

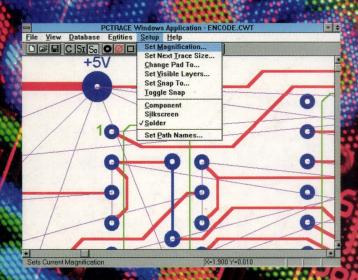
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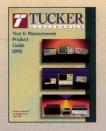


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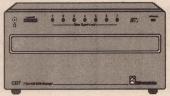
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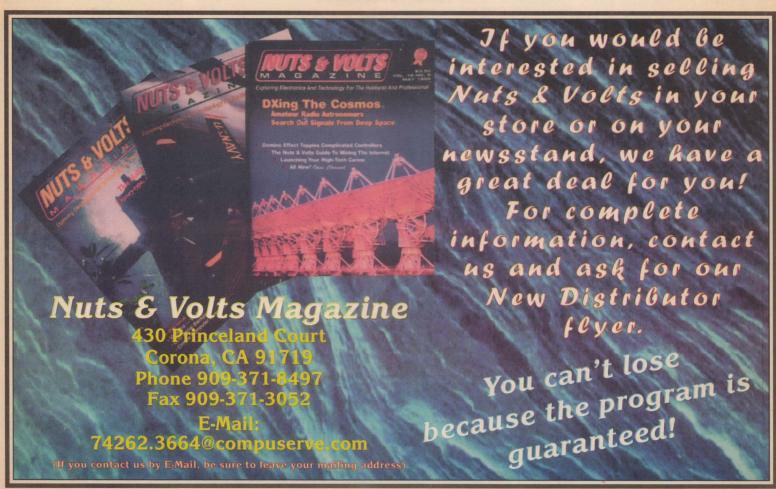
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Deadlines should be discussed in advance with the editor, but generally all material should be submitted by the 1st of the month for the next month's issue.

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# reagler ack

Dear Nuts & Volts:

I recently put together the IBM PC interface for LCD stereographic shutter glasses (I'm using SEGA glasses) following the article by John lovine on page 77 of the Sept. '94 issue of *Nuts & Volts*.

Now I need software to make it all work. Mr. Iovine mentions a program called 3DGV by John Swenson. Could you tell me: a) Where one might obtain the 3DGV software; b) How to contact the 3DGV author John Swenson; c) How to contact John lovine. Any help you can offer will be very much appreciated.

John McMichael Laramie, WY

Response to John McMichael: The program 3DGV, by John Swenson, is available from CompuServe. The author of the program is also a member. His CompuServe ID is included with the description of the program for anyone who wishes to contact Mr. Swenson directly.

To find Mr. Śwenson's program on CompuServe, go to the IBM file finder. "GO IBMFF" search under stereoscopic, and the program will be one of the ones listed.

I can be reached via the Internet. My Internet address is: jiovine@ix.netcom.com

John Iovine

Dear Mr. Charlton:

I have enjoyed reading your columns from their first appearance in Nuts & Volts, since I have been a subscriber for many years. I admire your wide ranging knowledge on the many topics of investigation.

Recently, you announced a project that is particularly interesting to me. The construction of a low-cost laser communications link for live video is something I have considered ever since CW diode lasers became affordable. My first thought was to amplitude modulate the diode current with a series transistor much like you suggest in your November column for a HeNe tube. The depth of modulation with both types of lasers is limited since the allowable current range to maintain lasing is relatively narrow. I recall someone telling me they could reliably achieve about a 15% modulation depth. This low-modulation index limits the system signal to noise ratio, but may be acceptable, depending on your image quality expectations. The other factors affecting the noise floor are receiver preamp noise, random noise generated by the laser source, and noise from extraneous light pickup.

I think a Motorola PIN diode. MRD-500 for the detector would yield good results. They are fast enough to produce good picture quality and have low-inherent capacitance. I have found the preamp design to be a major consideration. Of course, back then I was considering discrete transistors and FETs and now there are many

better choices in packaged IC designs. You mentioned Maxim; I will have to check them out. I have used their switched cap. filters and battery charging ICs and they keep announcing new analog designs. With the recent price reductions in surplus 670 nm and shorter wavelength diode lasers, it seems more practical to employ them instead of HeNes. The whole issue of high voltage and spikes is eliminated.

Then there is the possibility of going digital. This gets around the amplitude modulation dilemma of low-modulation levels in the darker portions of the video picture making system noise much more visible. The transmitter could use a low-cost CMOS 6-bit flash converter chip to digitize the composite video signal. This parallel data would be input to a fast clocked shift register whose serial output would drive the laser diode driver chip data input. The receiver might be a high-gain preamp feeding a simple ladder network D/A (high speed D/A, ICs might be too expensive) and then into an analog driver to achieve a 1-volt composite video output. With some diode clamping to maintain black level and a negative DC supply rail to maintain the negative sync pulses, it seems feasible. If the data rate can be preserved, this pulsed approach should have the advantage of maintaining higher laser power output with varying video brightness levels.

Unfortunately, I have been too involved with a new job recently to do anything but mental designs. I just thought I would pass along my thoughts.

Your column reminds me of the "Amateur Scientist" column that appears again in Scientific American. On occasion, the previ-

ous author would present experiments with lasers that I enjoyed reading. Incidentally, I prefer projects that can be presented within one issue when possible. I realize that editorial restrictions might make consecutive issues necessary for longer projects, but it is nice to wish for.

Please continue your fine efforts. There are very few construction columns I have found that are as instructive and novel as your writing. Nuts & Volts has transpired into a first rate construction and information publication, well beyond its original buy/sell beginnings.

Alan L. Woodman Mt. Prospect, IL

Dear Nuts & Volts:

Thanks so much for printing Donald Wilcher's articles on Macintosh I/O in your October and November '95 issues of *Nuts &* Volts! It's been a long time coming since someone started to recognize that there are other than PCs out there! I've been looking for Mac interfacing information for a long time. Please keep those Macintosh articles coming!

Jack Bozzuffi, Jr. Sewell, NJ

Response to Joseph A. Dickerson, Dec. '95:

In answer to question #9956: PRB (Projector-Recorder Belt Co.) in Whitewater, WI, 414-473-2151, 1-800-558-9572, produces a round rubber belt, P/N OA 7.8, which is .070 cross section and 7.8" inside circumference.

This cross section is only several thousandths of an inch different than 1/16", and the circumference is equivalent to a 2.5" diameter. This should meet your reader's device needs. The belt is available through Bayneville Electronics, locally in Baltimore, or other mainline electronics distributors.

Tim Mills Monroe, VA

Response to Joseph A. Dickerson, Dec. '95:

The first place to look for replacement drive belts, or any other parts, is the manufacturer. If you don't have the papers that came with the unit, try the 800 number telephone directory service (1-800-555-1212) since many manufacturers have toll-free numbers. Otherwise, local hobby shops or parts distributors may be able to help. Sometimes a local repair shop will sell the parts to you (at a markup!). Radio Shack could order the repair parts for you, even if it's not their product. One of the best places I have found for parts is MCM Electronics in Centerville, OH. Their catalog has six pages of belts and roller listings. You can reach MCM at 1-800-543-4330. Also try Parts Express at 1-800-338-0531, and Electronix at 1-800-223-3205.

> Joe D'Airo West Islip, NY

Continued on page 143



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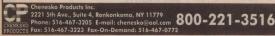
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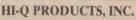
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PACKET FOR Commodore 64 users. Digicom modem wired, tested. Software and documents. \$49. Crawford Amateur Radio Society, PO Box 653, Meadville, PA

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REBUILT YAESU battery packs FNB-12(S) \$31.95, FNB-17 \$21.95 (plus \$3 shipping). Send order to: The NiCd Lady, PO Box 654, Wildomar, CA 92595. 909-

MILITARY COMPONENTS wanted. Capacitors, resistors, diodes, transistors, semiconductors, ICs. Electronic Material Industries, 818-842-5953, FAX: 818-845-

