3.7"H x 1.9"D **2 for $20, or 10 for $89**

MOTORIZED ZOOM LENS SPECIAL
6X magnification, 12X on a 1/3" camera! Auto iris too!

New, fabulous hi-res. optics with std. C-Mount. Superior Fujinon and Vicon lenses. Normally cost from $600 to $1500. There is no substitule for a good lens! All drive motors will operate from 6-12VDC. Auto iris. has a built in amp which works with any cameras video output for control.

Type B-6, 12.5 to 75mm, 6X, f1.2 .... $179 or 2 for $349
ZOOM LENS CONTROLLER, NEW $169

END FIELD of VIEW GUESSWORK!
3.5 to 8mm VARI-FOCAL LENS

Brand New, super f1.8 lens allows you to smoothly adjust from a 97 °FOV @ 3.5mm to a 44° FOV @ 8mm. Now you can frame your area of interest just the way you want it! Standard CS-Mount with adjustable focus and iris. **SPECIAL.....$79ea. or 2 for $149**

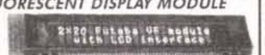
NOW YOU CAN SEE WHAT THE "FISHES ARE DOIN' (down 60 ft.) UNDERWATER B&W CAMERA with INTERNAL, INFRA-RED ILLUMINATOR!

Sleek black anodized, BRASS, housing. O-Ring sealed & WATERPROOF. Adjustabe mount incl. Specs: 1/3" CCD, 400 Lines res., 0.05 Lux sensitivity, AGC, Auto Shutter. 12VDC @225mA, 4mm, 78° FOV lens, A real glass lens. NTSC video out. Superior construction. SENSITIVE to IR. Ultra small Size only: 1.25"diam. X 2" long. With 60 ft. cable. Perfect as a remote aresa inspection camera. Great for general outdoor use as well. **GM-300KIR.......$179**

NEW, GM960 TIME LAPSE VIDEO RECORDER

Finally a brand new, 4 head, T/L recorder with all the features at a price you can afford. Features: • Up to 960 hours on a standard T-120 VHS tape • 12 different modes for record and playback • Audio recording in the 12H and 24H mode. • 30Day memory backup • Easy mode setting • On- screen menus • Auto-Repeat recording mode • Serial or One-shot recording • Time, Date, speed, and Alarm indicators on screen. These deluxe units are front loading and are 14"W x 3.5"H x 12.2"D, 110VAC powered. **SPECIAL......$699ea. or 2 for $1349**

FUTABA, 2X20 VACUUM FLUORESCENT DISPLAY MODULE



New or like new, model M202SD series. Can directly replace LCD displays. The module includes the VFD, microcomputer and driver. Connects directly to the system bus. Display up to 40 dot matrix, 5 x 7 characters (222 characters and symbols). 5mm H x 3.5mm W with cursor. Display color is green at 505nm. Brightness is 690 cd/m² with four level dimming function. Weight: 5 oz. Size: 6.7"L x 2.6"H x 1" thick. Power required is 5VDC @ 350mA. Serial or parallel interface selectable. Perfect for any high visibility display requirement. With data. **SPECIAL FUTABA...........$15ea. 3 for $39**

DAYLIGHT/LOW LIGHT MINI CAM & A/I LENS, For dawn 'till dusk applications. Rugged alum. housing, dual mtg. sockets. 1/3" CCD, 420 lines res., 0.1 Lux sens., AGC, 12VDC @120mA. Take full advantage of camera sensitivity with super, 4mm, f1.4, 78° FOV Auto Iris lens included. BNC video out. 50mm sq. X 65mmL. With pwr. adapt. **SPECIAL, GM-510A/I...$189 or 2/$349**

NEW! 4 or 8 CHANNEL, SEQUENCER

Model GM34 or GM38. Connect to any four standard video signals and they will be sequentially output to the dual rear panel BNC outputs. Front panel user adjustable, variable dwell 1 to 15 sec per channel. Auto or manual switching with channel bypass. Compact only 8.6"W x 3.7" D x 1.75" H, ac powered. Video loop through. **Special, GM-34..$69, GM-38..$89**

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

GM412, less lens..$119,
GM410, less lens..$169

WORLDS SMALLEST * 100mW *** VIDEO TRANSMITTER, ON SALE**

Incredibly only 0.9" x 0.8" x 0.37" Transmits crystal controlled hi-res. images with 100mW output! The transmitter you've been waiting for. **Shown actual size.** Much smaller than the 9V battery which powers it. Draws only 35mA! Factory tuned. Receive on cable channel 59. Will work with color or B&W cameras. UHF Bow tie antenna with balun and 3' F cable for TV included. Perfect with our GM1000A. **SPECIAL TVX-100.....$159.**
TVX100 with GM1000A CAMERA....$209.

Please fax us your list of unique surplus material.

NEW, GEN III, INTENSIFIED GOGGLES, STATE of the ART, U.S. MADE.

The NQ5001, the world's most rugged and reliable, high performance night vision goggle for ground operations. Extensively used by the U.S. Army, it is the State-of-the-Art in mono-tube Night Vision Goggles. Utilizing the MX-10130 Gen III intensifier, it can be used in the darkest of conditions, headstrap mounted or handheld. Engineered for maximum comfort and simple to use. The system contains an IR illuminator, low battery indicator & high light sensor for automatic power off to image tube. Soft Case, headstrap, demist shields, sacraficial filter, eye cups, 2 AA batteries, and operators manual.

Specifications:
Photocathode Gallium Arsenide
Resolution 45 lp/mm
Photo Response 1200 Ma/lu
Tube Gain 35,000x
System Gain 3,200x
Signal To Noise 18:1
Battery Type 2 AA Life 20Hrs.
Magnification 1x
Objective Lens 25mm F/1.2
Field Of View 40°
Focus Distance 2.5m To Infinity
Size 14.9 x 14.9 x 9.1 cm
Weight 680 gm

Special...2995ea.

Write in 60 on Reader Service Card.

Events CALENDAR

The Events Calendar is a free service for publicizing electronic events such as amateur radio hamfests, flea markets, etc. If your organization is sponsoring an event and would like a free listing, contact us at least 60 days in advance. Include your flyer, estimated attendance, name of the person to contact, and phone number.

Complimentary issues are available upon request for distribution to your attendees. A street addres for UPS is required.

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

All listing information should be sent to:
Nuts & Volts Magazine
Events Calendar
430 Princeland Court
Corona, CA 92879
Phone 909-371-8497
Fax 909-371-3052
E-mail events@nutsvolts.com

JANUARY 2000

JANUARY 7-8

FL - GAINESVILLE - Hamfest. Alachua County Fairgrounds, SR-222 (3400 NE 39th Ave.), 1/2 mi. E. of SR-24 (Waldo Rd.). Talk-in: 146.820 (-). Gainesville ARS, Tom Scott KF4I, 352-378-9711 eves. E-Mail: k4gnv@arrl.net
Web: http://www.gars.net/hamfest/

JANUARY 8

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

CO - LOVELAND - Hamfest. Larimer County Fairgrounds, 700 Railroad Ave. 9am-3pm. VE exams. Talk-in: 145.115 (- offset, 100Hz) or 146.52. NCARC, Michael Robinson N7MR, 970-225-7051. E-Mail: michael@frii.com
Web: www.info2000.net/~ncarc

WI - WAUKESHA - Hamfest. Waukesha Co. Expo Center Forum. 8am-2pm. VE exams. West Allis RAC, Phil Gural W9NAW, 414-425-3649.

JANUARY 8-9

FL - FT. MYERS - Hamfest. Shady Oaks Community Center. Sat: 9am-3pm, Sun: 9am-2pm. Talk in: 146.880- and 147.345+. Ft. Myers ARC, Inc., Doug Douglas N8SAQ, 941-542-4741. E-Mail: douglas2@iline.com

JANUARY 9

IN - SOUTH BEND - Hamfest. Century Center, US33 N. & Jefferson Blvd. 8am-3pm. Talk-in: 145.290. Michiana Valley Hamfest Assn., Bob Denniston KA9WNR, 219-291-0252, M-F 7pm-10pm

JANUARY 15

AZ - GLENDALE - Hamfest. ARCA & ADAW, Mark Kesauer N7KKQ, 602-779-2722.
E-Mail: arcathill@aol.com
Web: http://www.phx-az.com/arca

LA - HAMMOND - Hamfest. South East LA ARC, Nathan Gifford N5BFC, 504-542-6798.
E-Mail: n5bfc@arrl.net
Web: http://www.selarc.org/selarchamfest.html

MI - FLUSHING - Hamfest. Amateur Radio & Youth, Clay Hewitt KF8UI, 810-233-7889.
E-Mail: clay@iavbbs.com
Web: http://www.qsl.net/aray/page6.html

MO - ST. JOSEPH - Hamfest. Ramada Inn, I-29 & Frederick Ave. (exit 47). 8am-3pm. FCC exams. Talk-in: 146.85 & 444.925. MO Valley & Ray-Clay ARCs, Kevin R. Phillips KC0AWM, 816-320-2129. E-Mail: KevinRPhillips@hotmail.com
Web: http://www.kc.net/~oconnor

NY - MARATHON - Hamfest. Skyline ARC, Patrick Dunn KC2BQZ, 315-468-5909. E-Mail: patdunn@dreamscape.com

OH - MIDDLETOWN - Hamfest. Dial Radio Club, Hank Greeb N8XX, 513-385-8363.
E-Mail: n8xx@arrl.net
Web: http://w3.one.net/~rkuns/swohdigi.html

JANUARY 15-16

FL - SARASOTA - Hamfest. Sarasota ARA, William Eddie Martin KI4ZJ, 941-954-1869.
E-Mail: ki4zj@msn.com
Web: http://www.saraclub.org

JANUARY 16

MI - HAZEL PARK - Hamfest. High School, 23400 Hughes St. 8am-2pm. Talk-in: 146.64 (-). HPARC, Tom Krausnick WC9F, E-Mail: wc9f@arrl.org Web: http://www.qsl.net/w8hp

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

OH - NELSONVILLE - Hamfest. Sunday Creek AR Federation, Russ Ellis N8MWK, 740-767-2226.
E-Mail: scarf@hocking.edu

VA - RICHMOND - Frostfest. The Showplace, 3000 Mechanicsville Tpke. 8:30am-3:30pm. RATS, Jim Clark N3JJF, 804-739-2269 (Box 3378) or 804-271-1998. E-Mail: jim@compu data.net Web: http://frostfest.rats.net

JANUARY 22

FL - BROOKSVILLE - Hamfest. Hernando County Fairgrounds. 9am-4pm. Hernando County ARA, John Nedjedlo WB4NOD, 727-856-2568.
E-Mail: wb4nod@gate.net
Web: http://www.hcara.org

FL - PENSACOLA - Hamfest. University of West FL ARC, Ray Killough KE4UNR, 850-968-1048.
E-Mail: ke4unr@spydee.net
Web: http://qso.arc.uwf.org/~hamfest

MO - ST. CHARLES - Hamfest. St. Louis Repeater, Brad Ziegler KC0CDG, 314-569-5775. E- Mail: kc0cdg@qsl.net or Jim Glasscock W0FF, 314-504-1104. E-Mail: kb0mwg@arrl.net
Web: http://www.listen.to/stlouisrepeater

NC - WINSTON-SALEM - Hamfest. Forsyth ARC, John Kippe N0KTY, 336-723-7388. Web: http://members.xoom.com/w4nc/hamfest.htm

NH - NASHUA - Hamfest. Res Ctr Church. NE Antique RC, 617-923-2665

TN - GALLATIN - Hamfest. Sumner County ARA, Roger Good KC4WPS, 615-451-0213.
E-Mail: hamfest@rogerg.com
Web: http://www.rogerg.com/scara

JANUARY 23

IL - CICERO - Hamfest. Wheaton Community Radio Amateurs, Don Motz N9NYX, 630-545-9950. E-Mail: hamfest2k@hotmail.com
Web: http://www.w9ccu.org

NY - BABYLON - Ham Radio University 2000. Town Hall Annex, Phelps Ln. 9am-3pm. Great South Bay ARC, Phil Lewis N2MUN, 516-226-0698. E-Mail: lewisp@hazeltine.com. Not a flea market or hamfest, no items for sale, solely for educational purposes.

JANUARY 29

AL - GREENVILLE - Hamfest. Butler County Fairgrounds. 8am-3pm. Talk-in: 146.67 or 145.19. Butler County & Pike County RACES, Jerry McCullough KE4ERO, 334-382-7644.
E-Mail: KE4ERO@alaweb.com

FL - ARCADIA - Hamfest. DeSoto ARC, Doug Christ KN4YT, 941-993-4834 or 941-494-5070.
E-Mail: kn4yt@cyberstreet.com

MO - SPRINGFIELD - Hamfest. Friends of Amateur Radio, Michael Blake N0NQW, 417-742-3955. E-Mail: mikewfpd@worldnet.att.net

NM - ALBUQUERQUE - Albuquerque Winter Tailgate Swapfest. Tom Ellis K5TEE, 505-291-8122. E-Mail: k5tee@arrl.net

JANUARY 30

CA - SANTA ANA - Swapmeet. ACP parking lot. Mary Russo 714-558-8813

MD - ODENTON - Hamfest. Vol. Fire Dept. Hall, 1425 Annapolis Rd. (Rt. 175). 8am-2pm. Free VE testing, pre-register 410-761-1423. Talk-in: 146.205/805. MD Mobileers ARC, Bill Hampton N3WGM, 410-766-2199.
E-Mail: diamondb@space4less.com
Web: www.space4less.com/usr/mmarc

OH - DOVER - Hamfest. Tusco ARC, Billy Harper KB8CQG, 330-484-4634.
E-Mail: bharper@neo.rr.com

FEBRUARY 2000

FEBRUARY 4-5

MS - JACKSON - State Convention. Jackson ARC, Ron Brown AB5WF, 601-982-0101 or 601-956-1448. E-Mail: ab5wf@arrl.net
Web: http://www.jxnarc.org

FEBRUARY 5

KS - LA CYGNE - Hamfest. Mine Creek ARC, Mike Eyman W0XM, 913-898-4695.
E-Mail: w0xm@arrl.net

MI - NEGAUNEE - Hamfest. Hiawatha ARA, Bill Beitel N8NRG, 906-226-2779.
E-Mail: n8nrg@portup.com

SC - NORTH CHARLESTON - Hamfest. Charleston ARS, Jenny Myers WA4NGV, 843-747-2324. E-Mail: brycemyers@aol.com
Web: http://www.qsl.net/wa4usn/index.html

FEBRUARY 5-6

FL - MIAMI - Southeastern Division Convention. Fair Expo Center, 10901 SW 24th St. (Coral Way). Sat: 9am-5pm, Sun: 9am-4pm. Dade Radio Club, Evelyn Gauzens W4WYR, 305-642-4139.
E-Mail: w4wyr@bellsouth.net
Web: http://www.hamboree.org

FEBRUARY 7

AZ - PHOENIX - Hamfest. St. Clement of Rome Catholic Church Social Hall, 15800 Del Webb Blvd., Sun City. Talk-in: 147.30+. West Valley ARC, Fred Jones KC5AC, 623-214-7054.
E-Mail: kc5ac@arrl.net

FEBRUARY 11-12-13

FL - ORLANDO - State Convention. Orlando ARC, Ken Christenson KD4JQR, 407-291-2465.
E-Mail: KD4JQR@Juno.Com
Web: http://www.oarc.org/hamcat.html

FEBRUARY 12

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

NV - RENO - Hamfest. University of Nevada Radio Pack Club, Gary Grant K7VY, 775-784-6500 ext 276. E-Mail: k7vy@arrl.net

FEBRUARY 12-13

TN - MEMPHIS - State Convention. W. Ben Troughton KU4AW, 901-372-8031. E-Mail: bktrough@mem.net Web: http://www.dixiefest.org

FEBRUARY 13

OH - MANSFIELD - Hamfest. Richland County Fairgrounds. Talk-in: call W8WE 146.34/94. InterCity ARC, Inc., Pat Ackerman N8YOB, 419-589-7133

FEBRUARY 19

AR - RUSSELLVILLE - Hamfest. AR River Valley AR Foundation, Jonathan Setcer KC5BRY, 501-968-2938. E-Mail: hamfest@setcer.com

CA - MONTEREY - Hamfest. Naval Postgraduate School ARC, Will Costello WC6DX, 831-375-8133.
E-Mail: wc6dx@arrl.net
Web: http://www.k6ly.org/radiofest

MA - MARLBOROUGH - Hamfest. Algonquin ARC, Ann Weldon KA1PON, 508-481-4988

OR - RICKREALL - Hamfest. Polk County Fairgrounds, 520 S. Pacific Hwy. W. 9am-3pm. Talk-in:146.86-. Salem Repeater Association & The Oregon Coast Emergency Repeater, Inc., Evan Burroughs N7IFJ, 503-585-5924.
E-Mail: n7ifj@teleport.com Web:
http://members.xoom.com/kb7cw/sra/index.html

PA - OBERLIN - Hamfest. Citizens Fire Co. VE Testing. Talk-in: W3UU 146.16/76. Harrisburg RAC, Dick Bordner N3NJB, 717-939-4825. E-Mail: N3NJB@aol.com Web: http://hrac.tripod.com

TX - SMITHVILLE - Hamfest. Bastrop County ARC, John Creamer W5QXH, 512-321-1145 or 512-321-1074. E-Mail: jsc@smithsys.net
Web: http://www.qsl.net/kb5yae

FEBRUARY 20

CO - BRIGHTON - Hamfest. Aurora Repeater Association, Wayne Heinen N0POH, 303-699-6335. E-Mail: n0ara@qsl.net
Web: http://www.qsl.net/n0ara

MI - FARMINGTON HILLS - Hamfest. William M. Costick Activities Center, 28600 Eleven Mile Rd. 8am-3pm. Talk-in: 145.350, 146.52 simplex. Livonia ARC, Neil Coffin WA8GWL, club phone 734-261-5486. E-Mail: swap@larc.mi.org
Web: www.larc.mi.org

NC - ELKIN - Hamfest. Briarpatch & Foot Hills ARCs, Glenn Diamond N4VL, 540-236-6514

NY - CHEEKTOWAGA - Greater Buffalo Winter Hamfest. Luke Calianno N2GDU, 716-634-4667 or 716-683-8880.
E-Mail: lcalianno@freewwweb.com
Web: http://hamgate1.sunyerie.edu/~larc

PA - CASTLE SHANNON - Hamfest. Wireless Association of South Hills ARC, Steve Lane W3SRL, 412-341-1043. E-Mail: w3srl@arrl.net
Web: http://www.hky.com/~sanfordb/index.htm

FEBRUARY 26

IN - LA PORTE - Hamfest. Civic Auditorium, 1001 Ridge. 7am-1pm. Talk-in: 146.520 simplex, 146.610 (131.8 PL). Neil Straub WZ9N, 219-324-

COMPUTER SHOWS

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

Blue Star Productions
612-788-1901.
http://www.supercomputersale.com

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

Computer Central Shows
847-412-1900 & 1-888-296-6066.
E-Mail: compcent@megsinet.net
www.computercentralshows.com

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

Georgia Mountain Productions
706-838-4827.
E-Mail: gamtnpro@blrg.tds.net
georgiamountain.com

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

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

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

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

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

Narisaam Computer Show
770-663-0983.
E-Mail: narisaam@aol.com
Web: http://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

7525. E-Mail: nstraub@niia.net
VT - MILTON - NVT Winter Hamfest. High School, Rt. 7. Mitch Stern W1SJ, 802-879-6589. E-Mail: w1sj@arrl.net Web: http://www.ranv.together.com

FEBRUARY 27

FL - ZEPHYRHILLS - Hamfest. Zephyrhills ARC, Ernie Vanselow KD4VRV, 813-783-8389 E-Mail: kd4vrv@gte.net
NY - HICKSVILLE - Hamfest. Levittown Hall, 201 Levittown Pkwy. 9am-2pm. Talk-in: W2VL, 146.85 repeater (136.5 PL). Long Island Mobile ARC, Eddie Muro KC2AYC, 516-791-7630. E-Mail: ham fest@limarc.org Web: http://www.limarc.org
VA - ANNANDALE - Hamfest. Vienna Wireless Society, Mike Toia K3MT, 703-757-7021. E-Mail: k3mt@erols.com Web: http://www.erols.com/k3mt/vws

MARCH 2000

MARCH 4

KY - CAVE CITY - Hamfest. Mammoth Cave ARC, Larry Brumett KN4IV, 270-651-2363. E-Mail: lbrumett@glasgow-ky.com Web: http://www.scrtc.blue.net/mcarc
NJ - PARSIPPANY - Hamfest. PAL Bldg., 33 Baldwin Rd. Splitrock ARA, Peter Glenn KC2KI, 888-511-SARA or 973-442-7379. E-Mail: KC2KI@qsl.net Web: http://www.ham.hsix.com/sara

MARCH 4-5

FL - NEW PORT RICHEY - Hamfest. Gulf Coast ARC, Rickie Brown KF4GXS, 727-863-1457. E-Mail: richar@gte.net. Don KK4VK, 727-848-8000. Web: http://homel.gte.net/koerner/gcarc.htm

MARCH 5

NY - LINDENHURST - Hamfest. GSBARC & SCRC, Lenore Dunlop N2KYP, 516-785-0826. E-Mail: info@gsbarc.org Web: http://www.gsbarc.org

MARCH 10-11

NE - NORFOLK - State Convention. Elkhorn Valley ARC, Fred Wiebelhaus N0VLX, 402-379-1929. E-Mail: dfwiebel@sufia.net

MARCH 11

AZ - SCOTTSDALE - Hamfest. Scottsdale ARC, Roger Cahoon KB7ZWI, 602-943-7651
CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves
ND - WEST FARGO - Hamfest. Red River Valley Fairgrounds. 8am-3pm. AR license testing. Talk-in: 146.76-. Red River Radio Amateurs, Mark Kerkvliet KG0FR, 701-282-4716. Web: http://www.rrra.org
WA - PUYALLUP - Hamfest. Mike & Key ARC, Michael Dinkelman N7WA, 253-631-3756 or 425-867-4797. E-Mail: mwdink@eskimo.com

MARCH 11-12

LA - RAYNE - Hamfest. Rayne Civic Center. AARA. Al Oubre K5DPG, 318-367-3901. E-Mail: k5dpg@arrl.net Web: http://www.acadian.net/w5ddl/
NC - CHARLOTTE - Charlotte Hamfest and Computerfair. Charlotte Merchandise Mart, 2500 E. Independence Blvd. Mecklenburg Amateur Radio Society, Tom Hunt KA3VVJ, 704-948-7373 until 9pm EST. E-Mail: hamfest@w4bfb.org Web: www.w4bfb.org

MARCH 12

PA - YORK - Hamfest. York County Area Vocational-Technical School. VE Testing. Talk-in: 146.97-. Keystone VHF Club, Dick Goodman WA3USG, 717-697-2490. E-Mail: yorkfest@aol.com Web: http://members.aol.com/yorkfest
WI - WAUKESHA - Hamfest. County Expo Center, N.1 W.24848 N. View Rd. 8am-2pm. Talk-in: 146.820 PL 127.3. SEWFARS ARC, John Breecher N9NWN, 414-835-7035

MARCH 17-18

GA - MARIETTA - Hamfest. Kennehoochee ARC, Charles Golsen N4TZM, 404-252-3303. E-Mail: cgolsen@atlanta.com

MARCH 18

FL - STUART - Hamfest. Martin County ARA, Romund Madson KS4KM, 561-337-1841
NJ - NORTH HUNTERDON - Hamfest. Cherryville Repeater Assn., Marty Grozinski W2CG, 908-788-2644 or 908-730-2771. E-Mail: w2cg@arrl.net
WV - CHARLESTON - Hamfest. Jimmie Hewlett WD8MKS, 304-768-1142

MARCH 18-19

TX - MIDLAND - West Texas ARRL Section Convention. Midland County Exhibit Bldg. Sat: 8am-5pm, Sun: 8am-2pm. VE Exams. Beverly Harwood KC5BNT, 915-686-1841. E-Mail: sham rock@apex2000.net, Web: http://www.lxnet/e dge/midswap.htm. Larry Nix N5TQU, E-Mail: oilman@lx.net Web: http://www.w5qgg.org

MARCH 19

IL - STERLING - Hamfest. Sterling High School Fieldhouse, 1608 4th Ave. Talk-in: 146.25/146.85 W9MEP. Sterling-Rock Falls ARS, Lloyd Sherman KB9APW, 815-336-2434. E-Mail: lsherman@essexl.com
OH - MAUMEE - Hamfest. Lucas County Recreation Center, 2901 Key St. 8am-2pm. Talk-in: 147.27+ or 442.85+. Toledo Mobile RA, Paul Hanslik, 419-385-5056. Web: www.tmrahamradio.org

MARCH 24-25

OK - TULSA - West Gulf Division Convention. Green Country Hamfest Assn., Merlin Griffin WB5OSM, 918-622-2277. E-Mail: megriffin@ionet.net Web: http://www.greencountryhamfest.org

MARCH 25

OH - COALTON - Hamfest. Jackson County ARC, Edgar Dempsey KD8XL, 740-286-3239. E-Mail: kd8xl@juno.com
WV - BECKLEY - Hamfest. Plateau ARA & Black Diamond RC, James Martin KC8JSZ, 304-465-1428. E-Mail: w373@ientone.net Web: http://members.spree.com/sip1/plateau

MARCH 25-26

MD - TIMONIUM - Greater Baltimore Hamboree & Computerfest/MD State ARRL Convention. Timonium Fairgrounds, York Rd. Sat: 8am-5pm, Sun: 8am-4pm. VE Exams. Baltimore ARC, Sharon Dobson N3QQC, 410-HAM-FEST or 800-HAM-FEST. E-Mail: n3qqc@amsat.org Web: http://www.gbhc.org

MARCH 26

CA - SANTA ANA - Swapmeet. ACP parking lot. Mary Russo 714-558-8813
IL - GRAYSLAKE - Hamfest. North Shore Radio Club, Jacob Fishman KF9ZF, 847-291-4160. E-Mail: kf9zf@lightwriters.com Web: http://www.ns9rc.org
OH - MADISON - Hamfest. Lake County ARA, Roxanne N8BC, 440-209-8953. E-Mail: tbrown@ncweb.com

Events CALENDAR

APRIL 2000

APRIL 1

MO - LEBANON - Hamfest. Lebanon ARC, Micki Jensen KC0EEX, 417-588-2335.
E-Mail: mjensen@llion.org
TX - BRENHAM - Hamfest. Brenham ARC, Dan Lakenmacher N5UNU, 409-836-8739.
E-Mail: lindan@phoenix.net

APRIL 2

CT - SOUTHINGTON - Hamfest. Southington ARC, Chet Bacon KA1ILH, 860-628-9346.
E-Mail: chet@chetbacon.com
Web: http://www.chetbacon.com/sara.html
NC - KINSTON - Hamfest. Down East Hamfest Assn., Doug Burt W4OFO, 252-524-5724

APRIL 7-8

WI - MILWAUKEE - Hamfest. Amateur Electronic Supply, Ray Grenier K9KHW, 414-358-4088.
E-Mail: rayk9khw@aol.com
Web: http://www.aes/jam.com

APRIL 8

AR - FORT SMITH - Hamfest. Fort Smith Area ARC, Kelsey Mikel KK5KU, 501-651-7003. E-Mail: kk5ku@amsat.org Web: http://www.qsl.net/fsaarc
CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves
MN - ROCHESTER - Hamfest. Rochester ARC, John Scott N0HZN, 507-285-6522.
E-Mail: n0hzn@aol.com
Web: http://members.aol.com/rarchams
NH - TWIN MOUNTAIN - Hamfest. North County ARC and LARK, Richard Force WB1ASL, 603-788-4428. E-Mail: bhabooks@together.net
TN - CLINTON - Hamfest. Oak Ridge ARC, David Bower K4PZT, 865-690-8360. E-Mail: d.bower@ieee.org Web: http://www.korrnet.org/orarc
WA - SPOKANE - Hamfest. Lilac City ARC, Warren Kelsey KJ7BB, 509-534-8443

APRIL 9

NC - RALEIGH - State Convention. Raleigh ARC, Chuck Littlewood K4HF, 919-872-6555.
E-Mail: k4hf@arrl.net Web: http://www.rars.org
PA - MONROEVILLE - Hamfest. Two Rivers ARC, Michael Kowalcheck KV3L, 412-751-9657. E-Mail: w3oc@nb.net Web: http://www.qsl.net/w3oc
WI - STOUGHTON - Hamfest. Madison Area Repeater Assn., Paul Toussaint N9VWH, 608-245-8890. E-Mail: n9vwh@arrl.net

APRIL 14-15-16

CA - VISALIA - International DX Convention. Southern CA DX Club, Cathy Gardenias KF6LFB, 909-862-0720. E-Mail: wu6d@dreamsoft.com
Web: http://www.scdxc.org

APRIL 15

AL - ALBERTVILLE - Hamfest. Marshall County ARC, Buddy Smith KC4URL, 256-593-2516.
E-Mail: kc4url@airnet.net
MN - BLAINE - Hamfest. Robbinsdale ARC, Harriet Johanson KB0UPG, 612-474-7346
NC - MORGANTON - Hamfest. Tom Taylor KC4QPR, 828-433-6205. E-Mail: kc4qpr@vistatech.net Web: http://www.wp.cc.nc.us/~cvhamfest/

APRIL 16

MA - CAMBRIDGE - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: http://web.mit.edu/w1mx/www/swapfest.html
MI - GROSSE POINTE - Hamfest. South Eastern MI ARA, Jerry Rosner N8FGK, 313-331-3336.
E-Mail: n8fgk@amsat.org
Web: http://members.home.net/semara

APRIL 21-22

AR - LITTLE ROCK - Little Rock Hamfest, Jim Blackmon K5VZ, 870-246-7833 (h) or 870-246-6734 (w). Fax: 870-246-6736.
E-Mail: lrhamfest@usa.net
Web: http://www.aristotle.net/~ares/hamfest/

APRIL 22

ID - IDAHO FALLS - Hamfest. Eastern ID UHF Society, Jay Greenberg WA4VRV, 208-524-1388 or 208-526-7033. E-Mail: wa4vrv@srv.net
Web: http://www.srv.net/~wa4vrv/hamfest.htm
NH - NASHUA - Hamfest. Res Ctr Church. NE Antique RC 617-923-2665

APRIL 29

AL - MOULTON - Hamfest. Bankhead ARC, Rex Free KN4CI, 256-905-0822.
Web: http://www.homestead.com/n4idx
IA - DES MOINES - Hamfest. Des Moines RAA, Duane Bower WB0UCY, 515-287-6542.
E-Mail: duaneab@uswest.net
IL - STICKNEY - Hamfest. DuPage ARC, Ed Weinstein WD9AYR, 630-985-9256. E-Mail: DARCHamfest@aol.com
Web: http://www.qsl.net/dupagearc

APRIL 30

IL - ARTHUR - Hamfest. Moultrie ARK, Ralph Zancha WC9V, 217-873-5287.
E-Mail: rzancha@one-eleven.net

MAY 2000

MAY 6

AZ - SIERRA VISTA - Hamfest. Cochise ARA, Raymond Berger W1LYT, 520-378-4214
WI - CEDARBURG - Hamfest. Ozaukee RC, Joe Holly AA9HR, 262-377-2137; E-Mail: aa9hr@execpc.com. Skip Douglas, 262-284-3271

MAY 6-7

AL - BIRMINGHAM - Hamfest. Glenn Glass KE4YZK, 205-681-5019.
E-Mail: ke4yzk@bellsouth.net Web: http://www.bro.net/barc/slideshow/index.html

MAY 7

MD - HAGERSTOWN - Hamfest. Antietam Radio Assn., Tina Jones KB8ZQM, 304-728-7769.
E-Mail: kb8zqm@intrepid.net
Web: http://www.qsl.net/w3cwc
NY - YONKERS - Flea Market. Lincoln High School, Kneeland Ave. 9am-3pm. VE Exams. Talk-in: 440.425 PL 156.7, 223.760 PL 67.0, 146.910, 443.350 PL 156.7. Metro 70cm Network, Otto Supliski WB2SLQ, 914-969-1053.
E-Mail: wb2slq@juno.com
Web: http://www.metro70cmnetwork.com
PA - WRIGHTSTOWN - Hamfest. Warminster ARC, Roy Conners K3TEN, 215-947-9373.
E-Mail: k3ten@arrl.net
Web: http://www.voicenet.com/~k3dn

MAY 12-13

NH - ROCHESTER - Hamfest. Fairgrounds. Hoss Traders, Joe, 207-469-3492

MAY 13

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

MAY 19-20-21

OH - DAYTON - ARRL National Convention. Dayton ARA, Dave Coons, WT8W, 937-849-0604.

