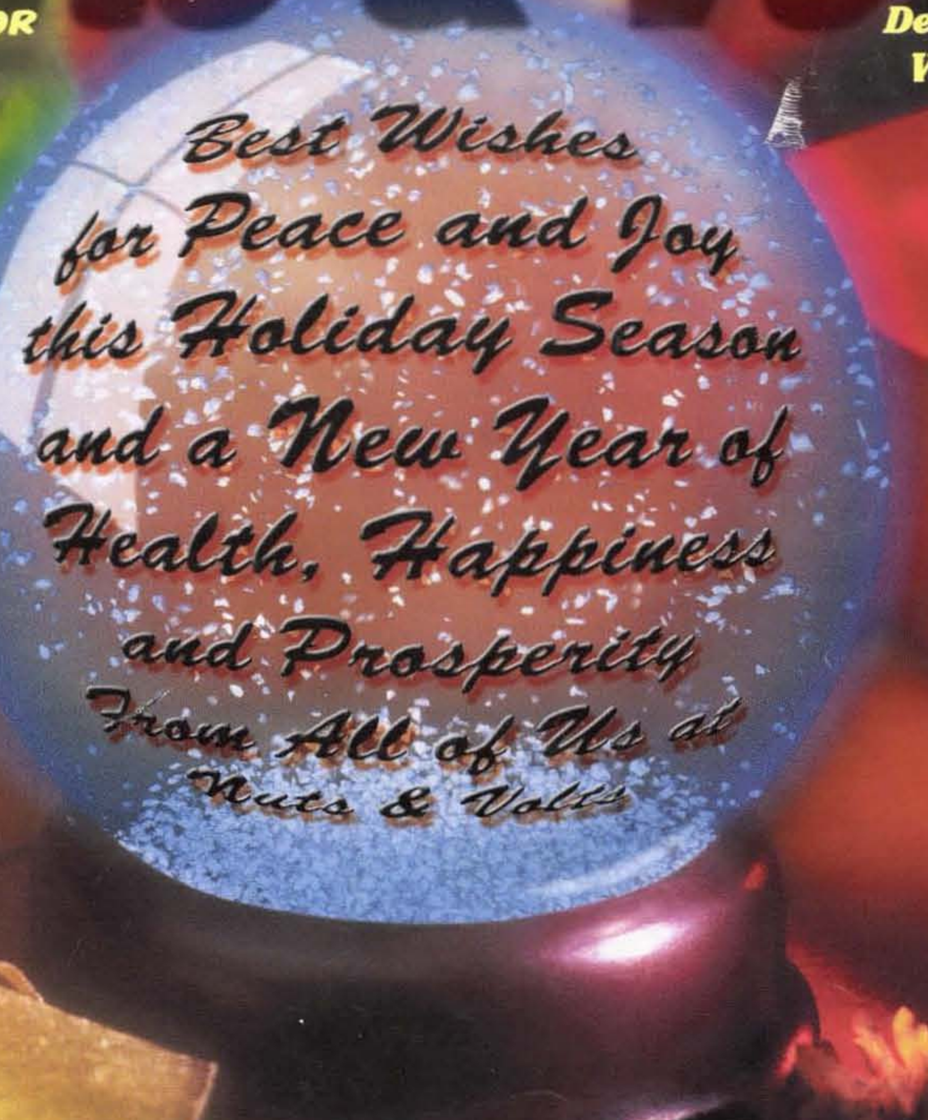
ROBOTICS · MICROCONTROLLERS · BUILD-IT-YOURSELF PROJECTS · TUTORIALS · CIRCUITS

Nuts & Volts

EVERYTHING FOR ELECTRONICS!

December 2000
Vol. 21 No. 12



U.S. $4.50 CANADA $6.50

www.nutsvolts.com

PROFESSIONAL DISK DUPLICATION

CLONE, TEST OR REPAIR ANY HARD DRIVE $995!

- SUPPORTS IDE, SCSI, SCA & NOTEBOOK DRIVES
- COPIES AND SERVICES HARD DRIVES
- PRINTS TEST REPORTS ON YOUR PRINTER
- DATA RECOVERY MODE BUILT-IN

Copy entire hard drives with this pro service station. Set up any SCSI or IDE drive with your original software. Attach a blank drive and press start. Make copies quickly and easily.

Use the built-in drive service system to make used drives run like new! Eliminate defective sectors, and restore hard drives to error-free condition with the factory re-mapping system. Test hard drives for top reliability using the built-in test feature. Print analysis reports on any standard parallel printer. Get the technology used by drive repair services. Call today!

25GB MP3 PLAYER $395!

after mail-in rebate

- PLAYS OVER 10,000 SONGS FROM HARD DISK!
- PLAYS STANDARD AUDIO AND MP3 CDs AND CD-R
- DOWNLOADS MP3 FROM CD-R TO HARD DRIVE
- POWER AMPLIFIER DRIVES SPEAKERS DIRECTLY

MP3 is here! Get high performance digital sound and store over 15,000 songs on hard disk. Download over 300 songs from a single CD!

Grab new music from the net. Use your PC to create custom MP3 CDs with just the songs you like. Load them to the internal hard drive for realistic, 3-D theater sound. Patented digital signal processing gives you crystal clear sound. No PC connection is required. Connect any stereo system, or directly power external speakers. Get digital sound and room-filling bass.

The hard drive organizes your music in folders. ID-3 tags display the title, album, and artist on a large LCD. Use the jukebox feature for an entire evening of great music. Play songs randomly or in sequence from the internal hard drive. Unlike CD changers, the A/V certified 25 GB hard drive won't wear out, even under continuous use. Call now and try your MP3 player tomorrow!

COPY ANY CD NOW NO PC REQUIRED from $995!

- MULTI-FORMAT DUPLICATION - FAST AND EASY!
- DUAL 8X DRIVES MAKE TWO COPIES AT ONCE
- INTERNAL 25GB HARD DRIVE STORES IMAGES
- PRO AUDIO MODEL HAS SP/DIFF AND ANALOG I/O

Instantly copy music and CD-ROM compact discs. Make backup copies of your favorite music and software on rugged, permanent CDs. Produce discs quickly and economically. Make custom audio CDs with just the songs you like.

Use our dual drive units to copy two CDs simultaneously, or choose the Pro Audio modelto make crystal clear music CDs from any analog or digital source. Dupe-It copiers are totally self-contained. No additional software or hardware is required. Call today for more information!

MULTI DRIVE IDE DUPLICATORS from $495!

- COPIES EVERYTHING, PARTITIONS, O/S, THE WORKS!
- BOTH STANDARD AND ULTRA, FOUR AND SEVEN DRIVE MODELS ARE AVAILABLE NOW!
- THE ULTIMATE HIGH SPEED PRODUCTION TOOL FOR SYSTEM BUILDERS AND CORPORATE MIS

Copy entire hard drives with ease. Multi-drive duplicators are an essential tool for dealers and system builders. Why spend hours installing and formatting drives when you can dupe them instantly? Work like the pros. Get your own multi-drive, stand-alone duplicators today. CSC offers a complete line of four and seven drive copiers in both standard and ultra versions. Ultra models transfer data faster than any hard drive! Rates of over 1GB per minute are supported.

Set up any IDE drive with all your original software. Attach blank target drives, and press "start". It's that easy! You can duplicate four drives in less time than it takes to copy one on a fast PC! Your duplicate drives will be identical, bit-for-bit perfect copies, with all the files, partitions, and information on the original drive. Building systems is tough enough. Why spend hours installing software? Save time. Save money. Call today and let us Fed-X your duplicator for a risk-free evaluation!

CORPORATE SYSTEMS CENTER
3310 WOODWARD AVE. • SANTA CLARA, CA 95054
WWW.DUPEIT.COM
408 330-5524

CSC

Over 80% of the Fortune 500 depend on CSC products. Shouldn't you? Call today. Most orders ship within 24 hours! Call now for more information and a free price comparison guide. Quantity discounts are available for dealers and system builders. Copyright laws must be observed when duplicating CDs and hard drives. © 2000 CSC.

Write in 209 on Reader Service Card.

HSC Electronic Supply

Serving Silicon Valley since 1964!

...brings you a potpourri of high-tech goodies for the techno-tinkerer!
For thirty years we have been your source for Silicon Valley exotica!

Nework Print Servers

- Milan 'Fastport' Model 3100
- 10BaseT, 10BaseT2 & AUI
- Serial and parallel ports
- Includes power supply and IEC cord

HSC# 18387 $45.00

- Milan 'Fastport' Model 3100CX
- 10BaseT Ethernet network print server
- Serial and parallel ports
- Includes power supply and IEC cord

HSC# 18386 $42.50

SCSI Drive Cases

Just in...two new styles of SCSI drive case. Perfect for those RAID systems, server backup, or other mass storage systems! Both feature: Power and drive status LEDs, front panel off/on switch, SCSI ID switch, fan-cooled switching power supply. Attractive beige color, curved front panels. Rear panel is punched for SCSI-1 (ICN-50) daisy-chain connectors, internal SCSI cable not included. Brand new in box, 90-day warranty

- Two-bay case
- RCA Jacks/ Sound Cable incl.
- Measures 6.3" x 7.0" x 11.25"
- 80-watt power supply

HSC# 18267 $39.95

- Four-bay case (similar styling to two-bay case above), no sound cable
- Measures 10.3" x 7.125" x 14.3"
- 200-watt power supply

HSC#18268 $49.95

...and two more cases!

- 3.5" compact SCSI cabinet
- Ideal for 1" high SCSI drives
- Built-in fan-cooled power supply
- Two 50-pin Centronics daisy-chain connectors & SCSI switch on rear panel
- New, with IEC power cord, 90 day warranty

HSC# 80545 $9.95

- CD-ROM drive tower case, made for Compaq Computer Systems
- Can handle 7 5/25" SCSI-I/II CD-ROM drives
- Includes 200W power supply, slides for drives
- Removable front and side panels
- Solid, heavy gauge construction
- Seven-position daisy-chain ribbon cable included
- New, 90-day warranty

HSC# 80544 $89.00

Keypad Mouse!

- 'Unia' mouse with multi-function keypad!
- Numeric & special function keys, including SHIFT, ALT, RETURN
- Unique all-in-one ergo design for easy data entry
- LED indicators, 400/1200dpi switchable
- PC/AT compatible, w 9-pin D conn.
- New, 90-day warranty

HSC# 80539 $9.95

Multimeter Specials!

- Model #AEEC-1890 3 1/2 Digit LCD DMM
- Adjustable large flip-up display for the easy viewing
- 0.5% basic accuracy, dual-slope integration A/D
- Measures AC/DC volts, ohms, current, capacitance, hFE & temperature (temp. probe included!)
- Ranges: 1000VDC, 700VrmsAC, 200 ohm - 200 Megohm, 20 mA - 20A, 2nF - 20 uF, NPN/PNP hFE
- Separate jacks for capacitors and transistors
- 'HOLD' function to capture measured peaks
- Soft rubber cradle protects meter, prevents skids
- Brand new! - With test leads
- Compare at prices of $70, $80 and up!

HSC# 80504 $39.95

- Some people just don't like digital meters...
- Soltec HM102S 20 KOhm per Volt Multitester
- Ranges: 0-1000VDC, 0-1000VAC, 0-50uA,0.5, 5, 50 & 500 mA, 0-20 MOhm with X1, X10, x1K & X10K ranges
- Standard banana-plug test leads, manual included
- Carrying handle/stand, measures 3.5" x 5.25" x 1.5", mirrored dial for parallax-corrected readings
- New...90-day warranty

HSC# 18260 $9.95

Disk Drive Deals!

- Seagate ST31722A 1.7 GB hard drive
- Great for back-up, add-on or small dedicated systems
- IDE 40-pin connector
- Brand new units
- Standard 1" high 3.5" form-factor
- 90-day HSC warranty

HSC# 18413 $37.50

- Seagate ST32171N "Barracuda Ultra-SCSI"
- 3.5" 2.16 GB hard disk drive
- 7200 RPM, 9.4 mS access time
- Packaged for Motorola product
- Brand new, with slide brackets
- OEM (Motorola) box, 90-day warranty

HSC# 18388 $49.00

- Seagate ST15150N 4.3 GB "Barracuda"
- 7,200 RPM, 8.0/9.0 ms avg. seek time
- 21 Hds, 11 Disks, 3,711 Cyl.
- Standard 50-pin SCSI
- Half-height size (1.5" tall)
- Refurbs, 90-day warranty

HSC# 18412 $99.00

Useful Utilities!

- Supercharge Windows with PowerDesk!
- Drag, drop files with multiple views, built-in ZIP utility
- View over 80 types of files -- Super search engine!
- Powerful email attachment decoder
- Instant graphic view of hard drive space
- Many more features...too much to list here!
- Windows 3.1, 95, 98 & NT compatible

HSC#18360 $9.95

- Conquer Zip files with "ZipMaster"!
- Use ZIP files without unzipping
- Saves tons of disk space!
- Makes regular ZIP files look like folders
- Integrated viewing previews over 50 file formats
- Handles ZIP, Z, RAR, ZOO, ARJ, GZ, TAR...MORE!
- Windows 3.1, 95, 98 & NT compatible

HSC#18361 $9.95

- Keep after the glitches with "Fix-It Utilities 99"
- Powerfui diagnostic and repair package
- View, open/convert 12 file types, 4 email formats
- Over a dozen hardware diagnostics
- NTFS, FAT, and FAT32 disk repair
- Integrated views for Work, Excel, PowerPoint, AVI files...MORE!
- For Windows 95, 98 & NT

HSC#18362 $9.95

Talk to your Computer!

- "Voice Express - Standard" (Version 4) L & H
- Talk...and your computer does the rest!
- Learns your voice in about 5 minutes
- 300,000+ vocabulary, with plug-in support
- "Say It Your Way" commands!
- Boost productivity + voice-enable applications!
- Works with Win 95/98/NT, Lotus, Corel, AOL...MORE!

HSC#18365 $14.95

- "Voice Express - Advanced" (Version 4) by L & H
- Learns your voice in about 5 minutes
- Accurately turns your voice to text
- "Say It Your Way" commands!
- Boost productivity + voice-enable applications!
- Works with Win 95/98/NT, Lotus, Corel, AOL...MORE!

HSC#18364 $19.95

- "Voice Express - Mobile Pro" (Version 4) by L & H
- Includes pocket-sized digital voice recorder!
- Speech recognition learns your voice in under 10 minutes! Works with favorite Window apps!
- "Say It Your Way" commands! 230,000+ words
- Dictate on the run or in the office
- Voice-enable 100's of applications!
- For Win95, 98 & NT

HSC#18366 $69.95

Standard — Mobile-Pro — Advanced

Rack-mount Chassis!

- Rugged construction for heavy duty server use
- Supports all standard ATX motherboards
- Industry standard 4U height
- 250W standard/350W surge high output supply
- Filtered cooling system, locking front panel
- Can mount up to ten drives
- Folding front handles, mounting ears & accessories
- Brand new, boxed with 90-day warranty
- Available in black or cream textured finish

HSC# 80540 Black $195.00
HSC# 80541 Cream $195.00

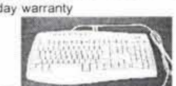
Do-It-Yourself Server Chassis!

- Standard 19" rack enclosure for 20-slot backplane
- 6.75"H x 24.25"D, heavy duty panels
- Brackets for 3.5" & 5.25" drives, power supply
- Front mounted 5-pin DIN with cable for keyboard
- Cabinet can be modified to accept AT-style motherboard (power extender cables included, some drilling required, no returns when drilled!)
- Hardware pack and IEC socket kit included
- Brand new, high-quality construction

HSC#18396 $99.00
Special, with 150W Power Supply $109.00

Comfort Keyboard!

- Dell Internet Keyboard, made by 'Microsoft'
- Special Internet "hot" keys for quick, mouse-less commands -- Ergo shape for comfort!
- Brand New...boxed, with PS/2-style connector
- HSC 90-day warranty



HSC#18367 $14.95

Power Supply Specials!

- Lite-ON model no. PS-5151, 145 watts
- 5V @ 18A, 12V @ 5A, -12V @ 0.8A 3.3V @ 7A, +5Vsb @ 0.15A
- Hi-Pot tested w/large cooling fan
- Standard ATX Form-factor
- Brand-new, 90-day warranty

HSC# 18350 $12.95

- Lite-ON model no. PS-4151-9B, 150 watts
- 5V @ 18A, -5V @ .3A, 12V @ 4.6A, -12V @ 0.3A
- Hi-Pot tested w/large cooling fan
- Standard AT "Mini Tower" Form-factor
- Brand-new, 90-day warranty

HSC# 18351 $14.95

- Power Computing TCX-20D
- Perfect for upgrading! Put modern motherboards into older cases
- 200W fan-cooled power supply
- Standard Mini-tower form-factor, ATX connector
- Units are brand new w/90-day warranty

HSC#18304 $17.50

Halted Specialties Co. HSC Electronic Supply

Toll Free (Orders Only) 1-800-4 HALTED (1-800-442-5833)
Internet World Wide Web: *http://www.halted.com*
3500 Ryder St., Santa Clara, CA 95051 (408) 732-1573
4837 Amber Ln., Sacramento, CA 95841 (916) 338-2545
5681 Redwood Dr., Rohnert Park, CA 94928 (707) 585-7344
-or- *FAX your orders to:* ***(408) 732-6428***

Watch HSC's Website!

- Changes are coming to our website...stay tuned!
- Simply point your browser to ***http://www.halted.com***
- We plan secure shopping, with shopping basket!
- Or, you can email your orders to ***hscmail@halted.com***

Weekly Web Specials!

- A new section has been added to our web page!
- Simply go to www.halted.com and click the top button!
- Items from our ads, as well as non-advertised items
- Also, you can download our catalog as Adobe PDF files

Terms: Some quantities limited; all items subject to prior sale. Minimum order: $10.00 plus shipping. Orders under $20.00 subject to $2.00 handling fee, in addition to shipping. All orders shipped FOB Santa Clara, CA (this means you pay freight!) by UPS Surface (no P.O. Boxes) unless otherwise specified, in which case prevailing carrier rate plus $5.00 handling fee applies. Prepaid orders that don't include shipping charges will be shipped freight COD. There is a $5.00 UPS charge added to shipping charges for COD shipments. If you have questions about your order, please call Customer Service at (408) 732-1854 M-F 9AM to 5PM PST.

Write in 215 on Reader Service Card.

VOLUME 21 • NO. 12 • DECEMBER 2000

Call our subscription *order only* line at 1-800-783-4624!!

Contents

Check out our special holiday subscription offer on Page 50!

... articles

columns ...

Classified Ad Index

Departments

Nuts & Volts (ISSN 1528-9885) is published monthly for $19.00 per year by T & L Publications, Inc., 430 Princeland Court, Corona, CA 92879. PERIODICALS POSTAGE PAID AT CORONA, CA AND AT ADDITIONAL MAILING OFFICES. POSTMASTER: Send address changes to Nuts & Volts, 430 Princeland Court, Corona, CA 92879-1300.

Holiday Project

Sequencing and Dimming – Add Some Pizazz to Your Holiday Lights

by Eric Gunnerson

A few years ago, my wife and I accidentally won third place in a holiday light contest in our development. In an attempt to win the rarely coveted first prize, I decided to do a microcontroller-based project. In the years since I first got into electronics (when we — to paraphrase Douglass Adams — thought that digital watches were a neat idea), the amount of equipment needed to do microcontroller work has decreased by quite a bit, so it was a good fit with my first project, an animated Santa, sleigh, and reindeer. In this context, "animated" means lights that are sequenced, not moving parts. At least for this year.

The project discussed in this article is the outgrowth of that first project, and it supports dimming of lights in addition to sequencing them. With two animations in the yard, the general illumination of the house in white lights had become a bit boring, so a change was in order. Rather than use a single string to outline the house, I'll use four (in red, green, blue, and white) and use my dimmer to slowly dim between them. The idea came from somebody who used X-10 dimmers and a computer to do this, but my implementation will be a bit cheaper and will operate stand-alone. It can also do chaser lights and fine (per cycle) control, which I've implemented, but which may not meet aesthetic standards.

This project involves potentially lethal AC voltages. It's not particularly dangerous, but please keep that in mind when you're working with the AC circuitry. If you use this project outside, you'll need to protect it from the weather.

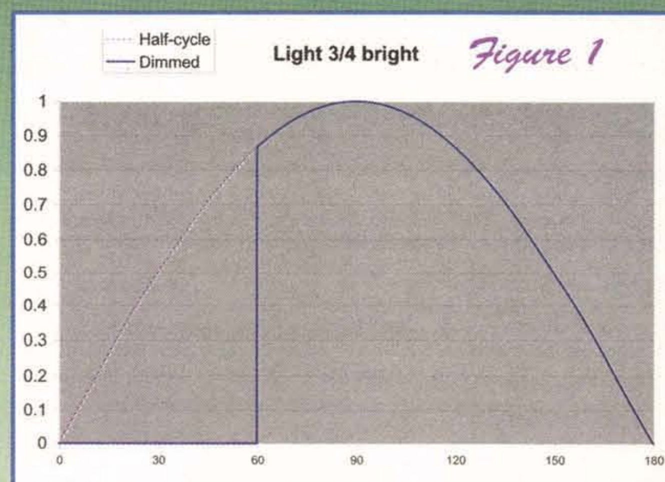
Switching and Dimming AC Lights

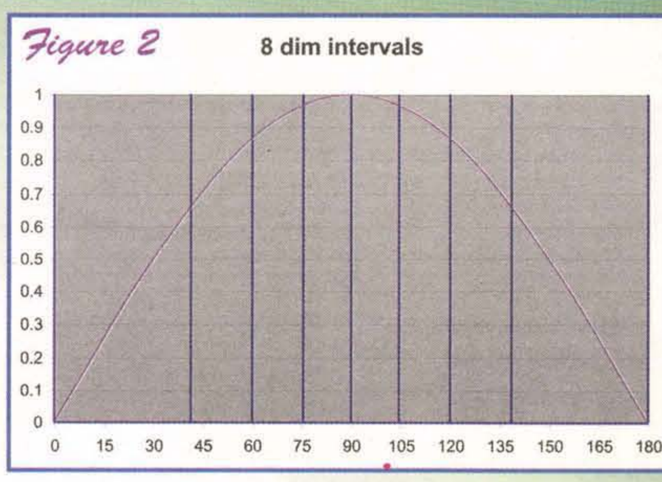
There are two ways to dim AC lights. The most obvious one is to simply reduce the voltage, which can be done either with a resistor divider, or an autotransformer (also known as a variac). Neither of these are good solutions in this case, because they aren't easy to control electronically.

Though incandescent light bulbs have very thin filaments, there is still some thermal mass in the filament, as evidenced by the fact that you don't see a 60Hz flash from them. Even though the current is switching on and off 120 times a second, the filament maintains a constant brightness. We can take advantage of this for dimming by controlling the duty cycle of the waveform rather than the voltage of the waveform. To do so requires that we delay our turn-on from the zero-crossing of the waveform.

As you can see in Figure 1, we can get the effect of three-quarters of the voltage by only turning the power on for the appropriate part of the cycle. To get other dim levels, we simply vary the time at which we turn on the power. Since the light output of the bulb depends upon the amount of power we send to it, we need to choose our intervals so that they represent intervals of equal power. The power is represented by the area under the waveform, which is why the line isn't at the quarter point.

It's easy enough to calculate this for as many dim levels as you want; the important point is that the intervals are not equally spaced. See Figure 2. This approach is fairly common in the DC world, as well; a heater can be nicely "dimmed" by varying





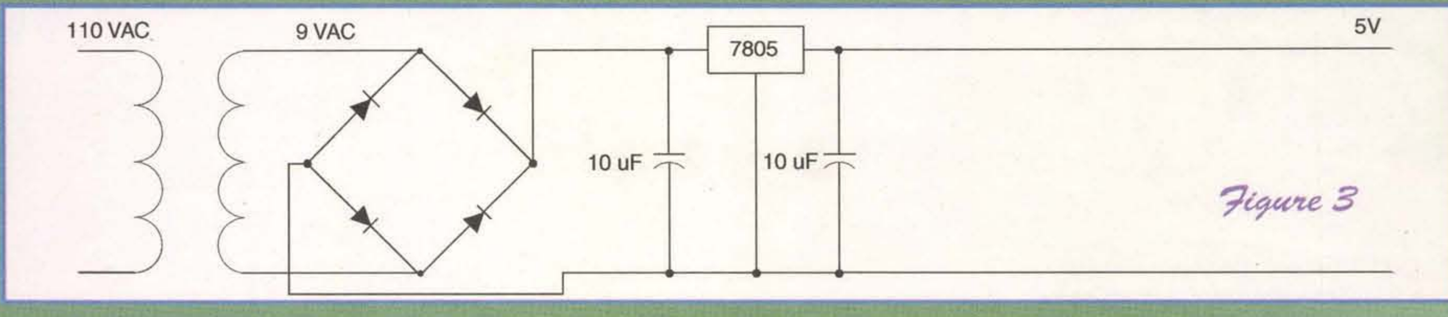


Figure 3

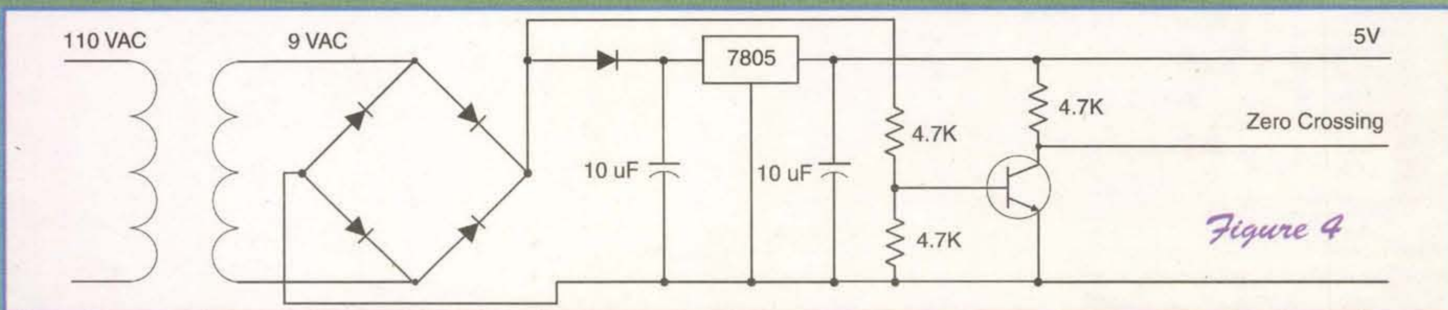


Figure 4

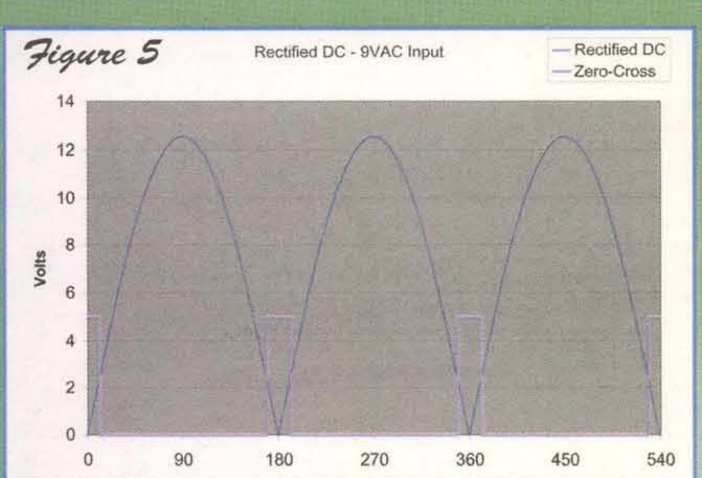


Figure 5

its duty cycle.

Doing the Switching

Now that we know how to do the dimming, we need to figure out how to actually switch the AC circuit. A triac is by far the most popular choice for controlling AC circuits. They are simple to use and interface, but they do have one interesting feature; once you turn a triac on, it doesn't turn off until the voltage across the load goes to zero. This makes them nicely suited to AC control, because the voltage goes to zero each half-cycle.

In most applications, it's easier to use a solid-state relay rather than a triac. A solid-state relay contains a triac, and can be thought of as an AC-switching black box; it isolates the AC world from the DC world (very important for safety), and switches with logic-level inputs. Most are also zero-crossing devices, which means they only switch as the waveform crosses zero, when voltage and current are low. This is nicer on the load (no sudden transients), and generates much less RF noise than switching at a random time.

For dimming, however, we have to be able to switch anywhere in the cycle, so zero-crossing doesn't work. I've chosen to use a solid-state relay without zero-crossing circuitry, though they are less common, and doing this has limited the amount of current I can switch. You can build your own solid-state relays if you wish to control larger amounts of current; see the references for a good starting point.

Hardware and Circuitry

Now that we understand how to do dimming, we need to choose the hardware we'll use to do it. I broke the circuitry into three modules: the zero-crossing circuit/power supply, the microcontroller, and the AC box. All of this will be contained in something sufficiently waterproof; I've found plastic toolboxes a good choice.

Zero-crossing Circuit/Power Supply

The zero-crossing circuit/power supply is quite simple. It starts as a standard 5V power supply using a 7805 regulator and a 9VAC transformer. This will provide power for the microcontroller and the solid-state relays. See Figure 3.

To generate the zero-crossing signal, we need to tap into the power supply after the bridge rectifier, so we get the pulsating DC at this point. The initial filter capacitor's job is to get rid of this signal, so we need to insert a diode in between the bridge rectifier and the capacitor.

Now that we have this signal, we want to generate a pulse when the signal is zero. We add a transistor with pull-up resistor and a voltage divider to the circuit. See Figure 4.

Figure 5 shows the pulsating DC and zero-crossing signals.

As long as the base voltage is greater than the turn-on voltage of the transistor, the transistor will pull the output to ground. When the voltage drops below the turn-on voltage, the transistor will turn off, and the output will be pulled high by the resistor. Since the pull-up is to the 5V supply, we get a nice pulse that is nearly symmetrical around the zero cross point. This signal is connected to an input pin on the microcontroller.

The width of the pulse is determined by the input voltage, the resistors used in the voltage divider, the diode drops in the rectifier, and the voltage at which the transistor turns on. Rather than try to measure this, I put the signal on the scope, zoomed in, and made a reasonable estimate to the width of the signal. This value is used later.

Microcontroller

For this project, I chose a Motorola 68HC11 controller (a 68HC811E2, to be precise). In my earlier projects, I chose this controller because it was fairly inexpensive, easy to deal with, and I had a local resource who had used them, and could provide technical support. It stores its program in EEPROM, and can be programmed over a serial link. It also lets me keep my assembly skills tuned up. For this project, the HC11 is especially nice, because of a feature known as output compare. More about that in the algorithms section.

The HC11 is built using Marvin Green's excellent BotBoard (see references). Though this board was targeted towards robotics, it's perfect for this project because it has a small prototype area for additional circuitry. Construction is very simple as long as you have a fine soldering tip and a magnifier (or young eyes).

AC Box

Putting all the AC components in a separate box makes life a lot easier; you can't shock yourself when working on the BotBoard. I use a standard dual-gang blue plastic box for my AC control. In it live two duplex outlets, giving me four circuits, and the solid-state relays glued to the backs of the outlets. Control signals are carried to the AC box via

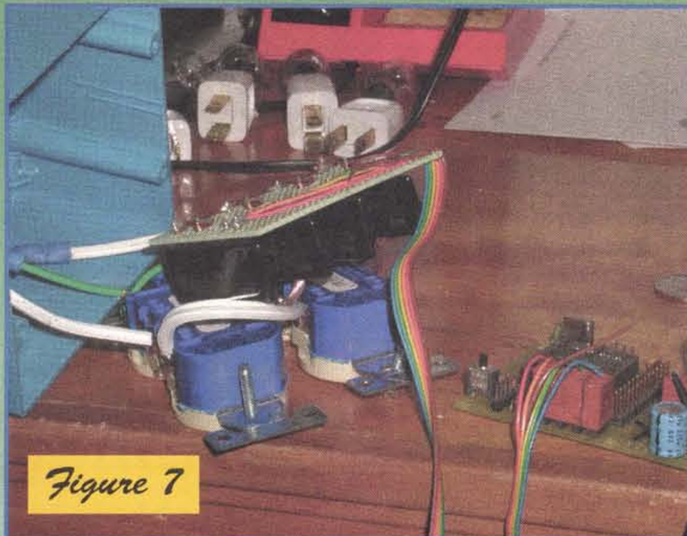


Figure 7

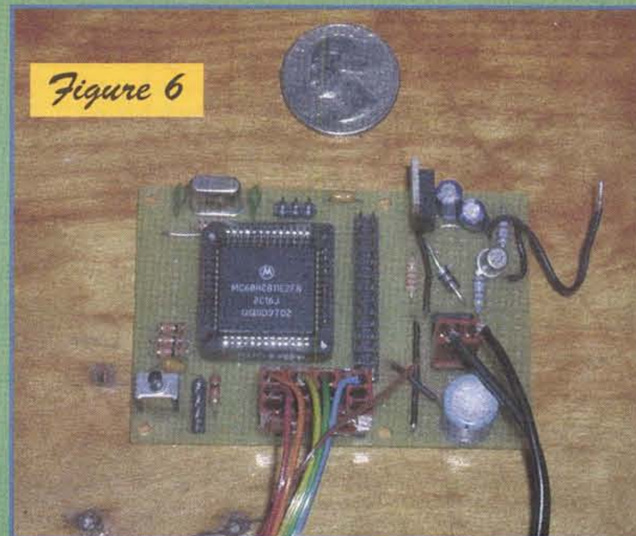


Figure 6

ribbon cable. A 3' grounded extension cord is cut in half; the plug end supplies power to the outlets, and the socket end brings AC power back out, so you have someplace to plug in the transformer.

Algorithms and Encoding

The HC11 has a sophisticated timer section that is perfect for this application. The timer section has a 16-bit timer that counts at 2 MHz, and a set of four output compare registers that correspond to four output pins. To make an output go high at a point in the future, merely take the current timer count, add in the delay offset, and store it in the appropriate output compare register. The HC11 will then set that output high when the counts match, without any program intervention. This simplifies the code immensely; the code merely has to set up the appropriate offsets for all four channels, store them to the output compare registers, and then have the rest of the half-cycle for housekeeping.

At the default count rate, the timer overflows every 32 (ish) mS, but a half-cycle is only about 8 mS, so there's no chance of overflow in this application

My current implementation supports 64 dim levels. These dim levels are stored in a table which encodes the offset needed for each dim level. Each count is 0.5µS, so to dim halfway, the count for 4.16mS (half of a half cycle, or 1/240th of a second) would be 8,333.

The Main Loop

Wait until the zero-crossing signal is received. This is done by polling the input that the zero-crossing signal is connected to. Store the current timer count.

Force all the outputs to low. This insures that when we get to the zero-crossing point, the relays will turn off.

Take the stored time count and add the offset that will get us to the true zero-cross.

For each channel, add in the offset for the current dim level, and store it to the proper output compare channel

Figure out the next offset for each channel
Go to step 1.

Because we want to be able to have an offset of zero (no wait to turn-on), this code has to finish executing before we hit the true zero-cross. The current implementation is fast enough to do this, but if it wasn't, I'd simply skip dim level 0 (zero offset), and only let dim level 1 be the brightest one. With 64 dim levels, the difference isn't noticeable.

The HC11 handles everything for us once we've finished step 4, so step 5 has until the next zero-crossing signal to get set up for the next half-cycle. This is something on the order of 16,000 clocks, which is a lot of code.

If you were doing this with a microcontroller without output compare – or you wanted to do more than four channels with an HC11 – it would become more complicated. You could use the first period to generate the information for the next cycle (assuming you can get it done in 1,300 clocks; the width of the first period at 64 levels). If that wasn't enough, you could do it piecemeal (yuck), or, if your microcontroller supports timer interrupts, set up a timer interrupt for the first period, and then have the interrupt service routine turn on any channels that needed to be turned on, and set up the next interrupt. This would allow the code for the next channel to run during the non-interrupt times, but would make the code quite a bit more complex.

Running at the same time are some timekeeping functions that handle starting the animation when it gets dark (about 4:30 in the Seattle area), running 4.5 hours, and then turning off until the next day.

All the code is written directly in HC11 assembler. There is an SBASIC compiler available, which you might want to use. I found I could write the assembly code fairly quickly once I got into the HC11 mindset.

Encoding

One of the real challenges of this project is coming up with a minimal encoding for the animations. For this project, each step is encoded in seven bytes:

Byte	Description
1	Type of animation (dim or chaser)
2	# of loops for this step
3	Cycles to wait between loops
4-7	Channel information

For a dim animation, a typical encoding would be:

1 3F 14 01 00 FF 00

This means we should do this step for 3F loops, and that each loop should happen after 14 cycles (1/6th of a second). At each loop, we should add 1 to the channel 1 dim level, and add FF to channel 3, which is the same as subtracting 1 from it. So, this encoding will ramp channel 1 from its current dim level (which had better be 0, or we have problems) up to 3F, and channel 3 from 3F down to zero. This will take 3F * 1/6th = 10.5 seconds.

Generating Tables and Encodings

Generating the offset table for the dim levels and the animation encodings isn't something you'd want to do by hand. I've therefore written some Perl scripts that generate both the dimming table and the animation encodings, which are then combined with the code and assembled using asm11.

After the code is assembled, it is downloaded to the HC11 with a utility called DL11. The interface needed to connect the HC11 to a standard serial port is detailed in the BotBoard documentation.

Construction

The BotBoard is built following the instructions. I usually populate the board fully even though I

References

Botboard	http://www.rdrop.com/users/marvin/botboard/botboard.htm
68HC11	http://www.nwlink.com/~kevinro/products.html
HC11 Reference Manual	**(68HC11RM/AD)** http://www.motorola.com
Solid-State Relays	http://www.hut.fi/Misc/Electronics/circuits/semiconductor_relays.html

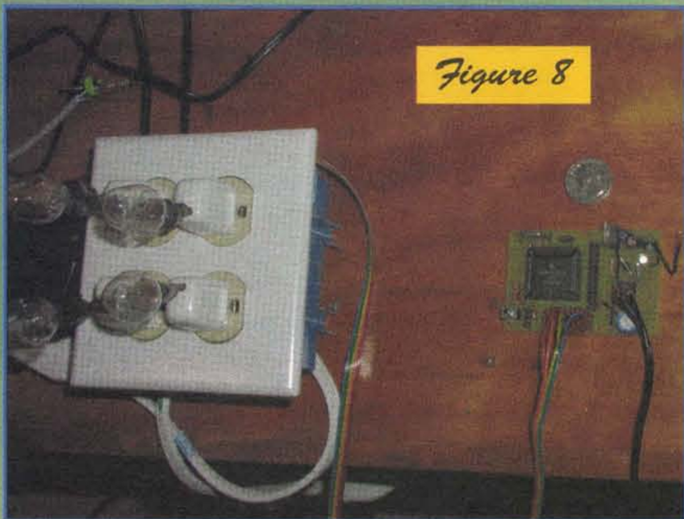


Figure 8

might not be using all the output pins at this time; it's easier to do now than later, and the extra headers are cheap.

In the prototype area next to the BotBoard, the power supply and zero-crossing circuits are built. I didn't breadboard the circuit first, which shows from my layout. It's not pretty, but luckily layout isn't critical for these circuits. The transformer connects to a three-pin header so it can be easily unplugged. See Figure 6.

The AC box holds the duplex outlets, with the bonding tab on the hot side broken off. The neutral wire for both outlets is hooked up, as are the grounds. A ribbon cable is hooked to the solid state relays, and then the whole business is placed in the box.

The appropriate connectors are then added to the ribbon cable. The BotBoard is designed to drive servos through these outputs, so the header locations aren't terribly convenient for this application. This required me to attach four individual three-pin connectors to the ribbon cable, and then use hot glue to create a single connector. See Figure 7. Figure 8 shows a picture of the whole project. I have night-light bulbs plugged into the outlets for debugging.

Debugging

Debugging an HC11 is interesting. I built a small status indicator out of a spare LED bar graph display I had lying around, and hooked it to a couple of four-pin headers. This can easily be slipped over the pins for the B port, so that debugging information can be written there. It's sometimes challenging to do debugging this way, but that's part of the fun.

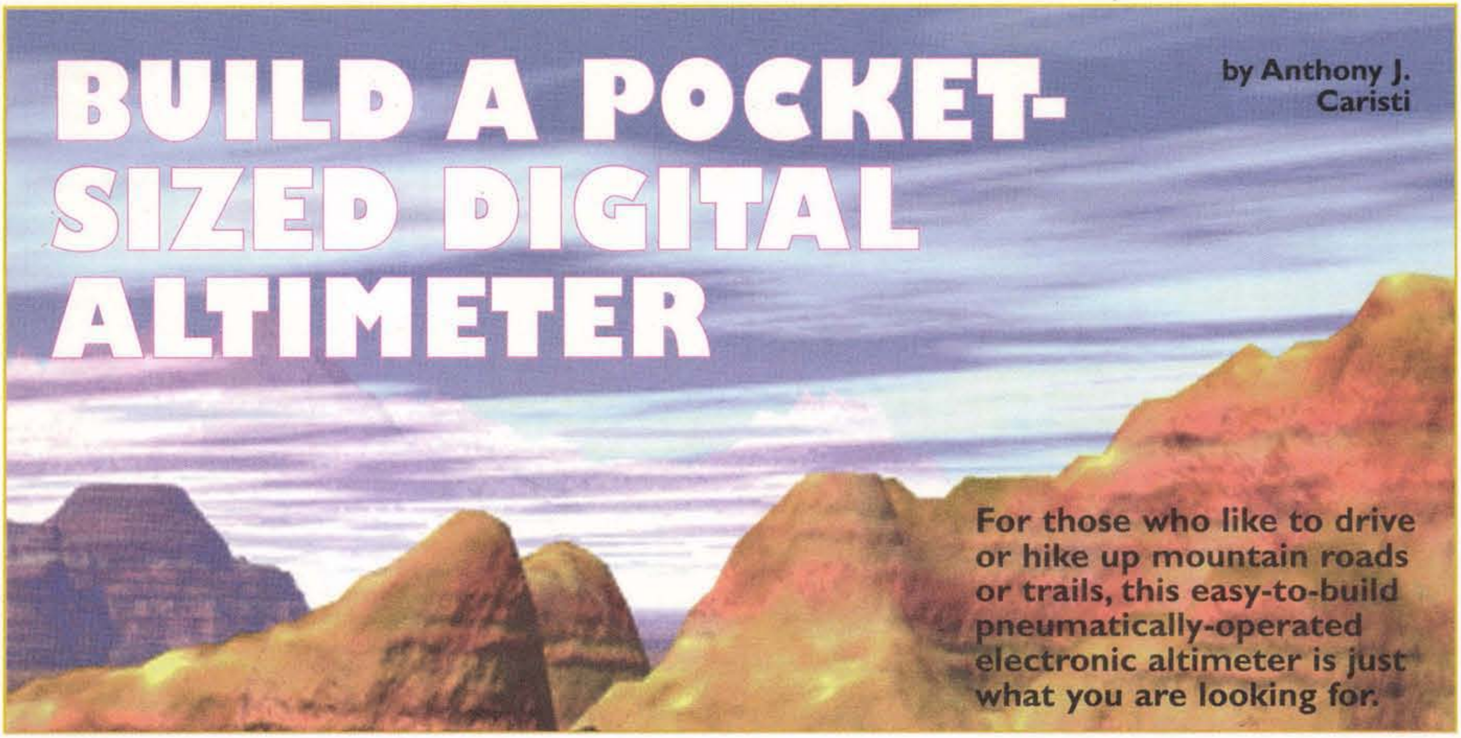
It's also useful to generate your own signals; I used this to determine closely when the zero-cross pulse starts. A simple loop finds the pulse, and then it's easy to wait for a given number of clocks, and then turn on the B port, and turn it off a short time after. With this signal on the scope along with the DC signal, it was easy to determine the interval to within a few clocks (a couple of microseconds).

Conclusion

Once you have the project built, you'll need to write the controller code or use mine (available on the *Nuts & Volts* website). Then you'll have to deal with the lights, which usually takes me more time than the controller.

Going Further

I've had a few ideas on where to go from here. A four-channel X-10 dimmer seems fairly straightforward, and if you can do that, you could add X-10 relay control easily. I'm also interested in using the A/D capability of the HC11 to do something that responds to people or cars. Perhaps a Santa who turns his head to follow you when you go by … **NV**



BUILD A POCKET-SIZED DIGITAL ALTIMETER

by Anthony J. Caristi

For those who like to drive or hike up mountain roads or trails, this easy-to-build pneumatically-operated electronic altimeter is just what you are looking for.

Unlike store-bought altimeters (which are in reality aneroid barometers calibrated in 200 feet increments of altitude), this digital instrument is a quality unit that is able to resolve changes of altitude as small as one or two feet! Its operating range is zero to 1,999 feet.

An altimeter, as its name implies, is an instrument that measures altitude or elevation above sea level. Pneumatic altimeters — present on every aircraft — use absolute air pressure as a measure of the height of the aircraft. Table 1 illustrates how air pressure varies inversely with altitude.

An altimeter, as its name implies, is an instrument that measures altitude or elevation above sea level.

This table assumes standard barometric conditions at sea level, which is defined as zero altitude.

The circuitry of the altimeter is remarkably simple, using one amplifier chip and a 3-1/2 digit A/D converter that drives a liquid crystal display (LCD). The circuit is contained on two small printed circuit boards that permit a compact assembly.

The unit is powered by a common nine-volt transistor radio battery, and is small enough to fit in a pocket. Since an altitude reading is usually taken only intermittently, battery life will be extremely long.

ALTITUDE FUNDAMENTALS

The most common method of determining altitude — or height above sea level — is to measure absolute air pressure which varies inversely with altitude. Pressure may be specified in several different ways, such as pounds per square inch, inches of mercury, or inches of water. Most people are familiar with the barometric reading often given in weather reports on TV and radio, usually specified as a quantity measured in inches of mercury.

Absolute air pressure is a quantity that is referenced to a perfect vacuum — zero pounds per square inch absolute (zero PSIA). The accepted level of absolute air pressure at sea level, measured under standard conditions, is 14.696 PSIA, or 29.92126 inches of mercury. When discussing altitude, pressure units in inches of mercury are generally used.

Although absolute air pressure varies inversely with altitude, the relationship is not linear. Refer to Table 1, a chart illustrating pressure versus altitude. This data, used as a basis for altitude measurement, is part of the accepted altitude/pressure tables used by manufacturers of air-

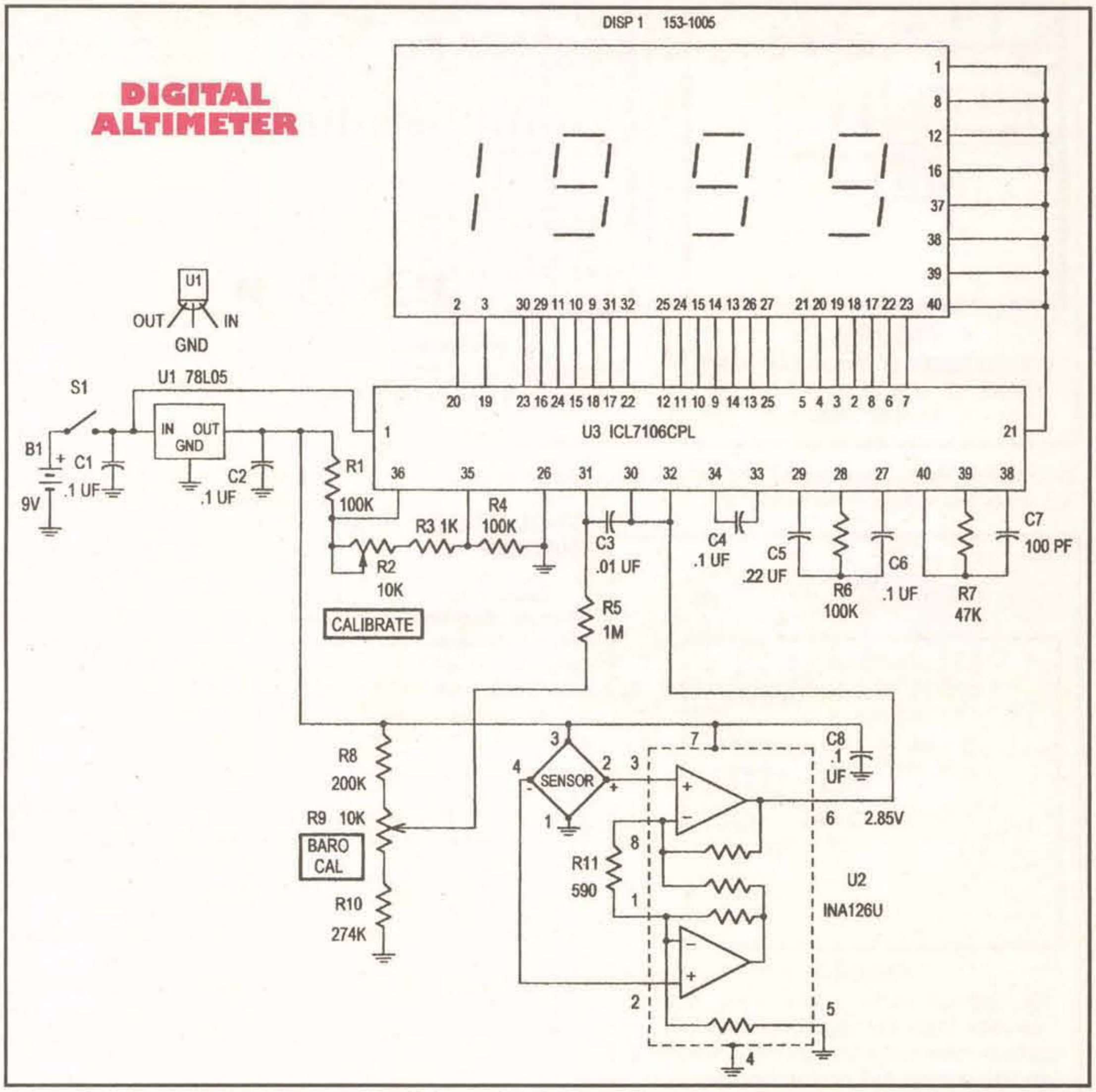
ALTITUDE IN FEET	ABSOLUTE PRESSURE IN INCHES OF MERCURY
0	29.921
200	29.706
400	29.491
600	29.278
800	29.066
1000	28.856
1200	28.646
1400	28.438
1600	28.231
1800	28.026
2000	27.821

TABLE 1
ALTITUDE VERSUS ABSOLUTE AIR PRESSURE

craft altimeters for calibration of their production instruments.

Note that the pressure change with an increase of altitude is a non-linear function, due to the compressibility of air. However, over the range of zero to 2,000 feet, the non-linearity is very small and does not result in any appreciable error in the altitude reading.

Note further that pneumatic altimeters are subject to variations of the prevailing barometric reading, since they are absolute pressure measuring devices. At sea level, a change of 0.001 inch of mercury in the barometric pressure translates to a change of one foot in the altitude display. For this reason all pneumatic altimeters, including this one, include a manually operated control which allows the user to set the instrument in accordance with the current barometric reading. This negates the effect of weather conditions which would otherwise cause an error in the display of altitude.



THE PRESSURE SENSOR

The heart of the altimeter is a solid-state device that is a product of modern integrated circuit technology. It converts the magnitude of ambient air pressure to a meaningful electrical voltage representing the absolute value of the pressure.

The pressure sensor is composed of a ceramic substrate upon which four piezo-resistive elements are ion implanted. The resistors are connected in a Wheatstone bridge configuration that is driven by a voltage applied to pin 3. With no stress on the substrate, the bridge is balanced and its differential output voltage — taken between terminals 2 and 4 — is zero.

The pressure sensor is designed so that the ceramic substrate separates two chambers of the housing. One chamber is sealed and evacuated at the factory to as perfect a vacuum (zero PSIA) that can be obtained by modern manufacturing techniques. The other chamber is exposed to the atmosphere.

At any altitude, the pressure difference between the two chambers of the pressure sensor causes the ceramic substrate to be stressed. As a result, the values of two of the resistors of the Wheatstone bridge become greater than nominal while the other two are less. This causes an unbalance of the bridge, which is a function of the pressure difference between the two chambers. Since one chamber is at zero pressure absolute, the electrical output of the bridge is a representation of the absolute pressure in the chamber that is exposed to the atmosphere.

The pressure sensor is designed to have a linear response to absolute pressure. At sea level, the nominal differential output of the sensor is about

Jumper #1	U3 pin 18 to display pin 9
Jumper #2	U3 pin 24 to display pin 11
Jumper #3	U3 pin 26 to circuit common

TABLE 2
DISPLAY BOARD JUMPER WIRES

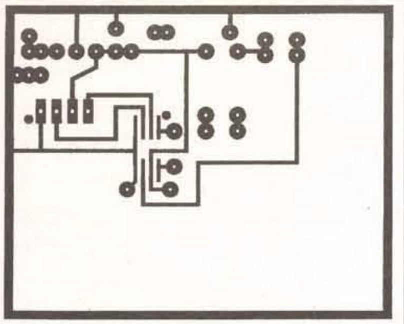


FIGURE 1
Printed layout of the analog board shown full size as seen from the copper side.

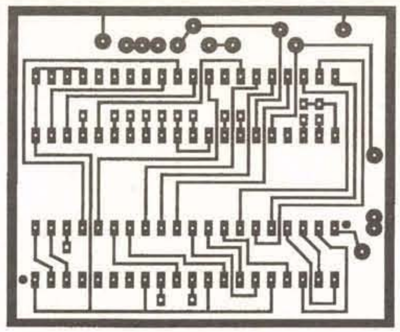


FIGURE 2
Printed layout of the display board shown full size as seen from the copper side.

Connection #1	Analog board +5 volts to display board U3, R1
Connection #2	Analog board +9 volts to display board U3, pin 1
Connection #3	Analog board R5 to display board U3, pin 31
Connection #4	Analog board U2 pin 6 to display board U3, pin 30
Connection #5	Analog board GND to display board GND

TABLE 3
BOARD-TO-BOARD CONNECTIONS

20.3 millivolts. At an altitude of 2,000 feet, the output voltage of the sensor falls to about 18.8 millivolts.

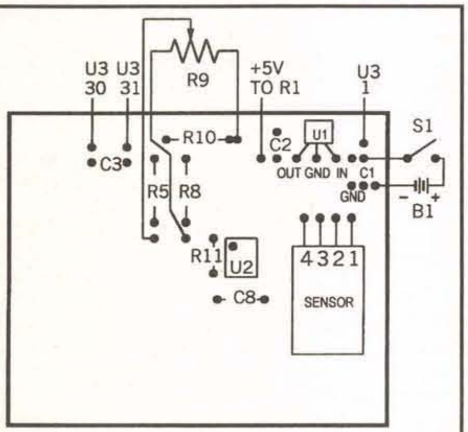


FIGURE 3
Component layout of the analog board as seen from the top. Note that U2, a surface-mounted component, is soldered to the copper foil on the bottom side.

ABOUT THE CIRCUIT

Refer to the schematic diagram. The circuit is powered by a common nine-volt transistor radio battery. U1 is a fixed voltage regulator IC that provides +5 volts to power the pressure sensor. The regulated supply is also used to generate a stable reference voltage for the A/D converter, through a voltage divider composed of R1, R2, R3, and R4. This ensures that altimeter calibration is maintained as the battery terminal voltage falls with use.

U2 is an instrumentation amplifier that accepts the differential output of the pressure sensor, amplifies it, and generates a single-ended voltage with respect to circuit common. In this circuit, the gain of the amplifier, as determined by the value of R11, is about 140.5. This will result in a change of 0.2 volts output at pin 6 as the altitude changes from zero to 2,000 feet.

At zero altitude, the output voltage of U2 at pin 6 is about 2.85 volts.

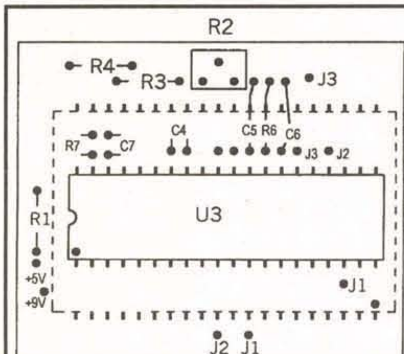


FIGURE 4
Parts view of the display board showing the location of components, jumper wires, and interconnections. Note that the LCD module is placed on the opposite side.

ANALOG-TO-DIGITAL CONVERTER

U3 and its associated components form a complete 3-1/2 digit voltage measurement system that drives an LCD. The maximum display reading is 1999, which represents 1,999 feet of altitude. The negative sign of the display is operational, even though it is unlikely that one would ever travel to a location that is below sea level.

U3 measures and displays the analog voltage appearing between terminals 30 and 31 of the chip. Pin 31 is the positive analog input terminal and is driven by a user-operated potentiometer (R9) which acts as a calibrating adjustment. This takes into account variations in pressure sensors, plus the current barometric pressure level which will affect the output voltage of the amplifier. R9 may be adjusted at any time when the altimeter is at a location where the altitude is known. Such adjustment will negate any possible error caused by a change in barometric reading. Note that when the wiper voltage of R9 is equal to the output voltage of U2, the display will read zero.

Pin 30 is the negative analog input and is driven by the output of the differential amplifier chip, U2. The polarity of the input terminals of U3 is chosen so that increasing altitude will result in an increasing display of feet.

The sensitivity of the A/D converter is determined by the reference voltage appearing between pins 35 and 36. In this circuit, it is necessary that the A/D converter have a full scale (1999) sensitivity of 199.9 (200) millivolts. This is accomplished by using potentiometer R2 to set the reference voltage to 100 millivolts (0.100 volts).

With a reference voltage of 100 millivolts, U3 will generate a display of zero to 1999 when the A/D input voltage varies from zero to 200 millivolts, as the altimeter location changes from zero to 1,999 feet.

CONSTRUCTION

The circuitry of the altimeter is contained on two printed circuit assemblies called the analog board and display board. The analog board contains the pressure sensor, regulator chip U1, and amplifier chip, U2. The

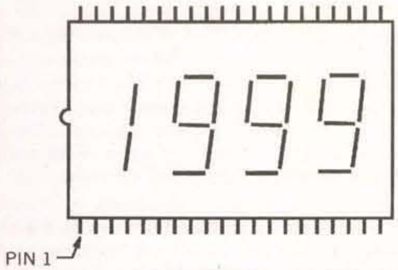
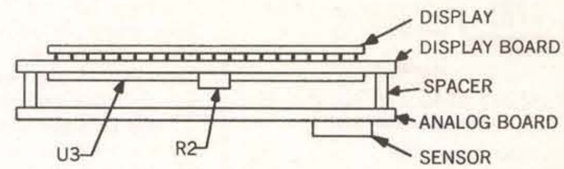


FIGURE 5
Display Module. Pin 1 is located at the lower left-hand corner.

FIGURE 6



The analog board and display board may be assembled with spacers to make a compact assembly.

display board contains the LCD, plus the A/D converter, U3. The calibrating adjustment potentiometer for U3 is also located on the display board.

The two boards have been designed so that they may be stacked upon each other, with suitable spacers and hardware, to produce a compact assembly that can be placed into a small enclosure. See Figure 6. The top of the enclosure will have a rectangular cutout to allow viewing the display. The only operating controls are power switch S1, and Baro Set potentiometer R9.

Full size layouts of the printed wiring of the two boards are illustrated in Figures 1 and 2. A source for etched and drilled boards is given in the parts list. Alternatively, the circuit is not critical and may be hardwired on a perfboard, using good construction techniques.

Figures 3 and 4 illustrate the parts placement of the boards as seen from the top or component side. Refer to these illustrations to ensure that all polarized components such as solid-state devices are properly oriented. Just one part placed backwards in the circuit will render the altimeter inoperative and may cause damage to one or more components.

It is recommended that sockets be used for U3 and the display module. A socket for the display may be fabricated by cutting a 40 pin IC socket in half lengthwise. The use of sockets is well worth the slight additional cost and will permit ease of service and troubleshooting should it become necessary. It is very difficult to remove a multipin component soldered into a PC board without damaging the component or board wiring.

Note: As indicated in Figure 4, the LCD module is mounted on the copper side of the board. Pin 1 of the foil pattern for the display is indicated by a small dot.

Do not insert the U3 or the display into its board at this time. This will be done later during checkout of the altimeter.

It is recommended that the first component installed on the analog board be U2, a surface mounted chip. The location of U2 is depicted in Figure 3, but note that this component must be soldered to the copper side of the board. To do this, first locate pin 1 of the chip, which may be identified by a small dot. Pin 1 of the chip will be located at the lower left-hand corner when viewing the IC from the top side, with the legend facing you so you can read it. Then locate pin 1 of the copper foil, which is also indicated by a small dot. Use the following procedure:

1. Be sure the foil pattern is clean, with no dirt, oil, or oxidation present.
2. Place the chip in position so that it is oriented properly and centered on the foil pattern with all terminals directly over the eight copper foil pads.
3. Gently solder just one corner pin with a small, sharply pointed soldering iron tip. Do not use too much heat or too much solder; to do so may cause the foil pattern to lift off the board.
4. Examine each terminal of the chip and verify that all are located directly over the foil pads. Make any adjustments, if necessary, or remove the chip and repeat steps 2 and 3.
5. When all terminals are properly positioned, solder them in place. Examine the chip for short circuits between terminals. Correct if necessary.

The altimeter circuitry contains several 1% precision metal film resistors to ensure accuracy and stability. Ordinary carbon resistors are not temperature stable and should not be substituted for metal film types where specified.

Be very careful when handling the pressure sensor. Note that pin 1 is identified by a notch on one terminal, and be sure to follow Figure 3 when placing it into the board. To bend the pins at a right angle, use two long nose pliers. Do not bend the terminals where they emerge from the housing; to do so may damage the sensor.

DISPLAY BOARD

The display board will require three jumper wires as depicted in Table 2. Place these in the board first, using flexible insulated #24 gauge wire. Be sure to allow sufficient lead length to allow the wires to be routed around U3.

Handle the glass LCD module carefully to avoid breakage. Refer to Figures 4 and 5, which show how this component should be placed into the display PC board on the copper side. Proper orientation is indicated by a small boss at one end of the LCD module.

When both printed circuit boards are completed, examine each of them very carefully for opens, short circuits between closely spaced conductors, and bad solder connections which may appear as dull blobs of solder. Any solder joint which is suspect should be redone by removing the old solder with desoldering braid, cleaning the joint, and carefully applying new solder. It is far easier to correct problems at this stage rather than later on if you discover that your altimeter does not work.

INTERCONNECTIONS

Completion of the wiring includes making five connections between the analog and digital boards. Table 3 illustrates the locations of these wires.

Figures 3 and 4 serve to identify the location of the interconnecting wiring between the two boards, plus connections to the external components. Follow these illustrations, along with the schematic diagram, as you go. Use flexible stranded wire for the connections. Do not use solid wire; it will break.

A battery clip may be salvaged from an old nine-volt battery. Solder a red and a black wire to the terminals, noting that the polarity will be opposite to that of a battery. When finished, plug the clip on to a new battery and use a DC voltmeter to verify that the red wire is positive and the black one is negative.

Mount S1 and R9 to any convenient location on the enclosure. It is recommended that R9 be a screwdriver adjust potentiometer so as to avoid inadvertent adjustment. Choosing a 10 turn pot for R9 allows ease of precise adjustment.

Use insulated stranded wire of different colors to make the connections between the battery clip, panel controls, and PC boards. Use the schematic diagram as a guide.

When mounting the display board to the enclosure after the checkout procedure is completed, use suitable length spacers to prevent the LCD module from touching the panel. No stress may be placed on this component since it is constructed of glass and can easily fracture.

When the altimeter is fully assembled, examine the wiring very carefully for proper connections. Do not attempt the checkout procedure unless you are satisfied that the assembly and wiring are 100% correct.

CHECKOUT

Checkout of the altimeter requires the use of a digital voltmeter or VOM with a high input resistance. The use of an oscilloscope should not be necessary unless the circuit is inoperative due to faulty construction.

Before inserting a battery into the clip, measure the resistance across the terminals of the clip with S1 set to the ON position. Normal indication is 50K or more. Then measure the resistance from pin 3 of the sensor to circuit common. Normal indication is about 1,200 ohms. If you obtain resistance readings substantially lower than specified above, there is most likely a short circuit or incorrectly placed component in one of the boards. Troubleshoot the circuit and correct the fault before proceeding.

Insert a fresh nine-volt alkaline battery onto the clip. Turn power on and verify that the voltage at pin 3 of the sensor — measured with respect to circuit common — is between 4.75 and 5.25 volts DC. Do not proceed with the checkout if you do not obtain the proper voltage specified above. Check the battery voltage under load to be sure it is delivering at least +8 volts to the circuit. Check the polarity of the battery and the orientation of U1 and U2. Check the circuit boards for short circuits. Try a new regulator IC.

When you are satisfied that the regulator is operating properly, disconnect power. Insert U3 and the display module into the board, making sure that proper orientation is observed and all pins are seated firmly in the sockets with none inadvertently bent under the body of the component.

Set the Baro Adjust pot, R9, to midposition. Apply power and carefully adjust R2 so that the voltage between pins 35 and 36 of U3 is between 99 and 101 millivolts, with pin 36 positive with respect to pin 35. If you are not able to obtain the correct reading, check the values of R1 through R4, and check the orientation of U3. Once R2 is properly set, do not readjust it again.

If the altimeter has been properly assembled and wired, you should see a display that can be set to both below and above the prevailing altitude as the front panel Baro Adjust pot, R9, is operated over its range. Verify that all digits are properly formed. Clockwise rotation of the knob should cause an increase in altitude reading. Maximum CCW position may result in a negative number. If the rotation of the pot is backwards, simply swap the two outside wires. Note: If the adjustment range of R9 is not centered on the prevailing altitude, you may trim R8 and/or R10 just a percent or so as required.

Set R9 so that the display reads approximately the correct altitude. Holding the altimeter in a horizontal position, slowly raise it as high as possible and as low as possible while watching the LCD. You should be able to see the change in altitude, just a few feet, as shown by the display. This completes the test.

If the altimeter is not performing as described, review the following paragraphs to locate and correct the fault.

If the display is totally blank, U3 is not functioning or the display module has been placed backwards into the board. Check all components associated with U3. Check the waveform at pin 21 of U3 with an oscilloscope to verify the presence of a squarewave backplane signal. Check the orientation of both U3 and the LCD module by reviewing Figures 4 and 5. Make corrections if necessary.