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11664A, Detector\$325	86602B, RF Plug-in, 1-1300
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11869A, Adapter for 8620C Plug-in Modules \$275	w/86602B RF Plug-in & 86
1630A, Logic Analyzer. \$700 1630D, Logic Analyzer \$800	8672A, Synth. Signal Gener
1630G, Logic Analyzer, 65 Channel \$1200	8684B, Signal Generator, 5.
1631D, Logic Analyzer	8754/H26, Network Analyze
1640A, Senal Data Analyzer\$450	8756A, Network Analyzer
1640B, Serial Data Analyzer\$650	8901B, Modulation Analyzer
1725A, 275MHz Oscilloscope	HUNDREDS OF P
1740A, Oscilloscope, 100MHz	STOCK. CAL
182T/8755C, Swept Amplitude Analyzer\$850	
214B, Pulse Generator, 200 Watt \$1500	TEKT
3310A, Function Generator\$250	1240/D1/D2, Logic Analyzer
3310B, Function Generator, .0001Hz-5MHz \$250	465, Oscilloscope, 100MHz
332A, Distortion Analyzer	465B, Oscilloscope, 100MH.
3400A, True RMS Voltmeter\$150	475, 200MHz Oscilloscope .
3437A, High Speed Digital Voltmeter \$200	475A, 250MHz Oscilloscope
3455A, Digital Voltmeter	494P, Programmable Specti
3456A, Digital Multimeter, 6.5 Digits\$800	10KHz-21GHz
3468B, 3.5 Digit Multimeter	5L4N, Spectrum Analyzer, .
3490A, Digital Multimeter	7104, 1GHz Mainframe W/(2
3580A/ANALOG, Spectrum Analyzer, 5Hz-50KHz \$1200	7854, Waveform Processing
3581A, Wave Analyzer         \$500           3581C, Selective Voltmeter         \$800	7B92A, Delaying Dual Time
3581C, Selective Voltmeter\$800	7L12, Spectrum Analyzer, 0.
3582A, Spectrum Analyzer, .02Hz-25.5KHz \$2500	7L13, Spectrum Analyzer, 1
3717A, 70MHz Modulator-Demodulator	7L18, Spectrum Analyzer Pl
4145B, Parameter Analyzer\$18,000	Capable of 60GHz with Mi AA5001, Programmable Dis
4145B, Parameter Analyzer	FG502, 11MHz Function Ge
4262A, LCR Meter \$2000 4271B, LCR Meter, 1MHz \$1500	FG504, Function Generator
42/1B, LCH Meter, 1MHz	
435A, Power Meter\$250	.001Hz-40MHz FG507, 2MHz Function Gen
435B, Power Meter	OF150, Fiber Optic Cable To
4800A, Vector Impedance Meter	PG501, Pulse Generator
4815A, Vector Impedance Meter\$1000	PG508, Pulse Generator Plu
5005B, Signature Analyzer	R7613, Storage Oscilloscop
5314A, Frequency Counter, 10Hz-100MHz\$200	S-4, Sampling Head
5315A, Universal Counter	S-6, Sampling Head SC503, 10MHz Storage Osc
5316A, Universal Counter, DC-100MHz \$600	SC504, 80MHz Oscilloscope
5328A, Universal Counter, DC-100MHz \$225	SC504, 80MHz Oscilloscope
5328B, Universal Counter	SG5010, Programmable Os
5335A, OPT. 10/20, Frequency Counter\$1450 5334A, Universal Counter, opt. 050\$1500	TR503, Tracking Generator
5340A, Frequency Counter, 10Hz-18GHz \$800	
5342A, Frequency Counter, 0.5-18GHz \$2250	MISCELI
5345A, Universal Counter\$750	Clarostat 240C, Decade Res
5345A, Universal Counter	Datron 4200, AC Standard
5345A, Universal Counter	Datron 4200, AC Standard Eaton 2052B, Amplifier, 100
5345A, Universal Counter \$750 54110D, Color Digitizing Oscilloscope \$4500 6002A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A \$800 6114A, Precision Power Supply, 0-20V/0-2A \$550 6227B, Dual Power Supply, 0-25V/0-2A \$600	Datron 4200, AC Standard Eaton 2052B, Amplifier, 100 EH Research 122, Pulse Ge
5345A, Universal Counter \$750 54110D, Color Digitizing Oscilloscope \$4500 6002A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A \$800 6114A, Precision Power Supply, 0-20V/0-2A \$550 6227B, Dual Power Supply, 0-25V/0-2A \$500 6260B, DC Power Supply, 0-10V, 0-100A \$350	Datron 4200, AC Standard Eaton 2052B, Amplifier, 100 EH Research 122, Pulse Ge EH Research 122A, Pulse G
5345A, Universal Counter 5750 54110D, Color Digitizing Oscilloscope 5450 6002A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A \$800 6114A, Precision Power Supply, 0-20V/0-2A \$550 6227B, Dual Power Supply, 0-25V/0-2A \$600 6260B, DC Power Supply, 0-10V, 0-100A \$350 6284A (HAR.), Power Supply, 0-10V, 0-3A \$125	Datron 4200, AC Standard Eaton 2052B, Amplifier, 100 EH Research 122, Pulse Ge
5345A, Universal Counter \$750 54110D, Color Digitizing Oscilloscope \$4500 6002A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A \$800 6114A, Precision Power Supply, 0-20V/0-2A \$550 6227B, Dual Power Supply, 0-25V/0-2A \$600 6260B, DC Power Supply, 0-10V, 0-100A \$350 6284A (HAR.), Power Supply, 0-20V/0-3A \$125 652A, Test Oscillator, 10Hz-10MHz \$200	Datron 4200, AC Standard Eaton 2052B, Amplifier, 100 EH Research 122, Pulse Ge EH Research 122A, Pulse G EH Research 129, Pulse Ge
5345A, Universal Counter         \$750           54110D, Color Digitizing Oscilloscope         \$4500           6002A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A         \$800           6114A, Precision Power Supply, 0-20V/0-2A         \$550           6227B, Dual Power Supply, 0-25V/0-2A         \$600           6260B, DC Power Supply, 0-10V, 0-100A         \$350           6294A (HAR.), Power Supply, 0-20V/0-3A         \$125           652A, Test Oscillator, 10Hz-10MHz         \$200           7090A, Measurement Plotting System         \$2750	Datron 4200, AC Standard Eaton 2052B, Ampliffer, 100 EH Research 122, Pulse Ge EH Research 129, Pulse Ge EH Research 129, Pulse Ge EH Research 137, Pulse Ge ENI 350L, Ampliffer, 250KH: ENI 406L, Ampliffer, 150KH:
5345A, Universal Counter         \$750           54110D, Cotor Digitizing Oscilloscope         \$4500           6002A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A         \$800           6114A, Precision Power Supply, 0-20V/0-2A         \$550           6227B, Dual Power Supply, 0-25V/0-2A         \$600           6280B, DC Power Supply, 0-10V, 0-100A         \$350           6284A (HAR), Power Supply, 0-20V/0-3A         \$125           652A, Test Oscillator, 10Hz-10MHz         \$200           7090A, Measurement Plotting System         \$2750           475A, 6 Pen Graphic Plotter         \$250	Datron 4200, AC Standard Eaton 2052B, Ampilifer, 100 EH Research 122, Pulse Ge EH Research 122A, Pulse G EH Research 137, Pulse Ge EH Research 137, Pulse Ge ENI 350L, Ampilifer, 250KH: ENI 406L, Ampilifer, 150KH ENI 4111A, Ampilifer, 150KH
5345A, Universal Counter         \$750           54110D, Cotor Digitizing Oscilloscope         \$450           6002A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A         \$800           6114A, Precision Power Supply, 0-20V/0-2A         \$550           6227B, Dual Power Supply, 0-25V/0-2A         \$600           6280B, DC Power Supply, 0-10V, 0-100A         \$350           6284A (HAR.), Power Supply, 0-20V/0-3A         \$125           5252A, Test Oscillator, 10Hz-10MHz         \$200           7090A, Measurement Plotting System         \$275           745A, Pen Graphic Plotter         \$250           750A, Plotter         \$200           8007B, Pulse Generator, 100MHz.         \$550	Datron 4200, AC Standard Eaton 2052B, Ampilifer, 100 EH Research 122, Pulse GE EH Research 122A, Pulse GE EH Research 132P, Pulse GE EN 1350L, Ampilifer, 250KH: ENI 406L, Ampilifer, 150KH: ENI 411LA, Ampilifer, 150KH Fluke 335D, DC Voltage Sta
5345A, Universal Counter         \$750           54110D, Color Digitizing Oscilloscope         \$4500           6002A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A         \$800           6114A, Precision Power Supply, 0-20V/0-2A         \$550           6227B, Dual Power Supply, 0-25V/0-2A         \$600           6260B, DC Power Supply, 0-10V, 0-100A         \$350           6284A (HAR.), Power Supply, 0-20V/0-3A         \$125           52A, Test Oscillator, 10Hz-10MHz         \$200           7050A, Measurement Plotting System         \$2750           7475A, 6 Pen Graphic Plotter         \$250           8007B, Pulse Generator, 100MHz         \$50           8013B, Pulse Generator, 11tz-50MHz         \$750	Datron 4200, AC Standard Eaton 2052B, Ampilier, 100 EH Research 122, Pulse Ge EH Research 129, Pulse Ge EH Research 139, Pulse Ge EH Research 137, Pulse Ge ENI 350L, Ampilier, 250KH- ENI 406L, Amplifier, 150KH- ENI 411LA, Amplifier, 150KI Fluke 335D, DC Voltage Sta Fluke 5100B/05, Multifunctic
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5345A, Universal Counter \$750 54110D, Color Digitizing Oscilloscope \$4500 6002A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A \$800 6114A, Precision Power Supply, 0-20V/0-2A \$550 6227B, Dual Power Supply, 0-25V/0-2A \$650 6226B, DC Power Supply, 0-10V, 0-100A \$350 6286B, DC Power Supply, 0-10V, 0-100A \$125 632A, Test Oscillator, 10Hz-10MHz \$200 7050A, Measurement Plotting System \$2750 7475A, 6 Pen Graphic Plotter \$250 7550A, Plotter \$250 8007B, Pulse Generator, 100MHz. \$550 8105B, Pulse Generator, 112-50MHz \$750 8105B, Pulse Generator, 112-50MHz \$750 8165A010/02, Signal Source \$2750 8349B Amplifier, 2-20GHz \$5000	Datron 4200, AC Standard Eaton 2052B, Ampilier, 100 EH Research 122, Pulse Ge EH Research 129, Pulse Ge EH Research 139, Pulse Ge EH Research 137, Pulse Ge ENI 350L, Ampilier, 250KH- ENI 406L, Amplifier, 150KH- ENI 411LA, Amplifier, 150KI Fluke 335D, DC Voltage Sta Fluke 5100B/05, Multifunctic
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5345A, Universal Counter \$750 54110D, Cotor Digitizing Oscilloscope \$4500 6002A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A \$800 6114A, Precision Power Supply, 0-20V/0-2A \$550 6227B, Dual Power Supply, 0-25V/0-2A \$600 6260B, DC Power Supply, 0-10V, 0-100A \$350 6280B, DC Power Supply, 0-10V, 0-100A \$350 6280A (HAR), Power Supply, 0-20V/0-3A \$125 652A, Test Oscillator, 10Hz-10MHz \$200 7090A, Measurement Plotting System \$2750 7475A, 6 Pen Graphic Plotter \$250 6007B, Pulse Generator, 10MHz \$550 8007B, Pulse Generator, 112-50MHz \$750 8165A/01/02, Signal Source \$2750 8165A/01/02, Signal Source \$2750 8350A, Sweep Oscillator Mainframe \$2400 8350A, Sweep Oscillator Mainframe \$2400	Datron 4200, AC Standard Eaton 2052B, Ampilifer, 100 EH Research 122, Pulse Ge EH Research 122A, Pulse Ge EH Research 129, Pulse Ge EH Research 137, Pulse Ge EH Research 137, Pulse Ge ENI 350L, Ampilifer, 250KH- ENI 406L, Ampilifer, 150KH- ENI 406L, Ampilifer, 150KH- ENI 411LA, Ampilifer, 150KH- ENI 411LA, Ampilifer, 150KH- ENI 411LA, Ampilifer, 150KH- ENI 4510B/05, Multifunctic Fluke 5100B/05, Multifunctic Fluke 5101B/03, Calibrator Fluke 5200A, AC Voltage Gi Fluke 540B, Transfer Standi