Events CALENDAR

E-Mail: wt8w@arrl.org
Web: http://www.hamvention.org

MAY 21

CA - SANTA ANA - Swapmeet. ACP parking lot. Mary Russo 714-558-8813
MA - CAMBRIDGE - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: http://web.mit.edu/w1mx/www/swapfest.html

MAY 27-28

WY - CASPER - State Convention. Casper ARC, Warren (Rev) Morton WS7W, 307-235-2799 or 307-237-9301. E-Mail: mortonwg@aol.com
Web: http://w3.trib.com/~carc/hamfest.html

JUNE 2000

JUNE 2-3-4

NY - ROCHESTER - Atlantic Division ARRL Convention. Harold Smith K2HC, 716-424-7184. E-Mail: rochfst@frontiernet.net
Web: http://www.rochesterhamfest.org

JUNE 3-4

OR - SEASIDE - Northwestern Division ARRL Convention. Convention Center. VE testing. Talk-in: 146.660 (-600). SEAPAC, Randy Stimson KZ7T, 503-297-1175. Web: www.seapac.org

JUNE 4

IL - PRINCETON - Hamfest. Starved Rock Radio Club, Alan Erbrederis N9PIB, 815-498-9675. E-Mail: w9mks@arrl.net
Web: http://www.qsl.net/w9mks
VA - MANASSAS - Hamfest. Ole Virginia Hams ARC, Jack McDermott N4YIC, 703-335-9139. E-Mail: N4YIC@arrl.net or patnjack@erols.com
Web: http://www.qsl.net/olevahams/

JUNE 10

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves
NC - WINSTON-SALEM - Hamfest. Forsyth ARC, John Kippe N0KTY, 336-723-7388. Web: http://members.xoom.com/w4nc/hamfest.htm
PA - BLOOMSBURG - Eastern PA Section Convention. Columbia-Montour ARC, George Law N3KYZ, 570-784-2299. E-Mail: n3kyz@epix.net
Web: http://www.bafn.org/~cmarc

JUNE 11

IL - WHEATON - Hamfest. Six Meter Club of Chicago, Joseph Gutwein WA9RIJ, 630-963-4922 or 708-442-4961. E-Mail: wa9rij@mc.net
Web: http://cyberconnect.com/orion/smcc.html
TN - KNOXVILLE - Hamfest. RAC of Knoxville, David Bower K4PZT, 423-670-1503.
E-Mail: rack@korrnet.org
Web: http://www.korrnet.org/rack

JUNE 18

MA - CAMBRIDGE - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: http://web.mit.edu/w1mx/www/swapfest.html

JULY 2000

JULY 2

PA - WILKES-BARRE - Hamfest. Murgas ARC, Stanley Perry KE3TC, 570-735-2385.
E-Mail: slperry@epix.net

JULY 7-8-9

UT - BRYCE CANYON - State Convention. UT Hamfest Committee, Kathy Rudnicki N7JSH, 801-547-9218. Web: http://www.utahhamfest.org

JULY 8

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves
GA - GAINESVILLE - State Convention. Lanierland ARC, Ken Johnson NZ4Q, 706-335-9658. E-Mail: nz4q@aol.com
MO - KANSAS CITY - Hamfest. PHD ARA, Bob Roske WA0CLR, 816-436-0069.
E-Mail: wa0clr@worldnet.att.net
Web: http://members.tripod.com/~PHDARA/

JULY 9

IL - PEOTONE - Hamfest. Kankakee Area Radio Society, Don Kerouac K9NR, 815-939-7548.
E-Mail: k9nr@juno.com
Web: http://www.w9az.com

JULY 16

MA - CAMBRIDGE - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: http://web.mit.edu/w1mx/www/swapfest.html
MO - WASHINGTON - Hamfest. Zero Beaters ARC, Dave Neal N0PNG, 314-532-2477 (days) or 314-458-3254 (eve). E-Mail: Dave_Neal@msc.com
Web: http://zbarc.usmo.com/
PA - KIMBERTON - Hamfest. Mid-Atlantic ARC, Bill Owen W3KRB, 610-325-3995.
E-Mail: gem@op.net
Web: http://www.marc.org/hamfest.html

JULY 22

NH - NASHUA - Hamfest. Res Ctr Church. NE Antique RC 617-923-2665

JULY 23

IL - SUGAR GROVE - Hamfest. Fox River Radio League, Maurice Schietecatte W9CEO, 815-786-2860. E-Mail: w9ceo@arrl.net
Web: http://www.frrl.org/hamfest.html

JULY 29-30

OK - OKLAHOMA CITY - State Convention. Central OK Radio Amateurs, Harold Miller KB1ZQ, 405-672-7735 or 405-650-9963.
E-Mail: n1lpn@swbell.net
Web: http://www.geocities.com/heartland/7332

JULY 30

CA - SANTA ANA - Swapmeet. ACP parking lot. Mary Russo 714-558-8813
OH - RANDOLPH - Hamfest. Portage ARC, Joanne Solak KJ3O, 330-274-8240. E-Mail: ljsolak@apk.net Web: http://parc.portage.oh.us

AUGUST 2000

AUGUST 5

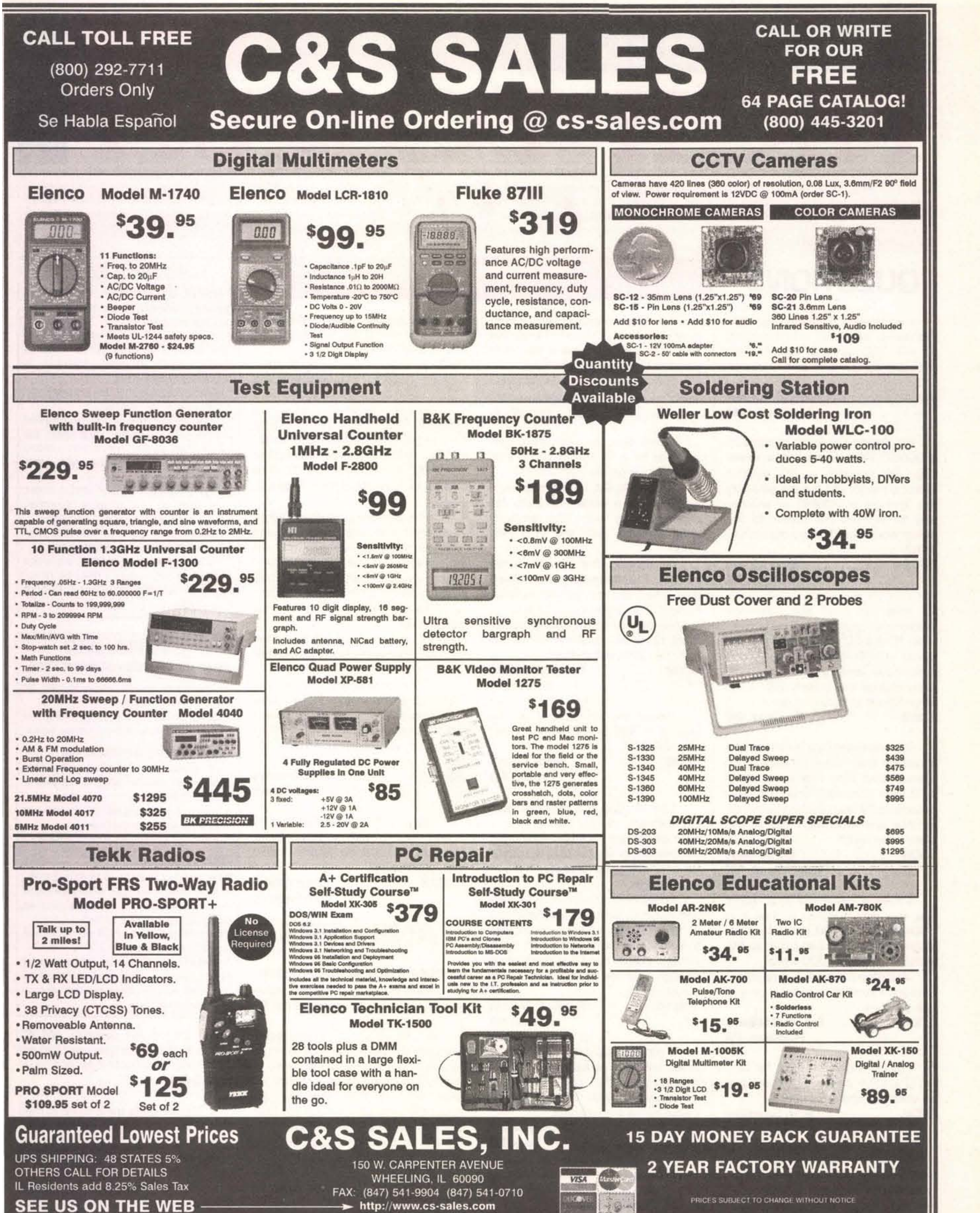
OH - COLUMBUS - Hamfest. Voice of Aladdin ARC, James Morton KB8KPJ, 614-846-7790.
E-Mail: kb8kpj@cs.com

AUGUST 12

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves
IL - QUINCY - Hamfest. Western Illinois ARC, Jim Funk, N9JF, 217-336-4191. E-Mail: jfunk@adams.net Web: http://www.qsl.net/w9awe

AUGUST 13

IA - AMANA - Hamfest. Cedar Valley ARC, Chuck Bassett N0UTS, 319-378-0448.
E-Mail: n0uts@rf.org Web: http://cvarc.rf.org



Write in 65 on Reader Service Card.

Questions & Answers

TECH FORUM

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!

QUESTIONS

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

I need any information available (hardware, software, programming) on HP 75D vintage laptop. Also accessories, printer, and mini-cassette.

1001 **David LaMoreaux**
Brecksville, OH

I'm driving a stepper motor with a UCN5804B stepper motor driver chip. The problem is, the stepper motor is mostly idle, but still gets very hot. Is there a MOSFET or another way to turn off the power to the motor when it isn't being directed to turn?

1002 **Greg Moran**
Riverside, CA

How can I tell the difference between a regulated and an unregulated 12-volt DC power supply? Can I power a VHF radio with a 12-volt automotive battery and simultaneously charge the battery with a 10 amp, 12-volt battery charger?

1003 **Portland, ME**

I am considering a purchase of a miniature color video camera, but I noticed that they only have about 410 lines horizontal scan. I believe broadcast TV uses 525. Why the difference and what will I lose at the lower scan rate?

1004 **Curt Powell**
Rocky Mount, NC

I have a generator that works fine, the only problem is that it is 110-volts DC at 100 amps. I need a diagram to build a converter to 60-cycles AC, about 2,000 watts.

Waveform is not important because I know how to take care of that problem.

1005 **Francis Hillibush**
Ringtown, PA

I would like information for DEC PC LPv/LPv+ computer, power supply voltages, and color codes.

1006 **R. H. Saunders**
Epping, NH

On my computer (COMPAQ PRESARIO 5715) when I go to MSDOS I get WINDOWS and in an attempt to find the revision level of the DOS in the computer, I can only get the revision level of WINDOWS. How do I find out the revision level of the DOS? I have a book on DOS and if I knew the REV then I would know if the book pertains to the level that I have.

I am a newbie to the PC world.

1007 **Donald Lambert**
Forsyth, IL

I have seen an interesting gadget (toy) for a PC that is called Intel Play QX3 Computer Microscope.

If it works like I think it does, it would make a wonderful basis for experimenting with. Has anybody done anything with the Intel Play QX3?

I'm thinking that it's like an eye (electronic of course) in which if you dismantled, the microscope could be hooked up to anything optical such as a telescope or other optical instrument. Or, is the resolution of the eye less than what will do that?

1008 **Donald Lambert**
Forsyth, IL

I need the pin readout on the plug of a GBC video camera. Lookout, LC2001.

1009 **Frank Bowen**
Fresno, CA

I am in need of a resistive heating element to use for igniting a hydrogen flame. I am currently using a model airplane glow plug but would like something with a higher temperature range.

I have heard that nichrome wire and platinum coatings are preferred as the platinum will act as a catalyst to sustain the burn at a much lower voltage. Where can I find information of such a device so that I may construct one?

10010 **Frank J. Prevatt**
via Internet

I am looking for a schematic which will allow a laptop computer, through the COM1 or LPT1 port to communicate with HPIB equipped electronic test equipment.

10011 **Jeffrey Shank**
York, PA

Does anyone have any information about a Lynx 500 hard drive tester? I need a manual.

10012 **Charles R. Wells**
Washington, MI

Does anyone have a schematic/service manual for a Zenith Model R476 AM/FM clock radio?

10013 **Ed Wetter**
Fremont, CA

I want to build an AC voltage conditioner. This would be a microprocessor controlled unit that would monitor the I/P voltage (household 120 VAC) and adjust the O/P to remain at 120 VAC if the I/P falls or rises.

There would also be spike/surge protection. Also, any other bells and whistles would be appreciated. I will be expecting to use this for a computer, so O/P current would only have to power a computer, monitor, cable modem, printer, and scanner at the most.

10014 **Jeff Strachan**
Keewatin, Ontario, Canada

I have a military transmitter made by Collins Model TCZ-2 Serial #36 dated 3/16/46. Where can I get information on this item? A schematic or operating manual is needed.

10015 **R. L. Delaney**
via Internet

I have an Electohome EH580 sound system with a blown amp. Does someone know where I could get schematics?

10016 **Colin Lohrer**
via Internet

ANSWERS

ANSWER TO #129915 - DEC. 1999

I have an older, color Mac scanner. Is it possible to convert it to PC?

Virtually all (pre-iMac) Mac scanners use the SCSI interface. In order to use it on your PC, you will need to find a SCSI card and the appropriate driver software. If the company marketed the scanner for both the Mac and PC, you should be able to find PC drivers on their web site. If not, a generic driver might work instead.

Tom Owad
Mount Wolf, PA

ANSWER TO #12991 - DEC. 1999

I enjoy listening to AM broadcast band DX on my portable AM/FM radio. Is there a simple way I can add an analog S-meter to it for AM reception only?

The simplest thing to do is measure the automatic gain control (AGC) voltage. It is derived from the AM detector diode, which should be easy to find.

The FM detector has two diodes. The AM detector usually has a bias voltage which may be positive or negative, depending on the design and

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 E-Mail.
- In most cases, only one answer per question will be printed.
- Your name, city, state, and E-Mail address, (if submitted by E-Mail), will be printed in the magazine, unless you notify us otherwise with your submission.
- 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 FOR PUBLICATION

All questions should relate to one or more of the following:
1) Circuit Design 3) Problem Solving
2) Electronic Theory 4) Other Similar Topics

INFORMATION/RESTRICTIONS

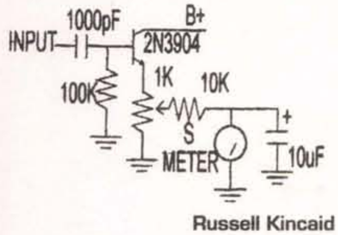
- No questions will be accepted that offer equipment for sale or equipment wanted to buy.
- Selected questions will be printed one time on a space available basis.
- Questions may be subject to editing.

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 and Phone Number. Only your name will be published with the question, but we may need to contact you.

whether NPN or PNP transistors are used. The AGC voltage varies with signal strength, increasing in a positive direction if PNP transistors are used and in a negative direction if NPN transistors are used.

If the bias is a problem, causing the meter to read full scale at all times, this isolation circuit will work: Connect the input to the IF transformer terminal that feeds the detector diode. You may not need the 1K pot, but it allows you to adjust the sensitivity so it doesn't register on noise or overload on strong signals.



Russell Kincaid
Milford, NH

ANSWER TO #129912 - DEC. 1999

I read enthusiastically Nuts & Volts articles on NC routers because I was building one. It is complete now, but has a serious motor noise problem.

How can I quiet it down so the logic board will stop getting lost?

I am surprised you are having trouble with the logic board because its signals should be low impedance and have good noise immunity.

The first suspect would be ground noise, the motor could be causing IR drops in a common ground that couples into the logic. If you have completely isolated the motor wiring from the logic wiring, then ground noise is not the cause.

The second suspect is radiated noise, and there are many steps to reduce it. Commutation noise from the 60W motor would be the noise source. The two motor leads should run close together. The radiated magnetic noise depends not only on the motor current, but also on the effective area of the loop. Keeping the leads close together minimizes the area.

Ott (*Noise Reduction Techniques in Electronic Systems*) recommends putting ferrite beads on the motor leads. The beads should be close to the motor, and on the supply side of the beads, there should be a shunt capacitor.

The beads minimize the high frequency currents in the motor leads by adding resistance and reactance, and the shunt capacitor minimizes the radiation area for high frequency currents. Ott warns that these measures can make the problem worse if the the values are wrong — the capacitance and inductance may resonate with motor.

Adding a shield will also help, but if most of the noise is magnetic

ANSWERS TO #129913 - DEC. 1999

Supposedly, stranded wire of a particular gauge is rated to carry more current than a solid wire of similar gauge (at DC or power line frequencies where skin effect is negligible).

***1.** Is it true that stranded wire has higher current carrying capability?*

***2.** If the answer to question #1 is yes, why is this?*

***3.** Does stranded wire of a particular gauge have more, less, or the same metallic crossectional area as its solid wire counterpart of a similar gauge?*

#1 Stranded wire has the same current carrying capacity as solid wire. The stranding is chosen to have about the same cross sectional area, so the current densities and IR losses will be about the same.

Here are some wire sizes and common strandings (areas are in circular mils).

AWG	area	stranding	strand area	equivalent area
28	159	7x36	25	175
26	253	7x34	40	280
24	404	7x32	64	448
22	640	7x30	100	700
20	1024	7x28	159	1113
18	1624	16x30	100	1600
16	2581	26x30	100	2600

Solid wire is less expensive than stranded, so solid is preferred. House wiring uses solid wire in the walls because it is less expensive and will not move after installation. Power cords are stranded because they must be flexible. Thin wires are less springy and they can bend around smaller radii without work hardening (yielding). Too much work hardening will break a wire.

I don't think there is any current carrying advantage of stranded over solid wire, but here are some reasons why someone might think stranded has an advantage.

Although interior house wiring is usually solid, the service entrance wire (which might carry 200A) is usually stranded. The wire is probably stranded for a couple reasons. First, solid wire that thick is awkward to handle because it won't bend easily. Second, the wire will sway in the wind, so stranding eases the problems of work hardening.

At high frequencies (say 50 KHz to 2 MHz), Litz wire can have much lower loss than the equivalent solid wire. Although Litz wire is a stranded wire, it is unlike ordinary stranded wire. The individual strands are insulated from each other, and the strands are woven rather than just twisted together.

Gerald Roylance
Mountain View, CA

#2 My wire tables show that solid and stranded wire of a given AWG have the same area in circular mils and that stranded wire has slightly higher maximum resistance, so stranded should definitely not be used for more current than solid wire. It may be that solid wire will fuse (melt) before stranded, but that is not a good design criteria.

Russell Kincaid
Milford, NH

#3 On page 241 of Oliver Heaviside's *Electrical Papers*, volume 2, copyright 1894, states "inductance can be increased indefinitely by thinning the wire." My thoughts are, this might be partially mitigated by the fact so many of them are in parallel, and partially enhanced by mutual inductance. That would mean that stranded wire might have a higher AC impedance.

But, as far as pure resistance, a theory has been put forward in U.S. patent 4,325,795 on April 20, 1982 by Ronald C. Bourgoin that if you make a conductor narrow enough it will force electrons to pair up — I guess, causing their spin induced magnetic poles (opposite spins at the same energy level) to stick together — and the electricity through that conductor would become superconducting (no resistance).

In his patent, Bourgoin claims to have had positive results with molecularly thin Bismuth strands.

As far as regular sized stranded verses solid wire is concerned, there may be an increase in conductivity in stranded wire, caused by just a partial increase in pairings ups.

Greg Moran
Riverside, CA

#4 To easier understand why stranded wire can carry more current than its solid counterpart, please know that the stranded versions are made up of nothing more than several conductors of smaller standard gauges and, in order to match the stranded and solid to exactly the same size, manufacturers would have to make non-standard sizes of conductor strands, which would be uneconomical.

For instance, the circular mil area, (abbreviated cmil), of 22-gauge solid wire is 642.4, but the stranded version of common 22-gauge hookup wire is usually composed of seven strands of solid 30-gauge wire which has a cmil of 100.5 per strand. Now multiply 100.5 by 7 and you get a stranded conductor with a total cmil of 703.5, an additional 61.1 of cmil, which would be close to having an extra strand of 32-gauge wire added in.

Even though stranded wire will always carry at least the same amount or slightly more current than solid wire, the difference is practically negligible as a strand of 32 gauge wire can only carry about a 10th of an ampere without excessively overheating.

Kevin T. Kaas
New Port Richey, FL

(instead of electrostatic), then the shield should be steel rather than aluminum.

Gerald Roylance
Mountain View, CA

ANSWER TO #12999 - DEC. 1999

What are fusible resistors? How are they constructed and tested? How are they specified?

All resistors are fusible if you overload them. Fusible resistors are calibrated to open at a specified current.

The most popular these days are surface mount chip resistors. You can get more information at **www.belfuse.com** or **201-432-0463** and **www.wickmannusa.com** or **404-699-7820**.

There is another device called a Positive Temperature Coefficient resistor (PTC) that changes from a low resistance at room temperature to a very high resistance at a high temperature. This change is sudden, so it makes a nice resettable fuse. You can get more information at **www.bourns.com** or **909-781-5500**.

Russell Kincaid
Milford, NH

ANSWER TO #129910 - DEC. 1999

I read the article on "Reviving NiCad Powered Devices."

I used to build power supplies for reclaiming gold by electroplating and the major problem was "dendrites" growing between the plates and having them short out. We then switched to "periodic reverse" plating in which for gold it was about 90% plating followed by 10% deplating.

Could a NiCad charger be built using this technique to eliminate this problem?

Your observation is a good one, but it already happens. Charging a battery is like plating it, and using a battery runs the charging reactions in reverse — deplating the battery. So just using the battery accomplishes your goal. Just make sure you discharge your NiCd batteries once in awhile.

Keeping a NiCd battery topped up all the time limits its life.

Some NiCd battery systems (such as those in satellites) deliberately discharge a bank of cells to guarantee a periodic deep discharge. The purpose of the deep discharge may be to remove dendrites, but I do not know for sure. Although some batteries, like NiCd, work better with deep discharges, other batteries (such as lead-acid) do not like deep discharges.

Gerald Roylance
Mountain View, CA

ANSWER TO #12996 - DEC. 1999

I would like to figure out how to make my door locks keyless. They are already electric, so some sort of transmitter is all that would be necessary.

Installing a remote keyless entry system is as easy as setting aside one Saturday morning, thanks to the number of add-on kits that are available today.

You can purchase a simple remote keyless entry system like the OMEGA AU-REC-8 from the Internet at www.partsexpress.com for around $70.00. If you would like to take a step up, for around $120.00, you can purchase a car alarm system, most of which come with the remote keyless entry as one of the standard

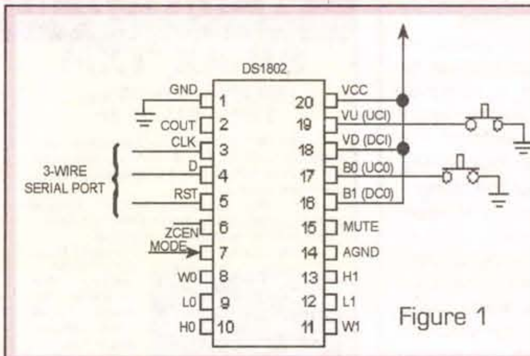


Figure 1

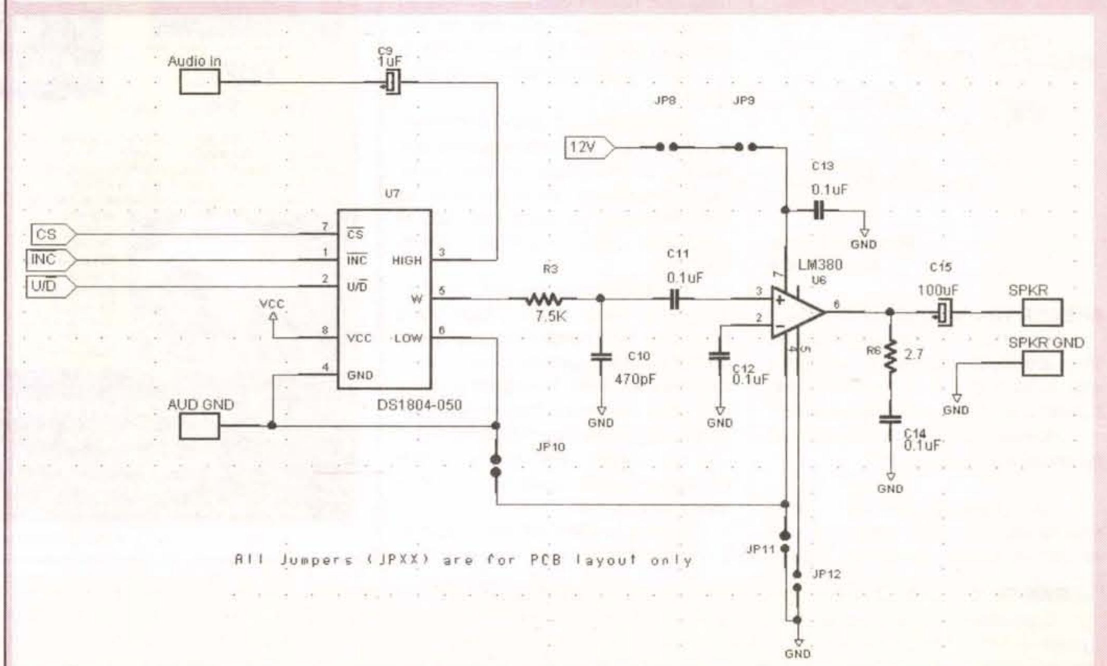
ANSWER TO #10991 - OCT. 1999

I need a volume control circuit that could connect to the tape in/out jacks on my stereo for remote volume control. Or, a low-cost commercial unit to do this, perhaps infrared.

The DS1802 dual audio taper digital potentiometer from Dallas Semiconductor can be used to provide the volume control that Jim is looking for.

Figure 1 shows how to control volume up/down and balance using two push button-switches.

The DS1802 consists of two audio taper potentiometers with 65 steps of resistance. Each press of UC0 or UC1 will increase or decrease the resistance seen



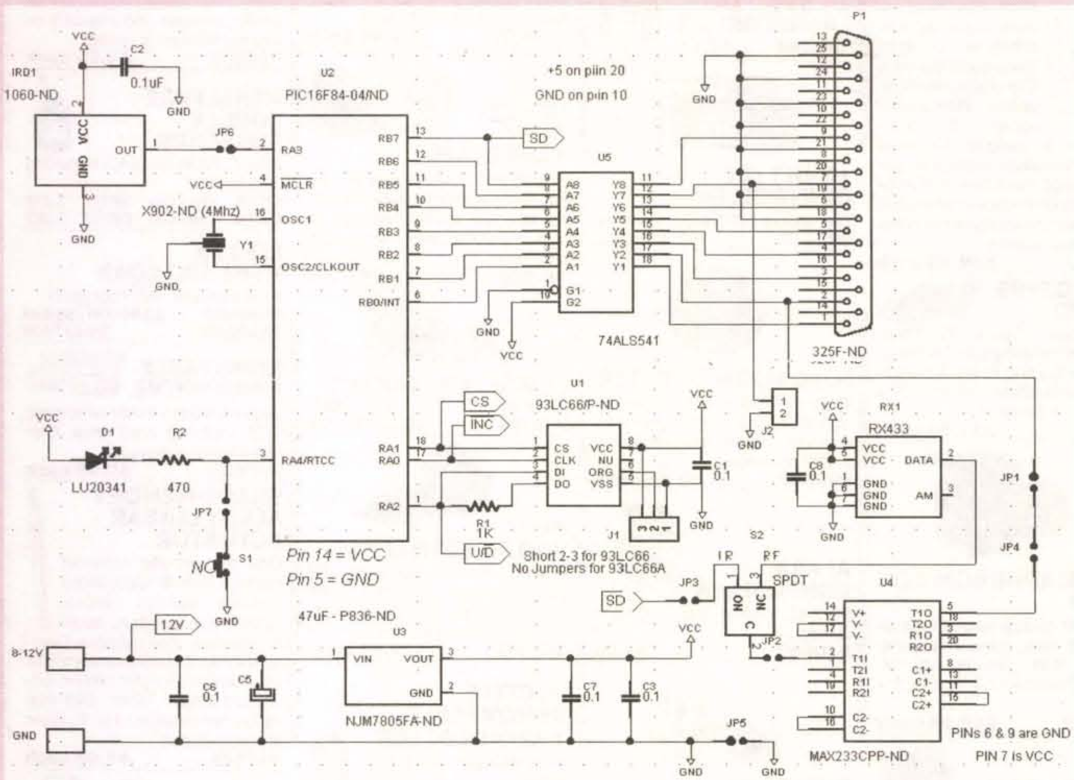
between the wipers (W0 and W1) and the ends of the potentiometers by 1 dB. Additional information on the DS1802 can be found at: **www.dalsemi.com/DocControl/PDFs/1802.pdf**

Now, if IR remote control of your volume control is what you want, check out my IR remote control add-on to the PROgramit scanner control project that was described in the Nov. '97 issue of *Nuts and Volts*.

This circuit includes a remote volume control based on a Dallas Semiconductor DS1804 digital potentiometer. A PIC microcontroller can learn the IR patterns produced by the volume up and down buttons of most any handheld remote and use these to control the volume of the applied audio signal.

For more information on this project, visit my WEB page at **www.qsl.net/ka2pyj/progamitirxt.htm**

John Montalbano
Middletown, NJ



features, or you can get a top-of-the line system for $200.00+ which includes the remote keyless entry, alarm, and remote starter.

The remote starter is a great feature to have if you live in a cold climate. These systems maybe purchased at any local electronics retailer like Circuit City or Best Buy.

Jim Teague
Coatesville, PA

ANSWER TO #12994 - DEC. 1999

I have an RCA VCR model No. VKP925T. When I try to play a cassette, the entire screen is filled with neat columns and rows of the same cipher.

The Pak-Man screen is a common problem with the RCA VKP925. The on-screen character generator IC is bad. It is located in the base unit near the fluorescent display. It is a larger IC 0.4" wide with about 30 pins.

The IC number is MB88303. It's available from any RCA parts dealer. The cost of that IC should be about $20.00.

Reed Adams
via Internet

ANS. #1 TO #12997 - DEC. 1999

I am investigating using a PC to operate different peripherials. What prevents Turbo C from being used to implement many programs is its dependence on the system clock, 18.2 ticks per second, much too slow for many applications.

However, a book describing Microsoft C v6.0, says it is able to measure events much quicker, 450,000 ticks per second.

Does the speed of response for a C program depend on the particular compiler being Visual C, Ansi C, etc.?

Turbo C is quite independent on the 18.2 Hz system clock provided by your PC. Turbo C is merely a programming language. Like most C language compilers, Turbo C comes with a "standard" library of already-written and compiled subroutines.

The dependence you refer to is a property of the library function named "clock;" it is not a property of the compiler, or the Turbo dialect of the C language.

Turbo C itself is capable of harnessing anything that your hardware is capable of providing. You are under no constraint whatsoever to use only functions provided by Borland.

On a PC running in real physical address mode, a program written in Turbo C can access any of the hard-

Continued on page 64

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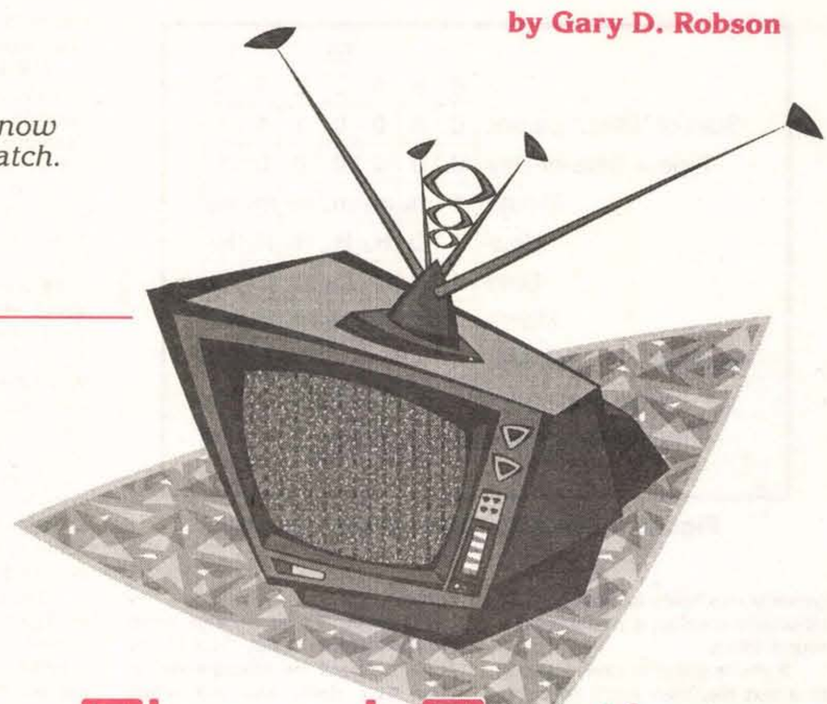
Download our latest catalog at http://www.alltronics.com Download our latest catalog at http://www.alltronics.com Download our latest catalog at http://www.alltronics.com

What can you do with the data?

- *Make transcripts of your favorite shows.*
- *Set up your own "TV Agent" to let you know when there's something interesting to watch.*
- *Track Internet links.*
- *Set the time on your computer.*
- *Watch for weather alerts in XDS.*
- *Collect song lyrics.*

by Gary D. Robson



Closed Captions, V-Chip, and Other VBI Data

There's more in your TV signal than just video and audio. Closed captions, V-chip information, time of day, program and network information, Internet links, and more lurk within the broadcast signal just waiting for you to pull it all out.

Remember those old TV sets with the "vertical hold" knob? If you turned the knob a bit, you'd see parts of two frames, with a black bar between them. That black bar is the VBI, or vertical blanking interval. It actually consists of the first 21 scan lines of the picture, although what's contained there is non-picture data and synch signals.

In 1976, the Federal Communications Commission (FCC) reserved line 21 of the VBI for closed captioning. Since mid-1993, all television sets 13" and larger have been required to have caption decoders built in. If your TV is newer than that, you can press the "CC" button on your remote or choose "captioning" from your on-screen menu, and watch the program audio rendered as text on the screen.

•

With the recent proliferation of inexpensive TV tuner cards for computers, you now have an easy way to get this data into your computer and manipulate it.

What's actually in there

Each picture line in a television signal has two fields. Each field of line 21 contains a single stream of data, containing different types of data packets. The bandwidth was kept very low to make the data as robust as possible, so each field of each frame can contain only two seven-bit characters. Since video is transmitted at 30 frames per second, that gives us 60 characters per second in each field.

Field 1 of line 21 contains two captioning channels (CC1 and CC2) and two "text" channels (TEXT1 and TEXT2). All four of these data channels share that 600 CPS data stream, and the information is sorted out using packet headers. Field 2 contains a matching set of data channels (CC3, CC4, TEXT3, and TEXT4), and can also contain extended data services (XDS) packets.

If you consider a "word" to be five characters plus a space, then we theoretically have 600 words per minute of bandwidth in field 1. Theoretically, this should be plenty for two caption channels, but when overhead, positioning information, attribute data, and the two text channels are factored in, it may not be enough. On top of all that, dialog comes in bursts, and it's those bursts that would likely be synchronized to happen on both caption channels at once.

For this reason, programs with two caption channels will typically put the second caption stream into CC3, which gives each caption stream its own 600 CPS of bandwidth. An example is CBS' "60 Minutes," which puts English captions in CC1 and Spanish captions in CC3.

The character set used for this data is a slightly modified seven-bit ASCII. All of the standard alphanumeric characters are where you would expect them, but some accented letters have been relocated into the hex 20-7F range. The full character set can be found in my Closed Caption FAQ at www.robson.org\capfaq\caption charset.html.

Closed caption and text data

The vast majority of programming in the US uses only CC1 for caption data. Until recently, few programs actually had captions, but the Telecommunications Act of 1996 made captioning mandatory. As of January 2000, the first milestone in the Telecom Act requires a minimum of five hours per day on each channel, and some channels caption much more than that, so there's plenty of caption data out there.

Although the caption data specification (EIA-608) allows for italicizing, underlining, flashing (blinking), and various foreground colors, the only attribute used with any regularity is italics. Captioners

What's A V-Chip?

Don't try tearing apart your television set looking for the V-chip. You won't find it. Even though all televisions must contain a "V-chip" now by law, there really is no such thing.

The data for the V-chip, as the article explains, is simply XDS packets containing parental content advisories. Since the TV must contain circuitry to interpret captioning information in the VBI, the V-chip capabilities were added to the captioning chip.

The V-chip, short for "violence chip," allows parents to control what shows their children can watch. To use this capability, you set filters on your TV. Depending on the rating system being used, you can get fairly detailed.

For example, you might choose to allow anything rated TV-14, unless it contains excessive violence (TV-14-V). The set will then monitor the incoming signal, and if it detects anything rated TV-14-V or higher, the audio, video, and captions will be blocked.

The visible content advisory icon that appears in the corner of your screen at the beginning of a program is not generated by your television, and isn't dependent on the V-chip data. The V-chip data is also retransmitted constantly so that if you change channels, it will detect the new rating quickly.

	bit 6	5	4	3	2	1	0
Start of "Misc." packet	0	0	0	0	1	1	1
Type = Time-of-Day	0	0	0	0	0	0	1
Minute	1	m_5	m_4	m_3	m_2	m_1	m_0
Hour	1	D	H_4	H_3	H_2	H_1	H_0
Date	1	L	D_4	D_3	D_2	D_1	D_0
Month	1	Z	-	M_3	M_2	M_1	M_0
Weekday (1 = Sunday)	1	-	-	-	W_2	W_1	W_0
Year (add 1990)	1	Y_5	Y_4	Y_3	Y_2	Y_1	Y_0
End of XDS packet	0	0	0	1	1	1	1

Figure 1. The XDS "Time of Day" Packet

typically use italics to designate an off-screen speaker, a narrator, or a sound effect.

If you're going to save captions to a text file, then you'll probably want to do your own wordwrapping. Most closed captioning starts a new line at the end of every sentence, and the 32-character line width is shorter than you'd want for most applications. The typical flag for "change of speaker" is a pair of greater-than symbols at the beginning of a line, which may or may not be followed by a speaker identification.

In most cases, the only service in field 1 with data in it will be CC1. If you aren't using a card that sorts out the data services for you, there's an easy way to deal with the raw byte stream in that CC1-only situation. Just take any block of consecutive bytes less than 20h, and replace them with a single space. You can use a simple lookup table to do the substitutions where the character set deviates from US-ASCII.

Caution: If you try this when there's data in CC2, TEXT1, or TEXT2, it will be interspersed in your CC1 data, and will make everything totally unreadable. Your best bet is to look for a TV tuner card that separates the data services for you.

Closed caption data may be positioned anywhere on the screen, and there can't be more than four lines (rows) visible at a time. Captions are typically positioned so that nothing critical in the picture will be covered. Text data, on the other hand, is designed to fill the screen (although some televisions limit it to half), completely covering the picture.

Interactive TV and Internet data

Traditionally, the text channels have been used for things like on-screen program guides, but they are rarely used today. The most common use of text is for ITV (Interactive Television) Links.

ITV Links were developed by WebTV and VITAC as a way to transmit Internet URLs (Uniform Resource Locators) in the video signal for set-top boxes. These URLs point to web pages that contain more information about the program or commercial currently airing.

For example, during a program about electronics magazines, the station may insert an ITV link pointing to *Nuts and Volts* magazine. When that link is broadcast, people with WebTV Plus set-top boxes would see an Internet icon in the corner of their TV screen. They could then press a key on their WebTV controller, and be taken directly to the *Nuts and Volts* home page, or whatever page was indicated.

The ITV link itself is broadcast in TEXT2, using US-ASCII (ISO-8859-1) characters rather than the modified closed caption character set described above. It consists of a URL enclosed in angle brackets, an optional series of attributes in square brackets, and a checksum.

The only attributes you're likely to care about if you're parsing ITV links are the URL and the name of the link. To find the name, scan for the text "[name:" (or just "[n:"), and parse to the next closing square bracket.

The URL field is not limited to only web addresses, so if you're using these links, be prepared to deal not only with http links, but with mailto, news, and other link types as well. For example, an ITV link might look like this:

```
<mailto:gary@robson.org>
[t:s][name:Email the Author]
[expires:20000521T115959]
[CE8A]
```

Where To Get More Information

If you want to get serious about decoding and interpreting captioning and other line 21 data, you'll want to pick up the appropriate standards documents. You can get them from:

Global Engineering Documents
15 Inverness Way East
Englewood, CO 80112-5776
Phone: 1-800-854-7179
(US and Canada)
303-397-7956 (International)
E-Mail: global@ihs.com
Web: global.ihs.com

Be prepared to pay, though. The base document — EIA-608 — is over $100.00, and there are auxiliary documents you would also need.