If any of the display digits are not properly formed or the display is blank, there may be a short or open circuit between one or more of the connections between U3 and the LCD. Any improper digit segment will lead you directly to the fault if you consult the schematic diagram to see which connection controls that segment. Check the jumpers shown in Table 2. Measure the output voltage of U2 at pin 6 to verify that it is about 2.85 volts. Check the analog and display boards visually, and also with an ohmmeter (with power off), to locate the fault.

Check the wiring between R9 and the analog board. Measure the voltage at the wiper of R9 to be sure it covers a range of about 2.8 to 2.9 volts. Note: Many potentiometers have notoriously poor resistance tolerance; if necessary, change the value of R8 and/or R10 to center the operating range of the Baro Set adjustment potentiometer so that the pot may be adjusted for readings both above and below the correct altitude.

USING THE ALTIMETER

As with all pneumatic altimeters, the instrument must always be corrected for the current barometric pressure before starting out on an excursion. The best way to do this is to learn the actual altitude at your home. This can be done by visiting a nearby airport on a day of steady barometric conditions, and adjusting R9 to obtain the correct altitude reading. This information is available from the control tower. Once the altitude reading is correctly set, immediately come home and record the altitude reading obtained there. This will be your reference altitude.

Before embarking on an excursion, always reset R9 for the correct reading at your home. Do not readjust it again unless you come to another location where the altitude is known, and the reading has changed due to variations in weather conditions.

Should the display reading become erratic or dim, replace the battery. **NV**

PARTS LIST

B1 Nine-volt transistor radio battery
C1, C2, C4, C6, C8 0.1 uFd 50-volt ceramic disc capacitor
C3 0.01 uFd 50-volt ceramic disc capacitor
C5 0.22 uFd 50-volt ceramic or mylar capacitor
C7 100 pF 50-volt ceramic disc capacitor
Display Digi-Key 153-1005
Pressure Sensor Motorola MPX2100A, 15 PSI absolute
U1 AN78L05 five-volt regulator
U2 INA126U Burr-Brown instrumentation amplifier
U3 ICL7106CPL 3-1/2 digit A/D converter
R1, R4 100K 1% 1/4 watt metal film resistor
R2 10K cermet pot, PC mount
R3 1K 1% 1/4 watt metal film resistor
R5 1 Megohm 1/4 watt carbon resistor
R6 100K 1/4 watt carbon resistor
R7 47K 1/4 watt carbon resistor
R8 200K 1% 1/4 watt metal film resistor
R9 10K potentiometer (see text)
R10 274K 1% 1/4 watt metal film resistor
R11 590 ohm 1% 1/4 watt metal film resistor
S1 SPST slide or toggle switch
Misc: IC sockets, battery clip, hook-up wire, hardware, enclosure

SOURCES OF SUPPLY

Digi-Key: 1-800-344-4539
Mouser: 1-800-346-6873
Newark Electronics: 1-800-4-NEWARK

Note: The following parts are available from A. Caristi, 69 White Pond Road, Waldwick, NJ 07463.

Set of two etched and drilled PC boards @ $19.75, U1 @ $3.00, U2 @ $12.75, U3 @ $12.75, pressure sensor @ $29.75. Please add $5.00 postage/handling.

reader FeedBack

Dear Nuts & Volts:

Last month in my article "RS-232 on a Breadboard," 15V LED was listed in the Parts List, page 47. It should have been one 5V not 15V.

Al Williams

Dear Nuts & Volts:

Regarding the "Solar-Powered Digital Barometer" in the Oct. 2000 issue.

A serious flaw appears to be that it would read correctly only near sea level.

Mechanical barometers are provided with an adjustment screw (electronic ones need an analogous circuit) to compensate for the altitude of the site. Often about 1" of Hg per 1,000 ft. above sea level. It is this "corrected" value reported by the news and weather meteorologists.

Charles D. Geilker
Liberty, MO

Dear Nuts & Volts:

I had just about given up hope of getting an answer to my question in the August issue about my Rustrak chart recorder. Then I opened the November issue and found not one answer but three!

Sincere thanks to Mr. Calabrese, Mr. Heck, and Mr. Mills for taking the time to write such clear and detailed answers, and to Nuts & Volts for devoting more than half of one of your oversized pages to publishing them.

There might be other magazines that would do this, but I haven't heard of them. I very much doubt they have subscribers as willing to be as helpful as yours and I'm very pleased to be among them.

Thanks again to all of you.

Richard W. Flaws
Oswego, IL

Dear Nuts and Volts:

I read Bob's hint about using an AM radio to test an infrared remote in the November issue. Not to burst anyone's bubble but, it really doesn't work. As a technician I have repaired a number of these devices and often the problem is the infrared LED. Since the signals picked up by the AM radio are the encoder harmonics you will get the signal even if the transmitter doesn't work because the LED is bad.

The easiest way to test the remote is to buy an infrared phototransistor from Radio Shack (part # 276-145) for 99 cents and connect its negative lead (emitter) to the negative lead of your ohmmeter and its positive lead (collector) to the ohmmeter positive lead. When infrared light hits the phototransistor, the ohmmeter shows a drop in resistance of several thousand ohms because the transistor begins to conduct. Enclose the transistor in the tip of an old felt tip marker case so light other than that from the remote is shielded. It works great on every ohmmeter I have tried it with. With a meter which has an analog bar display (such as the Fluke 66) you can see the remote output code pulse.

Joe Sloop
Ararat, VA

Dear Nuts & Volts:

The answer given to the question entitled "Are you Reeling in the Feet?" in the "Electronics Q & A" column (page 27, Nov. 2000 issue) is grossly in error.

Pure copper #12 AWG wire has a resistance of 0.00162 ohms per foot — about a thousand times less than the 1.67 ohms per foot stated in the article.

Although there are many types of stainless steel, on the average they exhibit a resistance of about 0.0606 ohms per foot — more than a thousand times less than the 76.98 ohms per foot stated in the article.

Bill Johnston
via Internet

Response from TJ Byers:

Yes, a lot of readers caught this error. The answer is 1.59 ohms per 1,000 feet, not per foot. I will have a correction in the Jan. '01 column.

TJ Byers
Q & A Editor

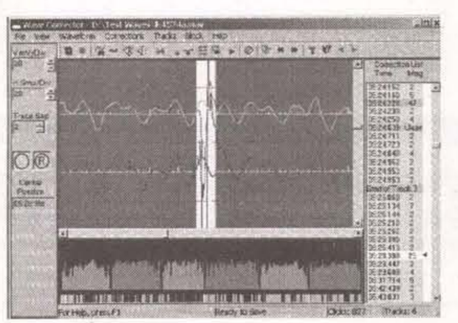
Since several comments and previous tech questions have concerned various frequency allocations in the US, here's a link to a site where the good old US govt. has a chart for viewing, or where you can buy one for only $6.00, if you want to hang one on your wall.

http://www.ntia.doc.gov/osmhome/allochrt.html

Dwight Johnson
Booneville, MS

NewsBytes

PROCESS VINYL AND TAPE/CASSETTE RECORDINGS BEFORE TRANSFER TO CD-R



Ganymede Test & Measurement announces the release of Wave Corrector 2.0. Aimed at the home music

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

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

Subscription Order ONLY Line
1-800-783-4624

PUBLISHER
Jack Lemieux *N6ZTD*

EDITOR
Larry Lemieux *KD6UWV*
MANAGING EDITOR
Robin Lemieux *KD6UWS*

CONTRIBUTORS
Robert Nansel
Joe Carr
Jon Williams
Ray Marston
TJ Byers
Gordon West
Al Williams
Robert Priestly
Eric Gunnerson
Anthony J. Caristi
Brian Beard
Dennis Shepard

ON-THE-ROAD EXHIBIT COORDINATOR
Audrey Lemieux *N6VXW*

SUBSCRIPTIONS
Robin Lemieux

CLASSIFIED ADS
Natalie Sigafus

DISPLAY ADS
Mary Gamar

lover and the professional archivist, Wave Corrector is a true WYSIWYG audio restoration application that automatically removes clicks and hiss from vinyl and tape/cassette recordings. It also divides album files into separate CD track files.

Remove unwanted noise while maintaining maximum fidelity

Wave Corrector takes a new approach to audio restoration, giving the user much greater control than has previously been available. The program uses a powerful click concealment algorithm to generate corrections for each individual vinyl click. The computer-generated corrections are based on the musical content surrounding each click to ensure the maximum fidelity to the original sound.

Wave Corrector provides a graphical overlay of the corrected and uncorrected waveforms and allows interactive adjustment and auditioning of corrections. By these means, even the most difficult corrections can be manually refined to the point of inaudibility.

Other Features

Wave Corrector also automatically finds track changes and assembles separate wave files representing each track of an album. Tracks can be easily split or merged and track boundaries can be manually manipulated to suit the user's requirements.

New in version 2.0 are a range of digital filters for the reduction of continuous noise (e.g., hiss) and for tonal correction of the original recording. There are also new tools for adjusting the volume and channel balance and there is an improved user interface.

Availability & Further Information

Wave Corrector runs on the Windows 95/98/NT/2000 platforms and can be downloaded from the Wave Corrector website at **www.ganymede.hemscott.net/wavecor.htm**. Single user licences cost just UK£28 or US$45. Registrations can be processed online at the same location. Until it is registered, the program runs in demo mode and limits processing to the first two minutes of a recording and only allows the first track of an album to be saved.

CONVERT SCANNED PAPER DRAWINGS INTO YOUR CAD-PROGRAM

RasterVect Software has released vectorizer RasterVect 3.0 for Windows, a program that lets users quickly convert uneditable scanned paper drawings into accurate vector files for editing in any CAD program.

RasterVect is a useful program for those who work with scanned drawings. With this program, you can transform raster drawings into vector format. Raster drawings can be imported by scanning original paper drawings. The target vector format (DXF) is supported by most CAD applications that use vector graphics, such as AutoCAD, Corel Draw and many others.

There are viewing tools like zooming, scrolling and color selection. RasterVect has: TWAIN support for importing from many scanners; the ability to automatically recognize orthogonal and inclined lines, as well as arches and circles; and the ability to maintain the scale of the initial paper drawing. RasterVect can transform grey and colored images into black-and-white for subsequent recognition; can change a turn of the raster image; and can correct union points of lines, arches and circles. There is also support for lines, arches and circles alignment.

The list below summarizes the process of transformation of a paper drawing to a CAD drawing using RasterVect:

- Create a raster file by scanning the paper drawing into RasterVect using a scanner.

- Use RasterVect to convert the raster file into a vector DXF file.

- Import the DXF file into your CAD program and edit the drawing.

Designed to work on all Windows platforms, vectorizer RasterVect saves a lot of time. It's a replacement for traditional tracing and digitizing.

RasterVect 3.0 for Windows costs $79.95(US) for a single-user license. Network and site licenses are available.

Web - **www.rastervect.com**

DUAL CIRCUITS IN A SINGLE SURFACE-MOUNT PACKAGE SAVES SPACE, LOWERS COST

Microsemi Corp. announced that its Power Management Division has developed a new dual-circuit low dropout regulator (LDO) for its line-up of power management integrated circuits. Designated the LX8815 Series, the device, which combines two 1-amp regulator circuits in a single package, is used to regulate power on circuit boards of applications that include: computer peripheral devices, battery charging circuits and instrumentation. "We work closely with customer design groups to identify ways to help them meet their ever-more-demanding space and cost targets," said James J. Peterson, president of Microsemi's Power Management business. "In this case, we initiated the dual LDO concept to serve a major disk drive manufacturer — Seagatem — for a digital VCR application. "They're already using the new devices in very large volume. In their highly competitive environment, every opportunity for savings is significant." Manuel Lynch, Microsemi vice president of Marketing and Business Development, points out that offering a breadth of power management solutions having unique design characteristics is fundamental to the company's new product development strategy. "Now that power management is Microsemi's largest business, we're focusing more and more on expanding this part of our product portfolio through new and enhanced process developments, coupled with Microsemi's exceptional packaging capabilities," Lynch said. Assembly process enhancements enabled Microsemi designers to package its new LDO circuits in a manner that provides superior thermal characteristics, improved operating margin, as well as saving space. Most importantly, the resulting five-pin S-Pak surface-mount package is believed to be the most robust in the industry. Microsemi's new surface-mount regulator is thin, measuring less than 2 mm tall and with a footprint of 9.52 mm x 10.67 mm, which replaces two regulators, saving 70 percent board space compared to the TO-263, which requires 10.67 mm x15.87 mm each. The LX8815 costs $0.94 in OEM quantities of 1,000, providing a savings of more than 20 percent over two conventional single-circuit LDOs, and an overall savings of more than 30 percent, including a reduction in external capacitors. Component reduction also helps customers to reduce costs associated with parts inventory, assembly and testing operations.

LX8815 Key Features

— Dual channel positive-voltage linear regulator

— Choice of two fixed output or one fixed/one adjustable output

— Each channel supplies up to one amp independently

— Consumes minimal ground current and directs quiescent current to the load

— On-chip trimming of internal voltage reference: precise output, typically ±1 percent of specified value

— Low dropout voltage at full output current (VDO less than 1.1V typ @ 1A)

— Independent thermal and current limit protection

— Low tolerance line (0.2 percent) and Load (0.4 percent) regulation

— Wide DC supply voltage, 4.0V - 12.0V

— Loop stability independent of output capacitor type

— Low profile surface-mount packaging

Additional information and technical data sheets can be found on the company's Web site at **www.Microsemi.com**


We accept Visa, Mastercard, AmEx, and Discover
Attention: Nerds–Geeks
Fax: 318-424-9771
To Order Call 1-800-227-3971 www.shrevesystems.com
Upgrade Your Old Mac!
LOGIC BOARD BLOWOUT!
STARTING AT $19!
Quadra 610/660 to PM 6100 ....ONLY $99
Quadra 650 to PM 7100/66 ....ONLY $149
NEW
FLOPPY DRIVE BLOWOUT!
STARTING AT $19!
PART # 661-0474
1.44 SuperDrives
NO EXCHANGE REQUIRED!
Be sure to check us out on the web at http://www.shrevesystems.com for the best prices on Vintage Mac gear!
MONITOR MAYHEM!
19"-21" fixed res 1024 X 768
ONLY....$49 as is
13"-14" fixed res 640 X 480
ONLY....$25 as is
15" Radius Pivot
ONLY....$25 as is
H.P. 17" fixed res 832 X 724
ONLY....$99 30 Day Warranty
H.P. 17" fixed res 640 X 480
ONLY....$99 30 Day Warranty
16" Rasterops fixed 832 X 624
ONLY....$99 30 Day Warranty
Global Village Gold internal Modem 14.4 Com Slot
ONLY $1
Global Village Bronze
External Modem 2400 Bps/9600 Fax
ONLY $1
Apple Color Composite Display
Great for Surveillance
Refurbished $69
PAS16 Audio Spectrum
16 Bit Sound Editing Card ONLY $19
CMS Tower SCSI Case
Holds 4 5.25 SCSI full ht. drives
$79
RAM
1 MB 30 Pin 4 For $1
4 MB 72 Pin 2 For $5
Apple II 256K Memory Expansion Kit
HM51256P-10 ONLY $1
$19
Curtis ADB Track Ball
Apple Remote Control
$5 EACH
Drive Lock Security System for Portable Computers-protects your data if lost or stolen!
ONLY....................$5
PDA Genuine Leather Carry Case
Let your palm pilot lead the life of luxury!
$5
Membrane Track Pad for laptop $2
Miscellaneous
Apple 8 bit Video Card $19
LaserWriter IINT $199
Apple ADB Keyboard $19
1.44 Super Drive $19
Clone ADB MouseII $19
Quicktake 100 Camera $99
Bernouli 90 MB EXT $10
44MB SyQuest Ext $10
88MB SyQuest Ext $19
Peltier Junction
with heat sink, works on 5V &12V
1 3/16îx 1 3/16î
$10 each or 3 for $25
$3
LC Power Supply
+5V, -5V, +12V Output
MacAlly ADB Keyboard
$19
$25 minimum order
Shreve Systems
1200 Marshall st
Shreveport, La 71101
Returns subject to a 15% restocking fee.
Prices are subject to change without notice. We accept Visa, Mastercard, AmEx, Discover

'555' ASTABLE CIRCUITS

by Ray Marston

In this '555 timer IC' application article, Ray Marston shows ways of using the IC in a variety of astable waveform generator circuits.

The '555 timer' is a popular and versatile bipolar IC that is specifically designed to generate accurate and stable C-R — defined timing periods, for use in a variety of monostable 'one-shot' pulse generator and astable squarewave generator applications. This article shows practical ways of using the IC in a variety of useful astable multivibrator or squarewave generator applications.

555 ASTABLE OPERATION

The eight-pin bipolar 555 IC can be used as a free-running astable multivibrator by wiring it in the basic configuration of *Figure 1*, with TRIGGER pin 2 shorted to the pin 6 THRESHOLD terminal, and timing resistor R2 wired between pin 6 and DISCHARGE pin 7. To understand the circuit operation, relate the following explanation to the 555 functional block diagram of *Figure 2*.

When power is first applied to this circuit C1 starts to charge exponentially via R1-R2 until eventually the C1 voltage rises to 2/3 V_{cc}, at which point DISCHARGE pin 7 switches low and starts to discharge C1 exponentially via R2 until eventually the C1 voltage falls to 1/3 V_{cc}, and TRIGGER pin 2 is activated, thus initiating a whole new timing sequence, which repeats *ad infinitum*, with C1 alternately charging towards 2/3 V_{cc} via R1-R2 and discharging towards 1/3 V_{cc} via R2 only.

Note that if R2 is very large relative to R1 the operating frequency is set by R2 and C1, and an almost symmetrical squarewave output is developed on pin 3 and a non-linear triangle waveform appears across C1; *Figure 3* shows the consequent relationship between frequency and the C1-R2 values. In practice, the R1 and R2 values can be varied from 1k0 to many megohms; note, however, that R1 affects the circuit's current consumption, since pin 7 is effectively grounded during half of each cycle. Also note that the waveform's duty cycle or mark-space ratio can be varied by suitable choice of the R1 and R2 ratios.

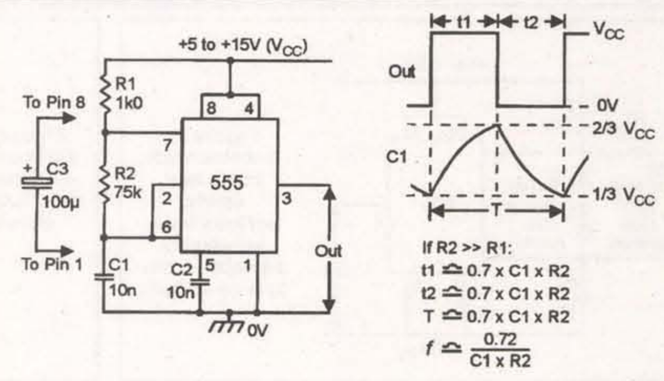


Figure 1. **Circuit and waveforms of a basic 1kHz 555 astable multivibrator, with optional RFI suppression via C3.**

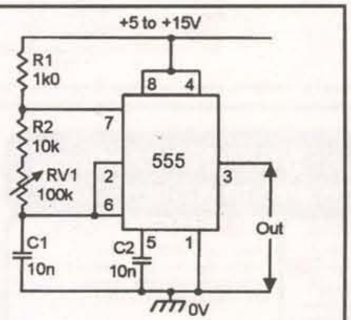


Figure 4. **Variable-frequency (650Hz-7.2kHz) squarewave generator).**

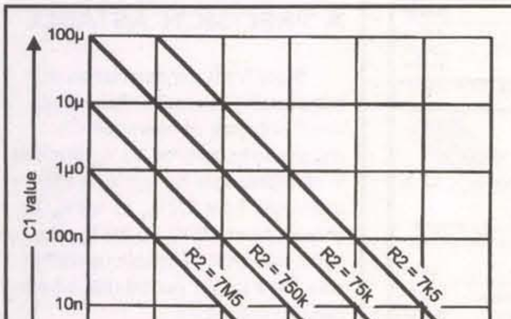


Figure 3. **Relationship between C1, R2, and 555 astable frequency when R2 is large relative to R1.**

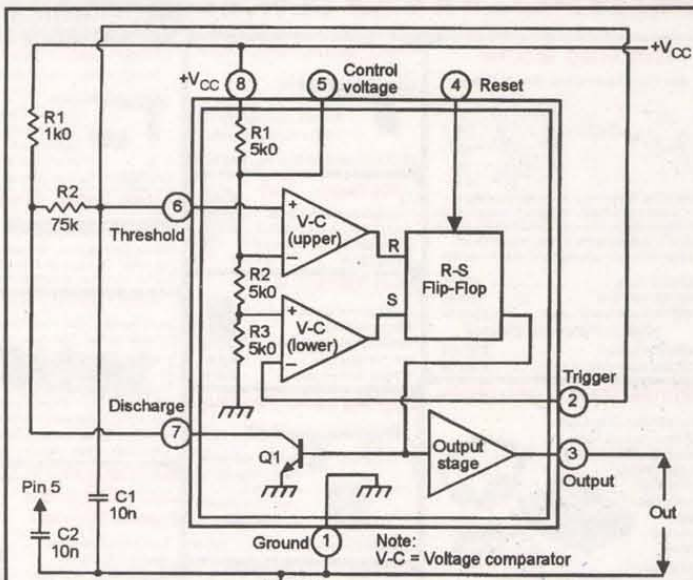


Figure 2. **Functional block diagram (within the double lines) of the 555 timer IC, with external connections for use as a basic 1kHz astable multivibrator.**

Figure 4 shows how the operating frequency can be made variable by replacing R2 with a series-wired fixed and a variable resistor. With the component values shown, the frequency can be varied from about 650Hz to 7.2kHz via RV1; the frequency span can be further increased by selecting alternative values of C1.

MARK-SPACE CONTROL

In each operating cycle of the *Figure 1* circuit, C1 alternately charges via R1-R2 and discharges via only R2. Consequently, the circuit can be made to generate a non-symmetrical waveform with any desired mark/space (M/S) ratio by suitably selecting the R1 and R2 values. *Figures 5 to 8* show ways of making the M/S ratios fully variable.

Figures 5 and *6* give independent control of the mark and space periods. In *Figure 5*, C1 alternately charges via R1-D1 and RV1, and discharges via RV2-D2 and R2. In *Figure 6*, C1 charges via R1-RV1 and D1, and discharges via RV2-D2 and R2. In both cases, the mark and space periods can each be varied over a 100:1 range; the frequency varies as the M/S ratio is altered.

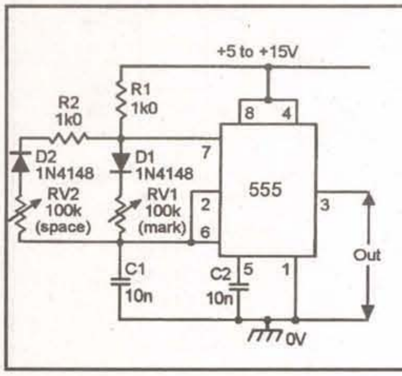


Figure 5. Astable with mark and space periods independently variable from 7μS to 750μS.

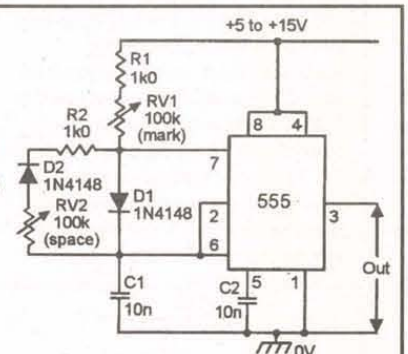


Figure 6. Alternative version of the *Figure 5* circuit.

Figures 7 and *8* show ways of altering the M/S ratio without significantly altering frequency; here, the mark period increases as the space period decreases, and vice versa, so the total period of each cycle is constant. The most important waveform feature of these circuits is their 'duty cycle' (the relationship between the mark and total periods of each cycle), and this is variable from 1 to 99 percent via RV1.

In *Figure 7*, C1 alternately charges via R1-D1 and the upper half of RV1, and discharges via D2-R2 and the lower half of RV1. In *Figure 8*, C1 charges via R1-D1 and the right-hand half of RV1, and discharges via D2-R2 and the left-hand half of RV1. Each circuit operates at about 1.2kHz with the C1 value shown.

A 'PRECISION' ASTABLE

Note from the description of basic astable operation that in the initial half-cycle of operation, C1 charges from zero to 2/3 V_{cc}, but that in all subsequent half-cycles it either discharges from 2/3 V_{cc} to 1/3 V_{cc} or charges from 1/3 V_{cc} to 2/3 V_{cc}; the initial half-cycle of astable operation thus has a longer period than all subsequent half-cycles.

In some special applications, this large period discrepancy may cause problems; they can be overcome by adding an external voltage divider and diode to bias C1 to slightly below $1/3\,V_{cc}$ (rather than to zero volts) at the moment of switch-on, as shown in *Figure 9*. Here, R1 rapidly charges C1 to $1/3\,V_{cc}$ via D1 at initial switch-on, but all C1 charging is subsequently controlled by R3 and/or R4 only.

ASTABLE GATING

The 555 astable can be gated on and off, via either a switch or an electronic signal, in several ways. One way is via the pin 4 RESET terminal, and *Figures 10* and *11* show ways of

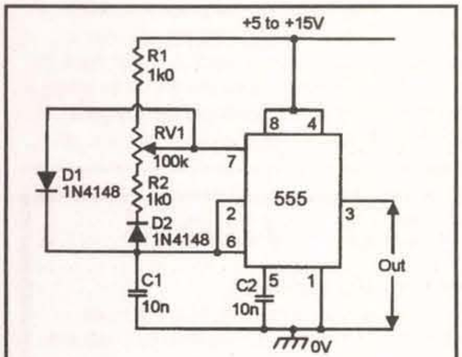


Figure 7. **1.2kHz astable multi with duty cycle variable from 1 to 99 percent.**

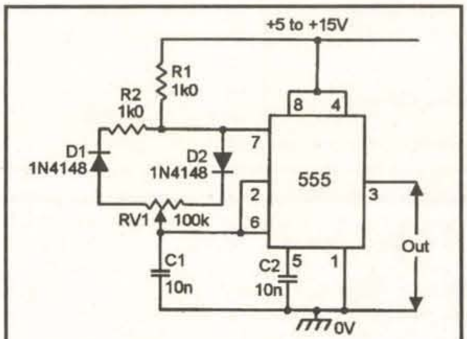


Figure 8. **Alternative version of the *Figure 7* circuit.**

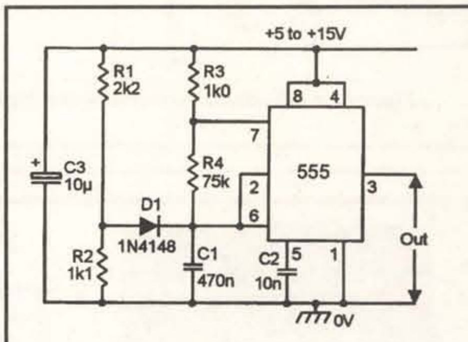


Figure 9. **'Precision' low-frequency (20Hz) astable.**

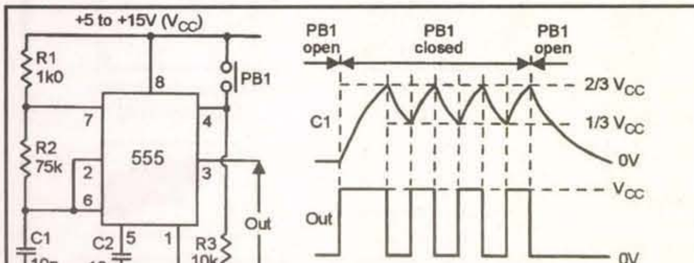


Figure 10. **Gated 1kHz astable with 'press-to-turn-on' operation.**

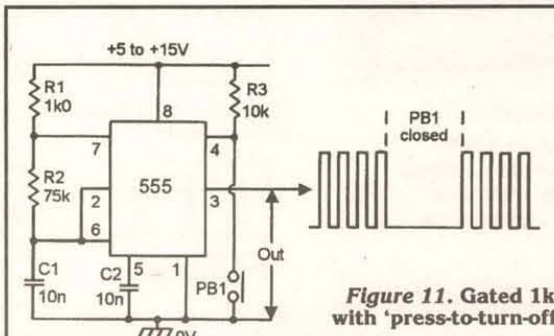


Figure 11. **Gated 1kHz astable with 'press-to-turn-off' operation.**

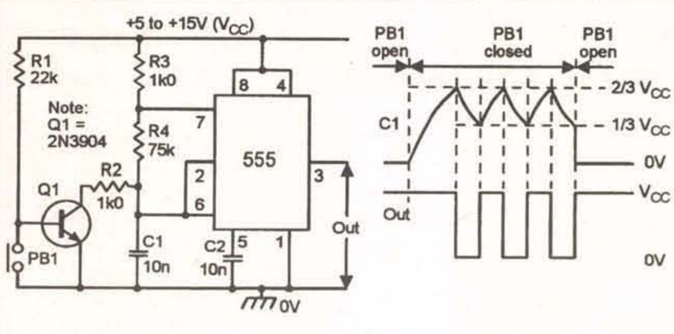


Figure 12. **Alternative gated 1kHz astable with 'press-to-turn-on' operation.**

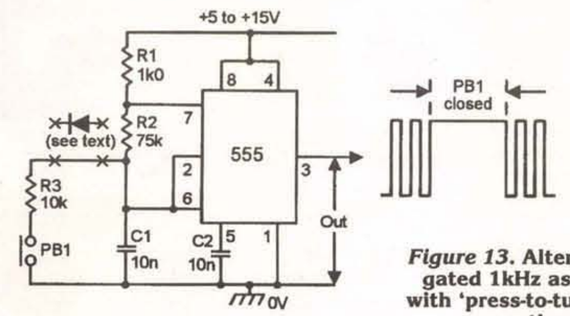


Figure 13. **Alternative gated 1kHz astable with 'press-to-turn-off' operation.**

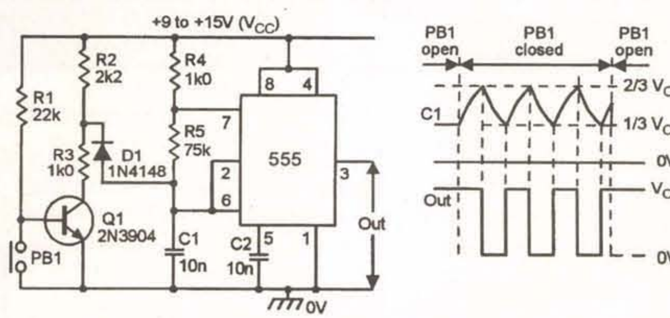


Figure 14. **'Precision' version of the *Figure 12* circuit.**

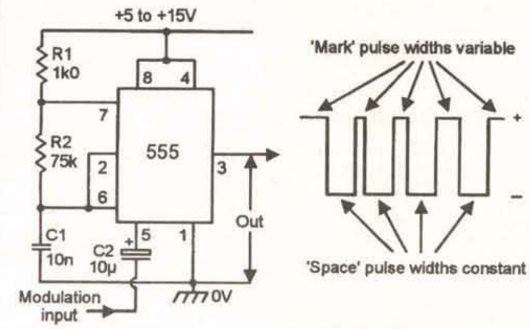


Figure 15. **Method of applying AC-coupled FM or PPM to the 555 astable.**

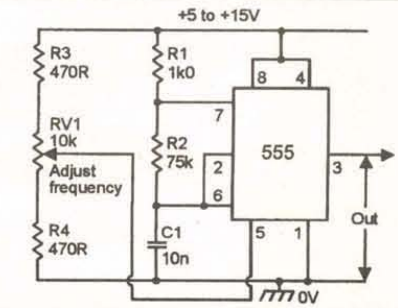


Figure 16. **Method of applying DC-coupled FM or PPM to the 555 astable.**

gating the astable via this pin and a push-button switch. The 555 action is such that the astable is enabled if pin 4 is biased above 0.7V, but is disabled (with its output low) if pin 4 is pulled below 0.7V by a current greater than about 0.1mA (by grounding pin 4 via 10k or less).

Thus, *Figure 10* is normally gated off by R3, but can be turned on by closing PB1, and *Figure 11* is normally on, but can be gated off by closing PB1; these circuits can also be gated electronically via pin 4.

Note in *Figure 10* that precise circuit waveforms are shown, and that the duration of the initial half-cycle is far longer than all others, and that C1 takes a fairly long time to decay to zero when the astable is first gated off again (the *Figure 11* circuit has similar characteristics).

Figure 12 shows another way of gating the 555 astable. Q1 is normally biased on via R1 and thus acts like a closed switch that (via R2) pulls the C1-R4 junction low and stops the astable operating, but when PB1 is closed, Q1 is turned off and the astable operates in the normal way.

Note that when the astable is gated on, the initial half-cycle is again far longer than all others, etc., and that the pin 3 output terminal is high when the astable is off.

Figure 13 shows the above circuit modified to give 'press-to-turn-off' operation by replacing Q1 with a push-button switch. A digital signal can be used to gate this circuit by wiring a diode as shown and removing PB1, in which case, the circuit will turn off

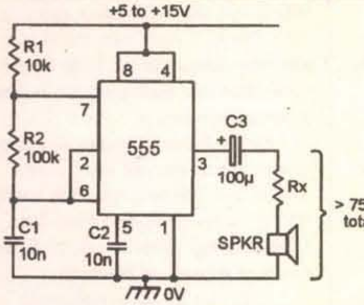


Figure 17. **Low-power (750mW max) 800Hz monotone alarm-call generator.**

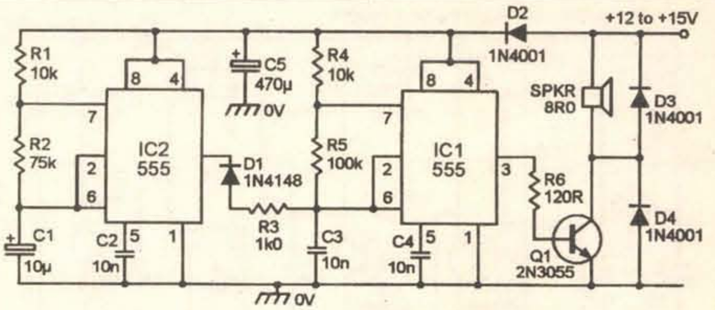


Figure 19. **Pulsed-tone (800Hz) alarm-call generator.**

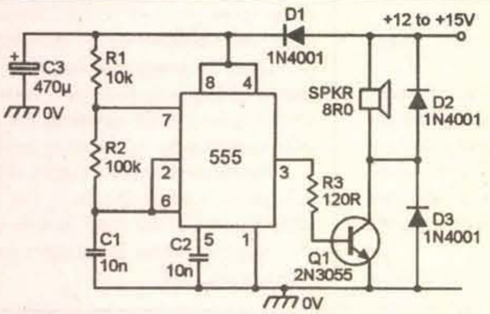


Figure 18. **Medium-power 800Hz alarm-call generator.**

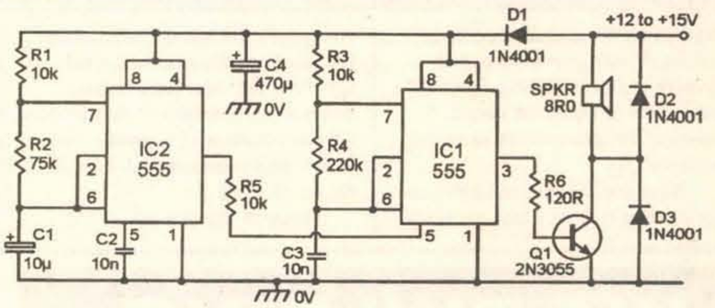


Figure 20. **Warble-tone alarm-call generator simulates British police car siren.**

when the gate signal is below $1/3\,V_{cc}$.

To complete this look at gating techniques, *Figure 14* shows the *Figure 12* circuit modified to give 'precision' operation.

Here, when PB1 is open Q1 is saturated, so R2-R3 pulls the R5-C1 junction to just below $1/3\,V_{cc}$ via D1, thus gating the astable off, but when PB1 is closed, Q1 turns off and D1 is reverse-biased via R2, and the astable is thus free to operate.

Note that when PB1 is first closed C1 charges from an initial value of almost $1/3\,V_{cc}$, and the duration of the initial half-cycle is thus similar to all others.

FM AND PPM

All the 555 astable circuits shown so far can be subjected to frequency modulation (FM) or to pulse-position modulation (PPM) by simply feeding the modulation signal to pin 5 (which connects to the IC's internal divider chain); this modulation signal may be an AC signal that is coupled to pin 5 via a blocking capacitor, as shown in *Figure 15*, or it may be a direct-coupled DC signal, as in *Figure 16*.

The 555's astable action is such that the pin 5 voltage influences the width of the mark, but not the *space* part of each cycle, and thus provides both PPM and FM actions.

These types of modulation are useful in special waveform generator applications, as in various electronic siren and alarm-call generator circuits.

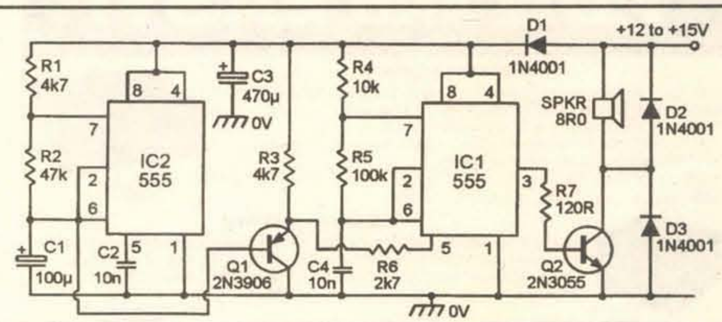
'555' SIRENS AND ALARMS

One very popular application of the 555 astable circuit is as a speaker-driving siren or alarm-call generator, and *Figures 17* to *22* show a selection of circuits of this type.

Figure 17 shows an 800Hz monotone alarm-call generator circuit that can be used with a 5V to 15V supply and with any speaker impedance; note that Rx is wired in series with the speaker, to give a total load impedance of 75 ohms (to limit peak output currents to 200mA).

Available alarm output power

Figure 21. **'Wailing' alarm simulates American police car siren.**



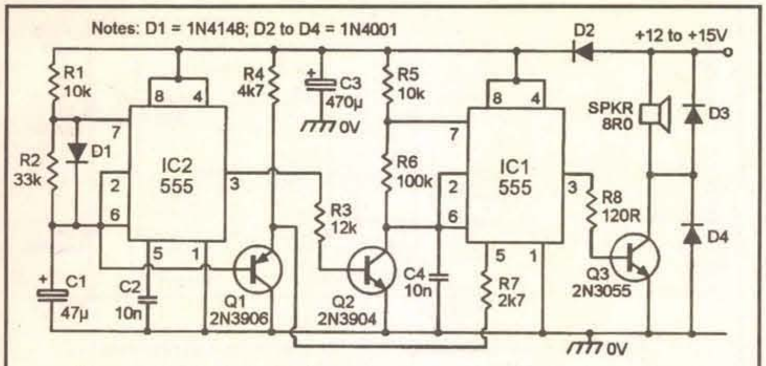


Figure 22. 'Red alert' siren simulates Star Trek alarm signal.

depends on the speaker impedance and supply voltage values; i.e., it is 750mW at 75R at 15V, etc. *Figure 18* shows how to boost the output power of the above circuit to several watts via Q1.

Note that the resulting high output currents may modulate the supply voltage, and D1 and C3 help isolate the 555 from this modulation; D2 and D3 clamp the inductive switching spikes of the speaker and thus protect Q1 from damage. This booster circuit is also used in the alarm circuits of *Figures 19* to 22.

Figure 19 shows a pair of 555 astables used to make a pulsed-tone 800Hz alarm-call generator; IC1 acts as the 800Hz generator, and is gated on and off once per second via IC2 and D1.

Figure 20 shows a warble-tone alarm-call generator that simulates the sound of a British police car siren. IC1 is again wired as an alarm tone generator and IC2 as a 1Hz astable but, in this case IC2 output is used to frequency modulate IC1 via R5, the action being such that IC1's frequency alternates between 440Hz and 550Hz at a 1Hz cyclic rate.

Figure 21 shows a 'wailing' alarm that simulates an American police car siren. IC2 is a low-frequency (6s) astable that generates a 'ramp' waveform that is buffered via Q1 and used to frequency modulate tone generator IC1 via R6.

IC1 has a mid-frequency of about 800Hz, and the modulation action is such that its output tone starts at a low frequency, rises for 3s to a peak value, then falls back again for 3s, and so on *ad infinitum*.

Finally, *Figure 22* shows an alarm that simulates the 'red alert' sound used in *Star Trek* programs; this sound starts at a low frequency, rises for 1.15s to a high tone, ceases for 0.35s, and then repeats *ad infinitum*.

IC2 is a 1.5s non-symmetrical astable that generates a fast rising, but slowly falling sawtooth across C1; this waveform is buffered via Q1 and used (via R7) to frequency modulate IC1, making its frequency rise slowly during the falling parts of the sawtooth, but collapse rapidly during the rising part.

The rectangular pin 3 output of IC2 gates IC1 off via Q2 during the collapsing part of the signal, so only the rising parts of the alarm signal are, in fact, heard. **NV**


The SuperComputer of your Dreams is Here
Netcom #! In Customer Service Since 1983
IBM ROAD WARRIOR
Professional Road Equipment
Waterproof !
Drop-proof !
Direct Sunlight !
email for more information
4 easy payments of $199.99
0% Financing! On Credit Cards only
for professional use
GPS option
Our Customers Call back with
Rave Reviews!
Sale
Low Price / High Performance
Compare at $1,500
SOYO "Traveler"
stereo
Ultra Fast
email for more information
96Meg! only $96 !
GPS $159
Wow $888 -or-
4 Easy payments of $229
CUSTOM Carry Case $24
SOYO "Traveler" Includes:
233Mhz MMX 3Gig Drive 32M Ram
56k Modem, 24X CD, Floppy,
MP3 Stereo, W98SE Touch Pad Mouse,
3hr Bat, 2 USB ports, IR Port, 2 PCMCIA ports, Serial & Parallel Ports, Super Lightweight 3.3 lb 9.5" x 7" x 1.5", 8.5"
16million Color SVGA Display,
Supports High Resolutions up to 1024 x 768
Runs ANY program with ease. Light weight & Ultra portable
GPS option
IBM
Tough!
CD Rom Works with ANY Computer
Desktop Parallel Port CD Drive
Built-in Printer Port
Power Supply & Audio output
for DOS, W3.1, W95, W98
50X!
$159
Why will this Small Laptop Become your Pal ?
You bring a big machine with you less & less often because it's a pain to drag around. Millions of PDA owners already know this. Unlike PDA's this is desktop power with a fraction of the BIG laptop Bulk & Weight.
Razor Sharp, BRIGHT & Easy Viewing
Comfortable Typing with Wrist Rests
WORLD'S BEST
ALL DUAL DRIVES
SuperComputer at a Desktop Price
CompuZilla
WILL Save Your Life !
10,000 Viruses hit the Web each month. If you've already gotten hit, you know it takes months to undo the damage. Should your Hard Drive ever go down, YIKES ! NOW, in minutes, you can completely back up your entire drive. Infinitely faster than Zip drives. You can do it often. Now, it's easy. PLUS: For the first time ever, Removeable hard drive bays allow you to use an unlimited number of different drives on your system. Change drives in seconds. Just pull em out.
It'll make you More Popular
Friends will be stopping by with their Music & Data CD's begging you to make copies. The ease and convenience of the Dual CD & CD Recorder makes copying CD's easier than ever before. Just press a single button and walk away. That goes for Floppies too. You'll tell your friends what this machine does but they won't believe it. They'll be coming by to see it for themselves. They'll go back to their whimpy machine and wish it did half of what yours does. It's all that and more. Fastest Computing speed, Fastest Video Speed, Supports ALL Maximum Video Resolutions Ever Created. Years from now you'll find it easy to upgrade every single feature of this machine. The only Tower with a lighted face.
NOTHING ELSE COMPARES
25"
ANIMAL POWER
900Mhz
AMD-K7
40Gig (20G x 2)
128MegRam
32Meg Video
Server Size Tower
2 Removable HDs
2 CDs 50X & CDRW
2 Floppies
Copies Hard Drives
Copies CDs & Floppies
AntiVirus Firewall
LAN 10/100 & 56Kmodem
illuminated Face,
4 Channel Stereo
2USB 4PCI,1AGP, Line in/out, Mic, Midi /Game, 2 Ser, 1 Par
Includes Mouse & Keyboard
email for more information
Wow ONLY $1299 500 Mhz Version
Wow ONLY $1499 900 Mhz Version
Compare Anywhere, Beats ANY Machine & Made with Top Brand Components
Optional W98se with disk, Netcom System & All Cloning Utilities only $125
Optional 7 Fan Cooling System $24
You Won't Find A Better Machine at ANY Price
1 Year Warranty - Satisfaction Guaranteed - The Friendliest People - The Best Customer Service
Email for Detailed Information
PAYMENT PLAN with Credit Card -or- Layaway ONLY
843-650-5700 For Questions-or- email: netcomd@aol.com
COD's SINGLE PAYMENT ONLY
ORDERS ONLY 800-733-3733 ORDERS ONLY 11-6 EST Mon-Fri FAX 843 650 5777

ELECTRONICS Q&A

With TJ Byers

In this column, I answer questions about all aspects of electronics, including computer hardware, software, circuits, electronic theory, troubleshooting, and anything else of interest to the hobbyist.
Feel free to participate with your questions, as well as comments and suggestions.
You can reach me at:
TJBYERS@aol.com
or by snail mail at
Nuts & Volts Magazine, 430 Princeland Ct., Corona, CA 92879.

What's Up:

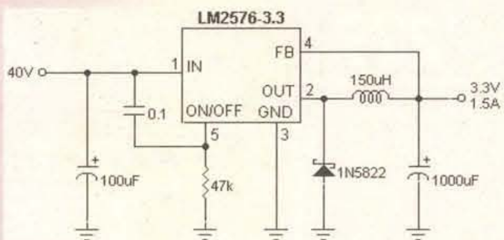
The response to my high-pass and notch filters in last month's column was overwhelming, so this month I've added instruments and websites that take the concept one step further. Specifically, a sensitive AC voltmeter, sinewave generator, and three bipolar power supplies. There's also a 3.3V switching supply and a coaxial "bias-tee" power supply.

Switching 3.3-Volt Voltage Regulator

Q. I have a RadioShack fluorescent lamp that works off three volts at 1.5 amps. I have a 13 VDC, two-amp wall adapter that I'd like to use to power the lamp. What is the most efficient way to bring the transformer down to three volts? I prefer a method which doesn't waste power or produce excessive heat.

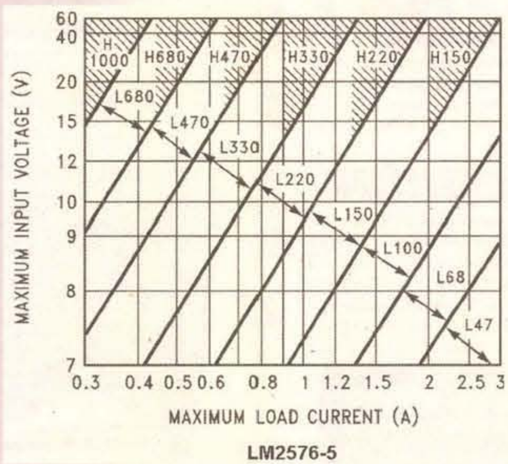
Sumeth Kongsuwan
via Internet

A. The best design for a power supply of this type should be based on a step-down voltage regulator, like the LM2576 from National Semiconductor.



The regulator comes in four fixed voltages (3.3V, 5V, 12V, and 15V), plus an adjustable version (1.23V to 37V), and is capable of supplying up to three amps of output current. At 3.3 volts, the circuit is 75% efficient, and 88% efficient at five volts. The 47k resistor and 0.1uF capacitor combination provides soft-start for the regulator. Essentially, the output voltage gradually increases to full-output voltage, preventing heavy surge currents from rushing through the load on startup.

The only critical component is the inductor, which must match the input voltage, output voltage, and output current. Here is the inductor selection chart for the LM2576-5.0 (five volts fixed output).



LM2576-5

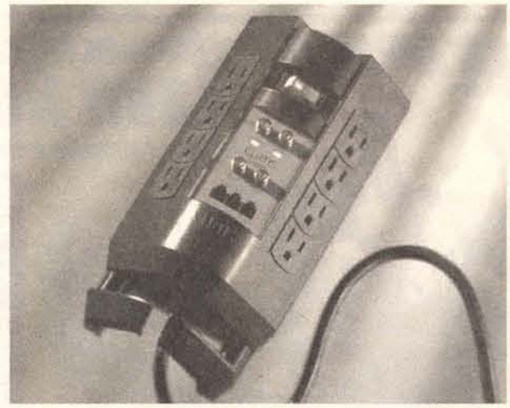
To find the correct value, simply locate the area where your input voltage and output current intersect; the values are in uH. When purchasing an inductor for this chip, make sure it can handle the output current.

Surge Protection For CATV

Q. Do you have a schematic diagram for a surge suppression circuit that can protect the cable TV input from lightning strikes, voltage surges, etc.? My TV is protected by an APC surge supressor for the AC line and I'd like to protect the cable TV as well.

Tony Tantay
via Internet

A. Yes I have, but it will cost you more to build than buy. Many manufacturers make combination AC-line/cable-TV surge protection devices, most of which sell for under $20.00. I'm partial to the Curtis SP4100, which you can find for as cheap as $15.95 — plus it comes with $50,000.00 of equipment warranty protection should the surge protector fail to do its job.



Sorry, But This Richoh Printer Has No Parents

Q. I have a Ricoh LP4081 EX printer with a 50-pin printer cable that I need to interface with my PC. The 50-pin connector is similar to the one used on Apple computers, but I don't know if it's a SCSI interface or not. Furthermore, I haven't been able to get any information from Ricoh. Any info you can furnish would be greatly appreciated.

Thomas Bristol
Granada Hills, CA

A. I'm not sure I can be of much help, but let me give you the excuses as to why not. Yes, it is probably a SCSI port made for the Wang PC, which means it's very unlikely you'll find a driver for it even if you can find an interface card. The problem of finding software drivers for the LP4081 has inundated Ricoh so much that they published a public response at **www.ricoh-red.com/support/printer/lp4081.htm**. Here is an excerpt from that message.

Dear LP4081 Owner,

The LP4081 has not been sold for almost 10 years now and we are sorry to inform you, but we do not make drivers for this printer anymore.

Reason:

The LP4080, LP4081, and PC6000 used a printer language that was based on an extended Diablo 630 language which added additional graphics and downloadable fonts to the already existing daisy wheel printer language Diablo 630 ECS.

Although we tried, this language did not become a standard and most of the LP4081s were sold with at least one emulation card, the "LaserJet Plus" emulation being the most popular. Since then Ricoh has started using, as almost everyone else, "hp-pcl5" compatibility.

Solution:

Your best bet is if you have either the HP-Laser Jet Plus emulation card (R1 LJP), the Epson Fx80 emulation (R1 F80), or the IBM ProPrinter emulation (R1 PRO). Then you should choose these drivers for usage with your application. See previous information above!

If you have older software, you can choose a Diablo 630 ECS driver for text only applications.

We also have a collection of old drivers for the PC6000 on our House BBS. But this is limited to some drivers for older Dos applications and a Win 3.0 driver, "which does not work with 3.1 or Win 95".

BBS +49 (0) 211 6546 - 341 / 342.

It might be possible to use these for your LP4081 also, however, most older applications already had an LP4081 or LP4080 driver included with the application.

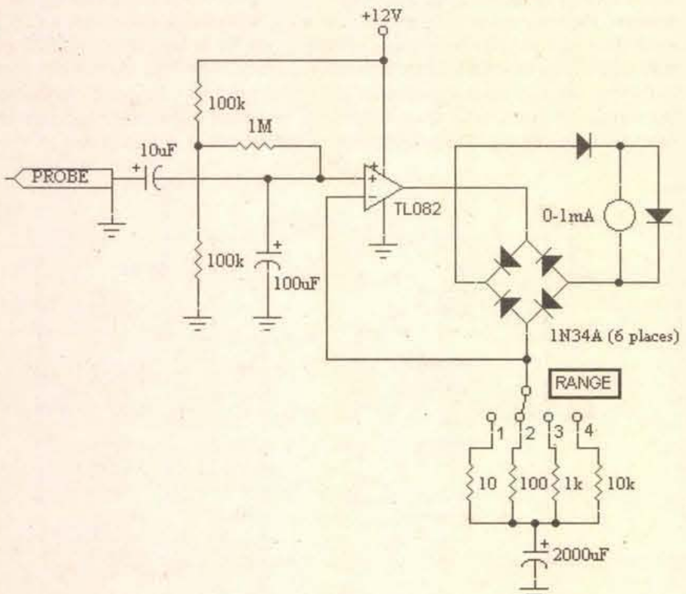
Again, we are sorry and hope that you have one of the emulation cards.
Best Regards,
printer-support@ricoh-red.com

Sensitive AC Voltmeter

Q: I'm trying to measure AC audio signals in the 30 millivolt (mV) range, but my DMM isn't sensitive enough. Do you have a circuit for a sensitive AC voltmeter or know of an inexpensive test instrument that will meet my needs?

Earl Smith
via Internet

A: Here's a simple circuit that can be constructed for under $20.00. The voltmeter is essentially a precision rectifier built around a TL082 op-amp. (Actually, any 741-type op-amp will work; it's not critical.) The gain of the amplifier is set by the value of the feedback resistors, which are selected via S1. The output is rectified by the 1N34A germanium diodes and sent to the analog panel meter.



This circuit has a flat frequency response from 8 Hz to 50 kHz on the 10 mV range. The lower frequency limit is 0.1 Hz on the higher ranges. Input impedance is one megohm, and the accuracy of the instrument is directly related to the tolerance of the resistors, which should be 1% or better.

S1	RANGE
1	10 mV
2	100 mV
3	1 V
4	10V

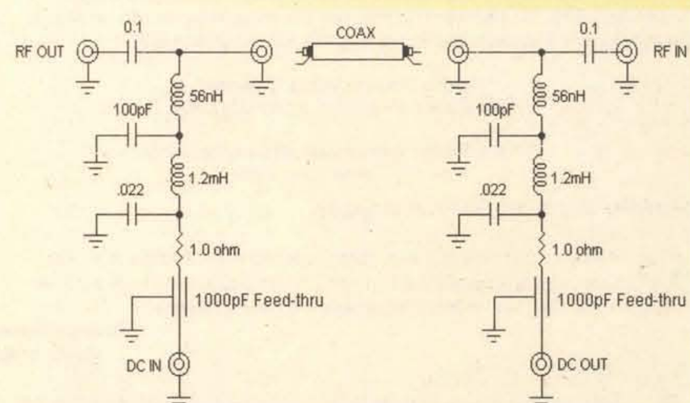
It's important that you use a shielded test probe to prevent stray AC hum from affecting the signal under test. Such probes are popularly used with oscilloscopes and are readily available, or you can make your own using a six-foot length of coax cable and a BNC connector.

Sending DC Volts Through Coax

Q: I am looking for a way to send nine volts DC down an RG-59 coaxial cable to power a CCTV camera. I have seen it done with mast mounted TV preamplifiers, but short of buying a VHF/UHF boost amplifier and reverse engineering it, I don't know how to mix RF and DC — or how to separate them at the camera.

BLMartin
via Internet

A: What you need is a device called a "bias tee." This passive device permits the mixing of RF and DC voltage without affecting the quality of either. Bias tees are commercially available from several sources, including **Down East Microwave Inc. (908-996-3584; http://www.downeastmicrowave.com)** and **Mini-Circuits (1-800-654-7949; http://www.minicircuits.com/znbt-60-1w.pdf)**. Prices range from $35.00 to $100.00. Fortunately, they're cheap and easy to build, as shown below.



The 0.1 capacitor blocks the DC voltage but allows the RF to pass, whereas the two chokes block the RF signal and allow the DC to pass. Use point-to-point wiring, keeping the leads as short as possible, and enclose the circuit inside a metal box to prevent EMI/RFI intereference. A gutted CATV splitter makes an excellent enclosure.

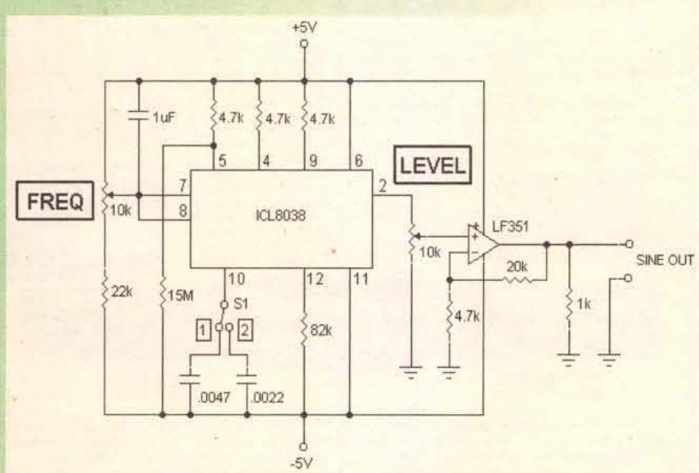
Simple Sinewave Generator

Q: I've been experimenting with the hum filters you described in the Nov. 2000 column, and find them to work as advertised. Now I'd like to take my experiments farther and investigate other types of filters. But to do so, I need a variable frequency sinewave generator. Do you have a simple one that won't cost me an arm and a leg to build?

G. Phillips
via Internet

A: I'm glad to hear that you're interested in playing with filters. Personally, I find them both interesting and frustrating (far too many variables) —

yet indispensable. Which is why a good signal generator and a sensitive AC voltmeter can take a lot of the pain out of the design process. The AC voltmeter is described in the answer above ("Sensitive AC Voltmeter") and the signal generator is shown below.



Instead of reinventing the wheel, and possibly introducing glitches in the test equipment, I used a venerable and very stable function generator chip available from **Jameco Electronics (1-800-831-4242; www.jameco.com)**. Basically, it's a squarewave multivibrator with internal shaping circuits to generate sawtooth and sinewave outputs. The output frequency is controlled by the voltage on pins 7 and 8, which is adjustable via the FREQ potentiometer, and the timing capacitor on pin 10. Using the values indicated, the frequency is adjustable from 20 Hz to 20 kHz and 10 kHz to 100 kHz.

S1	RANGE
1	20 Hz to 20kHz
2	10 kHz to 100 kHz

The output is buffered through an LF351 op-amp, and the output voltage is adjustable via the LEVEL control. I opted to use a bipolar power source so that the waveform moves symmetrically above and below ground, instead of an offset voltage that would be present with a single-ended power source. A suitable power supply can be built using the circuit shown in the answer below, "Simple Bipolar Power Supply." Replace the 7812 and 7912 with 78L05 and 79L05, respectively, and lower the input voltage to 12 volts using a RadioShack 273-1366 power transformer. For more information on filters, their design, and applications, check out the following sources:

Audio Design With Opamps
http://www.sound.au.com/dwopa2.htm

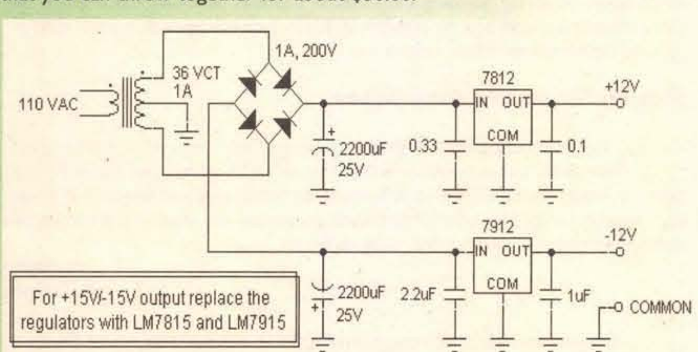
Active Filter Cookbook, Don Lancaster
http://www.amazon.com

Simple Bipolar Power Supply

Q. Many of the circuits I find of interest require a +12V and a -12V power supply, especially those using op-amps. Do you have a power supply circuit that will let me experiment with these designs?

George Simon
via Internet

A. Although the industry is migrating to single-source op-amps like the LM324, these chips won't work for all applications — particularly in circuits where CMR (common-mode rejection) is critical. Here's a simple circuit that you can throw together for about $30.00.



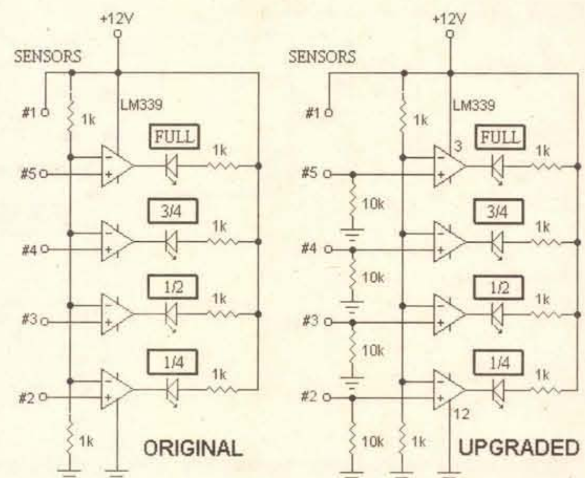
This bench power supply provides bipolar 12 volts at up to 1A. Moreover, the design is easily modified to accommodate other bipolar voltages and currents. For example, replacing the 7812 and 7912 with a 7815 and 7915, respectively, creates a +15V/-15V power supply, again at 1A. Unlike the switching power supply in "Switching 3.3-Volt Voltage Regulator," the regulators need a heatsink. If your experiments tend toward one and two op-amp designs, i.e., no high-power output devices, replacing the 7812 and 7912 with their low-power 78L12 and 79L12 counterparts will provide tighter regulation — and dissipate less heat — when the output current is less than 100 mA.

Suspect: A CMOS Ringer

Q. The circuit you describe in your Jul. 2000 column is just what I need to monitor my RV water supply — if I could make it work! I have breadboarded this thing six or eight times using RadioShack LM339s, resistors, and LEDs. I have even switched comparator ± leads, all to no avail. I'm getting power from a metered regulated power supply, so that can't be the problem. Is there an error in the published circuit or am I missing something?

P. J. Hicks
via Internet

A. Over the past years, I've built this circuit many times with never a problem. So I went to RadioShack, bought their parts, and guess what? It didn't work. I've had this happen before using RadioShack parts, and it's not because their parts are defective. It's because RadioShack often sells a CMOS equivalent of a popular part, most notably is the Texas Instrument CMOS version of the 555 timer, and they aren't the same as their TTL equivalents. First and foremost, the input impedances are MUCH higher. Consequently, the sensor inputs act like a radio antenna, picking up signals from hither and yon. The solution is to add a pull-down resistor, as shown in the circuit below.



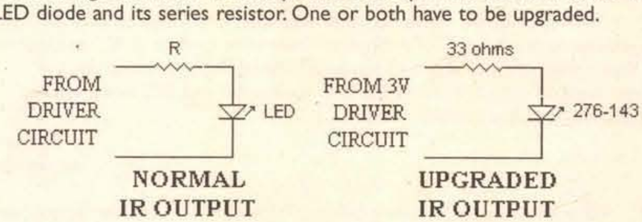
(Reader's response: "Your suggestion solved the problem. Thanks a lot; I appreciate all your trouble and interest in solving the mystery. Regards, PJH")

Supercharge That Bot Link

Q. Do you know of a simple 40-kHz amplifier circuit — preferably one IC? I'd like to extend the range of my robot's detectors.

Wally Good
via Internet

A. I assume you're using an IR receiver module, like the RadioShack 236-137, and feeding its output to a PIC or BASIC Stamp chip. In which case a 40-kHz amp won't help because the output is TTL logic. To increase the operating range, you have to up the light output from the IR transmitter. If you're using a handheld remote, you need to open the case and locate the LED diode and its series resistor. One or both have to be upgraded.



The LED is behind the filter lens and the current limiting resistor will be in series with one of the LED's leads, as shown above.

Cool Web Sites

Need a unique gift for that special someone who has everything? Try Ameriquest Distributing — a Sharper Image attitude with affordable prices.

http://www.ameriquestdistributing.com

If you want to help stamp out spam, expose the spam's headers and forward it to any of the following:

junk@brightmail.com
junk.earthlink@brightmail.com
spamrecycle@ChooseYourMail.com

MAILBAG

Mr. Byers,

I am in the design stages of building a high-current, PWM DC-motor speed controller. I noticed in your Sept. 2000 column a circuit similar to the one that I had in mind. It seems to me that there may be a problem with the circuit that you printed. Maybe I am wrong, but should there be a 1K resistor between pins 7 and 8 of the NE555 timer? I'm not an electronics engineer, just a hobbyist, 40-year ham radio licensee, and 51 years young. Would you please explain how this circuit will work as printed? I'd appreciate it.

Alan Schneiderman
Chancellor, SD

Response:

Well, the 1k resistor is simply a current limiter. If the wiper of the 1M pot were turned all the way up (to the pin 8 position) the only device between the +12-volt source and the timing capacitor is a 1N4148 steering diode, which has a current rating of 100 mA. Without the resistor, the surge current could destroy the diode. The circuit is a classic PWM (pulse-width modulated) multivibrator where the frequency remains stable while the duty cycle is variable from about 3% to 97%; you've seen me use this design for DC light dimmers, too. Focus on the 1M pot. As the wiper goes toward pin 8 (+12V), it takes less time to charge the 0.1 uF capacitor, but more time for it to discharge through pin 7. Moving the wiper to the other extreme reverses the scenario, where the charging time is long and the discharge time is short. Midway, the duty cycle is 50%.

Mr. Byers,

I was looking through some old Nuts & Volts issues. In the spring of 1999, you answered a question about telephone ring generators. Have you seen the Black Magic LBMR12? It's a little overpriced, but it works fine. Jameco Electronics sells it for $24.95, stock no. 145816. I have used one and it works fine and draws very little input current. It's a little black box, potted, with four wires sticking out. I bought mine when All Electronics had them on close-out for $5.00. I should have bought one or two more and done a little reverse engineering to see what's under that potting compound!

Bill Stiles, CET
via Internet

Hi Mr. Byers,

I read your answer to the defective AC lamp dimmer in the July 2000 issue. I find that spraying the pot in the Torchiere lamp with a tuner cleaner (RadioShack 64-4315) corrects the problem most of the time.