\$3450, Universal Counter \$750 \$4110D, Color Digitizing Oscilloscope \$4500 8002A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A \$800 8014A, Precision Power Supply, 0-20V/0-2A \$850 8227B, Dual Power Supply, 0-25V/0-2A \$600 8260B, DC Power Supply, 0-10V, 0-100A \$350 8284A (HAR.), Power Supply, 0-10V, 0-100A \$350 8284A (HAR.), Power Supply, 0-20V/0-3A \$125 852A, Test Oscillator, 10Hz-10MHz \$200 7990A, Measurement Plotting System \$2750 7475A, 6 Pen Graphic Plotter \$250 7475A, 6 Pen Graphic Plotter \$250 8007B, Pulse Generator, 10MHz. \$550 8007B, Pulse Generator, 11Hz-50MHz \$750 8013B, Pulse Generator, 11Hz-50MHz \$750 8349B Amplifier, 2-20GHz \$500 8350A, Sweep Oscillator Mainframe \$2400 83540A, 2-0-8.4GHz RF Plug-in \$250 83545B, RF Plug-in, 2-0-8.4GHz \$4200	Datron 4200, AC Standard Eaton 2052B, Ampilifer, 100 EH Research 1222, Pulse Ge EH Research 1222, Pulse Ge EH Research 129, Pulse Ge EH Research 137, Pulse Ge EH Research 137, Pulse Ge ENI 350L, Ampilifer, 250KH. ENI 406L, Ampilifer, 150KH. ENI 406L, Ampilifer, 150KH. ENI 411LA, Ampilifer, 150KH ENI 411LA, Ampilifer, 150KH Fluke 335D, DC Voltage Sta Fluke 5100B/05, Multifunctic Fluke 5101B/03, Calibrator Fluke 540B, Transfer Stand: Fluke 752A, Reference Divit Fluke 850SA, Digital Multimu Fluke 850SA, Digit Digits Fluke 850SA, Digital Multimu
5345A, Universal Counter \$750 54110D, Cotor Digitizing Oscilloscope \$4500 6002A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A \$800 6114A, Precision Power Supply, -0-20V/0-2A \$500 6227B, Dual Power Supply, 0-25V/0-2A \$600 6226B, DC Power Supply, 0-10V, 0-100A \$350 6286B, DC Power Supply, 0-10V, 0-100A \$350 6284A (HAR), Power Supply, 0-20V/0-3A \$125 652A, Test Oscillator, 10Hz-10MHz \$200 7050A, Measurement Plotting System \$2750 7475A, 6 Pen Graphic Plotter \$250 8007B, Pulse Generator, 10MHz \$550 8007B, Pulse Generator, 10MHz \$550 8013B, Pulse Generator, 11z-50MHz \$750 8165A/01/02, Signal Source \$2750 83549B, Amplifer, 2-20GHz \$500 8350A, Sweep Oscillator Mainframe \$2400 83540A, 2-0-4.4GHz RF Plug-in \$2250 83540B, RF Plug-in, 2-0-8.4GHz \$4750 83545A, Oscillator Plug-in, 5-12.4GHz \$4200 83572B/001-006, Oscillator Plug-in, 5-12.4GHz \$4200	Datron 4200, AC Standard Eaton 2052B, Ampilifer, 100 EH Research 122, Pulse Ge EH Research 122A, Pulse Ge EH Research 129, Pulse Ge EH Research 137, Pulse Ge EH Research 137, Pulse Ge EH Research 137, Pulse Ge ENI 350L, Amplifier, 150KH: ENI 406L, Amplifier, 150KH: ENI 411LA, Amplifier, 150KH: ENI 411LA, Amplifier, 150KH: ENI 411LA, Amplifier, 150KH: ENI 4510B/05, Multifunctic Fluke 510B/05, Multifunctic Fluke 510B/03, Calibrator Fluke 5200A, AC Voltage Ci. Fluke 540B, Transfer Standt Fluke 752A, Reference Divic Fluke 8506A, 6.5 Digit Digits Fluke 8506A, 0.5 Digit Digits Krohn-Hite 3100R, Tunable
5345A, Universal Counter 54110D, Color Digitizing Oscilloscope 54100, Color Digitizing Oscilloscope 54100, Color Digitizing Oscilloscope 54500 6002A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A \$800 6114A, Precision Power Supply, 0-22V/0-2A \$550 6227B, Dual Power Supply, 0-25V/0-2A \$600 6260B, DC Power Supply, 0-10V, 0-100A \$350 6280B, DC Power Supply, 0-10V, 0-100A \$350 6280A (HAR), Power Supply, 0-20V/0-3A \$125 652A, Test Oscillator, 10Hz-10MHz \$200 7090A, Measurement Plotting System \$2750 7475A, 6 Pen Graphic Plotter \$250 7475A, 6 Pen Graphic Plotter \$250 7475A, 6 Pen Graphic Plotter \$250 7550A, Plotter \$250 8013B, Pulse Generator, 11Hz-50MHz \$750 8013B, Pulse Generator, 11Hz-50MHz \$750 8165A0/10/2, Signal Source \$2750 8349B Amplifier, 2-20GHz \$350A, Sweep Oscillator Mainframe \$2400 83540B, BF Plug-in, 20-84 GHz \$450 83545A, Oscillator Plug-in, 5-9-12-4GHz \$420 83545A, Oscillator Plug-in, 2-65-40GHz \$12,000	Datron 4200, AC Standard Eaton 2052B, Ampilifer, 100 EH Research 122, Pulse Ge EH Research 122, Pulse Ge EH Research 129, Pulse Ge EH Research 137, Pulse Ge EH Research 137, Pulse Ge EN 350L, Ampilifer, 150KH: ENI 406L, Ampilifer, 150KH: ENI 411LA, Ampilifer, 150KH: ENI 411LA, Ampilifer, 150KH: Fluke 335D, DC Voltage Sta Fluke 5100B/05, Multifunctic Fluke 5101B/03, Calibrator Ci Fluke 540B, Transfer Stand: Fluke 752A, Reference Divid Fluke 850SA, 6.5 Digit Digits Fluke 850SA, 6.5 Digit Digits Fluke 850SA, Digital Multim Krohn-Hite 3103/R3103, Turable Krohn-Hite 3103/R3103, Turable
5345A, Universal Counter \$750 54110D, Cotor Digitizing Oscilloscope \$4500 6002A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A \$800 6114A, Precision Power Supply, -0-20V/0-2A \$500 6227B, Dual Power Supply, 0-25V/0-2A \$600 6226B, DC Power Supply, 0-10V, 0-100A \$350 6286B, DC Power Supply, 0-10V, 0-100A \$350 6284A (HAR), Power Supply, 0-20V/0-3A \$125 652A, Test Oscillator, 10Hz-10MHz \$200 7050A, Measurement Plotting System \$2750 7475A, 6 Pen Graphic Plotter \$250 8007B, Pulse Generator, 10MHz \$550 8007B, Pulse Generator, 10MHz \$550 8013B, Pulse Generator, 11z-50MHz \$750 8165A/01/02, Signal Source \$2750 83549B, Amplifer, 2-20GHz \$500 8350A, Sweep Oscillator Mainframe \$2400 83540A, 2-0-4.4GHz RF Plug-in \$2250 83540B, RF Plug-in, 2-0-8.4GHz \$4750 83545A, Oscillator Plug-in, 5-12.4GHz \$4200 83572B/001-006, Oscillator Plug-in, 5-12.4GHz \$4200	Datron 4200, AC Standard Eaton 2052B, Ampilifer, 100 EH Research 122, Pulse Ge EH Research 122, Pulse Ge EH Research 129, Pulse Ge EH Research 137, Pulse Ge EH Research 137, Pulse Ge EN 350L, Ampilifer, 150KH: ENI 406L, Ampilifer, 150KH: ENI 411LA, Ampilifer, 150KH: ENI 411LA, Ampilifer, 150KH: Fluke 335D, DC Voltage Sta Fluke 5100B/05, Multifunctic Fluke 5101B/03, Calibrator Ci Fluke 540B, Transfer Stand: Fluke 752A, Reference Divid Fluke 850SA, 6.5 Digit Digits Fluke 850SA, 6.5 Digit Digits Fluke 850SA, Digital Multim Krohn-Hite 3103/R3103, Turable Krohn-Hite 3103/R3103, Turable
5345A, Universal Counter	Datron 4200, AC Standard Eaton 2052B, Ampilifer, 100 EH Research 122, Pulse Ge EH Research 122A, Pulse Ge EH Research 129, Pulse Ge EH Research 137, Pulse Ge EH Research 137, Pulse Ge EH Research 137, Pulse Ge ENI 350L, Amplifier, 150KH: ENI 411LA, Amplifier, 150KH: ENI 411LA, Amplifier, 150KH: ENI 411LA, Amplifier, 150KH: ENI 411LA, Amplifier, 150KH: ENI 451B D. CV Voltage Sta Fluke 510B/05, Calibrator. Fluke 550B, Calibrator. Fluke 550B, AC Voltage Cr. Fluke 540B, Transfer Standt Fluke 752A, Reference Divic Fluke 850SA, 6.5 Digit Digite Fluke 850SA, 6.5 Digit Digite Fluke 850SA, 100 Light Multima Krohn-Hite 3100R, Tunable Krohn-Hite 3103R3103, Tun Rack Version Krohn-Hite 3202/R3202. Tun
5345A, Universal Counter \$750 54110D, Cotor Digitizing Oscilloscope \$4500 6002A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A \$800 6114A, Precision Power Supply, 0-20V/0-2A \$500 6227B, Dual Power Supply, 0-25V/0-2A \$600 6226B, DC Power Supply, 0-10V, 0-100A \$350 6226B, DC Power Supply, 0-10V, 0-100A \$350 6284A (HAR), Power Supply, 0-20V/0-3A \$125 652A, Test Oscillator, 10Hz-10MHz \$200 7050A, Measurement Plotting System \$2750 7050A, Plotter \$250 6007B, Pulse Generator, 10MHz. \$550 8013B, Pulse Generator, 100MHz. \$550 8013B, Pulse Generator, 14z-50MHz \$750 8349B Amplifer, 2-20GHz \$550 83540A, Oscillator Mainframe \$2400 8350A, Sweep Oscillator Mainframe \$2400 8350A, Sweep Oscillator Mainframe \$2400 83540A, 2-0-8 4GHz RF Plug-in, \$2450 83542B, Oscillator Plug-in, 2-6-4GHz \$4750 83542B, Oscillator Plug-in, 2-6-5-40GHz \$4750 83572B/001-006, Oscillator Plug-in, 26-5-40GHz \$250 8410B, Network Analyzer System \$250 8410B, Network Analyzer System \$250 8411A, 0713A & 8411A	Datron 4200, AC Standard Eaton 2052B, Ampilifer, 100 EH Research 122, Pulse Ge EH Research 122, Pulse Ge EH Research 129, Pulse Ge EH Research 137, Pulse Ge EH Research 137, Pulse Ge EN 350L, Ampilifer, 250KH- ENI 406L, Ampilifer, 150KH- ENI 406L, Ampilifer, 150KH- ENI 411LA, Ampilifer, 150KH- ENI 411LA, Ampilifer, 150KH- ENI 411LA, Ampilifer, 150KH- ENI 411LA, Ampilifer, 150KH- ENI 4510B, Calibrator- Fluke 530D, AC Voltage Sta- Fluke 540B, Transfer Stand- Fluke 520A, AC Voltage Ct. Fluke 550SA, 6.5 Digit Digits Fluke 8506A, Digital Multim Krohn-Hite 3100R, Tunable Krohn-Hite 3103R, Tunable Krohn-Hite 3103R, Tunable Krohn-Hite 3103R, Tunable Krohn-Hite 3102R/R3202, Tun Rack Version
5345A, Universal Counter 54110D, Cotor Digitizing Oscilloscope 54300 6002A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A 5800 6012A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A 5800 6114A, Precision Power Supply, 0-20V/0-2A 5850 6227B, Dual Power Supply, 0-25V/0-2A 58600 6260B, DC Power Supply, 0-10V, 0-100A 5850 6284A (HAR), Power Supply, 0-10V, 0-100A 5850 6284A (HAR), Power Supply, 0-20V/0-3A 5125 652A, Test Oscillator, 10Hz-10MHz 5800 7890A, Measurement Plotting System 58750 7475A, 6 Pen Graphic Plotter 58007B, Pulse Generator, 10MHz 5850 6007B, Pulse Generator, 11Hz-50MHz 6007B, Pulse Generator, 11Hz 6007B, Pulse	Datron 4200, AC Standard Eaton 2052B, Ampilifer, 100 EH Research 122, Pulse Ge EH Research 122A, Pulse Ge EH Research 129, Pulse Ge EH Research 137, Pulse Ge EH Research 137, Pulse Ge EH Research 137, Pulse Ge ENI 350L, Amplifier, 150KH: ENI 411LA, Amplifier, 150KH: ENI 411LA, Amplifier, 150KH: ENI 411LA, Amplifier, 150KH: ENI 411LA, Amplifier, 150KH: ENI 451B D. CV Voltage Sta Fluke 510B/05, Calibrator. Fluke 550B, Calibrator. Fluke 550B, AC Voltage Cr. Fluke 540B, Transfer Standt Fluke 752A, Reference Divic Fluke 850SA, 6.5 Digit Digite Fluke 850SA, 6.5 Digit Digite Fluke 850SA, 100 Light Multima Krohn-Hite 3100R, Tunable Krohn-Hite 3103R3103, Tun Rack Version Krohn-Hite 3202/R3202. Tun