The author of this article has written a book called *Inside Captioning*. It does not have detailed instructions for decoding line 21 data, but it does have extensive information about the industry, the technology, and the history of captions. It is available from CyberDawg Publishing at www.cyberdawg.com/captioning/.

If you want to do your research on the Web, you can start with the Closed Caption FAQ (frequently asked questions) at www.robson.org/capfaq/.

The [t:s] is a "type" field, the expiration date tells you how long the link will be good (May 25, 2000 at 11:59:59 in this example), and the final [CE8A] is a checksum (see Internet RFC 1071 for details).

XDS data

The extended data services

provide information about the current program, TV station, and network. Unlike the caption and text data, they are packets rather than continuous streams of data.

The XDS packet most likely to change the world is the time-of-day packet. VCRs and TVs can use it to set their own clocks, eliminating the "blinking 12:00" phenomenon so common in non-techie households. Other XDS packets include:

- Name, length, and start time of current show
- Type of show, based on a set of category codes
- Program content advisory (see "V-chip data" below)
- Network name
- Station name and number
- National weather service warning codes

To read XDS information, scan the data stream from line 21 field 2. The start code for an XDS packet is a byte less than 0Fh followed by a packet type byte. The end code is a 0Fh byte. As an example, if you wished to set your computer's clock from the TV signal, you'd scan for a packet starting with 07h 01h, as in Figure 1.

There are a few oddities about this packet that need to be explored. First, the seconds. Rather than transmitting a whole byte for the seconds, the Z bit is set to 1 whenever the seconds are zero. This means that setting the time could take as long as a minute, while you wait for the seconds to tick over. You could also just watch for the minute value to change, and use that as your "seconds = 0" indicator. The Z bit allows this process to be stateless.

All times are UTC (also known as GMT, or Greenwich Meridian Time). You need to know the time zone you're in to set your local clock. If the D bit is on, it is daylight savings time.

To set the date, add 1990 to the value of the year bits. Yes, this means the system will break down in 2054, but the broadcast industry expects everyone to be switched over to DTV by then, where this mechanism is different.

If the date shows as March 1, but your time zone indicates that your clock should be set a day earlier, you can use the L flag to determine if it is a leap year. If the L flag is on (one), then the date is February 29. Otherwise, it is February 28.

If you wish to decode and interpret these packets further, you'll want a copy of the EIA-608 specification (see the sidebar, "Where To Get More Information").

V-chip data

XDS is also how the infamous V-chip gets its data (see the sidebar, "What's A V-Chip?"). The V-chip spec supports four different rating systems, although any one program can only be rated using one system.

MPAA is the rating system you're used to from the movies (G, PG, PG13, R, NC17, and X).

US TV Parental Guidelines is the new system developed specifically for V-chip (TV-Y, TV-Y7, TV-G, TV-PG, TV-14, and TV-MA).

Canadian English is used throughout all of English-speaking Canada. Canadian French is used in Quebec.

Let's look at the anatomy of a typical V-chip packet. It will always begin with the two-byte pair 01h, 05h. The meaning of the next two bytes varies depending on the rating system.

Since the US TV Parental Guidelines is the system you'll see the most, we'll use that one. The next two bytes would look like Figure 2.

The D, V, S, and L bits are flags that further refine the rating. The D flag indicates sexually suggestive dialog, V is violence, S is sexual situations, and L is strong language.

Like all other XDS packets, the parental guidelines packets must end in 0F hex. To put this all together, a program rated TV-PG-V would have a V-chip packet of 01h 05h 48h 64h 0Fh.

bit	6	5	4	3	2	1	0
Byte 1	1	D	0	1	0	0	0
Byte 2	1	V	S	L	G_2	G_1	G_0

G_2	G_1	G_0	Rating
0	0	0	none
0	0	1	TV-Y
0	1	0	TV-Y7
0	1	1	TV-G
1	0	0	TV-PG
1	0	1	TV-14
1	1	0	TV-MA
1	1	1	none

Figure 2. A V-Chip Data Packet

What now?

Once you have figured out how to read and interpret this data, what do you do with it? You could:

- Make transcripts of your favorite shows. Note that this information is a copyrighted part of the video, and you can't sell it or post it on your web site.
- Make a smart "TV Agent" that runs in the background and tells you when there's something interesting to watch (see the sidebar, "Your Own TV-Watching Agent").
- Track Internet links. When an ITV link appears, automatically feed it to your web browser so you can see what's related to your current show.
- Set the time on your computer.
- Watch for weather alerts in XDS. You could tie this to audible alerts, or even have your computer use the modem to call your pager or cell phone. Don't rely on getting your alerts here, though, because few stations actually broadcast them.
- Collect song lyrics. Not that many music videos are captioned today, but the number is increasing steadily as the Telecommunications Act mandate begins to take effect. Again, be careful of copyright considerations here.

I even found someone who had built a "commercial killer" by detecting patterns in line 21 data that usually indicate the start and end of commercials. His would mute the volume on the TV when it detected a commercial, but yours could do whatever you wish.

Good luck, and have fun mining line 21. If you come up with an interesting application for caption data on your computer, E-Mail me and let me know! **NV**

Your Own TV-Watching Agent

Once your computer can read line 21 data from the VBI, an obvious application would be a program to "watch" a specified channel and notify you when something of interest comes up.

Such a program would require a triggering mechanism, such as recognition of a word or phrase from a keyword list. Make sure your keyword checking is not case-sensitive, as most, but not all, captioning is done in uppercase. You could also trigger on ITV links or XDS data.

Once you've defined your triggers, you need to define the action. Do you want the program to notify you, using audible alerts? Do you want it to activate a full-screen TV picture on your computer, with the volume turned up? Do you want it to save you a transcript for later? Turn on a VCR? Send you an E-Mail? Page you?

If you're going to have the program save caption data, make sure you back up a bit from the place where the keyword was recognized, so that you get the whole story in context.

You'll also need a trigger to turn it off. The easiest way to do this is with a timer. If you do that, you should reset the timer every time a keyword is triggered, so that you'll get all of a long story. You might also want to be more liberal with your keywords in this second trigger.

For example, if you're scanning CNN for mention of Apple Computer, you wouldn't want to use the keyword "apple" as a trigger, or you'd get far too many false hits. Once you've triggered on Apple Computer, though, you would probably want any mention of the word "apple" to keep the recorder running.

About the Author

Gary Robson has been developing captioning technology for over 10 years, and he currently works as the Chief Technology Strategist for VITAC Corporation, the largest closed captioning company in the US. Many more of Gary's articles and columns about closed captioning can be found on his web site at www.robson.org/gary/, and you can contact him via E-Mail at gary@robson.org.

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HP 86245A-001 RF Plug-in, 5.9-12.4 GHz, +17 dBm levelled ... $600.00
HP 86250D RF Plug-in, 8.0-12.4 GHz, +10 dBm levelled ... $500.00
HP 86260A-H04 RF Plug-in, ... $500.00
10.0-15.0 GHz, +10 dBm unlevelled
HP 86290A-004 RF Plug-in, 2.0-18.0 GHz, ... $1,750.00
+7 dBm levelled, rear output
WAVETEK 962 Sweep Generator, ... $1,250.00
1.0-4.0 GHz, markers, +12 dBm unlvld.
WILTRON 6647M Sweep Generator, ... $4,500.00
10 MHz-20 GHz, +10 dBm levelled

POWER METERS

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75-110 GHz (WR10), -20 to +20
BOONTON 42B/41-4E Analog ... $450.00
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HP 435B/8481A Power Meter, ... $900.00
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HP 435B/8481B Power Meter, ... $1,500.00
0 to +43 dBm, 10 MHz-18 GHz
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-10 to +34 dBm, 100 kHz-4.2 GHz
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-30 to +20 dBm, 10 MHz-18 GHz, HPIB
HP 436A-022/8484A Power Meter, ... $1,400.00
-70 to -20 dBm, 10 MHz-18 GHz, HPIB
HP 8477A Power Meter Calibrator, for HP 432 series ... $500.00
HP Q8486A Power Sensor, ... $1,500.00
33.0-50.0 GHz, WR22, for 435/6/7/8
HP R8486A WR28 Power Sensor, ... $1,500.00
26.5-40 GHz, for HP 435/6/7/8

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10 kHz-2 GHz, -77 to +23 dBm, GPIB

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HP 11729B-003 Carrier Noise Test Set, 5 MHz-3.2 GHz ... $2,250.00
HP 415E SWR Meter ... $200.00
HP 8406A Comb Generator, ... $500.00
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HP 8447D-001 Dual Preamplifier, ... $900.00
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0.1-1300 MHz, +13 dBm output
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HP 8901B-1,2,3 Modulation An., ... $3,000.00
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HP 8970A Noise Figure Meter ... $4,000.00
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>30 dB gain, 1.4-2.4 GHz, 20 Watts
HUGHES 8010H13F000 TWT Amplifier, ... $2,500.00
>30 dB gain, 3-8 GHz, 10 Watts
HUGHES 8020H01F000 TWT Amplifier, ... $4,250.00
>30 dB gain, 2-4 GHz, 20 Watts
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2-30 MHz, 47 dB gain, 50 Watts, metered, 28V
ROHDE & SCHWARTZ ESH2 Test Receiver, 9 kHz-30 MHz ... $3,750.00

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Coupler, 10 dB, 26.5-40 GHz
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CONTINENTAL MW. ... $225.00
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Tuner, 200-1000 MHz, 100 Watts max
FXR/MICROLAB SL-03N Stub Tuner,) ... $75.00
0.3-6.0 GHz, 100 Watts max., N(m/f
GR 874-LTL Constant Impedance ... $400.00
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HP 11692D Dual Directional Coupler, 22 dB, 2-18 GHz ... $800.00
HP 33321K Programmable Step Atten., ... $475.00
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HP 33327L-006 Programmable Step ... $1,000.00
Attenuator, 0-70 dB, DC-40 GHz, 2.9mm
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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
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HP K914B WR42 Moving Load, 18.0-26.5 GHz ... $300.00
HP Q752D WR22 Directional Coupler, 20 dB, 33-50 GHz ... $650.00
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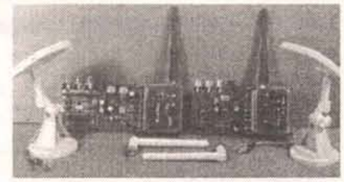

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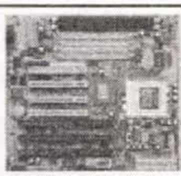

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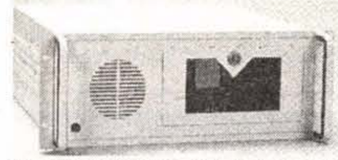

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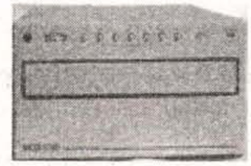

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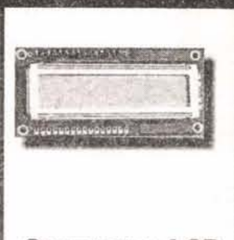

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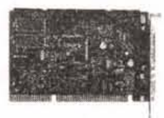

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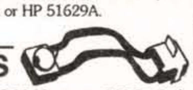

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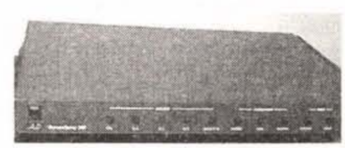

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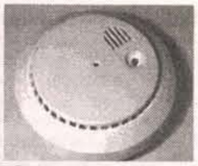

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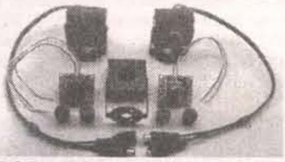

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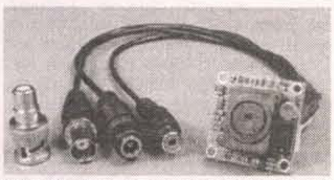

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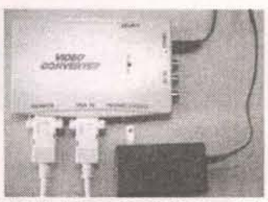

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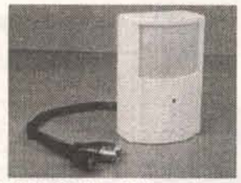

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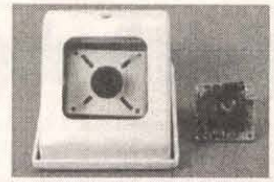

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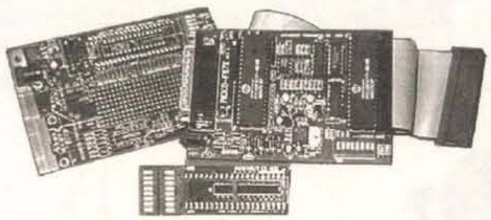

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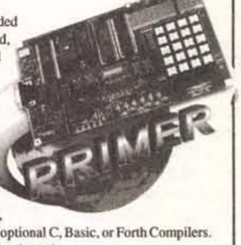

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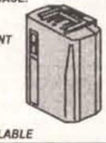

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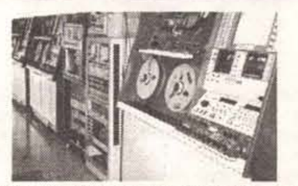

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Not limited to Valentine's Day, but appropriate for birthdays, anniversaries, or just to express your enduring love, 28 bright red LEDs form two heart shapes – one inside the other – that blink alternately, like a beating heart. It is powered by a common nine-volt battery, or an external DC supply.

Velleman – a 25-year-old Belgian company – has come on strong in the United States recently in advertising its large line of electronic kits. The current 32-page, full-color Velleman catalog, describes and pictures 167 items, mostly kits, but some assembled. They range from simple kits, selling for as little as $5.95, to very professional and elaborate specialized kits and assembled equipment selling for hundreds of dollars.

Recently added was a line of mini-kits. These are small, easy, and simple to build, and are specially designed for those making their first steps into the fascinating world of electronics.

We decided to purchase the MK101 "Flashing LED Sweetheart" just to check the nature and quality of a Velleman mini-kit. Although the complete information is provided here for you to build the unit from scratch, we are going to assume you are building the kit, and will add considerably to the brief information included with the kit.

"Brief" Information?

The MK101 – apparently typical of the mini-kit line – comes packaged for rack selling, and all the information for building the kit is provided on a single, well-illustrated card with very little text.

A schematic is provided, using some International notation, which we'll get to further on. No printed circuit layout, which would be handy for troubleshooting, is provided. No parts layout is provided, since the nicely-made etched and drilled printed circuit board is clearly silkscreened with all part locations. No explanation of circuit operation is provided.

This is not to say that any of these things "not provided" are actually necessary. Built carefully following the excellent illustrations (reproduced throughout this article with permission), the kit will work fine. Like a car, you do not have to understand how the internal combustion engine works to drive.

However, since we strive here with our simple construction articles, to address the needs of those new to electronics, we will go into the details of building, troubleshooting, and operating this Velleman mini-kit.

The Schematic

Figure 1 shows the circuit diagram for the Flashing LED Sweetheart. Readers accustomed to schematics using symbols and notation common in the United States will notice some obvious differences in this schematic. Velleman kits apparently use some "International" symbols and notation.

This was all explained in detail by Ray Marston in his excellent article, "Electronic Circuit Symbols and Notations" in the Dec. '98 issue of *Nuts & Volts*.

Referring to Figure 1, first look

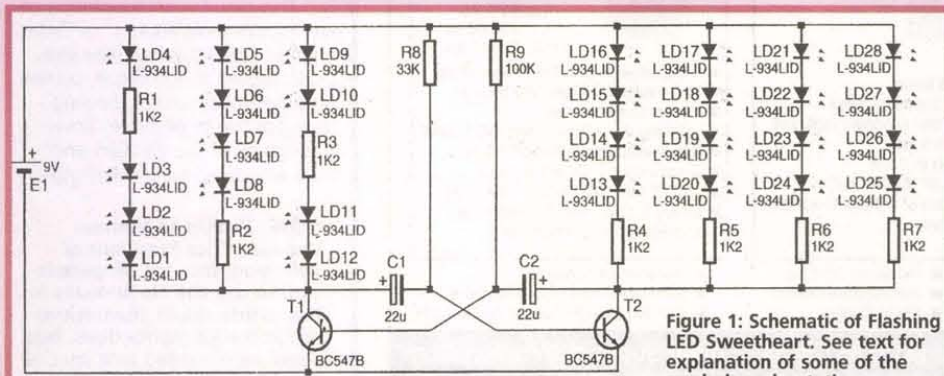


Figure 1: Schematic of Flashing LED Sweetheart. See text for explanation of some of the symbols and notation.

Holiday Project

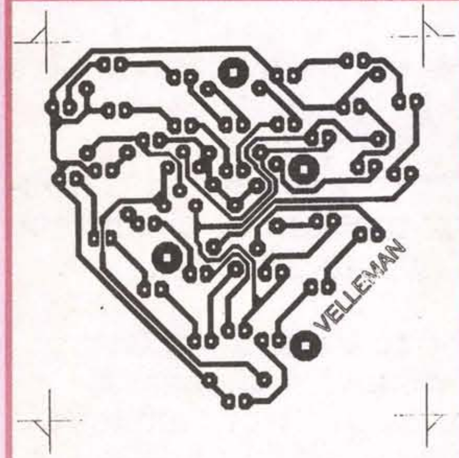


Figure 2: Printed circuit board layout (actual size).

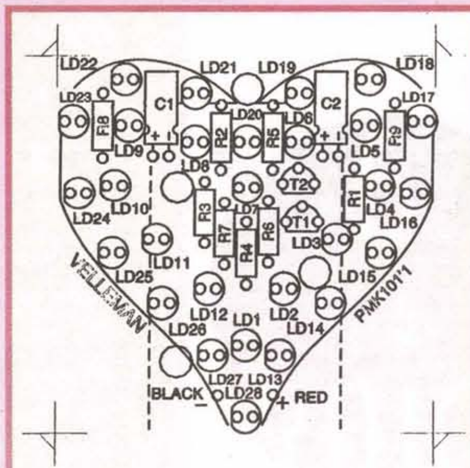
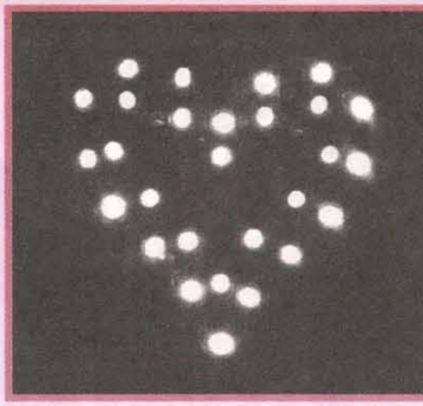


Figure 3: Parts layout (actual size).



In this time exposure, all 28 LEDs appear to be lighted. Actually, the "inner heart shape" and "outer heart shape" are lighted alternately.

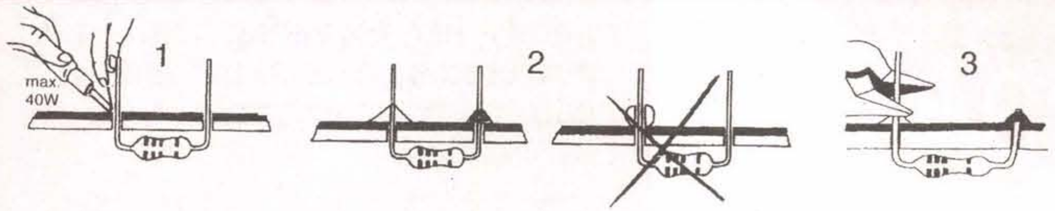


Figure 4: Proper soldering technique. See text.

at the symbols. A resistor is represented by a small rectangle instead of a zig-zag. The adjoining black and white rectangles with a plus sign is an electrolytic capacitor. The light-emitting diode (LED) and NPN transistor symbols are what we commonly use in the "US Customary" system.

Some notations look odd. The transistors are designated with "T" instead of "Q." The battery is "E" instead of "B." The LEDs are "LD" instead of "L."

The values for some components are another source of confusion. For example, where we would have "22uF," the International system (at least the one used here, since there are several!) just has "22u." Resistor value notation can be the most confusing, where the designation "1K2" would be "1.2K" in the US system. This is done to prevent possible drop-out of the decimal point in printing. Since there is no decimal point in "33K" and "100K," their notation is the same as the US notation.

Circuit Description

Now that you understand the symbols and notation, let's describe how this circuit works.

Notice that you have seven strings of four LEDS, each with a current-limiting resistor in series. On the circuit board, LD1-LD12 form the inner heart shape, while LD13-LD28 form the outer heart shape.

The schematic position of each resistor in its string represents where that resistor is physically assembled on the printed circuit board within its LED string. This is a great help in troubleshooting if the completed project doesn't work properly.

Each of the seven strings, plus resistors R8 and R9, are connected directly to the positive voltage. The termination of each LED string is at the positive side of either electrolytic capacitor C1 or C2, and also at the collector of either transistor T1 or T2. Resistors R8 and R9 connect to the negative side of C1 or C2, and the base of NPN transistor T1 or T2.

This circuit is an adaptation of an "astable multivibrator" or "relaxation oscillator." When nine volts DC is applied to the circuit, current (not electrons; current, flowing from positive to negative) flows through all of the 28 LEDS and their associated current-limiting

NOTE: Thanks to Michael Van Hee, Vice President of Velleman, Inc., for his permission to use the illustrations in this article. Most illustrations are in the kit instructions, but some he provided as a special courtesy.

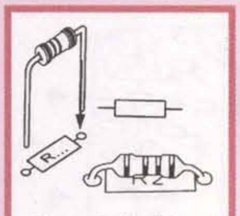


Figure 5: Resistor symbol and mounting.

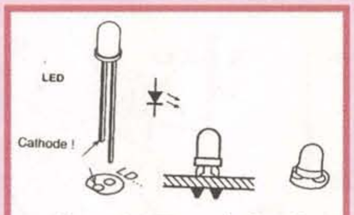


Figure 6: LED symbol and proper orientation. The flat on the base is the cathode side.

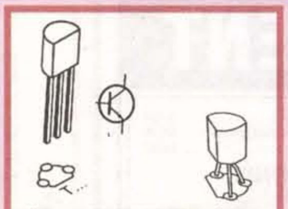


Figure 7: NPN transistor symbol, and orientation using the BC547B transistor supplied with the kit. If you use the 2N3904, reverse the position of the flat side. See text.

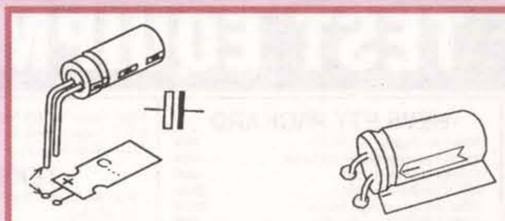


Figure 8: Electrolytic capacitor symbol and orientation.

resistors, looking for a return to the negative side of the battery.

At this point, NPN transistors T1 and T2 are cut off, since they need positive voltage on their base to conduct. As electrolytic capacitors C1 and C2 start to charge, they place a negative voltage on the bases of T1 and T2.

Resistors R8 and R9 are connected to the bases of NPN transistors T2 and T1, respectively, but R8 and R9 have greatly different values. First R8, with its lower resistance, applies positive bias voltage to the base of T2, turning it on and allowing it to conduct current between its collector and emitter and back to the negative side of the battery — just what the outer heart (LD13-LD28) is looking for, so it lights up. But not for long.

As C1 charges (since T1 is not yet conducting), its negative side cuts off T2, which needs sufficient positive voltage on its base to conduct. Now the positive voltage coming through R9 causes T1 to conduct and the inner heart (LD1-LD12) lights, and C1 discharges. But, with T2 now cut off, C2 starts to charge and causes T1 to get cut off. Now C1 charges, and the whole sequence keeps repeating.

Confused? It is tricky. The "speed" of lighting the alternating inner and outer heart shapes is based on the values of C1, C2, R8, and R9. To experiment with the finished project, change the values of any of these parts (easily done by putting a resistor or capacitor in parallel with an existing one) and watch the effect.

Finding the Parts

The Velleman MK101 kit provides all the necessary parts for this kit, including mini-LEDs, a 2.38-inch square silkscreened etched and drilled printed circuit board, and a battery holder. If you decide to build this from scratch, perhaps as a school project, you may have difficulty finding some of the part numbers in the Parts List at the end of this article.

All resistors and capacitors are commonly available. The LEDs are 1/8-inch diameter (3mm) high efficiency red, like Mouser 512-HLMP1340 for 18 cents each.

Common 2N3904 NPN silicon transistors can be used to replace the BC547B transistors — but with an *important* difference. The basing of the BC547B is CBE (collector, base, emitter) left to right looking at the front flat face. The 2N3904 is EBC. Since the center lead in both cases is the base, this just means inserting the 2N3904 transistor facing in the *opposite* direction from that shown for the BC547B.

The nine-volt battery holder is a Mouser 12BH610, and sells for 99 cents.

Construction

If you are going to build the kit from scratch, Figure 2 shows the printed circuit layout, and Figure 3 shows the parts layout. While there is nothing critical about parts placement (except the layout of the heart shapes), using a perforated board and point-to-point wiring would be asking for trouble. Either build this from the kit, or make a printed circuit board.

Although this is not a difficult construction project, there are some pitfalls. There are 86 solder points, and all 28 LEDs, the two capacitors, and the two transistors are "polarity sensitive" — they must be installed with the proper orientation. The illustrations will show this.

Since bad solder joints are a likely cause of improper operation, we must quickly cover the subject of soldering. Use a small — 40 watts or less — soldering iron with a small tip, and small-diameter (.020- or .031-inch) rosin core solder. Figure 4-1 shows that the tip of the iron and the solder should be placed together at the intended joint. Figure 4-2 shows proper solder joints covering the lead and with a smooth pyramid shape, and a balled-up unacceptable solder joint. Figure 4-3 illustrates cutting off the extra lead after soldering. This can be done easily with a nail clipper.

To begin assembly, insert all the resistors as shown in Figures 3 and 5. Resistors R1-R7 are color-coded brown, red, red. R8 has three orange bands. R9 is brown, black, yellow.

Next, insert all 28 LEDs (Figure 6), making sure the cathode side (usually a flat spot on the circular

The nine-volt battery holder mounts to the printed circuit side of the board.

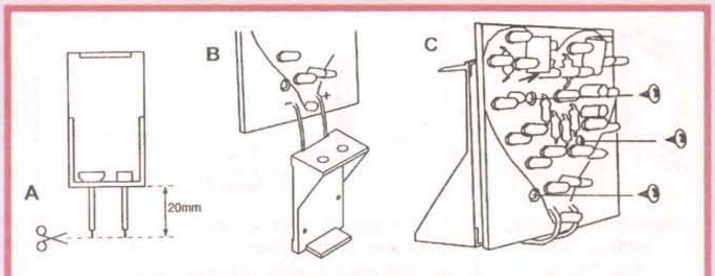


Figure 9: Nine-volt battery holder installation.

base) matches the flat spot on the part layout drawing, Figure 3.

The orientation of the transistors will be as shown in Figure 7, if you use the BC547B transistors. However, as mentioned earlier, if you use 2N3904 or equivalent transistors, they must be reversed, facing the opposite direction.

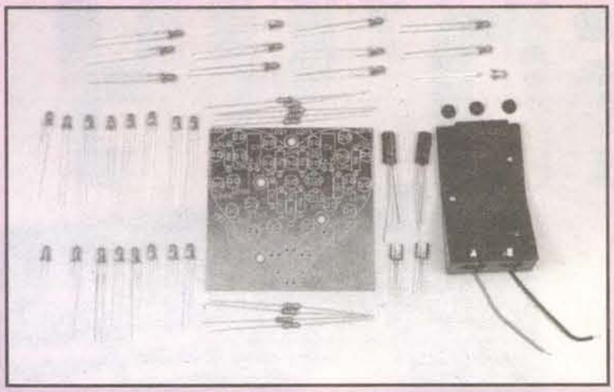
Figure 8 shows the orientation of the electrolytic capacitors. Figure 9-A indicates you should cut off the leads on the kit-supplied nine-volt battery holder at about 20mm (about .75-inches) and trim the ends; 9-B shows the installation; and 9-C shows how the three kit-supplied screws are used to mount the battery holder to the back of the PC board through three existing holes in the board.

Testing

To see how the "hearts" work, simply plug a regular nine-volt transistor radio battery into the snaps on the battery holder, observing polarity. Since there is no switch, the inner and outer heart shapes should immediately start blinking alternately. To stop the blinking, disconnect the battery.

Troubleshooting

While there is nothing complicated about this circuit, a single bad solder joint or a part installed "backwards" can create havoc with the display. If things don't work as they should, you'll need a magnifying glass and a multimeter to do some troubleshooting.



The kit includes all the parts, as well as an etched, drilled, and silkscreened printed circuit board, and a battery holder.

Don't let this scare you! Your project should work properly if you are careful in assembling it. But, just in case ...

If the project is not operating properly, typically, either some of the strings of LEDs will not light, or they will not alternate. Using a magnifying glass, check that all the LEDs are properly oriented (all flat spots on the base face the same way), and that the two capacitor negative leads are properly placed. As for the transistors, it depends which ones you use; the ones supplied with the kit should be oriented as shown in Figure 3. If you use the 2N3904 transistors, they should be facing the opposite way.

Be sure resistors R8 (orange, orange, orange) and R9 (brown, black, yellow) and R1-R7 (brown, red, red) are properly placed as shown in Figure 3.

Assuming all the parts are properly placed and oriented, you probably have a bad solder joint. (While an individual part may be bad, this is the *least* likely problem!) Using a magnifying glass, look for smooth, shiny, pyramid-shaped joints. If a joint is gray or grainy, touch it with a hot soldering iron — and maybe a bit of solder — until it looks right.

If the unit still does not operate properly, you can check each LED by using a nine-volt battery, two clip leads, and a 1,000-ohm current-limiting resistor in series with one of the leads.

With the back of the board facing you, and using a mirror to see the front side of the board, touch the leads to each pair of individual LED solder joints, making sure the positive lead is touching the anode (non-flat-side) of the LED. The individual LED should light brightly. If it doesn't, it is defective and should be changed.

Since testing the transistors, capacitors, and resistors, once they are soldered into the circuit board is impractical, the next best thing is a continuity check.

Using the ohmmeter function of a multimeter, set it to the lowest range and check the printed circuit paths between solder joints. A broken printed circuit trace may be too small to be noticed by eye alone, but will be immediately apparent with a continuity check.

You can also use a nine-volt battery and the voltmeter function of your multimeter to check that you have nine volts at the "top" (looking at Figure 1) of each of the LED strings, and R8 and R9. No voltage, no current.

Alternate Power

The nine-volt battery is being drained at the rate of about 10 milliamperes. Using a common nine-volt general-purpose rectangular battery, this should last for eight days if used four hours a day, or only one day if used continuously. Obviously, this could become expensive if you plan to have the heart "throbbing" all the time.

The solution is to use any of a number of wall-plug transformers that offer multi-voltages, polarity selection, and a nine-volt battery snap as one of the output connectors, such as the Mouser 41AC116 Universal Adapter ($6.29). NV

Parts List

C1, C2
22uF 25V electrolytic capacitor
LD1-LD28
1/8-inch (3mm) diameter high-efficiency red light-emitting diodes (see text)
R1-R7
1.2K 1/8-watt 5% carbon film resistor
R8
33K 1/8-watt 5% carbon film resistor
R9
100K 1/8-watt 5% carbon film resistor
T1, T2
BC547B NPN silicon transistor (see text)
Miscellaneous: Printed circuit board, 9V battery holder, three mounting screws.

Sources

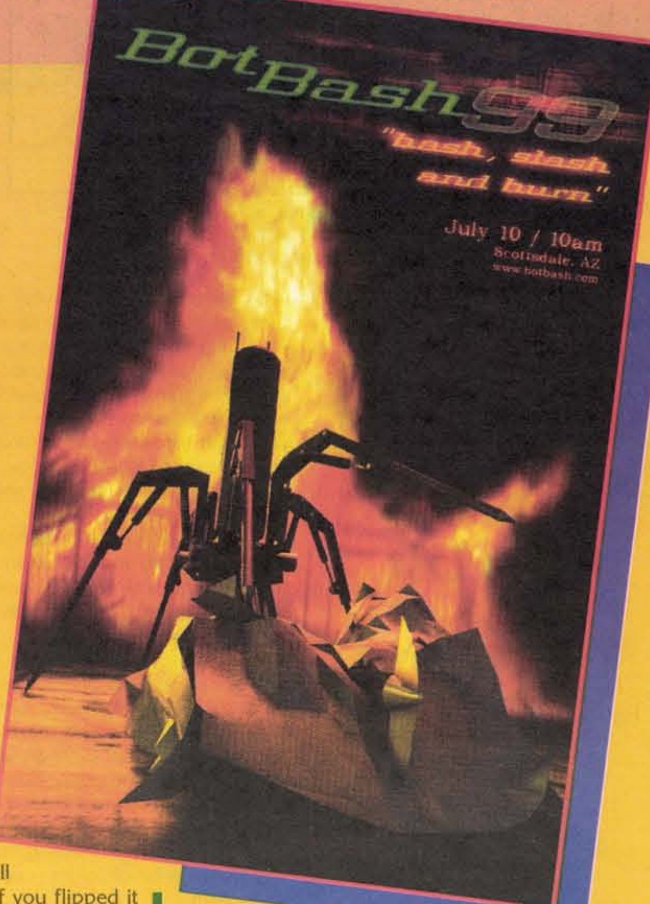
All of the items in the Parts List are supplied in the MK101 Flashing LED Sweetheart Kit from a Velleman distributor for $12.95 plus shipping and handling. Call **(817) 284-7785** for a list of US distributors or to request a free catalog.
Web site: www.velleman.be
E-Mail: velleman@earthlink.net

If building from scratch, parts (but not the PC board) may be ordered from
Mouser Electronics
1-800-346-6873
www.mouser.com or
sales@mouser.com

by Dan Danknick

BotBash'99

MECHADON



Sometimes, it's just easier to build something new than fix something old. That realization drove Mark Setrakian, builder of the "Snake" robot featured in the May '98 issue of *Nuts and Volts*, to abandon it in favor of a new project for the fighting robot events of 1999-2000.

Rising on six talon-shaped legs, "Mechadon" walked into the arena at the BattleBots event on August 14th to the amazement of all gathered around. "What people think of in a fighting robot is something animal – a big bug." This kind of pest would require a forklift or bazooka to squash, however.

Explaining that his goal was to create a machine with as many degrees of freedom as possible with a minimum number of servos, Mechadon really makes you stop to wonder: How did he do that? Each leg utilizes two linear actuators balanced with a fixed length spar to create motion in the X-Y plane of the floor. This, in itself, isn't enough for a walking gait without scraping along the ground so two body pivots swing the legs vertically into the Z axis to complete the sequence.

"Subconsciously, the viewer will compare it to a crab or bug. But when it flips on its back and the center sections begin to windmill, it's caught you off guard – now it's a machine!" explains Mark on the subtle surprise of watching it in action for the first time. Weighing in at 435 lbs., the forces involved are truly surprising, as well. Each leg can push with 800 lbs. at the toe, while each waist pivot has a peak torque over 31,000 in-lb. It is powered by 160 volts of gel-cell batteries. How large is it? "Well, if you flipped it over and put a sheet of glass on its toes, it would make a nice dining room table to comfortably seat eight."

"It's been in the back of my head to build a big walking robot since 1994." After experimenting with various walking methods through R/C hobby servos and popsicle sticks, Mark laid out the basic design in two days. The following four weeks were spent machining and welding it into shape from materials "I could get down the street," mostly aluminum and steel. It is electrically complex with 14 industrial servo amplifiers, each controlling a motor with positional feedback. "There were no huge problems but a lot of little ones. That in itself is taxing."

Currently, Mechadon is entirely puppeted through an R/C radio link. A complex stick mix delivers nine channels of control, but Mark has plans for the future to expand it all the way to the full 14. "A hobby of mine is music, so I'm going to control this with MIDI."

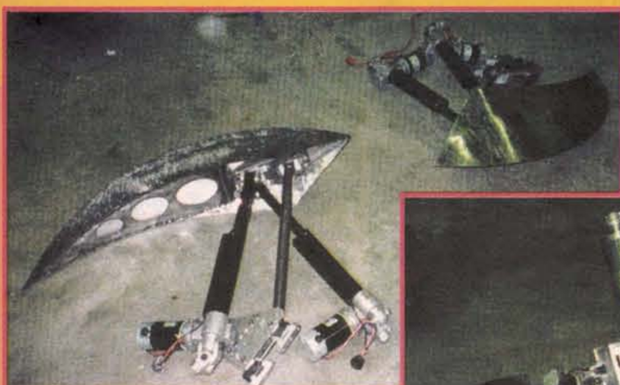
Using a Macintosh program called MAX, he has created high-level macros that command the independent motion profiles to create complex movements. He then plays these back though a special analog interface that overrides the controls on two R/C transmitters. By varying the speed of the playback, the man-machine interface becomes very intuitive: "step forward," "run back," "step left," "strike" etc. Not to mention the scheme is very stable: "That's the only way I could ever ride this into the arena."