Robert Eshoo
Santa Monica, CA

DEALER DIRECTORY

The dealers listed below carry the latest issue of Nuts & Volts, for your convenience.

ALABAMA
Little Professor Book Center
2717 S. 18th St.
Birmingham 35209

ARIZONA
Elliott Electronic Supply
1251 S. Tyndall Ave.
Tucson 85713
Tower Records
3 E. 9th St.
Tempe 85281

AUSTRALIA
DonTronics
P.O. Box 595
29 Ellesmere Cres.
Tullamarine 3043
www.dontronics.com

CALIFORNIA
Abletronics
9155 Archibald Ave. Unit E
Cucamonga 91730
All Electronics
905 S. Vermont Ave.
Los Angeles 90006

14928 Oxnard St.
Van Nuys 91411
Alltronics
2300-D Zanker Rd.
San Jose 95131
Centerfold International
716 N. Fairfax Ave.
Los Angeles 90046
Del Amo Books & News
3758 Sepulveda Blvd.
Torrance 90505
Electro Mavin
2985 E. Harcourt St.
Rancho Dominguez 90221
Ford Electronics
8431 Commonwealth Ave.
Buena Park 90621
Harding Way News
113 W. Harding Way
Stockton 95204
Harold's Newsstand
524 Geary St.
San Francisco 94102
Hi-Fi Doctor
1814 E. Ball Rd.
Anaheim 92805
HSC Electronic Supply
4837 Amber Ln.
Sacramento 95841

3500 Ryder St.
Santa Clara 95051

5681 Redwood Dr.
Rohnert Park 94928
Hyatt Electronic Surplus
371 N. Johnson Ave.
El Cajon 92020
JK Electronics
6395 Westminster Ave.
Westminster 92683
Lion Electronic Labs
4948 E. Townsend Ave.
Fresno 93727
Mar Vac Electronics
2001 Harbor Blvd.
Costa Mesa 92627

12453 Washington Blvd.
Los Angeles 90066

4747 Holt Blvd.
Montclair 91763

2000 Outlet Center Dr. Ste. 150
Oxnard 93030

1759 Colorado Blvd.
Pasadena 91106

2537 Del Paso Blvd.
Sacramento 95815

5184 Hollister Blvd.
Santa Barbara 93111
Panorama Electronics
8761 Van Nuys Blvd.
Panorama City 91402
Roger's System Specialists
24895 Ave Rockefeller
Valencia 91355
Sandy's Electronics Supply, Inc.
20655 Soledad Cyn. Rd. #15
Santa Clarita 91351
Sav-On Electronics
13225 Harbor Blvd.
Garden Grove 92643
Sierra Madre Newsstand
55 N. Baldwin Ave.
Sierra Madre 91024
The Red Barn
Hwy. 299
Bieber 96009
Tower Books
211 Main St.
Chico 95928

7840 Macy Plaza Dr.
Citrus Heights 95610

1280 E. Willow Pass Rd.
Concord 94520

630 San Antonio Rd.
Mountain View 94040

1600 Broadway
Sacramento 95818

2538 Watt Ave.
Sacramento 95821
Tower Records/Video
220 N. Beach Blvd.
Anaheim 92801

5703 Christie Ave.
Emeryville 94608

6310 E. Pacific Coast Hwy.
Long Beach 90803

3205 20th Ave.
San Francisco 94132

2525 Jones St.
San Francisco 94133

871 Blossom Hill Rd.
San Jose 95123
Video Electronics
3829 University Ave.
San Diego 92105

CANADA
Cody Books Ltd.
139-3000 Lougheed Hwy.
Westwood Mall
Port Coquitlam, BC V3B 1C5
Com-West Radio Systems Ltd.
8171 Main St.
Vancouver, BC V5X 3L2
Emma Marion Ltd.
2677 E. Hastings St.
Vancouver, BC V5K 1Z5
Muir Communications Ltd.
3214 Douglas St.
Victoria, BC V8Z 3K6

COLORADO
Centennial Electronics, Inc.
2324 E. Bijou
Colorado Springs 80909
Tower Records/Video
2500 E. 1st Ave.
Denver 80206

CONNECTICUT
Archway News
64 Bank St.
New Milford 06776

DELAWARE
Newark Newsstand
70 E. Main St.
Newark 19711

DISTRICT OF COLUMBIA
Tower Records
2000 Pennsylvania Ave.
Washington 20006

FLORIDA
Alfa Electronic Supply
6444 Pembroke Rd.
Miramar 33023
Astro Too
6949 W. Nasa Blvd.
West Melbourne 32904
Clarks Out of Town News
303 S. Andrews Ave.
Fort Lauderdale 33301
Mike's Electronic Distributing Co.
1001 N.W. 52nd St.
Fort Lauderdale 33309
Skycraft Parts & Surplus, Inc.
2245 W. Fairbanks
Winter Park 32789
Sunny's At Sunset, Inc.
8260 Sunset Strip
Sunrise 33322

HAWAII
SolarWorks!
525 Lotus Blossom Ln.
Ocean View 96737
Tower Records
4211 Waialae Ave.
Honolulu 96816
611 Keeaumoku
Honolulu 96814

IDAHO
Current Source
454 N. Phillippi St.
Boise 83706

ILLINOIS
Tower Records/Video/Books
383 W. Army Trail Rd.
Bloomingdale 60108

2301 N. Clark St. #200
Chicago 60614

1209 E. Golf Rd.
Schaumburg 60173

INDIANA
Harbourtown Sales
108 Park 32 W. Dr.
Noblesville 46060

KANSAS
Hollywood At Home
9063 Metcalf Ave.
Overland Park 66212
Lloyd's Radio & Electronic, Inc.
220 W. Harry St.
Wichita 67213

LOUISIANA
Lakeside News
3323 Severn Ave.
Metairie 70002

MARYLAND
Tower Records/Video
2566 Solomons Island Rd.
Annapolis 21401

1601 Rockville Pike #210
Rockville 20852

MASSACHUSETTS
Newsbreak, Inc.
579 G.A.R. Hwy. Rt. 6
Swansea 02777

MICHIGAN
Anything Goes
5108 Rochester Rd.
Troy 48098
Little Professors Book Center
22174 Michigan Ave.
Dearborn 48124
Purchase Radio Supply, Inc.
327 E. Hoover Ave.
Ann Arbor 48104

MINNESOTA
Radio City, Inc.
2633 County Road 1
Mounds View 55112

MISSOURI
Accurate Instruments
11201 E. 24 Hwy.
Independence 64054
Electronics Exchange
8644 St. Charles Rock Rd.
St. Louis 63114

NEVADA
Amateur Electronic Supply
1072 N. Rancho Dr.
Las Vegas 89106
House of Drake
3129 S. Carson St.
Carson City 89701
Less Buster's Electronics
2930 N. Las Vegas Blvd. VSTG-22
North Las Vegas 89030
Radio World
1656 Nevada Hwy.
Boulder City 89005
Tower Records/Video
4580 W. Sahara Ave.
Las Vegas 89102

6450 S. Virginia
Reno 89511

NEW YORK
All Phase Video Security, Inc.
70 Cain Dr.
Brentwood 11717
Ham Central
3 Neptune Rd.
Poughkeepsie 12601
Hirsch Sales Corporation
219 California Dr.
Williamsville 14221
Tower Records/Video
105 Old Country Rd.
Carle Place 11514

350-370 Route 110
Huntington 11746

1961 Broadway
New York 10023

383 Lafayette St.
New York 10003

OHIO
Compustuff
241 Great Oaks Trl.
Wadsworth 44281
Footsteps
4925 Jackman Rd. Store #58
Toledo 43613
Hosfelt Electronics, Inc.
2700 Sunset Blvd.
Steubenville 43952
Keyways, Inc.
204 S. 3rd St.
Miamisburg 45342
Leo's Book Shop
333 N. Superior St.
Toledo 43604
Powermaxx, Inc.
1587 U.S. Rt. 68 N.
Xenia 45385

OKLAHOMA
Steve's Books & Magazines
2612 S. Harvard
Tulsa 74114
Taylor News & Books
133 W. Main, Ste. 102
Oklahoma City 73102

OREGON
News & Smokes
1060 S.E. M St.
Grants Pass 97526
Norvac Electronics
7940 S.W. Nimbus Ave. Bldg. 8
Beaverton 97005

960 Conger
Eugene 97402

1545 N. Commercial N.E.
Salem 97303
Tower Books
1307 N.E. 102nd Ave.
Portland 97220

PENNSYLVANIA
Bedford St. News
308 Bedford St.
Johnstown 15901
Tower Books
425 South St.
Philadelphia 19147
Tower Records
340 W. Dekalb Pike
King of Prussia 19406

TENNESSEE
Tower Books
2404 W. End Ave.
Nashville 37203
Tower Records
504 Opry Mills Dr.
Nashville 37214

TEXAS
BDL News, Inc.
809 Pierce
Houston 77002
Electronic Parts Outlet
3753-B Fondren Rd.
Houston 77063
Mouser Electronics
958 N. Main St.
Mansfield 76063
Tanner Electronics
1301 W. Beltline #105
Carrollton 75006
Tower Records
2403 Guadalupe St.
Austin 78705

VIRGINIA
Tower Records/Video/Books
4110 W. Ox Rd. #12124
Fairfax 22033

1601 Willow Lawn Dr.
Richmond 23230

8389 E. Leesburg Pike
Vienna 22182

WASHINGTON
A-B-C Communications, Inc.
17541 15th Ave. N.E.
Seattle 98155
Oasis Hobby Shop
4171 Wheaton Way Ste. 8
Bremerton 98310
Service Request
3304 W. Rowan Ave.
Spokane 99205
Supertronix
16550 W. Valley Hwy.
Seattle 98188
Tower Books
10635 N.E. 8th St.
Bellevue 98004

20 Mercer St.
Seattle 98109

WISCONSIN
Amateur Electronic Supply, Inc.
5710 W. Good Hope Rd.
Milwaukee 53223
Greenfield News & Hobby
6815 W. Layton Ave.
Greenfield 53220
Cudahy News & Hobby Ctr.
4758 Packard Ave.
Cudahy 53110

WYOMING
Western Test Systems
2701 Westland Ct. #B
Cheyenne 82001

Open Channel

by Joseph J. Carr

Large Loop Antennas

In this month's column, we will take a look at the large loop antennas such as the quad loop, delta loop, and bi-square loop. These loops share certain characteristics in common, such as the approximate pattern. First, let's take a look at the conventional quad loop antenna.

Quad Loop

Figures 1 and 2 show the basic quad loop antenna. The antenna has been likened to a folded dipole that has been "pulled open." The nice thing about this antenna is that a full performance antenna can be built in a limited space. The only thing required is at least a quarter wavelength at the operating frequency. This antenna has a maximum gain of 1.4 dBd (dB over a dipole) or 3.4 dBi (dB over isotropic). The antenna has a figure-8 pattern in and out of the page as you view Figures 1 and 2.

The quad antenna was originally built as a beam antenna (more later). It was created by engineers at radio station HCJB in Quito, Ecuador after they experienced losses to their Yagi antennas due to corona arcing off the ends. The thin air in Quito made the use of Yagis – or any half wavelength antennas – somewhat problematical because of the arcing at the high voltage tips of the antenna. The quad loop solves that problem by putting the current loops and voltage loops (which cause the trouble) in the center of the radiator element's vertical and horizontal sides.

The big loop antenna shown here consist of one wavelength of wire formed into a square, that is to say it is a quarter wavelength on a side. The dimensions of the antenna are:

$$A = \frac{251}{F_{MHz}} \quad (1)$$

Or, for the overall length:

$$Overall = \frac{998}{F_{MHz}} \quad (2)$$

where:
A and Overall are the lengths in feet (ft)
FMHz is the frequency in MegaHertz.

The overall length is four times the length of the individual sides.

Impedance Matching

The feedpoint impedance of the quad loop is around 100 ohms, with 140 ohms being given for the free space impedance. The impedance closer to the earth's surface is probably the smaller number, as is the impedance for antennas with a large length-to-diameter ratio. This is not a good match to either 75-ohm or 52-ohm coaxial cable, so some sort of impedance matching is needed. Perhaps the best approach is to use the quarter wavelength matching stub in series with the transmission line. The length of the quarter wavelength stub should be:

$$L = \frac{246\,V}{F_{MHz}} \quad (3)$$

where:
L is the length of the matching stub in feet (ft)
FMHz is the frequency in MegaHertz

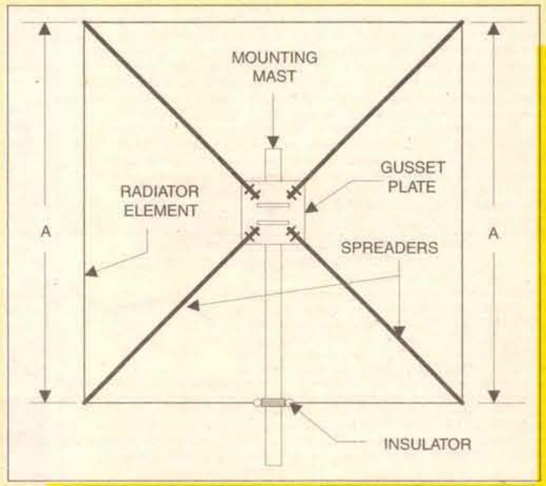
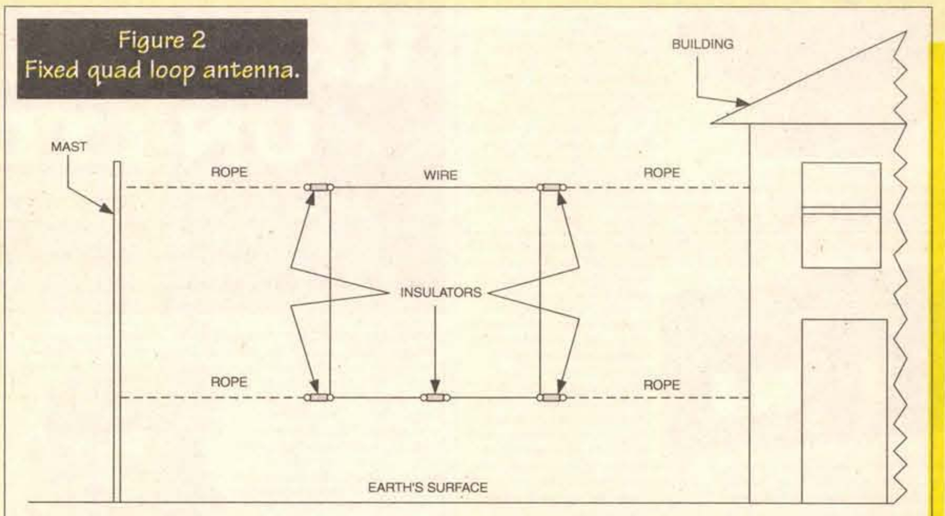


Figure 1 - Rotatable quad loop antenna.

Figure 2
Fixed quad loop antenna.


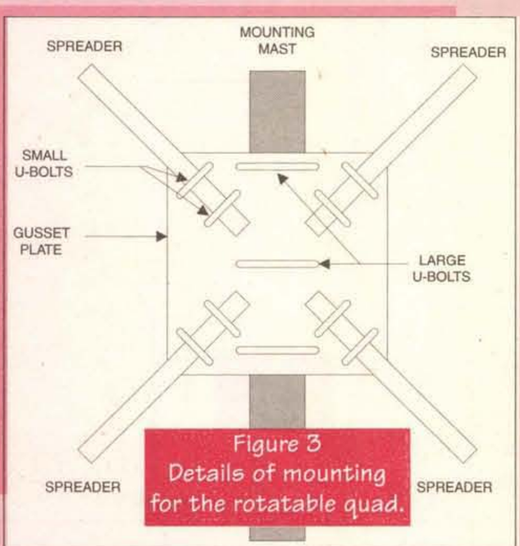


Figure 3
Details of mounting for the rotatable quad.

V is the velocity factor of the coaxial cable.

The term V in Equation 3 depends upon the type of coaxial cable that you use. You can use 0.66 for standard polyethylene coaxial cable, or 0.78 to 0.80 for polyfoam coaxial cable. Or alternatively, you can measure the velocity factor of the coaxial cable and use that number. I have seen substantial variation in the actual velocity factor, so prefer this latter method myself.

The impedance of the transmission line used for the quarter wavelength matching stub is found by taking the square root of the product of the impedances:

$$Z_1 = \sqrt{Z_O Z_L} \quad \textbf{(4)}$$

where:

Z1 is the characteristic impedance required of the matching stub

ZO is the impedance of the feedline to the receiver or the rig

ZL is the load impedance (i.e., the antenna feedpoint impedance)

Example

Take as our example the case where the feedpoint impedance is 140 ohms, and the receiver uses 52-ohm polyfoam coaxial cable with a measured velocity factor of 0.80. The frequency of operation is 14.25 MHz.

Overall Length:

$$Overall = \frac{998}{F_{MHz}}$$

$$= \frac{998}{14.25} = 70 \; feet$$

Length of each side:

A = Overall/4 = 70/4 = 17.5 feet

Length of the matching stub:

$$L = \frac{246\,V}{F_{MHz}}$$

$$= \frac{(246)\,(0.80)}{14.25} = 13.81 \; feet$$

Impedance of the matching stub:

$$Z_1 = \sqrt{Z_O Z_L}$$

$$= \sqrt{(52)\,(140)} = \sqrt{7280} = 85 \; ohms$$

The impedance of the matching section is supposed to be 85 ohms. One can buy 90-ohm coaxial cable but, in practice, the user will be able to obtain 75-ohm coaxial cable far more easily. This cable forms a good match when used as the matching stub, especially considering the fact that the antenna will be used closer to the ground than the free space impedance value indicates. This means the impedance of the load will be closer to 100 ohms, and that translates into an impedance of SQRT(52 (100) = 72 ohms.

Construction

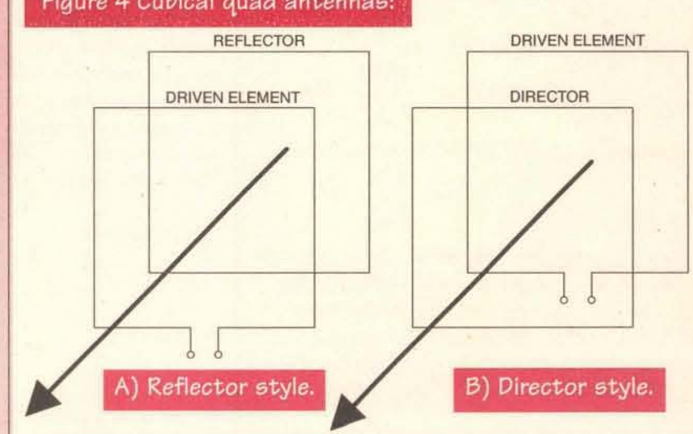
The quad loop antenna can be built in either a rotatable format such as shown in Figure 1, or it can be built fixed in a manner such as Figure 2. The advantage of the rotatable version should be obvious. One can send signals in any direction. More to the point, one can null interfering stations from any quarter.

The rotatable version shown in Figure 1 is mounted on a pole or mast that is, in turn, rotated either by hand or by an electrical antenna rotator. The antenna is built using fiberglass (or other insulating) spreaders connected to a gusset plate. The spreaders are connected to the gusset plate by a set or two or three U-bolts (Figure 3). The gusset plate is held to the mounting mast by larger U-bolts. The gusset plate is typically 10 to 24 inches square, and made of wood or fiberglass.

The mounting version shown in Figure 2 is fixed, but has the advantage of being able to be installed in an existing location, without the need for a rotatable mast. For example, the two supports shown in Figure 3 as a building and a mast, could be any combination of buildings, masts, trees, or other forms. Ropes are used to hold the antenna, which is about in the center of the distance between the supporting structures.

Although it is fed at the bottom in the case

Figure 4 Cubical quad antennas:



A) Reflector style.
B) Director style.

Large Loop Antennas

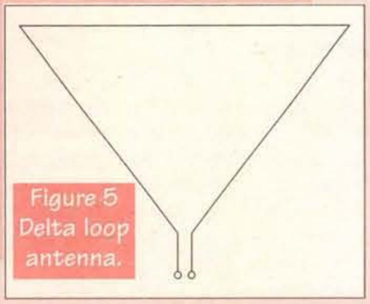


Figure 5
Delta loop antenna.

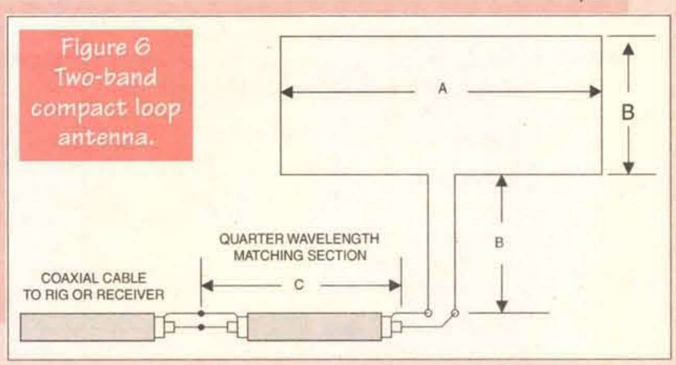


Figure 6
Two-band compact loop antenna.

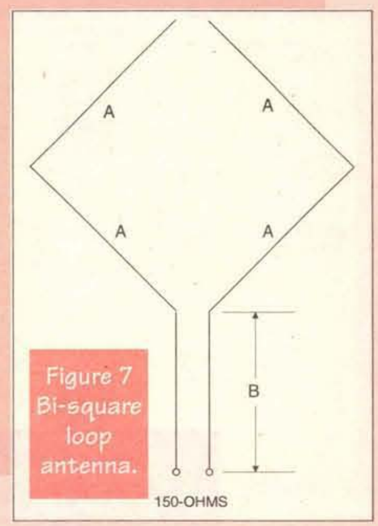


Figure 7
Bi-square loop antenna.

of Figures 1 and 2, giving it horizontal polarization, the antenna can also be fed along either vertical wire radiator segment for vertical polarization.

Quad Beam Antennas

The quad loop antenna can be formed into a beam antenna (Figure 4), giving a unidirectional pattern. The nice thing about the quad antenna is that close to the earth's surface it behaves better than a Yagi beam antenna. The antenna can be built in either of two ways: a driven element and either a reflector or a director. The driven element overall length is found from Equation 2, but the director and reflector element overall lengths are found from Equations 5 and 6:

Director:

$$Overall = \frac{976}{F_{MHz}} \quad (5)$$

Reflector:

$$Overall = \frac{1030}{F_{MHz}} \quad (6)$$

Spacing (0.13():

$$S = \frac{128}{F_{MHz}} \quad (7)$$

For a spacing of 0.13λ, the maximum gain of the two element quad beam antenna is 7.3 dBd, or 9.2 dBi. At a spacing of 0.13λ, the feedpoint impedance is about 60 ohms, which is a good match to either 52-ohm or 75-ohm coaxial cable (the VSWR when used with 52-ohm cable is only 1.15:1).

Delta Loop Antennas

The Delta loop antenna (Figure 5) gets its name from the resemblance to the Greek upper case letter "delta" Δ). The characteristic of this loop is that it is triangular shaped, which makes mounting and installation easier in some cases. Each side of the Delta loop is one-third of a wavelength (λ/3), but the overall length is found from Equation 2. The antenna can be fed at any corner. The antenna can also be inverted (sharp point up) and it will work approximately the same as for the case shown.

Two-Band Compact Loop

Most of the loops discussed thus far are basically monobanders, unless multiple loops are built on the same frame and fed in parallel. The loop in Figure 6, however, operates on two bands that are harmonically related to each other. For example, if FL is the lower band, and FH is the higher band, then FH = 2 X FL.

The overall length of the loop is half wavelength, but it is arranged not into a square, but rather a rectangle in which the horizontal sides are twice as long as the vertical sides, i.e., the horizontal elements are quarter wavelength and the vertical sections are one-eighth wavelength. The section lengths are:

Horizontal:

$$A = \frac{246}{F_{MHz}} \text{ feet} \quad (8)$$

Vertical:

$$B = \frac{123}{F_{MHz}} \text{ feet} \quad (9)$$

In both equations, the frequency is the center frequency of the lower band of operation.

The vertical stub is made of 600-ohm parallel open wire transmission line, although 450-ohm twin-lead could also be used. The length of the stub is found from the same equation (above) as the vertical segment if open wire line is used. If twin-lead is used, then multiply that distance by the velocity factor of the transmission line.

The coaxial line is a Q-section made of 75-ohm transmission line. It is cut to a quarter wavelength of the upper band, i.e., twice FMHz used in the calculations above.

The Bi-Square Loop

The bi-square loop in Figure 7 is twice as large as the quad loop. The overall length of the wire is two wavelengths, so each side is half wavelength long. The overall length is calculated from:

$$L_{Meters} = \frac{1919}{F_{MHz}} \text{ feet} \quad (10)$$

while each side is:

$$L_{Meters} = \frac{480}{F_{MHz}} \text{ feet} \quad (11)$$

The bi-square antenna can be used on its design frequency, and also at one-half its design frequency (although the patterns change). At the design frequency, the azimuthal pattern is a clover leaf perpendicular to the plane of the loop, and is horizontally polarized. At one-half the design frequency, the radiation is vertically polarized and the directivity is end fire.

The feedpoint impedance of the bi-square is on the order of 150 ohms. This means that some form of impedance matching will be needed to match the impedance to 52 or 75 ohms used by most receivers.

Conclusion

The large loop antennas offer gain over a dipole, and can be built on smaller sized lots than a host of other antennas. They are easy to build and use. **NV**

Connections ...

I can be reached via email at carrjj@aol.com, or via snail mail at POB 1587, Annandale, VA 22003.

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 address for UPS is required.

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

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

DECEMBER 2000

December 2

GA - CLAXTON - Hamfest. Claxton AR Emergency Service (CARES), Ellie Waters W4CJB, 912-653-4939. Email: ellie@premierweb.net

December 2-3

FL - PALMETTO - Hamfest. Manatee County Convention and Civic Center, 1 Haben Blvd. Talk-in: 146.730. FGCARC, Jean Endicott KC4KZU, 727-525-5178. Email: kr4yl@arrl.net Web: http://www.fgcarc.org

December 3

IN - GREENFIELD - Hamfest. Greenfield High School Pavilion, Broadway St. 8am-2pm. HARC, Tom Donaldson N9LFU, Email: tomd@freewwweb.com General info: 317-326-3168. Web: www.w9atg.org
MI - MT. CLEMENS - Hamfest. L'Anse Creuse High School. 8am-2pm. FCC exams. Talk-in: 147.080+, simplex 146.520. L'Anse Creuse ARC, Donna Luh KA8QBD, 248-651-7387. Email: jrluh@aol.com Web: http://www.ameritech.net/users/lc-arc/index.html

December 9

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves
SC - UNION - Hamfest. Union National Guard Armory. 8am-2pm. Union County ARC, Roger Gregory W4RWG, 864-427-1462. Email: rgregory@carol.net

JANUARY 2001

January 6

TN - MORRISTOWN - Hamfest. Lakeway ARC, John Ellenburg KE4QIH, 423-581-5645. Email: ellenburg@icx.net
WI - WAUKESHA - Hamfest. Waukesha County Expo Center. 8am-2pm. West Allis RAC, Phil Gural W9NAW, 414-425-3649

January 12-13

FL - FT. MYERS - Hamfest. Shady Oaks Community Center, 3280 Marion St. Fri: 4pm-9pm, Sat: 9am-3pm. Talk-in: 146.880. Ft. Myers ARC, Earl Spencer K4FQU, 941-332-1503. Email: k4fqu@juno.com

January 13

NY - MARATHON - Hamfest. Skyline ARC, Andrew Slaugh KB2LUV, 607-753-0597. Email: kb2luv@arrl.net
SC - GREENWOOD - Hamfest. Greenwood ARS, Frank Kolar WA9FWO, 864-229-5639
TX - SAN ANTONIO - Hamfest. Little Joe's Country Gold, 7405 Old Pearsall Rd. San Antonio RC, Royce Taylor KA5OHJ, 210-680-0432. Email: swapfest01@juno.com Web: http://community.webtv.net/k5ucq/SanAntonioRadioClub

January 14

IN - GOSHEN - Hamfest. Michiana Valley Hamfest Assn., Denny Denniston KA9WNR, 219-291-0252 (7-10 PM EST).
OH - NELSONVILLE - Hamfest. Sunday Creek AR Federation, Russ Ellis N8MWK, 740-767-2226. Email: scarf@hocking.edu

January 20

LA - HAMMOND - Hamfest. SLU University Center, Columbus Dr. Ve testing. Talk-in: 147.000-. Southeast LA ARC, Bill Borstel KB5SKW, 225-695-6414. Email: wborstel@aol.com Web: http://www.selarc.org
MO - ST. JOSEPH - Hamfest. Ramada Inn, I-29 & Frederick Ave. FCC exams. Talk-in: 146.85 & 444.925. MO Valley & Ray-Clay ARCs, Carlene Makawski KA0IKS, 816-279-3406. Email: nem3238@ccp.com Web: http://www.kc.net/~oconnor
TN - GALLATIN - Hamfest. Gallatin Civic Center. Sumner County ARA, John Hermon WB5OOL, 615-451-0213. Email: hamfest@scara.net Web: http://www.scara.net

January 20-21

FL - SARASOTA - Hamfest. Sarasota ARA, Eddie Martin KI4ZJ, 941-378-8371. Email: ki4zj@hotmail.com

January 21

MI - HAZEL PARK - Hamfest. Hazel Park High School, 23400 Hughes St. 8am-2pm. Talk-in: 146.64-. Hazel Park ARC, Inc., Tom Krausnick WC9F, email: wc9f@arrl.org Web: http://www.qsl.net/w8hp
NY - NORTH BABYLON - NLI Section Convention. Babylon Town Hall Annex, Phelps Ln. 9am-4pm. VE testing. Great South Bay ARC, Phil Lewis N2MUN, 631-226-0698. Email: n2mun@optonline.net Web: http://www.arrlhudson.org/nli/hru2001.htm
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. Email: wb2slq@juno.com Web: http://www.metro70cmnetwork cmnetwork.com
VA - RICHMOND - VA Section Convention. The Showplace, 3000 Mechanicsville Turnpike (Rt. 360). 8:30am-3:30pm. Richmond Amateur Telecommunications Society, Pat Wilson K4OW, 804-932-9424. Email: k4ow@arrl.net Web: http://frostfest.rats.net

January 27

FL - ARCADIA - Hamfest. DeSoto ARC, Doug Christ KN4YT, Email: kn4yt@cyberstreet.com

January 28

IL - CICERO - Hamfest. Sportsmans Park Race Track, 3301 S. Laramie Ave. 8am-1pm. VE testing. WCRA, 630-545-9950. Email: info@wheatonhamfest.org Web: http://www.wheatonhamfest.org
MD - ODENTON - Hamfest. Maryland Mobileers ARC, Tom Ostrosky W3NI, 410-766-9414. Email: ostrosky@erols.com Web: http://www.space4less.com/mmarc
OH - DOVER - Hamfest. Tusco ARC, Gary Green KB8WFN, 740-922-4454. Email: kb8wfn@tusco.net

FEBRUARY 2001

February 2-3

MS - JACKSON - Convention. Trade Mart Bldg., Fairgrounds. Fri: 5pm-8pm, Sat: 8am-4pm. VE testing. Talk-in: 146.76-. Jackson ARC, Ron Brown AB5WF, 601-956-1448. Email: ab5wf@arrl.net Web: http://www.jxnarc.org

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

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

February 3

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

February 3-4

FL - MIAMI - Southeastern Division Convention. Fair Expo Center, 10901 SW 24th St. (Coral Way). Dade Radio Club, Evelyn Gauzens W4WYR, 305-642-4139. Email: w4wyr@arrl.net Web: http://www.hamboree.org

February 4

TX - GEORGETOWN - Hamfest. Williamson County ARC, Mike Evans KD5AAD, Email: mlevans@mail.utexas.edu

February 5

AZ - PHOENIX - Auction. St. Clement of Rome Catholic Church Social Hall, 15800 Del Webb Blvd. Talk-in: 147.30+. West Valley ARC, Ron K6OP, 623-546-5710. Email: ronk6op@juno.com

February 9-10-11

FL - ORLANDO - Northern FL Section Convention. Central Florida Fairgrounds, 4603 W. Colonial Dr. Exams. Talk-in: 146.760 down 600, 145.110 down 600. Orlando ARC, Ken Christenson AF4ZI, 407-291-2465. Email: kd4jqr@juno.com Web: http://www.oarc.org/hamcat.html

February 10-11

TN - MEMPHIS - Convention. Shelby Co. Bldg., Mid-south Fairgrounds. Sat: 9am-5pm, Sun: 9am-2pm. Dixie Fest Committee, Ben Troughton KU4AW, 901-372-8031. Email: ku4aw@arrl.net Web: http://www.dixiefest.org

February 11

OH - MANSFIELD - Hamfest. InterCity ARC & MASER, Dean Wrasse KB8MG, 419-522-9893. Email: deanwrasse@yahoo.com Web: http://www.maser.org

February 17

CA - MONTEREY - Hamfest. Naval Postgraduate School ARC, Max Cornell K0MC, 831-883-0491. Email: cornell@redshift.com Web: http://k6ly.org/radiofest
MA - MARLBOROUGH - Hamfest. Algonquin ARC, Ann Weldon KA1PON, 508-481-4988. Email: annweldon@aol.com

February 18

CO - BRIGHTON - Hamfest. Aurora Repeater Assn., Wayne Heinen N0POH, 303-699-6335. Email: n0poh@arrl.net Web: http://www.qsl.net/n0ara
MI - FARMINGTON HILLS - Hamfest. William Costick Activity Center, 28600 W. 11 Mile Rd. 8am-1:30pm. LARC, 734-261-5486. Email: swap@larc.mi.org Web: http://larc.mi.org

Events CALENDAR

NY - CHEEKTOWAGA - Hamfest. Leonard Post VFW, 2450 Walden Ave. Talk-in: 147.255. Lancaster ARC, Luke Calianno N2GDU, 716-634-4667 or 716-683-8880. Email: luke@towncountryflorist.com Web: http://hamgate1.sunyerie.edu/~larc

February 24

IN - LA PORTE - Hamfest. La Porte Civic Auditorium, 1001 Ridge St. 7am-1pm. LPARC, Neil Straub WZ9N, 219-324-7525. Email: nstraub@niia.net Web: www.geocities.com/k9jsi/

VT - MILTON - Hamfest. Radio Amateurs of Northern VT, Mitch Stern W1SJ, 802-879-6589. Email: w1sj@arrl.net Web: http://www.ranv.together.com

February 25

NY - HICKSVILLE - Hamfest. Levittown Hall, 201 Levittown Pkwy. Talk-in: 146.850 PL 136.5. Long Island Mobile ARC, Eddie Muro KC2AYC, 516-520-9311. Email: hamfest@limarc.org Web: http://www.limarc.org

OH - CINCINNATI - Hamfest. Hartwell Recreation Center, May St. off Caldwell Dr. 9am-4pm. ARPSC, 513-661-1805. Email: gldivision@juno.com Web: www.arpsc.com

VA - ANNANDALE - Hamfest. Northern VA Community College. Vienna Wireless Society, Mike Toia K3MT, 703-757-7021. Email: k3mt@erols.com Web: http://winterfest.home.att.net

MARCH 2001

March 2-3

FL - NEW PORT RICHEY - Hamfest. Fred K. Marchman Technical Education Center, 7825 Campus Dr. 8am-5pm. Talk-in: 146.670. Gulf Coast ARC, Rick Brown KF4GXS, 727-863-1457. Email: richar@gte.net. Web: http://gcarc.cjb.net

March 3

AR - RUSSELLVILLE - Hamfest. Hughes Community Center, Knoxville & Parkway. 8am-4pm. Talk-in: 146.820. AR River Valley AR Foundation, Margaret Alexander KC5MCS, 501-968-7270. Email: ealexand@cswnet.com Web: http://www.cswnet/com/~arvarf/hamfest.htm

March 4

NY - LINDENHURST - Hamfest. GSBARC & SCRC, Phil Lewis N2MUN, 631-226-0698. Email: info@gsbarc.org Web: http://www.gsbarc.org

March 10

WA - PUYALLUP - Hamfest. Mike & Key ARC, Michael Dinkelman N7WA, 425-867-4797. Email: mwdink@eskimo.com

March 10-11

NC - CHARLOTTE - Hamfest & ComputerFair. Charlotte Merchandise Mart, 2500 E. Independence Blvd. The Mecklenburg ARS, Tom Hunt KA3VVJ, 704-948-7373 day & eves. until 9pm EST. Email: dealers@w4bfb.org Web: www.w4bfb.org/hamfest.html

March 17

CT - POMFRET - Hamfest. Eastern Connecticut ARA, Paul Rollinson KE1LI, 860-928-2456. Email: kelli@arrl.net

FL - FT. WALTON BEACH - Hamfest. Playground ARC, Louis Carter KF4HRM, 850-243-4315. Email: parcfest@aol.com Web: http://www.bsc.net/playground/

FL - STUART - Hamfest. Martin County ARA, Romund Madson KS4KM, 561-337-1841

March 17-18

TX - MIDLAND - State Convention. Midland ARC, Pete Stull WB7AMP, 915-686-6755 or 915-362-6644. Email: W5QGG@arrl.net

March 18

OH - MAUMEE - Hamfest. Lucas County Recreation Center, 2901 Key St. 8am-2pm. Talk-in: 147.27+. TMRA Hamfest, POB 273, Toledo, OH 43697-0273. Web: www.tmrahamradio.org

March 24

MN - ST. PAUL - Hamfest. Robbinsdale ARC, Harriet Johanson KB0UPH, 763-537-1722. Email: k0ltc@visi.com Web: http://www.visi.com/~k0ltc

WV - BECKLEY - Hamfest. Plateau ARA & Black Diamond ARC, James Martin KC8JSZ, 304-465-1428. Email: w373@inetone.net

March 25

NC - KINSTON - Hamfest. Down East Hamfest Assn., Doug Burt W4OFO, 252-524-5724. Email: jeanhd@icomnet.com

March 30-31

NE - NORFOLK - Convention. Elkhorn Valley ARC, Sam Seikaly WA6BRE, 402-379-4073. Email: sseikaly@conpoint.com Web: http://www.qsl.net/evarc/

March 31

KY - ELIZABETHTOWN - Hamfest. Lincoln Trail ARC, Leon Priest N4TFK, 270-351-4721. Email: n4tfk@qsl.net Web: http://www.qsl.net/w4bej

TX - BRENHAM - Hamfest. Brenham ARC, Dan Lakenmacher N5UNU, 979-836-8739. Email: lindan@pointcom.net Web: http://www.alpha1.net/~barc

March 31-April 1

MD - TIMONIUM - Greater Baltimore Hamboree & Computerfest/MD State ARRL

Events CALENDAR

Convention. Timonium Fairgrounds, York Rd. Baltimore ARC, Sharon Dobson N3QQC, 410-HAM-FEST or 800-HAM-FEST. Email: k3duh@amsat.org Web: http://www.gbhc.org

APRIL 2001

April 6-7

WI - MILWAUKEE - AES Superfest 2001. Amateur Electronic Supply, Ray Grenier K9KHW, email: rayk9khw@aol.com

April 7

MO - LEBANON - Hamfest. Lebanon ARC, Chuck Sears AA0RK, 417-589-8122. Email: freedom1@advertisnet.com

April 8

NC - RALEIGH - Hamfest. Raleigh ARS, Chuck Littlewood K4HF, 919-872-6555. Email: k4hf@arrl.net Web: http://www.rars.org

WI - STOUGHTON - Hamfest. Madison Area Repeater Assn., Paul Toussaint N9VWH, 608-245-8890. Email: n9vwh@arrl.net Web: http://www.qsl.net/mara/

April 28

SC - WINDSOR - Hamfest. Salkehatchie ARS, Adam Hoffman AF4QZ, 803-245-4673. Email: af4qz@arrl.net Web: http://www.qsl.net/kf4cvo

April 29

IL - ARTHUR - Hamfest. Moultrie ARK, Ralph Zancha WC9V, 217-543-2178 days or 217-873-5287 eves. Email: rzancha@one-eleven.net

OH - CANFIELD - Hamfest. Twenty Over Nine Radio Club, Don Stoddard N8LNE, 330-793-7072. Email: n8lne1@juno.com

MAY 2001

May 5

AZ - SIERRA VISTA - Hamfest. Cochise ARA, Robert Warren KF7TJ, 520-803-1453. Email: warnel@juno.com Web: http://www.qsl.net/k7rdg

SC - GREENVILLE - Hamfest. Blue Ridge ARS, Bob Watson W4RGW, 864-833-2204. Email: w4rgw@arrl.net Web: http://www.brars.org

WI - CEDARBURG - Hamfest. Ozaukee Radio Club, Gene Szudrowitz KB9VJP, 262-377-6792. Email: szudg@msn.com

May 5-6

AL - BIRMINGHAM - Hamfest. Glenn Glass KE4YZK, 205-681-5019. Email: ke4yzk@bellsouth.net Web: http://www.w4cue.com

TX - ABILENE - West TX State Convention. Key City ARC, Peggy Richard KA4UPA, 915-672-8889. Email: ka4upa@arrl.net Web: http://www.angelfire.com/tx/kcarc76/hamfest.html

May 6

MD - HAGERSTOWN - Hamfest. Antietam Radio Assn., Carl Morris WN3DUG, 717-267-3411. Email: morriscw@cvn.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. Email: wb2slq@juno.com Web: http://www.metro70cmnetwork.com

PA - WRIGHTSTOWN - Hamfest. Warminster ARC, Tony Simek N3YNH, 215-674-5218. Email: tsimek@aol.com Web: www.voicenet.com/~juno.com

May 12

WA - STANWOOD - Hamfest. Stanwood-Camano ARC, Dave Huppert KA7FDC, 360-387-6123. Email: huppert@whidbey.net

May 18-19-20

OH - DAYTON - Hamvention. Dayton ARA, Jim Graver KB8PSO, 937-276-6930. Email: info@hamvention.org Web: http://www.hamvention.org/

JUNE 2001

June 1-2-3

NY - ROCHESTER - Atlantic Division Convention. Monroe County Fairgrounds, Rt. 15A. Fri: 6am-5:30pm, Sat: 8:30am-5:30pm, Sun: 8:30am-1:30pm. Rochester ARA, Harold Smith K2HC, 716-424-7184. Email: harold@rochesterhamfest.org Web: http://www.rochesterhamfest.org

OR - SEASIDE - Northwestern Division ARRL Convention. Convention Center. SEA-PAC, Randy Stimson KZ7T, 503-297-1175. Web: www.seapac.org

June 2

IL - SPRINGFIELD - Hamfest. Sangamon Valley RC, Edmund Gaffney KA9ETP, 217-628-3697. Email: egaffney@family-net.net Web: http://www.w9dua.net

June 3

IL - PRINCETON - Hamfest. Starved Rock RC, Jerry Hagemann N9ZJK, 815-538-6932. Email: w9mkshamfest@hotmail.com Web: http://www.qsl.net/w9mks

VA - MANASSAS - Hamfest. Ole Virginia Hams ARC, Mary Lu Blasdell KB4EFB, 703-369-2877. Email: mblasd1638@aol.com Web: http://www.qsl.net/olevahams

June 9

PA - BLOOMSBURG - Eastern PA Section Convention. Columbia-Montour ARC, George Law N3KYZ, 570-784-2299. Email: n3kyz@jlink.net Web: http://www.bafn.org/~cmarc

WI - EAU CLAIRE - Hamfest. Eau Claire ARC, Jim Staatz KG9RA, 715-838-9108. Email: w9eau@ecarc.org Web: http://www.ecarc.org

June 10

IL - WHEATON - Hamfest. Six Meter Club of Chicago, Joseph Gutwein WA9RIJ, 630-963-4922 or 708-442-4961. Email: wa9rij@mc.net Web: http://www.cyberconnect.com/orion/smcc.html

WESTERN TEST SYSTEMS

WE BUY AND SELL

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

Orders **800-538-1493**

2701 Westland Court, Unit B, Cheyenne, Wyoming 82001

OSCILLOSCOPES & ACCESSORIES

OSCILLOSCOPES

TEK 7104 1 GHz 2-Channel Oscilloscope, w/7A29,7A29-04,7B10,7B15 ..... $2,000.00

PROBES

TEK 7904 Oscilloscope with plug-ins: 7A19; 7A26; 7B80; 7B85 ..... $850.00
TEK 1101 Accessory Power Supply, for FET probes $175.00
TEK A6902B Voltage Isolator, DC-20 MHz, 20 mV-500 V/div. $500.00
TEK P6046 100 MHz Differential Probe $400.00
TEK P6101A pair 1X 34 MHz Probe pair, 10 Megohm/32pF, new in plastic $50.00
TEK P6201 900 MHz 1X/10X/100X FET Probe $400.00
TEK P6202 500 MHz 10X FET Probe $150.00
TEK P6205 750 MHz 10X FET Probe, for TDS series $325.00
TEK P6701-opt.02 O/E Converter, 450-1050 nm/0-1 mW: DC-700 MHz, ST conn. $175.00

WAVEFORM GENERATORS

FUNCTION

HP 3310A 5 MHz Function Generator $250.00
HP 3312A 13 MHz Function Generator $500.00
HP 3314A-001 Function Generator, 0.001 Hz-19.99 MHz, 30 Vp-p, HPIB $1,200.00
HP 3325A-002 21 MHz Synthesized Function Generator, HV output option $1,200.00
TEK AWG5102 Arb.Waveform Gen., 20 MS/s,12 bits,50ppm synthesis <1MHz $650.00
TEK AWG5105-opt.02 Arbitrary Waveform Generator, dual channel option $800.00
TEK DD501 Digital Delay & Burst Gen., for function & pulse gen's $200.00
TEK FG5010 Programmable 20 MHz Function Generator, TM5000 series $800.00
TEK FG501A 2 MHz Function Generator, TM500 series $275.00
TEK FG502 11 MHz Function Generator, TM500 series $275.00
TEK FG503 3 MHz Function Generator, TM500 series $250.00
TEK RG501 Ramp Generator, TM500 series $175.00
WAVETEK 288 20 MHz Synthesized Function Generator, GPIB $650.00

PULSE

BERKELEY NUCLEONICS 7085B Digital Delay Generator, 0-100 mS, 1 nS res.,5 Hz-5 MHz $550.00
HP 8007B 100 MHz Pulse Generator $450.00
HP 8012B 50 MHz Pulse Generator, variable transition time $600.00
HP 8013A 50 MHz Dual Output Pulse Generator $500.00
TEK PG502 250 MHz Pulse Generator, Tr<1nS, TM500 series $500.00
TEK PG508 50 MHz Pulse Generator, TM500 series $350.00
WAVETEK 802 50 MHz Pulse Generator $250.00

VOLTAGE & CURRENT

VOLTMETERS

FLUKE 845AR High Impedance Voltmeter / Null Detector $400.00
HP 3456A 6-1/2 Digit Voltmeter, HPIB $450.00
HP 3478A 5-1/2 digit Multimeter, HPIB $450.00
KEITHLEY 181 6-1/2 digit Nanovoltmeter, 10 nV sensitivity, GPIB $675.00
SOLARTRON 7081 8-1/2 digit Voltmeter $3,000.00
TEK DM5010 4-1/2 digit Multimeter, TM5000 series plug-in $300.00
TEK DM501A 4-1/2 digit Multimeter, TM500 series plug-in $225.00

CALIBRATION

FLUKE 510A AC Reference Standard, 10 VRMS, 0-10 mA $450.00
FLUKE 515A Portable Calibrator, DC/AC/Ohms, line & battery power $900.00

VOLTAGE SOURCES

FLUKE 5220A Transconductance Amplifier, DC-5 kHz, 0-20 A $1,900.00
HP 6114A Precision Power Supply, 0-20 V 0-2 A / 20-40 V 1 A $850.00
HP 6115A Precision Power Supply, 0-50V 0-0.8A / 0-100V 0-0.4A $750.00
KEITHLEY 228 Programmable Voltage/Current Source $1,900.00

CURRENT METERS & SOURCES

FLUKE Y5020 Current Shunt, 20 V / 20 A max., 1 milliohm value $450.00
HP 6177C DC Current Source, to 50 V, 500 mA $500.00
HP 6181C DC Current Source, to 100 V, 250 mA $500.00
HP 6186C DC Current Source, to 300 V, 100 mA $750.00
KEITHLEY 225 Current Source, 0.1 uA-100 mA, 10-100 V compliance $450.00
TEK CT-5 High Current Transformer for P6021/A6302, to 1000A $375.00
TEK P6022 AC Current Probe w/termination, 935 Hz-120 MHz, 6 A pk $250.00

IMPEDANCE & COMPONENT TEST

L.C.R.

BOONTON 62AD 1 MHz Inductance Meter, 2-2000 uH $550.00
BOONTON 72BD 1 MHz Capacitance Meter, 3-1/2 digit display $650.00
BOONTON 72C 1 MHz Capacitance Meter, 1-3000 pF full scale $800.00
GR 1658 RLC Digibridge, 120 Hz/ 1 kHz $1,000.00
GR 1659 RLC Digibridge, 120 Hz/ 1 kHz/ 10 kHz $1,100.00
HP 4275A 5-1/2 digit LCR Meter, 10 kHz-10 MHz, HPIB $3,500.00

STANDARDS

E.S.I. SR-1 Standard Resistor, various values $125.00
E.S.I. SR1010 Resistance Transfer Standards, 1 Ohm-100 K/step $550.00
GENERAL RADIO 1409-SERIES Standard Capacitors $150.00
GR 1406 Standard Air Capacitors, GR900 connector, 0.1% acc. $275.00
GR 1413 6-Decade Precision Capacitor, 0-1 uF, 1 pF resolution $1,500.00
GR 1432-U 4-Decade Resistor, 0-111.10 Ohms, 0.01 Ohm resolution $100.00
GR 1433-J 4-Decade Resistor, 0-11,110 Ohms, 1 Ohm resolution $150.00
GR 1433-K 4-Decade Resistor, 0-1,110 Ohms, 0.1 Ohm resolution $150.00
GR 1433-P 5-Decade Resistor, 0-1.1111 Megohm, 10 Ohm resolution $500.00

T.D.R.

TEK 1503B-03,04 T.D.R., 0-50,000 ft., chart recorder & battery power $3,000.00
TEK 1503-opt.04 Time Domain Reflectometer, 0-50,000 feet,chart recorder $1,400.00

POWER SUPPLIES

SINGLE OUTPUT

HP 6024A 0-60 V / 0-10 A / 200 Watts max. CV/CC Power Supply $600.00
HP 6033A Power Supply, 0-20 V / 0-30 A / 200 Watts max., HPIB $1,200.00
HP 6110A 0-3000 V 0-6 mA CV/CL Power Supply $250.00
HP 6201B 0-20 V 0-1.5 A CV/CC Power Supply $175.00
HP 6203B 0-7.5 V 0-3 A CV/CC Power Supply $175.00
HP 6207B 0-160 V 0-200 mA CV/CC Power Supply $200.00
HP 6263B 0-20 V 0-10 A CV/CC Power Supply $375.00
HP 6266B 0-40 V 0-5 A CV/CC Power Supply $375.00
HP 6267B 0-40 V 0-10 A CV/CC Power Supply $550.00
HP 6271B 0-60 V 0-3 A CV/CC Power Supply $375.00
HP 6274B 0-60 V 0-15 A CV/CC Power Supply $650.00
HP 6282A 0-10 V 0-10 A CV/CC Power Supply $200.00
HP 6299A 0-100 V 0-750 mA CV/CC Power Supply $200.00
HP 6384A 4.0-5.5 V at 8 A CV/CL Power Supply $125.00
HP 6443B 0-120 V 0-2.5 A CV/CC Power Supply $450.00
HP 6643A 0-35 V 0-6 A CV/CC Power Supply, HPIB $1,200.00
HP 6652A 0-20 V 0-25 A 500 Watt Programmable Power Supply, HPIB $1,875.00
KEPCO ATE 36-30M 0-36 V 0-30 A CV/CC Power Supply $900.00
KEPCO ATE 36-8M 0-36 V 0-8 A CV/CC Power Supply $375.00
LAMBDA LK-352-FM 0-60 V 0-15 A CV/CC Power Supply $600.00
SORENSON DCR 600-0.75B 0-600 V 0-750 mA CV/CC Power Supply $550.00
SORENSON DCS 40-25 0-40 V 0-25 A CV/CC Power Supply $650.00
SORENSON SRL 20-12 0-20 V 0-12 A CV/CC Power Supply $350.00

MULTIPLE OUTPUT

SORENSON SRL 60-8 0-60 V 0-8 A CV/CC Power Supply $500.00
HP 6205C Dual Power Supply, 0-40 V 300 mA & 0-20 V 600 mA, CV/CL $300.00
HP 6228B Dual 0-50 V 0-1 A CV/CC Power Supply $375.00
HP 6236B Triple Output Power Supply, +/- 0-20V 0.5A & 0-6V 2.5A $375.00
HP 6253A Dual 0-20 V 0-3 A CV/CC Power Supply $375.00
HP 6255A Dual 0-40 V 0-1.5 A CV/CC Power Supply $375.00
KEPCO MPS-620M Triple Output Supply, dual 0-20V 1A tracking & 0-6V 5A $200.00
TEK PS5010 Programmable Triple Power Supply, TM5000 series $450.00
TEK PS503A Dual Power Supply, TM500 series $200.00

MISCELLANEOUS

ACME PS2L-500 Programmable Load, 0-75 V / 0-75 A / 500 Watts max. $350.00
BEHLMAN 25-C-D/OSCD-1 AC Power Source, 250 VA, 0-130 VAC, 45-2000 Hz $850.00
HP 59501B HPIB Isolated DAC/Power Supply Programmer $175.00
HP 6060A 300 Watt Programmable Load, 0-60 A / 3-60 V, HPIB $950.00
KEPCO BOP 50-2M Bipolar Op Amp/Power Supply, to 50 V 2 A $400.00
TRANSISTOR DEVICES DAL-50-15-100 Programmable Load, 0-50 V, 0-15 A, 100 Watts max. $200.00

TIME & FREQUENCY

UNIVERSAL COUNTERS

HP 5314A 100 MHz/ 100 nS Universal Counter $175.00
HP 5315A 100 MHz/100 nS Universal Counter $350.00
HP 5315A-001 100 MHz / 100 nS Universal Counter, TCXO reference $400.00
HP 5315A-002,003 100 MHz/100 nS Univ. Counter; batt. power & 1 GHz C-ch. $550.00
HP 5315A-003 100 MHz/100 nS Univ. Counter, 1 GHz C-channel option $450.00
HP 5316A 100 MHz/100 nS Universal Counter, HPIB $450.00
HP 5370B 100 MHz/ 20 pS Universal Counter, 11 digits $1,200.00
PHILIPS PM6672/411 120 MHz/100 nS Universal Counter, C-channel 70-1000 MHz $375.00
TEK DC5004 Programmable 100 MHz/100nS Counter/Timer, TM5000 series $200.00
TEK DC5009 Programmable 135 MHz Univ. Counter/Timer, TM5000 series $350.00
TEK DC503A 125 MHz/100 nS Universal Counter, TM500 series $275.00
TEK DC509 135 MHz/ 10 nS Universal Counter, TM500 series $275.00

FREQUENCY COUNTERS

FLUKE 7220A-010,131,351 1.3 GHz Counter; battery power, OCXO, and res. mult. $500.00
HP 5342A 18 GHz Frequency Counter $900.00
HP 5343A-001 26.5 GHz Frequency Counter, OCXO reference $3,000.00
HP 5345A/5355A/5356B 26.5 GHz CW/Pulse Frequency Counter $3,500.00
HP 5364A Microwave Mixer / Detector, for modulation domain an. $2,000.00
HP 5386A-004 3 GHz Frequency Counter, HPIB; OCXO reference option $1,000.00

STANDARDS

HP 105B Quartz Oscillator, 0.1/ 1.0/ 5.0 MHz, battery power $1,100.00

AUDIO & BASEBAND

SPECTRUM ANALYSIS

HP 3586C Selective Level Meter, 50 Hz-32.5 MHz, 50 & 75 ohms $1,200.00

DISTORTION ANALYSIS

HP 8903A Audio Analyzer, 20 Hz-100 kHz $1,200.00

RMS VOLTMETERS

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

OSCILLATORS

HP 3336C-004,005 21 MHz Synthesizer/ Level Gen., OCXO & hi accuracy att. $1,400.00
TEK SG502 Sine/Square Osc., 5 Hz-500 kHz, 70 dB step atten.,TM500 ..... $200.00
WAVETEK 98 1 MHz Synthesized Power Oscillator, GPIB $950.00

MISCELLANEOUS

HP 3575A Phase-Gain Meter, 1 Hz-13 MHz, single display $600.00
HP 3575A-001 Phase-Gain Meter, 1 Hz-13 MHz, dual display $850.00
HP 467A Power Amplifier, X1/X2/X5/X10, DC-1 MHz, 10 W output $375.00
KROHN-HITE 3103 High/Low Pass Filter, 10 Hz-3 MHz, 24 dB/octave $350.00
KROHN-HITE 3200 High Pass / Low Pass Filter, 20 Hz-2 MHz, 24 dB/octave $275.00
KROHN-HITE 3202 Dual HP/LP/BP/BR Filter, 20 Hz-2 MHz, 24 dB/octave $450.00
ROCKLAND 852 Dual Highpass/Lowpass Filter, 0.1 Hz-111 kHz $650.00
WAVETEK 716 Brickwall Filter $1,500.00

RF & MICROWAVE

SPECTRUM ANALYSIS

HP 11517A/18A/19A/20A Mixer Set, 12.4-40.0 GHz, for HP 8555A/8569A $500.00
HP 11970A WR28 Harmonic Mixer, 26.5-40 GHz $1,100.00
HP 11970K WR42 Harmonic Mixer, 18.0-26.5 GHz $1,100.00
HP 11970Q WR22 Harmonic Mixer, 33-50 GHz $1,400.00
HP 11971A WR28 Harmonic Mixer, for HP 8569B $800.00
HP 11971K WR42 Harmonic Mixer, for HP 8569B $800.00
HP 8449B Preamplifier, 1.0-26.5 GHz $4,500.00
HP 8559A/853A-001 Spectrum An., 0.01-21 GHz, 1 kHz res.,w/rackmount frame $3,500.00
HP 85640A Tracking Generator, 300 kHz-2.9 GHz, for HP 8560 series $5,000.00
HP 8565A-100 Spectrum Analyzer, 10 MHz-22 GHz, 100 Hz min. res. bw. $3,000.00
HP 8568B Spectrum Analyzer, 100 Hz-1.5 GHz, 10 Hz min. res. $8,500.00
HP 8569B Spectrum Analyzer, 10 MHz-22 GHz, 100 Hz min.res.bw. $5,500.00
TEK 492-opt.02 Spectrum Analyzer, 50 kHz-18 GHz, 1 kHz res. $4,250.00
TEK WM782V WR15 Harmonic Mixer, 50-75 GHz $1,500.00

NETWORK ANALYSIS

HP 11650A Network Analyzer Accessory Kit, APC7 ..... $600.00
HP 11665B Modulator, 0.15-18 GHz, for HP 8755/6/7 ..... $250.00
HP 4815A Vector Impedance Meter, 0.5-108 MHz, 1 Ohm-100 kilohm $1,200.00
HP 8502A Transmission/ Reflection Test Unit, 0.5-1300 MHz $675.00
HP 85054A Type N Calibration Kit, for HP 8510 series $1,800.00

Write in 212 on Reader Service Card.