5345A, Universal Counter \$750 54110D, Cotor Digitizing Oscilloscope \$4500 6002A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A \$800 6114A, Precision Power Supply, 0-20V/0-2A \$550 6227B, Dual Power Supply, 0-25V/0-2A \$600 6226B, DC Power Supply, 0-10V, 0-100A \$350 6280B, DC Power Supply, 0-10V, 0-100A \$350 6280A (HAR), Power Supply, 0-20V/0-3A \$125 652A, Test Oscillator, 10Hz-10MHz \$200 7090A, Measurement Plotting System \$2750 7090A, Measurement Plotting System \$2750 8075B, Pulse Generator, 100MHz \$250 8007B, Pulse Generator, 112-50MHz \$750 8013B, Pulse Generator, 112-50MHz \$750 8013B, Pulse Generator, 112-50MHz \$750 8165A/01/02, Signal Source \$2750 8349B Amplifier, 2-20CHz \$500 8350A, Sweep Oscillator Mainframe \$2400 8350A, Sweep Oscillator Mainframe \$2400 8350AB, Eleval System \$400 83572B/001-006, Oscillator Plug-in, 26.5-40GHz \$12,000 8405A, Vector Voltmeter 1MHz-1GHz \$250 8410B, Network Analyzer \$350 8441AB, Network Analyzer \$350 8441A, Arncking Generator/Counter \$350 8445B, Automatic Preselector \$4500 8447A, Amplifier, 0.1-400MHz \$300	Datron 4200, AC Standard Eaton 2052B, Ampilifer, 100 EH Research 122, Pulse Ge EH Research 122A, Pulse Ge EH Research 129, Pulse Ge EH Research 129, Pulse Ge EH Research 137, Pulse Ge EH Research 137, Pulse Ge EH Research 137, Pulse Ge ENI 350L, Amplifier, 150KH: ENI 406L, Amplifier, 150KH: ENI 411LA, Amplifier, 150KH: ENI 411LA, Amplifier, 150KH: ENI 411LA, Amplifier, 150KH: ENI 450B, DC Voltage Git Fluke 510B/03, Calibrator- Fluke 5200A, AC Voltage Git Fluke 540B, Transfer Standt Fluke 752A, Reference Divid Fluke 8506A, 6.5 Digit Digit: Fluke 8506A, 0.5 Digit Digit: Fluke 8506A, 0.5 Digit Digit: Fluke 8506A, Digital Multimu Krohn-Hite 3100R, Tunable Krohn-Hite 3202/R3202, Tur Rack Version Krohn-Hite 3342, Tunable F
5345A, Universal Counter 54110D, Cotor Digitizing Oscilloscope 54300 6002A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A 5800 6012A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A 5800 6114A, Precision Power Supply, 0-20V/0-2A 5850 6227B, Dual Power Supply, 0-25V/0-2A 58600 6260B, DC Power Supply, 0-10V, 0-100A 5850 6284A (HAR), Power Supply, 0-10V, 0-100A 5850 6284A (HAR), Power Supply, 0-20V/0-3A 5125 652A, Test Oscillator, 10Hz-10MHz 5800 7890A, Measurement Plotting System 58750 7475A, 6 Pen Graphic Plotter 58007B, Pulse Generator, 10MHz 5850 6007B, Pulse Generator, 11Hz-50MHz 6007B, Pulse Generator, 11Hz 6007B, Pulse	Datron 4200, AC Standard Eaton 2052B, Ampilifer, 100 EH Research 122, Pulse Ge EH Research 122, Pulse Ge EH Research 129, Pulse Ge EH Research 129, Pulse Ge EH Research 137, Pulse Ge EH Research 137, Pulse Ge ENI 350L, Amplifier, 150KH: ENI 406L, Amplifier, 150KH: ENI 411LA, Amplifier, 150KH: ENI 411LA, Amplifier, 150KH: ENI 411LA, Amplifier, 150KH: ENI 450B, DC Voltage Sta Fluke 510B/00, Calibrator Ci- Fluke 550B, AC Voltage Sta Fluke 550B, AC Voltage Ci- Fluke 540B, Transfer Standt Fluke 752A, Reference Divic Fluke 850SA, 6.5 Digit Digit Fluke 850SA, 6.5 Digit Digit Fluke 850SA, 6.5 Digit Digit Fluke 850SA, 100B/1873103, Tul Rack Version Krohn-Hite 3102/R3202. Tul Rack Version Krohn-Hite 3342, Tunable F Sorensen QRD 30-1, Power Sorensen QRD 30-1, Power Valhalla 27000, Calibration 1
5345A, Universal Counter 54110D, Color Digitizing Oscilloscope 54100, Color Digitizing Oscilloscope 54100, Color Digitizing Oscilloscope 54100, Color Digitizing Oscilloscope 54100, Color Digitizing Oscilloscope 5410A, Precision Power Supply, HP-IB, 0-50V/0-10A 5800 6114A, Precision Power Supply, 0-22V/0-2A 5800 6260B, DC Power Supply, 0-10V, 0-100A 5350 6280B, DC Power Supply, 0-10V, 0-100A 5350 6280A, (HAR), Power Supply, 0-20V/0-3A 5125 652A, Test Oscillator, 10Hz-10MHz 5200 7090A, Measurement Plotting System 52750 7475A, 6 Pen Graphic Plotter 5250 8138B, Pulse Generator, 114z-50MHz 5350 813B, Pulse Generator, 114z-50MHz 5350 8158A0, 1072, Signal Source 52750 8349B Amplifier, 2-20CHz 5350A, Sweep Oscillator Mainframe 52400 83540B, Re Plug-in, 2.0-8 4GHz 5354B, Oscillator Plug-in, 265-40GHz 5354B, Oscillator Plug-in, 265-40GHz 5410A, 1074 5410A, 108, Prequency Converter, 11 to 18GHz 5500 8411A, O18, Frequency Converter, 11 to 18GHz 5500 8447B, Amplifier, 0-41-3GHz 5350 8447B, Amplifier, 0-41-3GHz 5350 8447C, Amplifier, 0-41-3GHz 5350	Datron 4200, AC Standard Eaton 2052B, Ampilifer, 100 EH Research 122, Pulse Ge EH Research 122, Pulse Ge EH Research 129, Pulse Ge EH Research 137, Pulse Ge EN 350L, Ampilifer, 250KH- ENI 406L, Ampilifer, 150KH- ENI 411LA, Ampilifer, 150KH- ENI 411LA, Ampilifer, 150KH- Fluke 335D, DC Voltage Sta- Fluke 5100B/05, Multifunctic Fluke 5100B/05, Multifunctic Fluke 540B, Transfer Standt Fluke 540B, Transfer Standt Fluke 540B, Transfer Standt Fluke 550SA, 6.5 Digit Digits Fluke 850SA, 100 Tunable Krohn-Hite 3103/R3103, Tunable F Krohn-Hite 3103/R3103, Tunable F Sorensen QRD 30-1, Power Sorensen QRD 30-1, Power Sorensen QRD 40-2, Power Valhalla 27000, Calibration Valhalla 2701B, DC Calibratio
5345A, Universal Counter 54110D, Cotor Digitizing Oscilloscope \$4500 6002A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A \$800 6114A, Precision Power Supply, D-20V/0-2A \$550 6227B, Dual Power Supply, 0-25V/0-2A \$600 6260B, DC Power Supply, 0-10V, 0-100A \$350 6280B, DC Power Supply, 0-10V, 0-100A \$350 6280A (HAR), Power Supply, 0-20V/0-3A \$125 652A, Test Oscillator, 10Hz-10MHz \$200 7090A, Measurement Plotting System \$2750 7475A, 6 Pen Graphic Plottler \$250 7475A, 6 Pen Graphic Plottler \$250 0078B, Pulse Generator, 10MHz. \$550 8007B, Pulse Generator, 11Hz-50MHz \$750 8007B, Pulse Generator, 11Hz-50MHz \$750 8007B, Pulse Generator, 11Hz-50MHz \$750 8349B Amplifier, 2-20GHz \$500 8350A, Sweep Oscillator Mainframe \$2400 83540A, 2.0-8.4GHz RF Plug-in \$2250 8354BB, RF Plug-in, 2.0-8.4GHz. \$4200 83572B/001-006, Oscillator Plug-in, 26.5-40GHz \$12,000 8456A, Vactor Voltmeter Mirtz-1GHz \$250 8410B, Network Analyzer System w/8412A, 87343, 8411A 8500 8447B, Automatic Preselector \$450 8447B, Amplifier, 0.4-1.3GHz \$350 8447C, Amplifier, 0.1-400MHz \$350 8447C, Amplifier, 0.1-400MHz \$350 8436A, Network Analyzer 853A, Display for Spectrum Analyzer Plug-in \$250 853A, Display for Spectrum Analyzer Plug-in \$250	Datron 4200, AC Standard Eaton 2052B, Ampilifer, 100 EH Research 1222, Pulse Ge EH Research 1222, Pulse Ge EH Research 123P, Pulse Ge EH Research 137, Pulse Ge EH Research 137, Pulse Ge EH Research 137, Pulse Ge ENI 350L, Ampilifer, 250KH- ENI 406L, Ampilifer, 150KH- ENI 406L, Ampilifer, 150KH- ENI 411LA, Ampilifer, 150KH- ENI 411LA, Ampilifer, 150KH- ENI 411LA, Ampilifer, 150KH- ENI 4510B, Calibrator- Fluke 530D, AC Voltage Sta- Fluke 5100B/OS, Multifunctic Fluke 540B, Transfer Stand- Fluke 540B, Transfer Stand- Fluke 850A, Digital Multima Krohn-Hite 3103/R3103, Tur Rack Version Krohn-Hite 3020/R3202, Tur Rack Version Krohn-Hite 3342, Tunable F Sorensen QRD 30-1, Power Valhalla 27000, Calibration 1 Valhalla 2701B, DC Calibration Valhalla Function Function
5345A, Universal Counter 54110D, Cotor Digitizing Oscilloscope 54500 6002A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A 8800 6114A, Precision Power Supply, D-20V/0-2A \$500 6227B, Dual Power Supply, 0-25V/0-2A \$500 6226B, DC Power Supply, 0-10V, 0-100A \$350 6226B, DC Power Supply, 0-10V, 0-100A \$350 6280A (HAR), Power Supply, 0-20V/0-3A \$125 652A, Test Oscillator, 10Hz-10MHz \$200 7090A, Measurement Plotting System \$2750 8775A, 6 Pen Graphic Plotter \$250 8750A, Plotter \$250 8750A, Plotter \$250 8078, Pulse Generator, 10MHz \$750 8013B, Pulse Generator, 112-50MHz \$750 8013B, Pulse Generator, 112-50MHz \$750 8165A/01/02, Signal Source \$2750 8349B Amplifier, 2-20CHz \$350A, Sweep Oscillator Mainframe \$2400 8350A, 2-0-8-4GHz RF Plug-in \$2250 83540A, 0-8-4-4GHz RF Plug-in \$2400 83572B/001-006, Oscillator Plug-in, 26.5-40GHz \$12,000 8405A, Vector Voltmeter 1MHz-1GHz \$250 8410B, Network Analyzer System w/8412A, 8743A & 8411A \$500 8443A, Tracking Generator/Counter \$350 8447A, Amplifier, 0.1-400MHz \$350 8447A, Amplifier, 0.1-400MHz \$350 8450B, Alpsipaly for Spectrum Analyzer Plug-in \$250 8532B, IF Section Plug-in \$250 8536, Display for Spectrum Analyzer Plug-in \$250 8552B, IF Section Plug-in \$2500	Datron 4200, AC Standard Eaton 2052B, Ampilifer, 100 EH Research 122, Pulse Ge EH Research 122, Pulse Ge EH Research 129, Pulse Ge EH Research 139, Pulse Ge EH Research 137, Pulse Ge EH Research 137, Pulse Ge EH Risearch 137, Pulse Ge ENI 330L, Amplifier, 250KH- ENI 406L, Amplifier, 150KH- ENI 411LA, ENI