Mark works as the chief Creature Mechanic for Rick Baker's Cinovation Studios in Burbank, CA. His recent work includes design and construction of the animatronics in the film "Mighty Joe Young" while he is currently working on an adaptation of "The Grinch That Stole Christmas." Explaining his philosophy of anthropomorphic design, "Studying anatomy can be interesting, but creatures are made from bones and sinew, while you're working with metals and cable. I strive to make things move in a naturalistic way, not technically accurate. If it looks good then how you did it is irrelevant."

To many of us, this is an amazing project that generates the obvious "Where would I start?" question. Mark offers us this encouragement: "I don't feel anyone has limits when they work their way up to something. This was my most ambitious project yet. And my next robot will also be my most ambitious effort." NV

**Mark's webpage is at www.teamsinister.com.
AX software is by Opcode Systems, www.opcode.com. The author can be reached at dan@teamdelta.com.**









AN IMPROVED AC-DC VOLTAGE REFERENCE

by Ron Tipton

This article describes an improved AC-DC voltage reference. It is useful for calibrating AC and DC voltmeters and 'scopes, and it uses standard, off-the-shelf parts. It can be as accurate as ±0.1% and it has no calibration adjustments — just build it and use it!

INTRODUCTION

In 1995, I developed an AC-DC voltage reference which I called the model 304. It worked well, but it used a precision +5 volt DC reference IC, 12 opamps, and five other support ICs to do the job. I have included its block diagram as Figure 1.

The circuit starts with IC1, the precision +5 volt DC reference (more about this later). Positive and negative 10 volts DC for the output are produced by amplifiers IC2 and IC3. IC4 buffers the +5 volts and IC5 inverts it to apply plus and minus 5 volts to IC6, an electronic SPDT switch driven by 1 kHz from a crystal-controlled oscillator.

The resulting 10-volt peak-to-peak squarewave is buffered by a voltage follower (not shown) and goes to an output terminal.

The squarewave is also converted to a low-distortion sinewave by an active lowpass filter (IC8, 9, and 10). Then it's converted back to DC by IC12 and 13. By adjusting the gain of IC11, you can set its output to precisely 10 volts RMS (±0.1%) because the summing amplifier (IC14) balances the +10 volts from the DC converter with -10 volts (from IC2) for a zero or null output at "Test Point."

In 1998, Thaler Corporation (Tucson, AZ) developed an IC that let me redesign the reference circuit for a much lower parts count and no calibration adjustment. The Thaler SWR300 is a precision sinewave oscillator which is frequency programmable with two external capacitors.

In this article, I'm going to describe an improved AC-DC voltage reference which I am calling the model 305. Its block diagram is shown in Figure 2. It is useful for calibrating AC and DC voltmeters and 'scopes, and it uses standard, off-the-shelf parts. It can be as accurate as ±0.1% and it has no calibration adjustments — just build it and use it!

HOW DOES IT WORK?

The DC portion of the reference still uses a precision +5 volt reference IC and I've listed the specifications on some of the available devices in the Table. As you can see, there is quite a bit of difference in performance, but pin-outs are often the same between manufacturers so you can "plug-in" the performance you need. I think you get the best performance per buck from the Thaler VRE305C.

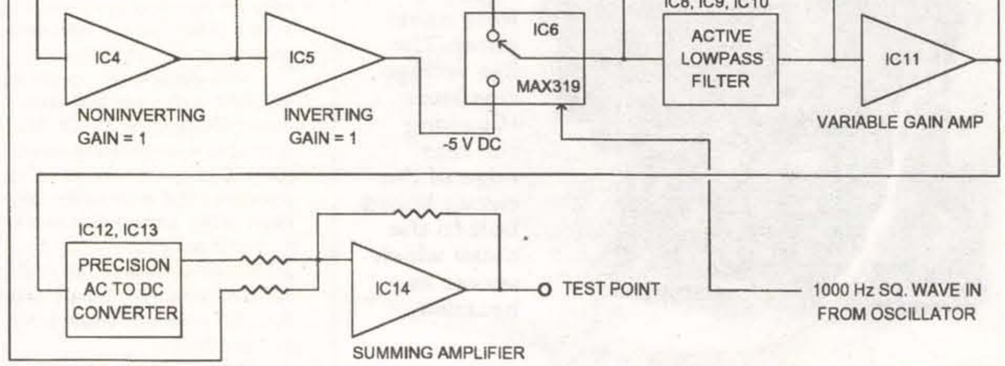
Now let's take a look at the Figure 2 block diagram. The DC portion starts with IC1, the +5 volt reference selected from the Table. A times two inverting amplifier gives us -10 volts which drives a unity gain inverting amplifier for +10 volts. One of these voltages or the AC voltage (which we'll talk about next) is selected by a front panel rotary switch. From the switch, the selected voltage goes either to an internal voltage divider or to output terminals to drive an external voltage divider — more about this later.

IC8 is the SWR300 which produces an output voltage of 7.071 volts RMS (±0.1%). This may seem an odd choice, but it's actually very easy to amplify this to 10 volts RMS.

I used ±0.1% metal film resistors in the IC9 opamp circuit, but you need only three of them so the expense is minimal. I set the frequency to 1,000 Hz with a pair of 0.01 uF (±5%) metalized polyester film capacitors (C3 and C5).

The SWR300 also has a buffered cosine output which I used to drive the zero crossing detector. This has no significance other than

Figure 1. Block diagram of original AC-DC voltage reference. R1 is adjusted to zero the voltage at "Test Point."



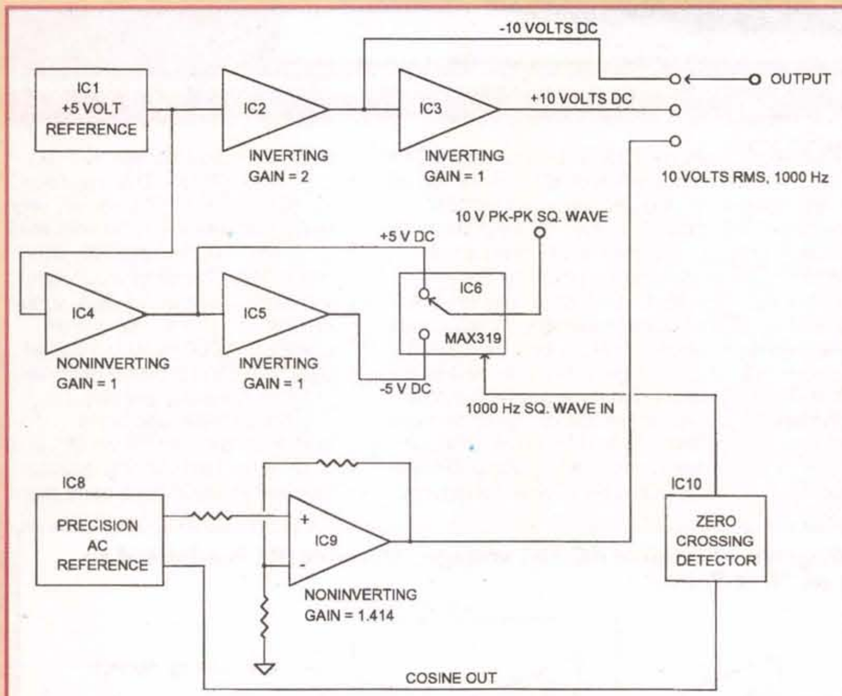


Figure 2. Improved AC-DC voltage reference. Note the absence of calibration adjustments.

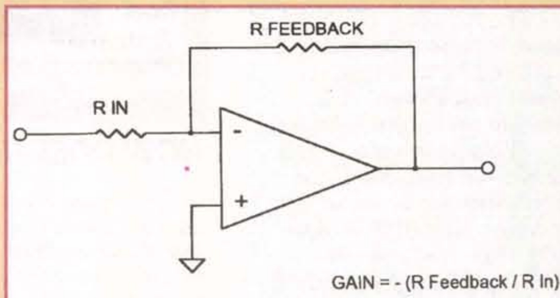


Figure 3. Gain of inverting op-amp depends only on the ratio of resistors.

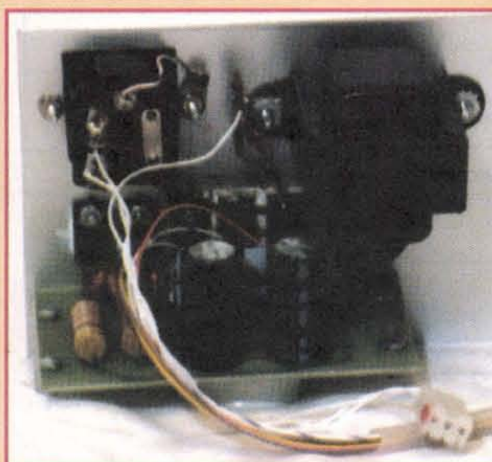


Figure 4. Rear panel photo. The five voltage regulator ICs along the rear edge of the circuit board bolt to the panel which serves as a heatsink.

it saved having to use another opamp in the circuit as a buffer.

The zero crossing detector (an LM393 comparator) produces a 1,000 Hz CMOS level squarewave which is compatible with the input needs of the electronic switch (IC6).

CIRCUIT DETAILS

Now that you know how the "box" works, let's look at some circuit details.

The opamp type is critical because we need low noise, low output offset voltage, and moderate price all at the same time.

After considering several types, including a chopper stabilized model, I settled on the OP-07. The commercial temperature version (OP-07D) has a maximum offset voltage of 150 microvolts, a maximum offset voltage drift of 0.6 microvolt per degree C, and is priced at less than $2.00. And "typical" performance is usually better than the maximum values listed on the spec sheet.

The next detail is how do we manage to get the DC accuracy we need with inexpensive resistors? To answer this, we need to review a bit of opamp theory.

In an inverting amplifier, the gain is set by the ratio of the value of the feedback resistor to the input resistor as shown in Figure 3. If both resistors are, for example, 10K ohms, we have a gain of -1. However, if both resistors are 9973 ohms, we still have a gain of -1.

With three matched resistors we get a gain of -2 for opamp IC2 by using two matched resistors in series as the feedback resistor. Thus, we see it's not the absolute value of the resistance that is critical, but just the ratio.

We can use 1% metal film resistors (which are very inexpensive) by matching them to 0.1% or better. All you need is your digital multimeter (DMM) set to an ohms scale.

A 3-1/2 digit meter gives you a resolution of 10 ohms (0.1%) for 10 Kohm resistors.

A 4-1/2 digit meter is 10 times better (0.01%). It doesn't even matter if your ohmmeter is accurate, as long as it's stable! For example, suppose it reads 43 ohms too high. The matched resistors are off by 43 ohms, but they still match and that's what counts.

You can easily determine stabili-

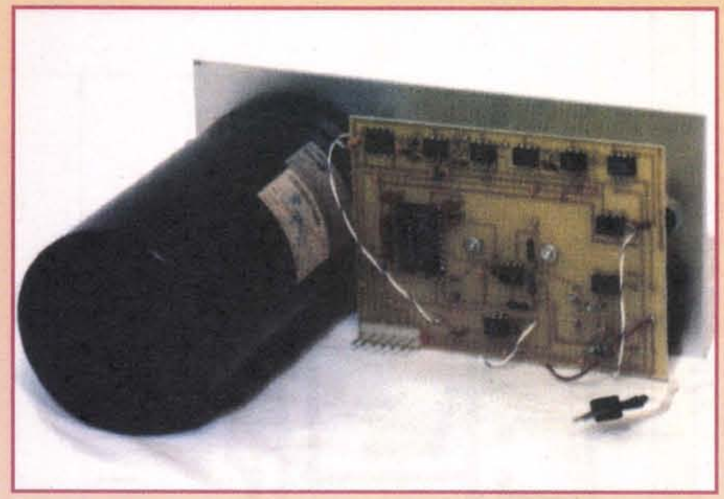


Figure 5. Front panel photo showing an internal voltage divider. The power on-off switch, power-on indicator, and output binding posts are between the circuit board and the panel.

ty by rechecking matched pairs after 30 minutes or so.

CONSTRUCTION

The first step is to make the circuit boards and I've included the layout artwork here. You can also download it in SuperCAD format (Mental Automation, Inc.) from our Web site; see the Resource List.

Most of the components are mounted on two PC boards: one board for the power supply and one for everything else.

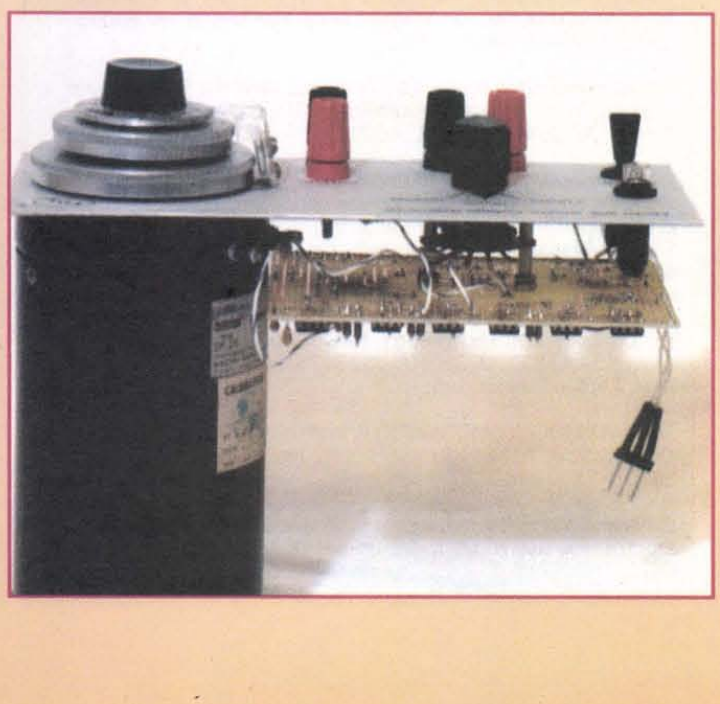
All power supply parts (except the on/off switch and power-on indicator) mount on the cabinet rear panel. All voltage reference components (plus the power switch and indicator) mount on the front panel.

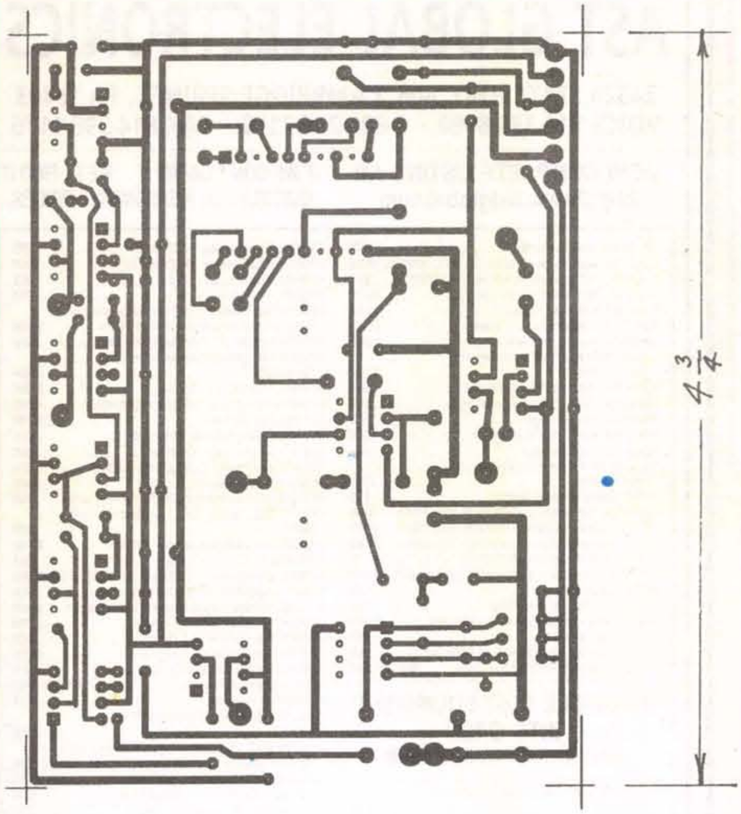
The panels are interconnected with two cable and connector assemblies: one for DC power and the other for AC line power. The photos in Figures 4 through 6 will help make this clear.

Both boards are single-sided as a few jumpers are usually preferable to having to make double-sided boards.

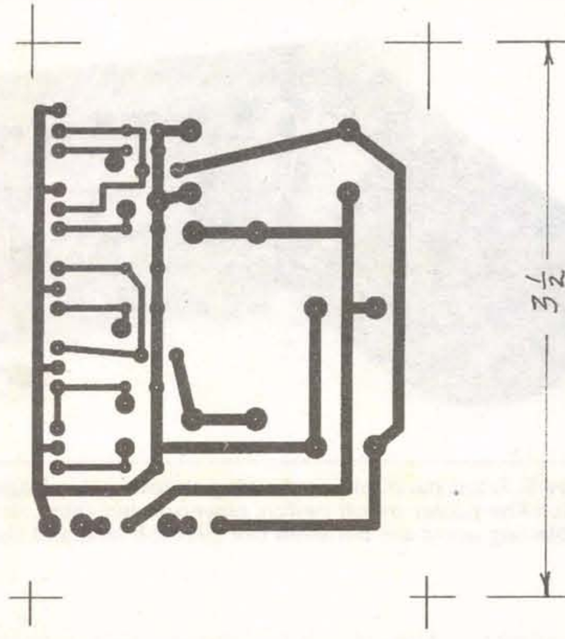
Let's begin construction with the power supply board by placing its two jumpers as shown on the parts placement diagram in Figure 7. Placement of the rest of the parts is not critical except for the regulator ICs, just remember to carefully check the polarities of the electrolytic capacitors and diodes.

Figure 6. The reference circuit board is mounted on rotary switch, S1. The switch then attaches the board to the front panel. This low-stress mechanical mounting helps insure good electrical performance.





ARTWORK FOR MAIN BOARD



ARTWORK FOR POWER SUPPLY BOARD

The rear panel is used as a heatsink so the regulators must be positioned so their mounting holes line up with the corresponding panel holes at the same time the two board mounting bracket holes match their panel holes.

Complete the board, clean off the solder flux and inspect it for good solder joints and no bridges. The wire lengths that go to the six-pin DC power connector, P5, aren't critical, but about nine inches seems okay. The wires to the three-pin AC line connector, P6, should be about six inches long.

"Braiding" the AC wires will

RESOURCE LIST

Possible sources of voltage dividers: **Joseph B. Cohen**, 200 Woodside Ave., Winthrop, MA 02152; 617-846-6312. **Psitech Plus**, 531 Gordon Court #A, Benicia, CA 94510; 707-745-4804. **Tech-Systems**, 1309 Highway 71, Belmar, NJ 07719; 1-800-435-1516.

New voltage dividers are available from **IET Labs, Inc.**, 534 Main Street, Westbury, NY 11590. 1-800-899-8438 (and others).

The cabinet shown in the photos is a type MC-9A. It is available from: **SESCOM, Inc.**, 2100 Ward Drive, Henderson, NV 89015-4249; 1-800-634-3457.

The recommended five-volt DC reference (and the SWR300) are available from: **Thaler Corporation**, 2015 N. Forbes Blvd., Tucson, AZ 85745; 1-800-827-6006.

PC board artwork, panel drilling drawings, and front panel artwork for both the internal and external divider models can be downloaded from our web site at http://www.zianet.com/tdl. Click on Magazine Article Reprints, then click on "model305.zip" to download. After you unzip the file, read "contents.txt" for an explanation of the other files. The power transformer and single-lug terminal are available (limited quantity) for $7.00 postpaid in the US from: **TDL Technology, Inc.**, 5260 Cochise Trail, Las Cruces, NM 88012-9736; 505-382-3173, FAX 505-382-8810; E-Mail: Rtipton@zianet.com.

The MAX319CPA CMOS switch is available from: **Digi-Key Corporation**, 701 Brooks Ave. South, Thief River Falls, MN 56701; 1-800-344-4539.

0.1% and 1% metal film resistors are available from: **Mouser Electronics**, 958 N. Main, Mansfield, TX 76063-4827; 1-800-346-6873.

help reduce line voltage pickup by the reference circuitry. And remember to use the female three-pin connector here for safety!

When this board is complete, place a small amount of heatsink compound on the back of each regulator and fasten it to the panel with 4-40 x 3/8 inch machine screws and nuts. If you have used the recommended TO-220F style regulators, you won't need any insulators since the packages are self-insulating.

Attach the board mounting brackets to the panel with 4-40 hardware and mount the AC input power connector. Place a grounding lug under one of these nuts for safety ground. Mount the power transformer with a pair of 6-32 machine screws and place the single-lug terminal strip under the left-side mounting nut as seen in the rear panel photo. The power transformer isn't critical, but its physical size is if you are going to use an internal voltage divider.

The reference PC board has 11 jumpers identified by "J" on the

PARTS LIST

RESISTORS

All resistors are 1/4 watt, 1%, metal film unless otherwise noted.

R1,R2,R3,R5,R6,R8,R9	10K (matched, see text)
R4	6650 ohms
R7,R10,R18	4990 ohms
R11,R12,R13,R14,R26	10K
R15	4120 ohms, 0.1%, metal film
R16	22.1 ohms, 0.1%, metal film
R17	10K, 0.1%, metal film
R19	499 ohms
R20,R21	5100 ohms
R22,R23,R24	100K
R25	20 Megohms, 1/4 watt, 5%, carbon film
R27,R28	4700 ohms, 2 watts, 5%, carbon film
R29,R30	82 ohms, 2 watts, 5%, carbon film

CAPACITORS

C1,C2,C14,C15	1 uF, 25 volts, dipped tantalum electrolytic
C3,C4,C5	0.01 uF, 5%, metalized film
C6	0.22 uF, 5%, metalized film
C7	0.022 uF, 5%, metalized film
C8,C9	1000 uF, 50 volts, radial electrolytic
C10	0.22 uF, 35 volts, dipped tantalum electrolytic
C11,C12,C13	0.01 uF, 50 volts, mono-ceramic
C16 through C27	0.1 uF, 50 volts, mono-ceramic

SEMICONDUCTORS

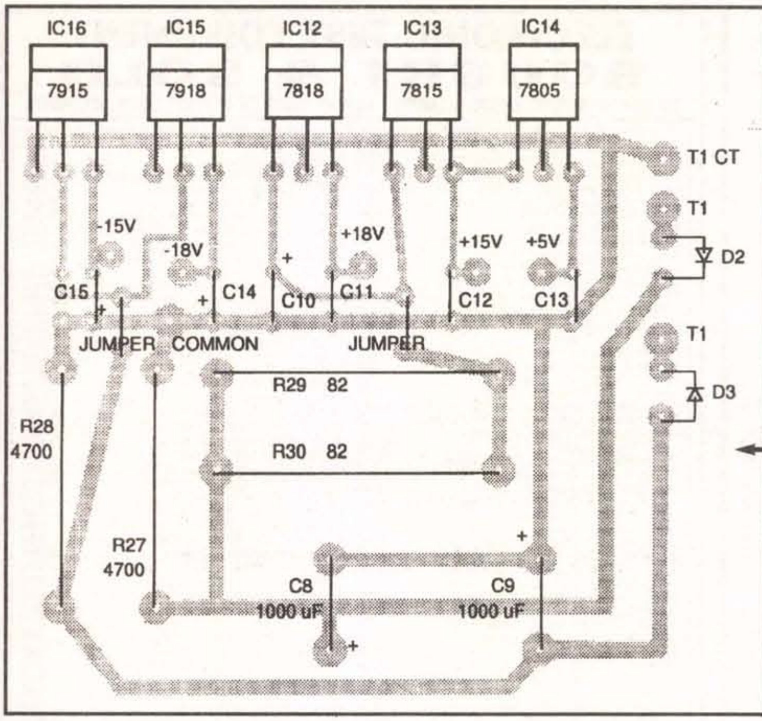
IC1	+5 volt DC reference, see text and Table
IC2,IC3,IC4, IC5,IC9,IC11	OP-07 opamp
IC6	SPDT CMOS switch, Maxim MAX319CPA or equal
IC7	LM310 voltage follower
IC8	Thaler SWR300 precision oscillator
IC10	LM393 comparator
IC12	7818 +18 volt regulator (TO-220F package recommended for all regulators)
IC13	7815 +15 volt regulator
IC14	7805 +5 volt regulator
IC15	7918 -18 volt regulator
IC16	7915 -15 volt regulator
D1	1N4148 silicon diode
D2,D3	1N4003 rectifier diode

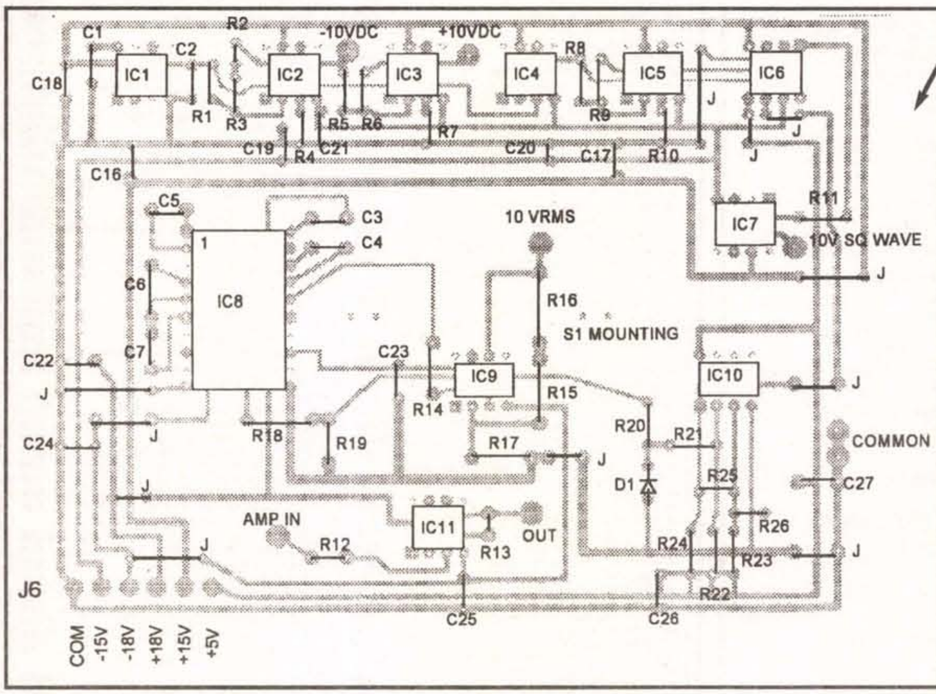
OTHER COMPONENTS

S1	Single-pole, three-position rotary switch, break before make, see text
S2	SPST toggle switch rated for 115 volts AC
T1	Power transformer, 115 VAC primary, 36 volts CT, 500 mA secondary
J1,J3	Binding post, red
J2,J4	Binding post, black
J5	Six-pin straight male header, 0.156" pin spacing (Molex 26-48-1061 or equal)
P5	Six-pin female connector (Molex 09-50-3061 housing with 08-50-0134 pins, or equal)
J6	Three-pin straight male header, 0.156" pin spacing (Molex 26-48-1031 or equal)
P6	Three-pin female connector (Molex 09-50-3031 housing with 08-50-0134 pins, or equal)

MISCELLANEOUS

Cabinet, AC input power receptacle with fuse, AC line cord, AC power-on indicator, knob, PC boards, wire, and hardware.





parts placement drawing in Figure 8. Place these first, then add the other components using the schematic and parts placement diagrams. I recommend you not use sockets for the ICs as a properly soldered connection has a lower voltage drop and a better temperature coefficient. You will notice this board mounts on rotary switch, S1, using the machine screws that hold the switch together (see photo in Figure 6).

Figure 7. Power supply board parts placement. I used brass eyelets in the pads for all off-card connections.

Figure 8. AC-DC voltage reference board parts placement. S1 mounting holes are shown for two different switch widths. Pin 1 of all the ICs is identified by a square pad.

The board was designed to fit a standard switch, such as the Electroswitch PA-1000 series. If you use another switch, make sure its mounting arrangement doesn't interfere with any parts on the PC board.

Mount the power on-off switch and the power-on indicator first and wire them according to the schematic diagram (Figure 11). It's a good idea to insulate each connection on the three-pin AC power connector (J6) with a short piece of shrink tubing. Add output binding posts J1 through J4. Then secure the rotary switch with its attached PC board to the front panel with the switch mounting hardware.

Pay attention to keeping the PC board edges parallel to the front panel edges as there's not a lot of clearance between the board and the top and bottom cabinet panels.

If you are using an internal voltage divider, secure it to the panel with its mounting hardware. Next, complete the front panel wiring using the schematic diagrams and photos. Note that IC11 is an opamp connected as a voltage follower with both input and output unconnected on the circuit board. It is used to provide a high impedance load for the voltage divider and a low output impedance for the reference output voltage.

The photos show an internal divider, a 10K ESI Dekapot. If you are using an external divider, you'll want to use the alternate front panel layout that includes two pairs of binding posts to connect to the divider's input and output (see Resources List). The divider's output connects to the input of IC11. And the IC11 output connects to the instrument's output binding post, J1.

Another binding post labeled "CASE" is included on the front panel when an external divider is used. The residual output noise may be lower when the reference and

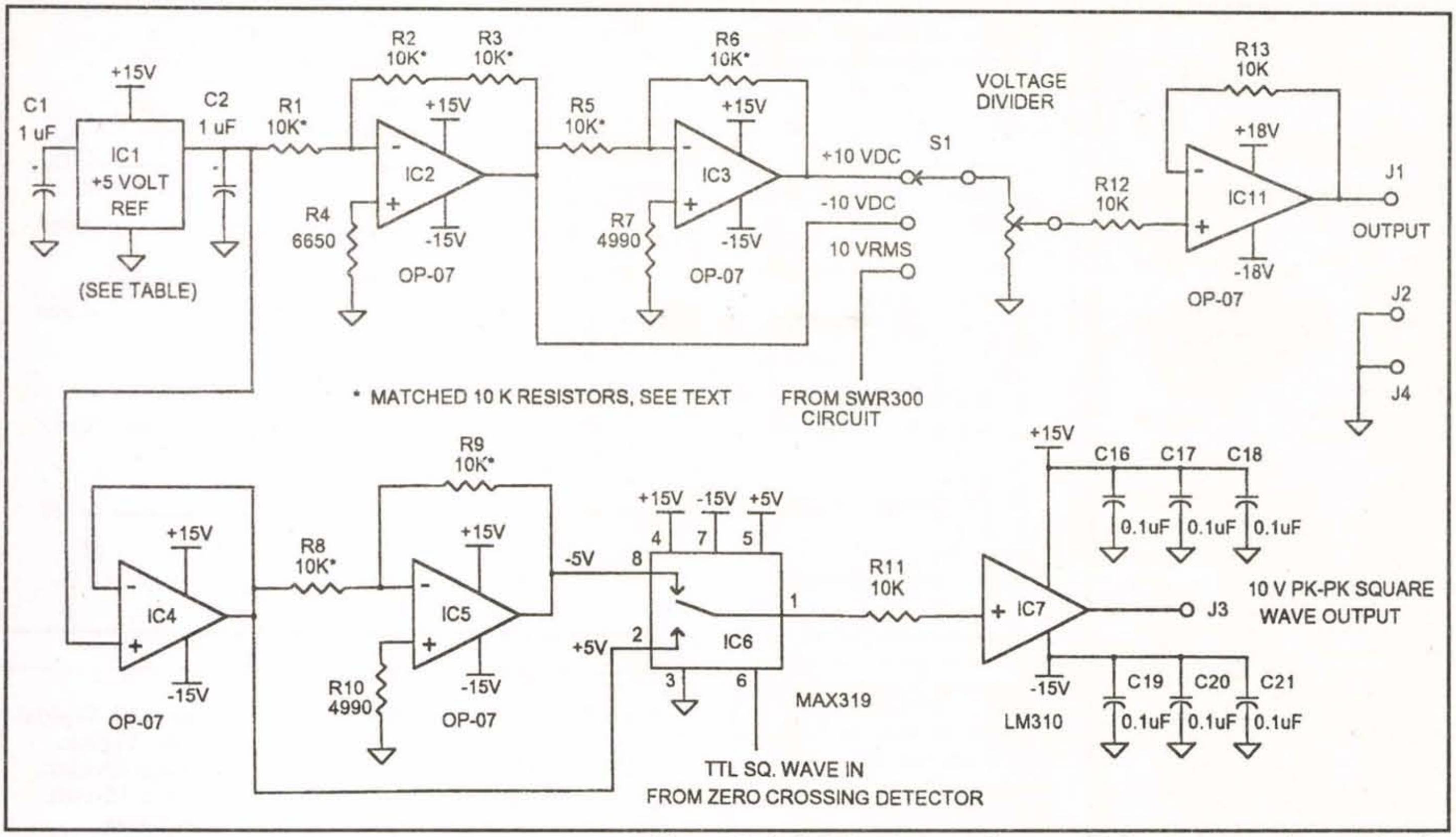


Figure 9. AC-DC voltage reference, DC voltage portion of circuit.

divider cabinets are connected.

When you are satisfied that everything is assembled and wired correctly, plug the two three-pin connectors together, but leave the six-pin DC power plug (P5) unconnected. Make sure there is a fuse in the AC power input connector, attach a line cord, and flip the power on-off switch to on.

Check each DC voltage at the six-pin plug (P5) to make sure they are correct and in the right order. The regulators are rated at ±5% so each voltage should be within this range.

With the power supply working okay, turn off the power and connect the six-pin plug. Now would be a good time to put a dot of red nail polish or other identifier on one end of both pairs of connectors to make reconnection easier. Turn on the power and check for proper operation.

(Tip: You can print the front panel artwork on a sheet of clear laser or inkjet label and stick it to the aluminum after doing the drilling. Although this isn't as durable as silkscreening, it's a whole lot easier!)

VOLTAGE DIVIDERS

Precision voltage dividers are known as Kelvin-Varley dividers. The circuit in Figure 12 shows the ESI Dekapot in which the third decade is a pot instead of a switched set of resistors. However, the principle of operation is the same regardless of model.

Two resistors of the first decade (left-hand side) are shunted by the

Figure 10. AC-DC voltage reference, AC voltage portion of circuit.