90 DAY WARRANTY PARTS AND LABOR • 10 DAY INSPECTION

TEST EQUIPMENT WANTED CALL OR FAX LIST • OPEN ACCOUNTS

HP 8511A Frequency Converter, 45 MHz-26.5 GHz, for HP 8510 ... $6,500.00
HP 8717A Transistor Bias Supply ... $500.00
HP 8756A Scalar Network Analyzer, HPIB ... $1,375.00
HP R85026A WR28 Detector, 26.5-40 GHz, for HP 8757 series ... $1,200.00

SIGNAL GENERATORS

FLUKE 6060A Synthesized Signal Gen., 0.1-1050 MHz, 10 Hz res. ... $1,500.00
FLUKE 6060B/AK Synthesized Signal Gen., 0.1-1050 MHz, 10 Hz res. ... $1,900.00
GIGATRONICS 1026 Synthesized Signal/ Sweep Gen., 50 MHz-26 GHz, +5 dBm ... $5,000.00
GIGATRONICS 600/6-12 Synthesized Source, 6-12 GHz, 1 MHz res., GPIB ... $1,800.00
GIGATRONICS 6000/8-16 Synthesized CW Gen., 8-16 GHz, 1 MHz res., +10 dBm ... $2,250.00
GIGATRONICS 875/50 Levelled Multiplier, x4, 50.0-75.0 GHz output, -3 dBm ... $2,500.00
GIGATRONICS 900/2-8 Synthesized Signal/Sweep Gen., 2-8 GHz, 1 MHz res.,GPIB ... $2,000.00
HP 11707A Test Plug-in for HP 8660 series ... $500.00
HP 11720A Pulse Modulator, 2-18 GHz, 80 dB on/off ratio ... $450.00
HP 3335A-001 Synthesizer/ Level Gen., 200 Hz-81 MHz, -87 to +13 dBm ... $3,500.00
HP 8656A-001 Signal Generator, 0.1-990 MHz, 100 Hz res., HPIB, OCXO ... $1,600.00
HP 8657A-002 Signal Generator, 0.1-1040 MHz, 10 Hz res., HPIB ... $2,750.00
HP 8660C/86603A/86632B Synthesized Signal Generator, 1-2600 MHz, AM, FM ... $3,250.00
HP 8671B Synthesized CW Gen., 2-18 GHz, 1-3 kHz res., +8 dBm ... $4,250.00
HP 8672A Synthesized Signal Generator, 2-18 GHz, +3 dBm output ... $4,500.00
HP 8673H-212 Synthesized Signal Generator, 2.0-12.4 GHz, 1 kHz res. ... $8,750.00
HP 8684B Signal Generator, 5.4-12.5 GHz, AM/ WBFM/ Pulse ... $3,000.00
WAVETEK 954 Signal Generator, 3.7-7.6 GHz, +10 dBm, AM, FM ... $750.00

SWEEP GENERATORS

HP 8350B/83522A Sweep Oscillator, 10-2400 MHz, +13 dBm levelled ... $3,900.00
HP 8350B/83540A-002,004 Sweep Oscillator, 2.0-8.4 GHz, 70 dB step attenuator ... $3,900.00
HP 8350B/83545A-002 Sweep Oscillator, 5.9-12.4 GHz, 70 dB step attenuator ... $3,900.00
HP 83570A RF Plug-in, 18.0-26.5 GHz, +10 dBm levelled ... $6,000.00
HP 8601A Generator/Sweeper, 0.1-110 MHz, +20 dBm levelled ... $400.00
HP 8620C Sweep Oscillator Frame ... $550.00
HP 86222B-002 RF Plug-in, 10-2400 MHz, +13 dBm lvld., 70 dB step att. ... $1,250.00
HP 86222B-E69/8620C Sweep Oscillator, 0.01-2 GHz & 2-4 GHz, +10 dBm, w/frame ... $1,500.00
HP 86230B RF Plug-in, 1.8-4.2 GHz, +10 dBm unlevelled ... $300.00
HP 86240A RF Plug-in, 2.0-8.4 GHz, +16 dBm unlevelled ... $400.00
HP 86241A-001 RF Plug-in, 3.2-6.5 GHz, +8 dBm levelled ... $300.00
HP 86260A-H04 RF Plug-in, 10.0-15.0 GHz, +10 dBm unlevelled ... $400.00
HP 86290A RF Plug-in, 2.0-18.0 GHz, +7 dBm levelled ... $1,200.00
HP 86290B RF Plug-in, 2.0-18.6 GHz, +10 dBm levelled ... $1,650.00
HP 86290C RF Plug-in, 2.0-18.6 GHz, +13 dBm levelled ... $1,850.00
WAVETEK 2001 Sweep Generator, 1-1400 MHz, +10 dBm, 70 dB step atten. ... $900.00
WAVETEK 2002A Sweep Generator, 1-2500 MHz, +10 dBm, 70 dB step atten. ... $1,200.00
WAVETEK 962 Sweep Generator, 1.0-4.0 GHz, markers, +12 dBm unlvld. ... $950.00
WILTRON 6717B-20 Freq. Synth./ Sweeper, 10 MHz-8.4 GHz, +13 dBm, AM, FM ... $6,500.00

POWER METERS

BOONTON 42B/41-4E Analog Power Meter, with 1 MHz-18 GHz sensor ... $450.00
HP 432A/478A Power Meter, -30 to +10 dBm, 10 MHz-10 GHz ... $300.00
HP 435B/8481A Power Meter, -30 to +20 dBm, 10 MHz-18 GHz ... $900.00
HP 435B/8482B Power Meter, 0 to +43 dBm, 100 kHz-4.2 GHz ... $1,500.00
HP 436A-022/8481A Power Meter, -30 to +20 dBm, 10 MHz-18 GHz, HPIB ... $1,200.00
HP 436A-022/8484A Power Meter, -70 to -20 dBm, 10 MHz-18 GHz, HPIB ... $1,200.00
HP Q8486A Power Sensor, 33.0-50.0 GHz, WR22, for 435/6/7/8 ... $1,500.00
HP R8486A WR28 Power Sensor, 26.5-40 GHz, for HP 435/6/7/8 ... $1,500.00

RF MILLIVOTMETERS

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

AMPLIFIERS, MISCELLANEOUS

AMPLIFIER RESEARCH 4W1000 Amplifier, 40 dB gain, 4 Watts, 1-1000 MHz ... $950.00
BOONTON 82AD Modulation Meter, AM / FM, 10-1200 MHz ... $650.00
ENI 2100L Amplifier, 50 dB gain, 10 kHz-12 MHz, 100 Watts output ... $2,750.00
ENI 310L Amplifier, 50 dB gain, 250 kHz-110 MHz, 10 Watts output ... $1,200.00
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, 1/ 10/ 100 MHz increments, to 5 GHz ... $500.00
HP 8447A Amplifier, 20 dB, 0.1-400 MHz, 5 dB NF, +6 dBm output ... $375.00
HP 8447E Amplifier, 22 dB, 0.1-1300 MHz, +13 dBm output ... $750.00
HP 8447F-H64 Dual Amp., 9 kHz-50 MHz 28 dB & 0.1-1300 MHz 25 dB ... $900.00
HP 8901A Modulation Analyzer, 150 kHz-1300 MHz ... $1,500.00
HP 8901B-1,2,3 Modulation An., 0.15-1300 MHz, rear input, OCXO, ext.LO ... $2,000.00
HUGHES 1177H01F000 TWT Amplifier, >30 dB gain, 2-4 GHz, 10 Watts output ... $1,750.00
HUGHES 1177H10F000 TWT Amplifier, >30 dB gain, 1.4-2.4 GHz, 20 Watts ... $2,500.00
HUGHES 8010H13F000 TWT Amplifier, >30 dB gain, 3-8 GHz, 10 Watts ... $2,500.00
RF POWER LABS ML50 Amplifier, 2-30 MHz, 47 dB gain, 50 Watts, metered, 28V ... $275.00
ROHDE & SCHWARTZ ESH2 Test Receiver, 9 kHz-30 MHz ... $3,750.00

COAXIAL & WAVEGUIDE

AEROWAVE 28-3000/10 WR28 Directional Coupler, 10 dB, 26.5-40 GHz ... $300.00
AMERICAN NUCLEONICS AM-432 Cavity Backed Spiral Antenna,LHC, 2-18 GHz,TNC(f) *NEW* ... $95.00
AVANTEK AMT-400X2 WR28 Active Doubler, +10 dBm in/ +10 dBm out 26-40 GHz ... $450.00
BIRD 6735-300 1 kW Load, 25-1000 MHz, LC(f), with wattmeter ... $650.00
BIRD 8201 500 Watt Oil Dielectric Load, DC-2.5 GHz, N(f) ... $350.00
FXR/MICROLAB SL-03N Stub Stretcher, 0.3-6.0 GHz, 100 Watts max., N(m/f) ... $75.00
GR 874-LTL Constant Impedance Trombone Line, 0-44 cm, DC-2 GHz ... $400.00
HP 11590A-001 Bias Network, 1.0-18.0 GHz, APC7 ... $450.00
HP 11636A 2-Way Power Divider, DC-18 GHz, N(m/f/f) ... $300.00
HP 11691D-001 Directional Coupler, 22 dB, 2-18 GHz, N(f)-all ports ... $450.00
HP 11692D Dual Directional Coupler, 22 dB, 2-18 GHz ... $800.00
HP 33321K Programmable Step Atten., 0-70 dB, DC-26.5 GHz, 3.5mm ... $475.00
HP 33327L-006 Programmable Step Attenuator, 0-70 dB, DC-40 GHz, 2.9mm ... $1,000.00
HP 774D Dual Directional Coupler, 20 dB, 215-450 MHz ... $275.00
HP 776D Dual Directional Coupler, 20 dB, 940-1900 MHz ... $275.00
HP 777D Dual Directional Coupler, 20 dB, 1.9-4.1 GHz ... $275.00
HP 778D-011 Dual Dir. Coupler, 20 dB, 100-2000 MHz, APC7 test port ... $450.00
HP 779D Directional Coupler, 20 dB, 1.7-12.4 GHz ... $400.00
HP 8431A 2-4 GHz Band Pass Filter, N(m/f) ... $150.00
HP 8494G-002 Programmable Step Attenuator, 0-11 dB, DC-4 GHz, SMA ... $350.00
HP 8496A-002 Step Attenuator, 0-110 dB, DC-4 GHz, SMA ... $375.00
HP K422A WR42 Flat Broadband Detector, 18.0-26.5 GHz ... $350.00
HP K532A WR42 Frequency Meter, 18.0-26.5 GHz ... $450.00
HP K752A WR42 Directional Coupler, 3 dB, 18.0-26.5 GHz ... $450.00
HP K752D WR42 Directional Coupler, 20 dB, 18.0-26.5 GHz ... $450.00
HP K870A WR42 Slide Screw Tuner, 18.0-26.5 GHz ... $275.00
HP K914B WR42 Moving Load, 18.0-26.5 GHz ... $300.00
HP Q752D WR22 Directional Coupler, 20 dB, 33-50 GHz ... $650.00
HP R422A WR28 Crystal Detector, 26.5-40 GHz ... $400.00
HP R752D WR28 Directional Coupler, 20 dB, 26.5-40 GHz ... $450.00
HP R914B WR28 Moving Load, 26.5-40 GHz ... $250.00
HP V365A WR15 Isolator, 25 dB, 50-75 GHz ... $750.00
HP V752D WR15 Directional Coupler, 20 dB, 50-75 GHz ... $650.00
HP X870A WR90 Slide Screw Tuner ... $150.00
HUGHES 45322H-1110/1120 WR22 Directional Couplers, 10 or 20 dB, 33-50 GHz ... $350.00
HUGHES 45712H-1000 WR22 Frequency Meter, 33-50 GHz ... $750.00
HUGHES 45714H-1000 WR15 Frequency Meter, 50-75 GHz ... $900.00
HUGHES 45721H-2000 WR28 Direct Reading Attenuator, 0-50 dB, 26.5-40 GHz ... $1,000.00
HUGHES 45722H-1000 WR22 Direct Reading Attenuator, 0-50 dB, 33-50 GHz ... $1,000.00
HUGHES 45724H-1000 WR15 Direct Reading Attenuator, 0-50 dB, 50-75 GHz ... $1,000.00
HUGHES 45732H-1200 WR22 Level Set Attenuator, 0-25 dB, 33-50 GHz ... $250.00
HUGHES 45752H-1000 WR22 Direct Reading Phase Shifter, 0-360 deg.,33-50 GHz ... $1,400.00
HUGHES 45772H-1100 WR22 Thermistor Mount, -20 to +10 dBm, 33-50 GHz ... $400.00
HUGHES 45773H-1100 WR19 Thermistor Mount, -20 to +10 dBm, 40-60 GHz ... $650.00
HUGHES 45774H-1100 WR15 Thermistor Mount, -20 to +10 dBm, 50-75 GHz ... $750.00
HUGHES 47316H-1111 WR10 Tuneable Detector, 75-110 GHz, positive polarity ... $600.00
HUGHES 47741H-2310 WR28 Phase Locked Gunn Osc., 32.000 GHz, +18 dBm ... $2,000.00
HUGHES 47742H-1210 WR22 Phase Locked Gunn Osc., 42.000 GHz, +18 dBm ... $2,750.00
KRYTAR 201020010 Directional Detector, 1-20 GHz, SMA(f/f)/SMC ... $200.00
KRYTAR 2616S Directional Detector, 1.7-26.5 GHz, K(f/m)/SMC ... $200.00
M/A-COM 3-19-300/10 WR19 Directional Coupler, 10 dB, 40-60 GHz ... $450.00
MICA C-121S06 Circulator, 17.5-24.5 GHz, SMA(f/m/m) ... $75.00
MINI-CIRCUITS ZFDC-20-4 Directional Coupler, 19.5 dB, 1-1000 MHz, SMA(f) ... $25.00
NARDA 3000-SERIES Directional Couplers ... $150.00
NARDA 3020A Bi-Directional Coupler, 50-1000 MHz, N ... $500.00
NARDA 3022 Bi-Directional Coupler, 20 dB, 1-4 GHz ... $400.00
NARDA 3024 Bi-Directional Coupler, 20 dB, 4-8 GHz ... $375.00
NARDA 3090-SERIES Precision High Directivity Couplers ... $225.00
NARDA 368BNM Coaxial High Power Load, 500 Watts, 2.0-18 GHz, N(m) ... $500.00
NARDA 3752 Coaxial Phase Shifter, 0-180 deg./GHz, 1-5 GHz ... $1,000.00
NARDA 3753B Coaxial Phase Shifter, 0-55 deg./GHz, 3.5-12.4 GHz ... $1,000.00
NARDA 4000-SERIES SMA Miniature Directional Couplers ... $75.00
NARDA 4227-16 Directional Coupler, 16 dB, 1.7-26.5 GHz, 3.5mm(f) ... $325.00
NARDA 4242-20 Directional Coupler, 20 dB, 0.5-2.0 GHz, SMA(f) ... $100.00
NARDA 4247-20 Directional Coupler, 20 dB, 6.0-26.5 GHz, 3.5mm(f) ... $200.00
NARDA 4247B-10 Directional Coupler, 10 dB, 6.0-26.5 GHz, 3.5mm(f) ... $200.00
NARDA 5070-SERIES Precision Reflectometer Couplers ... $300.00
NARDA 562 DC Block, 10 MHz-12.4 GHz, 100 V max., N(m/f) ... $65.00
NARDA 765-10 10 dB Attenuator, 50 Watts, DC-5 GHz, N(m/f) ... $165.00
NARDA 791FM Variable Attenuator, 0-37 dB, 2.0-12.4 GHz ... $600.00
NARDA 792FF Variable Attenuator, 0-20 dB, 2.0-12.4 GHz ... $375.00
NARDA 793FM Direct Reading Variable Attenuator, 0-20 dB, 4-8 GHz ... $225.00
NARDA 794FM Direct Reading Variable Attenuator, 0-40 dB, 4-8 GHz ... $375.00
OMNI-SPECTRA 2085-6010-00 Crystal Detector, 1-18 GHz, negative polarity, SMA(m/f) ... $50.00
PAMTECH KYG1014 WR42 Junction Circulator, 18.0-26.5 GHz ... $250.00
SONOMA SCIENTIFIC 21A3 WR42 Circulator, 20 dB, 20.6-24.8 GHz ... $75.00
TEKTRONIX 2701 Step Attenuator, 0-79 dB, DC-1 GHz, AC or DC coupled ... $175.00
TRG B510 WR22 Direct Reading Attenuator, 0-50 dB, 33-50 GHz ... $900.00
TRG V510 WR15 Direct Reading Attenuator, 0-50 dB, 50-75 GHz ... $900.00
TRG V551 WR15 Frequency Meter, 50-75 GHz ... $600.00
TRG W510 WR10 Direct Reading Attenuator, 0-50 dB, 75-110 GHz ... $1,000.00
TRG W551 WR10 Frequency Meter, 75-110 GHz ... $750.00
WAVELINE 100080 WR28 Terminated Crossguide Coupler, 30 dB ... $200.00
WEINSCHEL 150-110 Programmable Step Attenuator, 0-110 dB, DC-18 GHz, SMA ... $450.00
WEINSCHEL DS109 Double Stub Tuner, 1-13 GHz, N(m/f) ... $150.00
WEINSCHEL DS109LL Double Stub Tuner, 0.2-2.0 GHz, N(m/f) ... $150.00

COMMUNICATIONS

HP 4935A Transmission Impairment Measuring Set ... $600.00
HP 59401A HPIB Bus Analyzer ... $375.00
MICRODYNE 1200MR 215-320 MHz Telemetry Receiver, PSK demodulation ... $450.00
TEK 1411R PAL Gen.,w/SPG12 sync;TSG11 color bars; TSG13 linearity ... $750.00
TEK 1411R PAL Test Gen., w/SPG12,TSG11,TSG13, TSG15,TSG16 ... $1,000.00
TEK 1411R PAL Test Gen., w/SPG12,TSG11,TSG12, TSG13,TSG15,TSG16 ... $1,100.00
TEK 1411R-opt.04 PAL Test Gen.,w/ SPG12,TSG11,TSP11,TSG13,TSG15,TSG16 ... $1,400.00
TEK 147A NTSC Test Signal Generator, with noise test signal ... $800.00
TEK 148 PAL Insertion Test Signal Generator ... $700.00
TEK 520A NTSC Vectorscope ... $750.00
TEK 521A PAL Vectorscope ... $750.00

MISCELLANEOUS

EG&G / P.A.R. 5302 / 5316 Lock-in Amplifier, 100 mHz-1 MHz, GPIB / RS232C ... $2,250.00
FLUKE 2180A RTD Digital Thermometer ... $500.00
HP 59307A HPIB VHF Switch ... $200.00
P.A.R. 5206-95,98 Two-Phase Lock-in Amp., 2 Hz-100 kHz, GPIB ... $1,500.00
TEK TM5003 5000-series 3-slot Programmable Power Module ... $450.00
TEK TM5006 5000-series 6-slot Programmable Power Module ... $500.00
TEK TM504 500-series 4-slot Power Module ... $175.00
TEK TM506 500-series 6-slot Power Module ... $250.00
TEK TM515 500-series 5-slot Traveller Power Module ... $250.00

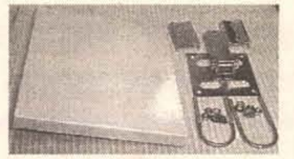
Write in 212 on Reader Service Card.

HAM GEAR FOR SALE

WANTED: MILITARY capacitors, resistors, transistors, diodes, ICs, semi's, etc. Please fax/E-Mail excess lists & RFQs 818-769-1002 fax 818-769-1084. electmatind@earthlink.net & http://www.militarycomponents.com

WANTED: ROCKWELL-Collins HF-80 equipment, 851S-1, 237B-3 log periodic, Collins literature. Jim Stitzinger 805-259-2011, 805-259-3830 (fax), bfl-jfs@smartlink.net

2.4GHz POWER amplifier with power supply. 10-40 mW input, 1 (one) watt output with in-line SMA connectors and built-in heat sink. Approx. 2" x 2" x 5/8" size. Frequency range 2.3GHz-2.5GHz. **$189/each.** Compatible with all ATV product lines. See our website for more info on accessories and transmitter and receiver modules. EzATV. Visit our web-site for dealers or order on-line at www.4atv.com



SUPER HIGH GAIN 14 dbi flat antenna with N or SMA connector tuned for 2.3-2.5 GHz. Use with 2.4GHz ATV 8 channel transmitter or receiver. **$179/ea.** SPECIAL PRICE. EzATV. Visit our web-site for dealers or order on-line at www.4atv.com

New Online Radio Forum On The www.nutsvolts.com Bulletin Board

Top 10 Favorite Gateway Gizmos and Gadgets

VOICE CHANGER KIT $49.50

Change your voice with this really cool kit! Using DSP (Digital Signal Processing), you can make a man sound like a woman, make a woman sound like a man, create scary monster sounds, and have lots of fun. Use the special echo and vibrato modes for additional special effects. Kit features clip-on electret mic, removable speaker with case, sound effects selector switch, adjustable volume control, up/down pitch shifts, and step-by-step instructions. 3.5mm jacks for the microphone and speaker make it easy to connect to other audio equipment. Requires 4 AA batteries (not included.)

Infrared Non-Contact Laser Thermometer *Introductory price* $149.95

This is such a cool thing, you gotta get one! No more climbing ladders or going down manholes trying to find temperatures. Are the rafters hot? How hot is that car? Point this little gizmo at almost anything and it will give you the temperature! Uses a laser sighting to help confirm target, and features an easy to read large LCD. Fahrenheit or Celsius selectable. Features a 0.95 emissivity, 8:1 distance to spot ratio, 0.1 resolution, and a temperature range of 14 to 950 degrees Fahrenheit. Manufacturer's 3-year limited warranty.
*shipping this item requires insurance, please add an additional $0.50

Lightwave 2000 Flashlight $29.95

Four super-bright white LEDs replace the bulb you'd find in a traditional flashlight, providing a long-lasting high-intensity light. LED lights mean your flashlight will last about 14 times longer than a regular flashlight, and these flashlights are waterproof and shockproof. Ideal for short-range use in cars, planes, etc.
Flashlight requires 3 AA batteries (included). Manufacturer's limited lifetime warranty even includes the LED lights!

Spectrum LED A Rainbow of Light! $5.95

Imagine an LED capable of producing all three primary colors in the same package! The entire spectrum, including near-white, can be created! Imagination becomes reality with this T 1-3/4 multi-color LED. Here's the technology: a red chip, a green chip, and two blue chips encased in a diffused T1-3/4 package. Using various current combinations, you can produce red, orange, yellow, green, aqua, blue, violet or white light! Detailed spec sheet included. What can you do with these (beyond the obvious amaze your friends!)? Create a single indicator system, designate various controls by color, make a multi-color bargraph, make your project something out of the ordinary with multicolor LEDs!

Lighted Screwdriver Supertool! $9.95

At first glance, this appears to be an ordinary screwdriver, but press a button on the base and two lights illuminate the area you are working on. Nifty, huh? But wait, there's more! The seven interchangeable bits are stored right there at the base of the screwdriver (6 storage slots) for easy access. No handles to unscrew or tool boxes to dig through. Hey, you ain't seen nothin' yet...remove the bit and the magnetic retrieval tool telescopes from the screwdriver shaft! Incredible!!! Of course, the comfort grip handle and rugged construction are icing on the cake! Definitely a 'gotta have it' tool!

The Photon Microlight II

A super bright keychain LED flashlight, push to light or switch on for continuous bright illumination. available in a variety of colors. Blue, Green, White, Turquoise, Red, Yellow, or Orange $15.95 (please specify)

AMAZING MINI MICRO FM RADIO! $7.50

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

Geophone vibration sensing kit *Detect a fly stomping across the desk!*

Well maybe not that sensitive, but almost. These vibration sensors made by Geosource® were used in oil exploration to determine geological statistics. They are made with a magnet suspended in a coil and are very sensitive to vibration. Compact size, the unit measures approx. 1.6" high and 1.2" dia.

The kit includes a geophone vibration sensor along with parts to build a basic detector that will light an LED. In addition we include a schematic that will show you how to operate a relay. The sensitivity is adjustable, so you can set it to detect elephants and other small creatures. Similar units were used by our armed forces to detect enemy troop movements...the perfect device to alert you to the pitter patter of little Leroy's feet! Unit sensitivity can be set high enough to detect a business card dropped on a table, and we've made it work with vibrations up to 40 feet away! Earthquake or Aunt Agatha...you decide! It's a fun gadget with many uses.

COMPLETE GEOSENSOR KIT....$ 9.95 GEOSENSOR UNIT ONLY....$7.95

RF LINEAR POWER BOOSTER AMPLIFIER KIT $39.95

A quick and simple boost for signal generators, transmitters, and other low power devices, this kit can boost power up to 1 watt over a frequency range of 100 KHz to over 1000 MHz. Operates on 12 to 15 vdc @ 250 mA, via a 2.1mm male power jack. 38 dB gain at 10 MHz, 10dB at 1000 MHz. Optional case $14.95

TV TRANSMITTER KIT $27.95

Tired of lugging the VCR to another room to see a movie while Aunt Martha watches reruns of the Julia Child special on PBS? Sick of stringing wires through the house so Junior can watch the latest Power Ranger movie in the comfort of his room? Never fear, we've got the solution! This kit allows you to send any audio and video source, like a VCR or TV camera, to any TV set for up to 300 feet. With this little kit, you're the producer and the programming director of your own TV station. Tunable to any TV chahnnel 2-6, runs on 12 VDC, and accepts standard audio and video signals. Optional matching case set, $14.95

www.gatewayelex.com

gateway ELECTRONICS, INC

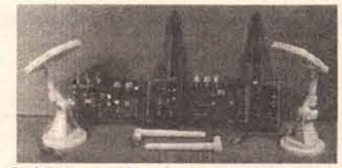
8123 PAGE BLVD * ST. LOUIS, MO 63130 * **(314)427-6116**
9222 CHESAPEAKE DR. * SAN DIEGO, CA 92123 * **(858)279-6802**
2525 FEDERAL BLVD. * DENVER, CO 80211 * **(303)458-5444**
MAIL ORDERS CALL TOLL-FREE 1-800-669-5810
FAX ORDERS (314)427-3147

THE FINE PRINT : PRICES SUBJECT TO CHANGE WITHOUT NOTICE * GATEWAY IS NOT RESPONSIBLE FOR PRINTING ERRORS * MASTERCARD, VISA AND DISCOVER ACCEPTED * YES, WE'LL TAKE YOUR CHECK -- SORRY, NO C.O.D.s * $10 MERCHANDISE MINIMUM ON MAIL ORDERS * SUPPLY OF SOME ITEMS IS LIMITED * PRICES DO NOT INCLUDE SHIPPING * UPS GROUND SHIPPING/HANDLING WITHIN THE CONTINENTAL U.S. (ITEMS REQUIRING ADDITIONAL AMOUNTS ARE NOTED)...$6.25 FOR THE FIRST ITEM, $0.50 FOR EACH ADDITIONAL ITEM. RESTOCKING CHARGE MAY BE ASSESSED ON RETURNED ITEMS. * I used to have a handle on life...but it broke!

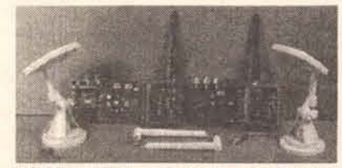
DISCOVER VISA

nv1100

TXRX 900MHz duplexers 890-960MHz 600 watt duplexers, $110/ea or $99/ea (2 or more). These are new units with circulator & load. www.amtronix.com Ph. 716-763-9104.



2.4GHz ATV — 8 channel TRANSMITTERS AND RECEIVERS. 35mW output power, 1 video channel, 2 audio. SMA connectors. NTSC/PAL compatible. Includes 1/4 wave rubber duck antenna. Standard frequencies are: 2398, 2405, 2412, 2416, 2420, 2428, 2435, 2442 MHz. Custom frequencies are available. See ad in this section for power amplifier. **$79/each for transmitter. $79/each for receiver.** EzATV. Visit our web-site for dealers or order on-line at www.4atv.com



1.2GHz ATV — 8 channel TRANSMITTERS and RECEIVERS. 75mW output power, 1 video channel, 2 audio. SMA connectors. NTSC/PAL compatible. Includes 1/4 wave rubber duck antenna. Standard frequencies are: 1250, 1255, 1260, 1265, 1270, 1275, 1280, 1290 MHz. Custom frequencies are available. **$79/each for transmitter. $79/each for receiver.** EzATV. Visit our web-site for dealers or order online at www.4atv.com

HAM GEAR WANTED

CB — SCANNERS

CBs, ACCESSORIES, SCANNERS, ANTENNAS, MICROPHONES, COAX. Best prices! Call 1-800-821-2769 for current flyer. We also carry NIMH batteries and chargers. http://www.thomas-distributing.com **THOMAS DISTRIBUTING, 128 Eastwood, Paris, IL 61944.**

CB MODIFICATIONS! Frequencies, books, kits, high-performance accessories, plans, repairs, amplifiers, 10-meter conversions. The best since 1976! Catalog $3. CBCI, Box 1898NV, Monterey, CA 93942. www.cbcintl.com

240+ CHANNEL CB/HAM/FRS/COMMERCIAL radios: AM/FM/SSB/CW export/domestic: RCI, TEKK, Motorola, Uniden, Cobra, Alinco, Kenwood. Mics, antennas, linears, meters, mod books, manuals, schematics, night scopes, and tons more stuff! Catalog $3. MAXTECH, Box 8086, New York, NY 10150. 718-547-8244. www.pennycircus.net

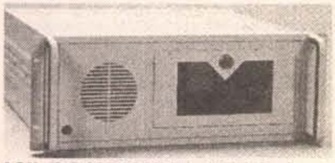
MUSIC & ACCESSORIES

COMPUTER HARDWARE

BRAND NAME low-end Pentium computers starting at $50. Call Jerry W2GIA, Disks N Data, 1-800-833-6893 or E-Mail: dndcom@earthlink.net

Write in 42 on Reader Service Card.

WE CARRY a variety of cables, switch boxes, accessories, and adapters to connect PCs, printers, Mac's, networks, telecommunications, and audio/video equipment. We offer: custom cables, free catalogs, and same day shipping on most orders. Visit our website at www.rogerssystems.com or call 1-800-366-0579.



19" RACKMOUNT ATX PC chassis, $159 (with ad). www.stores.yahoo.com/cti-texas, 972-242-8087.

DEC EQUIPMENT WANTED!!! We are buying DEC systems, boards, terminals, drives and peripherals. Also Scientific Micro Systems (SMS), DSD, Datability, Dilog, other DEC compatibles, and Computer Output Microfilm (COM) units. Please call for a quote or fax us your equipment list. We buy, sell, and trade. **KEYWAYS, INC.**, 937-847-2300 OR fax 937-847-2350.

PARTS PARADISE Monthly Special. Behold, USB universe. External hubs: Belkin 4 prt. $29, 6 prt. $49, 3 prt. w/serial/parallel/PS2 $89. Internal hubs: 5 prt. 3.5" bay $35, 4 prt. exp slot $32. Active adapters: printer $23, parallel DB25F $39, serial $59, PS2 $35, laplink $39, dual port PCI $23. Passive adapters $5. A-B cable: 3' $3, 6' $4, 10' $5, 15' $7 (10 pk 6' $25). Extensions: passive 6' $4 & 10' $5, active 8' $29 & 16' $39. Dual USB to motherboard: 2x5 $3 (1 piece or 2 piece), 2x8 $9, 2x4 $9, 2x9 w/PS2 $9. USB mouse 2 button $5. IEEE 1394 firewire: 3 port PCI card w/software & cable $59, 6 pin to 4 pin: (3', 6', 10', 15'), 4 pin to 4 pin: (3', 6', 10', 15'), 6 pin to 6 pin: (3', 6', 10', 15'). Mention this ad & $5 shipping anywhere in 48 states. All new & w/warranty. 1,500+ item catalog. Email PartsParadise@hotmail.com Check here for monthly specials. Visa/MC/AX accepted. 313-794-0172 or fax 313-794-0173.

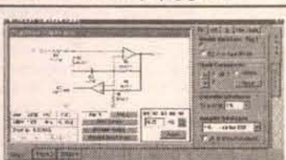
XMAS SPECIAL for Dec. and Jan. Smartcard programmer $75. High speed unprogrammer $200. Free flyer. Tony 419-385-3100.

VGA TO COMPOSITE (NTSC) VIDEO CONVERTER — ULT-2000. Handheld. Powered from keyboard with S-video and RGB outputs, too. 3:1 zoom control with many extras. **$99/ea.** Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com

I'LL PAY you $$ for your OLD software! Write: nuts@noonco.com or 428 Summit, Redlands, CA 92373.

COMPUTER SOFTWARE

FREE!!! CD-ROM and software disk catalog. **MOM 'N' POP'S SOFTWARE**, PO Box 15003-N, Springhill, FL 34609-0111. 352-688-9108. momnpop@gate.net



WWW.SCHEMATICA.COM FOR professional freeware and shareware. Active and passive filter design, 555 designer, linear simulators.

TROPICAL HAMBOREE®

Communications & Computer Show

February 3-4, 2001

Fair Expo Center, Miami, Florida

Commercial Booths, Swap Tables, Forums, Programs,

License Exams, Transmitter Hunts

www.hamboree.org

w4wyr@arrl.net or wd4sfg@bellsouth.net

TEL: 305-642-4139

FLORIDA STATE CONVENTION

FMSTUDY32 FM, LPFM allocation studies. Manage FCC database on your PC! Manual included, $39.95. Demo, info, special Web pricing at http://members.xoom.com/fmstudy

CAM & MOTION SW/HW: Z-trace, PCB toolpath. Plotcam motion control, step drivers. **www.megabits.net/ddt** FAX 321-452-7197, 321-459-2729. **heater@megabits.net**

COMPUTER EQUIPMENT WANTED

DEC EQUIPMENT WANTED!!! We are buying DEC systems, boards, terminals, drives and peripherals. Also Scientific Micro Systems (SMS), DSD, Datability, Dilog, other DEC compatibles, and Computer Output Microfilm (COM) units. Please call for a quote or fax us your equipment list. We buy, sell, and trade. **KEYWAYS, INC.**, 937-847-2300 OR fax 937-847-2350.

WANTED: MILITARY capacitors, resistors, transistors, diodes, ICs, semi's, etc. Please fax/E-Mail excess lists & RFQs 818-769-1002 fax 818-769-1084. electmatind@earthlink.net & http://www.militarycomponents.com

WANTED: FOR historical museum, pre-1980 microcomputers, magazines, and sales literature. Floyd, VA 24091-0341 (540-763-3311/540-382-2935).

TEST EQUIPMENT

FEITEK PROVIDES repair, calibration and traceable certifications of test equipment. Free estimates. We buy, sell and trade all makes of test equipment. Visa and MasterCard accepted. Check out our inventory and specials at WWW.FEITEK.COM 2752 Walton Road, St. Louis, MO 63114, 314-423-1770.

The Standard for checking Capacitors in-circuit

Good enough to be the choice of Panasonic, Pioneer, NBC, ABC, Ford, JVC, NASA and thousands of independent service technicians.

Inexpensive enough to pay for itself in just one day's repairs. At $179, it's affordable.

And with a 60 day trial period, satisfaction guaranteed or money-back policy, the only thing you can lose is all the time you're currently spending on trying to repair all those dogs you've given up on.

CapAnalyzer 88A

Locate shorted or leaky components or conditions to the exact spot *in-circuit*

Still cutting up the pcb, and unsoldering every part trying to guess at where the short is?

$179

Your DVM shows the same shorted reading all along the pcb trace. LeakSeeker 82B has the resolution to find the defective component. Touch pads along the trace, and LeakSeeker beeps highest in pitch at the defect's pad. Now you can locate a shorted part only a quarter of an inch away from a good part. Short can be from 0 to 150 ohms

LeakSeeker 82B

***Available at your distributor, or call* 561-487-6103**

Electronic Design Specialists www.eds-inc.com

Write in 43 on Reader Service Card.

It's almost like being paid to study.

Earn an Associate Degree in Electronic Engineering Technology...
Put your knowledge of electronics to work for you. CIE offers the most comprehensive Associate Degree program offered in electronics. Best of all you study at your own pace with the full resources of CIE just a phone call or a click of a mouse away.

It's Comprehensive and Unique. You Pay for Only the Time You Use!
You won't find a better school than CIE if you want to accomplish your goals without pesky time restrictions (commuting, 8 hour class days, etc.) at CIE you study at your own pace, even an accelerated pace. And if you're like most readers of this magazine, your electronics background can help you receive your degree in less than the maximum 8 terms allowed. Finish sooner and you can save thousands of dollars in tuition. It's almost like being paid to study.

Get all the details on CIE's Associate Degree Program, World College's Bachelor Degree Program and CIE's 10 Career Courses.

Send or call for a Free Catalog Today!
(800) 243-6446
visit www.cie-wc.edu

CIE

A School of Thousands.
A Class of One. Since 1934.

Yes! Please send me a FREE Course Catalog on all of CIE and World College's Courses and Degree Programs. ANV01

Name: ______
Address: ______
City: ______
State: ______ Zip: ______
Phone: ______
E-mail: ______

Send To CIE: 1776 E. 17th St., Cleveland, OH 44114-3679

Write in 44 on Reader Service Card.

KENTRONIX TEST EQUIPMENT SPECIALS. Check our WEB site at **http://www.kentronix.com** for monthly specials. We are also looking to buy test equipment, coaxial and waveguide components, manuals, etc. Contact Brian at 732-681-3229 or FAX 732-681-3312. E-Mail: brian@kentronix.com

DEC EQUIPMENT WANTED!!! We are buying DEC systems, boards, terminals, drives and peripherals. Also Scientific Micro Systems (SMS), DSD, Datability, Dilog, other DEC compatibles, and Computer Output Microfilm (COM) units. Please call for a quote or fax us your equipment list. We buy, sell, and trade. **KEYWAYS, INC.**, 937-847-2300 OR fax 937-847-2350.

AFFORDABLE HP power sensor repair! Most 8481As repaired for $305 or less. We also handle 478As and many others. Call or fax for more information. Willamette RF, Inc., 541-754-7226, FAX 541-753-4629.

TPI TEST equipment deals. 440 handheld oscilloscope with true RMS capabilities $269.95, new 373 infrared thermometer $149.95, 133 digital multimeter with rubber boot $49.95. 3-year warranty, check out our E-Deals section on our web-site for more information. www.j-tron.com Call J-Tron 1-888-595-8766, fax 201-398-1010.

BROWSE OUR Web site and check out the "monthly special." TDL Technology, Inc., www.zianet.com/tdl

POOR MAN'S Spectrum Analyzer/ Monitor Receiver Kit. 2 to 1,700 MHz. Basic kit only $98. Now available with switched resolution filters, tracking generator and direct digital frequency readout. Works with ANY scope or IBM compatible computer. Send stamped envelope for details. Science Workshop, Box 310B, Bethpage, NY 11714. http://www.science-workshop.com

MARCONI 2022E 10KHz to 1,000MHz signal generators in excellent condition, $1,200/ea. www.amtronix.com Ph. 716-763-9104.

WANTED: RADIO service monitors, IFR, Motorola, HP, Marconi, also late model HP equipment. 716-763-9104 or fax 716-763-0371. http://www.amtronix.com

WANTED: MILITARY capacitors, resistors, transistors, diodes, ICs, semi's, etc. Please fax/E-Mail excess lists & RFQs 818-769-1002 fax 818-769-1084. electmatind@earthlink.net & http://www.militarycomponents.com

TEST EQUIPMENT technicians needed: calibration and repair techs. Three full-time openings. Our company sells, rents, repairs, and calibrates HP and Tek. We are located in Broomfield, Colorado, between Boulder and Denver. We perform electronic and physical/dimensional calibrations. Please send resume to irl@calibration.com

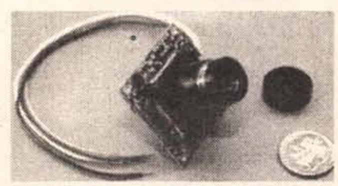
POCKET TESTBENCH, inexpensive RS-232 instrument, with scope, logic, counter, generator modes. Also, protoboards and products for PIC embedded systems development. www.oricomtech.com

TEST EQUIPMENT for sale/wanted (NEW/USED): RF, Microwave, video and fiber optic. Cable TV, Broadcast TV, satellite and related industries. Wavetek, Tektronix, Hewlett Packard and other manufacturers. Spectrum analyzers, signal level meters, sweep systems, TDRs, OTDRs, and much more. **PTL Test Equipment, Inc.** Phone 561-747-3647 FAX 561-575-4635. E-Mail: PTLTE@aol.com http://www.PTLTEST.com

PROM PROGRAMMER, 8-gang Needhams M/N SA-20 w/1MB. Details at www.needhams.com New price $750 + 80 mem = $830; like new $375 w/30 day warranty. Quantity Molex socketed PROMs also available. 630-879-6166 or dewell@inil.com

SECURITY

ALARMLAND.COM SECURITY devices for professionals. Motion detectors, panels, contacts, CCTV, and more. Fax your order to 732-840-1390.



9 VOLT IR sensitive B/W high res 430 TVL camera with optional black low-profile swivel adjustable enclosure. Pin hole or Std. lens type. 6, 8, and 12mm lens are available. 1/3" CCD, 3.6mm/F2.0 lens included; works from **7.5-13 VDC**, highest voltage range in market. 0.08 lux, 1.27" x 1.27" x 0.5"D pinhole or 1" deep standard. **$49 each**. Enclosure: $8; optional lens: $18. Dealers welcome. Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com

SCANNING MOTOR — A-330SC with universal mounting bracket accepts all standard 1/4 x 20 threaded CCTV cameras. No tilt, just PAN. 75 degrees of continuous motion with a scan rate of 5 seconds per cycle. 110 volt indoor operation, but can be adapted for outdoor use. Includes 12 foot power cord. Perfect solution to triple your effective camera viewing angle! **$39/each**, or **$25/each** in qty. of 4. Small size, 3-1/2"D x 2"H. Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com

Continued on page 54

Take Our Cash... Please!

We've gotta get rid of this money. If you've got systems or spare parts to sell, we're buying, **WORKING OR NOT**.

We'll swap ya cash for drives and RAM, too!

Compaq
H-P
IBM
Toshiba
Sony
Apple

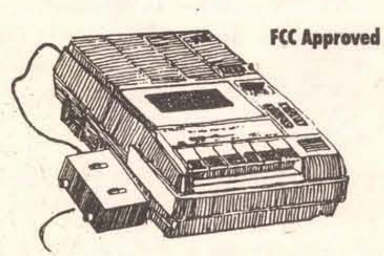
Contact Arthur today at: **Pre-Owned Electronics** INCORPORATED

800-274-5343 X4310
or email: ajr@preowned.com

DIS0089

TELEPHONE LISTENING DEVICE WITH 12 HR. RECORDER

FCC Approved



Record telephone conversations in your office or home. Starts automatically when phone is answered, records both sides of phone conversation. Recorder stops when phone is hung up. $99.95 + $7 shipping. For telehone listening device separately $19.95 + $2 ship.

For comprehensive 50 page catalog of Micro Video, VHF transmitters, Surveillance, and Counter-surveillance and much more! Send $3.00

Call 321-725-1000

USI CORP

P.O. Box N2052 Melbourne, FL 32902
COD'S OK

Write in 45 on Reader Service Card.

AMATEUR ROBOTICS NOTEBOOK

by Robert Nansel

I should start keeping a count of how many times I begin this column with the words "I had intended to do [insert project] this month ...", but I'm afraid if I did I'd never live down the embarrassment. I'm lousy at predicting the future, even just a month in advance, though I have lots of reasons why my foresight isn't 20/20.

This last month in particular demonstrates this abundantly. I had intended to cover rebuilding Jiffy, as well as some real software for the 'bot, but other stuff came up. I do have a couple pictures of a spiffy red, white, and blue Jiffy built by Michael Evens of Rancho Santa Fe, CA (see Photos 1 and 2). Way to go Michael! Sorry to disappoint, though; no Jiffy software this month. Photo 3 shows Jiffy's current state (actually, it's worse than that now because I've taken it apart for rebuilding).

I will talk about some books that would make great gifts for robot builders, though (get your highlighters ready, guys).

But first, here's the other stuff that came up:

First of all, Yonatan is almost two years old; not only is he a toddler, in the past month he became a toddler who runs. Zooms. Sprints, even. Being just 1/8th the mass of his Abba, it stands to reason his mechanical time constant is correspondingly eight times faster than mine. What this means is that I spend much more time chasing after him than I used to. Sorta like an aircraft carrier pursuing a Zodiac.

Second, our sole car, my '88 Nissan Stanza wagon (known variously as "the Smurfmobile," "Putt-putt," and "that @#$%& car!") is, at 150,000 miles, dying the death of a thousand oil leaks. With the second baby so soon to arrive – January 2001, God willing – Shoshana and I felt the primal urge to buy a new used car, something with a few more hamsters under the hood so it can get out of its own way. Something maneuverable enough to fit in our narrow driveway, yet with enough room to carry a sheet of plywood without taking out an extra insurance policy, a vehicle in which it would be possible –mirabile dictu! – to place two kids in completely separate rows where neither can touch the other should sibling politics demand this harsh step.

In short, we wanted a minivan.

In the past, shopping for a car had never been a big deal. Test drives were carefree (especially at dealerships where they let you try out cars without a salesman licking your ear from the back seat). But until last month, I had never gone car shopping with a child in tow, had rarely had to fuss with all the backup and support that a child requires to go for a 10-minute ride in a strange car.

There's the diaper bag, of course, and the toys and the books and snacks and security blanket, all the little things that keep an outing with a toddler from turning into scenes from Deliverance. But then you have the stroller and the carseat and its pad and straps and buckles and clips, and now we're talking infrastructure. Add to this one thing I had never suspected, the irresistible allure all those shiny cars in a row would have for a wide-eyed toddler, a crafty toddler who's only ever seen the Smurfmobile – last washed in 1996, definitely not shiny – and how quickly this toddler could disappear among the shiny cars. Did I mention that Yonatan runs? He also likes to hide.

Having no other choice, we grimly overcame these adversities, and joined the ranks of the bourgeoisie with the purchase of a '98 Ford Windstar, Robin-egg-blue,

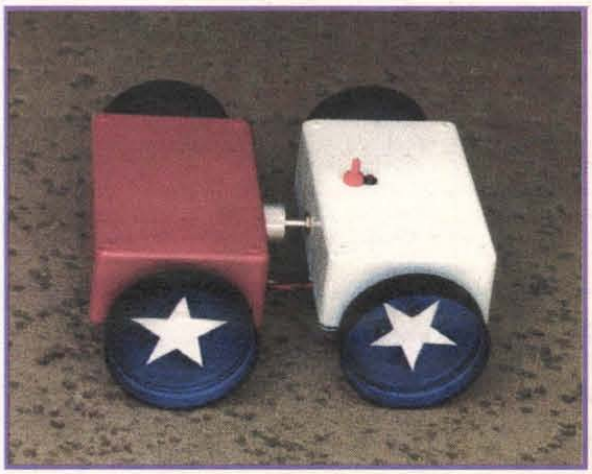


Photo 1: An excellent example of a Jiffy built by Michael Evans of Rancho Santa Fe, CA.

Photo 2: "Don't try this at home!" Another view of Michael's Jiffy.

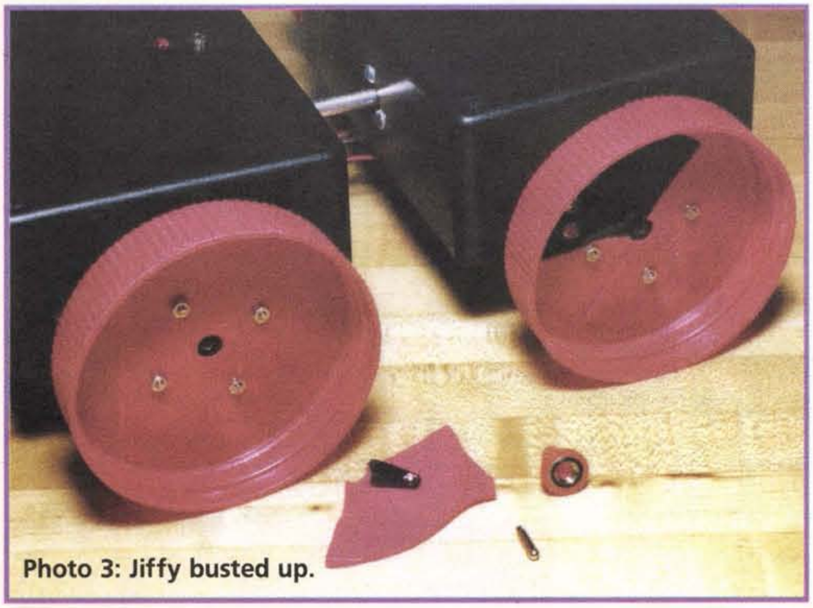


Photo 3: Jiffy busted up.

loaded, with only 26,000 miles. We even got a good deal.

We hope to be over the Post Traumatic Stress by spring.

Pumping Iron

Here I must come clean. For the past two months, I've also been very busy on another big robotics project, the first hints of which you can see in Photos 4 through 6. I'm building a three-axis CNC Mill/Drill machine. With a lot of behind-the-scenes help from Dan Mauch (who has presented several fine articles on his own CNC projects in this magazine), I think I've come up with a pretty good basic design. You'll see the full construction plans starting in February, but for now I'll just say you should be able to build it for under $600.00, substantially less if you are a talented scrounger.

In its early stages, it will use a Dremel-style motorized tool for the spindle, good enough for drilling printed circuit boards and light-duty routing of thin panels of wood, plastic, or aluminum. However, the design uses heavy-duty mechanical components to allow upgrading to a full CNC milling machine just by adding a more powerful spindle drive. Those machinist files I was talking about last month will get a good workout on this project.

The horizontal axes, X and Y, will be built up from an Enco Heavy-duty Mill & Drill Table (Model #201-2536). This thing is made of 56 pounds of cast iron; it's five inches tall, has a T-slotted table measuring 8" x 10.5". It's a nice unit, well-machined. The leadscrews are 10 TPI, so one full turn advances the table by .100". The Enco catalog claims it has a travel of 11" longitudinally (side to side), and 7.5" cross (front to back); the longitudinal travel is accurate, but the cross travel is 7.5" only if you run the table the full travel of the leadscrew. When you do that, the table is half way off the dovetail slides at each extreme of travel. You can actually rock the table from side to side in these positions.

The table's fully-supported cross travel is something more like 2.25", so some work is needed here to increase that range. Still, it's a bargain at $99.95 (sale price, normally $189.95, but Dan tells me this thing seems to be perpetually on sale at Enco). You couldn't buy the materials you'd need to make it at that price. (Check out www.use-enco.com to order parts; be sure to request a catalog.)

Photos 5 and 6 show the 6" cross-slide vise from Harbor Freight Tools that will become the Z-axis (Model #32997). I'll be removing the vise and using just the base slide and bolting it to a vertical steel column. The vise is quite roughly machined compared to the Enco table, so I don't feel bad at all about sacrificing the vise portion. Also, the bearing brackets are crude and will have to be entirely redone. Still, my main requirements are that it be rugged, and that means lots of cast iron, which this vise has — it weighs over 38 pounds — and that it be cheap. The vise is $64.94 including shipping and handling (www.harborfreight.com).

For anyone wanting more precision with less rework, Enco has another, smaller Milling & Drilling table (model #201-2826) that looks like just the ticket for the Z-axis. It's normally $99.95, but is on sale until Dec 31st for $66.95. I might have gotten it rather than the Harbor Freight vise had I known it would go on sale. It looks similar to the larger Enco X-Y table and also uses 10 TPI Acme leadscrews, but the base is oval-shaped and it has hand cranks instead of hand wheels.

I plan to use this machine extensively in upcoming projects (hint: some robots, such as walkers, robot arms, grippers, etc., require a lot of identical machined parts).

Anyway, I'll have lots more to say about this project in coming months. On to the book reviews.

Service Robots

Service Robots: Products, Scenarios, Visions by Rolf Dieter Schraft and Gernot Schmierer (A K Peters, 2000, ISBN 1-56881-109-8) is about, well, service robots, but what are these? The International Federation of Robotics defines a service robot as "a robot that operates partially or fully autonomously to perform services useful to the well-being ... of humans and equipment. They are mobile or manipulative or a combination of both." If that definition still doesn't tell you precisely what a service robot is, think of service robotics as amateur robotics being done by professionals with money.

I realize that's a pretty broad scope, but that's what this book attempts to do, to cover the gamut of mobile and manipulative robots (basically any robot that's not bolted to some factory floor).

But what this book really is, is a drool book for people like you and me, a glorious coffee-table book with sensational photos and illustrations — over 250 of them — of just about every kind of robot imaginable. You think the only killer applications for robots are the robovac and robomower? Think again.

The authors show robots designed to refuel cars, to work in forestry, agriculture, and the construction industry, to perform tasks too dangerous, awkward, or impossible for humans in industrial renovation and maintenance. They show robots cleaning, surveilling, scuttling about offices, sorting recyclables, and fighting fires. They show robots in hotels, robots cooking, robots tending bar, and robots serving espresso.

Not enough for you? Well, how about robots that climb the sides of skyscrapers to display advertisements — or to clean the glass; how about robots assisting the disabled, delivering meals and medications, or robots performing precision orthopedic surgery? Then there are robots doing jobs underwater, in space, and in active volcanoes, and robots just for the fun and entertainment of it.


Photo 4: Enco X-Y milling/drilling table.

And, yes, there are robot floor cleaners and lawn mowers in the book, too.

In 215 pages, even with over 250 photos and illustrations, it's impossible for a book this broad to cover any one system in depth. You won't find plans to build the robot espresso bar, for instance (you probably couldn't afford to build it anyway), nor will you get more than an overview of robot navigation and path planning.

No, I see the value of this book as a vivid source of inspiration to gearheads. We too easily get into ruts: take two wheels, two motors, a caster, and bolt them onto a disk of plywood; slap on a microprocessor and a few sensors, and, bam, you've got robot. *Service Robots* reminds us, to paraphrase Kipling, that there are nine and forty ways to construct the tribal lays, and each of them is right. There is so much essential rightness in so many of the designs that you can't help but come up with exciting new robot projects when browsing through this book. Like any coffee table book, this one is a bit on the pricey side at $47.50. Still, I think it's worth the price for the inspiration to be derived. This book cries out to be seen by as many robot builders as possible.

If it's just too expensive for you, though, maybe go in with some buddies or make a club purchase and share the book around. And you can always request your local library to include it on their buy list.

The Engines of Our Ingenuity

In *The Engines of Our Ingenuity: An Engineer Looks at Technology and Culture* (Oxford University Press, 2000, ISBN 0-19-513583), John Lienhard reflects on the nature of technology, culture, human inventiveness, and the history of engineering. This series of 17 essays had their genesis in Lienhard's daily essays on creativity produced by KUHF-FM Houston and heard nationally on Public Radio. *The Engines of Our Ingenuity* gives an intriguing collection of glimpses into technology, the way it mirrors human psychology, the dangers and opportunities it presents, and how often inventions are more product of idiosyncratic ego rather than actual need or market. People sometimes build stuff for no other reason than because it's cool; only later does it become useful.

Lots of people write books these days with the theme of how technology shapes culture and vice versa, and most of them, frankly, aren't worth the paper and ink. They too often go off on deconstructionist rants having less to do with technology than the author's own lack of understanding of technology. But Lienhard doesn't go down that path, preferring to show how the co-evolution of technology and culture, warts and gems, is basic to the human condition. For Lienhard, the history of technology is the history of humankind, and in a profound sense we are defined by the technologies we've created through the ages.

Lienhard makes the persuasive argument in essay two that the great emergence of Western technology can be traced directly from the medieval church, something that seems so unlikely today that most people would dismiss it as nonsense. After all, we often use the term "medieval" to describe things so hopelessly crude, inefficient, or barbaric that no possible connection could exist with modern science and technology. The medieval church, and the religious sensibilities it embodied, are often simplistically seen as the antithesis of the modern scientific ideals of detachment and objectivity.

"Scientific" Detachment

The ideal of objective detachment is a relatively new idea, causing us to mistakenly disassociate technology from the passions that drive the human heart. The medieval artisans building cathedrals were no less passionate technologists than we, and were unashamed in their refusal to separate the work of their hands from the work of their souls. Even human flight, the technology most easily associated with freedom and spirit, had its antecedents among these medieval artisans and monks.

According to the account of another monk, sometime just after the year 1000 A.D., Eilmer, a Benedictine monk at Wiltshire Abbey, built a sort of hang glider for himself and flew perhaps 200 yards before a wind gust ended his

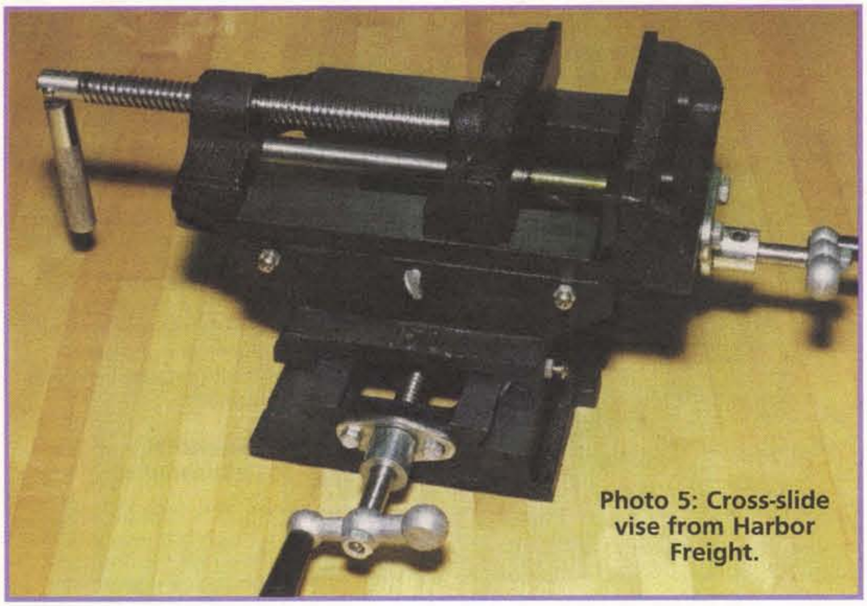


Photo 5: Cross-slide vise from Harbor Freight.

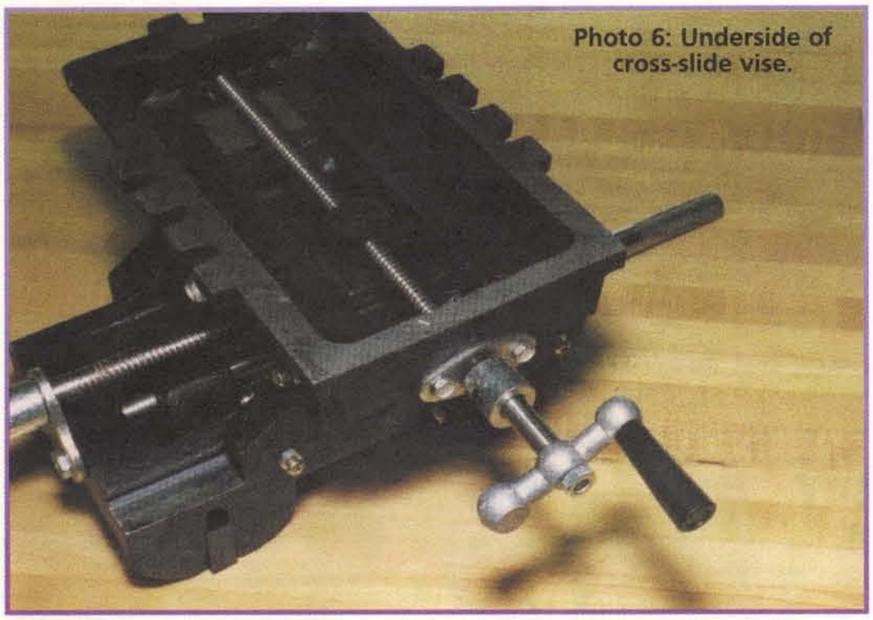


Photo 6: Underside of cross-slide vise.

flight. The same thing happened to Otto Lilienthal at the end of the 19th century, causing him to fall to his death; Eilmer merely broke his legs and walked with a limp thereafter.

He claimed — very likely correctly — that the fault with his invention lay in not adding a stabilizing tail, something the Wright brothers themselves had to re-learn 900 years later.

And Eilmer was not the only one. I don't want to spoil it for you, but Lienhard cites other unsung medieval pioneers of aviation and other technologies. Indeed, the dream of flight is old, but the fact of aeronautical experimentation is, surprisingly, just as old.

A Matter of Degree

I don't agree with everything he says, though. Most notably, in essay 10 he argues that war doesn't fuel invention, that the technical achievements most associated with World War II — jet aircraft, guided missiles, digital computers, and radar — all emerged before the war. He believes war may encourage refinement of pre-existing technologies, and it surely demands miracles of production and organization, but nothing fundamentally new comes out of wartime development. For Lienhard, solving problems of organization, logistics, and production don't really qualify as innovation.

I disagree. Whenever you change the scale of any system by orders of magnitude, you get not just a quantitative change, but also an inevitable qualitative change. In principle, a computer is nothing more than a collection of NAND gates wired up to form a CPU and memory. But what you can do with a machine made of a million NAND gates is radically different from what you can do with one made of just a hundred NAND gates. The former can calculate spreadsheets, play Doom, surf the internet, and control robots, whereas the latter would be taxed to handle much more than a fire alarm or an elevator.

Or consider today's space boosters: all are direct descendents of the German V-2 rocket, not Robert Goddard's rockets, despite the fact that Goddard had developed virtually every detail of liquid-fueled rocket propulsion and guidance here in America in the 20s and 30s. Still, even though I disagree with the core idea of this particular essay, the argument he presents fascinates me, and it was the first time I'd read a defense for the position intelligent enough to be worthy of comment.

I admit, I'm a sucker for this type of book. It helps that Lienhard is a real engineer with obvious delight in his subject material. As he shows, the history of technology abounds in surprises, and we learn much from the failures of obscure pioneers — perhaps more than from the famous successes.

I enjoyed this book, and if you are as interested in questions of the why and when of technology as you are about the how, you'll enjoy it too.

Practical Electronics for Inventors

I've saved the best for last. *Practical Electronics for Inventors* (McGraw Hill, 2000, ISBN 0-07-058078-2) by Paul Scherz is just what the title says. It's a practical guide to doing electronics aimed at technically-minded people not necessarily conversant in electronics theory, but it is in no way dumbed down.

Amateur robotics can be quite intimidating to the newcomer because of all the different areas of technical knowledge that must be dealt with, one way or another. Electronics, one of the three pillars of robotics (the other two being computation and mechanics), is itself a huge field that blows beginners away more often than not.

Partly this is because the field is so big and diverse, but it's also true that most electronics books oriented toward beginners are either too elementary or depend on cookie-cutter recipes lacking the depth of information to make them really useful. If they do have the depth, they often fall on the side of too much theory and not enough practical examples and are thus worthless as beginner's references.

Scherz's book is a delightful exception. He shows you first what a given electronic device is good for, with only the essential information you need to get it working in a real circuit. If you then need the detailed theory of operation and design, he provides that, too, in sections arranged so you can read until you know enough. His philosophy is that you shouldn't have to read the whole chapter to find out whether, say, a JFET is good for making power switches for motors (probably not). Instead, his style and organization encourage you to read a little here, a little there, to jump around until you find what you do need (maybe bipolar transistors or MOSFETs).

Analogies that Hold Water

The classic illustration used in most beginner's books on electrical theory is that of a water tank with various size holes punched at various heights in the side of the tank to show the analogies of water pressure and flow rates to voltage and current.

If the hole punched is tiny and has little pressure behind it, only a small amount of water will flow; if the hole is located further down the tank, there will be higher pressure and more water will flow through the same size hole. Or, for different size holes at the same height, more water will flow, naturally, through the larger hole.

That's as much as the typical text does with the water analogy, but Scherz takes it to a whole new level and makes it his own. First of all, he has lots of these prepossessing little hand-drawn diagrams that show you how to think of the actions of various electronic components as being analogous to collections of water pipes, valves, springs, and other easily understood gizmos, including the oft-slighted water balloon. His illustration of how a capacitor passes an AC current is nothing less than inspired.

The illustration style reminds me a bit of Forrest Mimms, one of the other rare technical writers who communicates effectively with both beginner and pro.

Sherz does his best to make this book a practical reference that clears up common misconceptions and shows you subtle tricks not taught in many more conventional electronics books. It's filled with worked-out examples and built circuits you can use right away, with enough background theory given to allow you to modify and extend the circuits.

He goes further and tells you nitty gritty details on how to build circuits, how to decipher transistor and IC labels, how to use test equipment, where to go for more information, and even how and where to buy electronic components. And how to avoid getting shocked.

I'd place this book somewhere midway between Mimms' various books and Horowitz and Hill's indispensable *The Art of Electronics*. If you are a complete beginner, you won't understand everything contained in the book at first, but that's okay.

It's got plenty to get you going in electronics. As you gain experience, the book will grow into a valuable, ongoing reference. This book belongs on any robot builder's bookshelf, beginner or advanced.

Saddling Up

Well, I'm out of space and literally saddling up for a trip: I'm driving to D.C. to attend the Eighth Foresight Conference on Molecular Nanotechnology. It's being held on the East Coast for the first time, so I couldn't pass up this opportunity (especially since my in-laws live just a few blocks from the hotel where it's being held).

Most of you have probably heard of nanotechnology, if only on Star Trek, but I'll wager few of you realize just how much progress has been made in the last year alone toward realizing the dream of molecular robotics. Next time, I'll talk all about that. Further than that, I promise nothing specific (I've learned my lesson), but it will be about robots, and it will be fun. **NV**

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

Robert Nansel
Box 228
Ambridge, PA 15003

Email: bnansel@nauticom.net

Starting with the 68HC11

by Al Williams

Although the 68HC11 is not the newest microprocessor around, it is widely used by both professionals and hobbyists. The HC11 has many peripheral options, it is inexpensive, and there are plenty of free tools and code examples.

However, getting started with the HC11 can be a bit of a problem. First, most of the common parts are in PLCC packages — not very experimenter friendly. Besides that, the easiest way to use the chips is in the single-chip mode. However, that requires some way to program the onboard memory. If you want to use an external EPROM or EEPROM, you'll have to resort to the expanded mode, which requires more external circuitry.

What would be ideal would be a version of the 68HC11 that would fit on a breadboard, and contain EEPROM onboard so you could run it in single-chip mode. There is such a member of the 68HC11 family, if you know where to look for it: the 68HC811E2CP2. The number contains an 811 instead of an 11, so it has EEPROM (2K to be exact). The CP2 at the end indicates a 48-pin DIP package. It fits handily in a breadboard.

What's Needed?

Armed with a breadboard and a 68HC811E2CP2, you are almost ready to jump into 68HC11 programming. You'll also need the following:

- An 8 MHz crystal or ceramic resonator.
- Two small capacitors to match the crystal or resonator (maybe optional; see text).
- A one megohm resistor.
- A few miscellaneous resistors and capacitors.
- Two switches (a push-button switch and a SPST toggle).
- An RS-232 to TTL converter.

You'll also need some software tools and a PC. All the tools you'll need are available free on the Internet. You can even download Karl Lunt's SBasic compiler that will let you write Basic programs, compile them, and run them on the HC11.

You could build an RS-232 converter just for the project, but I used my breadboardable converter from last month's issue (see "RS-232 on a Breadboard"). Pin 43 of the HC11 connects to the RX pin of the converter and pin 42 connects to RX. For a practical design, you'd want to include proper termination for all the inputs to reduce possible power drain. For experimenting, I've had no problem leaving the inputs unterminated.

Another shortcut I took was in the reset circuitry. On the HC11, the reset pin can be an input or an output. You should really use a reset supervisor circuit (like a Microchip MCP1XX device) on this pin. If you have one, use it. Otherwise, you can get by using a simple RC circuit. I included a reset switch, so I could reset the processor without cycling the power.

If you use a crystal or an ordinary ceramic resonator, you should include a capacitor from pins 29 and 30 to ground. The value of the capacitors will equal the load capacitance of the crystal. So if the crystal you use has a 15pF load capacitance, you'd use two 15pF capacitors. Some ceramic resonators have these capacitors built in (typically resonators with three leads have capacitors; those with two leads do not). However, the breadboard has so much capacitance anyway, you may not need them (I didn't). I also found the 1M resistor across the crystal didn't have much effect. I could remove it with no trouble.

Since I was operating the board off a clean 5V supply, and the breadboard has a lot of capacitance, I didn't include decoupling capacitors. Again, in a real design, you'd want at least a 1uF and a .1uF close to the chip between Vdd and Vss. However, on the breadboard with a bench supply, these were not necessary.

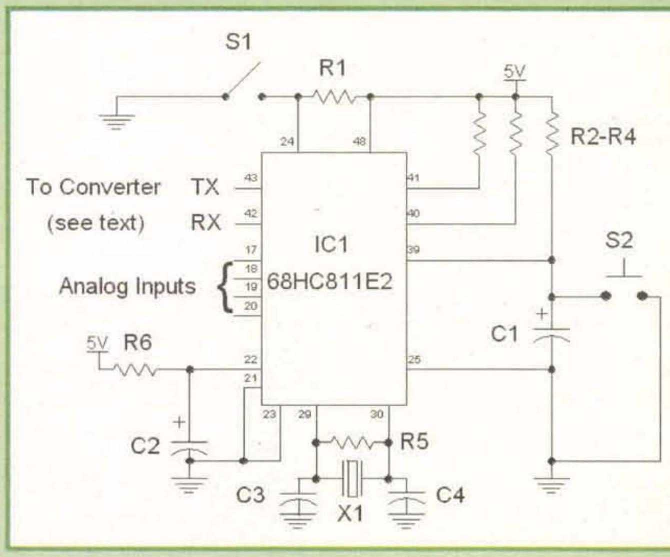


Figure 1.
The 68HC811E2 breadboard circuit.

Construction

For prototyping, construction is not critical. You can find the schematic in Figure 1 and a picture of the completed unit in Figure 2. Since the small breadboard I used was filling up quickly, I snapped on an extra bus bar to carry the RS-232 signals from one side of the board to the other. This isn't strictly necessary, but if you are planning on building significant extra circuits, you might want to add another breadboard or use a larger unit to start with.

You can find switches that will fit in the breadboard for use at S1 and S2. If you are planning on making the board permanent, you might use a little glue to hold the switches in place. The reset switch is not a problem, but the toggle switch has a tendency to slip out of the breadboard when you flip it until you get the knack of it. Luckily, the processor only reads

Listing 1.
The voltmeter example.

```
' voltmeter, prints four analog inputs every
' 1/2 second
' Al Williams
'
'

include "regs11.lib"

declare c
declare n
declare tval

main:

   gosub sci_init
         pokeb option,$90

   do
' This section takes just over 30mS at 8MHz xtal
      pokeb portb,peekb(portb) xor $80
      pokeb adctl,$90
' Wait for conversion
      do while (peekb(adctl) and $80) = 0
      loop
      n=peekb(adr1) ' Read it
      gosub printvolt
      print ", ";
            n=peekb(adr2)
            gosub printvolt
            print ", ";
            n=peekb(adr3)
            gosub printvolt
            print ", ";
            n=peekb(adr4)
            gosub printvolt
            print
            gosub pause ' pause for 500mS - 30 = 470
   loop

pause:
   declare j
   for j=1 to 470
         gosub pausems
   next
   return

pausems:
         declare t
         declare t1
         t1=peek(tcnt)+2000 ' 1mS @ E=2Mhz
      poke toc1,t1
            pokeb tflg1,$80  ' clear OC1F
twait:
            do
            loop while (peekb(tflg1) AND $80)=0
            return

' Voltage (in .1V units) is count * 50/256
printvolt:
            n=n*50
            n=rshft(n)
            n=rshft(n)
            n=rshft(n)
            n=rshft(n)
            n=rshft(n)
            n=rshft(n)
            n=rshft(n)
            n=rshft(n)
' print whole number . and fractional part
            print n/10; ".": n mod 10;
   return

sci_init:
 pokeb baud, $30       ' 9600 baud
 pokeb sccr2, $0c      ' enable rcvr and xmtr
 return

end
```

this switch on reset, so it will never be a problem as long as you can slip it right back in the holes it belongs in.