5345A, Universal Counter 54110D, Color Digitizing Oscilloscope \$4500 6002A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A \$800 6114A, Precision Power Supply, 0-20V/0-2A \$550 6227B, Dual Power Supply, 0-25V/0-2A \$550 6227B, Dual Power Supply, 0-10V, 0-100A \$250 6226B, DC Power Supply, 0-10V, 0-100A \$350 6280A (HAR), Power Supply, 0-20V/0-3A \$125 652A, Test Oscillator, 10Hz-10MHz \$200 7990A, Measurement Plotting System \$2750 7475A, 6 Pen Graphic Plottler \$250 7475A, 6 Pen Graphic Plottler \$250 0078B, Pulse Generator, 10MHz. \$550 8013B, Pulse Generator, 11Hz-50MHz \$750 8013B, Pulse Generator, 11Hz-50MHz \$750 8349B Amplifier, 2-20GHz \$350A, Sweep Oscillator Mainframe \$2400 83540A, 2-0-8.4GHz RF Plug-in \$250 8354BB, RF Plug-in, 2-0-8.4GHz \$3545A, Oscillator Plug-in, 2-6.5-40GHz \$4750 8410B, Network Analyzer System w/8412A, 8743A, 8411A \$600 8445A, Vactor Voltmeter 1MHz-1GHz \$450 8445B, Automatic Preselector \$450 8447B, Amplifier, 0-1-400MHz \$350 8447C, Amplifier, 30-300MHz \$350, Network Analyzer \$350 84547, Amplifier, 30-300MHz \$350 8552B, 88558B, Spectrum Analyzer	Datron 4200, AC Standard Eaton 2052B, Ampilifer, 100 EH Research 122, Pulse Ge EH Research 122, Pulse Ge EH Research 129, Pulse Ge EH Research 129, Pulse Ge EH Research 137, Pulse Ge EH Research 137, Pulse Ge EN 350L, Ampilifer, 150KH: ENI 406L, Ampilifer, 150KH: ENI 411LA, Ampilifer, 150KH: ENI 411LA, Ampilifer, 150KH: ENI 411LA, Ampilifer, 150KI: Fluke 335D, DC Voltage Sta- Fluke 5100B/05, Multifunctic Fluke 5100B/05, Multifunctic Fluke 540B, Transfer Stand: Fluke 540B, Transfer Stand: Fluke 540B, Transfer Stand: Fluke 850SA, 6.5 Digit Digits Fluke 850SA, 6.5 Digit Digits Fluke 850SA, 6.5 Digit Digits Fluke 850SA, Digital Multime Krohn-Hite 3103/R3103, Tunable F Krohn-Hite 3103/R3103, Tunable F Sorensen QRD 30-1, Power Sorensen QRD 40-2, Power Valhalla 2700L, Calibration 3 Valhalla 2701B, DC Calibration
5345A, Universal Counter 54110D, Color Digitizing Oscilloscope 54500 6002A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A \$800 6012A, Precision Power Supply, PIP-IB, 0-50V/0-10A \$800 6114A, Precision Power Supply, 0-22V/0-2A \$550 6227B, Dual Power Supply, 0-25V/0-2A \$600 6260B, DC Power Supply, 0-10V, 0-100A \$350 6284A (HAR), Power Supply, 0-10V, 0-100A \$350 6284A (HAR), Power Supply, 0-20V/0-3A \$125 652A, Test Oscillator, 10Hz-10MHz \$200 7990A, Measurement Plotting System \$2750 7475A, 6 Pen Graphic Plotter \$250 7550A, Plotter \$250 7550A, Plotter \$250 7550A, Plotter \$250 8007B, Pulse Generator, 11Hz-50MHz \$750 8007B, Pulse Generator, 11Hz-50MHz \$750 8013B, Pulse Generator, 11Hz-50MHz \$750 8013B, Pulse Generator, 11Hz-50MHz \$750 8349A Amplifier, 2-20GHz \$350A, Sweep Oscillator Mainframe \$2400 83540A, 2-0-8-4GHz RF Plug-in \$250 83540B, Nestwork Analyzer \$4200 83540B, Nestwork Analyzer System \$4405A, Vector Voltmeter MiHz-1GHz \$350 8410B, Network Analyzer System \$445B, Automatic Preselector \$445B, Automatic Preselector \$445B, Automatic Preselector \$445B, Automatic Preselector \$447B, Amplifier, 0.4-1,3GHz \$350 8450B, Alestwork Analyzer \$350 8552B, &BS55B, Spectrum Analyzer \$4500 8552B, &BS55B, Spectrum Analyzer \$4500	Datron 4200, AC Standard Eaton 2052B, Ampilifer, 100 EH Research 122, Pulse Ge EH Research 122, Pulse Ge EH Research 129, Pulse Ge EH Research 139, Pulse Ge EH Research 137, Pulse Ge EH Research 137, Pulse Ge EH Risearch 137, Pulse Ge ENI 330L, Amplifier, 250KH- ENI 406L, Amplifier, 150KH- ENI 411LA, ENI
5345A, Universal Counter 54110D, Cotor Digitizing Oscilloscope 54500 6002A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A \$800 6114A, Precision Power Supply, D-20V/0-2A \$550 6227B, Dual Power Supply, 0-25V/0-2A \$5600 6260B, DC Power Supply, 0-10V, 0-100A \$350 6280B, DC Power Supply, 0-10V, 0-100A \$350 6350A, Plotter \$3200 6007B, Pulse Generator, 10VHz. \$550 6013B, Pulse Generator, 10WHz. \$550 6013B, Pulse Generator, 11tz-50MHz \$750 6156A0/10/2, Signal Source \$2750 6349B Amplifier, 2-20GHz \$5500 8350A, Sweep Oscillator Mainframe \$2400 8350A, Sweep Oscillator Mainframe \$2400 83540A, 2-0-8 4GHz RF Plug-in \$2250 83540B, RF Plug-in, 2-0-8 4GHz \$4750 83545A, Oscillator Plug-in, 26.5-40GHz \$470 8405A, Vector Voltmeter 1MHz-1GHz \$400 8410B, Network Analyzer System w/8412A, 8743A & 8411A \$500 8447B, Amplifier, 0-1-400MHz \$300 8447B, Amplifier, 0-1-400MHz \$300 8447B, Amplifier, 0-1-400MHz \$300 8552B & 8555B, Spectrum Analyzer Plug-in \$250 8552B & 8555B, Spectrum Analyzer w/141T Mainframe \$1500	Datron 4200, AC Standard Eaton 2052B, Ampilifer, 100 EH Research 122, Pulse Ge EH Research 122A, Pulse Ge EH Research 129, Pulse Ge EH Research 129, Pulse Ge EH Research 137, Pulse Ge EH Research 137, Pulse Ge ENI 350L, Amplifier, 150KH: ENI 406L, Amplifier, 150KH: ENI 411LA, ENI 411LA
5345A, Universal Counter 54110D, Color Digitizing Oscilloscope 54500 6002A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A 5800 6114A, Precision Power Supply, HP-IB, 0-50V/0-10A 5800 6114A, Precision Power Supply, 0-22V/0-2A 5850 6227B, Dual Power Supply, 0-25V/0-2A 5850 6226B, DC Power Supply, 0-10V, 0-100A 5350 6284A (HAR), Power Supply, 0-20V/0-3A 5125 652A, Test Oscillator, 10Hz-10MHz 5200 7090A, Measurement Plotting System 52750 7475A, 6 Pen Graphic Plotter 5250 6078, Pluse Generator, 11tz-50MHz 5750 8158B, Pulse Generator, 11tz-50MHz 5750 8158B, Pulse Generator, 11tz-50MHz 5750 8349B Amplifier, 2-20CHz 5850A, Sweep Oscillator Mainframe 52400 83540B, RP Flug-in, 20-84 GHz 53545A, Oscillator Plug-in, 26.5-40GHz 53545A, Oscillator Plug-in, 26.5-40GHz 5405 8405A, Vector Voltmeter MHz-1GHz 5400 8411A/018, Frequency Converter, 11 to 18GHz 5400 8411A/018, Frequency Converter, 11 to 18GHz 5400 8447B, Amplifier, 0-4-13GHz 5400 8447B, Amplifier, 0-4-13GHz 5400 8452B, Automatic Preselector 5450 8447B, Amplifier, 0-4-13GHz 5350 8458B, Automatic Preselector 5450 8452B, 8555B, Spectrum Analyzer 6411T Mainframe 55508, 8555A, Spectrum Analyzer 6554B, RP Blug-in, 50.06Hz-1250MHz 5800	Datron 4200, AC Standard Eaton 2052B, Ampilifer, 100 EH Research 122, Pulse Ge EH Research 122, Pulse Ge EH Research 129, Pulse Ge EH Research 129, Pulse Ge EH Research 137, Pulse Ge EH Research 137, Pulse Ge ENI 350L, Amplifier, 150KH: ENI 406L, Amplifier, 150KH: ENI 411LA, Amplifier, 150KH: ENI 411LA, Amplifier, 150KH: ENI 411LA, Amplifier, 150KH: ENI 411LA, Amplifier, 150KH: Fluke 510B, DC Voltage Sta Fluke 510B/03, Calibrator Ciluke 510B/03, Calibrator Ciluke 540B, Transfer Standt Fluke 752A, Reference Divider 150KH;
5345A, Universal Counter 54110D, Cotor Digitizing Oscilloscope \$4500 6002A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A \$800 6114A, Precision Power Supply, D-20V/0-2A \$550 6227B, Dual Power Supply, 0-25V/0-2A \$550 6227B, Dual Power Supply, 0-10V, 0-100A \$256 6227B, Dual Power Supply, 0-10V, 0-100A \$350 6280B, DC Power Supply, 0-10V, 0-100A \$350 6280B, Power Supply, 0-20V/0-3A \$125 652A, Fest Oscillator, 10Hz-10MHz \$250 6707B, Pulse Generator, 10MHz \$350 6007B, Pulse Generator, 11Hz-50MHz \$750 6007B, Pulse Generator, 11Hz-50MHz \$750 6349B Amplifier, 2-20GHz \$350A, Sweep Oscillator Mainframe \$2400 83540A, 2.0-8.4GHz RF Plug-in \$250 83540B, RF Plug-in, 2.0-8.4GHz \$3540A, 2.0-8.4GHz \$4750 83545A, Oscillator Plug-in, 26.5-40GHz \$12,000 83545A, Oscillator Plug-in, 26.5-40GHz \$12,000 8445B, Automatic Preselector \$445B, Automatic Preselector \$445B, Automatic Preselector \$445B, Automatic Preselector \$445B, Automatic Preselector \$447C, Amplifier, 0.1-400MHz \$350 8447C, Amplifier, 0.1-400MHz \$350 8552B, 88555A, Spectrum Analyzer W/141T Mainframe \$1800 85540 RF Plug-in, 500KHz-1250MHz \$800 8557A/18ET, Spectrum Analyzer \$1600	Datron 4200, AC Standard Eaton 2052B, Ampilifer, 100 EH Research 122, Pulse Ge EH Research 122, Pulse Ge EH Research 129, Pulse Ge EH Research 137, Pulse Ge EN 350L, Ampilifer, 150KH: EN 411LA, Ampilifer, 150KH: Fluke 350D, DC Voltage Sta Fluke 5100B/05, Multifunctic Fluke 5100B/05, Multifunctic Fluke 5100B/05, Multifunctic Fluke 540B, Transfer Stands Fluke 752A, Reference Divic Fluke 850SA, 6.5 Digit Digits Fluke 850SA, 100 Digital Multim Krohn-Hite 3103/R3103, Tunable F Krohn-Hite 3103/R3103, Tunable F Sorensen QRD 40-2, Power Valhalla 27000, Calibration Valhalla 2701B, DC Calibration Valhalla 2701B, DC Calibrati Wavetek 166, Pulse Functio Wavetek 178, Automatic Sy Wavetek 186, Phase Lock C Wavetek 2002A, Signal Gene Wavetek 3000, Signal Gene Wavetek 3000, Signal Gene Wavetek 3001, Signal Gene
5345A, Universal Counter 54110D, Cotor Digitizing Oscilloscope 54500 6002A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A 8800 6114A, Precision Power Supply, 0-20V/0-2A 8500 6227B, Dual Power Supply, 0-25V/0-2A 8500 6226B, DC Power Supply, 0-10V, 0-100A 8350 6228A (HAR), Power Supply, 0-10V, 0-10A 8350 6284A (HAR), Power Supply, 0-20V/0-3A \$125 652A, Test Oscillator, 10Hz-10MHz \$200 7090A, Measurement Plotting System \$2750 7090A, Measurement Plotting System \$255 675A, Pen Graphic Plotter \$250 8007B, Pulse Generator, 10MHz \$550 8007B, Pulse Generator, 11Hz-50MHz \$750 8149B Amplifier, 2-20GHz 8350A, Sweep Oscillator Mainframe \$2400 8350A, Vector Voltmeter 1MHz-1GHz \$4750 83545A, Vector Voltmeter 1MHz-1GHz \$4750 8405A, Vector Voltmeter 1MHz-1GHz \$4750 8410B, Network Analyzer System w/8412A, 8743A & 8411A \$500 8445B, Automatic Preselector \$445A, Amplifier, 0.1-400MHz \$300 8447C, Amplifier, 0.3-400MHz \$300 8453A, Display for Spectrum Analyzer Plug-in \$250 8554B, RF Plug-in, \$250 8554B, RF Plug-in, \$0000 8552B, IF Section Plug-in \$500 8554B, RF Plug-in, 500KHz-1250MHz \$500 8559A W/184T, Spectrum Analyzer w/141T Mainframe \$1800 8559A W/184T, Spectrum Analyzer 901-216Hz \$3500 8559A W/184T, Spectrum Analyzer 901-216Hz \$3500	Datron 4200, AC Standard Eaton 2052B, Ampilifer, 100 EH Research 122, Pulse Ge EH Research 122, Pulse Ge EH Research 129, Pulse Ge EH Research 129, Pulse Ge EH Research 137, Pulse Ge EH Research 137, Pulse Ge EH Research 137, Pulse Ge ENI 350L, Amplifier, 150KH: ENI 440E, Amplifier, 150KH: ENI 4411LA, Amplifier, 150KH: ENI 4411LA, Amplifier, 150KH: ENI 4411LA, Amplifier, 150KH: ENI 450B, DC Voltage Sta Fluke 510B/03, Calibrator Ciluke 5200A, AC Voltage Sta Fluke 5200A, AC Voltage Sta Fluke 540B, Transfer Stands Fluke 752A, Reference Divic Fluke 8506A, 6.5 Digit Digitz Fluke 8506A, 6.5 Digit Digitz Fluke 8506A, 0.5 Digit Glene Wavetek 900A, Signal Gene Wavetek 900A, Signal Gene