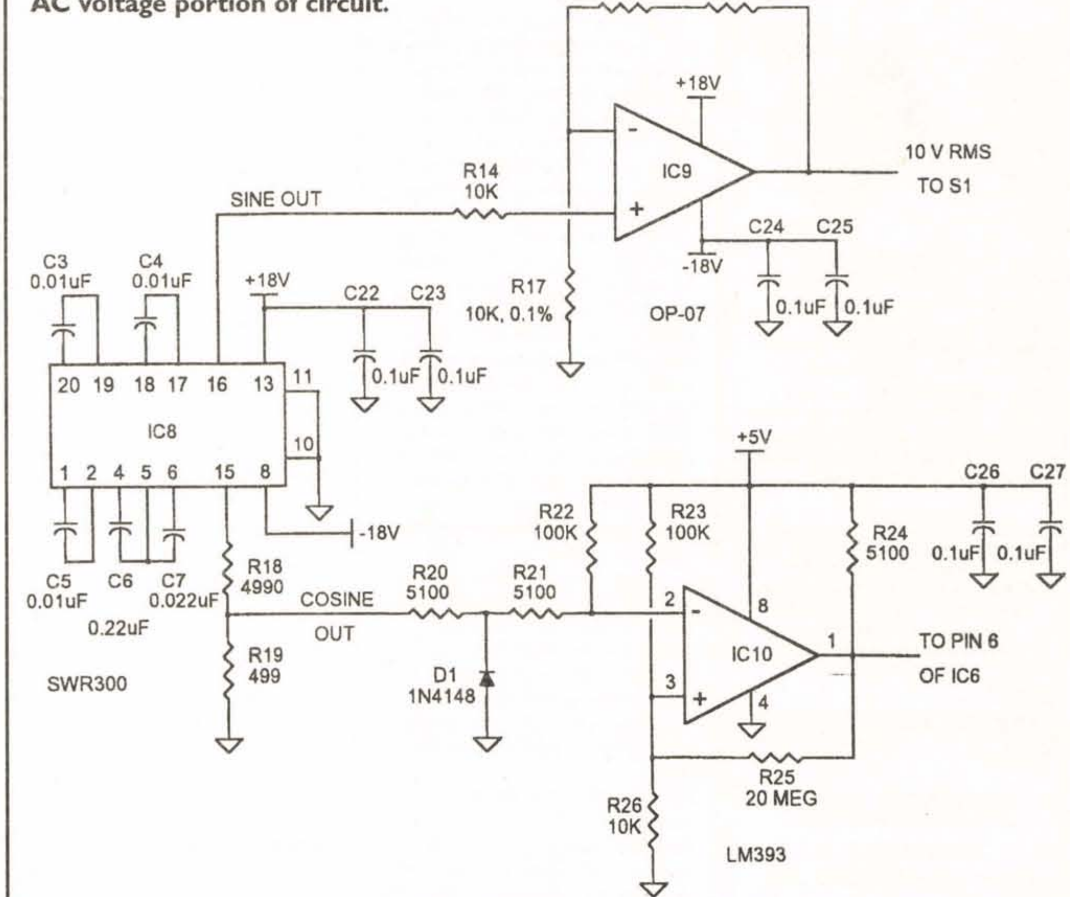
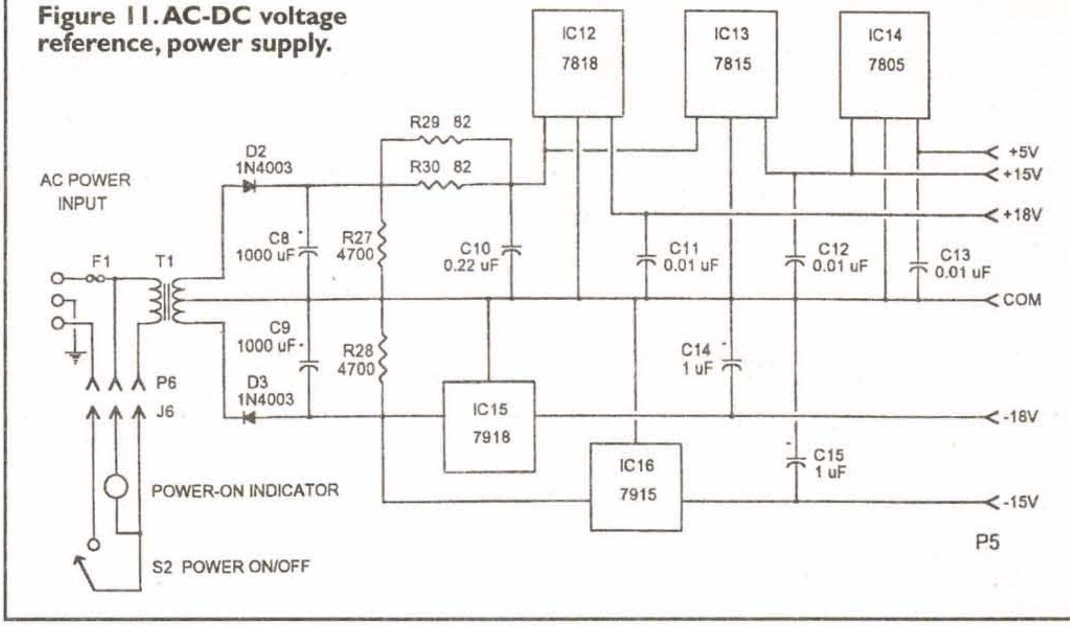


Figure 11. AC-DC voltage reference, power supply.



whole second decade, whose total series resistance equals the series resistance of the shunted pair in the first decade. Thus, each series resistor in a decade has 1/5 the resistance of the resistors in the previous decade. This circuit presents a constant input impedance and generally has excellent linearity due to the precision resistors used in its construction.

As you can see from Figure 12, the switching is somewhat complicated so this type divider isn't readily built in the average home workshop!

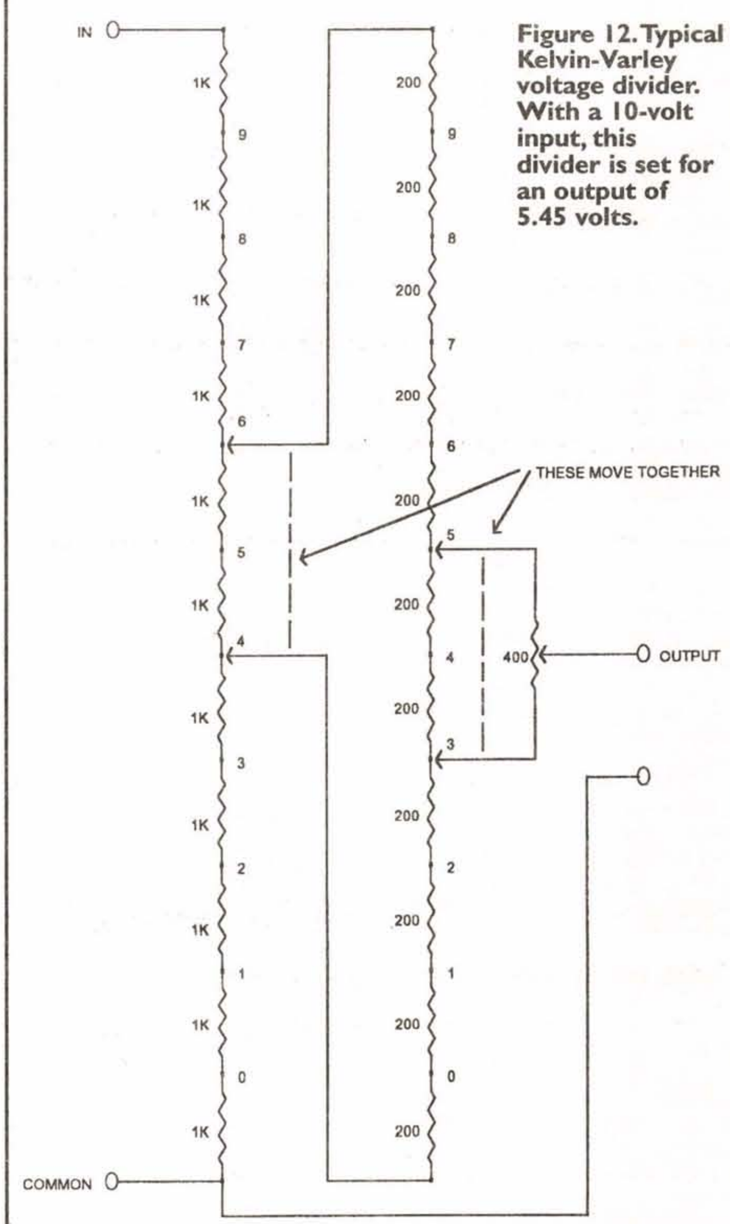
Various models have been built for many years by companies such as General Radio, Electro Scientific Industries (ESI), John Fluke, and others. Since so many have been built, they are fairly common in the "used equipment" market, sometimes at very low cost. "Pre-owned" dividers are often priced at $30.00 to $60.00.

Dividers you may find include ESI models DP211 (shown in the photos), CA1429 Dekapot, RV622, RV622A, and RV724 Dekaviders (Dekapot and Dekaviders are ESI trademarks), also General Radio models 1454A and 1455A and the Fluke model 720A (although its 7-decade resolution is overkill in this application!). Most of these are too large to fit inside the reference's cabinet so they would be used externally.

New dividers are available from companies such as IET Labs, Inc., but even their "economy" models are somewhat pricey. However, I've included their address and phone in the Resources List so you can get data sheets and prices if you are interested.

The ESI line of bridges, dividers and other instruments has been purchased by Tegam, Inc., Geneva, OH. General Radio is now QuadTech, Marlborough, MA. **NV**

Figure 12. Typical Kelvin-Varley voltage divider. With a 10-volt input, this divider is set for an output of 5.45 volts.



Continued from page 42

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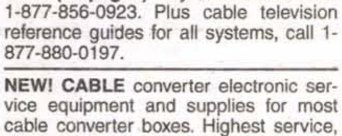

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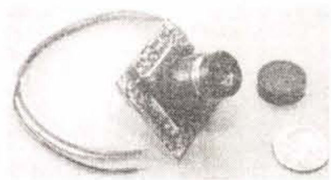

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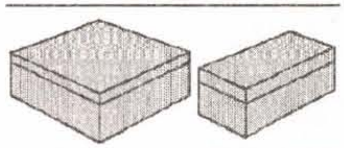

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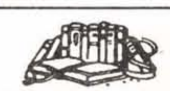

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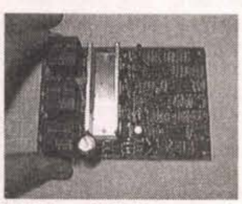

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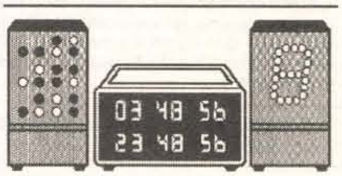

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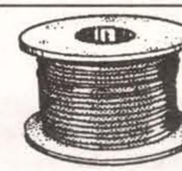

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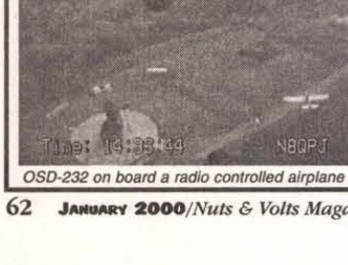

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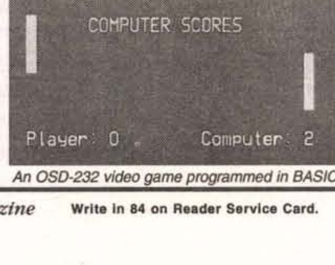

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TECH FORUM

Continued from page 29

ware on your machine. The constraint you really are faced with is the simple reality that you must learn how to access your hardware.

To that end you may want to consult the January '99 issue of this Forum where the answers to question #129815 discussed the PC hardware timer in some detail.

In real physical address mode, the Turbo C "inportb" and "outportb" functions can give you direct access to the I/O space of your machine. If you need blinding speed, you can resort to a C-callable subroutine written in assembler, or you can use assembly language instructions directly in-line with your C language program instructions.

For example, chapter 13 of Tom Swan's *Mastering Turbo Assembler* [ISBN 0-672-48435-8] where he discusses integrating Turbo C with assembly language code.

As discussed in the answers to Forum #129815, the PC clock rates available are given by

clock rate = 1,193,180/preset

where preset is a 16-bit unsigned integer that you get to load into the programmable interval timer (PIT) chip.

For preset=2 you get 596,590 ticks per second, and for preset=3 you get approximately 397,726 ticks per second, so the "450,000" ticks alluded to, in your book on MS C V.6.0, must have been generated by some other hardware. Or, maybe by some of that magic "vaporware" we've heard about.

Jack Dennon
Warrenton, OR

ANS. #2 TO #12997 - DEC. 1999

The simple answer is that a C compiler has little impact on processing speed. A poor C compiler could explain a factor of 2 or 5, but not a factor of 20,000.

An interpreter (instead of a compiler) can be thousands of times slower, but C interpreters are rare (BASIC interpreters were common). The compiler does not limit the rate.

The 18.2 ticks per second is the standard timer interrupt rate. Many programmers have reprogrammed the timer chip to provide a faster rate, but they risk hanging the operating system or breaking other programs.

You could reprogram the timer in Turbo C, but it is poor practice and indicates your hardware is poorly designed.

By your comments, you want to use the peripheral programming model called polling. With polling, the computer periodically checks the peripheral. Polling is simple to program, but it is horrible for high speed events. The problem with polling is low transfer rates and poor latency (if the computer is busy doing something else, it may not poll the peripheral in time).

Better performance is achieved with DMA and interrupts. If the transfer rate is low (say less than 1,000 transfers per second), then interrupt transfers will work. Interrupt transfers require the CPU's attention, so each interrupt causes a processor context switch.

These context switches can be expensive (hundreds or thousands of instructions), and that limits the transfer rate. Even though it's a bad idea, many people try to do it.

One hardware designer wanted to do 50,000 interrupts per second. If each interrupt were 1,000 instructions, then the interrupt routine would require 50MIPs — and we still had to run an application.

Furthermore, at the time Microsoft said interrupt latency could be more than 300 microseconds — 15 times longer than the interrupt interval. If the transfer rate is high, then DMA hardware should transfer a block of data and issue an interrupt when the transfer is complete.

Timer interrupts are still important in interrupt and DMA transfers, but they are used for reliability and need not happen often. A typical I/O transfer uses something like the following sequence.

The processor sets up a DMA transfer and tells the peripheral to start transferring data. The processor then does something else (e.g., runs some other task) while the peripheral transfers the data by stealing bus cycles. When the transfer completes, the hardware issues an interrupt, and the processor can work on the transferred data and start a new transfer.

The processor should also keep an eye on each transfer. It should remember when the transfer started, and the processor should check the outstanding transfers periodically (e.g., every timer interrupt). If the transfer does not complete in a reasonable time, then the processor should abort the transfer and reset the peripheral.

If the programmer doesn't include the timeout checks, then the computer will hang waiting for a transfer that never completes.

Gerald Roylance
Mountain View, CA

ANS. #3 TO #12997 - DEC. 1999

The "response speed" for measuring events depends on many factors. Primary ones are:

1. "Raw" system speed.

2. The "language" you use (i.e., C, compiled BASIC, assembly).

3. The speed of the interface bus (i.e., 8 MHz ISA or 33 MHz PCI).

4. The speed of the data acquisition hardware used (ties-in with 3) above).

There are a number of "fixed roadblocks" in the PC architecture that also limit your data acquisition speed: memory refresh interrupts (every five microseconds or so), operating system "overhead" (DOS programs will outstrip Windows-based programs on the same machine any day!), and peripheral interface speeds (again, ties-in with type of interface bus used).

To sum up, here are the primary ways to get the fastest possible data acquisition performance you need:

1. Using a "hot" machine.

2. Using the PCI bus for your acquisition hardware.

3. Writing your applications in Assembly Language and optimizing them for high speed/small size.

4. Running programs under a PURE DOS environment or as "standalone" without using any operating system (i.e., embedded "boot-and-go" from floppy).

5. Minimal (or no) use of "standard" magnetic storage (i.e., use a RAM drive).

I suggest browsing the Circuit Cellar web site, **www.circuitcellar.com.** This site is geared towards data acquisition and embedded computing applications.

I know you'll find lots of ideas and information there.

Ken Simmons
Auburn, WA

Open Channel

by Joseph J. Carr

Signal Generators — Part I

This month (and next month, too), let's take a look at signal generators. These devices are used to make the signals used in testing and troubleshooting of radio receivers and other circuits, so are of primary interest to almost everyone interested in electronics.

In the pages of this magazine, you will find advertisements for used and new signal generators. You can pick up really sweet signal generators of older style technology for a real song, if you're lucky.

Signal Sources and Signal Generators

Signal generators and signal sources are instruments that generate controlled signals for use in testing and measurement. There is a distinction made by some people between signal sources and signal generators. The former produce continuous wave (CW) output signals without modulation, while the latter will produce one or more forms of modulated signal (AM, FM, SSB, PM) in addition to CW output. In many cases, however, you will see the words "source" and "generator" used interchangeably in popular usage.

Some signal sources produce a single output frequency (or a discrete number of fixed output frequencies). These instruments are sometimes used for testing channelized receiver systems. Other signal sources will produce outputs over a very wide range of frequencies. Add a modulator stage to these instruments and a signal generator is created. Figure 1 shows a typical commercial signal generator.

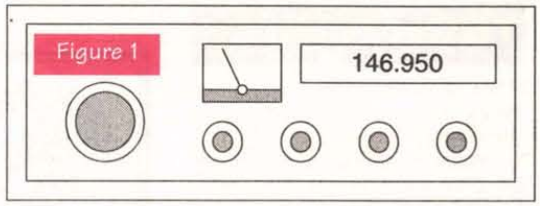


Figure 1

Grades of Instrument

Signal generators and sources come in several grades. Which to select depends on the use. A service grade instrument is used for troubleshooting common broadcast band receivers. They often lack a calibrated or metered output level control, and the frequency accuracy is usually low. More importantly, for many sensitive measurements at low output levels, more signal will escape around the flanges than comes through the output connector. Such instruments are useful for simple troubleshooting, but useless for accurate measurements.

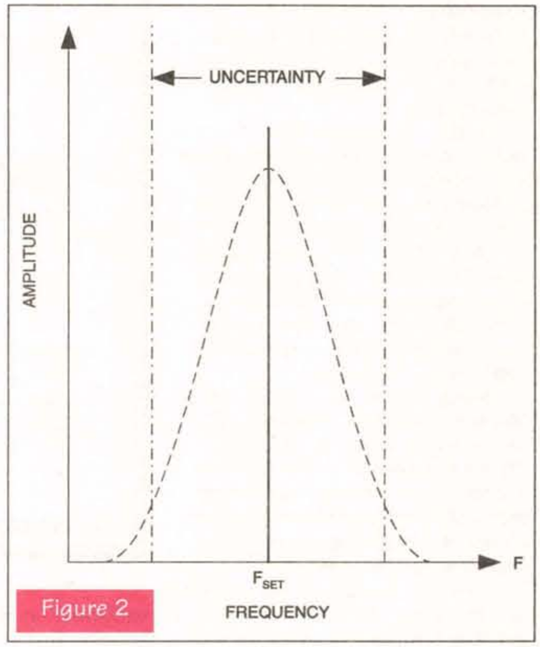


Figure 2

Laboratory grade signal sources and generators are very high quality instruments with accurate frequency readout and output level controls. These instruments are used in making lab measurements of receivers and other devices where high precision and accuracy is desired.

Quality service grade instruments fall somewhere between the two previous grades. Several mainline manufacturers of high quality laboratory signal sources and generators also manufacture "economy" lines that fit this category. They are considerably higher grade than the simple service instruments, but are not up to the lab grade. They are often used for troubleshooting high quality telecommunications and landmobile systems where the highly accurate and precise measurements are not needed.

Output Level

The output of a calibrated signal generator is usually expressed in either microvolts (µV) or dBm (decibels relative to one milliwatt in 50 ohms), or both µV and dBm. It is useful to have a feel for both forms of output level indication. One microvolt (1 µV) is 10^{-6} volts, so when applied across a 50-ohm resistive load, produces a power level of

$$V^2/R = (10^{-6}\ V)^2/(50\ \Omega) = 2 \times 10^{-14} \text{ watts}$$

The 0 dBm reference level is one milliwatt (1-mW) dissipated in a 50-ohm resistive load. This represents an applied voltage of

$$V = \sqrt{PR} = \sqrt{(0.001\,W)(50\,\Omega)} = 0.2236\ volts$$

If the output level set dial on a particular instrument is not calibrated in the correct units, then the required unit can be calculated using these methods.

To find the output power level in watts or milliwatts from dBm is similarly simple:

$$P = 10^{dBm/10} \text{ milliwatts}$$

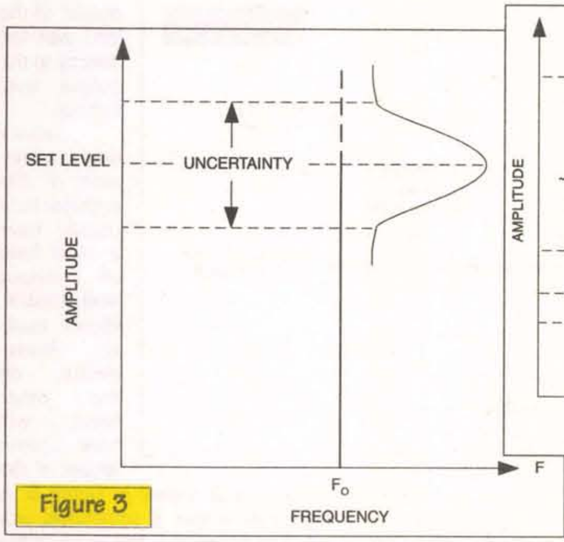


Figure 3

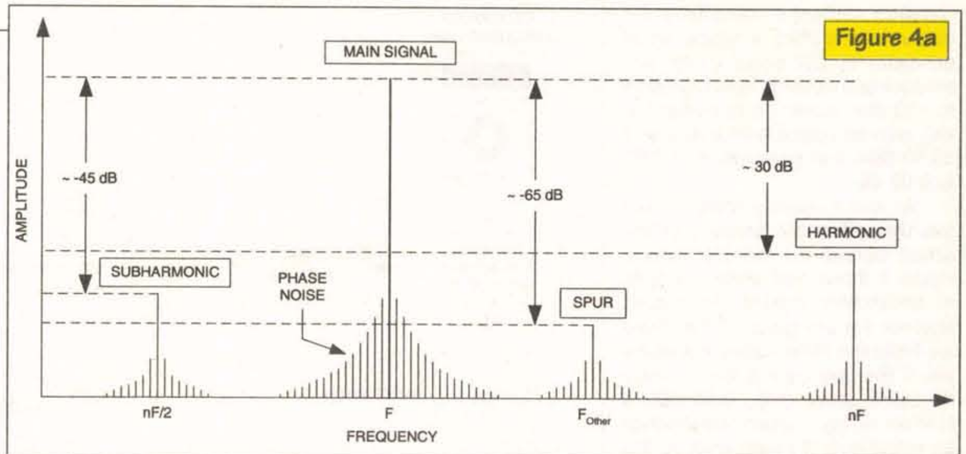


Figure 4a

To find the level in watts divide Equation (3) by 1000.

Output Signal Quality

It would be nice if all signal sources and signal generators were ideal, i.e., the output frequency and output level are noiseless and perfectly calibrated. That never occurs, although the differences in these specifications is a principal difference between high and low quality instruments.

Frequency

The important considerations regarding frequency are the range, resolution, accuracy, and (in automatic test equipment applications) the switching speed.

Range. The frequency range is a specification that tells the specific frequencies that are covered. In some cases, there will be only one frequency, or some small number of discrete frequencies. In other cases, one or more bands of frequencies are provided.

Resolution. The resolution is the statement of the smallest increment of frequency that can be set. On analog instruments that do not have a counter, the resolution is poor. The resolution may (but not certainly) be improved by adding a digital frequency counter to measure the output frequency. On modern synthesizers, it is possible to set frequency with extremely good resolution.

Accuracy. This specification refers to how nearly the actual output frequency matches the set frequency. The accuracy is a function of the set frequency (and how closely it can be set), F_{Set}, long-term aging (τ_{aging}) and the time since last calibration (τ_{cal}). Mathematically:

$$\text{Accuracy} = \pm F_{Set} \times \tau_{Aging} \times \tau_{Cal}$$

Example

A signal generator is set to 480 MHz, and has an aging rate of 0.155 ppm/year. It has been six months (0.5 year) since the last calibration.

$$\text{Accuracy} = \pm F_{Set} \times \tau_{Aging} \times \tau_{Cal}$$

$$\text{Accuracy} = \pm (480 \text{ MHz}) \times (0.155 \text{ ppm/year}) \times (0.5 \text{ year})$$

$$\text{Accuracy} = \pm 37.2 \text{ Hz}$$

There may also be some random variation in the output frequency. Figure 2 shows the uncertainty band around the set frequency. The actual output frequency, Fo, will be FSet ± Accuracy. It is the general practice to calibrate a signal generator on six-month or annual schedules, depending on the use.

Switching Speed (Settling Time). This is the length of time, usually in milliseconds or microseconds, that is required for a synthesized signal source or generator to move to a new frequency when digitally commanded to change. It is calculated as the length of time for the error of the frequency and/or output level commanded by the change to come into specification range.

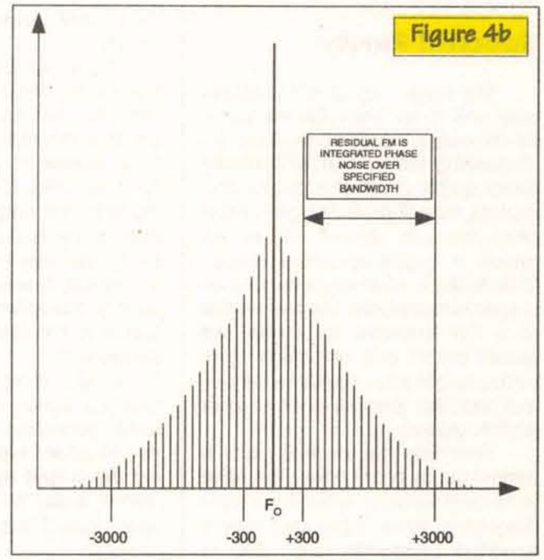
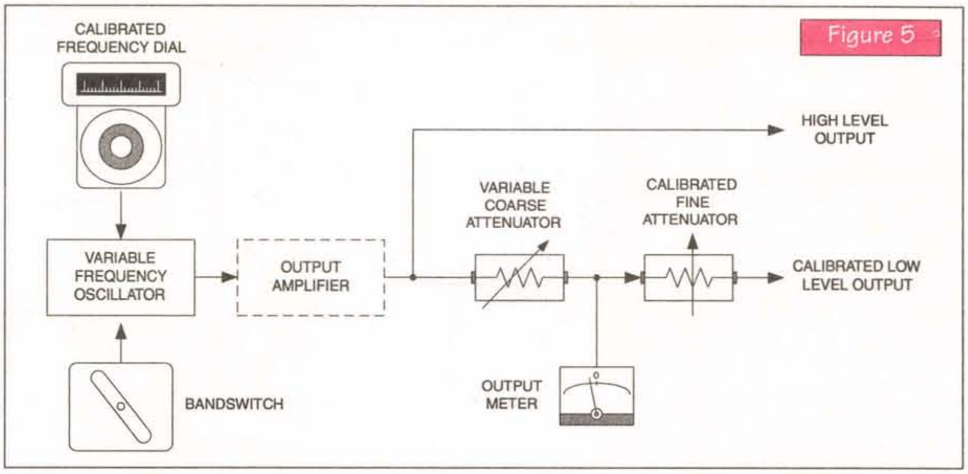


Figure 4b

Output Level

The output level can be expressed in either voltage, power, or dBm notations. All are equivalent, although one or the other will be preferred in most cases. The most common method of describing the output level is dBm. A typical signal generator or CW signal source will produce output levels from -136 dBm to +10 dbm (some go to higher levels), with an output level accuracy of ±0.50 dBm and a resolution of 0.01 to 0.02 dB.

As with frequency, there are factors that affect the accuracy of the actual output vs. the set output. Figure 3 shows that there is a zone of uncertainty around the output level set. For any given setting, there are Pmin and PMax values. For example, if the only error is the accuracy discussed above (e.g., 0.50 dB), a level set of, say, -10 dBm will produce an actual output power level of -9.5 to -10.5 dBm.



Spectral Purity

The output signal is not always nice and clean. Although the purity of the output signal is one of the distinguishing factors that differentiate lower quality and higher quality generators, they all produce signals other than the one desired. Figure 4A shows a typical spectrum output. This display is what might be seen on a spectrum analyzer. The main signal is a CW sinewave so, ideally, we would expect only one single spike with a height proportional to the output level. But there are a lot of other signals present.

First, note that the main signal is spread out by phase noise. This noise is random variation around the main frequency. When integrated over a specified bandwidth, e.g., 300 to 3,000 Hz, the phase noise is called residual FM (Figure 4B).

Second, there are harmonics present in Figure 4A. If the main signal has a frequency of F, the harmonics have frequencies of nF, where n is an integer. For example, the second harmonic is 2F, and the third harmonic is 3F. In many cases, the 3F harmonic is stronger than the 2F harmonic, although, in general, the higher harmonics are weaker than lower harmonics.

There are also sometimes subharmonics. These are integer quotients of the main signal. Again, if the F is the main signal frequency, nF/2 represents the sub-harmonics. Typically, unless something is interfering with the output signal, sub-harmonics are not as prominent. One thing that does make sub-harmonics prominent, however, is the use of frequency multiplier or divider stages (which is the case in many modern generators).

Finally, there are miscellaneous spurious signals ("spurs") found on some generators. These might be due to power supply ripple modulating the output signal, parasitic oscillations, digital noise from counter or phase locked loop circuits, and other sources.

Harmonics and spurs are usually measured in terms of decibels below the carrier (dBc), where the carrier is the amplitude of the main output signal. In general, the lower the unwanted components are, the better the signal source.

Phase noise warrants some special consideration. It is usually measured in terms of dBc/Hz, i.e., decibels below the carrier per Hertz of bandwidth. This noise is concentrated around the main signal frequency, and is normally graphed on a log-log scale to permit both close-in and further-out noise components to be compressed on one graph.

Architectures

Although there are many different configurations, with different "block diagram" representations, there are only a few different architectures used in designing signal generators. Figure 5 shows a simple analog architecture that was once common on even high-grade instruments, and is still common on service grade instruments.

The signal is generated in an L-C controlled variable frequency oscillator (VFO). The VFO typically has a bandswitch for selecting different frequency ranges. A calibrated tuning dial gives the user an approximate idea of the output frequency. However, because of drift and the mechanical aspects of calibrating the dial, these dials are not terribly accurate.

Some instruments have an output amplifier although, for many decades, even quality signal generators lacked power amplifiers. The output of the VFO was fed directly to the output level control.

Service grade generators of this architecture usually have a crude form of output level control. Higher quality instruments, on the other hand, will have some variant of the output circuit shown in Figure 5. A high level output is sometimes provided to permit the user to route the signal to a frequency counter so that an accurate determination of frequency can be achieved.

There are two attenuators in the output level setting circuit. A coarse attenuator is used to set a relative output meter to some calibrated point. In most cases, the meter would be calibrated with a zero in the center of the analog scale. The coarse attenuator is adjusted to center the meter pointer over the zero point in the center of the meter. When this is done, the settings of the fine output attenuator are valid.

Other Types of Signal Generator

In the main, this article is about RF signal generators. But there are two other types of signal generator that have to be accounted for. First, there is the straight audio signal generator. Second, there is the function generator. The audio signal generator will produce a high quality sinewave output, and possibly also a squarewave output. It will possibly offer a precision output control, either by metering or by dial. These signal generators universally have a 600-ohm output. What is also true is that they rarely cover more than the audio frequencies (20 Hz to 20 KHz), although a few go to 100 KHz. Function generators, on the other hand, may go to 1 MHz or 2 MHz for common grades, to over 20 MHz in some grades.

Function generators differ from straight audio generators in that they have three or more functions: sine-, square-, and trianglewaves. They usually have multiple outputs, or are switch-selectable between 50 ohms, 600 ohms, and TTL output. The typical function generator also differs from the audio generator in that the output control is rather crude being a single knob control.

Communications

I am behind in answering my mail. Since returning from Ireland and Scotland, I haven't been as diligent about the mail as before, so if you've written to me in the last six months, please be patient as I am getting around to the bottom of the pile in due course. My "day job" (the one I do when I am not writing) has gotten very busy recently, and that adds to the problem. It is usually better to communicate with me via E-Mail if you want to be answered quickly as I usually answer those in a day or two (see Connections ... below). I will get caught up soon, so be patient ... please.

British Boatanchors

A "boatanchor" is a radio that glows in the dark, i.e., a vacuum tube radio. In the United States today there are a number of boatanchor collectors (and, in fact, we have a list server on the Internet: boatanchors@theporch.com). While in the United Kingdom, I had the opportunity to visit a London-area based boatanchor museum during a boatanchor event.

It was interesting to see the differences in design philosophy between American and UK based designers. Most of the radios were of the superheterodyne design, but that is where the similarity ends. The cabinetry of the UK designs look different from American cabinetry (including a few "round" radios!). Other than that, the shape factors of the radios were different from typical American designs.

Speaking of boatanchors, I am a fan of the Hallicrafters SX-28A "Super Skyride" model. There is a web site devoted to the SX-28: http://www.exit109.com/~jimh/hallicrafters.shtml. Go take a look at it if you are so inclined.

New Book

I have a new book out. It is *Joe Carr's Loop Antenna Handbook*, and it is published by Universal Radio [6830 Americana Parkway, Reynoldsburg, OH 43068; phones **1-800-431-3939**; info **614-866-4267**; FAX **614-866-2339**]. It is priced at $19.95.

The chapters include: Radio Signals and Reception, Special Loops for Shortwave, Large Loop Theory, Large Loop Construction, Loop Sticks, Radio Direction Finding, Large Loop Antenna Projects, Quad Loop Beam Antennas, Small Loop Theory, Small Loop Deployment, Small Loop Preamplifiers, Additional Small Loop Topics, Small Loop Antenna Projects, Other Matters of Interest, and Some Commercial Products.

Next month ...

Next month, we will talk about frequency synthesizers – the king of signal generators – as well as several other topics applicable to all high quality signal generators. **NV**

Connections ...
I can be reached by snail mail at P.O. Box 1099, Falls Church, VA 22041, or via E-Mail at CARRJJ@AOL.COM.

AMATEUR ROBOTICS NOTEBOOK

by Robert Nansel

As I had hoped, I had a big response to my November call for people looking for robotics clubs and those who already belong to clubs. Because there were so many responses, though, I don't have room this month to include the high-level I2C routines I promised, so that will have to wait for next month. Check out the sidebars for people in search of clubs and clubs in search of people; I've checked what information I could, but no guarantees. If anyone spots errors in the club listings, in particular, I'd appreciate hearing about it.

Also, in the spirit of helping beginners get going in robotics, I'm starting a multi-part tutorial on the heart of robotics: motor control. I'm planning some bigger robot projects this year, which will require more oomph than hobby servos can economically provide.

Although the series is primarily for beginners, I've found that even seasoned gearheads don't always understand what's going on in their motor drive circuitry. My goal in this series is to help y'all – rank newbies and grizzled veterans alike – develop a gut-level feel for what it takes to make a motor perform the way you want it to (as well as lots of tried-and-true circuits).

I also seem to recall saying something in November about a prize for entering the Lonely Gearhead contest. Yes, it's all coming back to me ... some lucky robot nut out there is supposed to get a free GrowBot kit (to find out who, you'll just have to read the rest of the article).

First up, though, is a correction to last month's column. Somehow the first couple paragraphs got clobbered in transmission of the section on the improved I2C master. This is how it should have read:

The last two columns I've been using essentially the same version of code for the I2C master. That version was feeble, barely smart enough to generate I2C waveforms so I could bootstrap my I2C slave code. Except for checking for the Bus Free condition, it blissfully ignored the outside world as seen through the SDA and SCL lines. The master pulled off this trick by sending all ones for the second byte of the datagram, thus enabling a slave to jump in and put data on SDA without contention. This month, it's time to make the master pay attention to what the slave has to say, and that means that the master's get_byte routine must be tested.

The resulting code is shown in Listing 1 [see Dec. '99]. In keeping with the iterative design method, this master works fine with last month's slave.

What's All the Jitter?

The 'scope shot shows the datagram as it appears on SDA (the top trace) and SCL (the bottom trace). Notice that the second half of both traces show a fair amount of jitter. This is not caused by the slave clock-stretching; last month's [Nov. '99] slave is fast enough that it releases SCL before the master is done with Tlow. Rather, it's caused by the slave's inability to synchronize any closer to the master's SCL transition than 0 to 4 instruction cycles. This is still well within the timing constraint of 12 cycles for Tlow, so everything works fine.

Figure 1: Unidirectional Motor Drives

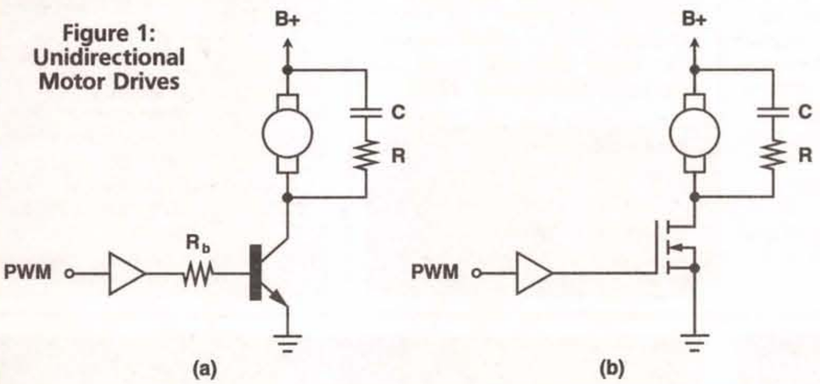
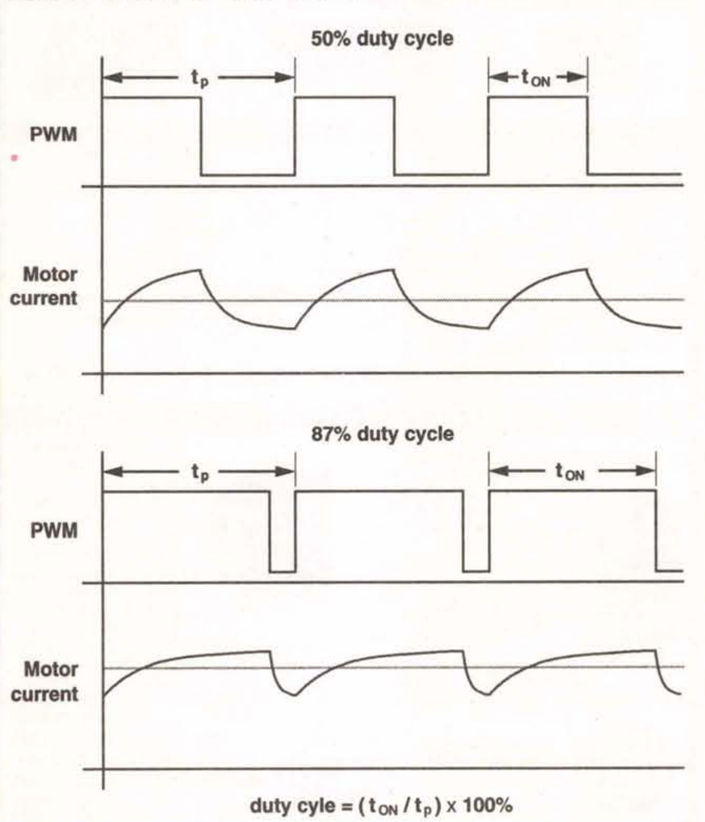


Figure 2: PWM & Motor Current



Motoring Along

Driving permanent magnet DC motors can seem mysterious and complex at first. It's easy to get overwhelmed with terms like Pulse Width Modulation, Locked Antiphase, H-bridges, Circulating Current, Snubber Networks, and Duty Cycle. Driving PM DC motors isn't hard, though, if you remember some basics.