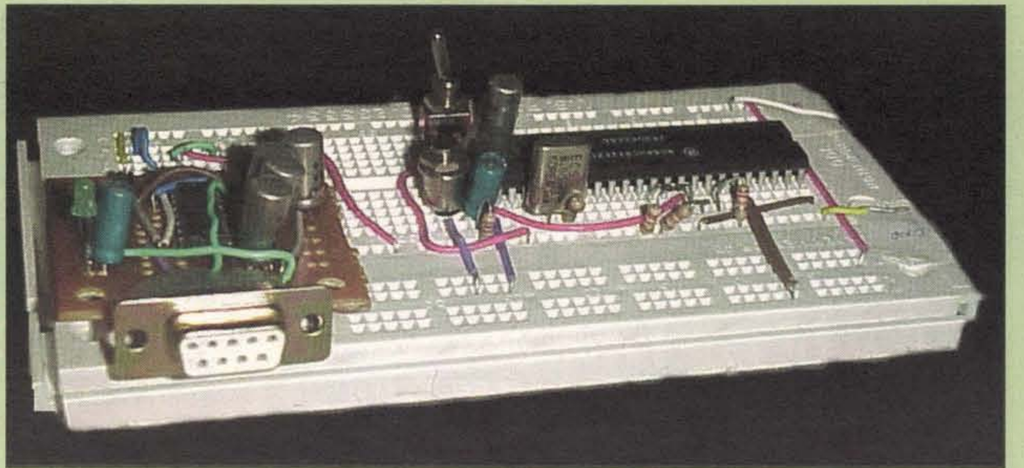


Figure 2. A completed breadboard.

Getting to Work

Programming the HC11 depends on a special test mode that is active when you set pin 24 and pin 25 to ground. That's the purpose of the toggle switch. You can close the switch and reset the processor to enter bootstrap mode. In bootstrap mode, the processor runs a simple loader that lets you write a program — usually a program known as a talker — into the processor's memory.

After the talker is running, you can run a monitor program that uses the talker to load more programs, execute them, and even debug them. There are several loaders that you can use, but one of the best is PCBUG11, which was written by Motorola and is free.

PCBUG11 has several talkers that you can use depending on the processor you are using. For the 68HC811E2, you can use one of the built-in talkers (specified with the -a option). However, the default talker has a problem. It loads into RAM. There are only 256 bytes of RAM to begin with, so that leaves you with very little room to experiment. If you don't need RAM, that's fine. But if you do, you'll wind up having to use PCBUG11 to write your program to EEPROM and then reset the computer in normal mode. That runs your program, but doesn't allow you to perform any debugging.

I decided to write a new talker just for the 68HC811E2. It loads into EEPROM and uses just a small amount of RAM. As long as you keep your program from using the small part of EEPROM and RAM that my talker uses, you'll be able to debug your program. You can download my talker online (see Online Resources).

Exactly how you write and compile your program will depend on the tools you select (again, see Online Resources). The general idea is you will use an assembler or compiler to generate an S19 file. Then you reset the HC11 in bootstrap mode and load PCBUG11. Once PCBUG11 starts, you can load the S19 file and execute it. If you've set the program up to run stand-alone, you can flip the bootstrap switch to normal mode and reset the processor to run it without PCBUG11. If you are running with PCBUG11, you can read registers and memory locations. You can also set breakpoints. All of these features are interrupt-driven, so they work even when the program is executing.

An Example

To show you how versatile this set-up can be, I decided to write a simple voltmeter program using SBasic (see Listing 1). The voltmeter uses the HC11's internal A/D converter and writes the result out to a PC connected to the RS-232 converter.

The voltmeter uses the built-in serial port (the same one PCBug11 uses). The pokeb and peekb commands allow you to directly access the A/D registers in the HC11. Each A/D result is eight bits wide and represents up to 5V. Therefore, each count is worth 5/256 volts. I wanted resolution to the tenth of a volt, so I compute the total voltage as the count times 50 and then divide by 256. So for a 1.3V input, for example, the final result is 13. Then it is simple to print the first digit of the result, a decimal point, and the fractional portion.

It is possible to use references other than 5V with the device. The circuit connects ground and 5V to Vrl and Vrh (pins 21 and 22). However, you could use an external reference. A 4.096V reference, for example, sets each count to exactly 16mV.

The entire conversion and printing cycle takes about 30mS, so the program delays an additional 470mS before starting another cycle. You can connect the analog voltages to pins 17, 18, 19, and 20 of the microprocessor.

Building the program is simple using SBasic. Your command line can look like this:

```
SBASIC volts.bas /CF920 /V0000 /S009D
/M6811
```

This will start the program at $F920, variables at $0000, and the stack at $009D. The EEPROM starts at $F800, but my EEPROM talker uses from $F800 to $F91F. Unfortunately, since the talker and this program both use the serial port, you won't really be able to debug it easily with PCBUG11 anyway.

SBasic generates assembly language that you can build using the assembler supplied. Just run:

```
ASMHC11 volts
```

The ASMHC11 program assumes your file is on the C drive. If it isn't, try prefixing the file name with the drive letter. In other words, use D:volts instead of vplts. Once you have a S19 file, you can close S1 and press S2 to reset the HC11.

Make sure your PC is connected to the RS232 converter. Start PCBUG11 using the -a option. If you are using COM2 instead of COM1, add port=2 to the command line. You'll want to issue at least three commands:

```
CONTROL BASE HEX
MS 1035 10
EEPROM F800 FFFF
```

The first command allows you to enter hex numbers at the command prompt. The second command enables the EEPROM on the chip. Without this command, the EEPROM will remain write-protected. The third command tells PCBUG11 to use its EEPROM writing algorithm. If you are using my talker, you won't need this third command.

Once you have the initial set-up complete, you can use the LOADS command to load the S19 file into the chip (for example, LOADS volts). If you set up your program to avoid the talker's memory (and other resources like the serial port) you are using, you can run the program using PCBUG11 commands. Even if you are using some of the talker's area, you can probably start the program (use G F920) and even use the TERM command to see the output. However, you won't be able to view registers or set breakpoints. Otherwise, open S1 and push S2 to reset the chip and run your program.

Finding 68HC811E2CP2 Chips

Several of the larger distributors sell these parts, but they are not as readily available as the PLCC parts. The good news is that the Internet has made these parts easier to find, and also easier to order since most distributors now accept Internet orders with low or no minimum order required.

A good way to locate chips of any sort is to use a search engine just for that purpose. My favorite is www.findchips.com. You can find a few others in the Online Resources section. **NV**

Parts List

C1 - 10uF 35V electrolytic capacitor (RadioShack 272-1025)
C2 - 4.7uF 35V electrolytic capacitor (RadioShack 272-1024)
C3, C4 - See text
IC1 - MC68HC811E2CP2
R1-R4, R6 - 10K resistor
R5 - 1M resistor (optional; see text)
S1 - SPST switch (RadioShack 275-645)
S2 - Momentary pushbutton switch (RadioShack 275-1571)
Converter - RS-232 converter from last month's article

Online Resources

http://home1.gte.net/tdickens/68hc11/my_tools.html
All the tools you'll need
http://www.seanet.com/~karllunt/index.htm - SBasic home page
http://www.rdrop.com/users/marvin/sbasic/sbasic.htm
SBasic information including an IDE
http://www.al-williams.com/wd5gnr/hc11.htm - Home page for my talker
http://www.osa.com.au/~cjh/electronics/db11.html
A Linux program similar to PCBUG11
http://www.findchips.com - Locate chips in stock
http://www.partminer.com - Another site that allows you to locate parts

Win with Nuts & Volts

Each month, 11 lucky names will be drawn!! Join the winners listed below!

Monthly Prize Donor: NETCOM (page 25)

PAID SUBSCRIBERS ARE AUTOMATICALLY ENTERED EACH MONTH!

CLIFF POSTISIL of Old Bridge, NJ
MICHAEL CAMPBELL of Tomball, TX
DALLAS COLLET of Ft. Collins, CO
JEFF KUPREL of Farmington Hills, MI
ANDY NEWMAN of Silver Spring, MD
DANNY ERWIN of St. Louis, MO
CHARLES SCHMITTER of Ann Arbor, MI
DIANNE SANCETTA of Jupiter, FL
ANTHONY COSTANZO of Flanders, NY
A. RODRIGUEZ of Seattle, WA
DAVID DELMAN of Jericho, NY

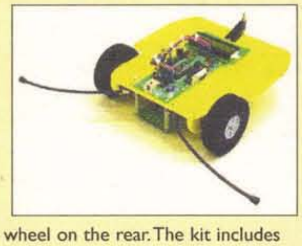
To Subscribe – Just fill in and mail the card supplied in the magazine or call our toll free order line at **(800) 783-4624** with a Visa or MasterCard.

If you do not wish to order a subscription, but would like to be entered in our drawing, simply send or email your name, address, and telephone number to *Nuts & Volts*, 430 Princeland Ct., Corona, CA 92879 or drawing@nutsvolts.com. No phone entries accepted. All orders/entries must be received by the last day of the month to be included in that particular month's drawing.

This month's sponsor ...

LYNXMOTION, INC.

The Carpet Rover II Robot Kit



The new body style of the Carpet Rover II features a beautiful laser-cut acrylic chassis. The platform is 8" x 8", with 3" drive wheels and a high performance caster wheel on the rear. The kit includes our Next Step, BASIC Stamp II based microcontroller, for the brains. We have thrown in our Tracker line follower, Infrared Proximity Detector, and Bumper Switch sensor kits for plenty of robotic fun. These kits are now available in Yellow, Red, Blue, and Flourescent Orange and Green; the donated kit is Flourescent Orange which lights up on the edges for a really cool effect. Also included is a 19-page assembly and project manual. The donated kit and accessories are valued at $180.00.

Visit the Lynxmotion website at www.lynxmotion.com

You can check out their ad on Page 57.

Get 2 One-Year Subscriptions For $20.00!!

That's right!! Buy or renew your own subscription and order a second subscription for a friend!! *That's a price savings of $18.00!!*

These are for one-year, US delivery subscriptions only. And please don't ask us if you can just have two years for yourself. This is the giving season remember!!

You can order on-line at our website (www.nutsvolts.com) or you can call us at 1-800-783-4624 to order with your Visa or MasterCard. Or, you can mail in a check or money order to our office at 430 Princeland Court, Corona, CA 92879.

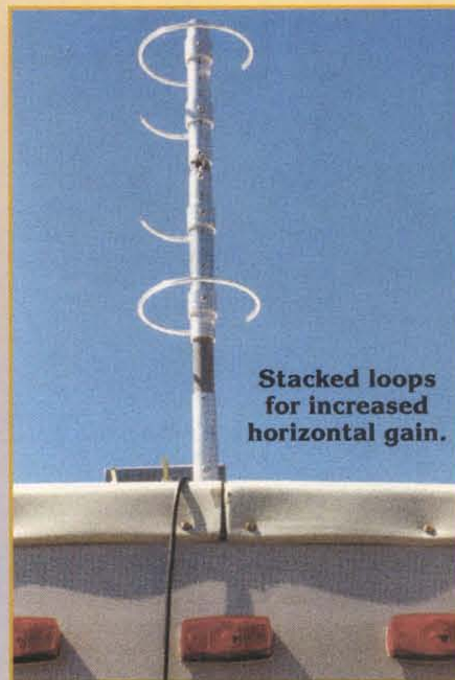
Don't delay! This offer expires January 31, 2001!

Give the gift that gives all year long ...

Because of the discounted price, **these special subscriptions must be prepaid**. No Bill-Me's allowed. Two separate mailing addresses must be given.
Sorry, no exceptions!

by Gordon West

LOOPS INTRODUCE VHF/UHF WEAK SIGNAL OPERATION



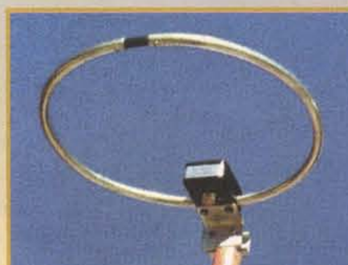
Stacked loops for increased horizontal gain.

Thousands of amateur radio operators have purchased the popular ICOM IC-706 multi-mode HF/VHF/UHF transceiver, but few have ever operated it on two-meter and 70 cm single sideband for weak signal DXing. There are thousands of Yaesu FT100 owners, but only a handful have listened into the weak signal DX coming in on 144.200 upper sideband and 432.100 upper sideband.

And Yaesu has just announced the FT-817, a QRP version of the FT-100. The FT-817 runs HF, VHF, and UHF with multi-mode weak signal SSB capabilities on both two meters, as well as 432 MHz.

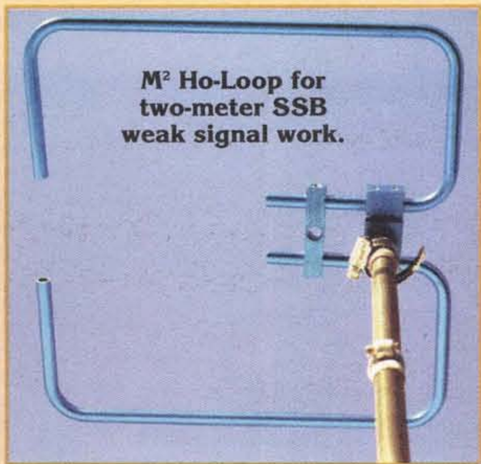
"The reason we don't have more SSB activity on 144.200 MHz and 432.100 MHz from these radio operators is the misconception that VHF and UHF long-range tropospheric ducting requires major-sized, horizontally polarized, beam antennas," comments Norm Pedersen KB6KQ, Education Chairman for the Western States Weak Signal Society (WSWSS, P.O. Box 332, Midway City, CA 92655; $10.00 for membership and newsletter; web www.wswss.org).

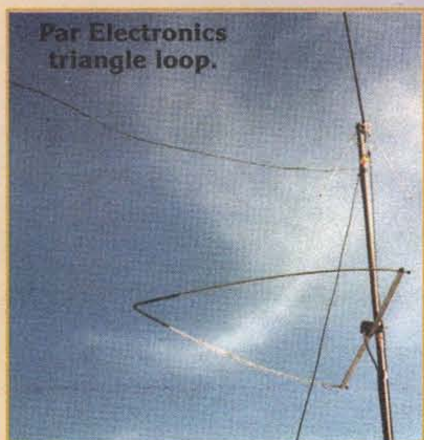
"I see plenty of these little Yaesu and ICOM all-mode, all-band transceivers in mobile installations, and the hams tell me the only reason they don't go weak signal on the

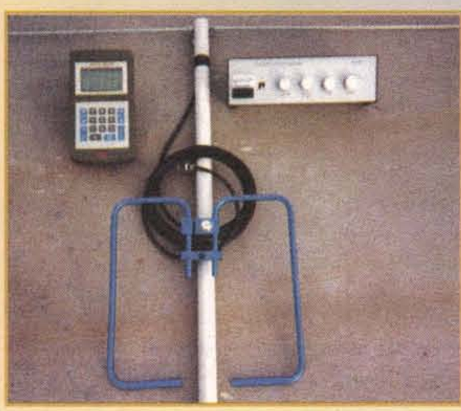


KB6KQ loop for two meters comes all assembled and tuned!

KB6KQ loop for the six-meter band.


M² Ho-Loop for two-meter SSB weak signal work.


Par Electronics triangle loop.


M² Ho-Loop (blue) next to antenna testing equipment.

VHF and UHF bands is a dual-band vertical whip is cross-polarized and they miss out on any significant DX," adds Pedersen.

Yes, these little transceivers for both mobile and base, and the new Yaesu FT-817 for portable, indeed need to go into a horizontal antenna system in order to work the regular DX found down on 144.200 and 432.100, predominantly tropo scatter and tropospheric ducting. There could be as much as a 20 dB loss in performance when trying to work these weak signal portions of the bands with just a mobile vertical antenna.

THE LOOP ANSWER

A single compact VHF or UHF mobile loop antenna puts you on 144.200 SSB or 432.100 SSB with a horizontally polarized signal that may surprise the daylights out of you when you are out on the flat lands, up on a hill, or driving along the shore of a lake or ocean.

What kind of results might you expect mobile to mobile using two meters or 432 MHz SSB, horizontally polarized? During recent summertime VHF and UHF operating events, two-meter SSB mobile-to-mobile contacts over 50 to 75 miles were quite common, and mobile-to-base on two-meter SSB exceeded 100 miles to a maximum of 300 miles. Pat Coker N6RMJ, Vice-President of the Western States Weak Signal Society, has many times made two-meter SSB contact between his mobile in Los Angeles and base stations with horizontal beams in the San Francisco Bay area.

What's happening on 432.100 MHz? This frequency, three times higher than the two-meter band, yields almost the SAME DX as on two meters — especially when common tropospheric ducting caps the signals and tunnels them in an inversion layer over hundreds of miles.

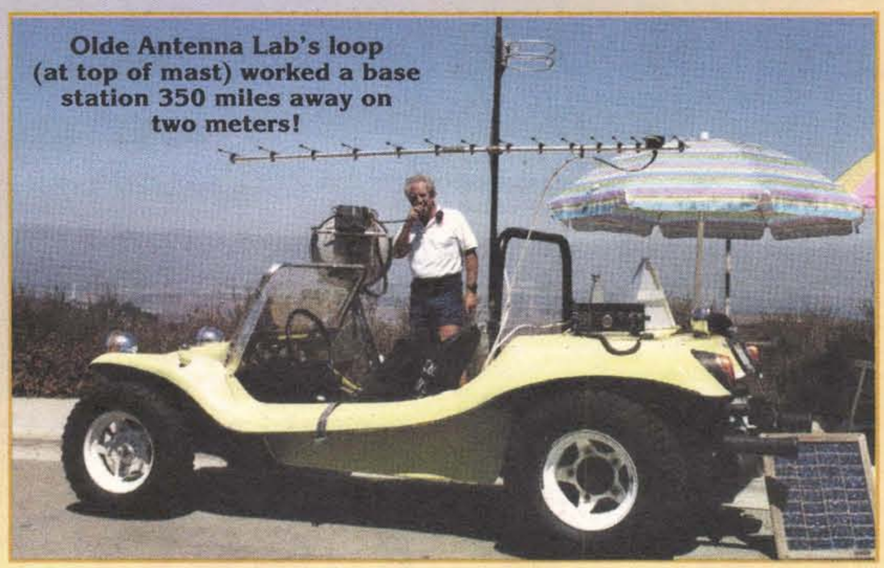
Larry Hogue W6OMF, in Vacaville reports consistent long-range, mobile-to-mobile contacts on both two meters and 432 using single sideband and horizontally polarized loops, and extraordinary base-to-mobile, hundreds-of-miles contacts down on 144.200 upper sideband and 432.100 upper sideband.

The small loop antenna is also the answer for those weak signal VHF/UHF operators who may live in a housing development where no external antennas are allowed.

"I run a two-meter loop and a 432 MHz loop in the attic, and I am talking VHF/UHF single sideband over hundreds of miles without anything showing on the roof," comments Bill Alber WA6CAX, a pal of Larry W6OMF. "I even heard about a mobile-to-mobile, loop-to-loop contact between Southern California and Paul Lieb KH6HME, driving up the slopes of a volcano in Hawaii!" adds Alber. I can confirm this contact that occurred about two years ago during the regular California-to-Hawaii tropo opening in August.

WHOSE LOOP IS BEST?

The horizontally polarized two-meter, 432 MHz, and 1.2 GHz loops are commercially available from about six different antenna

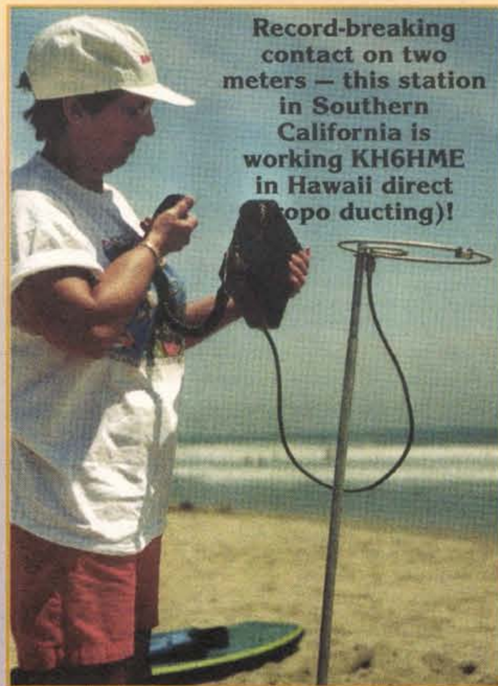

Olde Antenna Lab's loop (at top of mast) worked a base station 350 miles away on two meters!

manufacturers:

M² Antenna Systems
Fresno, CA; 209-432-8873
Olde Antenna Lab
Parker, CO; 303-841-1735
KB6KQ Antennas
Carson City, NV; 775-885-7885
Par Electronics
Lantana, FL; 561-586-8278
Laddy Loop
c/o Western States Weak Signal Society
P.O. Box 332, Midway City, CA 92655
Tillo-Currie Big Wheel Antenna
Ann Arbor, MI; 734-668-8696

If I left out any current VHF/UHF loop manufacturers, someone let me know! There are also some classic "halo" loops occasionally showing up at ham swapmeets, including loops from Hygain, Cushcraft, and High Par Products. I can remember my first "Saturn" loop.

About a year ago, Chip Margelli K7JA, and I did a series of mobile loop comparisons down at the seashore. We tested the difference between individual loops at different heights above our roof, and then tested the increase of signal strength by stacking loops with the manufacturer-supplied phasing harnesses. The results were interesting.


Record-breaking contact on two meters — this station in Southern California is working KH6HME in Hawaii direct (tropo ducting)!


Author West putting a stack of KB6KQ loops on their Funmobile!

Individual loops compared between themselves all did remarkably well for extremely low SWR at 144.200 or 432.100. The SWR settled down nicely as long as they were mounted a halfwave or higher over the metal top of our vehicle. During range tests to a distant station 80 miles away, all loops were put in a relatively close matching signal strength, and each loop was relatively omnidirectional as we did donuts in the parking lot.

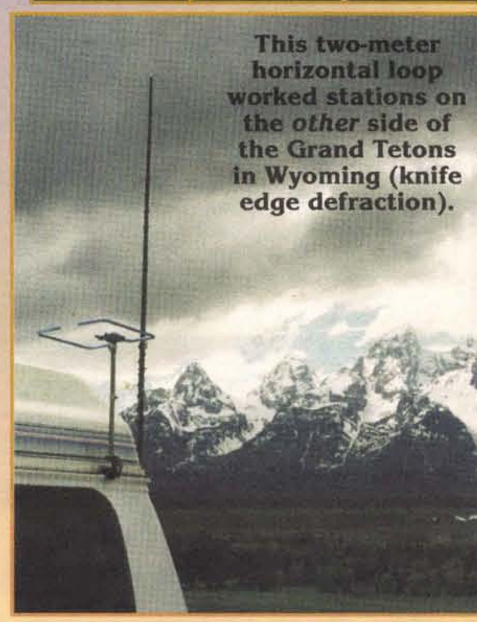
Indeed phasing and stacking a pair of loops will help increase signal strength, but the stacked pair didn't open up any new DX, but rather made our signal strength increase slightly. It was not like distant signals would magically appear when we stacked the loops as opposed to just working a single loop. Distant stations would simply increase slightly in signal strength when we switched over to the stacked pair versus the single loop. For the weak signal operator wanting the absolute strongest signal possible, stacked loops are a good way to go — but a weak signal operator just wanting a good distant signal that's going to go 99 percent as far as dual loops, the single loop will work just great.

All of the loop manufacturers continue to refine their two-meter, 432, and 1296 MHz loops. Slight redesigns from almost every loop manufacturer have dramatically improved the performance of the loops when water accumulates at their feedpoint. Each manufacturer has their own ideas on exactly how they feed the loop for a perfect match, and we really couldn't see any major difference in performance although each loop had its own characteristic tight or loose bandwidth.

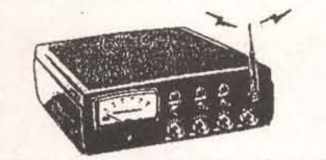
So which loop for you? I suggest going with one that most easily mounts on your particular mobile installation. Some mount with a relatively large mast because of their large surface area, yet others mount to a very narrow rod because they are relatively aerodynamic and small. Some are round, some are square, and some look like triangles. Again, they all seem to work about the same over the airwaves.

Go for a loop and add the capabilities to your two-meter or 432 MHz multi-mode mobile or base station using upper sideband. 144.200, upper sideband, is the calling frequency and meeting spot for new operators. 432.100 MHz is the calling frequency and meeting spot for new operators. Both frequencies using upper sideband mode only — no FM!

These loops will make a world of difference of getting some contacts on VHF and UHF SSB. Give a loop a try! **NV**

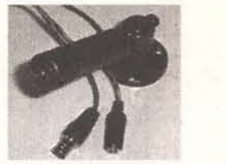

This two-meter horizontal loop worked stations on the *other* side of the Grand Tetons in Wyoming (knife edge defraction).

Continued from page 42



COUNTER-SURVEILLANCE=$250 HR! Electronic eavesdropping is unbelievably widespread! Are you sure you're safe? Learn how others (without prior experience) earn **$250 HR** in the fascinating field of COUNTER-SURVEILLANCE! For FREE catalog call: **1-800-732-5000**. HTTP://WWW.SPY-CITY.COM

PC MONITOR AS SECURITY MONITOR. The VGA-801 accepts standard NTSC or PAL inputs for display on any existing VGA/SVGA computer monitor. Small compact size. Over 600 lines of resolution, twice that of standard TV monitor! **$69 each**. Dealers welcome. Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com



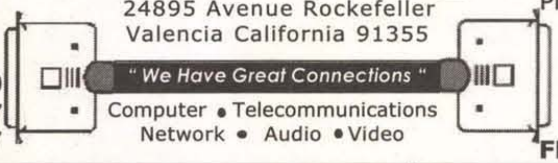
CCD BULLET CAMERAS B/W & COLOR. AX-800 series, weather resistant high impact design with swivel bracket. Will work with Matco's scanning motor. 3/4" diameter x 3" long approx. B/W: 400 line/0.2 lux. **$89/each**. Color: 350 lines/2 lux, **$129/each** — price reduction. Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com

5" AND 5.5" LCD high definition color monitors w/stereo. 960 x 240 pixels w/brightness and tint controls. Attractive enclosure with built-in speaker. Great for security or general purpose use. Both models have a small compact footprint, with an ultra-bright display, RCA inputs NTSC or PAL. Special price **this month only** with regulated power **$249/each**. Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com

Roger's Systems Specialist

24895 Avenue Rockefeller
Valencia California 91355

(800)366-0579
(661)295-5577
fax(661)295-8777



" We Have Great Connections "

Computer • Telecommunications
Network • Audio • Video

Place an **Order** on our Newly Updated **WebSite** and receive a **FREE** mouse pad!

w w w . r o g e r s s y s t e m s . c o m

CAT. 5 CABLE

Grey

TE-038-L5	3ft. Straight Patch	$1.75
TE-068-L5	7 ft. Straight Patch	$2.00
TE-128-L5	14ft. Straight Patch	$3.00
TE-258-L5	25ft. Straight Patch	$5.00
TE-508-L5	50 ft. Straight Patch	$8.00
TE-758-L5	75ft. Straight Patch	$14.00
TE-108-L5	100 ft. Straight Patch	$16.00

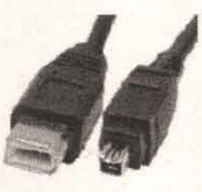
USB CABLES

CC-USB-6	6ft. USB "A"-"A" M/M	$5.00
CC-USB-AB6	6ft. USB "A"-"B" M/M	$5.00
CC-USB-AB10	10ft.USB"A"-"B" M/M	$8.00
CC-USB-AB15	15ft.USB "A"-"B" M/M	$8.00
CC-USB-X6	6ft. USB "A"-"A" M/F	$6.00
CC-USB-X10	10ft. USB "A"-"A" M/F	$6.00

CC-USB-PP $25.00

USB to Parallel Printer

IEEE-1394 FIREWIRE



$5.00

FW-6X4-6	6ft 6pin x 4pin......$5.00
FW-4X4-10	10ft 4pin x 4pin....$12.00

$20.00 min. Order required
Add $4.50 shipping for prepaid orders
Prices subject to change without notice
All major credit cards accepted
Special offers only valid on items in stock
Call for quantity discount
No out of state checks accepted

S-VGA Extensions

male/female black

CC-VGA-4C	6FT	$6.00
CC-VGA-5C	10FT	$8.00
CC-VGA-25CX	25FT	$16.00
CC-VGA-50CX	50FT	$25.00
CC-VGA-100CX	100FT	$44.00

S-VGA Switch Box Cable

male/male black

CC-VGA-3C	6FT	$6.00
CC-VGA-9C	10FT	$8.00
CC-VGA-11C	25FT	$16.00
CC-VGA50MM	50FT	$25.00
CC-VGA100MM	100FT	$44.00

These premium VGA cables are made with 75 ohm coaxial cables. They are triple shielded to support extremely high bandwidth and unsurpassed protection against interference.. Furthermore, our premium cables are Plug-N-Play ready and are compatible with the latest technology.

ADD ON CARDS

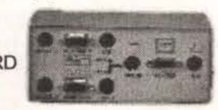
Call for more information on any of these cards!!

CA-PPGA-S1	PPGA Celeron CPU Slot 1 adaptor....$10.00
IO-398	ISA 8bit Single Parallel IEEE Card....$12.00
IO-400	PCI 32bit Single Parallel IEEE Card....$33.75
SD-884	16bit ISA Sound Card ESS Chip....$14.00
USB-PCI	USB x PCI Add on Card....$27.00
VD-466	S-VGA SIS 4MB PCI Video Card....$31.00

Multi-PC Controller

w/keyboard & mouse emulation
Easy to select by push button

HD15-S-VGA
PS/2 KEYBOARD
PS/2 MOUSE



CC-PS2-VGA6 Cable Kit with this Item $12.00

DS-HD2-66EM	2-WAY	$49.00
DS-HD4-66EM	4-WAY	$69.00

USB HUB

4-port USB hub with power & cable
Full compliance w/USB spec. Rev 1.0.
LED indicator for fault or dummy USB port.
Transmission for 5 meter cable segment.
Plug & Play capability for outside peripherals.
Support UHCI and OHCI spec.
One year factory warranty!

$35.00

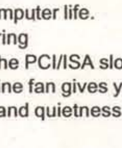
TM-USB-4HUB

Electronic CPU Switch

DS-102-KMMPS

$99.00 kit

Includes:
One MiniView KVM switch
2 Sets of Premium Grade KVM Cables
One PS/2 to AT keyboard adapter
One PS/2 to Serial mouse adapter
One User Guide
Features:
Keyboard & mouse emulation for error
Free PC booting
No external power required
Works virtually with any operating system
Fully hot plugable



SLOT FAN

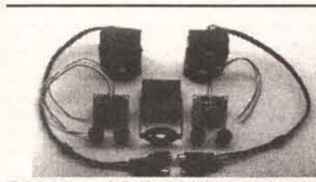
Extends your computer life.
Ball Bearing
Takes up only one of the PCI/ISA slots.
Special designed turbine fan gives you great performance and quietness.

$12.00

TM-FAN-SLOT

**CPU's-Motherboards-HardDrives
Memory -SCSI Adaptors -SCSI Cables
CD burners -CD's & Rewritable CD's
And Much Much More!!!!!**

14" COLOR — high resolution SECURITY MONITOR w/4 channel switcher. High impact enclosure with modern front panel 4 channel video and audio switcher. High quality speaker built-in. Components purchased separately would exceed $500. Winter special. **$349/each**. Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com



COLOR — LOW LIGHT 2 LUX 32mm x 32mm, 350 TVL with optional enclosure. Pinhole and standard lens types available. Price reduction, **$99/ea.** Add $10 for enclosure with swivel mount. Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com

AS-1004 wireless 2.4GHz, FCC approved. 2.4GHz transmitter & receiver with audio! Capable handling total of 4 wireless cameras, range: >300'. Built-in camera, 400 TV line. **$199 per system**. Additional cameras at **$129/each**. Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com

SEE ADMART SECTION, pages 70 and 71 for other MATCO products, including wireless systems.

WEATHER RESISTANT OUTDOOR CAMERAS. WR-700 type, high impact tempered glass with stand. Black & white (430 lines), or color (420+ lines) available. Standard 3.6mm lenses with optional lenses of 6, 8, and 12 mm at $20 extra. **B/W $119/each. Color $179/each**. Small compact size with sun shield. Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com

Write in 46 on Reader Service Card.

SATELLITE EQUIPMENT

BEST PRICING on 18" satellite TV systems for home and RV. DISH Network DirecTV, multi-room viewing options, accessories, more. www.skyvision.com **Call 1-800-543-3025**.

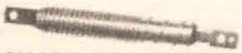
FREE BIG dish catalog. Low prices! Systems, upgrades, parts, and "4DTV." Skyvision, 1010 Frontier Dr., Fergus Falls, MN 56537. www.skyvision.com **Call 1-800-543-3025**.

XMAS SPECIAL for Dec. and Jan. Smartcard programmer $75. High speed unprogrammer $200. Free flyer. Tony 419-385-3100.

THE EASIEST way to recover your lost master code. 16C5X, 16C62X, PALS, GALS, other microcontrollers, custom ASICs. Chip readers and other custom hardware. Check out our web page at www.acdinc.com for details or call 703-764-5361 or write Advanced Circuit Designs, Inc., 5765-F Burke Centre Parkway #317, Burke, VA 22015.

CARL'S ELECTRONICS. Over 200 electronic plans and kits, including the latest in spy and surveillance gadgets. Visit us at www.electronickits.com

CHAPARRAL MONTEREY 95 receiver. Complete with all books, remote $250, plus S/H and 10 ft. dish with new rotor and LNB free if you pick it up. 510-222-4445.



SHAPE-MEMORY ALLOY LINEAR ACTUATOR

One inch-pound actuator made of Tinel.® Applications include robotics, doors, valves, toys, shutters, security devices, manipulators. Operated by temperature or electricity. De-energized length: 100mm. Energized length: 75mm. Self-activating temperature: 165°F. Spec sheets included.

95T001 $7.95 each

12V 3AH GEL CELL BATTERY

2-5/8"W x 5-1/4"L x 2-1/2"H. Orange, on white base. Powersonic PS-1230

20E011 $5.95 each

FAT HI-VOLTAGE CAPS!

Two 820µf 250V radial electrolytics soldered on a PC board with other goodies.

99P001 $4.95

DELUXE KEYCHAIN LASER

High quality laser pointer sports attractive finish. Projects plain beam and four designs up to 1000 feet on three tiny LR44 1.5V watch batteries (included). Weighs in at only 0.6 OZ. 645nm 5mW, class IIIA.

98L008 $9.95 each

ATARI 1020 COLOR PRINTER

For all Atari 8-bit computers. (Not PC-compatible!) Package includes: printer, power supply, software, pens, paper and interface cable. These are new units in factory sealed boxes.

94C037 $14.95 each

CCD COLOR ULTRA MINIATURE CAMERA

Ultra compact mini camera with 420 lines of resolution, 3.6mm, 0.5 Lux minimum illumination, 9-12VDC, 100mA. Metal housing with mounting bracket and power cord. 115VAC power supply included.

99V005 $219.95

HIGH VOLTAGE PULSE CAPACITOR

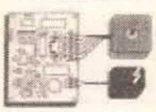
Maxwell #37667. Rated 0.03µF, 35KV ±10%. Size 2¼" x 4¼" x 6".

20P005 $195.00 each

RESISTOR RIOT

1/8, 1/4, 1/2 Watt, power, precision, fixed, adjustable, etc. Thousands of pieces.

20P003 5 Lbs. for $9.95



STEPPER MOTOR DRIVER KIT

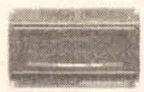
Drives unipolar motors from 5V to 30V. Controls speed, direction and step size. Four speed ranges plus single step. Logic output.

97K004 $39.00 each

TV AUDIO DEMODULATOR

Originally used in cable TV application, this subassembly takes channel 3, 4 or 5 signal and demodulates the audio. Comes with documentation and schematics, plus additional schematics to build add-on video demodulator board.

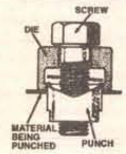
92A028 $9.95 each



LCD DISPLAY

Four lines by 20 characters. Back light attached. Standard 14-pin connection. Optrex #PWB2011. Spec sheet is at our website.

94L010 $14.95 each



RADIO CHASSIS PUNCH

Greenlee #730 - 9/16".

97Z018 $9.95 each

"FULL MOTION" VIDEO CARD

PCI VGA display card, 1MB, expandable to 2MB, with software and instructions. Trident TGUI9440., new in factory box.

20C005 $9.95 each

70 MHz DUAL I.F. BOARD

- Two independent 70MHz IF strips on one board. ±12V regulators for each strip.
- Three demodulator sections per strip with 5 IF transformers, balanced mixers (MCL #SBL-1), two MC1496 ICs, 5MHz crystal filter.
- 65MHz crystal.
- FM audio section with two LM3089 FM-IF IC and 10MHz crystal per strip.
- Lots of op amps (7 per strip), plus resistors, caps, inductors, transistors, sixteen 25-turn trimpots. All on 7" x 17" ground plane PC board with shield.

98G002 $24.95 each

IDE CARDS

Creative Labs #CT1870. Dealer inquiries invited.

98C007 Box of 20 $19.95

CERAMIC HI-VOLTAGE XMITTING CAP

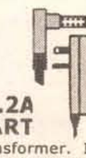
400pF @ 30KV, TC N4700. Made by TDK.

20P007 $12.50

HIGH POWER RECTIFIER STACK

Six 6500V, 350A hockey puck thyristors in series. Each thyristor has trigger network, 400pF 30KV bypass cap, and two 500K-Ohm equalizing resistors. Water cooled. (That's 39KV x 350A= 13.65MW!) Thyristors are ABB part number #5STP0365D0002, list price $288 each. Overall size 4" x 5¼" x 15".

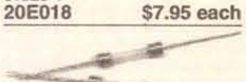
20S002 $250.00



13VDC 1.2A WALLWART

Class 2 transformer. Input: 120VAC 60Hz 25.5W through 3-prong grounded plug. Output: 13VDC @ 1.2A, 2.5mm x 5.5mm coax connector, center negative. Ivory, 3.25" x 2.5" x 3.125".

20E018 $7.95 each



PIGTAIL FUSE

0.25A, 3AG pigtail.

95P007 100 for $9.95

UNIPOLAR STEPPER MOTOR DRIVER IC

UCN5804. Drives a unipolar stepper in one of three operating modes: single phase, two phase or half step. Up to 1.25 Amps per phase. Step and direction input. Drive with a 555 timer, parallel port, etc. Build your own robot, anything that requires precision positioning.

93I002 $4.50 each

NIPPON PULSE MOTOR

7.5 deg./step, 48 s/rev, 5 V, stepper with brass gear mounted on shaft. NPM P/N PF42-48ES. With spec sheet.

92M010 $3.95 each

SPECIAL PACKAGE!

One 93I002 IC and 92M010 motor (both shown above) with schematics.

93I003 $7.95/set

ALLTRONICS

2300-D Zanker Road - San Jose, CA 95131-1114

(408) 943-9773 - Fax (408) 943-9776

Download our New Catalog: http://www.alltronics.com

Store Hours: 9-6 M-F & 10-3 Sat. - Pacific
Minimum Order - $15.00
Visa, M/C, AmEx Accepted. All Sales Final.
California Residents Add Sales Tax.
Shipping Additional on All Orders
Prices Subject to Change Without Notice.
Prices Good 60 Days from Date of Publication

011200

WANTED: MILITARY capacitors, resistors, transistors, diodes, ICs, semi's, etc. Please fax/E-Mail excess lists & RFQs 818-769-1002 fax 818-769-1084. electmatind@earthlink.net & http://www.militarycomponents.com

MILITARY SURPLUS ELECTRONICS

WANTED: MILITARY capacitors, resistors, transistors, diodes, ICs, semi's, etc. Please fax/E-Mail excess lists & RFQs 818-769-1002 fax 818-769-1084. electmatind@earthlink.net & http://www.militarycomponents.com

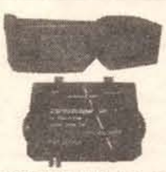
DOSIMETERS/RADIATION DETECTING KITS. New Canadian military surplus, now illegal to import due to recent change in Arms Control laws. Ten dosimeters, two chargers, two radiation meters w/carrying cases. Single D cell powers chargers and meters. Survival, nuclear war, nuclear power plants. $125 shipped US. Credit cards, checks. Dealers/quantities welcome. Steve 410-879-4035 or Steve@swssec.com

AUDIO — VIDEO — LASERS

FREE LASER CATALOG. Helium-Neon, Argon, ruby, visible laser diode modules, lightshows, holography, laser pointers. Lowest prices. Midwest Laser Products, PO Box 262, Frankfort, IL 60423. 815-464-0085 **www.midwest-laser.com**

ANTIQUE VIDEO TRANSFER SERVICE: transfer any 2" QUADRUPLEX tape. Affordable fast! Phone/fax 415-821-7500 or 415-821-3359. 5001 Diamond Heights Blvd., San Francisco, CA 94131-1621.

SYNC-A-LINK UNIVERSAL video sync generators. Phone 918-479-6451, Email: rlc@sstelco.com **Sync-A-Link**, PO Box 4, Locust Grove, OK 74352.



STEREOSCOPER VR is a stereo multiplexer that creates 3D stereoscopic video from two genlock cameras. Stereoscoper VR comes with LCS glasses and driver. 90 day warranty $247 or write to **Sync-A-Link**, PO Box 4, Locust Grove, OK 74352. Phone 918-479-6451, Email: rlc@sstelco.com

PC MONITOR AS SECURITY MONITOR. The VGA-801 accepts standard NTSC or PAL inputs for display on any existing VGA/SVGA computer monitor. Small compact size. Over 600 lines of resolution, twice that of standard TV monitor! **$69 each**. Dealers welcome. Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com

BARCODE LASER scanner $20. 3MW HeNe laser $25. HeNe new in box $20. P&H $4. Christensen, 9257 3rd St. NE, Blaine, MN 55434.

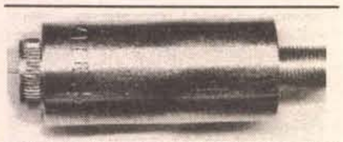
Write in 49 on Reader Service Card.

WANTED: PRO video equipment, VCRs, switchers, cameras, etc. Advanced Media 702-874-1911.

WANTED: EQUIPMENT made by HDS, Nagra, Aid, Photoelesis, Stellavox, old microphones, military radios, motion picture equipment, and broadcast video stuff. Call Jon 1-800-539-2859.

CABLE TV

NEW! CABLE converter electronic service equipment and supplies for most cable converter boxes. Highest service, lowest prices. Call Ken Erny Electronics. 24 hr. order and information hot line 516-389-3536.



NOTCH FILTERS 110, 108.5, 106.5, 97.5 75dB deep notch. $19.95 ea., 1-5 qty. $15.95 ea., 6-10 qty. $11.95 ea., 11-20 qty. $9.95 ea., 21 or more qty. Call 24 hr. order and information hot line 516-389-3536.

CABLE CONVERTERS. Original equipment with remote. Like new. Lowest prices. Guaranteed, ready to go. Limited models. Call for flyer 412-833-0773.

TOCOM UNMODIFIED 5503 cable converters, untouched, $6 ea. 10 lot min. Call 706-657-4445.

BRAND NEW basic converters, 550MHz w/remote, $9.95 ea. 10 lot min. Call 706-657-4445.

SA UNMODIFIED cable converters. 8550 @ $9.95 ea., 8570 @ $19.95 ea. 10 lot min. Call 706-657-4445.

NEW IN BOX 860MHz analog converters. Enjoy the newest technology CATV equipment can offer along with superior quality all in one unit. Channel ouput 3 or 4. HRC, IRC, standard switchable. Includes 1 set of audio/video cables, 1 RF quick connect cable and remote control. Parental control, sleep timer, last channel recall, memory 1 thru 4, and volume control are all available on remote. Minimum order taken for 10 pcs. at $59.95 each. $49.95 for 50 pc. order. Significant savings on larger quantities. Call 706-657-4445.

DISCOUNT CABLE converters, bullet snoopers, all makes and models: Genuine unmodified General Instrument, Jerrold, Tocom, Scientific Atlanta, Zenith, Pioneer, Panasonic and more. Best warranty. Free catalog 1-800-243-0962.

UNMODIFIED CABLE converters. SA 8590, $24.95 ea. 10 lot min. Call 706-657-4445.

CABLE PARTS! Computer parts. Call for great prices or visit us on the Web: HTTP://WWW.CB-Electronics.com or call 1-800-436-8630.

UNMODIFIED ORIGINAL equipment. Jerrold, SA, 125 channel converters. Lowest prices guaranteed. Dealers only. SA 8580 as low as $35. Call now 214-476-7177.

POSITIVE NOTCH FILTERS. All channels available. Starting at $16 each. Order by single channel #. Top quality non-tunable metal cylinder type. 75dB deep on the notch. Need to block the video on a cable channel? Order a negative notch filter. We carry a large stock on all channels for dealers and vendors. VISA, MASTERCARD, DISCOVER, and UPS COD for established customers. Quantity pricing on 5 or more. 100 pcs. $7 each. Open 8am to 5pm CST, Monday-Friday. All sales must comply with FCC 1996 Cable Act. On the web go to **WWW.GOFILTERS.COM "THE FILTER COMPANY."** Call for all orders **1-800-235-8080.**

THE EASIEST way to recover your lost master code. 16C5X, 16C62X, PALS, GALS, other microcontrollers, custom ASICs. Chip readers and other custom hardware. Check out our web page at www.acdinc.com for details or call 703-764-5361 or write Advanced Circuit Designs, Inc., 5765-F Burke Centre Parkway #317, Burke, VA 22015.

DREAMCAST MOD chips, 4 wire model, $14 each. Also Playstation one mod chips. Auto Dino mode program. Works with all models up to 900X. Seven wire hook up, $5 each. Playstation two mod chips. New 2 in 1 program $30 each. 10% discount for 10 or more, mix and match kits. Kits come with complete color instructions, but do not come with wires. Call 703-764-5118 to place an order. Orders shipped via US mail 2 day COD.

WHOLESALE CABLE TV box & accessories. Brand new unmodified Jerrold, Scientific Atlanta, Pioneer, etc. Please call 1-888-561-4796 10-6pm.

CABLE PARTS for all makes and models, raw boxes at low prices. Call 1-888-817-8100 www.chipplace.com

VIEWMASTER 4000 converter, 860MHz, 125 channels, volume control, STD/HRC/IRC. Brand new 10 lot $49. Call for other accessories and qty. discounts. 877-885-8873.

1-800-380-9530. SUPPLYING all your cable needs. Wholesale pricing on raw unmodified converters. This month's special Pioneer BA6110. Plus other models & manufacturers. Call for pricing.

CABLE CONVERTERS Samsung volume style 125 ch. $64. Price matching. More video accessories. 604-729-8917. http://www.blackboxes.xoasis.com

ZENITH UNMODIFIED converters. ST 1600, $29.95 ea. 10 lot min. Call 706-657-4445.

UNMODIFIED CATV converters. Original equipment & 125 ch. converters. Repairs and upgrade. Low price guaranteed. Call 1-888-959-5589.

QUAD VIDEO CABLE MODULATOR. CVS-600 inserts 4 color or black & white composite video signals on unused cable channels, 81 thru 95. Watch 4 remote security cameras from any TV in your home! Built-in signal amplifier and comb filter eliminates any ghosting and actually **IMPROVES** existing video! Only one unit needed with existing cable system. $199/each and **$169/each** in qty. of 4. Matco, Inc., Schaumburg, IL, 1-800-719-9605, sales@matco.com or visit/order on-line at www.matco.com

CABLE BROKER'S is having their final blowout of our warehouse. The following unmodified equipment is available to other brokers and cable companies in 100 lots: Zenth ST1600 550MHz $25 some dual cable input. VIP $12. Pioneer 6310 $40. 6111 $25. V5S8 $45. SA 8570 $28, 8600 $40. You must prepay shipping on all orders $175. Se hablan espanol. Call 1-800-219-8618.

CATV CONVERTERS WHOLESALE ONLY. Coolbxs 125V, Milleniums 3, Panasonics 175D, Boss, Avenger 2, Elite. **For best dealer pricing**, call: 702-860-7991.

WANTED MMDS — wireless cable TV receiving antennas. 505-525-0028.

READ THIS! We have 50 brand new touch screen remotes for only $49.95 each! Guaranteed to control any TV, VCR, cable, sat, stereo. etc. Controls 8 devices! Wow! Perfect for home theater! Fantastic gift! Mahone, 1637 W. Touhy, Chicago, IL 60626. Order now!

1-800-322-5286. SUPPLYING all your cable needs. Specializing in raw unmodified converters. Always large quantities in stock ready to ship.

TELEPHONE/FAX

BIZFON.COM PHONE system that is truly plug & play. Auto attendant and voice mail built in. Best deals at 732-840-1390 or hes@heselectronics.com

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

COMPONENTS

WANTED: MILITARY capacitors, resistors, transistors, diodes, ICs, semi's, etc. Please fax/E-Mail excess lists & RFQs 818-769-1002 fax 818-769-1084. electmatind@earthlink.net & http://www.militarycomponents.com

WANT TO Buy: ICs, military & aircraft relays, diodes, transistors, connectors, tantalum capacitors, electronic test equipment & most components. Hoffy Electronic Ent., E-Mail: Hoffie1165@aol.com 818-718-1165, FAX 818-341-5506.

CASH PAID FOR ICs. Military or commercial integrated circuits, transistors, diodes, any semiconductors. **ELECTRONIC SURPLUS, INC.**, 5363 Broadway, Cleveland, OH 44127. 216-441-8500 or fax 216-441-8503, since 1946. www.electronicsurplus.com

RF TRANSISTORS, TUBES, TEFLON WIRE, SILVER MICA CAPS. 2SC2290, 2SC2879, SD1446, MRF455, MRF454, 2SC1969, 2SC2166, 2SB754, TA7222AP, 2SC1947, TA7222AP, MRF247, MRF317, SAV7, etc., 3-500ZG $102 Procom, 4CX250B, 572B, 3CX400A7/8874, 3CX3000A7, 4CX400A, teflon wire specials 1,000 ft. 16 gauge .15 cents ft., 1,200 ft. 18 gauge .14 cents ft., silver mica caps, resistors, see our catalog for other products. Westgate 1-800-213-4563.

UV LEDs, new, have only 5 narrow beam and 5 wide beam, $30 ea. Bill 612-980-6503 or deltalight77@hotmail.com

SEE OUR ad on 4-channel 2.4GHz wireless systems in the AdMart section on page 70. Matco, Inc.

MATCO WILL design, engineer, and develop a 2.4GHz wireless 8 channel solution for your remote applications. FCC approved. Matco, Inc., Schaumburg, IL 1-800-719-9605. E-Mail: nsales@mat-co.com Web site www.mat-co.com

LCD MODULE w/on-board T6963C controller. 240x64 graphic reflective. Data International M/N DG-24064-09-S2-R. Same as DG-24064-02 and DMF-5005N except size is 153x57x9.5, dot is 0.41. Details at www.datainternational.com New $15 ea.; $12 ea./100; $9 ea./1,000. 630-879-6166 or dewell@inil.com

When Visiting Disney World And Sea World . . .
Come To The World Of Electronic Surplus!

SKYCRAFT

PARTS & SURPLUS, INC.
ORLANDO, FLORIDA

Located At The Intersection Of I-4 And Fairbanks Avenue.

Self-Service Retail Outlet Featuring Commercial And Government Electronic Surplus Including:

- ★ WIRE
- ★ SWITCHES
- ★ RESISTORS
- ★ TRANSISTORS
- ★ TRANSFORMERS
- ★ TEST EQUIPMENT
- ★ NI-CAD BATTERIES
- ★ COAX
- ★ RELAYS
- ★ HARDWARE
- ★ CAPACITORS
- ★ PANEL METERS
- ★ CIRCUIT BOARDS
- ★ INTEGRATED CIRCUITS

★ ★ ★ ★ ★ ★ ★ ★ ★

We Buy Surplus Electronic Parts —
FAX your list.
www.skycraftsurplus.com

FAX 407/647-4831
PH 407/628-5634
P.O. BOX 536186
ORLANDO, FLA. 32853-6186

HOURS:
Monday - Friday 8:30-6:00
Saturday 8:30-5:00

ACP'S 101st GIANT COMPUTER SWAP★MEET

All Day Sunday 8am-2pm
Jan 28th

Be a Seller ...for your space Call Julie

FREE Admission & Parking
Shop 100's of Sellers

in ACP's Giant Parking Lot !!!

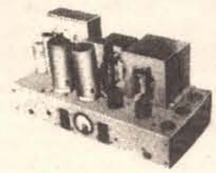
Advanced Computer Products, Inc.

ACP SUPER★STORE
Since 1976

1310 E. Edinger
Santa Ana, CA
714-558-8813
www.acpsuperstore.com

ANTIQUE ELECTRONICS

WANTED: FOR historical museum, pre-1980 microcomputers, magazines, and sales literature. Floyd, VA 24091-0341 (540-763-3311/540-382-2935).



ALWAYS WANTED Western Electric theatre amps, speakers, horns, drivers, and tubes. Also seeking vintage tube equip. by Marantz, McIntosh, and Tannoy. Chong Ong, 10223 Valentino Dr., #7304, Oakton, VA 22124. Tel: 703-255-3218, Fax: 703-255-3718. E-Mail: ongkt88@erols.com

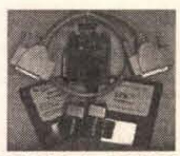
WANTED: MILITARY capacitors, resistors, transistors, diodes, ICs, semi's, etc. Please fax/E-Mail excess lists & RFQs 818-769-1002 fax 818-769-1084. electmatind@earthlink.net & http://www.militarycomponents.com

AVIATION ELECTRONICS

WANTED: MILITARY capacitors, resistors, transistors, diodes, ICs, semi's, etc. Please fax/E-Mail excess lists & RFQs 818-769-1002 fax 818-769-1084. electmatind@earthlink.net & http://www.militarycomponents.com

MICROCONTROLLERS

PIC & ATMEL PROGRAMMERS from $15.95 and $29.95! Visit www.electronics123.com for complete details. Amazon Electronics, Inc. Toll free 1-888-549-3749.



PROGRAM PICs in BASIC. Complete package to get started includes: PicBasic compiler, EPIC programmer, cable, batteries, PIC16F84. $159.95. **www.elproducts.com**

CARL'S ELECTRONICS. Over 200 electronic plans and kits, including the latest in spy and surveillance gadgets. Visit us at www.electronickits.com

WANTED: MILITARY capacitors, resistors, transistors, diodes, ICs, semi's, etc. Please fax/E-Mail excess lists & RFQs 818-769-1002 fax 818-769-1084. electmatind@earthlink.net & http://www.militarycomponents.com

ATMEL 89CXXXX programmer, IBM parallel port, C++ source code, schematics, $250 + S/H. http://members.aol.com/HawaiianComputer

Sell Nuts & Volts in your store!
Contact us for complete details.
phone 909-371-8497
fax 909-371-3052
E-Mail distributors@nutsvolts.com

Test Equipment Connection
Corporation

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

WE BUY TEST EQUIPMENT

RENT **REPAIR** **TRADE** **SELL**

CALL: 800.615.8378 **FAX: 800.819.8378**
WWW.TestEquipmentConnection.COM
Specialist in Hewlett-Packard, Tektronix, and many more manufacturers.

PUBLICATIONS

WANTED: MILITARY capacitors, resistors, transistors, diodes, ICs, semi's, etc. Please fax/E-Mail excess lists & RFQs 818-769-1002 fax 818-769-1084. electmatind@earthlink.net & http://www.militarycomponents.com

BASIC STAMP 2 users: "Inside the BASIC Stamp II" tells how the PBASIC interpreter works, how code is stored in EEPROM, how to optimize code for space and speed. 160 pages, 50 illustrations, many examples. See http://members.aol.com/stamp2book Send $29.95 check or money order (US funds) to Brian Forbes, PMB 326, 19672 Stevens Creek Boulevard, Cupertino, CA 95014-2465.

NEW SURVIVAL COMMUNICATIONS BOOK. How to build complete home communications systems. Covers all needs: shortwave radio, amateur radio, citizens band, scanners, federal, weather, alternate news, satellite radio, equipment sources. How to build and use alternate emergency power sources, solar, generators, backup batteries. 200 pages. $24 Fast delivery Priority Mail. MC or Visa. Call Universal Electronics 1-800-241-8171.

HI-TECH SURVIVAL: 150+ books, software, special projects: electronics, computers, internet, phones, security. **CONSUMERTRONICS**, PO Box 23097, Albuquerque, NM 87192, 505-321-1034. **www.tsc-global.com**

BIG PROFITS — Rent antenna sites to paging, cellular, & PCS providers. Over 100K sites needed. **Book** shows you how to build, market, & operate an **antenna site.** 325 pages. $25pp. MC/Visa. http://Antennasites@hypermart.net or 1-877-877-0040.

Write in 52 on Reader Service Card.

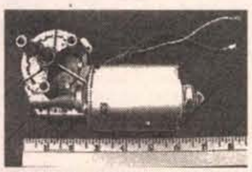
ROBOTICS

ROBOT BOOKS.COM visit our web site for reviews of robotics books, plus robot kits, toys, movies, and magazines! www.robotbooks.com

ROBOTS WANTED: Dead or alive, whole or parts. Marvin (Iowa Precision), Gemini, RoPet, Hubot, RB5X, Newton SynPet, ComroTot, ELAMI, ITSABOX, HeathKit (HERO JR, 1, 2000, or Arm Trainer), Androbots (TOPO, BOB, Fred, and Androman), Rhino, Maxx Steele, Omnibots, etc. Also looking for robot prototypes, options, and literature, will pay cash. Please E-Mail rdoerr@bizserve.com Call 810-777-1313 or write to: Robert Doerr, 26308 Cubberness, St. Clair Shores, MI 48081.

ARobot KIT from Arrick Robotics uses the BASIC Stamp II. Quality metal construction. Easy to assemble and very expandable. $235. http://www.robotics.com/arobot

MOTOR CONTROLLERS, PWM, 12V, 24V, 35A, many features from $40 plus S&H. Info: 570-735-5053. Details: http://divelec.tripod.com Toll free orders (only) 1-877-679-1865.



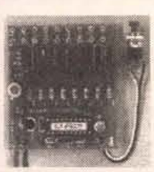
GEARHEAD MOTORS. 24V, 35 RPM. Manufacturer rated 900 pounds. $10 plus S&H. Info: 570-735-5053 Details: http://divelec.tripod.com Toll free orders (only) 1-877-679-1865.

CARL'S ELECTRONICS. Over 200 electronic plans and kits, including the latest in spy and surveillance gadgets. Visit us at www.electronickits.com

THE FIRST adaptable bot base for large scale experiments! BOB, the platform from Tekwild Robotics is versatile and extremely powerful. Visit our website for complete specs! $379. 512-444-8611. www.tekwild.com

PLANS — KITS — SCHEMATICS

200+ ELECTRONIC PROJECTS. Secure WEB ordering @ www.matcopublishing.com/plans1.htm or send $1 (refundable) for catalog. MATCO-5A, POB 509, Roseville, MI 48066-0509.



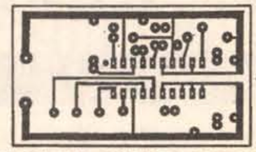
RUNNING LIGHTS KIT. Ideal for Christmas decorations etc. 8 LEDs switch on in 10 push button selectable patterns. 8 speed levels for a total of 80 combinations. Includes PCB, parts and instructions. $15.95 + $4.95 shipping. Can operate light bulbs with 8x TRIACs ($6 extra). Amazon Electronics, tel 1-888-549-3749. Lots of other products. www.electronics123.com

TEST EQUIPMENT kits. If you liked Heathkit, you will love Technology Systems, 4 Prospect Pl., Torrington, CT 06790.

FPGA PROTOTYPING kits: Lowest cost, easiest to use. Altera, Atmel. Xilinx kit now with 200,000 gates (!) and free design software! www.BurchED.com.au

ELECTRONIC KITS. Amplifier, internet broadcaster, fiber optic, transmitters, radio, security, voice changer. Check our website for monthly specials. Call J-Tron 1-888-595-8766, www.j-tron.com

CARL'S ELECTRONICS. Over 200 electronic plans and kits, including the latest in spy and surveillance gadgets. Visit us at www.electronickits.com



MAKE YOUR OWN PCB IRON-ON TRANSFERS for pennies apiece using a standard copy machine and materials available at **ANY** office supply store. Just iron and etch. For complete details on this proven method **PLUS** step-by-step instructions on making your own PCBs, send $5 cash, check, or money order to Cale Industries, PO Box 550, Calhoun, GA 30703-0550. US orders only.

MANUALS — SCHEMATICS WANTED

WANTED: FOR Tektronix 3002 logic analyzer, manuals or copies for 32GPX and 30DSM modules, and software for mainframe and modules, especially boot floppy. Chuck Forge, 201 Fremont Ave., Los Altos, CA 94024; 650-941-3084.

Online Bookstore Now Open at www.nutsvolts.com
Subscriber Discounts

Tired of Expensive Inkjet Cartridges ?

Save 90% on Inkjet Inks !

Printer (Call for Others Not Listed!)	# of Refills		Cost/Refill		Kit Price	
	Black	Color	Black	Color	Black	Color
HP 500 Series, 400, Officejet 300, 350, Fax	7	14	**4.71**	**2.85**	32.95	39.95
HP 600 Series, Officejet 500, 570, 600	7	14	**4.71**	**3.21**	32.95	44.95
HP 820C, 855C, 870C, 1000C, 1150C, Copier 120, 210	6	12	**6.67**	**3.33**	39.95	39.95
HP 720C, 722C, 712C, 880C, 890C, 895C 1120C, 1170C	6	12	**6.67**	**3.75**	39.95	44.95
Canon BJ-10, 200, 210, 240, 250 Apple SWriter 1200, 1500	14	20	**2.15**	**2.00**	29.95	39.95
Canon BJC-4000 Series, C2500, C3000, C3500, C5000	60	60	**0.50**	**0.67**	29.95	39.95
Canon BJC-6000	**14**	**8**	**2.85**	**1.67**	**39.95**	**39.95**
Canon BJC-600, 610, 620 Apple SWriter Pro	20	13	**1.50**	**3.07**	29.95	39.95
Epson Stylus Color, Color Pro, Pro XL	12	12	**2.50**	**3.33**	29.95	39.95
Epson Stylus Color II, IIs, 1500 (Black)	15	15	**2.00**	**2.66**	29.95	39.95
Epson Stylus Color 500, 200	20	17	**1.50**	**2.35**	29.95	39.95
Epson Stylus Color 400, 600, 800, 850, Photo / 440, 640	20	17	**1.50**	**2.65**	29.95	44.95
Lexmark JP 1000, 1020, 1100, ExecJet II, IIc, Medley 4C	10	17	**3.00**	**2.35**	29.95	39.95
Lexmark JetPrinter 3200, 5700, 5000, Z11, Z31	15	17	**2.67**	**2.35**	39.95	39.95
Compaq IJ700, IJ900, Xerox XJ8C, XJ9C	15	17	**2.67**	**2.35**	39.95	39.95
Xerox Home Center 450C, XJ6C Inkjet	22	12	**1.36**	**3.33**	29.95	39.95

SAVE 30 - 50% on New Compatible Cartridges
New *Quantity* Cartridge Pricing!

Printer	BLACK Cartridge	COLOR Cartridge
(CALL FOR OTHERS NOT LISTED !!)	Qty 1 / 3 / 6+	Qty 1 / 3 / 6+
Canon BJC-4000/5000/2000 Series, C2500, C3000	$4.95 / 4.21 / 4.06	$11.95 / 10.16 / 9.80
C3500, C5000, C5500 Apple StyleWriter 2400, 2500	$4.95 / 4.21 / 4.06	$11.95 / 10.16 / 9.80
Canon BJC-600, 610, 620 Apple StyleWriter Pro (9cc)	$4.50 / 3.83 / 3.69	$4.50 / 3.83 / 3.69
Hi-Capacity Canon BJC-600, 610, 620 (15cc Blk/12cc clr)	$4.95 / 4.21 / 4.06	$4.95 / 4.21 / 4.06
Canon BJC-70, BJC-80 (3 pack Black / 3 pack Color)	$9.95 / 8.46 / 8.16	$14.95 / 12.71 / 12.26
Epson Stylus Color, Color Pro, Pro XL	$10.50 / 8.93 / 8.61	$14.95 / 12.71 / 12.26
Epson Stylus Color II, IIs, 200	$10.95 / 9.31 / 8.98	$14.95 / 12.71 / 12.26
Epson Stylus Color 400, 500, 600, 800, 850, 1520, Photo	$10.95 / 9.31 / 8.98	$14.95 / 12.71 / 12.26
Epson Stylus Color 440, 640, 660, 670, 740, 760, 860, 1160	$10.95 / 9.31 / 8.98	$14.95 / 12.71 / 12.26
Epson Stylus Color Photo 750, 900, 1200	$10.95 / 9.31 / 8.98	$15.95 / 13.56 / 13.08

- **BULK Inks, Refill Accessories**
- **Glossy card stock & Coated Paper**
- **2 - 3 Day Shipping**

Inkjet Southwest

VISA

Quality Inks for:
HP • Epson • Lexmark
Canon • Apple • DEC
Call or see us online!
Monday - Friday
7:30 - 4:30 PST 10:30 - 7:30 EST

www.inkjetsw.com **1-800-447-3469**
(480) 668-1069 Fax **(480) 668-0959**

Write in 53 on Reader Service Card.

Do You Repair Electronics?

For only $7.95 a month, you'll receive a wealth of information:

Repair data for TV, VCR, monitor, audio, camcorder, & more.

Over 100,000 constantly updated problem/solutions plus...

- TechsChat live chat room.
- UL/FCC number lookup.
- Private user discussion forums.
- Hot tips bulletin board.
- Automated email list server.
- Manufacturer information.

To access RepairWorld, direct your internet browser to http://www.repairworld.com

RepairWorld.com

Electronix Corp. 1 Herald Sq. Fairborn, OH 45324 (937) 878-9878

Write in 54 on Reader Service Card.

SURVEILLANCE

Room Transmitters. . . . . from **$30.00**
Telephone Transmitters . from **$29.00**
UHF Pen Transmitters. **$299.00**
Crystal-Controlled
Transmitters. . . . . from **$75.00**
UHF Telephone Transmitter
& Receiver & Recorder . . . **$299.00**

Catalogues **$5.00**

And much more – too much to list here!

www.confidentialcommunications.com

MISCELLANEOUS ELECTRONICS FOR SALE

HARD-TO-find parts: big screen screens, keypads, picture tubes, flybacks, tuners, CRT sockets, & modules for all TVs. 478-272-6561. Scarborough TV, 1422 Old River Road, East Dublin, GA 31027.