5345A, Universal Counter 54110D, Cotor Digitizing Oscilloscope \$4500 6002A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A 8800 6114A, Precision Power Supply, -0-20V/0-2A \$500 6227B, Dual Power Supply, 0-25V/0-2A \$500 6226B, DC Power Supply, 0-10V, 0-100A \$350 6226B, DC Power Supply, 0-10V, 0-100A \$350 6284A (HAR), Power Supply, 0-20V/0-3A \$125 652A, Test Oscillator, 10Hz-10MHz \$200 7090A, Measurement Plotting System \$2750 7475A, 8 Pen Graphic Plotter \$250 7475A, 8 Pen Graphic Plotter \$250 6007B, Pulse Generator, 10MHz. \$550 8007B, Pulse Generator, 11Hz-50MHz \$750 8165A0/102, Signal Source \$2750 8349B Amplifier, 2-20GHz \$350A, Sweep Oscillator Mainframe \$2400 8350A, Sweep Oscillator Mainframe \$2400 8350A, Sweep Oscillator Plug-in \$2250 8349B, FP lug-in, 2-0-8 4GHz \$4750 83545A, Oscillator Plug-in \$250 8345A, Vector Voltmeter 1MHz-1GHz \$470 8410B, Network Analyzer System w/8412A, 8743A & 8411A \$600 8445B, Automatic Preselector \$445A 8447B, Amplifier, 0.1-400MHz \$300 8447B, Amplifier, 0.1-400MHz \$300 8447B, Amplifier, 0.1-400MHz \$300 8447B, Amplifier, 0.1-400MHz \$300 8453A, Display for Spectrum Analyzer Plug-in \$250 8552B, IF Section Plug-in \$250 8552B, IF Section Plug-in \$350 8552B, RF Plug-in, S000Hz \$350 8552B, RF Spectrum Analyzer w/141T Mainframe \$160 8554B, RF Plug-in, S000Hz \$552B, RF Spectrum Analyzer w/141T Mainframe \$160 8559A W/182T, Spectrum Analyzer 0.01-21GHz \$350 8569B, 10MHz-22GHz Spectrum Analyzer \$4500 8569B, 10MHz-22GHz Spectrum Analyzer \$4500	Datron 4200, AC Standard Eaton 2052B, Ampilifer, 100 EH Research 122, Pulse Ge EH Research 122, Pulse Ge EH Research 129, Pulse Ge EH Research 137, Pulse Ge EH Rissearch 137, Pulse Ge EH Research 137, Pulse Ge EH Rissearch 137, Pulse Ge ENI 350L, Amplifier, 150KH: ENI 411LA, Amplifier, 150KH: Fluke 350D, C Voltage Sta Fluke 510DB/05, Multifuncite Fluke 510DB/05, Multifuncite Fluke 510DB/05, Multifuncite Fluke 510DB/05, AC Voltage Sta Fluke 510DB/05, Multifuncite Fluke 50OA, AC Voltage Standth Fluke 850SA, 6.5 Digit Digite Fluke 850SA, 100 Fluke 1
5345A, Universal Counter 54110D, Color Digitizing Oscilloscope 54500 6002A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A \$800 6012A, Precision Power Supply, PIP-IB, 0-50V/0-10A \$800 6114A, Precision Power Supply, 0-22V/0-2A \$550 6227B, Dual Power Supply, 0-25V/0-2A \$560 6260B, DC Power Supply, 0-10V, 0-100A \$350 6284A (HAR), Power Supply, 0-10V, 0-100A \$350 6284A (HAR), Power Supply, 0-20V/0-3A \$125 652A, Test Oscillator, 10Hz-10MHz \$200 7990A, Measurement Plotting System \$2750 7475A, 6 Pen Graphic Plotter \$250 7550A, Plotter \$250 7550A, Plotter \$250 7550A, Plotter \$250 8013B, Pulse Generator, 11Hz-50MHz \$750 8013B, Pulse Generator, 11Hz-50MHz \$750 8013B, Pulse Generator, 11Hz-50MHz \$750 8349A Amplifier, 2-20GHz \$350A, Sweep Oscillator Mainframe \$2400 83540A, 2-0-8-4GHz RF Plug-in \$250 83540B, Nese Oscillator Plug-in, 5-3-12-4GHz \$4750 83545A, Oscillator Plug-in, 5-3-12-4GHz \$4750 8410B, Network Analyzer System \$4814A, Tracking Generator/Counter \$4845B, Automatic Preselector \$445B, Automatic Preselector \$445B, Automatic Preselector \$445B, Automatic Preselector \$447B, Amplifier, 0.4-1.3GHz \$350 8552B, 8 6555A, Spectrum Analyzer Plug-in \$500 8554B, RF Plug-in, 5, 500 8559A, Display for Spectrum Analyzer \$450 8552B, WH3ET, Spectrum Analyzer \$450 8552B, WH3ET, Spectrum Analyzer \$450 8556A, Network Analyzer \$450 8559A, WH3ET, Spectrum Analyzer \$450 8559A, WH3ET, Spectrum Analyzer \$450 8569B, 10MHz-22GHz Spectrum Analyzer \$450 8569B, 10MHz-22GHz Spectrum Analyzer \$450 8569B, 10MHz-22GHz Spectrum Analyzer \$450	Datron 4200, AC Standard Eaton 2052B, Ampilifer, 100 EH Research 122, Pulse Ge EH Research 122, Pulse Ge EH Research 129, Pulse Ge EH Research 129, Pulse Ge EH Research 129, Pulse Ge EH Research 137, Pulse Ge EH Research 137, Pulse Ge EN 350L, Ampilifer, 250KH- ENI 406L, Ampilifer, 150KH- ENI 411LA, Ampilifer, 150KI- ENI 411LA, Ampilifer, 150KI- Fluke 335D, DC Voltage Sta- Fluke 5100B/05, Multifunctic Fluke 5100B/05, Multifunctic Fluke 540B, Transfer Stand- Fluke 540B, Transfer Stand- Fluke 540B, Transfer Stand- Fluke 550SA, 6.5 Digit Digits Fluke 850SA, 7 Linable From 100 March
5345A, Universal Counter 54110D, Cotor Digitizing Oscilloscope 54500 6002A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A \$800 6012A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A \$800 6114A, Precision Power Supply, 0-22V/0-2A \$550 6227B, Dual Power Supply, 0-25V/0-2A \$5600 6260B, DC Power Supply, 0-10V, 0-100A \$350 6280B, DC Power Supply, 0-10V, 0-100A \$350 6280A (HAR), Power Supply, 0-20V/0-3A \$125 652A, Test Oscillator, 10Hz-10MHz \$200 7090A, Measurement Plotting System \$2750 7475A, 6 Pen Graphic Plotter \$250 7475A, 6 Pen Graphic Plotter \$250 7550A, Plotter \$250 8013B, Pulse Generator, 100MHz. \$550 8013B, Pulse Generator, 11Hz-50MHz \$750 8165A0/102C, Signal Source \$2750 8349B Amplifier, 2-20GHz \$3640A, 2-0-8-40Hz RF Plug-in \$2400 83540A, 2-0-8-40Hz RF Plug-in \$2400 83545A, Oscillator Plug-in, 26-5-40GHz \$4750 83545A, Oscillator Plug-in, 26-5-40GHz \$400 83572B/001-006, Oscillator Plug-in, 26-5-40GHz \$400 83572B/001-006, Oscillator Plug-in, 26-5-40GHz \$410B, Network Analyzer System w/8412A, 8743A, 8411A \$600 8443B, Automatic Preselector \$445B, Automatic Preselector \$445B, Automatic Preselector \$445B, Automatic Preselector \$447B, Amplifiler, 0.1-400MHz \$300 8447B, Amplifiler, 0.1-400MHz \$300 8447B, Amplifiler, 0.1-400MHz \$300 8452B, 8555B, Spectrum Analyzer w/141T Mainframe \$1500 8552B, 8555B, Spectrum Analyzer w/141T Mainframe \$1500 8559A, WH82T, Spectrum Analyzer w/141T Mainframe \$1500 8559A, WH82T, Spectrum Analyzer w/141T Mainframe \$1500 8559B, RP Plug-in, SOOKHz-1250MHz \$300 8559B, RP Rlug-in, SOOKHz-1250MHz \$300 8569B, 10MHz-22GHz Spectrum Analyzer w/141T Mainframe \$1500 8569B, 10MHz-22GHz Spectrum Analyzer w/141T Mainframe \$1500 8569B, 10MHz-22GHz Spectrum Analyzer w/141T Mainframe \$1600	Datron 4200, AC Standard Eaton 2052B, Ampilifer, 100 EH Research 122, Pulse Ge EH Research 122, Pulse Ge EH Research 129, Pulse Ge EH Research 129, Pulse Ge EH Research 137, Pulse Ge EH Research 137, Pulse Ge EH Research 137, Pulse Ge ENI 350L, Amplifier, 150KH: ENI 406L, Amplifier, 150KH: ENI 411LA, Amplifier, 150KH: ENI 411LA, Amplifier, 150KH: ENI 411LA, Amplifier, 150KH: Fluke 510B, DC Voltage Sta Fluke 510B00, Calibrator Ci- Fluke 510B00, AC Voltage Sta Fluke 510B0, AC Voltage Sta Fluke 540B, Transfer Standt Fluke 752A, Reference Divic Fluke 580SA, 6.5 Digit Digita Fluke 580SA, 6.5 Digit Digita Fluke 850SA, 6.5 Digit Digita Fluke 850SA, 6.5 Digit Digita Fluke 3100R, Tunable Krohn-Hite 3100R, Tunable Krohn-Hite 3100R, Tunable Krohn-Hite 3342, Tunable F Sorensen QRD 30-1, Power Valhalla 2701B, DC Catibrat Wavetek 166, Pulse Functio Wavetek 166, Pulse Functio Wavetek 178, Automatic Sy Wavetek 1800, Signal Gene Wavetek 3000, Signal Gene Wavetek 800, Pulse Generar Wavetek 800, Pulse Generar Wavetek 800, Pulse Generar
5345A, Universal Counter 54110D, Color Digitizing Oscilloscope 54500 6002A, Opt. 01, Power Supply, HP-IB, 0-50V/0-10A \$800 6014A, Precision Power Supply, PIP-IB, 0-50V/0-10A \$800 6114A, Precision Power Supply, 0-22V/0-2A \$850 6227B, Dual Power Supply, 0-25V/0-2A \$850 6226B, DC Power Supply, 0-10V, 0-100A \$850 6226B, DC Power Supply, 0-10V, 0-100A \$850 6280A (HAR), Power Supply, 0-20V/0-3A \$125 625A, Test Oscillator, 10Hz-10MHz \$200 7090A, Measurement Plotting System \$2750 7475A, 6 Pen Graphic Plotter \$250 7475A, 6 Pen Graphic Plotter \$250 7475A, 6 Pen Graphic Plotter \$250 80078, Plutise Generator, 11tz-50MHz \$750 8013B, Pulse Generator, 11tz-50MHz \$750 8165A0/102C, Signal Source \$2750 8349B Amplifier, 2-20CHz \$350A, Sweep Oscillator Mainframe \$2400 83540A, 2-0-8-4GHz RF Plug-in \$3545A, Oscillator Plug-in, 2-6.5-40GHz \$3545A, Oscillator Plug-in, 2-6.5-40GHz \$400 83540B, RF Plug-in, 2-0-8-4GHz \$450 8411A/018, Frequency Converter, 11 to 18GHz \$500 8411A, Amplifier, 0-1-3GMHz \$350 8445B, Automatic Preselector \$450 8447B, Amplifier, 0-1-3GMHz \$350 8455B, BS555A, Spectrum Analyzer Pug-in \$250 852B, BS555A, Spectrum Analyzer w/141T Mainframe \$1800 8556A, 10MHz-22GHz Spectrum Analyzer \$450 8559A W18gTs, Spectrum Analyzer 0.1-2GHz, \$350 8568B, 10MHz-22GHz Spectrum Analyzer \$450 8569B, 10MHz-22GHz Spectrum Analyzer \$450 8690A, Br Plug-in, 5.064CHz \$500 8690A, Br Plug-in, 5.064CHz \$500 8690A, Br Plug-in, 5.064CHz \$500	Datron 4200, AC Standard Eaton 2052B, Ampilifer, 100 EH Research 122, Pulse Ge EH Research 122, Pulse Ge EH Research 122, Pulse Ge EH Research 129, Pulse Ge EH Research 137, Pulse Ge EH Research 130, Calibrator College Sta Fluke 5100B/05, Multifunctic Fluke 530D, AC Voltage Sta Fluke 5100B/05, Multifunctic Fluke 540B, Transfer Standt Fluke 540B, Transfer Standt Fluke 540B, Transfer Standt Fluke 550SA, 6.5 Digit Digits Fluke 850SA, 100, Transfer Standt Krohn-Hite 3103/R3103, Tur Rack Version Krohn-Hite 3202/R3202, Tur Rack Version Krohn-Hite 3202/R3202, Tur Rack Version Krohn-Hite 3202/R3202, Tur Rack Version Krohn-Hite 3104, Tunable F Sorensen QRD 40-2, Power Sorensen QRD 30-1, Power Sorensen QRD 40-2, Power Sorensen QRD 40-2, Power Sorensen QRD 40-2, Power Sorensen QRD 30-1, Power Sor
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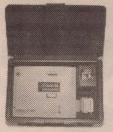
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# Stamp the Spotlight on BASIC Stamp Projects, Hints, and Tips