First, realize that PM DC motors respond to both voltage and current. The steady-state voltage across a motor determines the motor's running speed, but the current through its armature windings determines the torque. Apply a voltage and the motor runs (say) clockwise; reverse the polarity and it runs counterclockwise.

If you apply a load to the motor shaft, it will draw more current. If the power supply isn't "stiff" enough, the voltage will drop and the speed of the motor will drop. But if the power supply can maintain voltage while supplying the current, the motor will maintain its speed. Voltage controls speed, current controls torque.

To a first approximation, PM DC motors respond linearly to voltage and current, which makes them much easier to control than wound-field motors, particularly series DC motors.

Unidirectional Motor Drives

The simplest motor drive circuit is a single direction drive. Figure 1 shows two common circuits. The buffers on the left represent logic level outputs (perhaps from a microcontroller). Figure 1a shows an NPN transistor used as a simple switch where the motor minus lead is pulled to ground whenever a logic "high" biases the NPN transistor ON. Rb must be chosen so the current into the base is sufficient to fully saturate the transistor.

Figure 1b shows a MOSFET equivalent circuit. The NPN and MOSFET transistors act as switches, and they could even be replaced by switches or relays if all you cared about was turning the motor full ON or OFF. As we shall see later, using transistors instead of relays is advantageous because transistors can be switched ON and OFF much more quickly than relays, and this allows the speed of the motor to be controlled.

In both circuits, the RC network across the motor is an example of a snubber network. Some snubbers use diodes to shunt current to ground or B+ (this is the function of the diodes across the relay coils in Figures 4 and 5). Others use resistors and capacitors.

In both cases, a snubber's purpose is to limit the voltage spikes produced by the motor and to provide a current path for motor current to flow temporarily when the transistor is turned off. This current flow is known as circulating current; it is important to provide a place for this current to go when the transistor shuts off.

Immediately after the transistor turns off, the motor will still be turning. If the current has nowhere to go the motor's inertia and inductance attempt to keep current flowing in the same direction. This causes the voltage across the motor to change polarity, possibly destroying the transistor in the process.

However, with the capacitor C across the motor, the current has a low impedance path to follow so no destructive negative spike is formed. While the transistor is ON, C charges to the voltage across the motor.

When the transistor turns off, C then gives up its charge, acting as a local reservoir of energy to keep the motor turning for a short time. Resistor R burns off this current and forces it to decay rapidly with no electrical ringing. The net effect is that your transistors won't blow up and relay contacts won't arc.

Speed Control

Now consider what happens when the transistor is rapidly turned ON and OFF in such a way that the frequency of the pulses produced remains constant, but the width of the ON pulse is varied, as in Figure 2. This is known as Pulse Width Modulation (PWM). Current only flows through the transistor during the ON portion of the PWM waveform. Initially, with the motor at rest and C discharged, no current would flow in the motor's windings; current through the motor ramps up, and C charges.

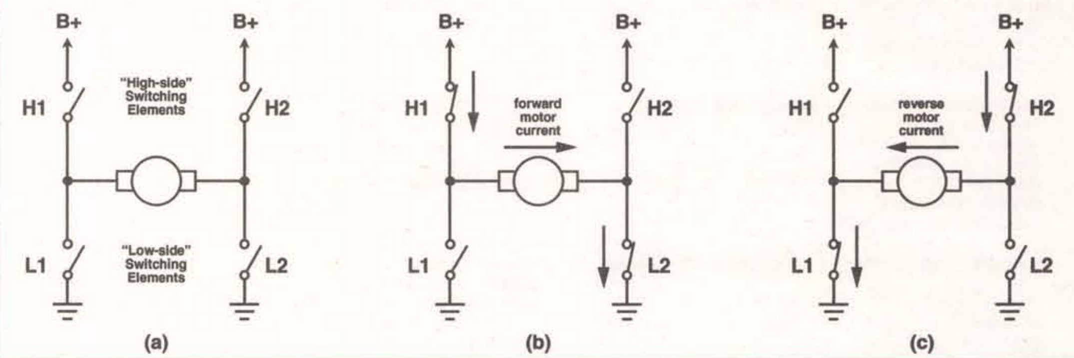
Before the motor reaches full speed, however, suppose the transistor turns OFF; this forces the motor to circulate current through R and C. Current decays until the transistor turns on again, then the whole cycle repeats. The motor "sees" a roughly trianglewave current. If the frequency of the PWM input is high enough, the mechanical inertia of the motor cannot react to the ripple in the trianglewave; instead, the motor behaves as if the current were the DC average of the trianglewave.

With a PWM duty cycle of 25%, the motor would "see" about a third the current that would flow with a PWM duty cycle of 75%, and would turn at roughly a third the speed, depending on the mechanical load. For a constant load, the motor speed will be proportional to the duty cycle of the PWM input.

Direction Control

You could build a robot using only unidirectional motors. In practice, this would severely limit the robot's mobility. It would be unable

Figure 3: H-Bridge Circuit Topology



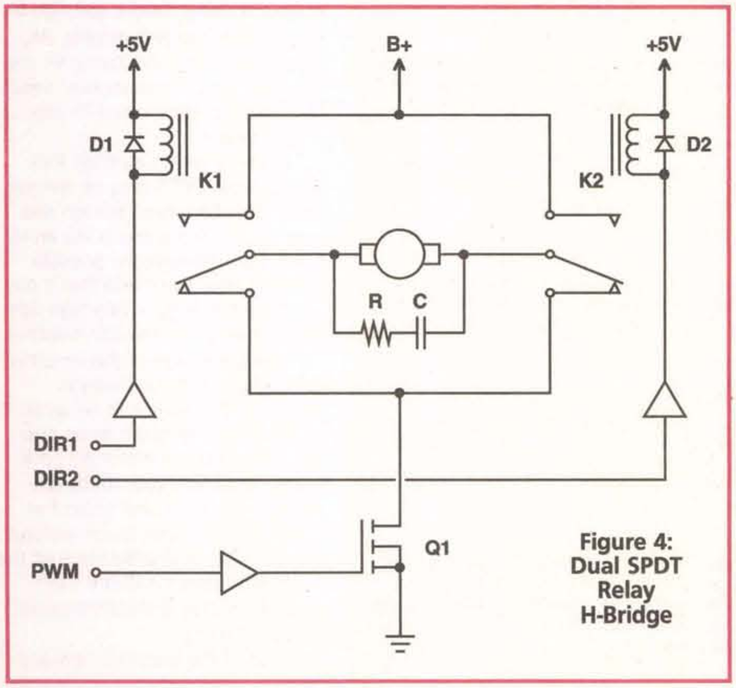
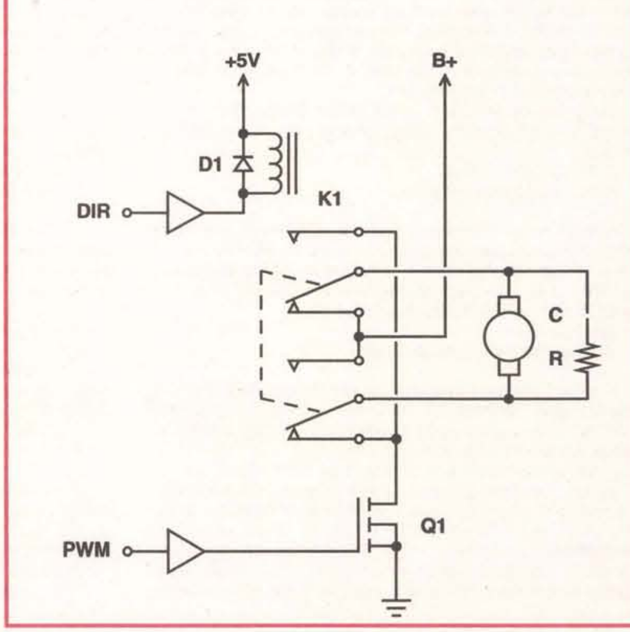


Figure 4: Dual SPDT Relay H-Bridge

Figure 5: DPDT Relay H-Bridge



My name is Jim Hepting and I am interested in a club. However, I live in Kitimat, British Columbia located in the center of the province on the coast (about 400-500 miles north of Seattle).
Jim Hepting
jhepting@methanex.com

I'm wondering if there is anyone working on robots in the Gold Country area of California within an hour of Grass Valley. I'm interested in finding others so we can exchange ideas, parts, etc., or just generally twiddle around with robots. Thanks.
Matthew Woolsey
mwoolsey@psn.net
mattwoolsey@mad.scientist.com

Hopefully others in the Sierra foothills will respond ... maybe get a Gold Country robotics club going.
Nick Taylor
ntaylor@iname.com

I'm in Berkeley, CA.
Tobin Fricke
tobin@sji.org

I regularly enjoy the column in *Nuts & Volts*. Saw your "gearhead" challenge in the Nov. issue. I'm presently clawing my way up the steep edge of the learning curve of robotics, mostly through reading everything I can get my hands on and trying to learn enough code to perform wonders with the two BASIC Stamp II chips that I have. Please include me in your list of contacts.
Mike Barry
3101 Vallejo St.
Riverside, CA 92503
myklb@aol.com

I'm Dan, and live in east central Florida, about halfway between Orlando and Daytona Beach. Sure would like to hook up with anyone interested in robotics in this area.
Dan Chiodo
dchiodo@mpinet.net
(407) 668-5040

I am interested in locating a robotics club locally.
Eben Whitcomb
39 Waterside Ln.
Clinton, CT 06413
(860) 669-7068
dirigo@uconect.net
www.uconect.net/~dirigo

Looking for club or other robot builders in the Orlando, FL area.
Doug Leppard
DLeppard@ccci.org
(407) 384-6545

I am a regular reader of your "Amateur Robotics" column in *Nuts & Volts*, and I saw your offer to assemble a list of "orphan roboticists." I think it is a great idea. I know that many people in the Boston area work on mobile robots, folks from the AI Lab at MIT, IS Robotics, Draper Labs, etc. – but I have yet to meet any individual hobbyists. It would be great to find out about any clubs here in the area, or perhaps other folks who are interested in starting one!
I live in Natick, MA, and I work in Cambridge, but I am interested in anything in the Boston metro area, if it makes a difference.
R. Mark Adams, Ph.D.
rmadams@epotential.com.

Anybody know of a club in Nebraska? Anybody even from Nebraska? (Besides me.) Anybody know where Nebraska is? If you are ... from Omaha/Lincoln, send me an E-Mail and even if there isn't a club, we could get together and discuss 'bots. Helps to have someone to bounce ideas off.
Dan Creagan
dcreagan@scholars.bellevue.edu

I am the Secretary/Treasurer for the Connecticut Robotics Society based in Hartford, CT. Now that is great in and of itself. We usually draw around 20-25 people each month, and the meetings are pretty lively. My problem is that I live in the Albany, NY area which is not all that close to Hartford. So, each month, for about the past couple of years, I've been driving a total of 5 hours (2.5 hours each way) from home to the meeting and back. The rest of the time I communicate with my fellow members via E-Mail.
It would be great to start a club here in the upstate New York area where I live, and find a few folks who would like to build robots with me. So, if you run across anyone who lives near me in the Albany, NY area ...
Jim Salvino
73 Spring Rd.
Scotia, NY 12302
(518) 374-1394
jims@capital.net

I read your article in the 11/99 *Nuts & Volts*, and I would be interested in finding out about clubs in my area. Over a year ago, I subscribed to *Nuts & Volts* specifically to learn more about robotics and to get more involved. I have half-heartedly been searching for a club in my area, but have not been successful, and would appreciate any help you could lend ... I am located in Queens, NY, about 25 minutes from Manhattan, 10 minutes from Nassau County, and one hour from Suffolk County. I would like to hear about any clubs that you may know of in my area.
Michael Cassidy
pmcassidy@mindspring.com

I am interested in finding others from my area of the map who are interested in robotics. I don't know how far north your list of clubs spans; I'm up here in Canada, attending my second year at Royal Military College, Kingston, Ontario. My address is:
II North
1 Sqn
RMC
Box 17000, Stn. Forces, CFB Kingston
Kingston ON
Canada
K7K 7B4
So far, I've hooked up with the robotics lab here at the College, but I was wondering if there were any clubs in the Kingston area. Thanks.
Eric North
s22274@rmc.ca

I am looking for a club in the Sault Ste. Marie, Ontario (Canada) or Northern Michigan area.
Pat Caron
kacpac@sympatico.ca
(705) 759-4602

Count me in on the club listing. Looking for a club in the Ottawa/Hull, Ontario (Canada) area.
Stephen Winsor
(819) 459-1506 (B)
(819) 459-2069 (fax)
Winsor_Consulting@ottawa.com

Your column in *Nuts & Volts* is correct; I do think I'm the only one who wants to build hobby robots. I've mentioned starting a club to people from time to time, with no interest. Although I don't have enough time right now to organize a club, I'd love to join one in my area: Philadelphia, PA or Wilmington, DE.
Kathy Garges
(610) 459-1897
gargesks@pond.com

I enjoy the interesting articles you have written. If you find out that there is a robot club in the northern Utah area, would you please publish that info? Thanks.
Gary Harston
zaphod@uswest.net

I'm interested in being a member of a robot club in Spokane, WA. Your efforts are appreciated.
Terrel Nichols
tnichols@tei.com

I am interested in robotics clubs in the Milwaukee, WI area. I hear that there might be one at UW Parkside, but have not found any info. Thanks for playing matchmaker to robotics enthusiasts.
Tom Gralewicz
mot@ieee.org

I read your article (Amateur Robotics Notebook) in *Nuts & Volts* magazine, and am interested in finding a robot builders club in Milwaukee, WI. Thank You.
Linda Szeremet
szeremet@worldnet.att.net

I am a roboticist in England (for all of you who think stereotypical England is cold and wet, it's not – most of the time!). Anyway, I'd be glad if anyone could get back to me – I live on the south coast and would be willing to start up a club.
Angus Thomson
angus@ukmax.com

to back up, for instance, nor would it be able to pivot in place. For worthwhile mobility, a robot must have full directional control over its drive motors. The way to accomplish this is through H-bridges.

H-bridges take their name from the shape of the circuit as conventionally drawn; it resembles a capital H with switching elements in both the high-side and low-side branches of the H (see Figure 3). With an H-Bridge, a motor can be made to run forward, reverse, or even brake to a halt.

The Classic H

Figure 4 shows such a circuit implemented with two SPDT relays and a MOSFET. With neither relay coil energized, or both coils energized, the pole contacts are shorted together. In both cases, nothing happens when the PWM signal turns the MOSFET ON because shorting the leads of the motor together tends to lock the rotor in place, a useful form of braking that comes for free with this circuit.

If one side or the other is energized alone, however, a current path is created when the MOSFET turns on. If DIR1 is high and DIR2 is low, relay 1 will pull its pole to the B+ contact and relay 2 will remain unenergized with its pole pulled to ground through the MOSFET. If DIR2 is high and DIR1 is low, current will flow in the opposite direction through the motor.

If you don't need speed control, the transistor in Figure 4 could be replaced by a direct connection to ground. The motor would then operate either full forward, full reverse, or locked rotor.

(As an aside, the winner of the contest is Kathy Garges gargesks@pond.com in the Philadelphia, PA, Wilmington, DE area. Kathy, let me offer you my congratulations; send your mailing address and I'll ship your GrowBot.)

Figure 5 shows a circuit that uses a single DPDT relay to reverse motor direction. Even though this circuit doesn't look much like an H, if you trace through the possible current paths, you'll find that it has the same topology – two high-side switches and two low-side switches.

The advantage of this circuit is its simplicity: only one relay is required. The motor can be wired so the relay only needs to be energized to make the motor go backwards. Assuming your robot will spend most of its time going forward, this can mean lower average battery drain. A disadvantage of the single relay circuit is that it can't short the motor terminals together to allow braking.

Also, if the transistor fails and

shorts to ground or, if the PWM input gets stuck high, the motor will run, regardless of the state of DIR. The two relay configuration isn't susceptible to this because the motor only runs when either of the relays – but not both – are energized.

And the Winner Is ...

Ha, fooled you. Go back and read the article; the winner is in the middle, somewhere inconspicuous.

And those of you shy people out there who haven't yet contacted me about your robotics club (or search for same), here's another chance: Send me your club listing and your name and contact info by March 1, 2000, and you'll be eligible for the next Lonely Gearhead drawing (I'll let you know what the prize is next month, as soon as I figure it out).

If you're convinced nobody but you builds robots in your part of the world, think again. We're everywhere.

Next time, I'll look at completely solid-state motor driver circuits, review books of interest to robot builders, and update the I2C project. **NV**

As always, if you have suggestions for improving Breadbot, if you've built a Breadbot, or if you have questions or comments about amateur robotics topics, you can reach me at:

Robert Nansel
69 S. Fremont Ave. #2
Pittsburgh, PA 15202
E-Mail:
bnansel@nauticom.net

City & State: **Russellville, AR**
Group Name: Arkansas Tech University IEEE student branch
Contact: Dr. Murray Clark
Email: murray.clark@mail.atu.edu
URL: engr.atu.edu/Projects/engr/EGR_HME.htm
Meetings:
Address: Murray Clark
ATU Engineering Dept.
Highway 7 North
Russellville, AR 72801
Telephone: (501) 964-0876

City & State: **Hartford, CT**
Group Name: Connecticut Robotics Society
Contact: Jacob Mendelssohn
Email: JMENDEL141@aol.com
URL: family.knick.net/salvinoj/crs/
Meetings:
Address:
Telephone:

City & State: **Anaheim, CA**
Group Name: Robotics Society of Southern CA
Contact: Art LeBouthillier
Email: apendragn@earthlink.net
URL: home.earthlink.net/~apendragn/rssc
Meetings: 2nd Saturday of month at Room EE321
California State University Fullerton
12:30-1:00 Business meeting
1:00-3:00 General meeting
Address: RSSC
P.O. Box 26044
Santa Ana, CA
92799-6044
Telephone:

City & State: **San Diego, CA**
Group Name: SDRS – San Diego Robotics Society
Contact: Peter Cresswell
Email: peter.cresswell@funtv.com
URL: www.eGroups.com/group/sdrs-list
Meetings: 1st Saturday at ITT Techical Institute, San Diego,
9AM - 12PM General meeting
Address:
Telephone:

City & State: **San Jose, CA**
Group Name: Palo Alto Homebrew Robotics Club
Contact: Bill Benson
Email: wbenson@ibm.net
URL: www.augiedoggie.com/HBRC/index.html
Meetings: Last Wednesday of each month (no meeting in Dec.)
Held at 7:30 PM, library of Castro Middle School
Address: Castro Middle Scool
4600 Student Ln.
San Jose, CA 85130
Telephone: (408) 874-3300

City & State: **San Francisco, CA**
Group Name: San Francisco Robotics Society of America
Contact: Roger Gilbertson
Email: SFRSA@mondo.com
URL: www.robots.org
Meetings: 1st Wednesday, 7:30 PM
at the San Francisco Exploratorium
Address: 3601 Lyon St.
San Francisco, CA 94123
Telephone: (415) EXP-LORE

City & State: **Aurora, CO**
Group Name: Rockies Robotics Group
Contact: Frank Arteseros
Email: kiko2@ix.netcom.com
URL: www.he.net/%7Eroundy/RRG.html
Meetings:
Address:
Telephone:

City & State: **Colorado Springs, CO**
Group Name: Pikes Peak Robotics Group
Contact: Jay Snively
Email: pprg@pcisys.net
URL: www.pcisys.net\~phantom\pprg.htm
Meetings:
Address:
Telephone:

City & State: **Atlanta, GA**
Group Name: Atlanta Hobby Robot Club
Contact: C. Barry Ward, president
Email: cbward@abraxis.com,robotclub@idea-vision.com
URL: www.botlanta.org
Meetings:
Address:
Telephone: (770) 663-3420

City & State: **Peoria, IL**
Group Name: Central Illinois Robotics Group
Contact: Jim Munro, Alan Kilian
Email: jimmn@xnet.com, kilian@pobox.com
URL: www.circ.mtco.com/
Meetings: 3rd Sunday (?), 1:00 p.m.
Address: Lakeview Museum of Arts & Sciences
1125 West Lake Ave.
Peoria, IL 61614-5985
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City & State: **ISU, IA**
Group Name: Iowa State University Robotics Club (ISURC)
Contact:
Email:
URL: www.public.iastate.edu/%7Estu_org/ISURC/
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Group Name: Wichita Robot Club
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Tom Light VP, (tlight@club-net.org)
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City & State: **Minneapolis, MN**
Group Name: Twin Cities Robotics Club
Contact: Rand Whillock (whillock@htc.honeywell.com)
Email: tcrobots-request@orbis.net
URL: www.tcrobots.org/
Meetings: 3rd Thursday of each month, 7 to 10 PM
Science Museum of Minnesota in St. Paul
Address:
Telephone: (612) 404-2009

City & State: **Nashua, NH**
Group Name: Nashua Robot Builders Club
Contact: Quentin Lewis
Email: bigqueue@tiac.net
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Meetings:
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City & State: **Los Alamos, NM**
Group Name: Northern NM Robotics Group
Contact: Mark Dalton
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Meetings:
Address:
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City & State: **Raleigh, NC**
Group Name: Raleigh Triangle Amateur Robotics Group
Contact: Russell Lyday, president, Alan Porter webmaster
Email: r.lyday@worldnet.att.net, alan.porter@ericsson.com
URL: http://welcome.to/TAR
Meetings: 7:30pm on 1st Monday at Clark Labs
Room 110, North Carolina State University
Address: 10 Clark Labs
North Carolina State University
Raleigh, NC
Telephone:

City & State: **Cleveland, OH**
Group Name: Robo CWRU R&D Group
Contact: Joyce A Boone
Email: jab3@po.cwru.edu
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Meetings:
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City & State: **Troy, OH**
Group Name: The Miami Valley Robotics Club
Contact: Jon Magin (jmagin@allegro.net)
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City & State: **Waterloo, Ontario**
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City & State: **Portland, OR**
Group Name: Portland Area Robotics Society
Contact: Marvin Green
Email: marvin@agora.rdrop.com
URL: www.rdrop.com/users/marvin/
Meetings: 1st Saturday of each month
at Mt. Hood Community College.
Room #1277 at 10:30 AM
Address:
Telephone: (503) 666-5907

City & State: **Pittsburgh, PA**
Group Name: CMU Robotics Club
Contact: Ryan Miller
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City & State: **Austin, TX**
Group Name: The Robot Group
Contact: Alex Iles, Don Colbath
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URL: www.robotgroup.org/
Meetings:
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Telephone:

City & State: **Dallas, TX**
Group Name: Dallas Personal Robotics Group
Contact: Clay Timmons, Kipton Moravec
Email: ctimmons@asic.sc.ti.com, kmoravec@airmail.net
URL: www.dprg.org/
Meetings:
Address:
Telephone:

City & State: **Seattle, WA**
Group Name: Seattle Robotics Society
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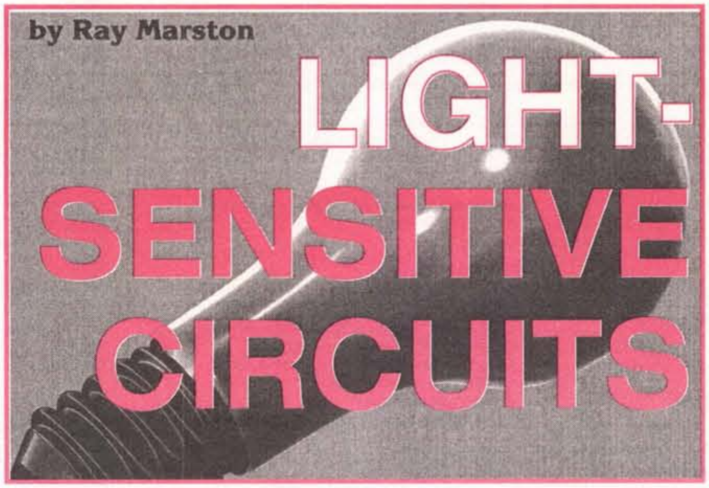
URL: www.seattlerobotics.org/
Meetings: 3rd Saturday of every month
Renton Technical College, Room J314
10 AM-12 Noon.
Address: Seattle Robotics Society
P.O. Box 1714
Duvall, WA 98019-1714
Telephone:

City & State:
Group Name: The Robotics Club of Yahoo (TRCY)
Contact: Justin Ratliff, president
Email: Weyoun7@aol.com
URL: members.tripod.com/RoBoJRR
Meetings: Weekly chat session every Wednesday
around 9 PM EST and ending around 11:30 PM
Address:
Telephone:

Ray Marston describes the basic operating principles and applications of a variety of light-sensitive devices.



LDR BASICS

Electronic optosensors are devices that alter their electrical characteristics in the presence of visible or invisible light. The best known devices of these types are the LDR (light dependent resistor), the photodiode, the phototransistor, and the PIR (passive infrared) detector.

LDR operation relies on the fact that the conductive resistance of a film of cadmium sulphide (CdS) varies with the intensity of light falling on the face of the film. This resistance is very high under dark conditions and low under bright conditions.

Figure 1 shows the LDR's circuit symbol and basic construction, which consists of a pair of metal film contacts separated by a snake-like track of light-sensitive cadmium sulphide film, which is designed to provide the maximum possible contact area with the two metal films. The structure is housed in a clear plastic or resin case, to provide free access to external light.

Practical LDRs are available in a variety of sizes and package styles, the most popular size having a face diameter of roughly 10mm. *Figure 2* shows the typical characteristic curve of such a device, which has a resistance of about 900R at a light intensity of 100 Lux (typical of a well-lit room) or about 30R at an intensity of 8000 Lux (typical of bright sunlight). The resistance rises to several megohms under dark conditions.

LDRs are sensitive, inexpensive, and readily available devices with power and voltage handling capabilities similar to those of conventional resistors. Their only significant defect is that they are fairly slow acting, taking tens or hundreds of milliseconds to respond to sudden changes in light level.

Useful LDR applications include light- and dark-activated switches and alarms, and *Figures 3* to *9* show some practical circuits of these types; each of these circuits will work with virtually any LDR with a face diameter in the range of 3mm to 12mm.

LDR LIGHT-SWITCHES

Figures 3 to *5* show some practical relay-output light-activated switch circuits based on the LDR. *Figure 3* shows a simple non-latching circuit, designed to activate when light enters a normally-dark area, such as the inside of a safe or cabinet, etc.

Here, R1-LDR and R2 form a potential divider that controls the base-bias of Q1. Under dark conditions, the LDR resistance is very high, so negligible base-bias is applied to Q1, and Q1 and RLA are off. When a significant amount of light falls on the LDR face, the LDR resistance falls to a fairly low value and base-bias is applied to Q1, which thus turns on and activates the RLA/1 relay contacts, which can be used to control external circuitry. The relay can be any 12V type with a coil resistance of 180R or greater.

The simple *Figure 3* circuit has a fairly low sensitivity, has no facility for sensitivity adjustment, and its light trigger points vary with variations in circuit supply voltage and ambient temperature. *Figure 4* shows a very sensitive, precision light-activated circuit that suffers from none of these weaknesses.

Here, LDR-RV1 and R1-R2 are connected in the form of a Wheatstone bridge, and the op-amp and Q1-RLA act as a sensitive balance-detecting switch. The bridge balance point is quite independent of variations in supply voltage and temperature, and is influenced only by variations in the relative values of the bridge components.

In *Figure 4*, the LDR and RV1 form one arm of the bridge, and R1-R2 form the other arm. These arms act as potential dividers, with the R1-R2 arm applying a fixed half-supply voltage to the non-inverting input of the op-amp, and with the LDR-RV1 divider applying a light-dependent variable voltage to the inverting terminal of the op-amp.

In use, RV1 is adjusted so that the LDR-RV1 voltage rises slightly above that of R1-R2 as the light intensity rises to the desired trigger level and, under this condition, the op-amp output switches to negative saturation and drives the relay on via Q1 and biasing resistors R3-R4.

When the light intensity falls below this level, the op-amp output switches to positive saturation and, under this condition, Q1 and the relay are off.

The *Figure 4* circuit is very sensitive and can detect light-level changes too small to be seen by the human eye. The circuit can be modified to act as a precision dark-activated switch by either transposing the inverting and non-inverting input terminals of the op-amp, or by transposing RV1 and the LDR.

Figure 5 shows a circuit using the latter option; this circuit also shows how a small amount of hysteresis can be added to the circuit via feedback resistor R5, so that the relay turns on when the light level falls to a particular value, but does not turn off again until the light intensity rises a substantial amount above this value. The magnitude of hysteresis is inversely proportional to the R5 value, being zero when R5 is open circuit.

A BELL-OUTPUT LDR ALARM

The *Figure 3* to *5* light-activated LDR circuits all have relay outputs that can be used to control virtually any type of external circuitry. In some light-activated applications, however, circuits are required to act as

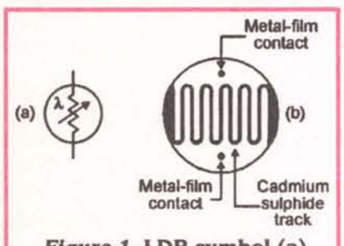


Figure 1. **LDR symbol (a) and basic structure (b).**

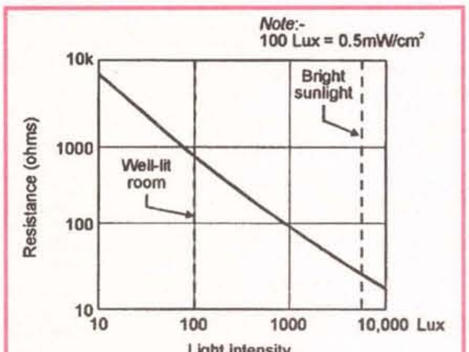


Figure 2. **Typical characteristics curve of a LDR with a 10 mm face diameter.**

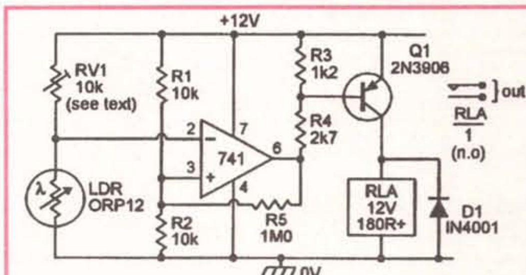


Figure 5. **Precision dark-activated switch, with hysteresis.**

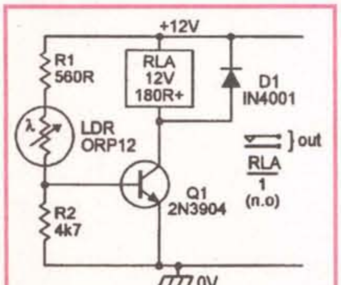


Figure 3. **Simple non-latching light-activated relay switch.**

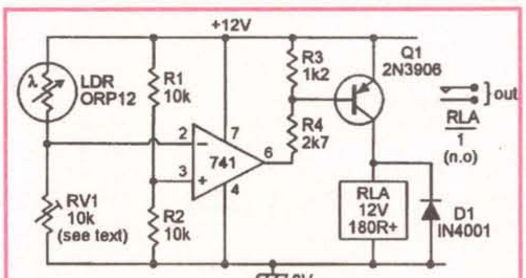


Figure 4. **Precision light-sensitive relay switch.**

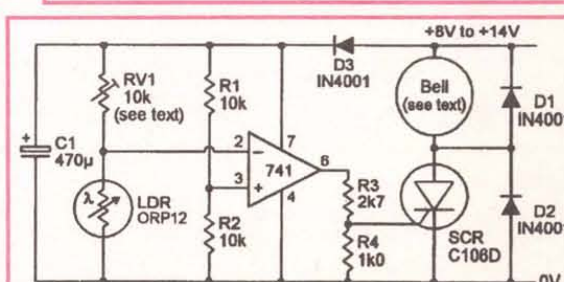


Figure 6. **Precision light-activated alarm bell.**

audible-output alarms, with a bell or siren-sound output, and this type of action can be obtained without the use of relays.

Figure 6 shows a practical 'alarm bell output' circuit that gives a direct output to an alarm bell, which must be of the self-interrupting type that consumes an operating current of less than 2A. The circuit's supply voltage should be 1.5V to 2V greater than the nominal operating value of the bell.

The *Figure 6* circuit uses a Wheatstone bridge (LDR-RV1-R1-R2) and an op-amp balance detector to give the precision sensing/switching action (as described in the basic *Figure 4* circuit), but its output drives the alarm bell via an inexpensive SCR; the basic circuit can be converted into a dark-activated alarm by simply transposing RV1 and the LDR; hysteresis can also be added, if required.

Note in the *Figure 6* circuit that, although the SCR is a self-latching device, the fact that the bell is of the self-interrupting type ensures that the SCR automatically unlatches repeatedly as the bell operates (and the SCR anode current falls to zero in each self-interrupt phase). Consequently, the alarm bell automatically turns off again when the light level falls back below the trip level.

SIREN-OUTPUT LDR ALARMS

Figures 7 to *9* show ways of using CMOS 4001B quad two-input NOR gate ICs as the basis of various light-activated 'siren-sound' alarms that generate audible outputs in loudspeakers.

The *Figure 7* circuit is that of a light-activated alarm that generates a low-power (up to 520mW) 800Hz pulsed-tone signal in the speaker when the light input exceeds a pre-set threshold value.

Here, IC1c and IC1d are wired as a 800Hz astable multivibrator that can feed tone signals into the speaker via Q1 and is gated on only when the output of IC1b is low, and IC1a-IC1b are wired as a 6Hz astable that is gated on only when its pin-1 gate terminal (which is coupled to the LDR-RV1 potential divider) is pulled low.

The action of the *Figure 7* circuit is as follows. Under dark conditions, the LDR-RV1 junction voltage is high, so both astables are disabled and no signal is generated in the speaker. Under 'light' conditions, the LDR-RV1 junction voltage is low, so the 6Hz astable is activated and, in turn, gates the 800Hz astable on and off at a 6Hz rate, thereby generating a pulsed-tone signal in the speaker via Q1.

The precise switching or gate point of the 4001B IC is determined by the threshold voltage value of the IC, and this is a percentage value of the supply voltage: the value is nominally 50%, but may vary from 30% to 70% between individual ICs. In practice, the switching point of each individual 4001B IC is very stable, and the *Figure 7* circuit gives very sensitive 'light'-activated alarm triggering.

Figure 8 shows the circuit of a self-latching, light-activated alarm with an 800Hz monotone output. In this case, IC1c-IC1d are again wired as a gated 800Hz astable, but IC1a-IC1b are wired as a bistable multivibrator with an output that (under dark conditions) is normally high, thus gating the 800Hz astable off.

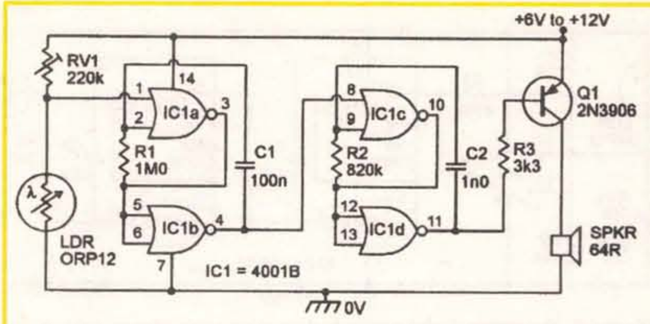


Figure 7. **Light-activated alarm with pulsed-tone output.**

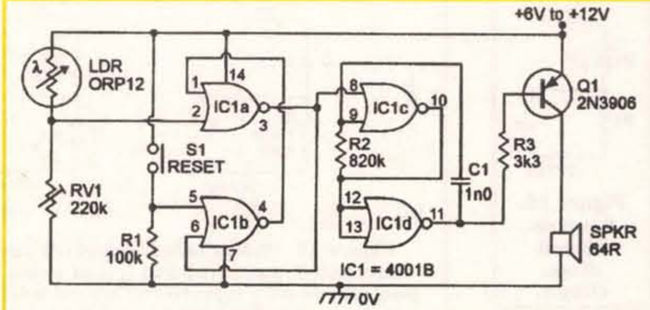


Figure 8. **Self-latching light-activated alarm with monotone output.**

Under bright conditions, however, the LDR-RV1 junction goes high and latches the bistable into its alternative 'output low' state, thereby gating the 800Hz astable on and generating the monotone alarm signal; once latched, the circuit remains in this 'on' state until dark conditions return and the

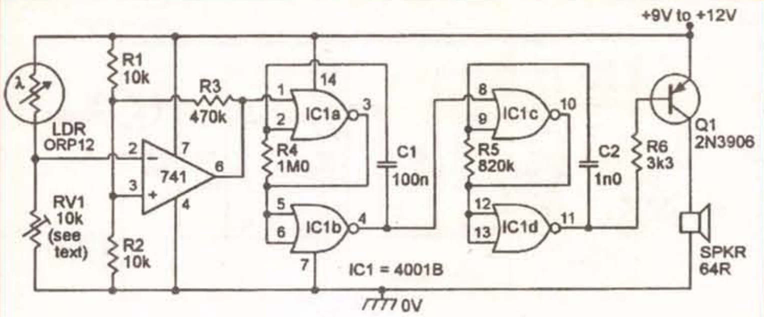


***Figure 9.* Precision light-activated pulsed-tone alarm with hysteresis.**

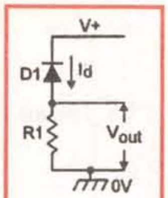


***Figure 10.* Reverse-biased diode circuit.**

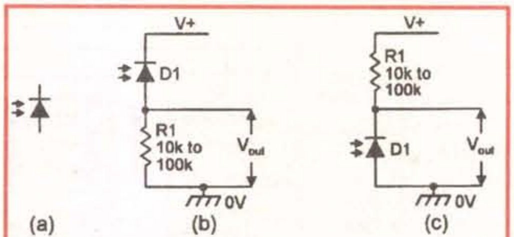


***Figure 11.* Photodiode symbol (a) and alternative ways ((b) and (c)) of using a photodiode as a light-to-voltage converter.**

bistable is simultaneously reset via S1.