SOLAR-POWERED FAN HAT. Baseball type hat with solar powered fan. Great for sports fans, golfers, etc. Available in red or blue. $19 plus $2.00 shipping. CA residents add 7.75% sales tax. Visa/MC/Disc/Amex OK. H.T. Orr Computer Supplies, 249 Juanita Way, Placentia, CA 92670. 714-528-9822, 1-800-377-2023, FAX 714-993-6216.

HIGH QUALITY TOOLS AND STAINLESS STEEL HARDWARE. European and American screwdrivers, nutdrivers, pliers, hexkeys, balldrivers, and more! Wiha, Bondhus, and Knipex. Stainless cap screws, machine screws, nuts, washers, U-bolts, and eyes. Free catalog. Robert Mink Import-Export, Box 6437V, Fair Haven, NJ 07704. Telephone or fax 732-758-8388. E-Mail: w2tv@compuserve.com

FREE FLYER on DBS, cable TV, phones, credit cards, schematics, health items. Bill 1-800-879-9657.

NUCLEAR ELECTRONICS (NIM, CAMAC), PMTs, optics, high vacuum, and high voltage components and equipment. Guaranteed quality at reasonable cost. OE Technologies, Box 703, La Madera, NM 87539. Ph: 505-583-2482, Fax: 505-583-9190, E-Mail: oetech@newmexico.com http://www.oetech.com

ANAHEIM WIRE PRODUCTS. DISTRIBUTOR OF ELECTRICAL WIRE AND CABLE since 1973. Items available from our stock: Hook up wire, Automotive primary wire, GXL, SXL, Plenum cable, Teflon wire, Multi-conductor cable, Irradiated PVC, SO-CORD, Mil-Spec wire, Building wire, Welding cable, Battery cable, Telephone wire, Shrink tubing, Cable ties, Connectors. Wire cut & strip to specs. If interested, please call **1-800-626-7540**, FAX: 714-563-8309. Visa/MC/Amex. SEE US ON THE INTERNET: http://www.anaheimwire.com OR E-Mail: info@anaheimwire.com

SAVE 15% ON EXTENSION CORDS. SPECIAL PRICING — WHILE SUPPLIES LAST. 12/3, 14/3, AND 16/3 power cords w/male and female ends. Various colors in lengths of 25 ft., 50 ft., and 100 ft. Please call for details. ANAHEIM WIRE PRODUCTS, 1-800-626-7540, or FAX 714-563-8309.

MISCELLANEOUS ELECTRONICS WANTED

DEC EQUIPMENT WANTED!!! We are buying DEC systems, boards, terminals, drives and peripherals. Also Scientific Micro Systems (SMS), DSD, Datability, Dilog, other DEC compatibles, and Computer Output Microfilm (COM) units. Please call for a quote or fax us your equipment list. We buy, sell, and trade. **KEYWAYS, INC.**, 937-847-2300 OR fax 937-847-2350.

WANTED: MILITARY capacitors, resistors, transistors, diodes, ICs, semi's, etc. Please fax/E-Mail excess lists & RFQs 818-769-1002 fax 818-769-1084. electmatind@earthlink.net & http://www.militarycomponents.com

WANTED: BALANCING machines & vibration analyzing equipment manufactured by the following: Spectral Dynamics, Hofmann, Bentley Nevada, Schenck, IRD Mechanalysis, Gishott. Contact Mike Park at E.T. Balancing, 12823 Athens Way, Los Angeles, CA 90061. 310-538-9738. FAX: 310-538-8273.

CASH PAID FOR ICs. Military or commercial integrated circuits, transistors, diodes, any semiconductors. **ELECTRONIC SURPLUS, INC.**, 5363 Broadway, Cleveland, OH 44127. 216-441-8500 or fax 216-441-8503, since 1946. www.electronicsurplus.com

TUBES: BUY, sell. SASE for list AD. Selling sockets, saveirs, amphenol, Cinch-Jones plugs, sockets, HV ceramics. Wanted: 9-pin mini plug, phenolic, like bottom end of a 12AT7 tube. Any quantity. Typetronics, Box 8873, Ft. Lauderdale, FL 33310-8873. 954-583-1340, FAX 954-583-0777. Fred Schmidt N4TT.

WANTED: TUBES, radios, transmitters, receivers, gyros, bearings, connectors, relays, lamps, synchros. Hyness Company, 709B Delair Road, Monroe Twp., NJ 08831. Phone: 609-395-1116, FAX 609-395-1117.

WANTED: X-BAND radar equipment. Military, civilian, working or not, parts, TMs, etc. Box 10215, Pittsburgh, PA 15232.

WANTED: WESTERN Electric, RCA, Mcintosh, Marantz, JBL, EV, Altec, tubes, amplifiers, speakers, etc. Maury 713-728-4343, fax 713-723-1301.

BBS & ONLINE SERVICES

WANTED: MILITARY capacitors, resistors, transistors, diodes, ICs, semi's, etc. Please fax/E-Mail excess lists & RFQs 818-769-1002 fax 818-769-1084. electmatind@earthlink.net & http://www.militarycomponents.com

EDUCATION

MAGICIAN IS available to solve your RF problem. I will teach you in my laboratory how to do it. Young engineers and technicians are welcome. SMT prototyping up to 3GHz for customers. Minaret Radio, John Horvath ph: 909-943-3676.

BUSINESS OPPORTUNITIES

EXPERT WANTED to design unusual computer for web access. 626-350-1302.

FASTER THAN MOTOROLA

Two-way radio jamming equipment 800/900MHz. Stop illegal surveillance. **Pager jammers 900MHz.** Stop pagers from going off during school or church service. **Cellular phone jammers.** Stop cellulars from going off during school or church service. **PCS jamming, PCS phones. Lojack**/teletrack/boomerang. Stop illegal tracing/anti-surveillance. Cordless phone jammers 49MHz/900MHz • Radar jammers Xband • Nextel jammers • Car alarm jammer • CB radio jammer • Garage door jammer • RC radio jammers • AM/FM radio • HF/VHF/UHF radios • 1/8000MHz jamming equipment.

This equipment is designed for anti-surveillance customers: embassies, schools, churches, governments, law enforcement.

IF YOU DON'T SEE WHAT YOU WANT, WE WILL BUILD IT FOR YOU!!

We sell only to specific organizations or for export. Anyone implying illegal activity will be denied assistance and will be reported to law enforcement.

Jam RF • 954-561-8128 or www.jamrf.com

HUDSON ELECTRONICS

CABLE BOXES!

RETAIL SALES WELCOME!

Guaranteed Lowest Prices

GENERAL INSTRUMENT • SCIENTIFIC ATLANTA • PIONEER • ZENITH • TOCOM *All Genuine, unmodified*

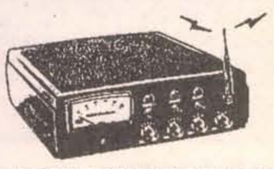
★★★ ATTENTION ★★★ DISTRIBUTORS!!

CALL TOLL FREE (877) 449-3737

7 Days • 9 am-9 pm EST

No intention to defraud

WANTED: MILITARY capacitors, resistors, transistors, diodes, ICs, semi's, etc. Please fax/E-Mail excess lists & RFQs 818-769-1002 fax 818-769-1084. electmatind@earthlink.net & http://www.militarycomponents.com



COUNTER-SURVEILLANCE=$250 HR! Electronic eavesdropping is unbelievably widespread! Are you sure you're safe? Learn how others (without prior experience) earn **$250 HR** in the fascinating field of COUNTER-SURVEILLANCE! For FREE catalog call: **1-800-732-5000**. HTTP://WWW.SPY-CITY.COM

Website News

Online Store Now Online!

Yeah, that's right! Now you can order your electronics books from the *Nuts & Volts* Bookstore online. Last month, we promised it, and as of November 2nd, the store is open for business. We now offer many titles published by McGraw Hill and will be adding more regularly. You can also buy back issues of *Nuts & Volts*. And, if you're a paid subscriber, you'll get a 10% discount off any book titles you order.

Fuzzball's Pick of the Week

Fuzzball has been working hard to build up his 'Best Picks" library of articles and projects. He's been adding a new selected reprint each week and now has quite a collection. *(Inside tip - He has been known to do requests. His email address is fuzzball@nutsvolts.com)* His new pick is usually posted on Wednesday or Thursday of each week. Check em out!

Electronics Forums

The bulletin board is starting to see some action, but still needs more participation from all you techies out there, to really take off. C'mon guys, let's hear some of those great ideas and that awesome techno advice the *Nuts & Volts* readers are famous for. You want a forum dedicated to a special topic? *Tell us and we'll start it!*

www.nutsvolts.com
www.nutsvolts.com
www.nutsvolts.com
www.nutsvolts.com
www.nutsvolts.com

COMPUTER SAVVY? Provide data handling service for government contractors. Restructuring created outstanding opportunity. Information and application $25. CD-ROM listing over 170,000 government contractors $18. Miltech, Box 7NV, Fairland, IN 46126.

TECHNICIAN WANTED for audio telephone conferencing. Tech wanted to design telephone conferencing unit. Located in El Monte, CA. Contact Larry at 909-688-6467.

DO YOU have a good idea you can't afford to develop? Apply for government funding. Guidelines and POCs; 358 pps. $69.00. Miltech, Box 7NV, Fairland, IN 46126.

REPAIRS — SERVICES

WANTED: MILITARY capacitors, resistors, transistors, diodes, ICs, semi's, etc. Please fax/E-Mail excess lists & RFQs 818-769-1002 fax 818-769-1084. electmatind@earthlink.net & http://www.militarycomponents.com

PRINTED CIRCUIT design by professional with 30+ years: conventional, multilayer, downhole, fine line. Prototype and production fabrication. Reverse engineer existing 2-layer board. Toll free 877-236-3223. www.circuit-applied-tech.com

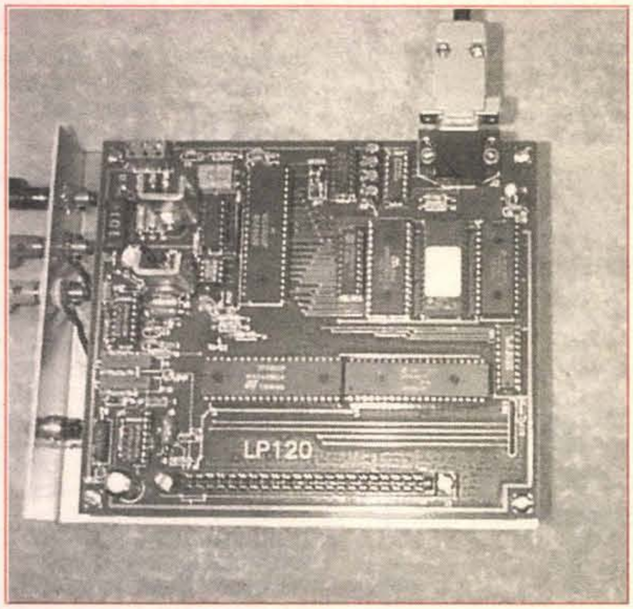
CIRCUIT BOARDS for projects, prototypes, short runs. From your artwork. Low rates. Atlas Circuits 704-735-3943. www.pcbatlas.com

(E)EPROM PROGRAMMING done quickly and economically. One day turn around typical. Simple copy $3 per device. Also prototyping, design, and consulting services available. Call or send SASE to: **Luzer Electronics, 4023 North Bayberry, Wichita, KS 67226. 316-687-2127, FAX 316-687-3103.**

WELD ALUMINUM WITH PROPANE! EZ, INEXPENSIVE, STRONG. DETAILS: WEEKS, 36 CAROLINA ST., TAYLORS, SC 29687. 1-800-547-WELD(9353) FAX 864-244-6349. http://www.durafix.com

Write In 213 on Reader Service Card.

by Brian Beard



DESIGNING A GENERAL-PURPOSE PROGRAMMING SYSTEM

Part 1

INTRODUCTION

Since I started working with microcontrollers and other programmable devices, I've collected over a dozen programmers for use with different chips. I thought about purchasing an expensive "universal" programmer but found that even they require software upgrades, or personality modules, for new parts, and socket adapters for various packages, such as: SO, PLCC, PGA, etc. Plus, while a "universal" programmer may program a wide variety of chips, it may not universally work with all computers.

Some programmers require an ISA or PCI expansion slot, most require a particular operating system. As computer design and operating systems change, you may find your "universal" programmer is useless, not because it can't program the devices, but because it's not compatible with your new PC.

Then, I started looking at all my programmers and realized much of the same circuitry was duplicated in every programmer. That's not surprising since all programmers perform similar basic functions. Those basic functions are: communication with a host system, generating the programming-pulse voltage, generating any unique supply voltage required by the device, and controlling the digital interface to the device.

DESIGN GOALS

I decided to build a general-purpose programmer that incorporated all the basic functions, yet was versatile enough to program any part I might ever use in a project. Since I work with lots of computers, I also wanted it to work with Windows PCs, Macs, laptops, and desktops; both old and new. I called this design the LP120.

The interface with the host PC is via an RS-232 COM-port rather than via the parallel printer-port. This allows me to use existing terminal software — like Procomm or Hyperterm — to communicate with the LP120 rather than writing a unique driver for the printer-port. It also means the host can be any computer with an RS-232 port and terminal software; this makes the host interface independent of the type of computer and operating system.

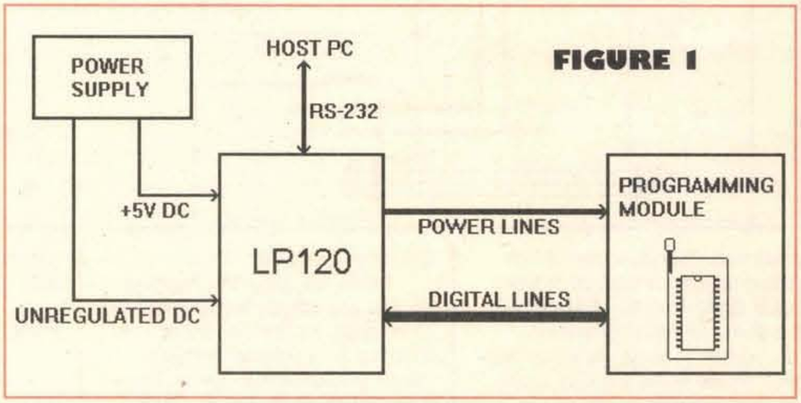


FIGURE 1

Programming-pulse voltages can vary from 25V, for some of the older EPROMs, to 5V, for some of the new flash devices. Typically, the tolerance on the programming-pulse voltage is ±0.25V. Therefore, the programming-pulse voltage (Vpp) should cover at least 5 to 25 volts with better than 0.25V accuracy.

To fully comply with published programming algorithms, the device's supply voltage also has to vary. For example, some 5V EPROMs are programmed while powered at 6.5V, and PIC microcontrollers are verified at the min and max supply voltages. Typically, the tolerance on supply voltages is ±0.1V. Therefore, the LP120 should be able to power the device being programmed with voltages from 3 to 6.5 volts with better than 0.1V accuracy. I use the symbol Vps for this voltage since it is the Voltage supplied to the Programming Socket.

Including address, data, and control lines, an EPROM may need 26 digital interface lines for proper pro-

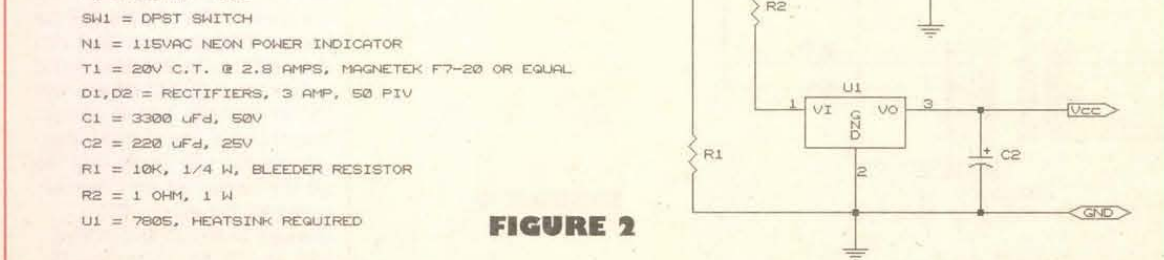


FIGURE 2

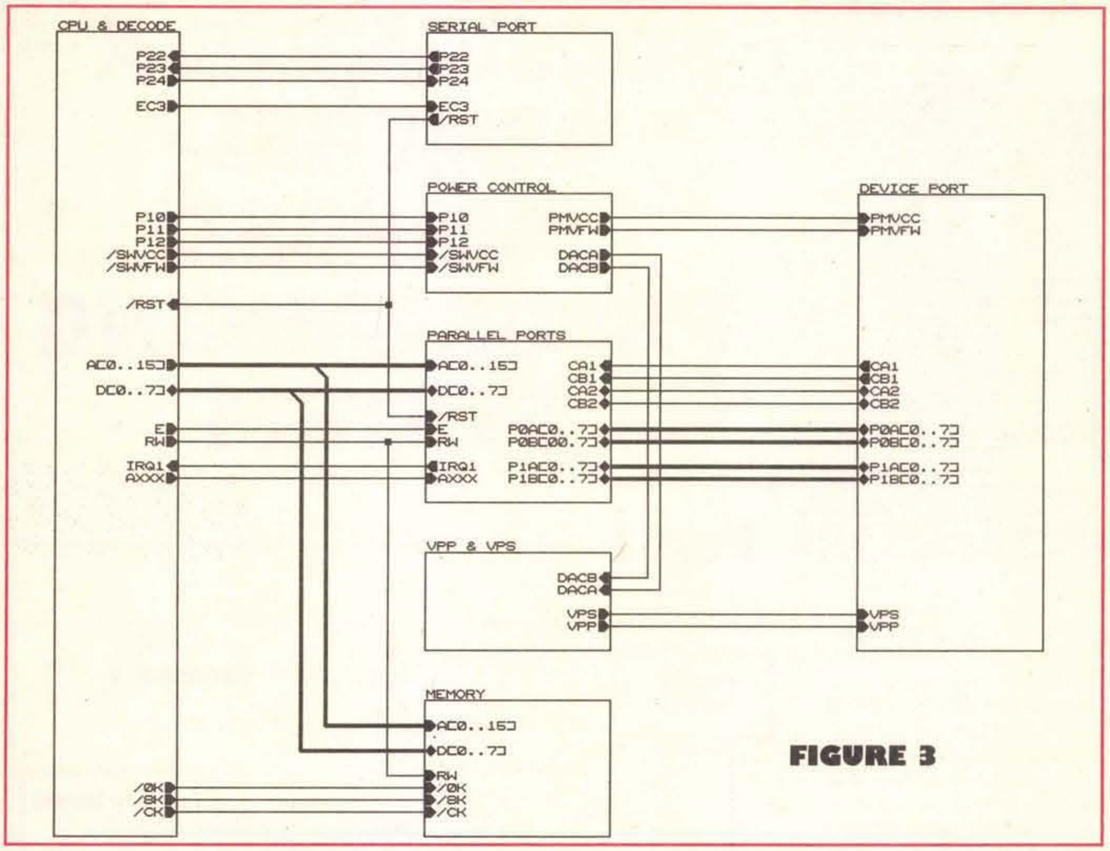


FIGURE 3

gramming. Therefore, the LP120 should provide at least 26 bidirectional digital lines to interface with the device being programmed.

I prefer to reuse my power supplies, so the primary power supply was not included as part of the LP120 circuit board.

Finally, the programming socket, and any unique circuitry required to program a particular device, are included on a separate programming-module for that device. Figure 1 shows the block diagram for the general-purpose programming system.

POWER SUPPLY

I hate to build a power supply for every single project, so the main power supply for the LP120 is external. The power supply I use with my own LP120 is shown in Figure 2. Originally, it was a +5V supply I built years ago; I simply added a connection to the filtered full-wave-rectified voltage (Vfw). The voltage at Vfw should be the RMS value of the transformer's secondary, or approximately 14V in this case.

WARNING: BUILDING A POWER SUPPLY THAT CONNECTS TO HOUSEHOLD AC CURRENT IS POTENTIALLY DANGEROUS AND SHOULD ONLY BE ATTEMPTED BY KNOWLEDGEABLE AND EXPERIENCED PERSONNEL. EXPOSED AC VOLTAGES ARE A POTENTIALLY LETHAL SHOCK HAZARD! INCORRECT CONSTRUCTION TECHNIQUES CAN RESULT IN A FIRE HAZARD! IF YOU ARE UNCOMFORTABLE WITH BUILDING YOUR OWN POWER SUPPLY, DO NOT ATTEMPT THIS PROJECT!

LP120 CIRCUITRY

Figure 3 shows the functional blocks on the LP120 circuit board and how they interconnect.

CPU and Address Decode

The LP120 is an eight-bit microcomputer system with its own RAM, EPROM, and I/O. Figure 4 is the CPU block with the 6803 microprocessor (U1), address latch (U2), and address decoder (U6). The 6803 provides a 64K byte-wide address space, an asynchronous Serial Communications Interface (Motorola calls this a SCI instead of UART), clock oscillator, and a parallel port; all in one chip. The E-clock output of the 6803 (pin 40) is a squarewave at one-fourth the crystal frequency or 921.6kHz. In addition to address decoding, the PAL16R4's registers are configured to divide the E-clock by three, producing an asymmetric pulse-train of 307.2kHz at EC3. This is important because EC3 is an exact binary multiple of the standard baud rates while the crystal frequency is not.

Serial Port & Baud Rate Selection

The serial port schematic is shown in Figure 5. The serial connector is a female DB-9 type, wired as a DCE device. This mates directly with the nine-pin DTE connectors found on most IBMs and compatibles. The MAX232 (U13) contains two RS-232 drivers, two RS-232 receivers, and an on-chip charge-pump. The charge-pump uses the five-volt supply to generate the bipolar voltages needed by the RS-232 drivers. RTS is received, buffered, and looped back to CTS, so CTS tracks RTS.

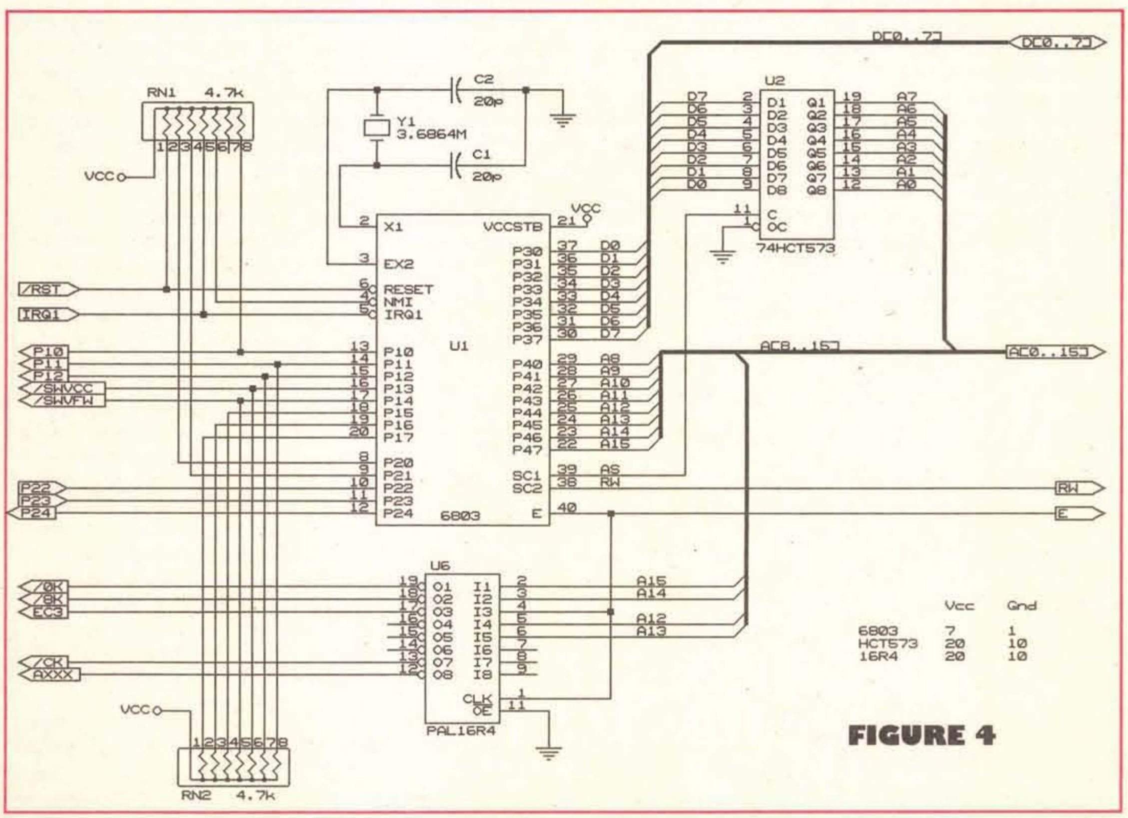


FIGURE 4

DCD and DSR are both held in the ON condition.

Even though the 6803 has an internal SCI, its programmable baud rate selection is very limited. However, the SCI can run at any baud rate if a squarewave of eight times that rate is connected to P22 (pin 10 of the 6803). The 74HCT393, dual four-stage binary counter (U9), squares up the asymmetric clock on EC3 and divides the frequency to provide a selection of standard rates. A single jumper on header JP1 can select any rate from 1200 to 19200 baud.

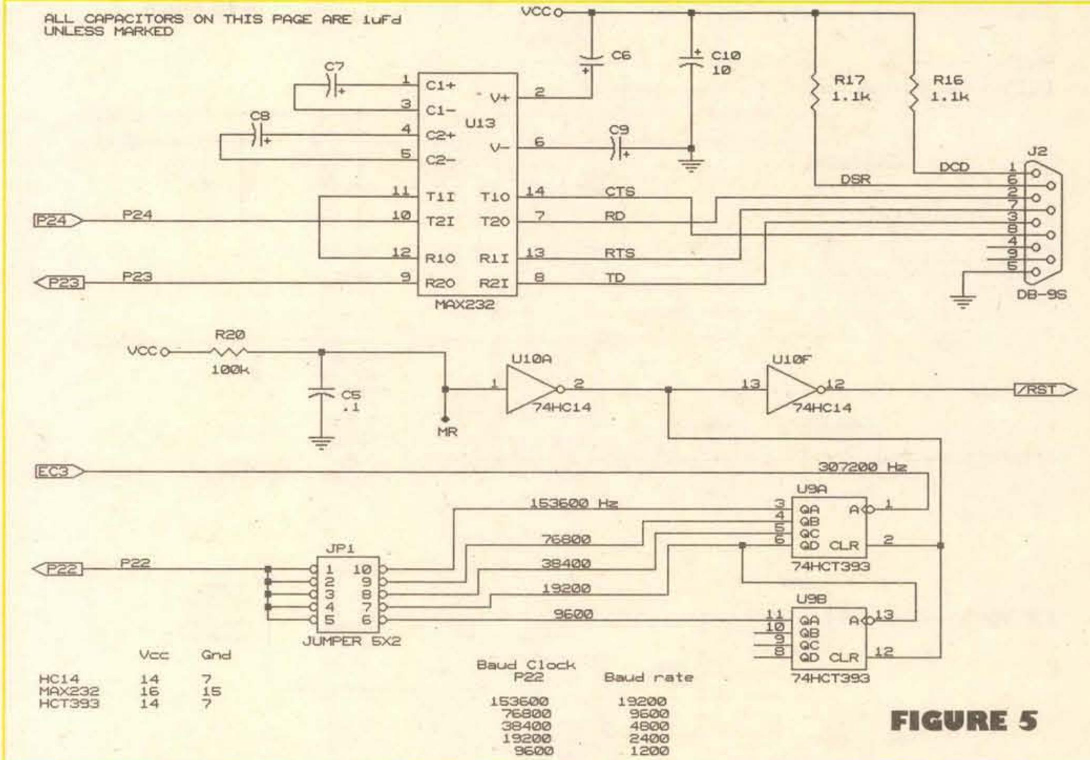


FIGURE 5

Memory

Figure 6 shows the schematic for the LP120's memory. The LP120's firmware is stored in a 27128 EPROM (U4). The 62256 and 6264 chips (U3 and U5, respectively) form 40K of continuous RAM. The firmware doesn't have the code to program all the devices the LP120 is capable of programming, it only contains the operating system, test routines, and hooks to lots of subroutines. To program a specific device, "driver" software must be uploaded to the LP120 and executed out of RAM.

Power Control

Figure 7 shows the power control circuitry, Vcc, Vfw, and ground from the external power supply connect to J1.

Transistor Q3 can switch Vcc to the programming-module where it is called PMVcc. Circuitry on the programming-module should draw no more than 100 milliamps from PMVcc.

Transistor Q2 can switch Vfw to the programming-module where it is called PMVfw. Circuitry on the programming-module should draw no more than 500 milliamps from PMVfw.

The MAX522 (U14) is a serial-input voltage-output dual eight-bit DAC. The serial interface is handled by three lines from the parallel port on the 6803. The output range for both DAC channels is zero to the reference voltage on pin 7. The TL431 (U15) provides a 2.5V reference for the DAC. The resolution of the DACs is (2.5V/255) = 9.8mV per count.

Vpp & Vps

The DC-to-DC converter circuits for Vpp and Vps are shown in Figure 8. Both converters are powered by Vfw and both are controlled by voltages from the MAX522 dual eight-bit DAC. The DAC voltages go to the reference inputs (pin 9) of the 78S40 switching voltage regulators (U11 and U12). The 78S40s will change their output voltage to make the feedback voltage (pin 6) equal the reference input (pin 9). Both circuits use the on-chip 1.25V reference (pin 8) and diode (pins 1, 2) to bias the feedback network slightly above ground. Without this bias, the regulators would switch erratically when the DAC voltage went to zero; with the bias, the regulators switch off completely when the DAC voltage goes to zero.

The Vpp regulator is the upper part of Figure 8. U11 is configured as a step up/down switching regulator. This configuration allows Vpp to be above or below the nominal 14V on Vfw. To meet the design goals, Vpp must span 5 to 25 volts. I decided to let one DAC step equal 100 mV of output; for example, if DACA is set to 210 (D2 hex) Vpp should go to 21.0V. To accomplish this, the feedback network (R7, R9, R11, R13) gain must be (2.5/255)*10 = 0.098. The circuit shown allows Vpp to be set from 4.8 to 25.5 volts in 0.1V steps, which meets the design goals. Below 4.8V the regulator begins to cut off and settings are unreliable.

FIGURE 6

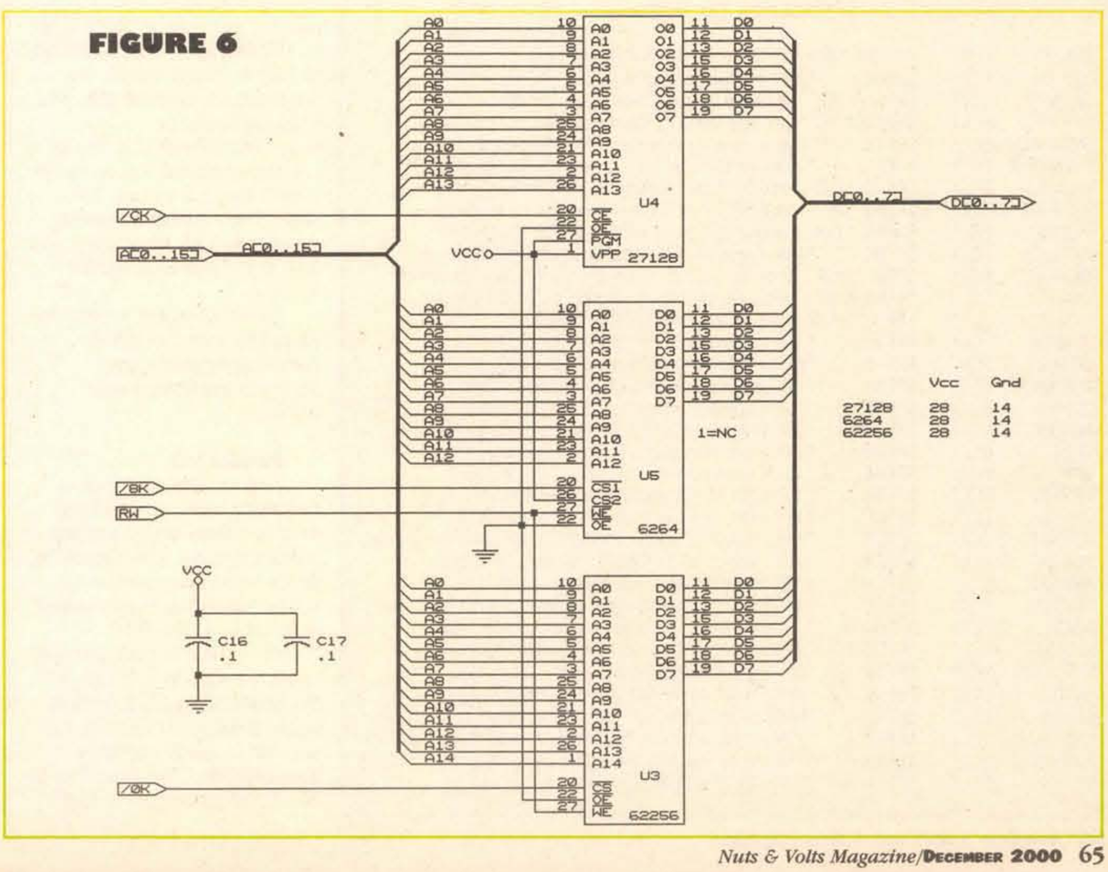
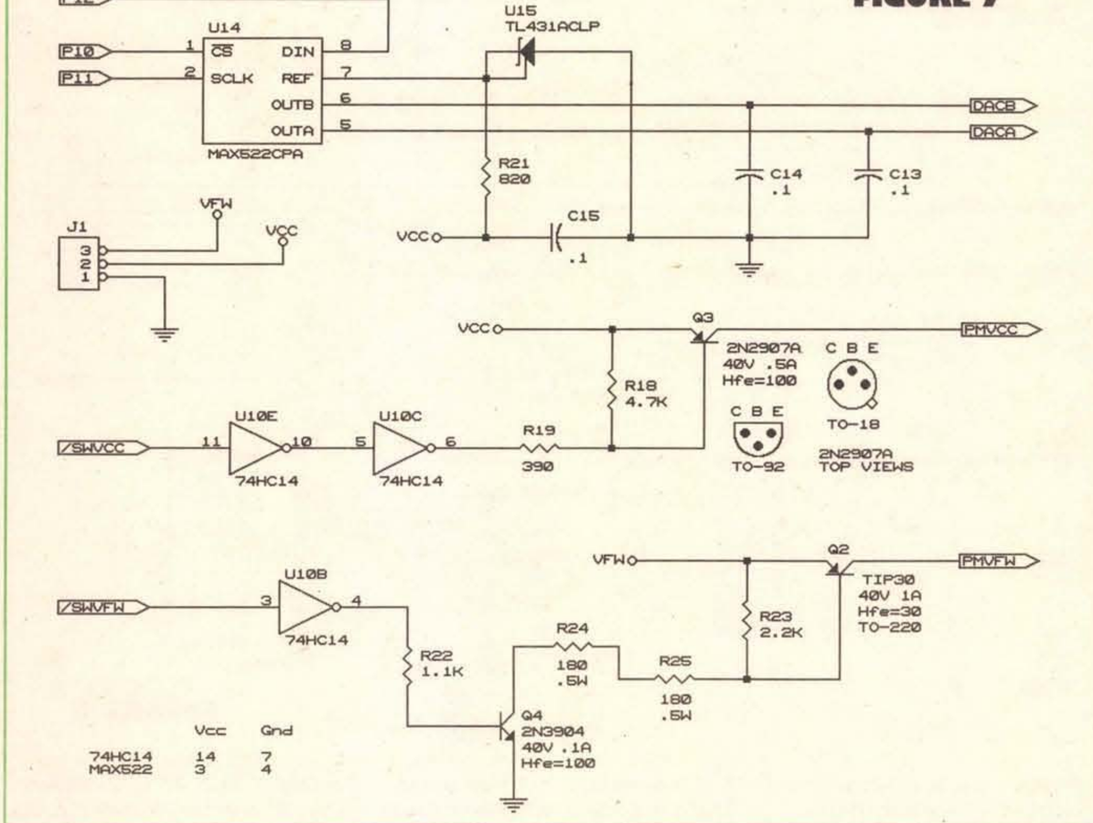


FIGURE 7



The measured current capacity is non-linear, but can be approximated by the equation I_{pp} (amps) $= -0.263 + 0.298 \cdot e^{(4.8/V_{pp})} - 23 \cdot e^{(-V_{pp})}$. At 25V, Vpp can supply approximately 100 mA and, at 5V, approximately 350 mA.

The Vps regulator is the lower part of Figure 8. U12 is configured as a step-down switching regulator. Vps powers the programming socket and any other circuitry on the programming module that must operate at the same voltage.

To meet the design goal of 3 to 6.5 volts, I decided to let one DAC step equal 30 mV of output. For example, if DACB is set to 167 (A7 hex), Vps should go to 5.01V. To accomplish this, the feedback network (R8, R10, R12) gain must be $(2.5/255)*33 = 0.327$. The circuit shown allows Vps to be set from 1.8 to 7.2 volts in 0.03V steps. The measured current capacity is 0.5A for Vps<6V and 0.5 - 0.72*(Vps-6) amps for Vps>6V.

For an excellent tutorial on designing with the 78S40 switching regulator, see Motorola application note AN920.

TOOLBOX EQUATES

RESET	EQU	$C000	*JMP HERE TO TERMINATE DRIVER
DLY_B	EQU	$FF6C	*JSR - short software delay
GETVPP	EQU	$FF70	*JSR - get Vpp setting from user input
GETVPS	EQU	$FF74	*JSR - get Vps setting from user input
DWNMOT	EQU	$FF78	*JSR - send hex data as an ASCII S-record
DWNHEX	EQU	$FF7C	*JSR - send hex data as an ASCII Hex-record
RX4HEX	EQU	$FF80	*JSR - receive 4 hex values as ASCII characters
RX3HEX	EQU	$FF84	*JSR - receive 3 hex values as ASCII characters
RX2HEX	EQU	$FF88	*JSR - receive 2 hex values as ASCII characters
RX1HEX	EQU	$FF8C	*JSR - receive 1 hex value as ASCII character
TX2ASC	EQU	$FF90	*JSR - send byte (2 hex values) as ASCII characters
TX4ASC	EQU	$FF94	*JSR - send word (4 hex values) as ASCII characters
EXITMM	EQU	$FF98	*JMP HERE FOR LP120 MAIN MENU
BINBCD	EQU	$FF9C	*JSR - convert 16-bit binary to BCD
UPMOT	EQU	$FFA0	*JSR - upload an S-record from host
ADRMOT	EQU	$FFA4	*JSR- return address of S-record buffer
UPHEX	EQU	$FFA8	*JSR - upload a Hex-record from host
ADRHEX	EQU	$FFAC	*JSR - return address of Hex- record buffer
VPPSET E	QU	$FFB0	*JSR - set Vpp using linear correction
VPP_NC	EQU	$FFB4	*JSR - set Vpp without linear correction
VPSSET	EQU	$FFB8	*JSR - set Vps using linear correction
VPS_NC	EQU	$FFBC	*JSR - set Vps without linear correction
PWROFF	EQU	$FFC0	*JSR - turn off all power to programming-module
PIAOFF	EQU	$FFC4	*JSR - make all PIA ports outputs and zero
PIADAT	EQU	$FFC8	*JSR - select data registers on both PIAs
PIADDR	EQU	$FFCC	*JSR - select data direction registers on both PIAs
ASCHEX	EQU	$FFD0	*JSR - convert ASCII character to hex nibble
HEXASC	EQU	$FFD4	*JSR - convert byte to two ASCII characters
MSGOUT	EQU	$FFD8	*JSR - send message to host
SCITX	EQU	$FFDC	*JSR - wait while SCI sends a byte
SCIRX	EQU	$FFE0	*JSR - wait while SCI receives a byte
RXECHO	EQU	$FFE4	*JSR - wait while SCI receives a byte then echo it
RXWAIT	EQU	$FFE8	*JSR - wait for SCI incoming data to end
DLY_A	EQU	$FFEC	*JSR - long software delay

Parallel I/O

Address and data lines to the device being programmed must be steady during any programming pulse. This means the device being programmed cannot be connected to the address or data bus of the 6803. Therefore, parallel ports are used to set the address and data for the device being programmed. Figure 9 shows U7 and U8, the two 6821 parallel interface adapters (PIAs). The PIAs' four bi-directional parallel ports, two bi-directional control lines, and two control inputs are all routed to the programming connector.

Programming Connector

The connections to the programming connector (J3) are shown in Figure 10. J3 is an edge connector with 44 contacts (22 per side) at 0.156 inch spacing. The programming module for the specific device being programmed plugs into J3.

PROGRAMMING MODULES

The next article in this series will cover the programming module for mid-range PIC microcontrollers. This month, I'll just talk about programming modules in general. In addition to the device being programmed, the programming module contains any required circuitry not provided by the LP120. This might be: glue logic, a transistor switch controlled by the device being programmed, a level translator, etc. The device being programmed should be powered by Vps while the programming pulse voltage should be supplied by Vpp. Data, control, and address lines on the device being programmed should be connected to the bi-directional parallel ports from the LP120.

If a particular device doesn't use all the digital lines or voltages, it is only connected to those it needs. Programming modules are small and can easily be built using wire-wrap. Many vendors sell 44 contact plug-in boards that are perfect for the job.

LP120 SOFTWARE

All microprocessor-based instruments have software in some form or another. There are three parts to the software associated with the LP120: the host's communication program, the LP120 firmware, and the device driver. As mentioned earlier, the host system must run a communication program that will do terminal emulation and ASCII file transfer. Most operating systems include such an application, like HyperTerminal under Windows. Many terminal emulation/communication programs can be found for free on the Internet. Any of these programs that will run on your machine should work since terminal emulation and ASCII file transfer are the lowest common denominators for all communications programs.

LP120 FIRMWARE

Opening Menu

Whenever the LP120 is turned on, the firmware operating system will initialize the hardware and send an opening menu, like that shown below, to the host. Menu selections are made by typing the character in brackets. Any other character will cause the menu screen to be retransmitted. All inputs to the LP120 are case sensitive.

LP120 OPENING MENU
[U]pload driver program
[J]ump to driver at 0100 hex
[D]isplay system memory
[T]est static RAM
[C]alibrate Vpp and Vps
?

[U]pload driver program

This option is used to upload the driver for the device you want to program. Drivers are stored as ASCII files in the Motorola S-record format. The upload is accomplished via the ASCII file transfer facility of whatever terminal/communication program you are using on the host. After uploading, control should automatically transfer to the driver program and its menu screen should appear. If the LP120 OPENING MENU reappears, use the [J]ump option to start the driver.

[J]ump to driver at 0100 hex

Use this option to transfer control to 0100 hex which is the starting address for driver programs.

[D]isplay system memory

This option is included as a debugging aid for users who write their own device driver programs. Any portion of the LP120 memory space can be displayed.

[T]est static RAM

This test checks all available RAM, from 0020 to 9FFF. Each memory scan writes the same test byte at every address, then goes back and reads every address to confirm the data is correct. The test byte is incremented with each new scan. An "*" is printed on the screen every 256 scans. If an error is encountered, the test will halt and the address of the bad byte will be displayed. The test may be stopped at any time by pressing the ESCape key.

[C]alibrate Vpp and Vps

Use this option to calibrate the DC-to-DC converter circuits. This calibration trims the gain of the DC-DC converters so that their outputs match the voltages called for by the microprocessor.

DEVICE DRIVER PROGRAMS

The device driver is a necessary part of the software for programming any device. The LP120 firmware alone is not capable of programming anything. Device driver programs are transient programs loaded into the LP120's RAM. The first step in programming any device is to upload the device driver for that part. The device driver will present its own menu, usually with another upload option for the data to be programmed into the device.

Writing Device Drivers

I have written device drivers for 2716-27256 EPROMs, 68705P/R/U microcontrollers, 68701/U4 microcomputers, and PIC mid-range microcontrollers. All the device drivers are written in 6803 assembly language due to the limited memory resources. A freeware DOS cross-assembler is available on the Lucid Technologies website. Writing the device drivers isn't really that hard and the assembly language Toolbox that comes with the LP120 handles many of the tedious details. In my experience, the hardest part is find-

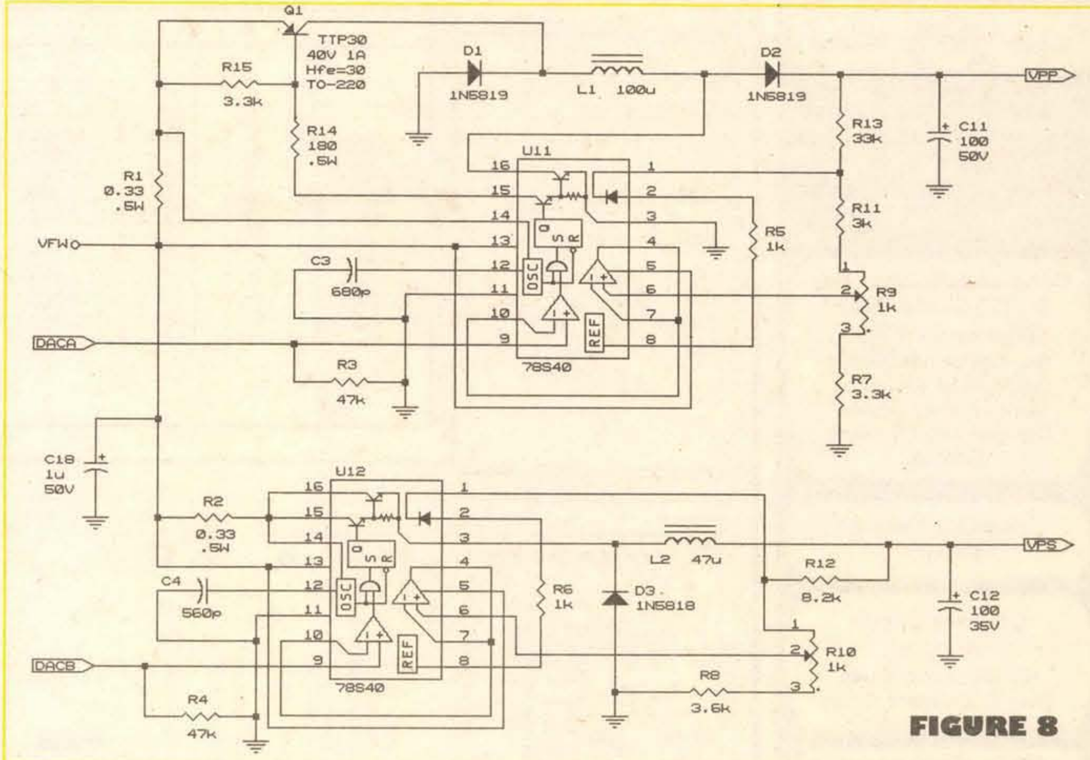


FIGURE 8

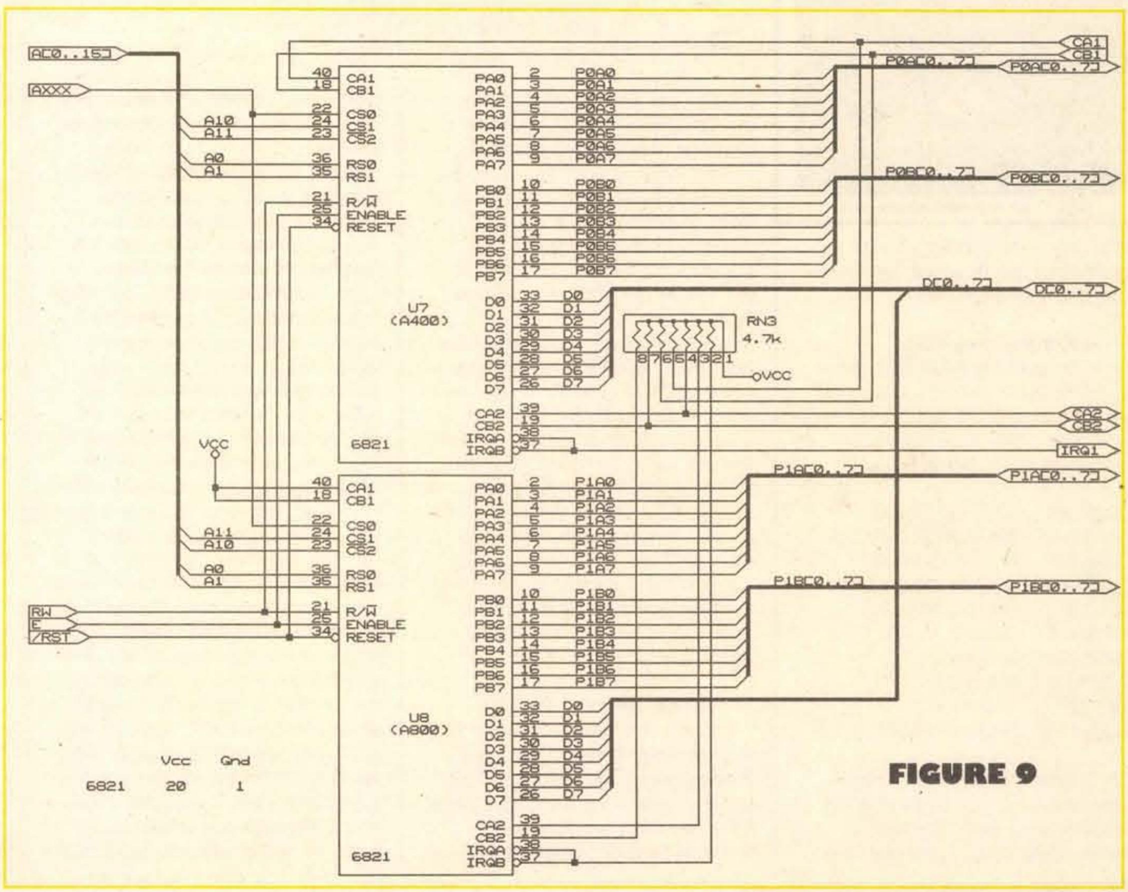


FIGURE 9

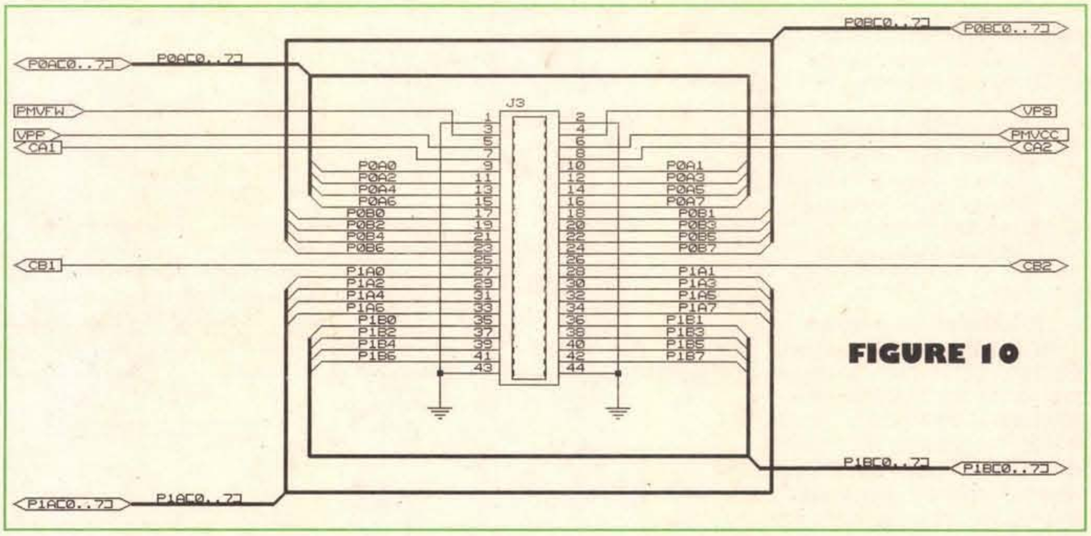
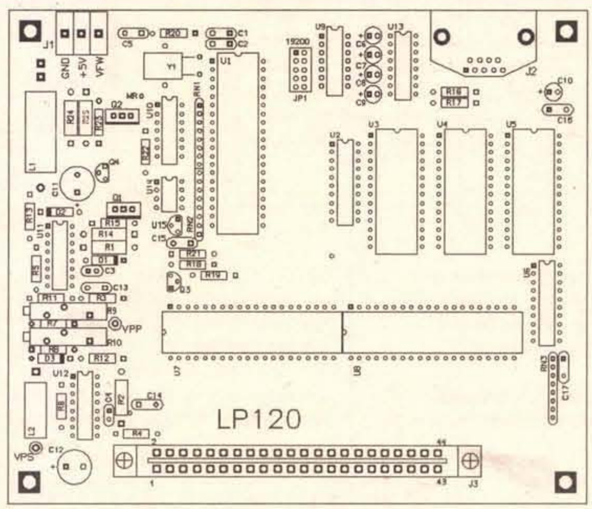


FIGURE 10



PCB 2:1

ing, and understanding, the programming specifications from different chip manufacturers.

LP20 Memory Map

The available RAM is of prime concern when writing a device driver. The memory map for the LP120 is shown in the table below. All addresses are in hexadecimal.

0000-001F	6803 Registers
0020-007F	External RAM, 62256
0080-00FF	Internal RAM, 6803
0100-7FFF	External RAM, 62256
8000-9FFF	External RAM, 6264
A000-A3FF	Unused
A400-A7FF	PIA Zero
A800-ABFF	PIA One
AC00-BFFF	Unused
C000-FFFF	External EPROM, 27128

Although not all of it is available, there are 40k bytes of RAM, from 0000 to 9FFF. The first 32 bytes, 0000 to 001F, are registers used by the internal resources on the 6803; these are I/O port data direction registers, I/O port data, internal timer control and data, SCI control and data, etc. The top 1k of RAM, 9C00 to 9FFF, is reserved for system variables and stack. The firmware for the LP120 resides in the 16k of EPROM from C000 to FFFF.

Device drivers should use RAM from 0020 to 00FF as variable storage and 0100 to 9C00 for the program and data buffer. The start of executable code should be at 0100. The output of the freeware assembler is an ASCII file in Motorola S19 format. Each line of this file is an S-record. The lines with data are S1-records, they begin with the ASCII symbols "S1." The last line in the file is an S9-record which contains no data, but can carry the address where execution is to begin.

LP120 Firmware Toolbox

Part of the development package that comes with every LP120 is an assembly language header (include file) that contains equates for all the 6803 and 6821 registers, and firmware Toolbox subroutines. These subroutines provide a programmer's Toolbox that can handle most of the low-level I/O and data conversion required in any device driver. The complete list of current Toolbox equates is shown in the sidebar.

All but two of the Toolbox subroutines are used by executing a Jump to SubRoutine (JSR). The other two are used with a JuMP (JMP) instruction and are more properly thought of as vectors rather than subroutines. As you'll notice from Table 1, the Toolbox equates each occupy four bytes. The code in those four bytes consists of another JSR (three bytes) to the actual subroutine in EPROM, followed by a return from subroutine instruction (one byte).

This two-level call structure is used to insure compatibility between future upgrades to the firmware and device drivers. If the firmware is reassembled, changing the absolute address of subroutine code within the EPROM, it won't affect device drivers because the Toolbox equates, already at fixed absolute addresses, will link to the new locations of the subroutines. This means device drivers written for one version of the firmware will continue to work with all future versions.

The details of all the Toolbox subroutines are explained in the Developer's Guide which is included with all LP120s. It explains what registers need data pre-loaded before calling the Toolbox subroutine, what action is taken, what registers are affected, what conditions cause error bits to be set, and what data is returned in which registers. The descriptions for all the Toolbox subroutines are too large to reprint here, so consider this one example.

SUBROUTINE: MSGOUT
PRELOAD: X=starting address of ASCII character string
ACTIONS: Transmit ASCII character string via SCI. Special characters:
A tilde (~) is transmitted as a carriage-return line-feed sequence.
A zero (00) byte terminates the transmission.
REGISTERS: =Changed, B=Not Changed, X=Changed
ERROR FLAG: None
NOTES: Use this subroutine to send messages to the host.

I use MSGOUT to send all multi-character message data to the host. Load index register X with the address of the first byte in the message then do a JSR MSGOUT. MSGOUT will send the byte at X, then X+1, X+2, etc. If the value of the next byte is 7E hex (a tilde), a carriage return and line feed are sent instead. If the value of the next byte is zero, MSGOUT does a ReTurn from Subroutine (RTS).

Assembling and executing the subroutine in Table 1 would result in this display on the host:
Hi there
world!

LP120 CONSTRUCTION

Building the LP120 circuit board shouldn't be any problem for an experienced kit builder. Detailed

Quan.	Reference	Part
Semiconductors		
2	D1,D2	1N5819, 40V Schottky diode
1	D3	1N5818, 30V Schottky diode
2	Q1,Q2	TIP30, TO-220, PNP
1	Q3	2N2907A, TO-18 or TO-92, PNP
1	Q4	2N3904, TO-92, NPN
1	U1	MC6803, microcomputer
1	U2	74HCT573, octal transparent latch
1	U3	62256, 32k x 8 CMOS RAM
1	U4	27128, 16k x 8 EPROM
1	U5	6264, 8k x 8 CMOS RAM
1	U6	PAL16R4, address decoder
2	U7,U8	6821, peripheral interface adapter
1	U9	74HCT393, dual 4-bit binary counter
1	U10	74HC14, hex inverter
2	U11,U12	78S40, switching regulator
1	U13	MAX232, RS-232 interface
1	U14	MAX522CPA, dual 8-bit DAC
1	U15	TL431ACLP, TO-92, voltage reference
Capacitors		
2	C1,C2	20p disk
1	C3	680p
1	C4	560p
6	C5,C13-C17	0.1u disk
4	C6,C7,C8,C9	1u, 16V radial
1	C10	10u, 16V radial
1	C11	100u, 50V radial
1	C12	100u, 35V radial
1	C18	1u, 50V radial
Resistors (0.25W, 5% unless noted otherwise)		
2	R1,R2	0.33 ohm (or less), 0.5W
2	R3,R4	47k (yellow-violet-orange-gold)
2	R5,R6	1k (brown-black-red-gold)
2	R7,R15	3.3k (orange-orange-red-gold)
1	R8	3.6k (orange-blue-red-gold)

Quan.	Reference	Part
2	R9,R10	1k 3/4" trimmer
1	R11	3k (orange-black-red-gold)
1	R12	8.2k (gray-red-red-gold)
1	R13	33k (orange-orange-orange-gold)
3	R14,R24,R25	180, 0.5W (brown-gray-brown-gold)
3	R16,R17,R22	1.1k (brown-brown-red-gold)
1	R18	4.7K (yellow-violet-red-gold)
1	R19	390 (orange-white-black-gold)
1	R20	100k (brown-black-yellow-gold)
1	R21	820 (gray-red-black-gold)
1	R23	2.2K (red-red-red-gold)
3	RN1,RN2,RN3	4.7k, 8-pin SIP, pin 1 common
Sockets		
1	U14	8 pin
2	U9,U10	14 pin
3	U11,U12,U13	16 pin
2	U2,U6	20 pin
3	U3,U4,U5	28 pin
3	U1,U7,U8	40 pin
Miscellaneous		
1	J1	3 x 5mm terminal strip
1	J2	DB-9S, right angle, PC mount
1	J3	22/44 edge connector, 0.156" contact x 0.20" row spacing
1	JP1	Double row jumper header, 5 x 2
1	L1	100 uH coil
1	L2	47 uH coil
1	Y1	3.6864 MHz crystal, HC-18 or HC-49
1	JP1	Shorting jumper

The LP120 kit is available from **Lucid Technologies**, see the web site at **www.cs.net/lucid/**. Send questions or comments to **lucid@cs.net**.

LP120 PARTS LIST

assembly instructions are included with the kit. As with all kits, you should check the circuit board carefully before you start soldering. Hold the board up to a lamp so that the light shines through the board. This backlighting makes it easy to examine the traces on the near side. Look for breaks in the traces or shorts caused by incomplete etching of the copper. Pay particular attention to the areas where the traces run between the pins of the ICs. If you have any doubts, use an ohmmeter to double-check your visual inspection. Bridge any breaks and cut any shorts you find. Remember to check both sides of the board.

I recommend organic core solder rather than acid core. Organic flux can be cleaned with warm water unlike the strong solvents required for acid flux. I've seen too many projects that were never cleaned just because the acid flux was hard to get off.

Start by installing the sockets for the ICs, but don't plug the ICs into the sockets yet. Next, install the resistor networks noting the correct orientation of pin one. Continue by installing the discrete resistors, capacitors, crystal, inductors, and jumper pins. Be sure the electrolytic capacitors are properly polarized before soldering them in place. Now the transistors and diodes can be installed. Again, be sure they are properly oriented before soldering any leads.

Before you solder the connectors (J1, J2, J3), give some thought to how you are going to mount the board. You can use standoffs as simple legs at each corner or you can get fancy and mount both the board and power supply in a nice chassis; it's entirely up to you. If you do use a closed chassis, you might want to run wires from the board to J2, J3, or both. This would allow you to mount the connectors on the chassis. Be sure to ground the chassis properly.

LP120 Checkout

With no ICs installed, attach the common lead of your ohmmeter to a convenient ground point. Check continuity at the ground pin of all the IC sockets. Next, attach ground and +5V (Vcc) to J1. Turn on the power supply and touch the positive probe of your voltmeter to the Vcc pin of all the IC sockets. The power pins for all ICs are shown on the schematics. If you don't read five volts at all these points, power down the circuit and carefully check all wiring, soldering, and component installation. Do not proceed until you have corrected the problem.

Measure the no-load voltage on Vfw at the power supply. Turn the power supply off and add Vfw, the third connection, to J1. Turn the power supply back on and check for Vfw at the following points:

U11 - pins 5,13,14,15
U12 - pins 5,13,14,15,16
Q2 - emitter

If you don't read Vfw at all these points, power down the circuit and carefully check all wiring, soldering, and component installation. Do not proceed until you have corrected the problem.

Remove power and install all the ICs. Make certain each chip is in the correct socket, oriented properly, and has no pins folded under the IC. Attach +5V, Vfw, and ground to the designated positions on J1.

Further check-out requires communication between the host system and the LP120. Connect an RS-232 cable from the LP120 to your computer's serial port. Start your host's communications program and insure it is set for the correct COM port and baud rate. Confirm jumper JP1 on the LP120 is set for the same baud rate.

Turn on the power supply and observe your computer screen. If the characters on the screen are gibberish there is probably a baud rate mismatch. If nothing appears, there are several potential problems. Be sure your RS-232 cable is wired correctly for the LP120. If possible, check the operation of the host's serial port. Confirm the settings for the communications program are correct. Recheck all the voltages on the LP120, a shorted line may be pulling one of them down. Check the 6803 clock for correct operation, a 921.6 kHz TTL squarewave on U1 pin 40.

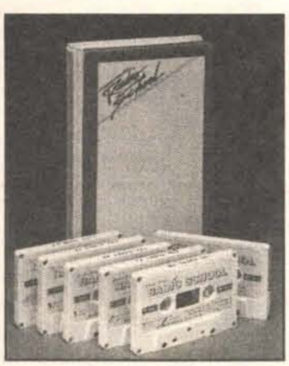
If one of the ICs on the LP120 is exceptionally hot, it may be installed backwards, have a shorted data line, or just be a bad chip. Remove all ICs and run board continuity checks for all the pins of the suspect IC. Be sure the pins connect to all of the points they should and nowhere else! If you have some way of testing the chip do so, and replace, if necessary.

If the initial screen is a legible menu, it should indicate a calibration option. Select the calibration option. Measure Vpp and Vps at the test points indicated on the LP120. Adjust Vpp to the voltage indicated on the screen with trimmer R9.

Adjust Vps to the voltage indicated on the screen with trimmer R10. Press ESCape when both voltages are correct. Turn power off, the LP120 is now ready for use. **NV**

Table 1

```
HELLO      LDX  #MSG1         *load X immediate, address of message
           JSR  MSGOUT        *send the message
           RTS                *return from subroutine
MSG1  FCC  'Hi there~world!   *form character data, message text
           FCB  0             *form byte data, end of message
```



FREE ON-AIR CODE LEARNING INSTRUCTOR CASSETTES

Morse Code instructors may hold their code-learning classes over their local repeater or simplex frequencies with free code-learning cassettes from Gordon West WB6NOA. Each cassette is 90 minutes long and recorded monaural for easy player-to-microphone pick up.

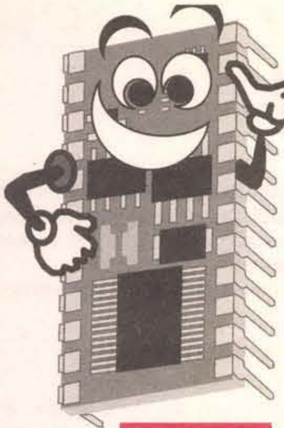
"All of the code-learning practice is narrated, and these audio cassettes are ideal for instructors to play over their local repeater system," comments West, well-known for his innovative amateur radio teaching methods and materials.

"Instructors may also use these cassettes in the classroom, too, working in live code off the air as well as additional code practice using computer programs or a set of paddles," adds West.

CW instructors may receive these cassettes at no charge by including a brief letter describing their upcoming on-air or in-class scheduled code course, as well as 10 first-class stamps for Priority Mail delivery.

"These free training cassettes are part of the Ham Ambassador program, and I encourage all instructors and repeater control operators to take advantage of this unique teaching opportunity," finalizes West.

Send your request and class details to: Gordon West Radio School, 2414 College Drive, Costa Mesa, California 92626.



by Jon Williams

Stamp Applications

THERE'S A NEW STAMP IN TOWN

The BSP takes all the really good stuff of the BASIC Stamp IISX, makes it better, and adds some really great features. Here's an overview:

Wow, 2001 is just around the corner. The first time I saw the movie that made the year famous, 2001 seemed like it was an eternity away ... but here it is. Arthur C. Clarke is an incredibly bright man and yet, it seems he over-predicted the ability of computers in the year 2001. Or, perhaps, he under-predicted ... I guess it depends on one's point-of-view. No, we don't have HAL this year, what we have is the very well-mannered BASIC Stamp IISX+ (BSP).