tamp and Counterfeit ousers have a wish list a mile long. They want displays, ADCs, DACs, more program memory, more variables, networking, keypads, motor drivers, wireless RF and infrared, faster serial communications, interrupts, and on, and on . . . But the one thing that more of you seem to want more than anything in the world is a real-time clock.

**Crystal-Controlled Oscillator** is Heartbeat of 60-hour Timer

**Precision Countdown Timer and** Part 2 of an Introduction to BASIC

'm not going to give it to you - Instead, I'll show you a technique for implementing precise time-keeping without the overhead of a real-time clock. I'll start by explaining why typical real-time clocks are not particularly Stamp-friendly peripherals, then encourage you to abandon human timekeeping conventions, and finally give you a preview of a new BS2 carrier board that will include a conventional clock chip and more.

In our BASIC-for-beginners department, I'll discuss programs as lists of things to do.

#### **Clock Watching**

Many applications need to know the current time of day, day of the week, time elapsed since an event, etc. Unfortunately, PBASIC's built-in timing functions aren't up to the job. They are designed to make or measure pulses or pauses, then continue the program. In other words, PBASIC doesn't provide a background clock like the one in your PC.

Some users want to overcome this limitation by brute force; "Just tell me how many microseconds each instruction takes, and I'll figure it out from there." Tain't that simple. Aside from the fact that no one has compiled a list of PBASIC instructions and the time they take, all of the math functions take varying amounts of time depending on the numbers involved in the calculation. Add the relative inaccuracy of the built-in ceramic resonator (±1 percent) and you'll conclude that this approach is hopeless.

A bit more reasonable is the idea of connecting a real-time-clock (RTC) chip to the Stamp. If you're not familiar with these guys, they're sort of a pocket watch for computers. A low-power oscillator and some digital logic keep track of the current calendar date, day of the week, hour, minute, and sec-

A problem with RTCs is that they generally provide their data in their data binary-coded decimal (BCD) digits of four bits each. (In BCD, each four bits used represent the numbers 0-9, the decimal digits, rather than 0-15 as in pure binary. The idea is to make it simpler to display the data in human-readable

form.) As BCD digits, the date and time might look

95/11/13/1/15/04/31

meaning, "1995, 11th month, 13th day, day 1 of the week (Monday), 15 hours, 4 minutes, 31 sec-

In the original PBASIC (BS1 flavor) there are no four-bit variables, so the 13 digits of RTC data would take 13 bytes - virtually all of the Stamp's variable storage. Even if a program converted the data from BCD to binary as it came in, it's still a lot of data. And don't forget that our traditional timing units don't follow normal rules of math - quick, add 16 hours 44 minutes to 3 days 10 hours and 52 minutes. See what I mean?

In microcontroller designs, it makes sense to look at what the controller really needs to do with the timing data, rather than trying to bend human

time-keeping conventions to fit. For example, do you need the time of day to the nearest minute? Break the day into one-minute units of 0 to 1339, with 0 being midnight, 720 being noon, etc.

like this:

Need to collect data at intervals of eight hours? Record the starting time/date and use the eight-hour offset between samples as an implicit time tag. That is, if the first sample is taken at the start time, the second is 8 hours later; the third at 16: the fourth at 24.

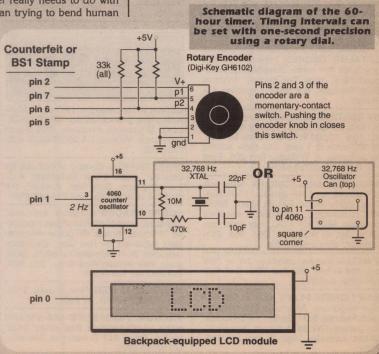
Need to record the time and date that some event occurred? Again, record the start time and tag each event with an offset in appropriate units. (Remember the NASA and military habit of reporting time relative to a reference mark, like "T minus 59 seconds" or "X-hour plus 18 hours.")

Even if you do need to keep time in humanreadable form in order to display it, it may still be simpler to use a timebase and a little math. That's what our knob-driven countdown timer does.

#### **Countdown Timer**

The countdown timer application shown in Figure 1 and Listing 1 can be set to turn on an output after an interval ranging from 1 second to 59 hours, 59 minutes and 59 seconds with 1-second precision. It has a user-friendly interface consisting of a twist-knob for setting the timing, and an LCD to show the time set or current state of the countdown.

Its accuracy as tested was within ±1 second per 24-hour period. This could probably be improved by trimming the values of the ground capacitors on the crystal, but it's respectable nonetheless. If you don't like to fiddle with discrete components, you may substitute the canned oscillator shown on the schematic. These guys cost a couple of bucks, and draw more current, but are factory tuned for better than 100-parts-per-million accuracy. Hmmm . . that's a worst-case error of more than 8 seconds in a 24-hour period, so our homebrew version checked out better. Food for thought.



# Stamp Applications:

- Program: ROT\_TIME.BAS (Timer with rotary-encoder interface) This program implements a 60-hour countdown timer with a user-friendly rotary-encoder (twist-knob) interface and LCD Serial Backpack display. When first powered up, the display shows "00:00:00" and waits for the user to twist the knob to set the hours. Clockwise increases the
- setting, counter-clockwise reduces it. When the hours are set, the user pushes the knob in to set the minutes and seconds in the same
- way. Once the seconds are set, pushing the knob in one more time starts the timer. The display counts down to zero, then turns on the
- This application relies on an external timer as an accurate source of 2-Hz 'ticks.' Typical accuracy is within 2-3 seconds over the maximum timing period of 59:59:59 (almost 60 hours). Another interesting feature of the application is its control of the rotary-encoder power supply. Since the encoder's LEDs draw almost 20 mA of current, the
- program shuts them off when they're not needed and thereby conserves
- battery power.
- 'Variables and constants.

SYMBOL old = b0SYMBOL new = b1 SYMBOL directn = bit0 SYMBOL count = b2 SYMBOL hours = b3 SYMBOL minutes = b4 SYMBOL seconds = b5 SYMBOL temp = b6 SYMBOL pmPos = b7 SYMBOL btn = b8 SYMBOL case = b9 SYMBOL out\_pin = 3 SYMBOL encoder = 2 SYMBOL I = 254

' Previous bit pattern of rotary encoder.

' Direction of knob rotation.

' Number dialed in by encoder. Timer hours setting.

'Timer minutes setting. 'Timer seconds setting.
'Temporary variable used by display routine.

Printing position on LCD screen.

Workspace variable for Button command. Offset for Branch command.
Output pin controlled by timer.

Power to rotary encoder LEDs. LCD Backpack instruction prefix (see note). LCD Backpack clear-screen instruction.

NOTE: This program is written for the rev3A Backpack firmware, which uses an instruction prefix, rather than a toggle. The new firmware makes this latest Backpack "reset proof" since the controller can always put the LCD into a known state by clearing

the screen (and optionally also turning the cursor on/off).

Main Program Start

SYMBOL cls = 1

Begin:

low out\_pin high encoder pause 1000 serout 0,n2400,(I,cls) let new = pins & \$C0 let prnPos = 132 gosub Display

Turn off the output pin.

'Turn on power to encoder LEDs. 'Wait a sec for LCD initialization.' Clear the LCD screen.

Get initial state of encoder pins. Set print position to 4 (128+4).

' Put 0s on the display.

'User Setup of Time Duration

gosub rotary serout 0,n2400,(I,prnPos) gosub showDigs button 5,0,255,0,btn,1,pushed goto Setup

Check the knob.

Position cursor on the display.

' Display digits.

'Check for knob push on pin 5.

'Loop.

'If the knob is pushed in, causing a low on pin 5, the program jumps from setup to here. It checks the current printing position

to determine whether the user has been setting hours, minutes, or seconds and determine what to do next.

let case = prnPos-132/3

branch case, (setHours, setMins, setSecs) setHours:

let hours = count goto continue setMins: let minutes = count

goto continue setSecs: let seconds = count goto runTimer continue:

- 'Convert position to 0-2. 'Branch based on 0-2).
- ' Put the count into hours. 'Continue setting timer.
- Put the count into minutes.
- 'Continue setting timer.
- ' Put the count into seconds.

' And start the countdown.

let count = 0 let prnPos = prnPos+3 goto Setup

Continue: clear count for next.

' Move to next screen position. 'Get more input from user.

'Timing Countdown

runTimer: let old = 0low encoder

'Initialize "old" to track ticks from timer.

'Turn off the encoder.

'This code counts changes in state from the external timer. Every 'fourth change (transition from 0-1 or 1-0) of the 2-Hz clock means that a second has passed. When that happens, the program subtracts 1 from the seconds, minutes, and hours.

DoTiming: if pin1 = bit0 then DoTiming let old = old + 1 let new = old & %11 if new <> 3 then DoTiming let seconds = seconds - 1
if seconds <> 255 then update let seconds = 59 let minutes = minutes -1 if minutes <> 255 then update let minutes = 59 let hours = hours - 1

' No change? Loop.
' Changed: increment old.
' Look at bottom two bits of old. 'Loop is not 3 (4th count, 0,1,2,3). Fourth count: decrement seconds. 'If not underflow (-1 = 255), update.
'Underflow: wrap around to 59 seconds.
'Seconds underflowed: borrow 1 from mins. 'If not underflow (-1 = 255), update. 'Underflow: wrap to 59 minutes.

' Minutes underflowed: borrow 1 from hours.

update: gosub Display check: if hours <> 0 then DoTiming if minutes ⇔ 0 then DoTiming if seconds ⇔ 0 then DoTiming high out\_pin hold: goto hold

'Display new hours/mins/secs.

'If not 00:00:00, continue timing.

'Time's up: turn on the output. ' Endless loop: reset to start again.

'Subroutines

' Check the rotary encoder. If it has moved, determine direction and 'adjust the value of the variable "count" accordingly.

rotary: let old = new & \$C0 again:

let new = pins & \$C0 if new = old then done let directn = bit6 ^ bit15 if directn = 1 then CW

let count = count - 1 if count <> 255 then skip let count = 59

skip: return ' Make old = top two bits of new.

' Make new = top two bits of pins.

'No change? Done.
'Change: determine direction. 'Clockwise: goto routine below.

Counterclockwise: decrement count. 'If count < 0, then count = 59.

' Return to main program.

return

let count = count + 1 if count <> 60 then done let count = 0 done:

'Clockwise: increment count. ' If count = 60, wrap around to 0.

' Return to main program.

'Display the hour:minute:second digits on the LCD screen.

Display: serout 0,n2400,(I,132) let count = hours gosub showDigs serout 0,n2400,(":") let count = minutes gosub showDigs serout 0,n2400,(":") let count = seconds gosub showDigs return

'Start at hours position. 'Show hours digits.

' Colon. ' Now minutes.

'Colon. ' Now seconds.

'Return to main program.

Display the two-digit value stored in count on the LCD. showDigs:

let temp = count/10 serout 0,n2400,(#temp) let temp = count//10 serout 0,n2400,(#temp)

Get the tens-place digit. ' Put it on the display.

Get the ones-place digit. ' Put it on the display. 'Return to main program.

# Stamp Applications:

#### Modifications

The countdown timer could readily be changed into a duration timer by moving the instructions high out\_pin to the beginning of the timing cycle and high out\_pin to the end. The output would turn on when the timer started, and off when it finished

You could also substitute some other timebase for the 4060 and 32,768-Hz crystal. For example, you might divide the 60-Hz powerline frequency by 10 or 100 with a digital counter to get manageable 6- or 0.6-Hz (50 pulse/minute) pulses. The powerline frequency is tightly controlled, so it's a decent timebase - motorized electric clocks are directly synchronized to the 60-Hz coming out of the wall.

#### **BASIC** for Beginners

Last month, I announced this new section; this month, we'll get started learning the fundamentals of BASIC programming as they apply to the Stamp and Counterfeit. I plan to start at the very beginning by examining what a program is.

In its simplest form, a program is nothing more than a to-do list for a computer. In the case of the Stamp, suppose you wanted to turn on a light, wait one second, then turn on another light. We'll assume that the lights are low-current LEDs connected to pins 0 and 1 such that they're on when the pins are high (putting out +5 volts). The to-do list would read:

high 0 'Turn on first light.

pause 1000 'Wait 1000 milliseconds (1 sec).

high 1 'Turn on second light.

Just like a to-do list, you can accomplish a lot by just figuring out a sequence of actions for the Stamp to perform, then converting that list into a program.

#### Sources

For more information on the BASIC Stamp, contact: Parallax, Inc.

3805 Atherton Road, #102, Rocklin, CA 95765 (916) 624-8333

FAX (916) 624-8003 • BBS 916-624-7101 E-Mail info@parallaxinc.com

Send questions, suggestions, or requests for future Stamp Applications to:

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E-Mail (CompuServe) at 72037,2612 Internet 72037.2612@compuserve.com

#### Scott offers Stamp-related kits, including:

The Counterfeit controller, a kit alternative to the BASIC Stamp, is \$29.00. Double- and quad-speed options are \$2.00 and \$4.00, respectively. The Counterfeit Development System, required to program Counterfeits (also for programming BS1 Stamps) is \$69.00 and includes a 150-page manual, downloading cable kit, Parallax software, and one Counterfeit controller kit.

The LCD Serial Backpack is a daughterboard that attaches to LCDs, converting their fussy parallel interface to Stamp-compatible serial at 2400 or 9600 baud. The assembled Backpack is \$29.00; with 16 x 1 LCD, \$40.00; 16 x 2 LCD, \$45.00; or backlit 20 x 4 LCD, \$89.00.