Note that the light/dark operation of the *Figure 7* and *8* circuits can be reversed by simply transposing the LDR-RV1 positions. The sensitivity levels of these two basic circuits are adequate for most practical purposes, but can, if required, be boosted (and the trigger-level stability increased), by interposing an op-amp voltage comparator (of the basic *Figure 4* or *5* type) between the LDR-RV1 light-sensitive potential divider and the gate terminal of the CMOS waveform generator, as shown in the *Figure 9* circuit; resistor R3 controls the hysteresis of the circuit, and can be removed if the hysteresis is not needed.

The *Figure 7* to *9* circuits generate fairly modest values of acoustic output power, with the power input to the 64-ohm loudspeaker reaching a maximum value of 520mW when using a 12V supply. The available output power can, however, easily be boosted by feeding the circuit's output to low-impedance horn-type loudspeakers via simple power-boosting amplifiers.

PHOTODIODES

Cadmium sulphide (CdS) LDRs are sensitive but slow-acting devices. They are ideal for use in slow-acting, direct-coupled light-level sensing applications, but are not suitable for use as optical sensors in medium- to high-speed applications. The ideal optical sensors for use in the latter applications are the silicon photodiode and the silicon phototransistor.

In its very crudest form, a photodiode is a normal silicon diode minus its opaque (light-excluding) covering. If a normal silicon diode is connected in the reverse-biased circuit of *Figure 10*, negligible current flows through the diode and zero voltage is developed across R1.

If the diode's opaque covering is now removed (so that the diode's semiconductor junction is revealed) and the junction is then exposed to visible light in the same circuit, the diode will pass a significant reverse current and thus generate an output voltage across R1.

The magnitude of the reverse current and the output voltage is directly proportional to the intensity of the light source, and the diode is thus truly photosensitive.

All silicon junctions are photosensitive, and a basic photodiode can — for most practical purposes — be regarded as a normal diode housed in a case that lets external light easily reach its photosensitive semiconductor junction. *Figure 11(a)* shows the standard photodiode symbol.

In use, the photodiode is reverse-biased and the output voltage is taken from across a series-connected load resistor; this resistor can be connected between the diode and ground, as in *Figure 11(b)*, or between the diode and the positive supply line, as in *Figure 11(c)*.

In reality, the physical form of a normal silicon diode's *pn* junction is such that the device exhibits fairly low optical sensitivity; all practical photodiodes use special types of junction design, to maximize their effective photosensitivity. Most photodiodes come in one or the other of two basic types, being either 'simple' photodiodes or PIN photodiodes. *Figure 12* illustrates some basic points on these subjects.

Normal silicon junction diodes use the basic form of construction shown (in symbolic form) in *Figure 12(a)*, in which the device's *p*- and *n*-type materials are moderately thick (and thus fairly opaque), and are effectively fused directly together to form the device's junction; the relatively high opacity of the *pn* junction's materials gives the junction fairly poor photosensitivity.

In a simple photodiode, the photosensitivity is greatly increased by using a very thin (and thus highly translucent) slice of material on the *p*-type side of the junction, as shown in *Figure 12(b)*; external light can be applied, via a built-in lens or window, to the opto-sensitive *pn* junction via this thin slice of *p*-type material.

Simple *Figure 12(b)*-type photodiodes have minimum on/off switching times of about 1μS, and can thus be used at maximum pulsed or switched operating frequencies of about 300kHz.

The prime cause of this relatively long switching time is the high capacitance that occurs at the device's junction, between the *p*- and *n*-type materials. This problem is greatly reduced in PIN photodiodes, in which a very thin slice of intrinsic ('I') or 'undoped' silicon material is interposed at the junction between the *p*- and *n*-type materials, as shown in *Figure 12(c)*, thus greatly reducing the *p*-to-*n* junction's capacitance value.

Modern PIN-type photodiodes have typical minimum on/off switching times of about 10nS, and can thus be used at maximum switched-mode operating frequencies of about 30MHz, which is adequate for the vast majority of practical optoelectronic applications (in cases where even higher switching frequency optical sensing is required, special ultra-high-frequency avalanche-type photodiodes can be used).

Photodiodes can be designed to respond to either visible light or to IR light. The human eye has the type of spectral response curve shown in curve '*a*' in *Figure 13*. It has a maximum sensitivity to the color green, which has a wavelength of about 550nm, but has a low sensitivity to violet (400nm) at one end of the spectrum and to dark red (700nm) at the other.

General-purpose visible-light photodiodes have typical spectral response characteristics like those shown in curve '*b*' in *Figure 13*, and infrared (IR) types have the type of response shown in curve '*c*.'

PHOTOTRANSISTORS

Ordinary silicon transistors are made from an npn or pnp sandwich, and thus inherently contain a pair of photosensitive junctions. Some types are available in phototransistor form, and use the standard symbol shown in *Figure 14(a)*.

Figures 14(b) to *14(d)* show three basic ways of using a phototransistor; in each case, the base-collector junction is effectively reverse-biased and thus acts as a photodiode.

In *(b)*, the base is grounded, and the transistor acts as a simple photodiode. In *(c)* and *(d)*, the base terminal is open-circuit and the photo-generated currents effectively feed directly into the base and, by normal transistor action, generate a greatly amplified collector-to-emitter current that produces an output voltage across series resistor R1.

The sensitivity of a phototransistor is typically one hundred times greater than that of a photodiode, but its useful maximum operating frequency (usually a few hundred kHz) is proportionally lower than that of a photo-

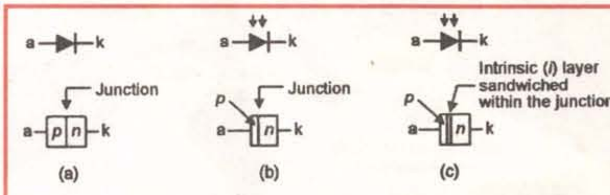


***Figure 12.* Symbol and basic construction of (a) a normal silicon junction diode, (b) a simple photodiode, and (c) a PIN photodiode.**

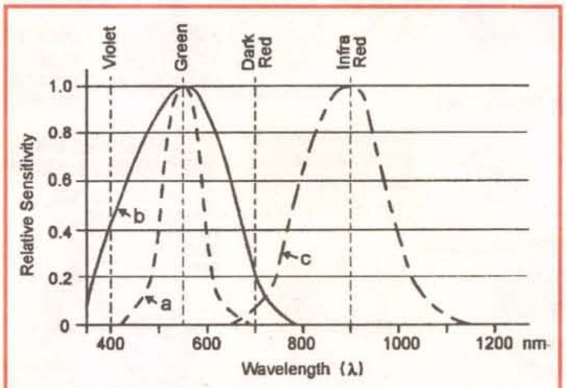


***Figure 13.* Typical spectral response curves of (a) the human eye and (b) general-purpose and (c) IR photodiodes.**

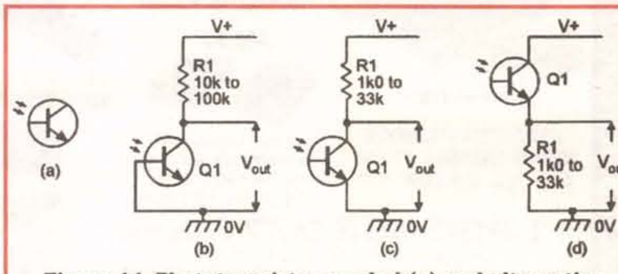


***Figure 14.* Phototransistor symbol (a) and alternative ways (b) to (d) of using a phototransistor.**

diode.

Most phototransistors are manufactured in two-pin form, with only the device's collector and emitter made externally available; three-pin types can be used in any of the basic configurations shown in *Figure 14*. Some phototransistors are made in very-high-gain Darlington form.

Note in the *Figure 11* and *14* photodiode and phototransistor circuits that, in practice, the R1 load value is usually chosen on a compromise basis, since the circuit sensitivity increases but the useful operating bandwidth decreases as the R1 value is increased. Also, the R1 value must, in many applications, be chosen to bring the photosensitive device into its linear operating region.

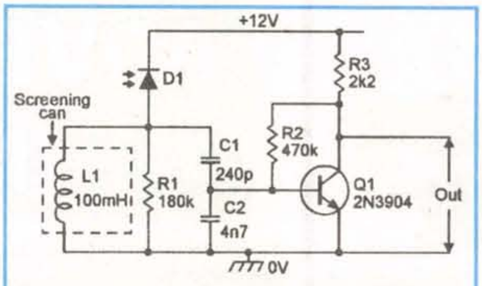


***Figure 15*. Selective IR pre-amplifier designed for 30kHz operation.**

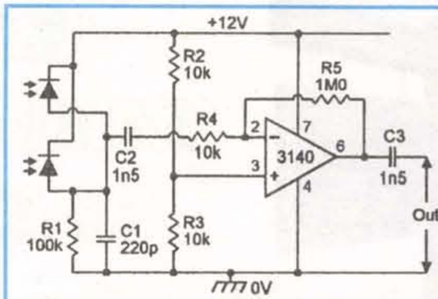


***Figure 16*. 20kHz selective pre-amp for use in IR lightbeam applications.**

IR PRE-AMP CIRCUITS

Photodiodes or phototransistors are often used as the sensing elements at the receiver end of light-beam alarms, remote control, or fiber optic cable systems. In such applications, the signal reaching the photosensor may vary considerably in strength, and the sensor may be subjected to a great deal of noise in the form of unwanted visible or IR light signals, etc.

To help minimize these problems, the systems are usually operated in the IR range, and the optosensor output is passed to processing circuitry via a low-noise pre-amplifier with a wide dynamic operating range. *Figures 15* and *16* show typical examples of such circuits, using photodiode sensors.

The *Figure 15* circuit is designed to detect an IR optical signal that is switched at a 30kHz rate. Photodiode D1 senses the IR signal and feeds it into 30kHz tuned circuit L1-C1-C2, which is lightly damped by R1. The resulting frequency-selected low-noise output of the tuned circuit is tapped off at the C1-C2 junction and then amplified by Q1.

Figure 16 shows a 20kHz selective pre-amplifier circuit for use in an IR light-beam alarm application, in which the alarm sounds when the beam is broken. Here, two IR photodiodes are wired in parallel (so that beam signals are lost only when *both* diode signals are cut off) and share a common 100k load resistor (R1). R1 is shunted by C1 to reject unwanted high-frequency signals, and its output is fed to the x100 op-amp inverting amplifier via C2, which rejects unwanted low-frequency signals.

PIR MOVEMENT-DETECTING SYSTEMS

IR light-beam alarms are active IR units that react to an artificially-generated source of IR radiation. Passive IR (PIR) alarms, on the other hand, react to naturally generated IR radiation such as the heat-generated IR energy radiated by the human body, and are widely used in modern security systems.

Most PIR security systems are designed to activate an alarm or floodlight, or open a door or activate some other mechanism, when a human or other large warm-blooded animal moves about within the sensing range of a PIR detector unit, and use a pyroelectric IR detector of the type shown in *Figure 17* as their basic IR-sensing element.

The basic *Figure 17* pyroelectric IR detector makes use of special ceramic elements that generate electrical charges when subjected to thermal variations or uneven heating.

Modern pyroelectric IR detectors — such as the popular PIS201S and E600STO types — incorporate two small opposite-polarity series-connected ceramic elements of this type, with their combined output buffered via a JFET source-follower, and have the IR input signals focused onto the ceramic elements by a simple filtering lens, as shown in the basic PIR detector usage circuit of *Figure 17*.

It is important to note at this point that the detector's final output voltage is proportional to the *difference* between the output voltages of the two ceramic elements.

The basic action of the *Figure 17* PIR detector is such that, when a human body is within the visual field of the pyroelectric elements, part of that body's radiated IR energy falls on the surfaces of the elements and is converted into small but detectable variations in surface temperature and corresponding variations in the output voltage of each element.

If the human body (or other source of IR radiation) is stationary in front of the detector's lens under this condition, the two elements generate identical output voltages and the unit's final 'difference' output is thus zero, but if the body is moving while in front of the lens, the two elements generate different output voltages and the unit produces a varying output voltage.

Thus, when the PIR unit is wired as shown in the *Figure 17* basic usage circuit, this movement-inspired voltage variation is made externally available via the buffering JFET and DC-blocking capacitor C1 and can — when suitably amplified and filtered — be used to activate an alarm or other mechanism when a human body movement is detected.

In practice, pyro-electric IR detectors of the simple type just described have — because of the small size (usually about 20mm^2) and simple design of the detector's IR-gathering lens — maximum useful detection ranges of roughly one meter. In modern commercial PIR movement detecting security units, however, this range is usually extended to at least 10 meters with the aid of a large (about 2000mm^2) multi-faceted external IR-gathering/focusing plastic lens, which splits the visual field into a number of parallel strips and focuses them onto the two sensing areas of the PIR unit.

Figure 18 shows the typical PIR sensing pattern of a commercial 'intrusion detector' unit designed to protect a normal-sized room in domestic-type applications. In this example, the unit is mounted on a wall at a height of seven feet and is aimed downwards at a shallow angle, and the multi-faceted plastic lens splits the visual field into a large number of vertical and horizontal segments.

Any person moving through a single segment will activate a single trigger signal within the PIR sensor; a person moving through the entire visual field thus produces numerous triggering signals, but a stationary IR source produces no signals.

Most intrusion detectors of this type incorporate 'event counting' circuitry that will only generate an alarm-activating output if three or more trigger signals are detected within a few seconds, thus minimizing the chances of a false alarm due to sudden changes in temperature caused by the auto-activation of time-switched security lights, etc.

The lens-generated PIR sensor pattern shown in *Figure 18* is the type usually used to protect single rooms in domestic burglar-alarm systems.

Alternative lenses offer different ranges and coverage patterns for various special types of application; amongst these are the 'pet' type, in which the field's vertical span is restricted to 2.5 to 6.6 feet above ground level to avoid activation by domestic pets while giving good sensitivity to normal humans, and the 'corridor' type, in which the field's horizontal span is restricted to about 20 degrees to give long-distance coverage (typically about 30 meters) of narrow corridors and passageways.

Note that, because high-quality commercial PIR security units of this basic type are widely available at comparatively low cost, it is not practicable (on aesthetic and cost-effective grounds) to try to build similar units on a DIY basis. **NV**

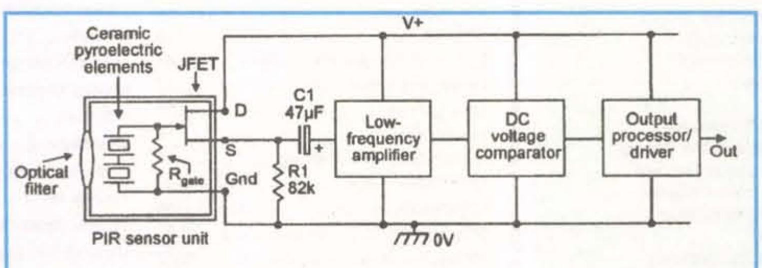


***Figure 17*. Basic PIR detector usage circuit.**

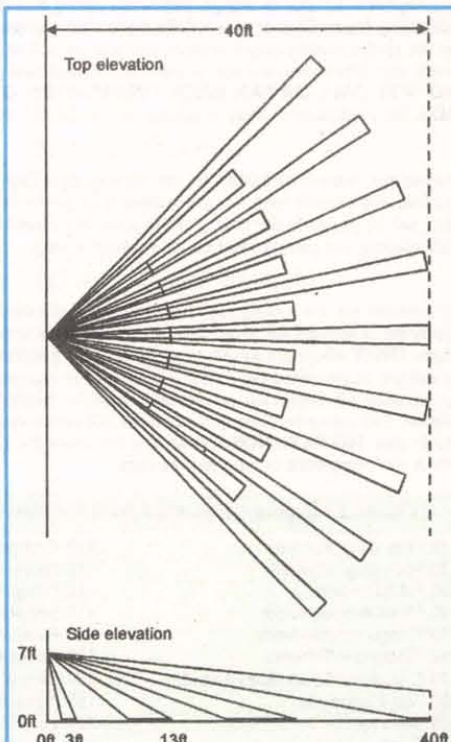


***Figure 18*. Typical PIR sensing pattern of a commercial 'intrusion detector' unit designed for normal domestic-type applications.**

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Cheyenne 82001

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*** ***TJBYERS@juno.com*** *or by snail mail at Nuts & Volts Magazine, 430 Princeland Ct., Corona, CA 92879.*

What's Up:

Lots of **automotive stuff**. Some clues on **magnetic fields** and how they are measured and detected. Fun stuff with **Lissajous patterns** and other **oscilloscope topics**. Finally, in search of **the lost IC** defined. Have a Prosperous New Year!

Windows DLL Sources

Q. I'm trying to write a PIC chip program using Windows and interface hardware, and I need a DLL driver. Unfortunately, I don't know how to write Windows drivers, but I've heard that I don't have to. There are lots of these drivers out there free for the picking, right?

Eric Kirby
via Internet

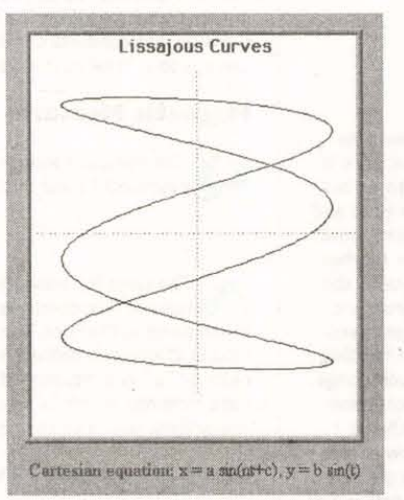
A. Two web sites, **www.driverguide.com** and **www.mrdriver.com**, provide access to many up-to-date drivers needed to control PC hardware. Visit T & M World Online's Cool Web Sites page at **http://www.tmworld.com/articles/links.html** and scroll down to "Software for Download" to access these sites and other useful sites.

Lissajous Reflections

Q. I remember making interesting Lissajous figures in a physics class years ago. Could you explain their uses and how to make them on an oscilloscope?

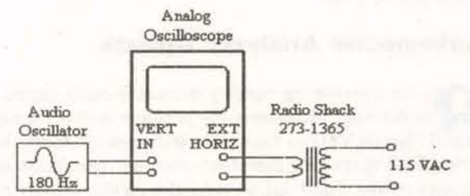
Keith Penner
via Internet

A. A Lissajous pattern is a graph of a curve in which both the x and y Cartesian coordinates are periodic functions of time (t) given by equations — typically, x = sin(nt + c) and y = sin(t). Different patterns may be generated for different values of n and c. A Lissajous figure is easily generated on the screen of an oscilloscope by turning off the internal horizontal sweep and applying a sinewave to both the vertical and external horizontal inputs. The shape of the pattern is a function of the frequency ratio and phase angle between the two signals. For example, if the two sine waves are in phase and of the same frequency, the screen displays a circle. A frequency ratio of 2:1 generates a figure eight pattern and a ratio of 3:1 produces three loops, like the one shown below.

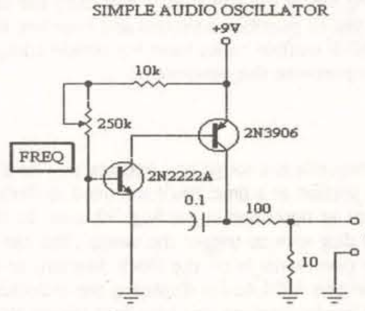


Before electronic counters, Lissajous patterns were often used to measure the frequency of an unknown signal by comparing it to that of an known frequency. By counting the number of horizontal and vertical nodes, complex ratios like 4:5 and 11:9 are easily recognized and the unknown frequency easily calculated. *N & V* published an article on building a Lissajous effects generator ("Artistic Design Generator") that appeared in the May 1993 issue. This issue is still available from our back issue order desk; contact us at 909-371-8497 for details.

However, you don't have to go to this extreme to have fun with Lissajous graphics. All you need is a sinewave oscillator, a 12-volt power transformer, and an analog oscilloscope. That's it! Here's the setup, including the schematic for a very simple audio generator.



SIMPLE AUDIO OSCILLATOR

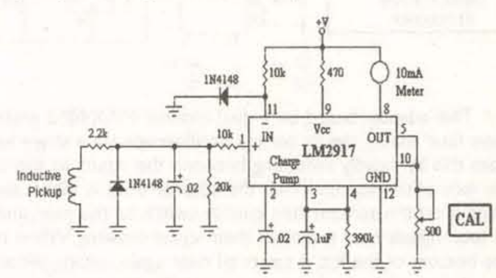


Motorbike Tachometer

Q. I have a motorized bicycle powered by a small two-stroke gasoline engine that I'm having a problem with. It keeps cutting in and out. Is there a circuit (or a commercial product) to tell whether or not the spark is still there when the engine cuts out, thereby indicating a fuel problem? Perhaps some inductive coupling to the spark plug wire? It must be battery powered. The spark is created by an engine driven magneto. I prefer a meter rather than a light because in daylight I can't see indicator lamps too well.

Tony Serra
via Internet

A. How about a tachometer? Not only will it tell you if there's a spark or not, but it'll display the RPM speed of the engine. Here's a simple 12-volt (actually, 8 to 16 volts) circuit built around an LM2917 frequency-to-voltage converter chip.



An inductive pickup made from a 100 uH coil placed next to the spark plug wire feeds one pulse per revolution to the LM2917. SMT (surface mounted) devices are smaller and easier to install. Alternatively, you can try wrapping a few turns of insulated wire around the spark plug wire. Here, you'll have to play it by ear to determine how many turns of wire are needed to trigger the IC. I'd guess 6 to 30 turns, but this will vary according to your engine. Fortunately, you can test the tach circuit to see if it's working before installing the sensor. The signal is then rectified, filtered, and input to the LM2917. Inside the IC is a charge pump that integrates the pulses into a DC voltage that's directly proportional to the input frequency. From here it's buffered and adjusted (using the CAL control) to drive the current meter for an accurate RPM reading. This step can be eliminated if all you want to do is see if the spark is there or not. The meter is available from **Mouser Electronics (1-800-346-6873; http://www.mouser.com)** for about $15.00 and the IC can be found under the guise of NTE995 (about $3.00) from RadioShack and others if you can't locate the original.

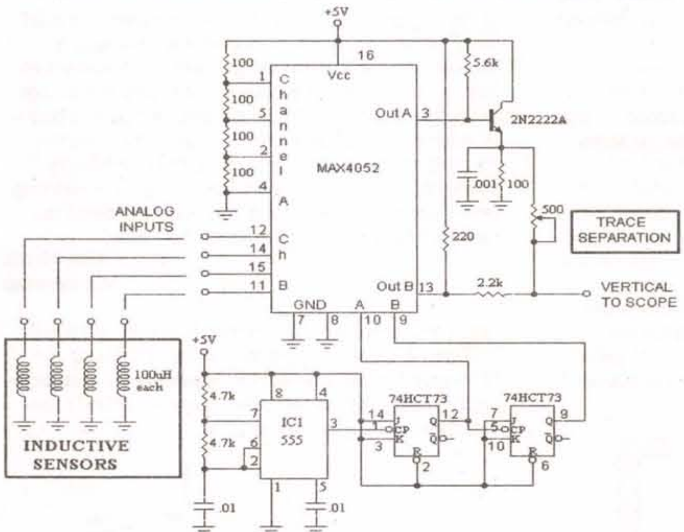
If everything is working properly, the meter will register a speed of 3600 RPM. Use the 500-ohm CAL potentiometer to adjust the pointer needle to your selected scale reading. Now replace the transformer with the sensor coil ... and you're done.

Automotive Analyzer Update

Q. I'm considering building the automotive engine analyzer you described in the Aug. '99 column. My problem is that my vehicle (a '96 Mercury Grand Marquis V8) has four coils with two cylinders that fire together in series. Each spark plug then fires once per revolution on the compression and exhaust stroke. Can I use an inductive pickup loosely coupled to the four HV wires coming out of the coil pairs? What can I use as an inductive pickup? I would also like to purchase software and interface cables to use with my PC to read OBD-II trouble codes from my vehicle computer. Do you know where I can purchase this equipment?

Ken Overland
via Internet

A. Oh boy, this is a tough one because you have four coils, so let's look at it one section at a time. You'll still need to derive the horizontal from spark plug #1 as described in the Aug. '99 issue, so that's cool (actually, you can use any plug wire to trigger the sweep). You can also use this signal for the tachometer (the Points In on the block diagram) so that the sweep rate will follow the engine RPM. As for displaying the individual plugs on the vertical input, that's harder because you have four signals. What I'd do is use a scope capable of displaying four traces on one screen. Don't have a four-trace scope? Not a problem. This circuit will give your single-input scope that capability.



This adapter, based on a dual-channel MAX4052 analog multiplexer, displays four analog signals on any oscilloscope via a single vertical input port. It does this by rapidly switching between the inputs as the trace sweeps across the face of the screen. What the adapter does is take a slice of each input and place it on the screen, then quickly switch to the next and do the same, until all four signals have a slice of their signal showing. When the sampler reaches the bottom of the list, it starts all over again, adding yet another piece to the waveform puzzle. And so it continues. The limiting factor to this approach is that the sampling rate has to be fast enough so there are no significant missing slices. This circuit has a 10 kHz sampling rate, which is capable of handling digital signals up to 1 MHz and analog signals at least through the audio range. As for the inductive pickup, I'd use a surface-mount 100 uH coil placed near the coils HV output. A fouled plug will show itself easily using this scheme because the input gain is the same for all inductors. The problem now is sorting through this scramble of information and deducing which plug is the bad apple. Maybe you can narrow it down by swapping pickups. Just remember, I've never built or tested these circuits as a system, only individually and they work, but I can't guarantee they'll work in harmony together. This is just guidance; I'm sure some tweaking will be required.

As for finding hardware and software to interface your PC with OBD-II computer, here are two companies that sell it at very reasonable prices (starting at $122.00).

Alex C. Peper
http://www.obd-2.com/
EASE Diagnostics
1-888-366-3273; http://www.easesim.com/products.htm

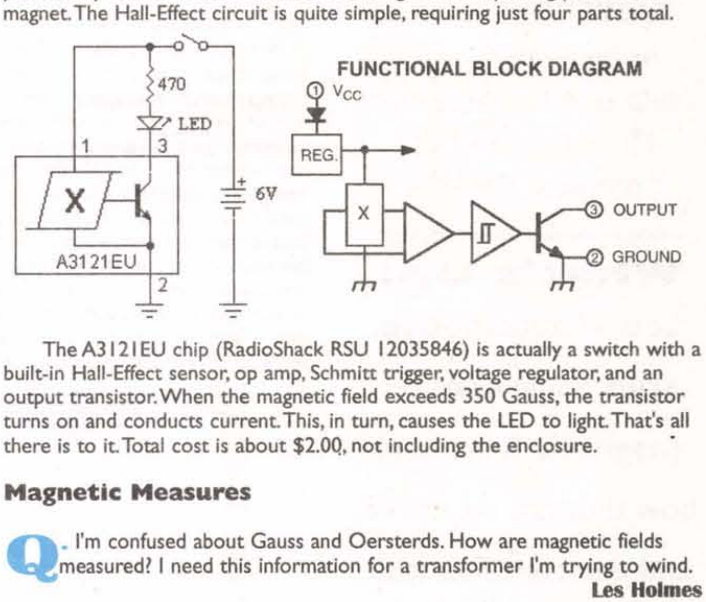
For those readers who don't know about OBD, it stands for On-Board Diagnostics and it is found in most cars and light trucks on the road today. During the '70s and early '80s, car makers started using electronic means to control engine functions to meet the newly imposed EPA emission (smog) standards. Since these "computers" were monitoring the engine's vitals already, it was a short step to interface with computer-based diagnostic equipment. Through the years, the process became more sophisticated, with a lot of variations along the way, until 1996, when the industry agreed on the OBD-II standard. Bottom line, if you want to know the health of your car, including details about the transmission and suspension, these readout gadgets can save you a bunch of bucks on car repair by catching a gremlin before it becomes a headache — or a disaster. If the demand is enough, I'll expand on the OBD-II format in a future column.

Proximity Solenoid Tester

Q. I'm considering buying a pen-size instrument that detects strong magnetic fields, like that found in an electric solenoid valve. When the solenoid valve is energized, there is a strong magnetic field present that causes an LED in this little tester to light. I'm specifically thinking of one called "Little Devil," which sells for about $30.00. I wonder what the guts are in these testers?

Peter Stratigos
via Internet

A. I'm not sure what's inside the Little Devil, but I suspect it's a Hall-Effect sensor. Hall-Effect devices are unique in that they can detect and measure static magnetic fields; that is, unfluctuating magnetic fields like that from a stationary permanent magnet or electric solenoid. Inductive magnetic sensors, on the other hand, need a changing magnetic field — one where the field periodically increases and decreases in strength, like a spinning permanent magnet. The Hall-Effect circuit is quite simple, requiring just four parts total.



The A3121EU chip (RadioShack RSU 12035846) is actually a switch with a built-in Hall-Effect sensor, op amp, Schmitt trigger, voltage regulator, and an output transistor. When the magnetic field exceeds 350 Gauss, the transistor turns on and conducts current. This, in turn, causes the LED to light. That's all there is to it. Total cost is about $2.00, not including the enclosure.

Magnetic Measures

Q. I'm confused about Gauss and Oersterds. How are magnetic fields measured? I need this information for a transformer I'm trying to wind.

Les Holmes
via Internet

A. The units for measuring magnetic fields are Gauss and Oersted. Magnetic flux density is measured in Gauss, while magnetic field intensity is measured in Oersted. The ratio of B, magnetic flux, in Gauss, to H, magnetic field, in Oersted, is defined as permeability, "μ" (pronounced "mew"). The B/H ratio, or "μ," is a measure of the material's properties. It is high for ferromagnetic materials. In air "μ" is equal to one, making Gauss and Oersted identical numerically, adding to the confusion. Still confused? Me, too.

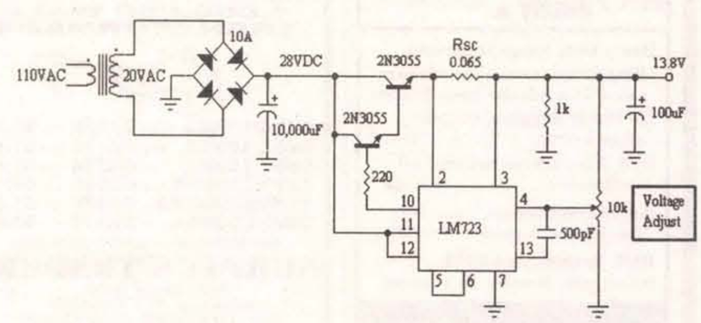
POPS (Plain Old Power Supply)

Q. I have two regulated power supplies which are not working. One is a Pyramid 30 amp and the other is an Astron 20 amp. The Pyramid was stripped by the previous owner and the Astron burned up the control board.

So now I have two good power transformers and rectifiers that put out about 25 to 30 volts unregulated; plus four 2N3055 power transistors on each chassis. All the rest is zapped. If you will, I need a circuit that I can use to put these supplies back in use — just a simple regulator circuit to hold at 13.8 volts would do nicely. Short circuit protection would be nice, but not necessary. Can you help?

Frank Schwartz
via Internet

A. This is an easy order, thanks to the venerable LM723 regulator chip. By itself, the LM723 can only provide 150 mA of output current, but external transistors can be added to provide load currents as high as 10 amps and more. The following circuit is an 8-amp, 13.8-volt power supply using the parts you have on hand.



The power supply is powered by a line transformer with a rectified output of about 28 volts DC (anything between 25VDC and 30VDC will work; but the higher the input voltage, the hotter the 2N3055 transistors will run). The 2N3055 is rated at 115 watts, 15 amps, so I've limited this design to 8 amps. By limited, I mean I've selected the value of the Rsc resistor, that's across the current limit (pin 2) and current sense (pin 3) pins, so that the power supply output voltage drops to zero when the 8-amp limit is exceeded. (If the input voltage is 28 volts, the output voltage is 13.8 volts, and the load current is 8 amps, then the 2N3055 has to dissipate 113.6 watts of heat — which is pushing the power envelope.) The formula is

$$Rsc = \frac{0.65V}{I(limit)}$$

In Search Of The Lost IC

Q. I have a scanner that has a bad IC, which for the life of me, I can't find a replacement. The markings on this chip are NJM3359. Do you have any answers?

Tim
via Internet

A. Well, finding replacement chips can be both tricky and frustrating. I get so many requests like this that I'm going to give our readers the "Yellow Brick Road" solution that I use to find IC replacement parts.

STEP 1: Try to identify the manufacturer. This will tell you if this is an over-the-counter chip or a propriety device. As it turns out, NJM parts are made by JRC, which tells me this is a stock part, which means it's worth my time to search it out. The table below is an overview of manufacturer prefixes, but it is by no means definitive. You can download this table from our website under the name ICPREFIX.PCX or ICPREFIX.DOC (Word 6.0 format).

STEP 2: Go to **QuestLink (http://www.questlink.com)** and enter the part number under Search. When searching, I usually drop the prefixes and all suffixes. For example, instead of searching for an NJM3359AN, I'll enter 3359. Yes, I get a lot of bad hits but, in this case, I discovered that Motorola makes an identical chip under the guise of MC3359. Make a note of this, because it will be helpful very soon.

STEP 3: If STEP 2 fails to produce results, go to the on-line catalogs and try the same type of search, using nothing but the 3359 search seed. Using this approach I discovered a lot of Amp connectors, but scrolling through the Mouser site produced, guess what — an NJM3359D for just $1.20. Here's where I'd normally stop, but let's say I couldn't find an NJM3359 or an MC3359. Then I go to STEP 4. Here's a list of the on-line catalogs that I use, in the order that I address them.

Digi-Key
http://www.digikey.com

Jameco
http://www.jameco.com

Tech America
http://www.techam.com

Newark Electronics
http://www.newark.com

Mouser Electronics
http://www.mouser.com

Allied Electronics
http://www.alliedelec.com/default.asp

Alltronics
http://www.alltronics.com

STEP 4: Look for a replacement part from **NTE (http://www.nteinc.com)**. While there are other replacement parts out there, like RCA's SK series, NTE is the most comprehensive. Incidentally, the NTE part numbers are identical to ECG part numbers, which are stocked by **Tech America (aka RadioShack; 1-800-877-0072, http://www.theshack.com)**. However, my search for an NJM3359 produced nada. Fortunately, my discovery of the MC3359 twin did find an NTE replacement, the NTE 680. I'd now go to RadioShack and order an ECG 860 and have the problem solved. Total cost, $5.60.