- Parallel LCD routines for the Hitachi HD44780
- Dallas 1-Wire™ routines
- Philips I2C routines
- Firmware interrupts
- 24-pin (16 I/Os) and 40-pin (32 I/Os) versions
- Double the scratchpad RAM of the BS2-SX (now 127 bytes)
- 20% faster than the BS2-SX (about 12,000 instructions per second)
- Uses less power (about 30%) than the BS2-SX — operates near 40 mA

If you've used the BS2 or BS2-SX for any length of time, you'll recognize that this is a very cool list of features and goes a long way toward extending the Stamp's versatility. This month, we'll focus on LCD, 1-Wire™, and I2C routines since they bring us the most bang. Next month, we'll cover expanded I/O on the 40-pin version and the use of firmware interrupts.

You know me, I learn by doing and teach by having you do. Let's jump right in.

There is a commonality among the LCD, 1-Wire™, and I2C routines: they have an input/output structure that is identical to **SERIN** and **SEROUT**. And even though several Stamp programmers have been successful at implementing LCD (easy) and I2C (not so easy) routines, the code is often slow and bulky. Until the BSP, 1-Wire™ support was not possible without external support, and even then it was difficult and clumsy.

LCD Support

The BSP has native support for the popular Hitachi HD4470 LCD controller. The routines that support LCD control are:

LCDCMD E-pin, command
LCDOUT E-pin, command, [output data]
LCDIN E-pin, location, [input data]

These routines require that the LCD be configured in four-bit mode and have specific requirements as to where the connections can be. The syntax of each statement (specifically the control pin for LCD.E) tells the BSP how the LCD is connected.

Connections:

LCD	Option 1	Option 2
LCD.E	BSP.0 or BSP.1	BSP.8 or BSP.9
LCD.R/W	BSP.2	BSP.10
LCD.RS	BSP.3	BSP.11
LCD.DB4	BSP.4	BSP.12
LCD.DB5	BSP.5	BSP.13
LCD.DB6	BSP.6	BSP.14
LCD.DB7	BSP.7	BSP.15

This table shows that the LCD can be connected to the pins at OutL (0-7) or the pins at OutH (8-15), and specific requirements as to where E, R/W, RS, and the data lines need to be connected. Keep in mind that you don't have to use the LCD's R/W line if you are not going to read from its RAM. In this case, you can simply ground the LCD.R/W pin and use the Stamp control pin for other duties. Note that the Parallax documentation suggests that the LCD.E line be pulled down to ground through a 4.7K resistor.

The first of the LCD commands is **LCDCMD** and is used to send a command control code to the LCD. This command will be used during initialization and for moving the cursor home, clearing the LCD, etc. Here's a few typical commands:

Clear the LCD	$01
Move cursor home	$02
Move cursor left	$10
Move cursor right	$14

There are others. Consult the program listings here and the Hitachi documentation for the HD44780.

Writing data to the LCD has been made very easy with **LCDOUT**. There are two nice things about this new command: you can send the LCD a command byte (i.e., clear the LCD) before the write, and the output data is structured just like **SEROUT**. This means you can use the typical **SEROUT** modifiers like BIN, HEC, DEC, STR, and REP.

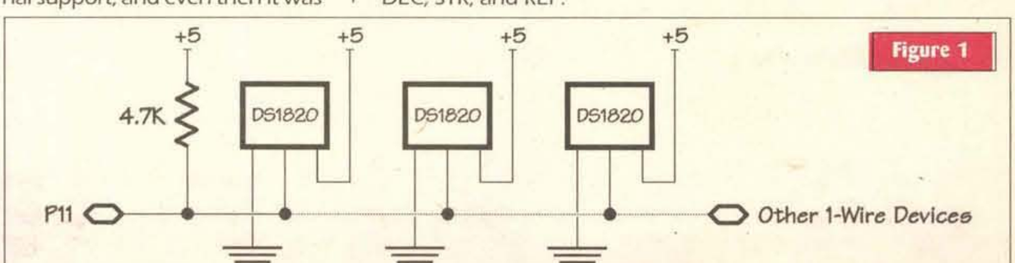


Figure 1

STAMP APPLICATIONS
THERE'S A NEW STAMP IN TOWN

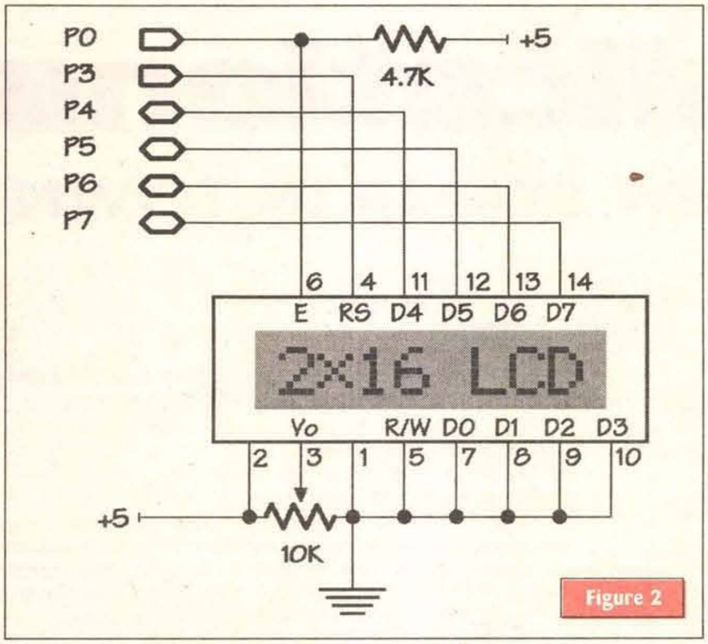


Figure 2

Reading information back from the LCD is just as easy with **LCDIN**. Its syntax is identical to **LCDOUT**. With LCDIN, the location byte needs to point to the starting memory location to read. The following constants are useful in programs that use the LCD commands:

```
DDRam    CON  $80
CGRam    CON  $40
```

DDRam is the memory that holds the characters being displayed. CGRam is the 64-byte memory area where custom character patterns are stored. If your program doesn't use this memory for custom characters, it can be used as off-board RAM with LCDOUT and LCDIN. The STR modifier can be used to transfer a block of bytes to or from the LCD.

Dallas 1-Wire™ Support

The Dallas 1-Wire™ bus is a system which has a single bus master and one or more slaves. In this case, the BSP acts as the bus master. Each device on the 1-Wire™ bus has a unique serial number (used for addressing) that is manufactured right into the device.

1-Wire™ devices are supported with two easy-to-use commands:

OWOUT pin, reset, [output data]
OWIN pin, reset, [input data]

Communication to 1-Wire™ devices can be on any available pin. This pin should be pulled up to Vdd (+5) through a 4.7K resistor. The reset parameter has four options:

- No reset or presence pulses
- Reset and presence pulses only before data initiation
- Reset and presence pulses only after data termination
- Reset and presence pulses before data initiation and after data termination

Resets shown are for byte input data running at regular speed. Add four for bit input data and add eight for overdrive speed. You should consult the Dallas 1-Wire™ documentation for specifics on the reset option.

Philips I2C Support

The Philips I2C bus is a two-wire, bi-directional bus. The two lines are SDA (serial data) and SCL (serial clock). Like the 1-Wire™ line, the SDA and SCL lines must be pulled up to Vdd (+5) through 4.7K resistors.

I2C devices are supported with:

I2COUT pin, slave addr, word addr\extra byte, [output data]
I2CIN pin, slave addr, word addr\extra byte, [input data]

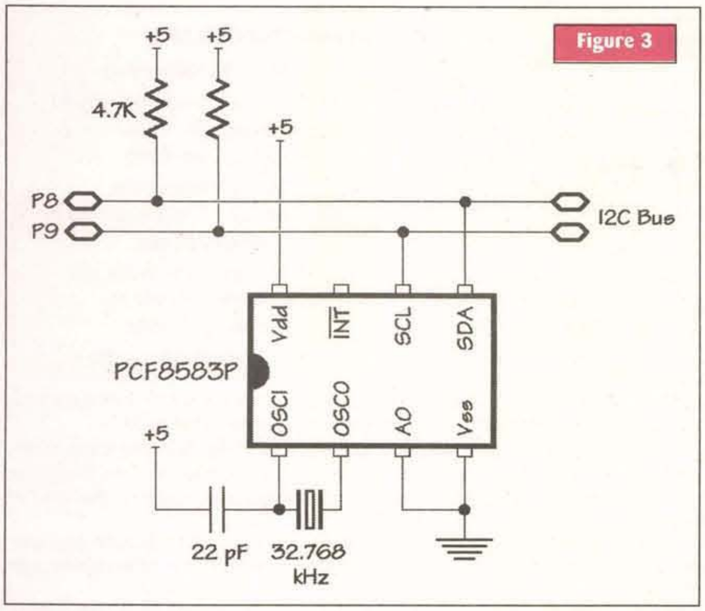
The I2C devices can only be connected to group pins 0 & 1 or 8 & 9.

I2C Bus	Option 1	Option 2
SDA	BSP.0	BSP.8
SCL	BSP.1	BSP.9

Listing 1

```
' Listing 1
' Nuts & Volts - December 2000

' -----[ Title ]-----------------------------------------------------------
-
'
' File...... DS1820.BSP
' Purpose... BASIC Stamp SX Plus <--> DS1820 Demo
' Author.... Jon Williams
' E-mail.... jonwms@aol.com
' Started... 04 NOV 2000
' Updated... 04 NOV 2000


' -----[ Program Description ]---------------------------------------------
-
'
' This program reads and displays the ROM code and temperature data from
' a DS1820 (1-wire) sensor.
'
' Program requires 2x16 LCD
'   - LCD.E     --> Pin0 (pulled down [to ground] through 4.7K)
'   - LCD.R/W   --> Pin2 (or grounded for write-only operation)
'   - LCD.RS    --> Pin3
'   - LCD.D4    --> Pin4
'   - LCD.D5    --> Pin5
'   - LCD.D6    --> Pin6
'   - LCD.D7    --> Pin7


' -----[ Revision History ]------------------------------------------------
-
'


' -----[ I/O Definitions ]-------------------------------------------------
-
'
LCDpin          CON     0                       ' data on pins 4 - 7
DS1820pin       CON     11

' -----[ Constants ]-------------------------------------------------------
-
'
' LCD control characters
'
NoCmd           CON     $00             ' just print
ClrLCD    CON   $01                     ' clear the LCD
CrsrHm    CON   $02                     ' cursor home
CrsrLf    CON   $10                     ' cursor left
CrsrRt    CON   $14                     ' move cursor right
DispLf    CON   $18                     ' shift display left
DispRt    CON   $1C                     ' shift displayright
DDRam           CON     $80             ' Display Data RAM control
Line1           CON     $80             ' address of line 1
Line2           CON     $C0             ' address of line 2

DegSym          CON     223             ' degrees symbol

' DS1820 control
'
ReadROM         CON     $33             ' read ID, serial num, CRC
MatchROMCON     $55                     ' look for specific device
SkipROM         CON     $CC             ' skip rom (one device)
ConvertTemp     CON     $44             ' do temperature conversion
ReadScratch     CON     $BE             ' read DS1820 scratchpad


' -----[ Variables ]-------------------------------------------------------
-
'
idx             VAR     Byte            ' loop counter
romData         VAR     Byte(8)         ' ROM data from DS1820
tempIn          VAR     Word            ' raw temperature
sign            VAR     tempIn.Bit8     ' 1 = negative temperature
tInLow          VAR     tempIn.LowByte
tInHigh         VAR     tempIn.HighByte
tSign           VAR     Bit
tempC           VAR     Word            ' Celsius
tempF           VAR     Word            ' Fahrenheit
```

THERE'S A NEW STAMP IN TOWN



The pin parameter of each command specifies the SDA pin. The slave addr is the I2C device to connect with. The word addr is the location the I2C device writes to or reads from. The use of the backslash allows two-byte addressing for those devices that support it.

Demo Programs

Okay, enough chit-chat ... let's write a few programs that demonstrate these new features.

Listing 1 (DS1820.BSP) is a program that reads and displays the temperature from a single Dallas DS1820 1-Wire™ thermometer (do not run this program with more than one device on the 1-Wire™ bus). The output of the DS1820 is the same as the DS1620. The current temperature is returned in half-degrees Celsius. Negative numbers are returned in two's compliment format.

After defining I/O pins, constants, and variables used in the program, we initialize the LCD. The Hitachi guidelines for a four-bit interface are followed. What you'll notice is a **PAUSE 0** between each of the **LCDCMD** statements. This small delay is necessary because of the increased speed of the BSP.

With the LCD initialized, a splash screen is displayed with **LCDOUT**. Notice how easy this command is to use, with the ClrLCD command embedded in the same statement. This is a far cry easier than the old days of using **LOOKUP** or loops to read strings from **DATA** statements.

The first active process in the program is reading back the ROM code from the DS1820. We'll need this information later if we want to individually address the DS1820. Each DS1820 contains a 64-bit (eight bytes) ROM code. The first eight bits are the 1-Wire™ family code ($10 for the DS1820), the next 48 bits are a unique serial number. The final eight bits are the CRC of the first 58 bits.

Using **OWOUT**, the ReadROM command is issued to the DS1820. The next line of code uses **OWIN** to retrieve the data from the DS1820. The STR modifier and \8 specification make it very easy to read all eight ROM bytes into the array called romData. With the ROM data in memory, we use a loop and the HEX2 modifier to display the data as hex bytes on line 2 of the LCD. Be sure to write down this code so you can use it later.

Finally, we get to read the temperature. The DS1820 is a bit easier to use than its cousin, the DS1620, in that we only have to tell it to take a temperature reading; there are no other configuration requirements. In this program, we've only placed one device on the 1-Wire™ bus so we don't need to match ROM contents. This is accomplished by issuing the SkipROM command, followed by the ConvertTemp command (done in one statement).

The DS1820 needs about half a second to take a reading. After the **PAUSE 500**, the temperature reading is retrieved by sending the ReadScratch (after SkipROM, of course) command. Since we're only interested in the temperature, we'll just grab the first two bytes. There is more information available, including data that will allow higher resolution temperature readings. I'll leave that experimenting to you.

Once we have the raw temperature reading, we drop the half-degree bit and convert to Fahrenheit, as well. A couple of **LCDOUT** commands using SDEC (signed decimal — allows negative numbers) displays the temperature neatly. Easy, huh? Yep, I like this new Stamp.

If you've got more that one DS1820, you can enter (or download) Listing 2 (DS1820-x.BSP) and cycle through all of them. Before you do

```
' -----[ EEPROM Data ]-------------------------------------------------
-
'


' -----[ Initialization ]----------------------------------------------
-
'
LCD_Setup:
  LCDCMD LCDpin,%00110000 : PAUSE 5          ' 8-bit mode
  LCDCMD LCDpin,%00110000 : PAUSE 0
  LCDCMD LCDpin,%00110000 : PAUSE 0
  LCDCMD LCDpin,%00100000 : PAUSE 0          ' 4-bit mode
  LCDCMD LCDpin,%00101000 : PAUSE 0          ' 2-line mode
  LCDCMD LCDpin,%00001100 : PAUSE 0          ' no crsr, no blink
  LCDCMD LCDpin,%00000110                    ' inc crsr, no disp
shift

' -----[ Main Code ]---------------------------------------------------
-
'
Main:
  LCDOUT LCDpin,ClrLCD,["BSP <---> DS1820"]  ' splash screen
  PAUSE 2000


DisplayROM:
  LCDOUT LCDpin,ClrLCD,["DS1820 ROM:"]
  OWOUT DS1820pin,1,[ReadROM]                ' send Read ROM command
  OWIN  DS1820pin,2,[STR romData\8]          ' read serial number &
CRC
  LCDCMD LCDpin,Line2
  FOR idx = 0 TO 7
    LCDOUT LCDpin,NoCmd,[HEX2 romData(idx)]  ' show ID, serial num,
CRC
  NEXT

  PAUSE 5000

TempDemo:
  LCDOUT LCDpin,ClrLCD,["CURRENT TEMP:"]

ShowTemp:

  ' * send conversion command
  ' * allow time for conversion
  ' * send read scratch ram command
  ' * grab the data

  OWOUT DS1820pin,1,[SkipROM,ConvertTemp] ' start conversion
  PAUSE 500                               ' give time for conversion
  OWOUT DS1820pin,1,[SkipROM,ReadScratch]
  OWIN  DS1820pin,2,[tInLow,tInHigh]      ' read temperature

  tSign = sign                            ' save sign bit
  tempIn = tempIn/2                       ' round to whole degrees
  IF tSign = 0 THEN NoNeg1
  tempIn = tempIn | $FF00                 ' extend sign bits for negs

NoNeg1:
  tempC = tempIn                          ' save Celsius value
  tempIn = tempIn */ $01CC                ' multiply by 1.8
  IF tSign = 0 THEN NoNeg2                ' if neg, extend sign bits
  tempIn = tempIn | $FF00

NoNeg2:
  tempF = tempIn+32                       ' finish C -> F conversion

  ' display temps
  '
  LCDOUT LCDpin,Line2,[SDEC tempC, DegSym, " C"]
  LCDOUT LCDpin,NoCmd,[" / ", SDEC tempF, DegSym, " F"]
  LCDOUT LCDpin,NoCmd,[REP " "\6]

  PAUSE 1500
  GOTO ShowTemp                           ' update temp display
```

THERE'S A NEW STAMP IN TOWN

that though, make sure you plug each of them into your circuit and record the ROM data using Listing 1. You'll need this information for the program to work. In fact, the program in Listing 2 will only work with my three DS1820s. You'll need to update the **DATA** statements for your sensors.

The bulk of the program is the same as Listing 1. It differs in reading the temperature data from a specific device. Take a look at the subroutine called GetTemp. The address of the first byte of the ROM code is passed in the variable eeAddr. A simple loop reads the ROM code bytes from EEPROM and stores it in the array called romData.

In this program, the MatchROM command is issued, followed by the romData string. The ReadScratch command is issued in the same manner and the subsequent **OWIN** retrieves the temperature from the specified device.

Keep in mind that different types of devices can exist on this single-wire network. The I/O and expansion options are nearly limitless. Take a look at the Dallas Semiconductor (www.dalsemi.com) website for 1-Wire™ devices as new ones are being introduced almost every day.

The final listing, PCF8583.BSP listing 3, demonstrates the BSP's I2C routines by connecting to a real-time clock with RAM. In fact, the PCF8583 is built around a 256-byte RAM and several of the registers are automatically updated.

The PCF8583 typically uses a 32.768 kHz crystal, but it can be driven by a 50 Hz signal, as well (not very useful here in the US, but still an option). This chip can also be configured as an event counter and features an alarm output pin that can save us the trouble of polling and comparing data.

My middle name is "Simple" (okay, not really, but play along), so that's just how we're going to deal with this program. By letting the device power-up on its own, the time is set to midnight, 24-hour mode, and it expects to be driven by a crystal. We'll use a four-button interface to set the minutes, hours, and day-of-week. The fourth button allows us to decrement these values.

After defining I/O pins, constants, variables, and initializing the LCD, the program displays a short splash screen and then enters the main loop. The loop process is simple: we read the clock and day, update the LCD, then scan the buttons. If a button is pressed, the clock is updated and the loop continues.

Since the PCF8583 is register-oriented, we can read and write locations individually or in blocks. The subroutine called GetTimeAndDay retrieves seven bytes from the PCF8583, beginning at address 0. These bytes contain the control, time, and date registers. Most PCF8583 registers hold their data in BCD format, so we use the HighNib and LowNib variable modifiers to convert to standard decimal for our program variables. The day-of-week value is stored in the highest three bits of the register that holds the current month. The right shift operator (>>) lets us move this value into the variable called day.

Our main time variable is called rawTime. This word-sized variable holds the time in minutes past midnight. When updating the clock, we'll actually update rawTime, then pass it to the routine that takes care of sending data to the PCF8583.

The name of the current day is sent to Line 1 of the LCD with the subroutine PrintDay. The day variable is used by a **LOOKUP** table to get the EE address of the zero-terminated string. This technique is nice because you can update your strings without modifying operational code.

The program loops through the BSP's EEPROM, reading each character in the current day name until a zero is encountered. Zero flags the end of the string. Since some strings are longer than others, the end is cleaned up by printing a few spaces.

Printing the time on the LCD is even easier with **LCDOUT** and the DEC2 modifier. One line of code prints the current time on the right edge of Line 2.

The buttons are scanned and debounced with a loop. The idea behind this code is that a button must start pressed and stay pressed through the entire loop for it to be a valid (debounced) button press. The state of the buttons is returned in a nibble with each bit aliased so we can use it to make the update.

Again, the variable rawTime is our master time variable and any updates will be performed on it. This variable holds minutes. When the minutes button is pressed, one is added. When the hours button is pressed, 60 is added. The program uses a trick with the modulus operator (//) to keep rawTime in the range of 0 to 1439. Using the modulus operator means that we can subtract from rawTime by adding (1439 for one minute, 1380 for 60 minutes) and then doing the modulus operation. The day value is handled in the same manner.

The subroutine called PutRawClock takes rawTime and converts it to the proper BCD format used by the PCF8583. The new data is sent to the PCF8583 with **I2COUT**.

I don't know about you, but I'm really excited about the BASIC Stamp SXII+. More functionality, faster, consumes less current ... it's a winner.

Next month, we'll talk about the firmware interrupts and additional I/O support on the 40-pin version of the chip. Until then, Happy Stamping. **NV**

Resources:

Jon Williams
3718 Valley View Lane, #3040
Irving, TX 75062
(972) 659-9090
jonwms@aol.com

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

by Robert Priestley

OZTRIP CAR COMPUTER

The OzTrip Car Computer can be used to display trip information on 27 functions of speed, fuel, time, and distance of a vehicle. These 27 functions are updated every one-second and can be displayed in three quantity display modes effectively giving 81 display functions!

The OzTrip Computer also contains a sprint timer, which is accurate to 1/10th of a second over any distance. This sprint timer is ideal for timing a standing quarter mile (400m).

The computer can be used as a rally computer or even a boat computer. It has diagnostic functions, an optional serial data interface for telemetry and control, and there is even PC software available for virtual dashboard data logging. It could even be used as a general-purpose data logger not even related to vehicles.

Details of all the functions of the OzTrip Computer are listed in Table 1. Each of the 27 display functions has three readings: Metric, US, and Imperial. One US gallon (3.785L) = 0.833 Imperial gallons (4.546L); one mile = 1.604 km.

Every time a new function is selected, a brief message is shown on the display indicating the function number selected. An eight-LED display is used to indicate the information on the display.

Physically the computer measures 140x110x36mm and contains two small printed circuit boards (PCBs), which mount back to back, connected by wire links and resistors. If a fuel flow sensor or data logging features are required, then a third PCB is used to provide these features.

On the front of the computer, a screen-printed, red acrylic panel is used giving the unit a professional look, hiding all LEDS and LED display underneath until they are lit. The four push buttons used to select the various functions emerge through the front panel.

The OzTrip Computer supports two methods of fuel measurement: electronic fuel injection (EFI) by measuring the pulse width of the injector or by using a fuel flow sensor.

Block Diagram

Despite the OzTrip Computer's versatility, the computer contains relatively few components, all of the hard work being performed by a Motorola 68HC705C8 microcontroller. This 40-pin, one-time programmable chip is perfect for this application. It has 4 x 8-bit I/O ports, 384 bytes of RAM, 8K EPROM, 16 bit internal timer, serial port, interrupt pin, and a timer input capture pin. Just about every resource of the controller is used in this application.

We will not attempt to describe the internal workings of the software; it is very complex and coded in assembly. Suffice it to say it manages the data presented to it and presents it in an understandable form. Just about every byte of EPROM space is used to achieve this. Perhaps the best way to understand the circuit operation is to refer to the block diagram in Figure 1.

On the left are the inputs to the microcontroller, the distance input, and the fuel input. The microcontroller counts the number of pulses per second from the distance input to derive speed and measures the injector open time to calculate fuel used.

If a fuel flow sensor is used, then the microcontroller simply counts the number of pulses received from the sensor in one second to calculate the fuel used. It is this raw data that the microcontroller uses to give you the various output functions on the right.

The tone generator with its piezo buzzer is used to acknowledge keyboard inputs and also warn you that you are traveling faster than your preset speed, among other things.

The 8x status LEDS and 4x seven-segment LED displays provide the user with information in an understandable form.

The four-button keypad is used to select the various functions of the OzTrip Computer and enter numerical values when required.

The optional serial interface (bottom left) is used if you really want to get serious and input and/or extract data from the computer. A typical application here would be a laptop computer, which could be linked by a radio data link or mobile phone. The data rate is 9600 baud.

There is also a five-volt power supply for the controller and most of the circuitry, and a variable supply for the display. The display can be dimmed for night-time driving by making a connection to the headlights.

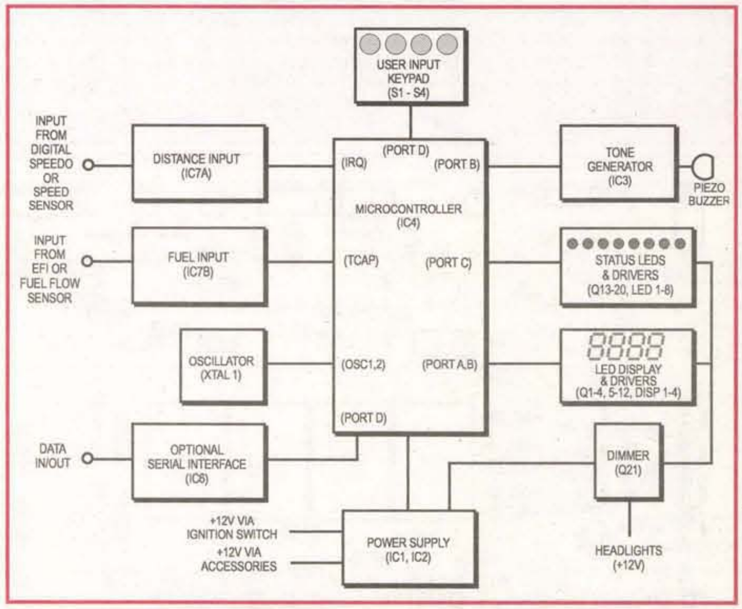
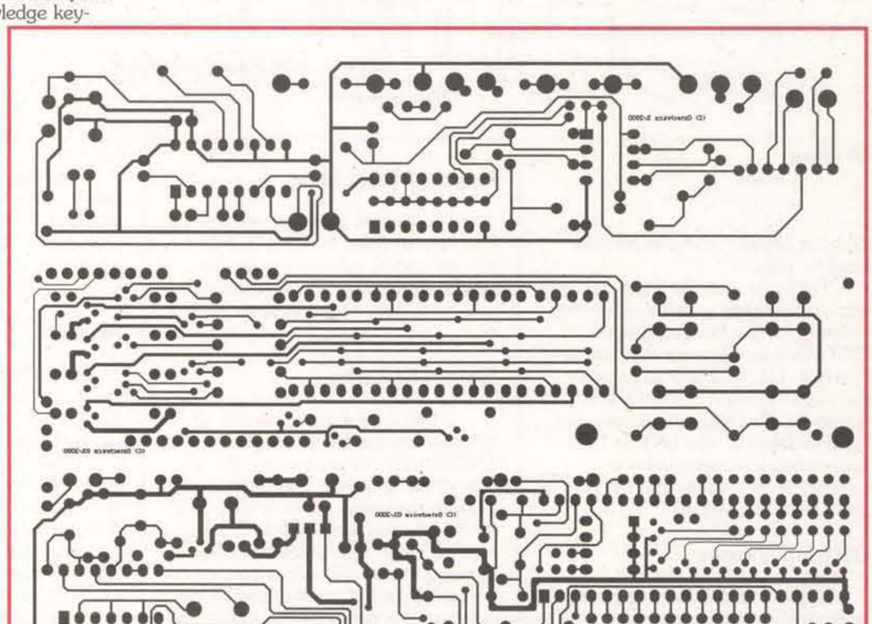


Figure 1 — Despite its versatility, the OzTrip can be broken down into just a few elements.



Bot Layer

Display Interface

The display consists of four multiplexed 0.56" seven-segment displays and eight indicator LEDs. The seven-segment displays are used to display messages and values. The messages

Metric	US	Imperial	Display
F 1	F 28	F 55	Current Speed
F 2	F 29	F 56	Average Speed
F 3	F 30	F 57	Peak Speed
F 4	F 31	F 58	RPM (only works in EFI Mode)
F 5	F 32	F 59	Trip 1 Up Counter (Journey Counter)
F 6	F 33	F 60	Trip 1 Down Counter
F 7	F 34	F 61	Trip 2 Up Counter
F 8	F 35	F 62	Trip 3 Up Counter
F 9	F 36	F 63	Distance to Empty based on average fuel consumption (Trip1)
F 10	F 37	F 64	Distance to Empty based on current fuel consumption
F 11	F 38	F 65	Fuel Used during Trip1 (Journey)
F 12	F 39	F 66	Fuel Remaining in Tank
F 13	F 40	F 67	Average Fuel Consumption (Km/L, m/g) (Trip1)
F 14	F 41	F 68	Current Fuel Consumption (Km/L, m/g)
F 15	F 42	F 69	Average Fuel Consumption (L/Km, g/m) (Trip1)
F 16	F 43	F 70	Current Fuel Consumption (L/Km, g/m)
F 17	F 44	F 71	Fuel Flow Rate per hour
F 18	F 45	F 72	Fuel Trip1 (Journey) Cost
F 19	F 46	F 73	Fuel Total Cost
F 20	F 47	F 74	Elapsed Time of Trip1 (Journey)
F 21	F 48	F 75	Time Remaining at Average Speed to end of Journey (Trip1)
F 22	F 49	F 76	Time Remaining at Current Speed to end of Journey
F 23	F 50	F 77	Elapsed Time of Trip 2
F 24	F 51	F 78	Elapsed Time of Trip 3
F 25	F 52	F 79	Total Elapsed Time of Engine
F 26	F 53	F 80	Total Fuel Used by Engine
F 27	F 54	F 81	Total Distance Travelled

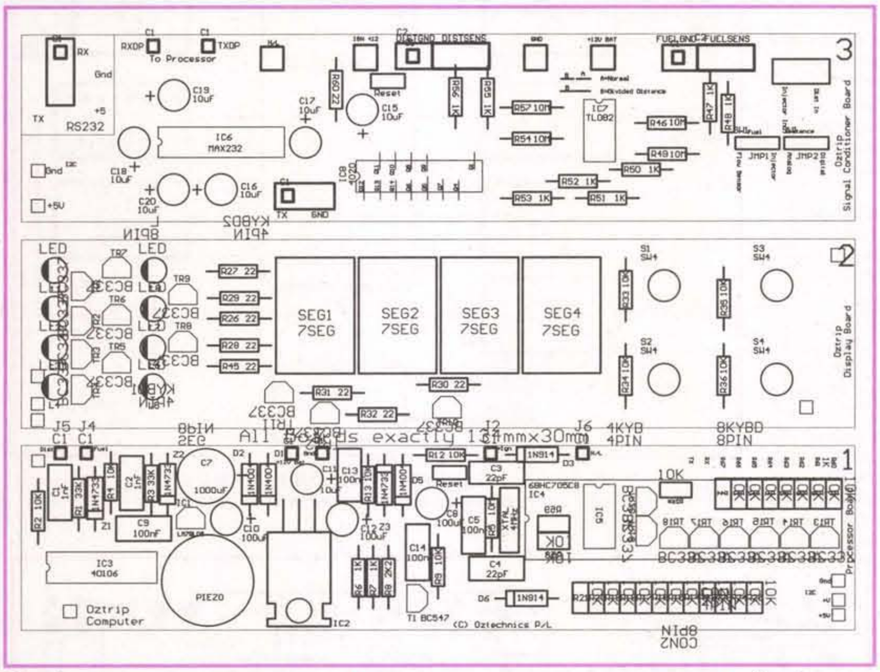
Table 1. Computer Functions.

7 Segment Display	Description
Rst	Reset Computer
EFI	Electronic Fuel Injection Mode
CAL	Calibrate
Done	Done / complete
Err	Error
Trip	Trip
Fuel	Fuel
CoSt	Fuel Cost
Flo	Flow Sensor Mode
Hold	Freezes Counters
DiAg	Diagnostics
USEd	Used
Tach	Tacho
Clr	Clear
In	Fuel Entered Into Tank

Table 2. Display Messages: Here's how to decode the various LED messages.

FUEL	NOW
DIST	AVG
TIME	REM
SPEED	ENTER

Table 3. LED Functions: The eight indicator LEDS are split into two columns.



Overlay

that can appear on the display are listed in Table 2.

The eight indicator LEDs are split into two columns which indicate the current function being displayed, i.e., DIST REM for Distance Remaining of Journey. The LED indicators cover the main functions of the OzTrip Computer. The LED's indicators are listed in Table 3. The ENTER LED lights when a numeric value is required to be entered into the computer from the keypad.

Display Values

The computer has four physical digits and a maximum display resolution of six digits. When a value exceeds the four-digit physical resolution, the computer alternates the display between the last four least significant digits and the first two most significant digits on a 5:1 second ratio.

The ranges that can be displayed are listed in Table 4.

Keypad Interface

The keypad interface consists of four keys as listed in Table 5. Some actions require two keys to be simultaneously pressed. The key functions and combinations are listed in Table 6.

Entering Values

When a value is required to be entered into the computer, the ENTER LED illuminates and the display clears to 0. The computer accepts the values entered according to the function range selected, i.e., F1-F27 metric, F28-F54 US, F55-81 Imperial format. All values entered are converted back to metric, and all calculations are performed in metric and displayed in the selected function range.

To enter a value, use the "+" and "-" keys to select the value of the digit, the Set/Clear key to lock the current digit in and scroll the display to the left for a new digit, and the Mode/Enter key to insert a decimal place. The second time the Mode/Enter key is pressed it acts like an Enter key and the value displayed on the screen is locked into the computer.

If the Set/Clear key is pressed twice in succession within 3/10ths of a second, it clears the display, leaving it ready for a new entry.

Note the computer will accept up to two decimal places; enter any more and the computer will display the "Err" message and clear the display ready for another attempt.

If no decimal places are required to be entered, then the Mode/Enter key has to be pressed twice to enter the value. The first press inserts a decimal point, which has no effect on the value of the number entered, and the second press of the Mode/Enter key acts as an enter function.

The computer can accept input values up to 999.99, even though the first digit scrolls off the display. For example, to enter "19.1" into the computer, you would use the sequence of keys shown in Table 7.

Menus

In addition to the 27 functions which can be selected, two-sub menus are available for diagnostic and calibration functions.

When the diagnostic menu is accessed with the UP + Set/Clear key sequence, a "diAg" message is briefly displayed, then the ENTER LED lights. You must enter a value between 1-5 into the computer to select the appropriate diagnostic function.

When a menu is accessed, the computer stops some of its periodic calculations. On exiting the menu, some functions may display an incorrect value until the next calculation is performed. Calculations are performed every one-second. The diagnostic functions are listed in Table 8.

When the calibration menu is accessed with the Down + Set/Clear key sequence, a "CAL" message is briefly displayed, then the ENTER LED lights. You must enter a value between 1-7 into the computer to select the appropriate calibration function. The calibration functions are listed in Table 9.

Speed Alarm

The speed alarm can be set and cleared when the speed is displayed, i.e., Functions 1, 28, or 55. Pressing the Set/Clear key when the speed is above 40Km/h will set the speed alarm. When this speed is exceeded by 5 Km/hr, the speed alarm is sounded at one second intervals for 500mS and the computer display switches to the Speed Display, Function 1. To disable the speed alarm, press the Set/Clear key when the speed is below 40Km/h.

Sprint Timer

The sprint timer is used to time the acceleration of the vehicle over any set distance, typically 400m (1/4 mile). When this option is selected from the Cal Menu Option 7, the computer asks for the "Dist" — distance to be timed over — and then a nine-second countdown starts. When the countdown reaches 0000, a BEEP is heard and the timer starts. When the vehicle travels the entered distance, the timer is frozen displaying the time duration down to 1/10th of a second. Press the Mode/Enter key to return to normal operation.

Journey Counter

The journey counter is the main distance/timer counter and is represented by the Trip 1 Counter, F5 (distance) and F20 (time). The functions which are derived from the journey counter are F2, F9, F11, F13, F15, F18, and F21. When the computer is RESET using the Mode/Enter + Set/Clear combinations, the Distance Traveled on the Trip1 counter is copied to the Distance Remaining Function (F6) and the Trip1 counters are cleared ready for a new journey.

If the same trip is being traveled, then the distance remaining in F6 is already set, otherwise it will have to be entered for correct operation. If the distance remaining of journey is not entered or is incorrect, then the distance remaining of journey (F6) and time remaining at current/average speed to complete journey (F23/F24) will be incorrect.

EFI Operation

The OzTrip Computer measures

F1, F2, F3	0 → 999 km/hr
F4	0 → 9999 RPM
F5, F6, F7, F8	00.00 → 4294 Km
F18, F19	00.00 → $9999
F20, F23, F24	00.00 min/sec → 99.59.59 hrs/min/sec
F25	0 → 999,999 hours
F26	0 → 42,949 litres
F27	0 → 294,967 Km

Table 4. Display Values: The range of values displayed for the various functions.

+	Mode / Enter
-	Set / Clear

Table 5. Keypad Arrangement.

the fuel flow of an EFI engine by measuring the time one injector is open.

At different RPMs and under different engine loads, the time the injector is open is varied by the EMC for maximum operating efficiency.

The main components of the EFI engine fuel delivery system include the fuel pump, pressure regulator, fuel rail, and fuel injector valve.

The pressure in the fuel rail — which feeds the injectors — is kept at a constant by the pressure regulator. Because the pressure is kept at a constant, the fuel flow through each injector on average is the same, so we only need to measure one injector to determine the total fuel flow.

In other words, the fuel flow is directly proportional to the injector open time, and by measuring the injector open time, we can calculate the fuel consumption.

Before we can determine fuel flow, the computer needs to be calibrated so it can relate fuel consumption to injector open time. This is achieved by measuring the total injector open time over a full tank of fuel, then entering the total fuel used during the calibration process into the computer. The OzTrip Computer has a special calibration mode which makes this easy to do. Calibration can be performed over several days, if required. The greater the volume of fuel used during calibration, the more accurate the calibration process is.

This method of fuel measurement is only suitable for EFI engines with one injector per cylinder and constant fuel rail regulation.

The fuel calibration number for a V6, 4.0L engine is around 440. The calibration number is proportional to the fuel burn rate, i.e., increasing the calibration number will show more fuel used.

EFI Calibration

To calibrate the computer for EFI operation:

1. Fill the fuel tank to full.
2. Ensure the "EFI" Mode is selected (Cal Menu Option 7).

Select the Fuel Calibrate Mode from the Cal Menu Option 3 to start calibration. During calibration the message "Fuel," "CAL," "EFI," "value" will be displayed. The "value" represents the total pulse width time. This value must not exceed "4294." Drive the vehicle for as many trips as required until 80-99% of the fuel tank is used or the value approaches "4294." If you exceed the value of "4294," then an error message will be displayed and you will have to start calibration again.

When the value reaches "3500," the computer will beep to indicate that it is approaching the end of its calibration range. When calibration is complete, fill the tank and note how much fuel was used. Press the Mode/Enter key and then the computer will ask you to enter the Fuel Used. Calibration complete!

It is a good idea to take a note of the fuel calibration number using Cal Menu Option 4. If the computer loses its settings, you can manually input the calibration number without having to re-calibrate the computer.

Fuel Flow Sensor Calibration

To calibrate the computer for Flow Sensor operation, ensure the "FLO" Mode is selected (Cal Menu Option 7). Select the Fuel Calibrate Mode from the Cal Menu Option 3. Enter the flow sensor calibration factor as number of pulses per 0.1L of fuel used. The sensor used by Oztechnics has a fuel calibration factor of 780. Calibration is now complete.

Speed Sensor

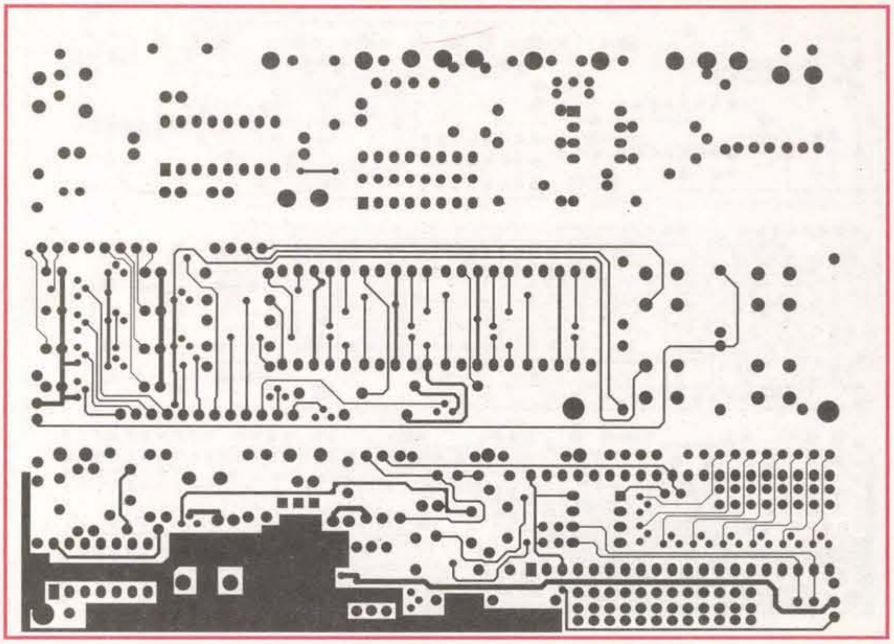
The OzTrip Computer requires a digital (TTL) input from a speed sensor. Most new cars have an electronic speedo fitting, which produces a TTL type signal. If your car has such a speedo, connect the distance input of the computer to the electronic speedo sensor. Most speed sensors typically produce eight pulses per wheel revolution. The computer can operate from 1 to 20 pulses per wheel revolution. Eight pulses per wheel revolution is the optimum number of pulses for the computer.

Speed sensors are available in several types including inductive pick-up (analog output), Hall-Effect (digital output), Proximity switch (digital output), and Speedo Sensor Cable type (both analog and digital outputs).

Speed Calibration

Speed sensor calibration can be achieved in two ways:

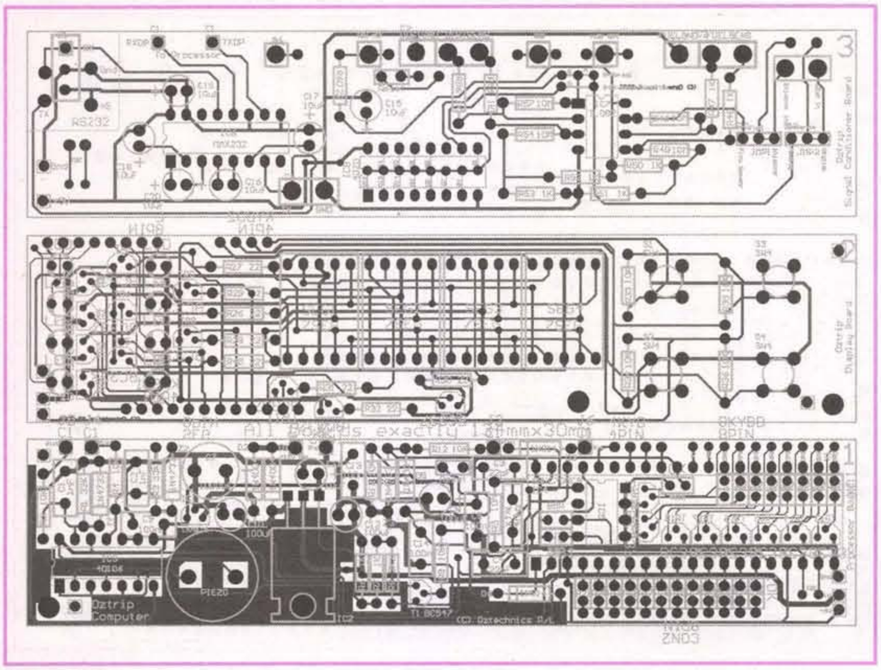
1. By using the Cal Menu Option 1, automatic calibration mode. This requires you to drive a known distance while the computer counts the pulses from the speed sensor. During calibration, the computer displays the message "DiSt," "CAL," "value," where "value" represents the number of pulses received from the speed sensor. Once a known distance



Top Layer

Key	Function	Key Value
(+) Up	1. Increment Display Function 2. Increment Keyboard Input	0
(-) Down	1. Decrement Display Function 2. Decrement Keyboard Input	1
Mode/Enter	1. Function + 27, Toggle Metric--> U.S.--> Imperial display format 2. Decimal Point 3. Enter Key	2
Set/Clear	1. First Press acts as a Set Function only for the following selected functions, - Functions 1,28,55 (Speed) - Set Speed Alarm - The current speed (+ 5) is stored and when exceeded the speed alarm sounds (same as Up + Mode/Enter). - Functions 6,33,60 (Distance Remaining of Journey) - Enter the journey distance to be undertaken. - Functions 12,39,66 (Fuel Remaining) - Enter the fuel added to the tank and cost. 2. Second Press acts as a Clear Function only for the following selected functions: • Functions 5,32,59 - Zero Trip 1 Counter • Functions 7,34,61 - Zero Trip 2 Counter • Functions 8,35,62 - Zero Trip 3 Counter • Functions 11,38,65 - Zero Fuel used in Trip • Functions 19,46,73 - Zero Fuel Cost • Functions 20,47,74 - Zero Trip 1 Timer • Functions 23,50,77 - Zero Trip 2 Timer • Functions 24,51,78 - Zero Trip 2 Timer • Functions 25,52,79 - Zero Elapsed Time of Engine • Functions 26,53,80 - Zero Total Fuel Used • Functions 27,54,81 - Zero Distance Travelled	3
Up + Mode/Enter	Function + 5	4
Down + Mode/Enter	Function - 5	5
Mode/Enter + Set/Clear	Reset Function - Used to start a new journey by Resetting values. The "Rst" message is displayed for 3 seconds during which time the Set/Clear Key must be pressed to Reset the computer. The "Done" message is displayed when correctly Reset.	6
Up + Down	Set Speed Alarm (current speed + 5)	7
Up + Set/Clear	Enter Diagnostics Menu - Enter 1-5 for options, 1. Distance Input Test 2. Fuel Input Test. 3. Display Injector Pulse Width 4. Keyboard Test	8
Down + Set/Clear	Enter Calibrate Menu - Enter 1-7 1. Calibrate Fuel 2. Modify Fuel Calibration Number 3. Calibrate Distance 4. Modify Distance Calibration Number 5. Calibrate Tacho (EFI Mode only) 6. Sprint Timer 7. Fuel Mode, EFI or Fuel Sensor 8. Reset Computer, Clear Memory	9
Up + Down + Mode/Enter	Hold – Freezes the counters (Up + Down + Mode/Enter = Normal)	10

Table 6. Key Combinations and Functions.



Composite

Step	Key Press	Display	Action
		0	
1	(+)	1	Increment
2	SET/CLEAR	10	New digit
3	(-)	19	Decrement
5	Mode/ENTER	19.0	Decimal point
6	(+)	19.1	Increment
7	Mode/ENTER		Finished

Table 7. Example of entering a numerical value into the computer.

has been traveled — typically 1-5 km — the Mode/Enter key is pressed to end counting and the distance traveled is entered. The computer divides the distance traveled by the number of pulses counted and stores the value as a calibration number. It is a good idea to record the distance calibration number using Cal Menu Option 2 — View Modify Speed Sensor Calibration number, so that if power is lost, you can manually enter the number into the computer without having to repeat the entire calibration process.

2. By manually calculating how many mm's each pulse from the speed sender represents, and entering the value in number of mm's using Cal Menu Option 2. This number can be calculated by determining the diameter of the tire and dividing it by the number of sensor pulses per wheel revolution.

Telemetry

A Windows95/98 Virtual Dashboard application is used to display the OzTrip Computer's telemetry. It is also possible to control the OzTrip Computer from this application.

A two-way serial data link is used between the OzTrip Computer and a PC. The data from the microcontroller needs to be RS232 translated. This is achieved on the Signal Conditioning Board 3.

The Virtual Dashboard Visual Basic source code is available so that it can be customized for individual applications.

Circuit Description

The speed conditioning circuit consists of R2, C1, ZD1, and R1 which are used to protect the input to Schmitt trigger IC3f, which produces a clean digital signal to the interrupt input (pin 2) of the controller, IC4.

Similarly, the fuel input conditioning circuit consists of R4, C2, ZD2, and R3 and is identical to the speed input protection. Two Schmitt triggers are used — IC3e and IC3d — so that pulse is not inverted. The output of IC3d is connected to the timer capture input, pin 37 of the controller.

The microcontroller oscillator circuit consists of C3, C4, a 4MHz crystal (X1), and R5.

The microcontroller RESET and Accessories sense circuitry is formed around R12, R26, and ZD3. Because of the likelihood of noise coming in from the ignition wiring, these components protect the inputs to the controller by clipping any voltage above 5V. D5 and D6 provide additional protection while R13 and C14 form a delay network to the input of the RESET pin.

When the accessories are switched off, the RESET pin is at 0V, holding the controller in a low power state. When the accessories are switched on, the voltage at the RESET input pin is pulled high by R12 after a short delay while C14 charges. Eventually C14 is charged to +5V, taking the controller out of RESET.

The controller uses PB5 pin 17 to hold the RESET pin high. When PD3 senses the accessories have been switched off, the controller executes a shut down procedure and clears the PB5, causing the voltage at the RESET pin to fall to 0, and placing the controller in RESET. If the accessories input was used to directly control the RESET input, then correct controller shut down could not be guaranteed and data could be lost.

Moving now to the controller's output ports (there are four of them), we can see that PortA is used to drive the individual seven segments of the four seven-segment displays via transistor buffers Q5-Q12. The controller multiplexes all of the segments. To switch all of the segments on, the controller drives the output pins PA low.

Port B0-B3 is used to address the appropriate seven-segment displays via transistor buffers Q1-Q4.

PortB (B4) is used to drive the audible tone generator, formed by IC3A, B, and C, and a piezo buzzer. When IC3A input is pulled low by PB4, the three inverters hold the piezo input high. But when PB4 goes high, the output goes low, allowing the piezo transducer to sound.

PortC is used to drive the eight indicator LEDs via transistor buffers Q13-Q20. Eight 1K resistors are used for current limiting of the LED indicators. These resistors are connected between the two boards, not only forming the circuit elements, but also providing mechanical rigidity.

PortD 7, 5, 4, and 3 are connected to the four push buttons or "keys" (S1-S4). Each of the four inputs is normally pulled high by a 10K resistor, and pressing a key pulls its input low. The controller samples the keyboard inputs 200 times per second, or every 5mS.

PortD 0,1 provides the RX and TX serial communications. This section of the circuit is optional, IC6 and C16-C20.

The power supply is split into two. A permanent +5V supplied by

Diagnostic Menu	Function
1	Distance Input Test The computer displays a count starting from zero of the number of pulses it receives from the Distance Input. The display can be Zeroed by pressing the Set/Clear key. To Exit the test press the Mode/Enter Key.
2	Fuel Input Test The computer displays a count starting from zero of the number of pulses it receives from the Fuel Input. The display can be Zeroed by pressing the Set/Clear key. To Exit the test press the Mode/Enter Key.
3	Injector Pulse Width Only available in EFI mode, the computer measures the injector pulse width presented to the Fuel Input. The display is calibrated in microseconds, for example 4000 represents 4mS. To Exit press the Mode/Enter key. The computer holds the last measured PW on the display.
4	Keyboard & Display Test Selecting the various key combinations displays the appropriate key value and its value is written to the display. To Exit the test, do not press a key for five seconds.

Table 8 – Diagnostic Menu Options

Calibrate Menu	Function
1	Calibrate Fuel - Flow Sensor Mode - Enter flow sensor calibration number per 0.1L. The Flow Sensor used by Oztechnics produces 780 pulses per 0.1L of fuel. - EFI Mode – the computer measures the Pulse Width of the injectors over a known quantity of fuel used. While in Fuel Calibrate mode the message "Fuel", "EFI", "Cal", "value" is displayed where "value" is the total PW of the injector. The "value" must not exceed 4294 otherwise an error message "Err" will be displayed and calibration aborted. The Mode/Enter Key ends the EFI calibration then the "Fuel", "Used" message is displayed where the Fuel Used must be entered into the computer. The computer gives warning BEEPS from the 80% calibration point indicating it is time to end fuel calibration before a computer overflow condition occurs.
2	Modify Fuel Calibration Number The Fuel calibration number is first displayed briefly before you input a new calibration number. If you choose not to change the value, only press the Mode/Enter key or let the input routine time out.
3	Calibrate Distance Sensor The "Cal," "Dist," "count" message is displayed where "count" represents the number of pulses from the distance sensor. Once a know distance is travelled (1-5km) the Mode/Enter key is pressed and the "Dist" message is displayed briefly indicating to enter the distance travelled during the calibration process.
4	Modify Distance Sensor Calibration Number The Distance calibration number is first displayed and then you input a new value. If you choose not to change the value, only press the Mode/Enter key or let the input routine time out.
5	Calibrate Tacho For EFI mode only. The default calibration number is 120, which represents the number required to multiply the injector count in 0.5 second to convert to RPM.
6	Sprint Timer Used to measure the time down to 1/10's the vehicle takes to travel a specified distance, typically 400m. Enter the Distance to travel after the "Dist" message is displayed and then a 9 second count down occurs. Once the vehicle has travelled the specified distance the timer is frozen on the display. Pressing a key while the timer is active aborts the timer and freezes the display. Pressing any key exits the function.
7	Select Fuel Operating Mode Use the "+" & "-" keys to select between EFI or Flow Sensor operation. Default "EFI."

Table 9 – Calibrate Menu Options

IC1, a 78L05 regulator, is used to supply the controller and logic while IC2, a LM317 variable regulator, is used to supply the variable display voltage.

When the headlights are switched on, transistor Q21 is turned on via D3 and the 10K resistor. This effectively shorts the 2.2K ohm resistor, which lowers the output of the LM317 voltage regulator. This has the effect of dimming the display for nighttime driving.

Provision has been made on the PC board for six components not used in this version of the computer IC5, IC8.

Construction

The OzTrip Car Computer is available in two versions depending on engine type, telemetry, and sensors required. The basic unit requires two PCBs and only accepts digital type pulses from the sensors.

If data telemetry, a fuel flow sensor, or an analog speed sensor is used, then a third signal board needs to be added ahead of the main computer to condition the analog signals from the flow sensor/speed sensor or perform RS232 translation.

If a flow sensor with a digital TTL type output is used, then the signal board is not required. The flow sensor used by Oztechnics is an inductive type, which produces an analog output, which requires signal conditioning to drive the front end of the computer.

Assembling the boards is made easy by following the component mask printed onto the PCBs. Board 2 has components mounted on both sides of the PCB. You must solder the components on the bottom side first as IC1 socket hides resistors R26*, R37-R44, and transistors TR13-T20, which are mounted on the bottom side of Board 2. Resistors R37-R44 are mounted on their ends.

A 4K7 resistor, R, is soldered on the backside of Board 2 between pins 1 and 7 of IC3.

Note there is provision for mounting IC5 (serial EEPROM), R58, and R59 (10K) on the solder side but it is not used in this application.

A step-by-step assembly manual is available for download from the Oztechnics website.

Resistor Color Codes

Value	Four-Band Color Code
22	Red Red Black Gold
1K	Brown Black Red Gold
2.2K	Red Red Red Gold
4.7K	Yellow Violet Red Gold
10K	Brown Black Orange Gold
33K	Orange Orange Orange Gold
10M	Brown Black Blue Gold

Table 11. Resistor Color Codes

Parts List – Signal Board 3

Quantity	Description	Designation
8	1K	R47, R48, R50, R51, R52, R53, R55, R56
1	22	R60
4	10M	R46, R49, R54, R57
7	10uF	C15, C16, C17, C18, C19, C20
1	4020	IC8
1	MAX232	IC6
1	TL082	IC7
2	16 pin IC sockets	
1	8 pin IC socket	
1	TRIP-PCB3	

Table 12. Optional Board 3 components.

Testing

After assembling the computer:

1. Apply +12VDC and ground to the respective inputs. Nothing should happen

2. Apply +12V to the accessory input. You should hear a BEEP out of the computer and a message displayed on the display "tRiP" computer, version "1.2." Disconnecting the accessory input from the +12V should shut the computer down.

3. Check that the keyboard is functioning correctly by pressing every key; a BEEP should be heard every time a key is pressed. Use the Diagnostic Menu Option 4 to check all the key combinations.

4. Check the display and use the Diagnostic Option 4 to cycle through all of the display.

5. Check the speed input by using the Diagnostic Option 1 and pulsing the speed input with a voltage between 5-12VDC. The display should register the pulses. Remember the display might jump up very quickly because the input is very sensitive.

6. Check the fuel input by using the Diagnostic Option 2. If the computer has been configured for EFI operation, pulse the input with a 5-12VDC signal to trip the counter. If the flow sensor is connected, blow into the sensor and it should register on the display.

7. Test the display-dimming feature by connecting +12VDC to the head light input.

8. Testing complete. Install into vehicle.

Note there is a DOS-based application on the Oztechnics website (EFI.EXE) which is used to create pulses on the parallel printer port. You can make a connection from the PC to the computer to test the inputs to the computer. The software allows you to vary the pulse width and frequency of the signal on the data pins (2-11) on the parallel port.

Installation

The computer requires:

- Permanent +12VDC (battery) supply.
- Accessories connection (switched +12V).
- Speed sender connection.
- Fuel connection .
- Optional headlight connection so that the display can be automatically dimmed when the headlights are switched on.

The engine type determines the fuel sender connection. For carbureted engines, a fuel flow sensor is required. The fuel flow sensor selected by Oztechnics is an inductive type, which requires signal conditioning to drive the digital input to the computer. Signal conditioning for the flow sensor is achieved on Board 3.

For EFI engines, a direct connection is required from the OzTrip Computer fuel input to the injector. The injector has two connections: one side of the injector coil is connected to +12VDC and the other side is connected to the engine management computer (EMC).

The OzTrip Computer must be connected to the EMC side of the injector. It is sometimes easier to make the injector connection directly across the EMC computer, which is usually located in the front passenger foot well or under the dashboard.

If installing a fuel flow sensor, mount the sensor away from ignition noise and heat sources. For best operation, mount the sensor in a vertical position so that the fuel enters from the bottom of the sensor. Screened cable must be used to connect the sensor to the computer and the shield of the cable must be tied to ground. This can be done at the computer end. The flow sensor used by Oztechnics produces 780 pulses for every 0.1 liters of fuel which flows through it. The OzTrip Computer needs the calibration number entered into it so it can calculate the fuel flow. **NV**

Parts List

Quantity	Description	Designation
8	22	R26, R27, R28, R29, R30, R31, R32, R45
10	1K	R6, R7, R60, R61, R62, R63, R64, R65, R66, R67
21	2K2	R8, R14-R25, R37-R44
1	4K7	R (pin 1 & 7 of IC3)
10	10K	R2, R4, R9, R12- R13, R26*, R33-R36,
2		33K R1, R3
1	10M	R5
2	22pF	C3, C4
2	1nF (102)	C1, C2
4	100nF (104)	C5, C9, C13, C14
1	10uF	C11
3	100uF	C8, C10, C12,
1	1000uF	C7
3	1N914	D3, D5, D6
2	1N4004	D1, D2
3	1N4733	Z1, Z2, Z3
4	SA56-21SRWA	SEG1, SEG2, SEG3, SEG4
1	4MHz	XTAL
1	BC547	T1
20	BC559	TR1, TR2, TR3, TR4, TR5, TR6, TR7, TR8, TR9, TR10, TR11, TR12, TR13, TR14, TR15, TR16, TR17, TR18, TR19, TR20
8	LED 3mm RED	L1, L2, L3, L4, L5, L6, L7, L8
4	PCB Push buttons	S1, S2, S3, S4
1	40106 OR 74C14	IC3
1	68HC705C8	IC4
1	LM78L05 (TO-92)	IC1
1	LM317 (TO-220)	IC2
1	PCB Piezo	PIEZO
2	10mm Spacer	
4	Bolts	
1	Instrument Case	
1	Front Filter Panel	
1	TRIP-PCB1	
1	TRIP-PCB2	

Table 10. Note there are 2 x R26 resistors on the PCB. R26* is a 10K installed on the solder side of the board under the controller.

Electrical Characteristics

Characteristic	Typical
Supply Voltage	12VDC
Supply Current	
1. Operating	150mA
2. Off	11mA
Speed Input Trip Voltage	5V
Injector Trip Voltage	12-0-12V

Project Details

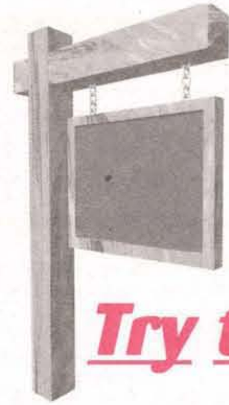
This project and software is Copyright to Oztechnics Pty Ltd. A full kit can be purchased from Oztechnics. You can place your order on-line from the Oztechnics secure web server or make inquiries via email or FAX. Visa and MasterCard accepted. All components, case, and laser cut screen-printed front panel filters are included in the kit. A comprehensive user and construction manual is available for download, as well as some PC test software from the Oztechnics website.

Oztechnics Pty Ltd.
P.O. Box 38
Illawong NSW 2234
AUSTRALIA
www.oztechnics.com.au
information@oztechnics.com.au
FAX: +61-2-9541-0734

OzTrip V1.2 Car Kit	AUD $110.00	~US $66.00
OzTrip Interface Board	AUD $45.00	~US $27.00
Fuel Flow Sensor	AUD $110.00	~US $66.00
Air Mail	AUD $25.00	~US $15.00

~ US prices subject to exchange rate fluctuations.

ADVERTISER INDEX



Got something to sell?

Try the classifieds!!

TYPE or PRINT your **ELECTRONICALLY RELATED** ad copy **CLEARLY (not all caps)** on a separate piece of paper. Spell out words when submitting handwritten copy. Calculate the number of words and multiply it by the appropriate rate (see RATE PER WORD section). Include any charges for **bold** and/or CAPPED words, any artwork costs that would be applicable, and/or costs for boxing your ad (explained below). Choose the appropriate classification for your ad(s) to appear in (see below). If no classification is indicated, it will be placed in Misc. Electronics or wherever we deem most suitable. **Enclose your name, address, phone number, and *Nuts & Volts* account number from your mailing label** (if available) for identification purposes. Include full payment — **CLASSIFIEDS RUN ON A PRE-PAID BASIS ONLY** — and mail your completed order to:
NUTS & VOLTS MAGAZINE, 430 Princeland Ct., Corona, CA 92879.

RATE PER WORD

The ad rate for **current PAID subscribers** is **60¢** per word. All others pay **$1.20** per word. There is a **$9.00 minimum** charge per ad per insertion.

WORDS IN BOLD AND/OR ALL CAPS

Words to be set in **bold** or CAPS are each 10¢ extra PER WORD. **BOLD CAPS** are 20¢ extra per word. The first two words of each ad are bold capped at no charge. Indicate bold words by underlining. Words normally written in caps (e.g., IBM) and accepted abbreviations such as VAC or MHz are NOT charged as all cap words. Use a two-letter abbreviation for states.

PHOTOS, DRAWINGS, AND BOXES

A photo or drawing may be run at the top of your classified ad for an additional **$10.00** (1" depth max.) for camera-ready art. No wording is allowed in this area. To **BOX** your ad, include an additional **$50.00** for copy-only ads, or **$75.00** for ads with art or photos. Photos may be emailed to classad@nutsvolts.com.

EMAILING OR FAXING IN AD COPY

You may email or fax in ad copy or changes before the closing date (5:00pm on the **5th**) using MasterCard or Visa. Include credit card expiration date, the name that appears on the card, a daytime phone number, and your *Nuts & Volts* account number. Email ad(s) to classad@nutsvolts.com or fax to 909-371-3052. Ads without credit card information will not be listed as received until payment is received in full. **WE DO NOT CALL, EMAIL, OR FAX BACK VERIFICATION OR QUOTES OF EMAILED AND FAXED-IN ADS.** For verification of emailed or faxed-in ads, please call 909-371-8497.

DEADLINE

Prepaid ads received by 5:00pm on the **closing date (5th of the month)** will appear in the following month's issue. Ads postmarked through the **5th**, but received after the closing date, will be placed in the next available issue. No can ellations or changes after the 5th. Cancellations and changes must be submitted in writing.

IMPORTANT INFORMATION

All classified ads are running copy only. No special positioning, centering, dot leaders, extra space, etc. is allowed. All advertising in *Nuts & Volts* is limited to **electronically related items ONLY**. All ads are subject to approval by the publisher. We reserve the right to reject or edit any ad submitted. We do not take ad copy or changes over the phone. We do not bill for classified ads. Repeat ads or ads run in multiple classifications within the same issue are allowed. Paid subscribers may run ads at the 60¢ rate only through their subscription expiration date. **NO REFUNDS**. Credit only. No credit for typesetting errors will be issued unless you *clearly* print or type your ad copy.

Choose a category for your ad from the classifications listed below.

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

Product/Category INDEX

Find what you need FAST

AMATEUR RADIO & TV

ASSEMBLY SERVICES

BATTERIES/CHARGERS

BUSINESS OPPORTUNITIES

BUYING ELECTRONIC SURPLUS

CABLE TV

CB/SCANNERS

CCD CAMERAS/VIDEO

CIRCUIT BOARDS

COMPONENTS

COMPUTER

Hardware

Software

Microcontrollers / I/O Boards

Printers/Printer Supplies

DESIGN/ENGINEERING SERVICES

EDUCATION

EVENTS/SHOWS

KITS

LASERS

MISC./SURPLUS

PROGRAMMERS

PUBLICATIONS

RF TRANSMITTERS/ RECEIVERS

ROBOTICS

SATELLITE

SECURITY

SOLAR EQUIPMENT

STEPPER MOTORS

TELEPHONE

TEST EQUIPMENT

TOOLS

WIRE/CABLE & CONNECTORS

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**

Don't forget to check out the new online electronics forums at the *Nuts & Volts* website. There are currently boards for discussing Robotics, Microcontrollers, Radio, Computers, and a General forum for discussing any electronic topic at all. We'll even add new dedicated boards for hot topics. Just let us know!

I have a 10-year-old 27" color TV and the horizontal output is starting to sag.

When there are bright (especially white) areas on the right edge of the screen, the entire scan lines corresponding to the bright areas are shifted to the left.

When venetian blinds are displayed it looks very wavy.

I have examined the 500V flyback primary voltage and the hsync driver transistor waveforms and they look okay.

My question: is this a case of "tired flyback?" Does age affect the coils or just the diodes? I don't have an HV probe, so I can't examine the CRT high voltage, which seems scary, anyway.

It's a great set, and a new flyback and a proalignment/adjust would cost much less than a new one.

#12001 — **Greg Morris, Boulder, CO**

I am using an HTX-10 10 meter radio with 25 watts PEP into a Hooker 100 amp. To make it legal, I'm using a big lowpass filter.

Is the 25 watts too much input? What resistors should I change?

Does a schematic of the Hooker 100 exist?

#12002 — **Anthony Glen, via Internet**

I need help on how to hook up a "record your own 10-second message" device — operating on four A74 button batteries — on the phone line so that my own recorded message can be heard by both parties and repeated every minute (or less), either getting its entire power supply from the phone line or through an AC adaptor, but not both. Yes, this device has a momentary N.O. switch.

Could someone please help me with a diagram ?

#12003 — **Dan Ghergher, via Internet**

I'm looking for a circuit for an "automatic on/off" feature that will switch power to a home-brew powered sub-woofer whenever the main audio system is energized.

The circuit should use the speaker wires from the main amplifier as a sense input to control the power to the sub-woofer.

Has anyone got a workable circuit or a pointer to a schematic?

#12004 — **Len Kastner, Moneta, VA**

I restore old cars and I am trying to replace a 'seatbelt reminder' timer which is no longer available.

The timer should activate a 12V bulb for approximately 30 seconds and turn off. The simpler the better.

Can someone point me in the right direction to locate a circuit diagram or off-the-shelf solution?

#12005 — **David Cavender, via Internet**

What I am wanting to build is a DC six-volt photo cell timing circuit wildlife feeder that will feed dawn and dusk.

#12006 — **Robin Williams, via Internet**

I am looking for a delayed paging circuit. This circuit would record a message and play it back over a paging system.

The delay is needed to avoid problems with feedback when a phone near a paging speaker is used.

The input would be a mic-level audio input and a contact closure indicating when record should take place.

When recording is complete (contacts open), the circuit should output a line-level audio signal and a voltage indicating paging is active.

#12007 — **Greg Krumrey, via Internet**

I have two AM broadcast stations within a few miles.

I have a very strong overload problem, specifically a 2a+b signal at 3.850 (smack dab in the heart of the 80-meter band).

How about a highpass filter that cuts off the AM broadcast band?

Since I am using a transceiver, it would have to handle about 100 watts.

How about a schematic or a source for this filter?

#12008 — **Bill O'Neil, Cuyahoga Falls, OH**

I would like to build an audio CD player display similar to those found at stores like Target, and Barnes and Noble.

These players are disguised behind a panel of photo thumbnails showing which artist's music CDs are available for listening before purchasing.

Each selection is played by pressing a memory-bubble keypad, and listening to a song lasting for 20 seconds or longer.

One store indicated that the hardware is generic and not proprietary.

#12009 — **Mike Warner, via Internet**

I have a RadioShack remote control truck which runs at 49.9 MHz. I would like to change the operating frequency. Can this be done?

#120010 — **Brett Bailey, via Internet**

Does someone have a flowchart for tracking down service schematics?

Present wish list is a motion sensor schematic — known information on same. Model 52-4076-2 (NW-12) made in China, possibly packaged in Quebec. SA (probably the manufacturer's symbol) LR96805.

The manufacturer is a little elusive. The registered trademark is SA. The SA is inside a circle with a small portion of the circle missing (between two and four o'clock).

#120011 — **Ken Schultis, via Internet**

I am looking for specifications and wiring data for a 4012 Travelling Wave Tube made by RCA.This TWT has six color-coded wires attached: brown (two), orange, blue, yellow, and green.

#120012 — **Thomas Peasley, New Hudson, MI**

I'd like to make a float charger to keep my motorcycle battery up to snuff over the winter. Any ideas?

#120013 — **Don, via Internet**

I was wondering if anyone knows of a place or vendor who has obso-

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.
- 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.

lete ICs for sale, and doesn't require a large minimum order?

Two places on the Internet that have them will not sell to individuals or they have a $100.00 minimum order.

I need an **Analog Device** (ca. 1985) AD7550BD A/D converter IC.

#120014 **E. Kirk Ellis**
Pikeville, NC

Will someone please explain how VCR+ works?

I have never seen an article or even a mention of the system anywhere, and I read a lot of "stuff."

I have a feeling that if I experiment with the "numbers" that I can find a code that would allow me to produce a set of numbers that would result in any desired programming.

#120015 **Orlo Hudson**
Kansas City, MO

ANSWERS

ANSWER TO #11009 - NOV. 2000

I haven't found any BCD up/down/presetable counter chips that are compact with multiple stages that drive seven-segment displays (something cascadable at least out to 10 digits).

The Motorola MC14553B (CMOS logic) comes the closest to meeting your requirements.

It has three BCD counters and multiplexing circuitry so you can get nine digits with three 14553s and three BCD to seven-segment decoders (MC14543B). It is not presettable and does not count down.

If you need those features, you are stuck with the 74193 and 7447.

The CMOS units are available from NTE as NTE4553B and NTE4543B.

Russell Kincaid
Milford, NH

ANSWER TO #7006 - JULY 2000

I recently bought a cable converter for my TV, but now I can not get closed caption on the set. Any Suggestions?

There are two basic types of cable converters out there.

The first type is the frequency conversion type. They shift the incoming signal much like the front end of a communications receiver. The output signal is un-altered except for a shift in frequency.

The second type is the receiver remodulator. This is the style used by most cable descramblers. The signal they send to your TV is highly processed and stripped of all (Vertical Blanking Interval) VBI signals.

Unfortunately, the closed captioning information is embedded in the VBI signal area.

These converters process the signal by demodulating the video and audio signals, and processing the video to eliminate the effects of scrambling.

Finally, the processed video and audio are sent to an RF modulator to create an RF signal that your TV and VCR can receive.

Many of these styles of converters also have a set of video and audio jacks on the back.

So, if this describes your converter, you're out of luck.

You can always bypass the converter to receive the closed captioning on non-scrambled signals.

Dennis Shelton
Chesapeake, VA

ANSWER TO #110011 - NOV. 2000

I have an engine-driven generator for power outage emergencies.

Unfortunately, I have found some references to the unsuitability of the brute force type generator for solid-state devices. I put a scope on the output at load and it seemed to produce 60-cycle power, but with tiny "notches" along the trace lines. Are these concerns valid?

The amplitude of the notches will determine whether they cause any problems. Modern devices based on solid-state electronics are reasonably well protected from surges. Your refrigerator is probably safe from the "notches" (unless it has a control panel).

There are a number of things you can do to improve the quality of the AC line.

1) Put UPSs (Uninterruptible Power Supply) in front items that you want to "ride" through the power outage. UPS units can be expected to filter out AC line glitches that may affect your devices. **www.upsshop.com/**.

2) Isolation transformers are good for removing spikes. Sometimes these can be obtained surplus. EMD appears to have isolation transformers for sale. **www.emd-inc.com/surplus!.htm**

The isolation transformer must be sized to carry the max load you expect to put on it.

3) Line filters can help remove high frequency glitches. These are cheaper and not as effective as isolation transformers. They may be adequate in many cases.

This is one site I found **www.elect-spec.com/wire_in.htm**

Of course, *Nuts & Volts* is a good place to look for surplus items such as the isolation transformers and line filters.

The Internet addresses I gave are suggestions and not a recommendation.

Gus Calabrese
Denver, CO

ANSWER TO #110012 - NOV. 2000

Where can I get a cable or pinout diagram for my Moniterm VK2400? It must be a nine-pin, two-row to 15-pin, three-row cable.

A cable has two ends, so an accurate answer depends on knowing to what video controller the monitor is to be connected.

The VK2400 is said to be a fixed-frequency monochrome monitor.

Its high resolution suggests that it is designed to be driven by an SVGA controller in which case, it would most likely be using the green signal for video. If that is the case, and the controller is indeed a standard SVGA card for a PC, then the cable sounds like a DB9 to HDD15 "multisync" VGA cable.

Such a cable is available at **Dalco 1-800-445-5342** as catalog numbers 49630 (DB9P/HDD15S) and 49625 (DB9S/HDD15P).

In other words, you need to state which end has pins (P) and which end has sockets (S).

The HDD15P (pins) connector is the one that matches the SVGA card of an IBM compatible PC. The nine-pin end needs pins or sockets to match your monitor.

JDR at 1-800-538-5002 has a multisync cable, catalog number CBL-VGA, described as DB09P-HDB15P that evidently has pins at both ends.

You can find a number of cable connection diagrams at **www.repairfaq.org/REPAIR/F_Pinouts1.html**

Here is a pinout diagram from that source for the 9-pin D-connector to 15-pin "high-density D" (three row) VGA cable:

ANSWER TO #100011 - OCT. 2000

I would like to equip a model police car with strobe lights that would flash alternately with a cadence of four rapid flashes for the left and four for the right.

Circuits are available for full-size cars, but no doubt are too big for a model.

This solution uses three ICs which are available in Small Outline (SO) package.

The circuit could be built on a two-square-inch board.

The circuit operates on 6 volts.

The logic ICs are CMOS for low power and to allow me to use RC timing.

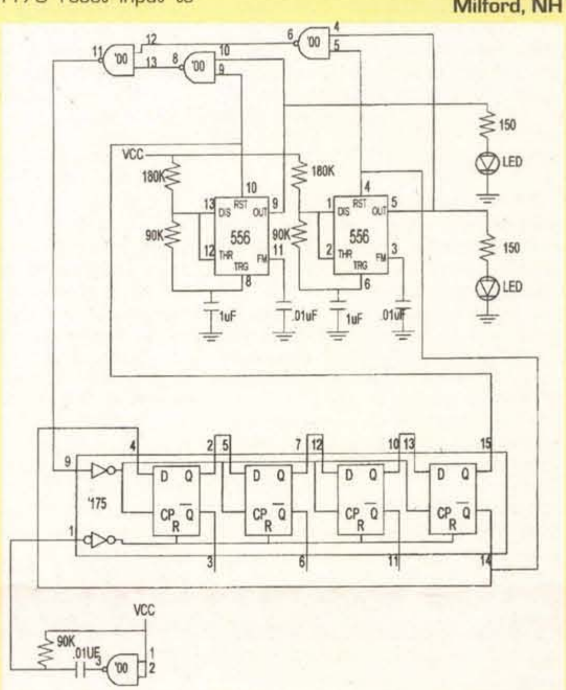
This is how it works: The LM556 is a dual 555 timer. Each timer oscillates at 4 Hz with 25% duty cycle.

The 74175 is a quad D flip flop which is used like a shift register to count four pulses. When power is applied, the 7400 whose inputs are connected to VCC puts a negative pulse to the 74175 reset input to start in the right mode. Otherwise, it could get stuck.

The circuit starts off with pin 15 of the 74175 low which inhibits the right section of the 556 from oscillating.

Pin 14 of the 74175 is high which enables pulses from the left side of the 556 to be passed on to the clock input of the 74175.

After four pulses, the high that was on pin 4 of the 74175 has moved down to pin 15 and the right side of the LM556 starts oscillating.



A delay between right side flashing and left side flashing would be desirable, but requires several more ICs.

Email me at **russlk@aol.com** if you want to get that complex.

Parts are available from **Digi-Key** (all surface mount):

Quad nand 74AC00SC-ND
Dual Timer LM556CM-ND
Quad D FF 74AC175SC-ND
LED P405-ND (clear lens)
LED 404-ND (diffuse lens)
180K resistor (10) P180KVCT-ND
90K resistor (10) P91KVCT-ND
150 ohm (10) P150VCT-ND
1uF cap (10) PCC1882CT-ND
.01uF cap (10) PCC103BCT-ND

Russell Kincaid
Milford, NH

15-pin HDD 9-pin DB

1 ——— 1 red
2 ——— 2 green
3 ——— 3 blue
4 - reserved for monitor ID bit 2
5 - n/c
6 ——— 6 GND (red return)
7 ——— 7 GND (grn return)
8 ——— 8 GND (blue return)
9 - n/c
10 - GND
11 - reserved for monitor ID bit 0
12 - reserved for monitor ID bit 1
13 ——— 4 horizontal sync
14 ——— 5 vertical sync
15 - n/c

For a monochrome monitor it would appear that you need only video (green), GND (green return), and horizontal and vertical sync.

Jack Dennon
Warrenton, OR

ANSWER TO #11008 - NOV. 2000

I need a schematic for a timer circuit. The total time is 20 seconds with a warning when five seconds are left.

I have tried using two 555 ICs. The first one would count down 15 seconds and then trigger a buzzer for a chirp and another 555 would count down five seconds which would then trigger the buzzer on for up to two seconds. I can't seem to get it just right. Can someone help me?

This method uses a CD4017 counter with 1 of 10 outputs.

Datasheet: www.fairchildsemi.com/ds/CD/CD4022BC.pdf ~$0.64.

You will also need an inverter package such as a 74C04, ~$0.48.

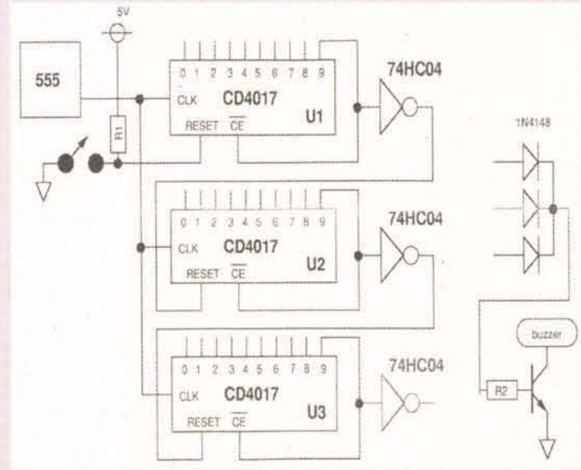
These can be obtained from **RadioShack**, **Digi-Key www.digikey.com**, or other vendors.

The 555 is set up to provide a clock running at 1 Hz (one clock per second).

Reset holds all the 4017s in an off-state until released. Closing the switch releases reset.

Each 4017 is set up to clock through its 10 outputs and freeze at the 10th one.

Then, the next 4017 is enabled and clocks through its 10 outputs.



Thus, the first 4017 (U1) represents seconds 1 thru 10, the second (U2) represents seconds 11 thru 20, and the third 4017 (U3) represents seconds 21 thru 30.

To obtain a chirp at 15 seconds, have the #5 output on U2 drive a transistor that turned on a buzzer, #5 output will be on for one second.

Combining outputs #7 and #8 on U2 will create a two-second output at the 18th second. Output #9 of U1 turns on at 10 seconds and stays on until the switch is opened.

Output #9 of U2 turns on at 20 seconds and stays on until the switch is opened.

Using small signal diodes such as the 1N4148 will allow outputs to be ORed to a transistor that will turn on the buzzer.

Any questions can be directed to **wft@frii.com** or **www.WFTelectronics.com**.

Gus Calabrese
Denver, CO

ANSWER TO #10005 - OCT. 2000

I need a solar system that could be used for running a laptop, small radio, or charging other smaller batteries while camping.

There are plenty of places that sell solar panels, regulators, and even pre-made systems. But, I don't think you wrote to *Nuts & Volts* just to buy something "off-the-shelf!" So, let's see what hardware we need and how to make it!

First, we need the panels themselves. Here are some sources I found: **AstroPower (www.astropower.com)**; **Evergreen Solar (www.evergreensolar.com)**; **Solarex (www.solarex.com)**; and **United Solar (www.unisolar.com)**.

Next, since the sun is constantly moving and because of atmospheric effects such as clouds, the voltage from a PV (photo-voltaic) panel is constantly changing.

In order to prevent damage to the battery, we need a regulator. A really complex but powerful regulator is at: **www.eklektix.com/gfc/elect/solarcirc/ccntlvd/**

Not only does it prevent "overcharge," it also provides an LVD (low-voltage disconnect) to prevent your devices from draining too much power from the battery, which can also ruin a battery.

If this circuit is too complex, big, heavy, or expensive, try searching the net for "solar shunt regulator" and find a circuit you like better.

I'll leave it up to you how to mount the cells, regulator, and battery for your application. But remember, DC is very susceptible to "copper losses," so use heavier wire over shorter distances whenever possible.

When you're finished, you'll have a way to run most anything designed to run off of a car battery (i.e., through the cigarette lighter socket).

Amos Bieler
via Internet

ANSWERS TO #10003 - OCT. 2000

One of Nuts & Volt's advertisers (Ramsey Electronics) features a TV transmitter which can be received by "... any TV tuned to cable channel 59."

What are the differences, if any, between cable channel 59 and TV broadcast channel 59?

#1 Yes, there is a difference in the frequencies used to broadcast TV signals over-the-air, and the frequencies used by cable TV operators to send signals to your television set.

Most television sets sold in this country in recent years, have either a switch or an option in the setup menu to allow selection between CATV and Broadcast reception.

Broadcast TV Channels 2-6 operate on frequencies between 50-88 Hz. There is a gap between 88 and 174 MHz, which is occupied by the FM radio band (88-108 MHz) and various Land-Mobile services, such as local police, fire, ambulance, as well as the two-meter amateur band.

Broadcast Channels 7-13 are between 174-216 MHz. Then, there is a pretty large jump between these and the UHF Broadcast Channels 14-69, which lie between 470-540 MHz.

CATV systems — as long as they operate in a "closed system" manner, and do not radiate their signals outside their cable networks — often convert off-the-air and satellite TV stations to lower frequency channels on their cable system. This is to their advantage, as all coax cable has more attenuation, or loss per foot, as the frequency of the signal increases.

CATV Channels 57-61 (420-450 MHz) corresponds to the "440" amateur radio band for over-the-air usage.

Most hams use this band for FM radio communications, but some also use it for amateur TV.

To receive these signals, connect a UHF antenna to a TV capable of "CATV reception" and select Channel 57-58.

There may no

t be much activity in your area; it depends on where you live, so check with a local ham to see if there is any ATV in your neighborhood.

For more details on CATV and Broadcast TV channel frequency allocation, there is an excellent chart of this information in the *ARRL Handbook*. It's usually near the back of the book, in the "References" chapter, it depends on which edition you have.

Most any public library should have a copy of this book, as will most radio amateurs.

The Ramsey C-2000 and C-2001 units are low-power devices, with outputs of 20 mW and 100 mW, respectively.

I'd think a directional UHF antenna would be required to receive these signals over much of a distance.

Dwight Johnson
Booneville, MS

#2 Cable Channel 59 is at 433-439MHz. Broadcast Channel 59 is at 740-746MHz.

Cable Channel 59 is in the 70CM amateur band, which extends from 420-450MHz.

I checked the FCC Part 15 regulations covering unlicensed operation available at: http://www.fcc.gov/Bureaus/Engineering_Technology/Documents/cfr/1998/47cfr15.pdf.

I did not find any rule that would allow unlicensed operation in this amateur band, even at low power.

I believe that to legally use the Ramsey product, you would need at least a Technician Class amateur radio license.

Tim Godfrey
via Internet

ANSWER TO #110016 - NOV. 2000

I need to find a low(er) cost video combiner which will take video from at least two video cameras, and allow the combined video to be recorded on one VHF VCR.

VLSI (now STMicroelectronics) produces a low-cost CMOS image sensor that outputs video.

These devices are designed to be easily synchronized, by designating one camera as master, and the other cameras as slaves.

A single synchronization wire is connected between the cameras, and they can all share a common video connection. When connected in this manner, the cameras can be programmed to "time share" the video connection, resulting in one to four camera images sharing one monitor or VCR.

The cameras can be programmed to display the images of two cameras side by side on a single monitor, or one image above the other on a single monitor. If four cameras are used, one image can be displayed in each of the four corners of a single monitor.

Of course, any standard VCR could also record the multiple camera images and play them back to a single video monitor.

For more details go to http://www.vvl.co.uk/products/image_sensors/430/5430.htm.

Note: VLSI Vision Ltd was acquired by STMicroelectronics in early 1999 and is now part of this world-wide organization as the Imaging Division within ST's Consumer and Micro Group.

Ron Jesme
Plymouth, MN

Build Your Own Voice Recognition X-10 Control System

by Dennis Shepard

In this modern age of new technology, man has sought the convenience and versatility of remotely controlling his world. We have everything from our TVs, stereos, and VCRs, to our sprinklers, lights, and air conditioning on remote control. A very popular format used for remotely controlling lights and appliances has been the X-10 protocol which transmits signals over your household wiring to facilitate that control. These systems have been around for over 20 years now. The interfaces have developed to the point where you can link through your computer and telephone for controlling these devices.

Voice recognition has now made it possible to control X-10 modules using your own voice. A leading-edge technology company named Sensory has just developed a continuous listening mode, voice-recognition module for $49.95. It is with this module and an X-10 PL513 interface (available from X-10 for $19.95) that allows us to construct a complete voice-operated controller for around $100.00, depending on what you've already got on hand.

What's a PL513?

It's pretty easy to guess that would be your first question. Because of the popularity of X-10, interface modules were designed to allow others to control the modules, namely, third-party developers and manufacturers. This opened up a whole new arena of outside products which could be compatible with the X-10 system.

To give you a better understanding, let's redefine what X-10 is. It's a protocol for sending signals over your power wiring to remotely control devices in your home/business. It does this by modulating a 120 kHz signal on the 60 Hz AC cycle. There is a starting sequence code (two cycles) followed by a house code (four cycles) followed by a key or function code (five cycles). So ... an 11-bit code is sent for each command.

The PL513

The PL513 module has a four-pin RJ11 standard phone jack attached to a small case which plugs into the AC power line. A red LED illuminates when power is present and dims whenever a valid X-10 command is sent. Inside the unit is a 120 KHz oscillator which interfaces to the power wiring plug. Also contained is an opto-isolator which provides an indication of when the AC cycle crosses zero. That's all there is to the interface. For those of you with a true engineering spirit, please visit X-10's website at http://www.x10.com. There you will find a 12-page document free for the downloading which covers all the specifications, including schematic, for the PL513. The document is entitled Technical Note for PL513\TW523.

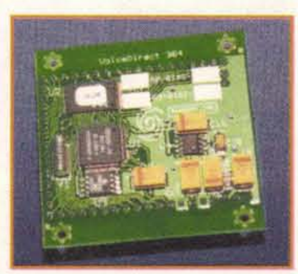
What's the PIC for?

Another good question. Although the PL513 provides a power line interface and zero-crossing signals, it's a far cry from a smart interface. Let's go a little more in-depth into the protocol and I think you'll see what I mean. Each time a code is sent, you have to send a complementary bit immediately after each bit on each alternating half cycle. For example, the start code which is 1110, is sent as 1 0 1 0 1 0 0 1. This format is true for the house codes and key/function codes, as well. And you have to repeat it twice with three cycles of silence in between. And at least two repeats for each dim and brighten command *continuously* without any missing cycles.

And for the clincher, each one bit must be sent three times on each cycle. This allows the system to be used on three-phase power systems. Since a power cycle (each half) is 8.33 msec, a one msec burst happens at zero crossing (within 50 usec), and again at 2.778 msec and again at 5.556 msec. This is all available in detail with diagrams and explanations so do your brain a favor and get the spec sheet. I guarantee it'll be a lot easier to understand!

The PIC also decodes the signals from the VoiceDirect 364 module. It has eight output lines which can control up to 15 separate outputs. Outputs 1-8 are verbatim, but outputs 9-15 are output 8 + outputs 1-7. For example, output 12 would be output 8 + output 4. Obviously, some way of deciphering the outputs is needed, as well, so the PIC takes care of both decoding from the VoiceDirect 364 module and encoding the 11-bit code for each X-10 command sent to the PL513 module.

VoiceDirect to the rescue

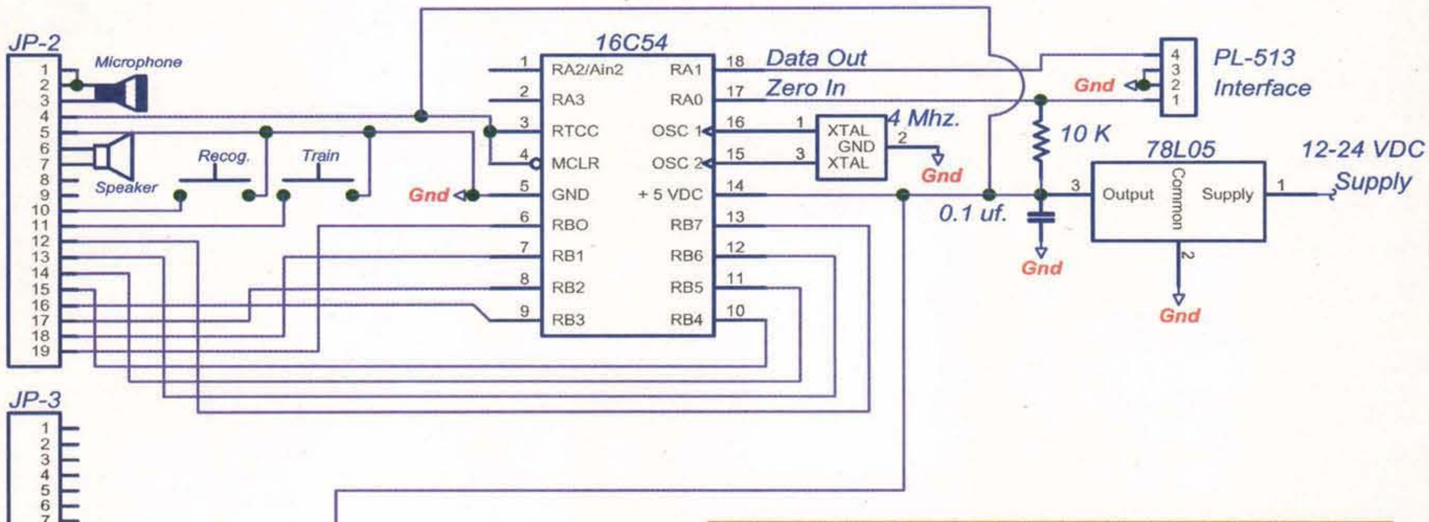


VoiceDirect Module

Sensory Corporation is a high-tech company based in the silicon valley in California. Their website at http://www.sensoryinc.com pro-

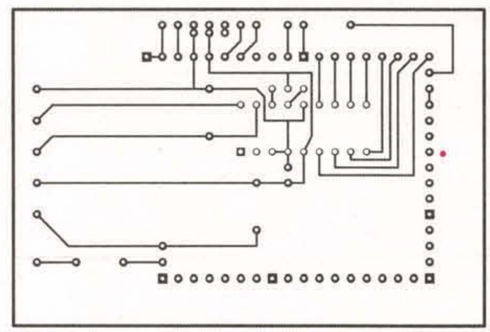
Continuous Listening X-10 Voice Recognition System

Copyright (c) 2000-Dennis Shepard/Shepard Engineering Concepts



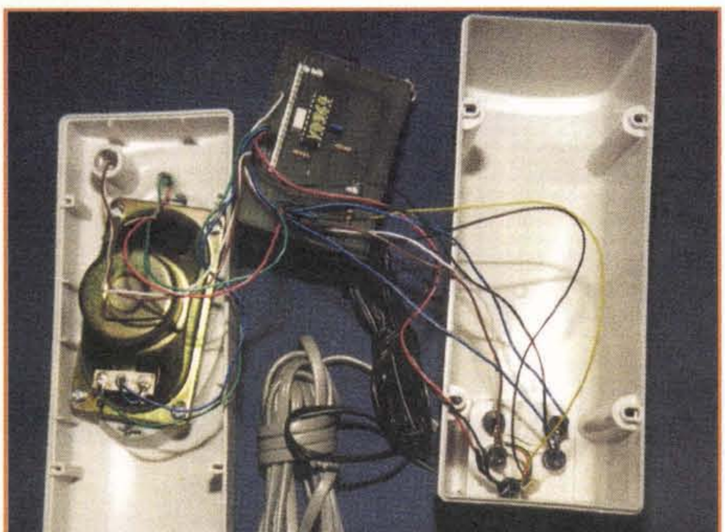
Object code for burning your own PIC can be found on the Nuts & Volts website. www.nutsvolts.com A preprogrammed PIC can be ordered from Shepard Engineering Concepts. See Parts list for details.

PCB Layout

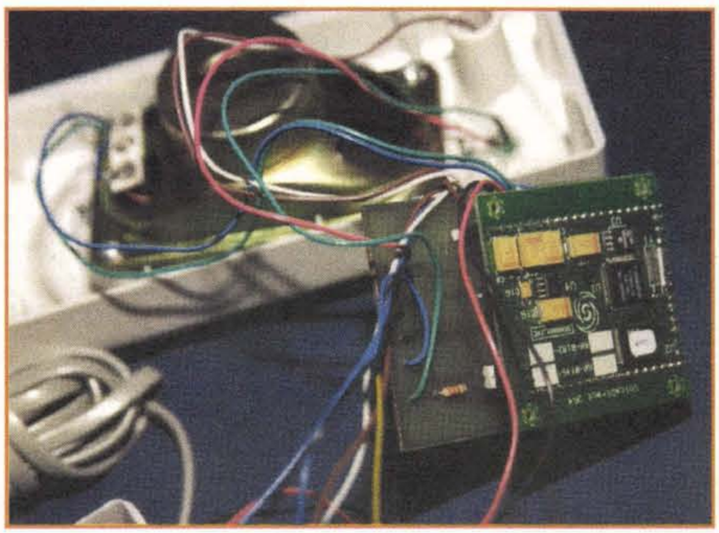


vides a wealth of information and technical background. They are the manufacturers of the VoiceDirect series of voice-recognition modules for whom I am a consultant/developer. They have developed modules which had the necessary support circuitry and firmware to make their modules a plug-and-go solution to many needs. The kit contains the microphone, speaker, switches, and resistors necessary for a stand-alone application.

Until recently, however, the units required some form of physical interaction to initiate a voice-recognition mode. They required a 'recognize' line to be pulled low for 100 msec to initiate that mode. Although this wasn't a major problem, it was somewhat of a nuisance. The newer units have their latest 364 chip which is faster

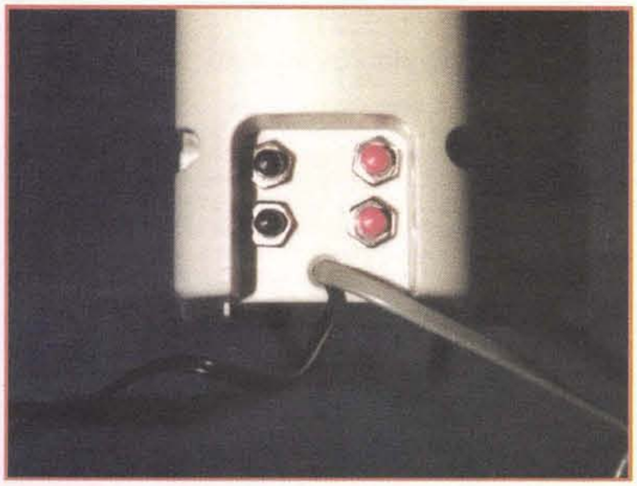


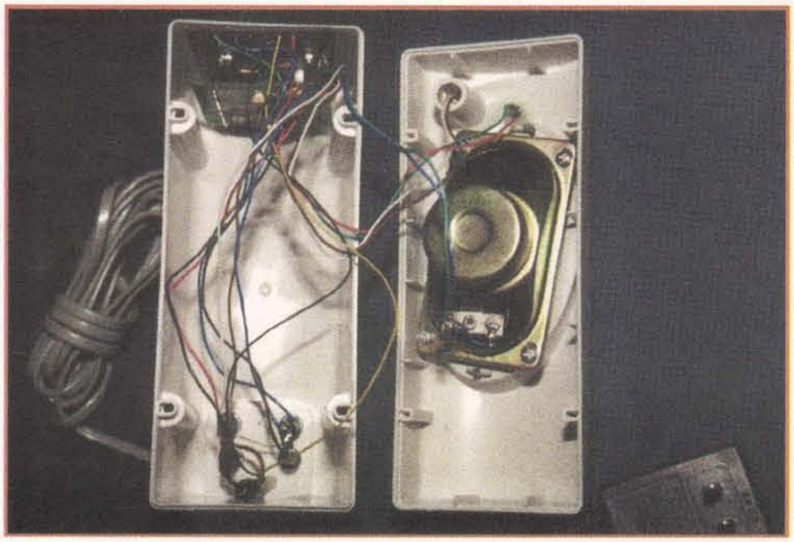
Our prototype had the microphone mounted in the enclosure with the LED visible from the front. I just drilled a couple of holes and mounted it with some clear adhesive.



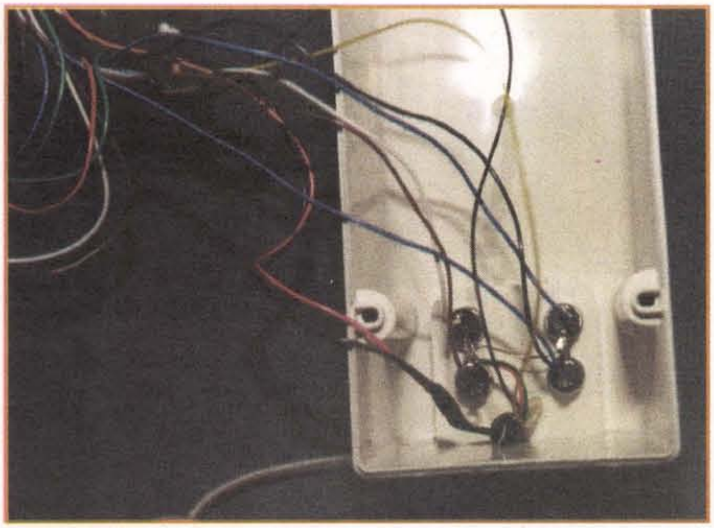
The VoiceDirect 364 module comes as a 2" x 2" assembly with standard posts to accept 0.1" male headers. This allows the module to be piggybacked on a perf board or PCB for compact installation.

In this modern age of new technology, man has sought the convenience and versatility of remotely controlling his world ...





A small computer speaker enclosure is a good choice for mounting the unit. Pushbutton switches can be easily installed in the back.



Four SPST momentary contact push-button switches allow you to easily enter and exit the training mode and access system functions.

and more accurate than its earlier predecessors. It also has a continuous listening mode which can use a 'gateway' word to precede each of the 15 commands it will respond to. This makes it completely voice-operated!

I have actually prototyped an earlier version using a proximity detector located inside the top of a small speaker enclosure to initiate the recognition mode and would pulse the line low every three seconds for continuous voice prompting. Then I used another command to silence the unit after I had spoken whatever commands I needed. This worked quite well, but it required some physical contact to get the unit to respond.

The circuitry involved

From a hardware point of view, this is an extremely simple circuit. It consists of a PIC 16C54 microcontroller, 4 MHz ceramic resonator, 78L05 voltage regulator, VoiceDirect 364 module, three resistors, and four switches. The PL513 interface plugs into the wall and attaches through a standard RJ-11 phone cord. An external wall wart power supply completes the circuitry.

Putting it all together

Now that we've discussed the various pieces of the system, it's time to put it all together. The VoiceDirect 364 module comes as a 2" x 2" assembly with standard posts to accept 0.1" male headers. This allows the module to be piggy-backed on a perf board or PCB for compact installation. A small computer speaker enclosure (without amplifier) is a good choice for mounting the unit. Obviously, you can use your own imagination and mount the unit anywhere you want ... including out of sight! Our prototype had the microphone mounted in the enclosure with the

LED visible from the front. I just drilled a couple of holes and mounted it with some clear adhesive.

Setting it up

Once the unit is assembled, we're ready to set it up for proper operation. On power up, the speaker will beep once to let you know the VoiceDirect module is okay. The talk LED will flash but extinguish if no training has occurred. Pressing the CL train (continuous listening mode) button will prompt you to say "word 1" and repeat it a second time. It will also tell you if it got it right, or if it didn't, and even why it didn't! Once you have trained your 'gateway' word, you're ready to train each of the 15 commands.

Each individual command is set up using the train (non-CL) button. It needs to be pressed for each word because the system doesn't know beforehand how many commands it will be responding to. Once training is complete, you can put the system into operation by pressing the recognize button. At that time, the talk LED will light indicating the system has entered the continuous listening mode. Reset will reinitiate the Voice Direct module.

Pressing the recognize button or CL train button will extinguish the LED and take the system out of listening mode. The system can be erased by holding down BOTH the train and recognize buttons together for at least one second. The system will respond with "memory erased." There are lots of other prompts like "spoke too soon," "similar to previous word," "please talk louder." It's all covered in the documentation which accompanies the module and which is also available on Sensory's website.

In operation, the talk LED is lit and will flash to let you know it's recognized the proper 'gateway' word. If it recognizes the next word as well, the appropriate command is sent. It will also tell you which command number was sent. If not, the unit has to recognize the 'gateway' word again before it will recognize another command.

Although the house code is set in firmware to House Code 'A,' any single house code will be programmed free of additional charge when requested with your order. Two different kits are available from Shepard Engineering Concepts. The first one consists of the preprogrammed PIC, ceramic resonator, and 78L05 voltage regulator for $20.00 delivered anywhere in the continental US. The second kit includes the VoiceDirect 364 module ONLY and all components included above for $70.00 including S&H anywhere in the continental US. See parts list for details.

Basically, the system will literally "talk you through it" (no pun intended) on the set-up. Since the commands are hard coded in the PIC, here's the breakdown of actual commands by channel number in the system:

Command Word	Function (X-10)
1	Channel 1
2	Channel 2
3	Channel 3
4	Channel 4
5	Channel 5
6	Channel 6
7	Channel 7
8	Channel 8
9	All Units Off
10	All Lights On
11	On
12	Off
13	Dim
14	Brighten
15	Not used

Well, that pretty well covers the system. We hope you will get as much excitement and enjoyment out of your system as we did ours! I even stayed up all night playing with the system when the prototype was developed.

Of course, I'll have to confess that I do have an espresso machine, so I'm quite sure that helped. **NV**

Continuous Listening X-10 Voice Recognition System Parts List

C1	0.1 uF 50 WVDC monolithic capacitor, RadioShack #272-109 or equal
*CR1	4.00 MHz ceramic resonator, Digi-Key #PX400-ND or equal
*IC1	Microchip Technology PIC #16C54-XT/P microcontroller Digi-Key PIC#16C54-XT/P-ND (requires programming)
JP-x	see below
LED1	T1¾ green LED, RadioShack #276-022 or equal
MIC1	Omnidirectional electret microphone element, RadioShack #270-092 or equal
PS1	Power supply 9-24 VDC 100 mA output, RadioShack #273-1767 or equal
R1	330 ohm 1/4W 5% carbon resistor, RadioShack #271-1342 or equal
R3	10K ohm 1/4W 5% carbon resistor, RadioShack #271-1335 or equal
S1-S4	SPST momentary contact push-button switch, RadioShack #275-1547 or equal
*VR1	78L05 5 VDC 100 mA voltage regulator, Digi-Key #78L05ACZ-ND or equal
*Voice Recognition module	VD364 voice recognition module, sensory #VD364
Misc.	4/c phone cord w/RJ-11 plug attached, small enclosure w/8 ohm speaker, 0.1" male headers, hook-up wire, etc.

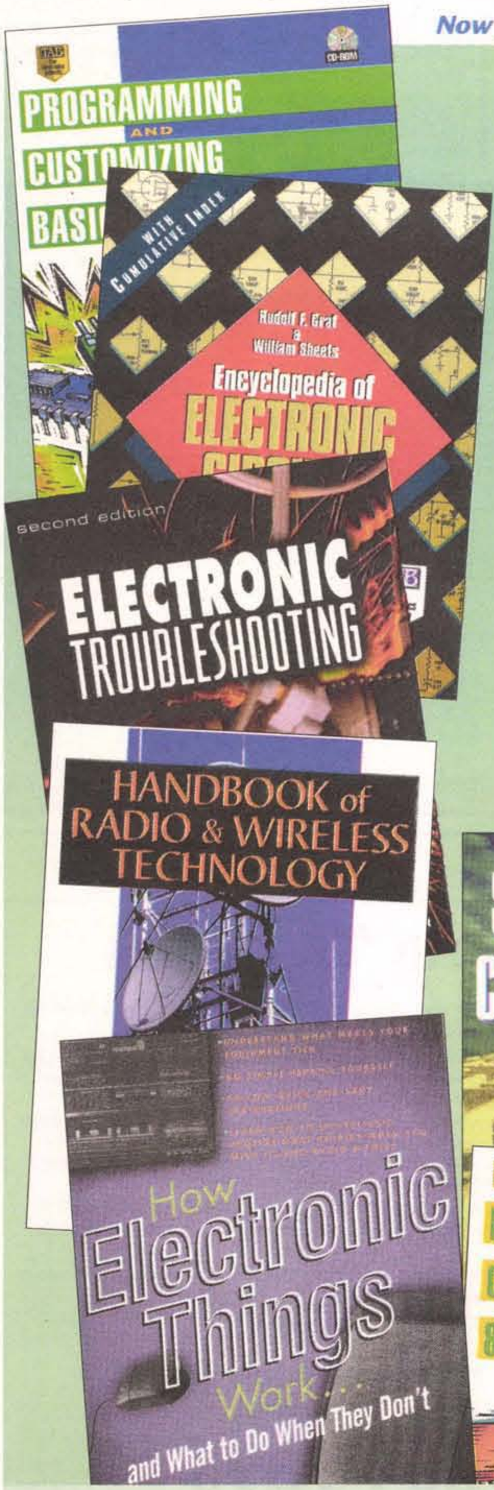
* The following items are available directly from:

Shepard Engineering Concepts
8315 D Laborough Dr., Bakersfield, CA 93311
web — http://home.att.net/~dennis.shepard/
email — dennis.shepard@worldnet.att.net

A kit of programmed IC1, CR1, and VR1 are available for $20.00 ppd. A kit including these items and the voice recognition module are available for $70.00 ppd. These prices are for the continental US only. Please make payment to: Dennis Shepard. Payment methods preferred are money orders, certified checks, or Western Union.

Nuts & Volts Book Store

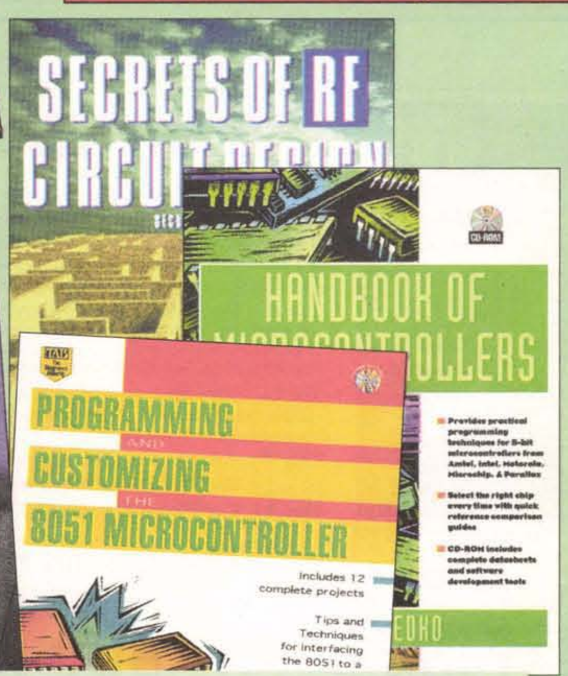
Now you can order on-line! Check out our new store at www.nutsvolts.com



BOOKS PUBLISHED BY MCGRAW HILL

AUTHOR/TITLE	REG PRICE	SUB PRICE
Axelson, JL – Making Printed Circuit Boards	$22.95	**$20.65**
Brown, RM & Lawrence – How to Read Electronic Circuit Diagrams	$19.95	**$17.95**
Carr, J – Practical Antenna Handbook	$49.95	**$44.95**
Carr, J – Secrets of RF Circuit Design	$29.95	**$26.95**
Davidson, HL – Build Your Own Test Equipment	$22.95	**$20.65**
Davidson, HL – Radio Receiver Projects You Can Build	$21.95	**$19.75**
Davidson, HL – Troubleshooting and Repairing Consumer Electronics Without a Schematic	$24.95	**$22.45**
Edwards, S – Programming and Customizing the BASIC Stamp Computers	$34.95	**$31.45**
Gibilisco, S – Amateur Radio Encyclopedia	$29.95	**$26.95**
Gibilisco, S – Handbook of Radio and Wireless Technology	$44.95	**$40.45**
Gibilisco, S – TAB Encyclopedia of Electronics for Technicians and Hobbyists *(hard cover)*	$69.50	**$62.55**
Gibilisco, S – The Illustrated Dictionary of Electronics	$39.95	**$35.95**
Goodman, R – How Electronic Things Work ... and What to Do When They Don't	$24.95	**$22.45**
Graff, R – Encyclopedia of Electronic Circuits	$39.95	**$35.95**
Horn, DT – Basic Electronics Theory	$26.95	**$24.25**
Horn, DT – Ready-to-Build Telephone Enhancements	$17.95	**$16.15**
Lenk, J – Circuit Troubleshooting Handbook	$39.95	**$35.95**
McComb, G – The Robot Builder's Bonanza	$18.95	**$17.05**
Predko, M – Handbook of Microcontrollers	$54.95	**$49.45**
Predko, M – Programming and Customizing the PIC Microcontroller	$39.95	**$35.95**
Predko, M – Programming and Customizing the 8051 Microcontroller	$39.95	**$35.95**
Scherz, Paul – Practical Electronics for Inventors	$39.95	**$35.95**
Sinclair, J – How Radio Signals Work	$24.95	**$22.45**
Tomal, D/Widmer, N – Electronic Troubleshooting	$34.95	**$31.45**
Veley, V – The Benchtop Electronics Handbook: 260 Most Common Popular Electronics *(cloth cover)*	$65.00	**$58.50**

Call 1-800-783-4624 today! WE ACCEPT VISA AND MASTERCARD



10% OFF

FOR PAID SUBSCRIBERS

Send check or money order to Nuts & Volts, 430 Princeland Court, Corona, CA 92879. Include a complete shipping address (no P.O. Boxes, please). Shipping & handling $4.50. CA residents add 7.75% sales tax. Or, call our toll-free order-only line at 1-800-783-4624 and use your MasterCard or Visa. *Or order on-line at www.nutsvolts.com. ALL ORDERS MUST BE PREPAID.*

New Product News

ASP275 AUDIO SIGNAL PROCESSOR

The ASP275 high-quality miniature Audio Signal Processor splits the audio spectrum into two frequency bands to optimize the dynamic behavior for each band. This reduces low-frequency distortion due to control signal ripple, phase distortion, high-frequency channel overload, and noise modulation.

The ASP275 analyzes the speaker's voice on an individual basis and modifies the sound for improved speech discrimination while improving normal sound quality and preserving transparency, therefore reduces the ambient noise up to 10dB.

The circuit also maintains the user preset volume level from a whisper to a shout. This approach greatly augments perception for normal or the hearing impaired in helping to achieve a higher level of sound discrimination, higher levels of speech intelligibility are attained, especially in noisy environments.

Recommended applications are for radio and TV broadcast station and high-end communications. It is a must for military, aviation systems, and law enforcement applications where a misunderstood command could result in the loss of life or equipment.

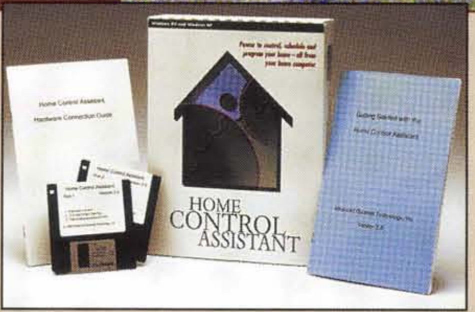
The ASP275 is also ideal for situations where many different operators share the same audio equipment. The miniature size makes it favorable for new design or add-on applications.

The module can be powered from the host equipment or external power source, 7 to 26 VDC @ approximately 20mA.

Single quantity price is $119.00. Dimensions are 1" x 1" x 0.25".

For more information, contact:

C & S ELECTRONICS
2 CHRISTY ST., DEPT. NV
NORWALK, CT 06850
203-866-3208 FAX: 203-854-5036
EMAIL: sszabo@candselect.com



HOME CONTROL ASSISTANT SOFTWARE

Safely come home to a brightly lit entryway Save electricity by automatically shutting off appliances when leaving the house. Conveniently control all of your electrical appliances while on vacation

This easy-to-use, yet powerful program allows you to control your home with the touch of a few buttons, without being a computer software genius!

Though some home control systems can be rather complex, the Home Control Assistant helps you to easily program a schedule for your home with simple-to-follow setup wizards. You can set any program for your home, including brightening and dimming lights, or turning on and off appliances such as coffee makers, aquarium controls, or stereos. You can even set the program to automatically turn off major appliances, reducing the risk of fire in your home.

The setup walks you through an inventory of the devices in your home, and can even help you assign device addresses for X10 devices based on your needs. But the functionality doesn't stop there.

You can set up powerful schedules to control your home with equal ease. For example, while on vacation, you can set the lights to go on in the evening, and then off after a couple of hours to simulate an "at-home" appearance while on vacation, and to reduce your risk of being burglarized.

You can preset any number of automation schedules, including schedules for weekdays, weekends, or vacations.

There's no need to worry about a power outage, either, because the Home Control Assistant will automatically reset itself, catching up on your preset schedule.

The possibilities are endless with this amazingly simple, convenient, yet powerful program!

The Control Assistant Software is only $97.90

For more information, contact:

LORD & WYATT COMMUNICATIONS, INC.
147 HALSEY ST., DEPT. NV/DSM
BROOKLYN, NY 11216
718-789-7329, ext-12
FAX: 718-789-7329
EMAIL: AtHomeThings@aol.com
WEB: www.AtHomeTechnology@.com

DIGIMAX 35 MP3 DIGITAL CAMERA

Samsung Opto-Electronics America, Inc., announces the availability of their new Digimax 35 MP3 digital camera with MP3 audio player.

The Digimax 35 MP3, with a suggested retail price tag of $289.99, is designed with today's Internet generation in mind and takes the category to a new dimension.

The major features of the Digimax 35 MP3 include the ability to use it as a web camera for live Internet video conferencing at up to 15 frames a second. In the digital camera mode, it can capture up to 120 frames of 640 x 480 resolution pictures to the included 8MB compact flash card (up to 300 frames at 320 x 240 resolution).

The Digimax 35 MP3 adds a third dimension to its full-featured compact design – an MP3 player. You can download directly from the Internet MP3 files to the removable compact flash card. With the included headphones and carrying case incorporating a belt loop, it becomes a portable music player.

The Digimax 35 MP3's sleek design features an aluminum case with blue translucent accents and a large optical viewfinder and a built-in flash. It is USB-compatible and ships with a complete range of accessories and software. Accessories include stereo headphones, 360° tripod stand, and 3D glasses that work with the included 3D-image creator software.

For more information, contact:

SAMSUNG OPTO-ELECTRONICS AMERICA, INC.
40 SEAVIEW DR., DEPT. NV
SECAUCUS, NJ 07094
201-902-0347 FAX: 201-902-1359
WEB: www.samsungcamerausa.com

MODEL PB-5 PRECISION PULSE GENERATOR

The model PB-5 provides unprecedented performance in a precision pulse generator. It includes a full-featured, highly flexible ramp generator and complete programmability.

As a precision pulse generator, the PB-5 surpasses or equals all existing designs in the important performance areas of resolution, linearity, and stability. The pulse repetition rates, which are variable over a broad range, go up to 0.5MHz. The higher rates are required when testing for MCA and PHA linearity because of the high number of data points required for a statistically valid test.

The built-in ramp generator allows you to control ramp duration, the number of ramps, and the ramp limits. Now you can test the entire range of your system or just a portion of that range. This ramp generator and precision pulse generator combination allows you to tackle the most demanding applications.

The new user interface is intuitive and easy to use. Items can be selected and changed by the spinner knob and/or keypad push buttons.

For more information, contact:

BERKELEY NUCLEONICS CORPORATION
3060 KERNER BLVD. #2, DEPT. NV
SAN RAFAEL, CA 94901
1-800-234-7858
FAX: 415-453-9956
WEB: berkeleynucleonics.com

www.web-tronics.com www.web-tronics.com www.web-tronics.com
High Performance Auto Ranging DMM
New to our DMM line-up and possibly (probably) the best DMM value anywhere! Includes: Analog Bar Graph! Auto-Ranging! Data Hold! Temperature Probe! Frequency Test! Continuity Test! AND MORE!
ONLY $29.95
NOW IN STOCK!
Features
Data Hold: Freezes reading for easy checking
Auto Ranging: For easy, precise range settings
Range Hold Control: allows for manual selection of your test range
3-3/4 Digit LCD Display: Reads up to 3260. Easy to read display.
Function Dial: Easy to use to select measurement type or turn unit off.
4 Jack Plug-ins: Safety design with different capacities for different functions.
Diode, Continuity Check Push-Button: For toggling between diode check and continuity check.
Low Battery Indicator: Advises you when it's time to change battery.
Extra Long 44" Test Leads: Helps get to hard to reach places
Screw-On Alligator Clips: Convert one or both probe tips to alligator clips.
Fuse-Protected Circuitry
Built-In Stand: Makes one hand operation easier.
Shock Absorbing Rubber Carrying Case: with convenient probe storage clips and hanging tab. Helps protect the DMM from damage if accidentally dropped.
Measures:
DC Volts: up to 1000V
AC Volts: up to 750V
AMPS: up to 20 Amps (AC & DC)
Resistance: up to 30M ohm
Continuity Check: with audible signal (signal sounds if resistance is less than 20 ohms. Display reads actual resistance)
Frequency: (1KHz to 300KHz) displays both digital and bar graph reading
Transistor hfe Test: Display shows approximate hfe value based on test condition of 10uA base current and Vce of approx. 3V.
Temperature Test: Measures from 0° to 1832° F (probe supplied!)
Diode Test: Tests if diodes are shorted or open
Specifications
Accuracy
Vdc: ±1.0% reading +5 digits
Vac: ±1.5% reading +8 digits
Adc: ±1.2% reading +5 digits
Aac: ±1.5% reading +5 digits
Resistance: ±1.5% reading +5 digits
Frequency: ±3.0% reading +5 digits
Temperature: ±1.0% reading +6 digits
Input Impedance: 10Mohm (Vdc/Vac): over 100Mohm on 300 mVdc range
Requires two AAA batteries sold separately.
#CSI9903
2GHz RF Field Strength Analyzer
ONLY $1589
Frequency Range: 100KHz to 2,060MHz
Narrow Band FM (NFM), Wide Band FM (WFM), AM and Single Side Band (SSB) Modulated Signals May Be Measured
PLL Tuning System for Precise Frequency Measurement and Tuning
LED Backlight LCD (192x192 dots)
Built-In Frequency Counter
Hand-Held and Battery Operated
All Functions are Menu Selected
RS232C for PC Interface and Printer
#3201
See the web site for details
Removable Hard Drive Rack
For IDE/Ultra DMA Hard Drives
We Sold Over 14,000 in 1998!
ONLY $14.95 any qty.
This product can be used with any 3-1/2 IDE hard drive up to 1" high. It includes an electronic keylock for safe removal and insertion. Made of ABS 707 fireproof plastic. Use this product to protect sensitive hard drive data, take your hard drive between work and home or even set up different users with their own hard drives that they physically insert every time they use a PC. Other models available from C.S.I. include RH10 series and RH20 series, which are interchangeable within the same interface design (IDE or SCSI).
RH-10C-IDE
Other Models are Available. See www.web-tronics.com under "hard drive and accessories" for more details and pictures.
Removable Hard Drive Rack with Auto Door And Cooling Fan
ONLY $18.95 any qty.
Auto door on the outer frame
ABS material of outer frame, High efficiency cooling fan
Worldwide patent pulling function handle
CE Approved
Coating iron bottom cover
For IDE interface
For 1" high 3.5" HDD
Not compatible with our RH10 & RH20 series. Compatible with our RH17-IDE model.
#MR-27
Details at www.web-tronics.com
Auto-Temp Solder Station with Ceramic Element
ONLY $39
With Ceramic Heating Element for More Accurate Temp Adjustment
3 Conductor Grounded Power Cord
250°C-480°C (470°F-900°F)
Fast Heating Feature
SR-976
Extra Tip Options Available. See Web!
For More Info See www.web-tronics.com
CTRL - D to bookmark this site
www.web-tronics.com
Don't forget the dash
Circuit Specialists Inc.
Easy to Navigate
Includes a Search Engine That Really Works
New Items Added Constantly
In Business Since 1971
Mini CCDs (B/W & Color (
Sensational NEW Design for Small Observation Cameras. Smaller and Better!
LOWER PRICES
Ultra Miniature Design
Black & White Versions Only 25mm x 25mm
Color Versions Only 32mm x 32mm
Available in Standard Lens or Pinhole Lens
All Include Pre-Wired Cable Harness for Video & Power
12V Regulated Power Supply Required (120mA typical power consumption (
0.1 LUX Rating (B/W (1 LUX (color (
CCD Area Image Sensor for Long Camera Life
Back Light Compensation Circuit
Built-In Electronic Auto Iris Lens
Detailed Specs on the Web
VMCW-H11A 32mmx32mmx30mm, Color CCD with standard lens, pre-wired cabling, 12V DC Power $139.00 / $129.00 5 or more
VMCW-H12A 32mmx32mmx19mm, Color CCD with pinhole lens, pre-wired cabling 12V DC Power Input $139.00/ $129.00 5 or more
VCC-3232 32mmx32mm, CMOS Color with standard lens, See our website for details $79.00 any qty.
VMPS-718A 25mmx25mmx30mm, B/W CCD with standard lens, pre-wired cabling, 12V DC Power Input $59.00 / $49.00 5 or more
VMPS-250A 25mmx25mmx15mm, B/W CCD with pinhole lens, pre-wired cabling, 12V DC Power Input $59.00 / $49.00 5 or more
CCD B&W Board Cameras
ASIC CCD Area Image Sensor
Extremely Low Power Consumption
0.5 Lux Min Illumination
Built-In Electronic Auto Iris for Auto Light Compensation
Detailed Specs on the Web
LOWER PRICES
VM1030PA-B 30mmx30mmx25mm, Pinhole lens, 12V $39.00 any qty.
VM1030A 30mmx30mmx26mm, Standard lens, 12V $39.00 any qty.
VM1035A 42mmx42mmx25mm, Standard lens, 12V with back light compensation $49.00 any qty.
VMCB21 44mmx38.5mmx28mm, with 6 infra-red LEDs, 12V $49.00 any qty.
VM1036A 32mmx32mmx25mm, Standard lens, 12V, reverse mirror image feature $49.00 any qty.
VISA
MasterCard
DISCOVER
Bullet CCD Cameras
B&W and Color
Smart Rugged Metal Housing
Extremely Low Power Consumption
12 Volt
CCD Area Image Sensor for Long Camera Life
Built-In Electronic Auto Iris for Auto Light Compensation
No Blooming, No Burning
0.1 Min Lux Illumination (B&W (1 Lux Min Lux Illumination (color (
Detailed Specs on the Web
LOWER PRICES
VMBLT1020 B&W, 21mm(D)x55mm(L) $49.00 any qty.
VMBLT1020W B&W Weatherproof, 21mm(D)x58.5mm(L) $79.00 any qty.
VMBLTJC19BW COLOR! Weatherproof, 17mm(D)x88mm(L) $139.00 any qty.
new! Hot Air SMD Rework Station
WOW! ONLY $489
Similar Systems Cost 100s More!
ONLY $489
#SR-979
For technicians, service/repair depots and assembly rework. We also stock a selection of nozzles for QFP, SOP & PLCC devices (see our website for selection details). Hot Air temperature variable from 100°C to 400°C (212°F to 754°F) power consumption: 275w max. Auto cooling feature cools system after shut off to extend service life of heating elements and handle. One year limited warranty from C.S.I.
Comes with QFP Nozzle (0.68" x 0.68")
new! O'Scope Offer
30MHz! ONLY $299!
ONLY $299
Take Advantage of this low price!
Dual Channel
Dual Trace
Vert Trigger
1 Year C.S.I. Warranty!
#OSC-1030
Manufactured for CSI by a leading O.E.M. manufacturer. See our website for detailed specifications!
COLOR CCD Mini Board Cameras
PRICE REDUCTION
Low Power Consumption
1 Lux Illumination
Built-In Electronic Auto Iris for Auto Light Compensation
Internal Synchronization
12Volts
400 TV Lines
Detailed Specs on the Web
VM3010PA 33mmx33mmx18mm, Pinhole lens $99.00 any qty.
VM3011-A 45mmx40mmx24mm, Standard lens, single board $89.00 any qty.
VM3010-A 33mmx33mmx32mm, Standard lens $99.00 any qty.
new! 2.4 GHz A/V Sender/Receiver System
ON SALE!
Wireless FM transmission of video (color or B/W) and sound (stereo or mono) up to 150 meters (line of sight)
Directional Antenna Design optimizes performance
Use with remote cameras or any input (satellite TV, cable etc.) where wireless transmission is desired. View on a TV set.
Performance through walls varies depending on construction methods etc.
Each set includes a plug-in power supply for the transmitter & receiver.
7 segment LED displays channel (1-4) on receiver & transmitter.
CSIHTR2400 Includes One Transmitter & One Receiver with Power Supplies $139.00 $109.00
CSIHTR2400TX Extra Transmitter/Each Receiver will Monitor up to 4 Transmitters $89.00
See more detailed specifications at www.web-tronics.com in the CCD camera setcion.
new! 3-1/2 Digit JUMBO Digital Panel Meters Check these LOW PRICES!
NOW IN STOCK!
AS LOW AS $6.25
21mm Figure Height
5 Volt Common Ground or 9V Independent Power Supply Versions Available
Voltage Divider Resistors included and max. Measured Range Selectable by Soldering a Selection Joint
Easy Bezel Snap-In Design (84mm x 41mm rectangular hole typical)
"0" Reading for "0" Voltage Input
High Quality SMD Production Method
Dual Slope Integration A-D Converter System ±0.5% Accuracy
PM-1028A LCD 9V Independent Power Supply Version 1/$12.95 10/$10.89 100/$7.99 250/$6.25
PM-1028B LCD 5V Common Ground Power Supply Version 1/$13.95 10/$11.84 100/$8.89 250/$7.15
PM-1029A LED 9V Independent Power Supply Version 1/$14.95 10/$12.50 100/$9.95 250/$7.89
PM-1029B LED 5V Common Ground Power Supply Version 1/$15.95 10/$13.40 100/$10.79 250/$8.65
3000 Series Digital R/O Bench Power Supplies
◆ Low Cost Single Output ◆ 3 Amps
High stability digital read-out bench power supplies featuring constant voltage and current outputs. Short-circuit protection and current limiting protection is provided. Highly accurate LED accuracy and stable line regulation make the 3000 series the perfect choice for lab and educational use.
Our Most Sophisticated DMM We Sold Over 700 Last Year!
with RS-232 Interface & Software, 3-3/4 Digit, 4000 Count, Auto-Ranging with Analog Bargraph
True RMS Mode
10MHz Frequency Counter
Time Mode with Alarm, Clock, and Stop Watch
Dual Display
10 Location Memory
Min, Max, Avg and Relative Mode
Decibel Measurement
Cap and Ind. Measurement
Temperature Mode (C/F)
K Type Temperature Probe Included
Pulse Signal for Logic & Audible Test
Continuity/Diode Test
Logic Test
Auto Power OFF/"Keep ON" Mode
Fused 20A Input with Warning Beeper
Back Light
Data Hold/Run Mode
Safety Design UL1244 & VDE-0411
Protective Holster
Silicon Test Leads
NOW ONLY $129
Reg. $169
More Details on our Web Site
PROTEK 506
Line Regulation: 2x10 -4 +1ma
LED Accuracy: Voltage: ±1% +2 digits
Current: ±1.5% +2 digits
Wave Line Noise: ±1mVrms
Dimensions: 291mm x 158mm x 136mm
CSI3003: 0-30v/0-3amp
Digital R/O Bench PS,
1x10-4+5mv Load Regulation
$99.00 5/$89.00
AS LOW AS $89
CIRCUIT SPECIALISTS, INC. 220 S. Country Club Dr., Mesa, AZ 85210 800-528-1417/480-464-2485/FAX: 480-464-5824

CLONE, TEST OR REPAIR ANY HARD DRIVE

"THE MOST COMPLETE HARD DRIVE WORKSTATION WE'VE SEEN!" BOB ROSENBLOOM, DIGITAL VIDEO, INC.

DRIVE SERVICE STATION

Copy entire hard drives with ease. Drive duplicators are essential tools for dealers and system builders. Don't spend hours installing and formatting drives. Do it instantly with the Pro. Set up any SCSI or IDE drive with your original software. Connect blank drives to the Pro and presss start. You'll copy entire drives faster and more accurately than is possible on any PC. With our combination IDE and SCSI model, you can even copy data between diffferent interfaces. All models include both 2.5" and 3.5" interface adapters. The Pro also supports SCA and Wide SCSI drives.

Choose the Pro, and you'll also have an entire factory drive test and repair system for under $1000. The Pro gives you the ability to copy, reformat, repair, translate, and test any hard drive. Use the Pro to put any hard drive through its paces. A full factory final test and performance analysis is performed. Complete test and repair reports are sent to any standard printer.

The Pro will also reassign and eliminate drive defects. Here's how it works: First, a precise media analysis system scans the disk for errors. Defects are mapped out, and effectively "erased." The error correcting system then "trains" the drive to permanently avoid defective areas. Data is stored only on the safe areas of the disk. Capacity is reduced by an insignificant amount, and the drive works flawlessly once again. Get the technology used by major repair shops and data recovery centers. The Pro repairs all disk defects caused by normal wear. Drives with mechanical damage may not be repairable.

BUY MANUFACTURER DIRECT: $995

408 330-5525

CORPORATE SYSTEMS CENTER
3310 WOODWARD AVE., SANTA CLARA, CA 95054
WWW.DRIVEDUPLICATORS.COM

Call today for high volume multi-drive copiers and CD Duplicators
Sold and intended for backup purposes only. Copyright laws must be observed.

Write in 217 on Reader Service Card.

NUTS & VOLTS MAGAZINE
430 PRINCELAND COURT
CORONA, CA 92879-1300

[redacted]