STEP 5: If all the above fail, I pull out the big guns and search the obsolete/obscure parts dealers. They are as follows:

Just In Time IC's
http://www.batnet.com/justintime/JUTIC.html

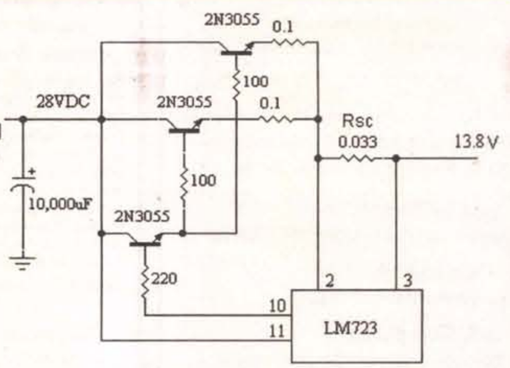
Onlinetechx
http://www.onlinetechx.com

D.R. Components
http://www.drcomponents.com/stockcheck.html

Surfing through these web sites produced three hits, two for the MC3359 and one for the NJM3359. Mission accomplished. What about chips you can't find, you ask? In 90% of the requests, I can find a replacement chip for you, but it's a low priority request and I don't normally publish the results. I'll send you E-Mail. But sometimes, it's a dead end. For example, a reader a while back needed a microprocessor chip for his Osterizer blender. That chip is no longer available, and I couldn't help him (they haven't made it for 20 years). Well, that's how I do it, and now you know how to do it, too. While this task isn't always easy, vendors like **ON Semiconductor (602-244-6600; http://www.onsemi.com)** provide second sourcing for many popular chips that lightens the burden. BTW, I'm open to suggestions for avenues that I can use to expand my search scope.

IC Prefix	Manufacturer	Phone Number	Web Site
ALDxxx	Advanced Linear Devices	408-747-1555	http://www.ald.com
ADxx, OPxx	Analog Devices	800-262-5643	http://www.analog.com
OPAxx, INAxx	Burr-Brown	520-746-1111	http://www.burr-brown.com
ELxxx	Elantec	888-352-6832	http://www.elantec.com
LMxx, RCxx, KAxx, uAxx	Fairchild	207-775-8100	http://www.fairchildsemi.com
MBxxx	Fujistu	408-922-9000	http://www.fujitsumicro.com
CAxx, HAxx, HCxx, HFxx	Intersil	407-724-7000	http://www.intersil.com
LFxx, LMxx, LTxx, OPxx	Linear Technology	408-432-1900	http://www.linear-tech.com
MAXxx, ICLxx	Maxim Integrated Prod.	408-737-7600	http://www.maxim-ic.com
MICxxx	Micrel	408-944-0800	http://www.micrel.com
LMxx, LFxx, LHxx, CLCxx	National Semiconductor	800-272-9959	http://www.national.com
NExx, SAxx	Philips Semiconductor	800-234-7381	http://www.semiconductor.philips.com
BAxxx	Rohm	--	http://www.rohm.co.jp
LMxx, MCxx, TSxx, etc.	STMicroelectronics	781-259-0300	http://www.st.com
TLxx, TLCxx, TLVxx	Texas Instruments (TI)	972-644-5580	http://www.ti.com
TAxxx	Toshiba	212-596-0600	http://www.toshiba.com/taec

Electronics Q & A



If you want to lower the output current limit, increase the value of Rsc. For example, a 1-amp load limit calculates out to be 0.65 ohms. To increase the output current, you have to parallel the top pass transistor. Just make sure you include a small 0.1-ohm resistor in series with the emitter leads and a separate base resistor (100 ohms) for each 2N3055 when paralleling them; the collectors can be tied directly together. Here's what that section of the circuit looks like.

Mailbag

Dear TJ:

In the Sept. '99 issue, Garry Iman asked about using a 115 VAC, 400 Hz Variac. You mentioned using two of them in series powered by the 60-Hz line. I find this questionable since it means the output has no neutral reference and some people may forget that these are autotransformers and there is no line isolation here.

I think there is a better use for this unit. I suggest placing the Variac across a 24 VAC transformer (RadioShack 273-1512 or better), and voila! — an adjustable 0-24 VAC source at up to 2 amps. The transformer provides isolation, the 24-volt secondary prevents saturation of the core (the source of the excessive current draw and overheating), and the Variac provides adjustability. I did something like this with a 12-volt transformer and a 48-volt 400-Hz Variac a while ago, and was surprised how handy this device can be. Just my $.02 worth.

Francis Grosz WD5IBJ
via Internet

Your suggestion is worth more than two cents! Thanks for sharing your discovery.

TJ Byers
Q & A Editor

Dear TJ:

The Dec. '99 Q & A suggested substituting a uA741 for a uA702, but I'm not so sure that it would work. The uA702 is a wideband amplifier, and Wavetek may have chosen it for that feature. The gain is low (about 2,000), but the uA702 can be configured for a gain of 100 with a 5MHz cutoff — that's a gain-bandwidth product of 500MHz. The uA741 has a gain-bandwidth product of about 1MHz, so, the substitution may fail. It depends on the circuit and the upper frequency range of the function generator (which was not given).

Jerry
via Internet

I contacted Bob Pease, who writes a column for EDN and was the co-inventor of the uA702, and he agreed that an LM741 would work in this application.

TJ Byers
Q & A Editor

The Controlled World: RS-232 Network Control Methods and Applications

Byte Bugs

by Ryan Sheldon, National Control Devices • (417) 646-5644 • www.controlanything.com

Simple is the name of the game with these exclusive, pre-programmed processors.

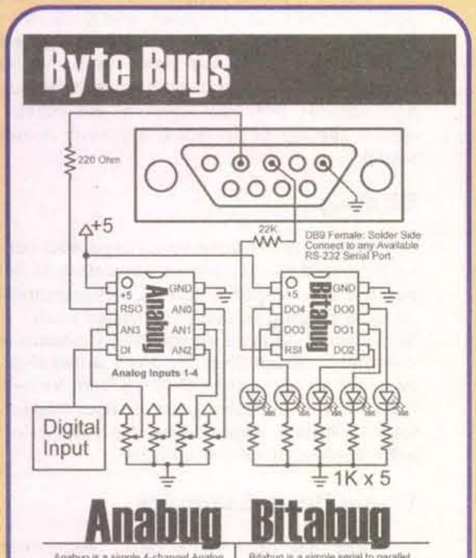
Simple is the name of the game, whether you are a beginner or an expert in the field of computer control. Sometimes you just don't have the time to learn a bunch of junk, you just want to get the job done as quickly and as cheaply as possible.

If I just described you, then our new line of Byte Bugs may be perfect for your next simple, low-cost computer-controlled application.

Byte Bugs are simple processors that are pre-programmed with simple instructions to do simple things. Designed by simple minds for the simple-minded, they are easy to wire up using only a few components. Put simply, they don't boast a lot of features or options, they just get the job done cheaply and easily with

Figure 1 (right) shows Anabug (left processor) with four analog inputs and a digital input; Bitabug (right processor) has five logic-level outputs.

Figure 2 (below) shows the schematic for the Anabug and the Bitabug attached to the serial port of your computer.

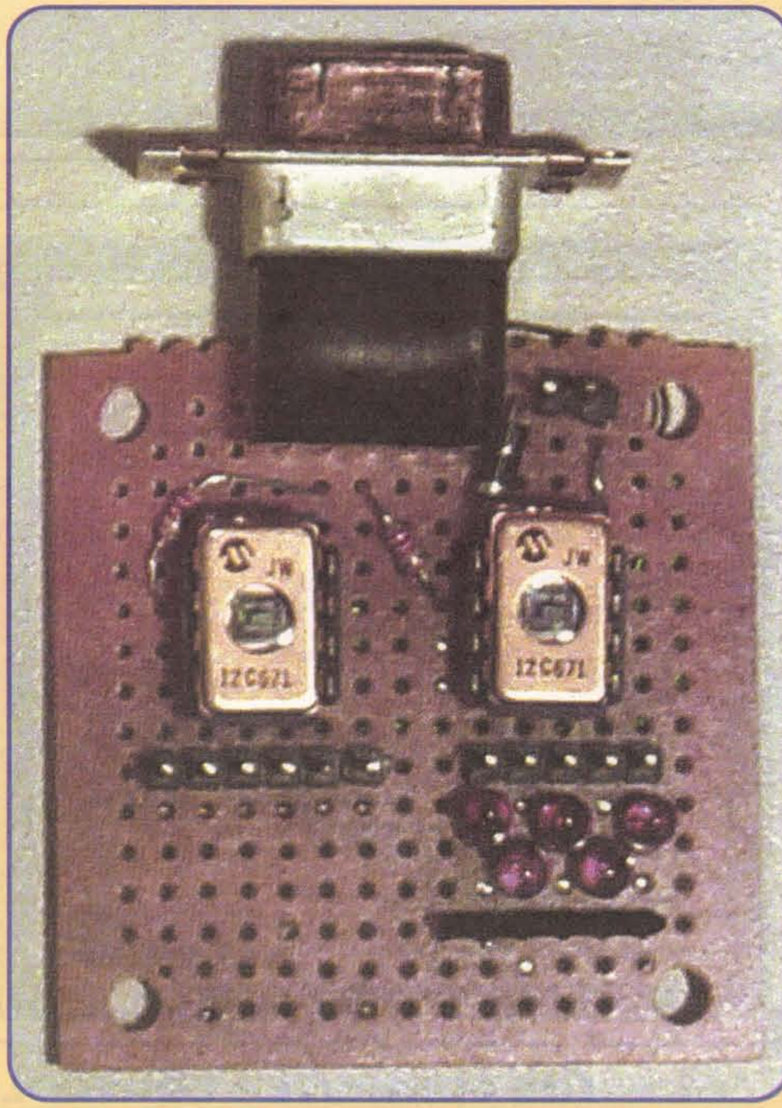


Anabug is a simple 4-channel Analog to Digital Converter. It simply reads the Analog voltage level (0-5 volts) on all four channels as well as one Logic-Level input and transmits a packet of data to your computer at 2400 baud. Anabug is an ideal low-cost solution for getting analog data into your computer with minimal electronics and programming.

Bitabug is a simple serial to parallel converter with only 5 output bits. Bitabug only responds to ASCII character codes 0 to 31 and outputs the equivalent binary data to the 5 logic-level outputs. Bitabug operates at 2400 baud and is ideally suited for controlling relays, LEDs, or other TTL logic.

Table 1

Byte	Description	Value	Details
1	Header Byte	254	Begins the data packet and is always 254.
2	Analog Input 1	0-255	Analog voltage on input 1 from 0 to 5 volts DC.
3	Analog Input 2	0-255	Analog voltage on input 2 from 0 to 5 volts DC.
4	Analog Input 3	0-255	Analog voltage on input 3 from 0 to 5 volts DC.
5	Analog Input 4	0-255	Analog voltage on input 4 from 0 to 5 volts DC.
6	Digital Input	0 or 1	Logic Level Input 0 or +5 volts DC.
7	Terminator Byte	85	Concludes the data packet and is always 85.



```
Project1 - Form1 (Code)
(General)    (Declarations)

Dim dat(10)
Private Sub Form_Load()

    MSComm1.Settings = "2400,n,8,1" 'Set Baud Rate
    MSComm1.CommPort = 1            'Set the Comm Port
    MSComm1.PortOpen = True         'Open the Comm Port
    Form1.Visible = True            'Show the Interface

    'Continuous Loop to Monitor All 5 Inputs
    Do
START:
        'Get 7 Bytes in the Packet
        For N = 1 To 7
            'Wait for a Byte
            Do
                DoEvents
            Loop Until MSComm1.InBufferCount > 0
            'Grab the Byte and Store in Array
            dat(N) = Asc(MSComm1.Input)
            'Sync the First Byte with the First Byte in the Packet
            If dat(1) <> 254 Then GoTo START
        Next N
        'Make Sure the Packet has been properly terminated
        If dat(7) = 85 Then
            'Set Level Meters
            ProgressBar1(0).Value = dat(2) 'Analog Input 1
            ProgressBar1(1).Value = dat(3) 'Analog Input 2
            ProgressBar1(2).Value = dat(4) 'Analog Input 3
            ProgressBar1(3).Value = dat(5) 'Analog Input 4
            ProgressBar1(4).Value = dat(6) 'Digital Input
        End If
    Loop

End Sub
```

Figure 3 shows the program code for receiving data from the Anabug.

```
Project1 - Form1 (Code)
Form    Load

Private Sub Form_Load()

    MSComm1.Settings = "2400,n,8,1" 'Set Baud Rate
    MSComm1.CommPort = 1            'Set the Comm Port
    MSComm1.PortOpen = True         'Open the Comm Port
    Form1.Visible = True            'Show the Interface

End Sub
Private Sub Command1_Click(Index As Integer)

    If Command1(Index).Caption = "OFF" Then
        Command1(Index).Caption = "ON"
    Else
        Command1(Index).Caption = "OFF"
    End If

    dat = 0
    If Command1(0).Caption = "ON" Then dat = dat + 1
    If Command1(1).Caption = "ON" Then dat = dat + 2
    If Command1(2).Caption = "ON" Then dat = dat + 4
    If Command1(3).Caption = "ON" Then dat = dat + 8
    If Command1(4).Caption = "ON" Then dat = dat + 16

    MSComm1.Output = Chr$(dat)

End Sub
```

FIGURE 5

no frills. So, if you are new to computer control of the outside world, Byte Bugs are an excellent place to start. This month, I am going to introduce two new Byte Bugs: Anabug and Bitabug.

Anabug

Anabug has four analog inputs, a digital input, and an RS-232 output. Anabug simply reads all A/D channels and the digital input, and sends a packet of data out the RS-232 port at 2400 baud. Your desktop computer easily decodes data packets, providing analog information from the outside world to your favorite programming language. Anabug data packets consist of seven bytes and are simple to decode (see Table 1).

Anabug constantly sends packets of data to your computer at 2400 baud. I recently connected a couple of audio lines to the analog inputs of the Anabug. Using the Anabug Monitor program (written in Visual Basic), I was able to get four channels of VU level meter effects that responded VERY fast to incoming signals.

Anabug packets are easily decoded in Visual Basic. Figure 3 illustrates a simple Visual Basic program that decodes data packets generated by the Anabug processor. In this example, the program starts by configuring the communication settings of your serial port. Once configured, the port is opened and the Monitor form is displayed.

The program then synchronizes itself to the incoming data packets generated by the Anabug. This is done by reading incoming data bytes into an array and looking for the 254 header byte. The header byte is stored as the first byte in the array. All subsequent data bytes are stored into the array until the terminator byte (85) is received. The terminator provides an extra level of protection in the event an analog value is read as 254.

Simply put, the program looks for the header byte (254) and the terminator byte (85) filled in the byte 1 and 7 slots, respectively. If these conditions are met, then the progress bars are updated with the current analog and digital values as shown in Figure 4.

Anabug runs at five-volts DC and does NOT require an external crystal or resonator. It only needs a power supply, a connector for the serial port of your computer, and a resistor to be fully functional. Anabug has four eight-bit A/D channels and a logic level input. Anabug is easily interfaced to temperature sensors, light sensors, potentiometers, or any other device capable of providing a 0-5 volt analog signal.

Bitabug

Bitabug is a simple serial-to-parallel converter with a five-bit output. Operating at 2400 baud, it only responds to ASCII characters 0 to 31. The Bitabug is easily controlled from Visual Basic, Qbasic, or the BASIC Stamp with minimal programming. Figure 5 shows how easy it is to control the Bitabug from Visual Basic. Figure 6 shows a simple user interface for the Bitabug. Simply click the buttons to activate/deactivate the outputs.

Visual Basic Examples

Note that these Visual Basic programming examples make use of the MS Comm Control for serial communications. The MS Comm Control is only available in the Professional

Figure 4 (left) shows the level meter interface for the Anabug.

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SOURCES:
BASIC Stamp II SX, Board of Education
Parallax, Inc.
3805 Atherton Road, #102
Rocklin, CA 95765
Phone: (888) 512-1024
FAX: (916) 624-8003
www.parallaxinc.com
info@parallaxinc.com

ASEL Video Switcher, R85 Relay Controller, VF Display/Controller

National Control Devices
P.O. Box 455
Osceola, MO 64776
Phone: (417) 646-5644
FAX: (417) 646-8302
www.controleverything.com
ncdryan@aol.com

FIGURE 6

and Enterprise editions. These programming examples are available from my web site at www.controleverything.com.

Availability

Other new Byte Bugs are planned for release in the year 2000. Currently, Anabug and Bitabug are the only ones available for purchase. Note that Byte Bugs are available ONLY to *Nuts & Volts* subscribers for the year 2000. They are priced at $8.00 each in single quantities or buy 10 for $59.00 (it is okay to mix and match). But you MUST have a *Nuts & Volts* subscriber number to purchase. **NV**

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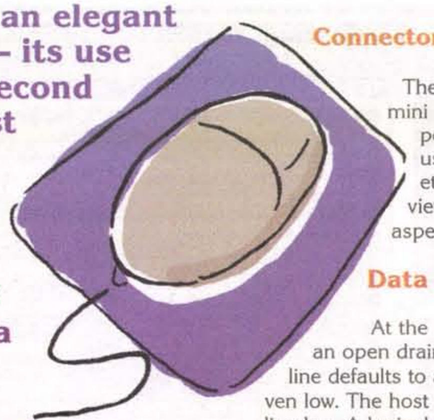
I would also like to encourage first-time readers to subscribe to *Nuts & Volts* magazine. Last month, we introduced our 10-piece pricing for *Nuts & Volts* readers. Your response was so overwhelming that we decided to offer this pricing plan permanently. We are offering special prices to *Nuts & Volts* subscribers, which can easily save you the cost of the subscription in just a couple of months. We are also offering a FREE upgrade to UPS two-day delivery (domestic shipment only) with a valid subscriber number.

Here's how it works: Subscribe to *Nuts & Volts* magazine. On your *Nuts & Volts* mailing label, you will find a subscriber number. Call us with your order and current subscriber number and receive ANY NCD device at the 10-piece price. *LIMIT ONE DEVICE PER SUBSCRIBER PER MONTH.* Don't let your subscription lapse, because the savings are ONLY valid as long as you are a *Nuts & Volts* subscriber.

BUILDING A BETTER MOUSE TRAP — PART 1

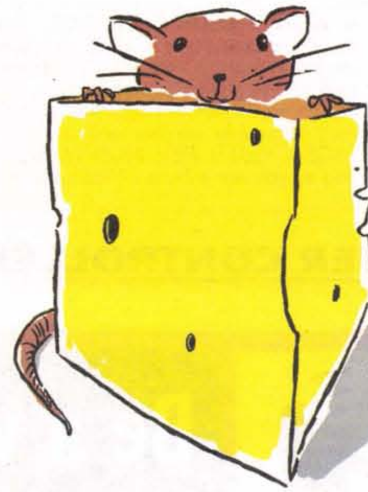
by Steve Parkis

The mouse is an elegant input device — its use has become second nature to most computer users.



Although usually found plugged into a computer, a mouse could serve as a nifty input device for programming your VCR, controlling your model train layout, or other homebrew gadget of choice.

This article describes the PS/2 mouse interface and how to build one with just a single chip — the Scenix SX28 microprocessor.



Introduction

This discussion's scope is limited to a standard, two-button PS/2 mouse from the logical perspective of the plug at the end of the mouse cable. The remarkable optical, electrical, and mechanical functions within the mouse itself are not addressed. The included assembler program is a series of low-level routines to send commands to and receive data from the mouse. These routines may be viewed as building blocks from which a custom, useful mouse-controlled project may be developed. The program also includes an LCD interface used to analyze mouse activity.

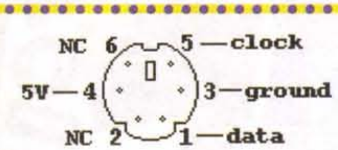


FIGURE 1. MOUSE CONNECTOR

Part 2 will use the interface to implement a mouse + LCD menu capability for Parallax's BASIC Stamp. The third and final article in this series will show how programming modifications alone provide a PS/2 keyboard interface for use with a BASIC Stamp.

Connector

The mouse plugs into a six-pin mini DIN connector. Four of the possible six connections are used. Figure 1 shows the socket's numbering scheme as viewed from the plug insertion aspect.

Data Line

At the physical layer, the data line is an open drain interface. In other words, the line defaults to an open, 5V high unless driven low. The host or the mouse may drive this line low. A logical 1 is represented by 5V, while 0V signifies a logical 0. The SX28 host drives the line low by setting rb.0 — the connection to the clock line — to the output, low state. To release the line so it may assume a high state, rb.0 is set to input and the SX28's programmable, internal pull-up resistor for rb.0 is enabled. During data transmissions, the data line is sampled during low clock pulses.

Clock Line

The active-low clock line duplicates the open drain physical configuration of the data line. Again, the host or the mouse may drive this line low, as described later. For now, remember that the mouse supplies the clock pulses for data transmissions in both directions, while the host drives the clock line low only to inhibit mouse transmissions. Mouse clocking cycles may vary from approximately 50 microseconds (µsec) to 150 µsec.

Data Exchange

All data exchanges between the host and the mouse occur as synchronous serial transmissions. A logical transmission unit consists of a low start bit, an eight-bit byte transmitted least significant bit first, an odd parity bit, and a high stop bit. Taken together, these 11 bits are often referred to as a serial data unit (SDU). A logical grouping of SDUs sent one after another is called a data packet. Transmissions from the host to the mouse are always commands. The mouse may transmit command acknowledgements, status information, or operational data.

Host-to-Mouse Transmission

Commands to the mouse should only be initiated when the interface is idle, i.e., when clock and data are released (high). To begin transmitting an SDU, the host seizes control of the interface by driving the clock line low for ~200 µsec to inhibit mouse transmissions. At the end of this period, the data line is driven low and the clock line is released. The mouse interprets this configuration as a start bit. The mouse will shortly drive the clock line low, which is a signal to the host to present the low order data bit value to the data line. After sampling the data line, the mouse releases the clock back to a high state.

This process is repeated seven more times as the host presents successively higher order data bits in response to the low clock pulses. A ninth clock pulse from the mouse signals the host to provide the parity bit value, and a 10th clock pulse prompts the host for the stop bit. Finally, the mouse pulls the data line low and generates an additional clock pulse to acknowledge receipt of the SDU. The interface is then returned to the idle condition.

Following receipt and execution of a host command, the mouse will typically transmit an acknowledgement SDU back to the host. However, the set loopback mode and repeat last data packet commands are not acknowledged in this manner. Invalid commands result in a nack SDU returned by the mouse.

Mouse-to-Host Transmission

The mouse will not initiate SDU transmissions unless the interface is idle. To begin transmission, the mouse drives the data line low and pulses the clock low, which the host must recognize as a start bit. Eight succeeding low clock pulses then signify the presence of data bits to be sampled. A 10th pulse accompanies the parity bit, and a final low pulse indicates the stop

bit is on the data line. The host has the parity and stop bits at its disposal to verify the SDU's integrity.

Mouse Functional Modes

In normal operation, your mouse accumulates displacement information over an interval of time. When the interval expires, the mouse transmits a summary of movement during the reporting interval along with the then-current status of the mouse buttons. Displacement is tracked and reported in terms of x axis and y axis counts, which have a direct relationship to millimeters (mm) moved left or right (x axis) and forward or backward (y axis).

Movement to the operator's left is reported as negative x displacement, and movement toward the operator as negative y displacement. Accumulated movement during a reporting interval that results in a return to the same location occupied at the beginning of the interval is reported as zero displacement. Similarly, a complete button press and release cycle that takes place after the start and before the end of a reporting interval is invisible in data reported to the host.

The reporting interval depends on several factors, the most important of which is the mouse's operational mode. In stream mode, the interval begins upon mouse movement or button press/release, and ends 1/200 to 1/10 second later (determined by set rate command).

This is the usual operational mode for a mouse used with a personal computer, and the default mode upon power application to the mouse (stream mode transmissions must also be enabled for data packets to actually be sent). In remote mode, a new interval begins after the previous interval's data packet was transmitted, and ends only when the host requests a subsequent data packet.

A third loopback mode — often referred to as wrap mode — is available for testing purposes. When placed in this mode, the mouse simply echoes any SDU it receives back to the host, excluding the send status and reset loopback mode commands.

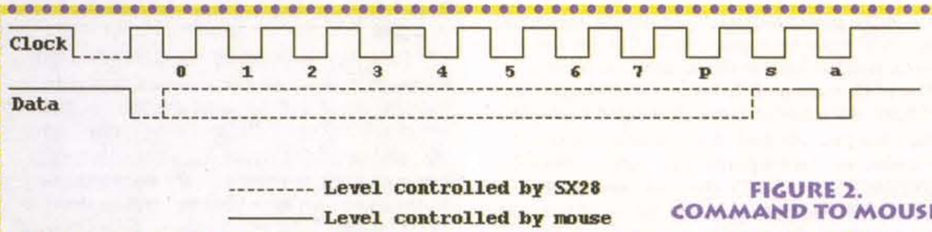


FIGURE 2. COMMAND TO MOUSE

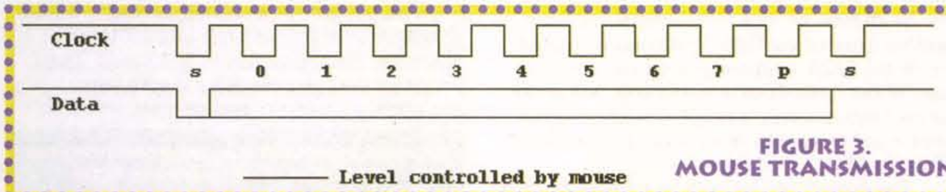


FIGURE 3. MOUSE TRANSMISSION

Mouse Commands

The interface implements 16 standard PS/2 mouse commands. The command identifiers and sequences are fully documented in the program code and not repeated here.

Data Packets

An understanding of the status and operational data packets allows effective use of the interface. See the program source code for a quick summary of the packet formats.

The mouse transmits a three-byte status data packet in response to a send status command. The packet contains the current button status, as well as operational mode status, resolution, and sample rate. The resolution (counts/mm) and scaling factor (1:1 or 2:1) together determine how many counts are reported for each mm of mouse displacement in the operational data packets. The sample rate determines the duration of the reporting interval when in stream mode.

Once the mouse is configured to the desired operating mode and parameters, most

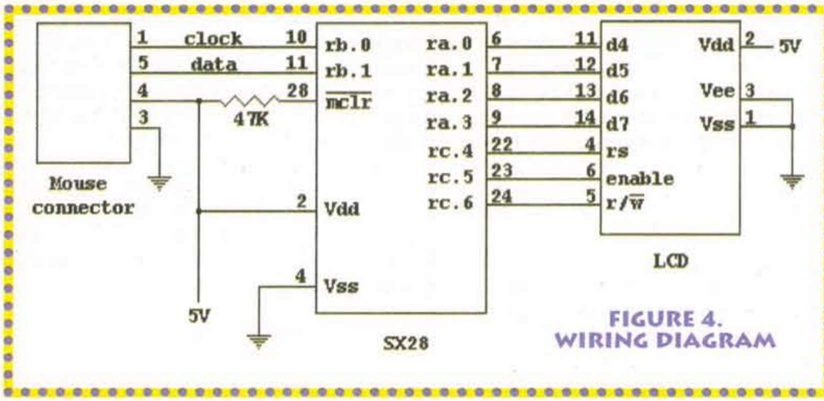


FIGURE 4.
WIRING DIAGRAM

activity revolves around the three-byte operational data packets. These packets are transmitted at the end of the reporting interval and contain the real meat of the mouse repast. The packet's first byte tells you if either button is pressed, and how to interpret the displacements indicated in the second and third bytes.

If bit 7 is set, the absolute value of the y axis displacement count exceeded 255, which is hard to do unless the reporting interval's duration is overly long.

Bit 6 reflects the same condition for the x axis displacement count. If bit 5 is set, the y axis displacement count in the packet's third byte is a twos-complement negative number.

Similarly, if bit 4 is set, the x axis count in the packet's second byte is a negative value. If the right or left mouse buttons were depressed when the packet was assembled, bits 1 or 0, respectively, will be set. The second and third bytes in the packet contain the interval's x and y displacement values.

Construction

A 5V power supply, PS/2 mouse and socket, SX28 microprocessor, and LCD are the only parts needed for this demonstration project. The LCD, such as B G Micro's 4x20 LCD1002 ($5.95, www.bgmicro.com/) is used to display the data packets and other mouse responses. Parallax Inc. (www.parallaxinc.com/) offers the SX28AC/DP for $4.25, the free, feature-filled SXKey28L assembler, and a choice of hardware programmers for the SX. Because precise timing is not critical for this demonstration project, the SX28 runs on its 4 MHz internal oscillator and no external oscillator/resonator is needed. Since the SX28's internal pull-up resistors take care of the open drain requirements, the entire project requires only a single discrete component — a 47K resistor from SX28 pin (master reset) to 5V.

The project can be built on a breadboard, if desired (the LCD 1002 header pins slip nicely onto a breadboard for quick prototyping). Connect the SX28, mouse, and LCD as shown in Figure 4. **NV**

DEMONSTRATION PROGRAM

The program configures the SX28 to use its internal 4 MHz oscillator. Program variables, equates, and macros are then declared and designed to maximize flexibility and readability. An initialization routine clears variable memory and prepares the LCD display. Subroutines occupy the low program memory locations due to typical first-half-page subroutine calling constraints.

Program execution consists of running through all mouse commands and displaying the results. A loop at the end of the program accepts stream mode data packets and displays more intuitive interpretations of their contents — try moving the mouse around and clicking the buttons to see the interface at work and how it could serve in your project.

The program's comments and modular structure should ease translation to an alternate microprocessor, if desired. The program was successfully tested with Logitech, Microsoft, and generic mice.

You can download this program from our website at www.nutsvolts.com

Newsbytes

Continued from page 16

Capture Web Sites, playing with DISCo Pump

Arsenal has released DISCo Pump version 3.1, a powerful and easy-to-use web site capture and offline browser program for Windows 98/95/NT4. DISCo Pump lets you conveniently save all or part of the Internet sites that you visit, and rebuilds the links on your local drive so you can browse them offline, without being connected to the Internet. DISCo Pump saves money because its offline browser lets you view important web screens without being connected to the Internet, avoiding connect time charges. Because DISCo Pump downloads sites faster than most off-line browsers, it saves you valuable time.

Users can interact with DISCo Pump as it is pumping data from the Internet. As the downloading begins, DISCo Pump tells you which pages have been read, which are waiting to be read, which were saved in previous download sessions, and which were excluded from the process by the user. You determine from how many levels into a web site you want the program to pump data, and which pages you want to ignore.

Using the Explorer-style file tree interface, you can just while pumping specify which branches to expand, and which to ignore. Broken Internet connections are detected and corrected, and DISCo Pump restarts the download process at the point where the interruption occurred.

In addition to the file tree interface, you can use DISCo Pump's navigation map and approach the captured web site by viewing the hierarchical structure of the downloaded documents. With either view, DISCo Pump offers draft preview of any downloaded pages. Thus you can navigate the entire downloaded site, quickly and easily.

DISCo Pump version 3.1 costs $29.95(US). You can download a trial version of DISCo Pump or purchase it online from

http://www.disco-software.com/pump.htm

E-Mail: arsenal@ars.ru

New Product News

NEW COMPONENTS CATALOG

Jameco Electronics announces the release of their latest catalog 994 "Your Component Path to the New Millennium."

The free 150-page catalog features thousands of ICs, components, tools, test equipment, and computer products for OEMs, engineers, educators, and service/repair technicians.

More than 190 new products have been added including a new line of power supplies and converters by Volgen and Atmel ICs.

Jameco has also expanded their lines of data acquisition products by ComputerBoards, motors, USB products, Parallax basic controllers, SX chips, and much more.

Log on to www.jameco.com and check out the on-line catalog and Virtual Spec Room. Jameco features product photos, expanded descriptions, and a user-friendly ordering process from a secure web server. Look for new and special product offers and helpful tech tips.

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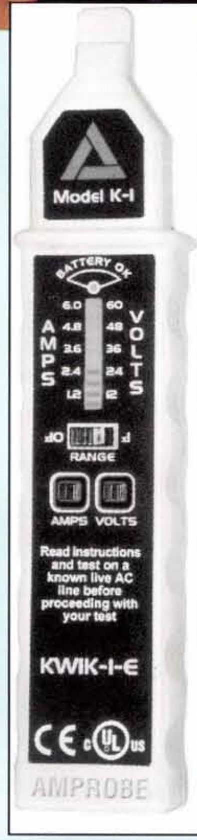

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TALK-N-TELL™

National Systems, Inc. announces its latest audio recorder and player. Dubbed the model MR460 Talk-N-Tell™ digital message repeater, the unit will record an audio message into electronic memory (no magnetic tape) up to 60 seconds long.

The unit is self-contained within the loudspeaker housing and may be triggered by a variety of external switches.

Purchasers of the unit will record their own messages into non-volatile memory (no backup battery required), saving production costs and installation delays.

National Systems, Inc. also offers both mechanical and infrared push buttons, as well as infrared motion sensors to trigger the unit to play the message.

Customers may also use their own device to trigger the unit, the internal circuit only requires a switch closure or an open collector transistor to start the unit playing. The audio output volume is adjustable with a maximum of 10 watts of output power.

The basic cost is under $300.00 and is available from stock.

For more information, contact:

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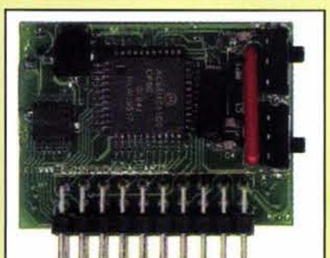

MICROSTAMP 11

Technological Arts has launched the first product of a new family, dubbed MicroStamp11. Billed as the world's smallest commercially available 68HC11 microcontroller module, MicroStamp11 brings the power and flexibility of Motorola's 68HC11 – one of the most widely used eight-bit microcontroller chips – to a whole new range of applications.

Utilizing a 68HC11(E)D0 operating in expanded mode, MicroStamp11 offers a rich set of hardware features including three input captures, four output compares, pulse accumulator, real-time interrupt, serial communications interface (SCI), serial peripheral interface (SPI) watchdog timer, 25 programmable interrupts, and up to 512 bytes of RAM.

Boasting 14 multi-purpose programmable input/output lines and two hardware interrupts pins, MicroStamp11 is particularly well-equipped for multitasking in real-time control and monitoring applications.

Measuring only 1.0 by 1.4 inches, Microstamp11 is available with a choice of 8K or 32K of in-circuit programmable EEPROM, and comes complete with on-board 5-volt regulator and low-voltage inhibit reset circuit.

Thanks to the 68HC11s well-engineered architecture and instruction set, MicroStamp11 can easily be programmed in all of the popular embedded control languages, including Assembler, C, BASIC, and Forth.

With a single-piece price of only US $34.00 (with 8K EEPROM), and US $45.00 (with 32K EEPROM), MicroStamp11 is ideal for a broad spectrum of applications requiring a compact low-cost 68HC11 core.

Loading code into MicroStamp11's EEPROM is made easy, thanks to a low-cost docking module, which provides a reset button, indicator lights, and an RS232 interface, to take advantage of the 68HC11's special bootstrap mode.

Technological Arts offers a starter package, which includes one MicroStamp11 module, docking module, serial cable, documentation, and a disk of DOS utilities and sample code.

A starter package for the 8K MicroStamp11 (MS11SP8K) is available for US $49.00, while a 32K version (MS11SP32K) is available for US $60.00.

For more information, contact:

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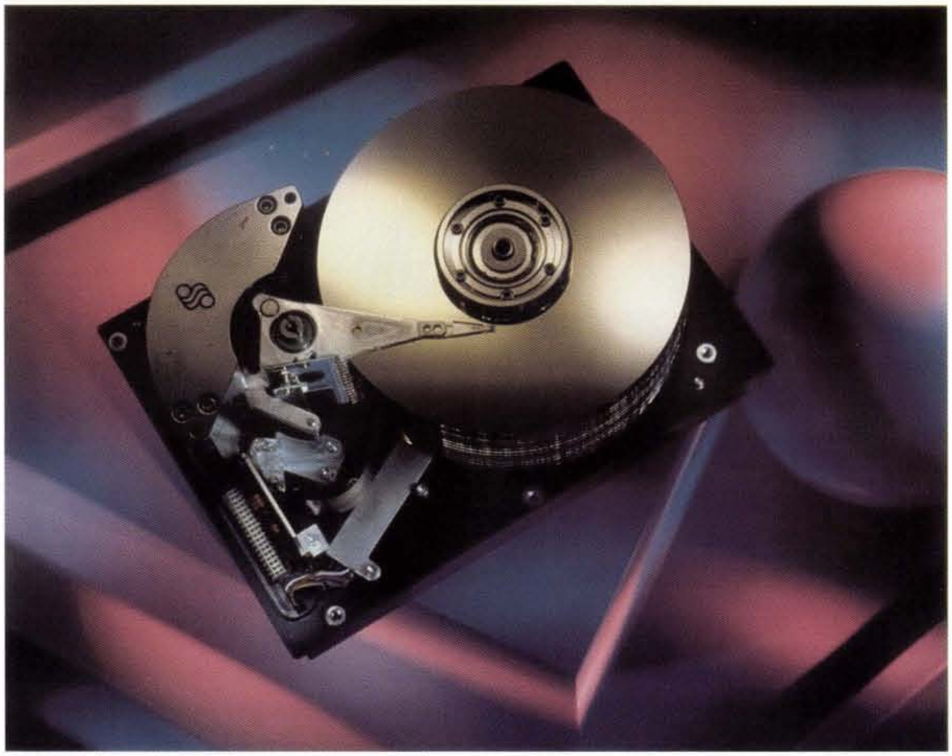

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