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To-do lists have a couple of weaknesses and straight-line programs that imitate them and share these limitations: They don't express repeated actions, and they don't adapt to changing condi-

For example, a to-do list procedure for my mailorder business might read:

- · Answer phone.
- · Get name of product ordered.
- · Get credit-card data and shipping address.
- · Hang up phone.

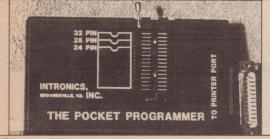
This procedure is terribly flawed. What if the call isn't an order, but a supplier, or a tech-support question? If it is an order, what if the customer wants more than one item? What if the credit-card and shipping information is already on file?

This is the kind of thinking that goes into programming - identifying decisions that must be made and working out responses for all of the possibilities. An improved mail-order program might

- · Answer phone.
- · Get caller's request.
- · If request is "order" then process order.
- · If request is "info" then tech support . . . and so on. The person answering the phone gets a piece of information - the caller's request - that leads to a decision about which other to-do list to use.

The BASIC programming language lets you instruct a computer to make such simple IF/THEN decisions and act on them. Next time, we're going to write a few short programs that give IF/THEN a workout. NV

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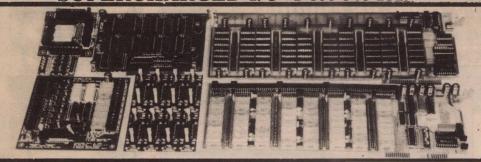


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# Circuit Design Software Under \$100.00

by T. J. Byers

If the high cost of circuit design software has kept you in the dark ages of templates and hobby knives, take a look at what you can get for under \$100.00 — including some for free.

Are you tempted to build some of Nuts & Volts construction projects, but are hesitant to try because you don't feel skilled enough to fabricate the printed circuit board? Do you like to draw schematics, but don't have a drafting table or the templates needed to do a professional job? Would

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late circuit operation. This same software can generate a bill of materials and print out the artwork. Despite what you may have heard, this hightech software doesn't cost an arm or a leg. There are plenty of circuit design programs selling for under \$100.00 — including a couple that you can downpermutations include schematic draw with PCB layout, and schematic capture with PCB layout. A related circuit design program is circuit simulation, which lets you test your design on the PC before committing it to a printed circuit board, but that's a topic better left to another article. In this article, you'll get a look at a dozen schematic and PCB layout programs costing under \$100.00



#### **Component Libraries**

All circuit design programs are CAD (computer-aided design) programs with built-in tricks and shortcuts that facilitate the tasks of bringing an electronic design from concept

Generally, the more symbols the library contains, the better. However, you have to balance quantity with quality. For example, a schematic program with a library of 5,000 components that doesn't have a symbol for an LED or an LM555 IC isn't really a practical library. PCB layout libraries are generally smaller because the outline used for a capacitor can be used to represent a resistor or inductor, too. The clinker is connectors, which often come in a wide variety of shapes, sizes, and sexes (plug and socket, sometimes called male and female). Often library components are grouped together in modules according to function or family, resulting in multiple libraries instead of one big library.

You place symbols on the drawing by calling them from the library The way the parts are selected and placed determines how easy the program is to use. Obviously, it's a lot easier to highlight a component from a menu than it is to type in its name from a command line. The ability to repeatedly place a selected item further improves ease of use because it reduces the number of times you

have to delve into the library.

#### Figure 3. Easytrax is a PCB layout program that sold for \$450.00 in its heyday. While you can now download this program for free, Easytrax hasn't lost its punch. It can still keep

Figure 2. AutoSkem is a schematic draw program that, like the alligator, has survived since Prehistoric times. Since the last retailer of this program dropped it, AutoSkem can only be found as shareware.

you like to be able to sketch a schematic and have it automatically transformed into a working printed circuit board?

If you answered yes to any of the above questions, then what you need is a healthy dose of self-esteembuilding circuit design software — PC programs that draw schematics, lay out printed circuit boards, and simu-

So where do you find these circuit design software bargains? Read on.

#### Circuit Design Basics

Circuit design software can be divided into five categories. At the root are schematic draw and PCB (printed circuit board) layout. Their

to contrivance. The real power of circuit design software is in its libraries one or more files that contain predefined symbols which are called upon for a myriad of duties. For example, a resistor may wear many hats, depending on where it's used. In a schematic draw program, it looks like a squiggly line. On a PCB layout, it becomes a rectangle whose physical dimensions adjust to suit the wattage of the resistor, rather than its ohmic value. For example, a five-watt resistor has a much larger footprint than does a 1/4-watt resistor, and the program has to adjust accordingly.

up with the best of them.

#### **Schematic Draw**

If all you want to do is draw schematics using your PC, then what you need is a schematic draw program. Schematic draw software lets you create professional-quality schematics by simply extracting components from the library and wiring them together.

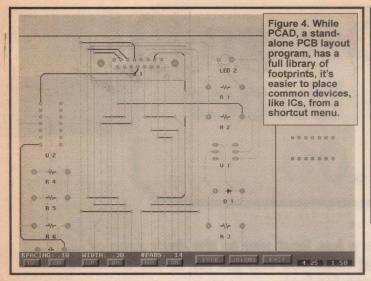
The fewer times you have to press keys or click the mouse button during the wiring process, the easier the pro-

gram is to use.

Many schematic draw programs support buses, which is a symbolic way of having one thick line represent a cable bundle - like a telephone cord — which contains many wires inside it. Not only does this eliminate clutter, it also reduces wiring errors.

#### **PCB** Layout

The ultimate goal of design soft-Nuts & Volts Magazine/January 1996 17



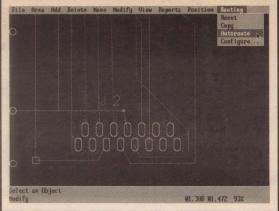


Figure 5. Circuit Layout is a DOS-based PCB layout program that has the look and feel of a Windows application.

ware is to create a working printed circuit board that will become the gizmo you had in mind. There are two types of PCB layout programs: those that stand alone, e.g., you do everything manually (the most common under \$100.00), and those that can "read" schematics and translate the symbols into physical components.

What you need to look for in a PCB layout program is a large selection of trace widths and pad types, and the ability to mix and match them in the design. While it's nice to have a PCB layout program that supports

multilayer boards, I doubt many of our readers have a use for more than two, top and bottom.

All the PCB layout programs here can output the artwork to a dot-matrix or laser printer, which can then be used to fabricate the board using materials available from Dyna-Art Designs and Techniks (see "Making Printed Circuit Boards" in the May '95 issue). If you prefer to have a service like AP Circuits fabricate the board for you, let me assure you that all these products (except TurboCAD) support both Gerber and N/C drill files, the

industry standard file formats used by all service bureaus.

#### **Schematic Capture**

The way PCB layout software reads a schematic is through an intermediary file called a netlist. Only schematic capture programs have the ability to netlists; generate schematic draw programs can't. Basically, a netlist is well, a list of all the components in the schematic, their physical description, and how they're wired together. The PCB layout program uses this information to more-orless automatically create a printed circuit board.

Of course, it's not all that automatic. You'll still have to manually place the com-

ponents on the circuit board and route the traces. Furthermore, the ability to create a netlist doesn't necessarily mean the PCB program can read it. There are dozens of netlist formats in existence, and you must make sure that the schematic capture and PCB layout programs you select are talking the same language.

#### **Schematic Draw**

The following programs are schematic draw only, and are in no way related to any other circuit design

software. They range in price from freeware to \$29.00, and are organized by price in ascending order.

#### Electronics Parts-bin

Electronics Partsbin is a freeware program created by Jim Marincelli that lets you draw schematics using clip art (Figure 1). The clip art sheet contains about 100 general-purpose electronics symbols saved in PCX To draw a format. schematic, you simply copy the symbol from the clip art sheet and paste it into a graphics or word processor document. You draw wires using the line function contained in the host software: dots may be added where lines cross to represent an electrical connection.

For example, to make a schematic using Paintbrush, which is found in the Windows Accessories group, all you have to do is start two sessions of Paintbrush. Use one

session to open Parts-bin, and set the other session to New. Now, cut and paste between the two using the Clipboard. The beauty of this method is its simplicity and flexibility. Paintbrush also lets you vary the width of the lines (to represent buses), add TrueType fonts, and color the schematic — enhancements that can really jazz up a dull drawing.

that can really jazz up a dull drawing.
I found Parts-bin easy to use, and
even easier on my pocketbook. If you
like playing with graphics, give this
program a try — you'll like it.

#### **AutoSkem**

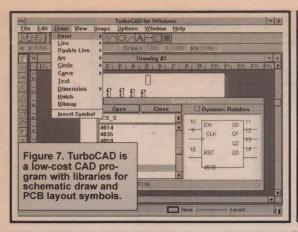
AutoSkem is a \$29.00 program written in 1990 that's modeled after the very expensive PADS advanced circuit design software package. Like PADS, AutoSkem isn't an easy program to learn or use. Unlike PADS, though, this primitive program lacks some rather basic editing features, like rotation and sizing for many parts. On the other hand, it's one of the few circuit design programs that can run on an 8088 system with just 384K of RAM.

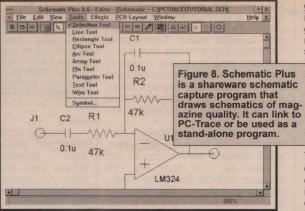
There's no limit to the number of libraries you can have, each with its own collection of components, but the schematic itself is connected to a single library. If the component doesn't exist in the current library, it's simply not shown. However, objects can be copied and moved between libraries, so, with care, this isn't a problem. While you can zoom out to see the overall picture and locate an area of interest, you can't run commands from the zoom-out mode, which makes it difficult to place parts precisely. You generally have to do precision parts placement afterwards, one agonizing grid step at a time.

You select drawing and editing commands from a menu, which is positioned on the right side of the screen (Figure 2), using cursor keys and/or the mouse. A handful of the more basic commands, like grid on, are actuated by function keys only, and aren't available from this menu.

The only thing that keeps this program alive is its decent library count, low price, and ability to run on 286 PCs. In fact, the last retailer of this program, BSoft, has dropped it

Table 1. Circuit Design Software At A Glance				
Program	Price	Function	Operating System	Source
Parts-bin AutoSkem Easytrax PCAD Circuit Layout BoardMaker I TurboCAD Schematic Plus PC-Trace SuperCAD PCBoards PCPlace PCRoute	free \$29.00 free \$65.00 \$80.00 \$95.00 \$99.00 \$75.00 \$99.00 \$99.00 \$50.00 \$99.00	Schematic Draw Schematic Draw PCB Layout PCB Layout PCB Layout PCB Layout Draw/PCB Draw/PCB Schematic Capture PCB/Capture Link Schematic Capture PCB/Capture Link PCB Part Place PCB Autorouter	DOS DOS Ohi Windows Windows Windows	freeware shareware Protel s Technology PC Logic o Automation IMSI shareware shareware al Automation PCBoards PCBoards





Change Pad To... Set Visible Layers.

Set Path Names.

File Yiew Database Entitles

Dial C SI So O

the PCB layout part-

with Schematic Plus, PC-Trace lets you turn a schematic

drawing into a fin-ished circuit board.

ner to Schematic

Plus. When linked

from its catalog, so it can only be found as shareware now. I'd pass on this one

#### **PCB Layout**

Like the schematic draw programs above, each of the following PCB layout items is a stand-alone program. The cost range is from free to \$80.00. Again, we go from least to most expensive.

#### Easytrax

Five years ago, when I first looked at Easytrax, it sold for \$495.00 and I gave it a four-star rating. A lot has happened in the circuit design community since, so I approached Easytrax with a first-look attitude again, and I can say that it's still a four-star program. It's lost nothing, despite stiff competition. What has changed, though, is its cost. Today you can get Easytrax for the price of a phone call. Yes, Protel, a big-league player in the circuit design arena, has placed this dynamite program in the public domain free of cost!

Easy to learn and easy to use, Easytrax can construct circuit boards up to 32-inches square with up to eight layers of copper. Easytrax works with any PC-compatible computer — and it can run from floppies. as well as a hard disk. The program comes with a large count of graphics drivers that support video resolutions of up to 1024 x 768, though most of the video boards supported are long obsolete. Fortunately, you can download the graphics driver source code from the Protel BBS (408-243-0125), which tells you how to write your own graphics driver.

The Easytrax library contains about 200 components, and includes a good assortment of connectors and (surface mounted device) devices. Parts may be selected from the library by name or by highlighting them from a library menu. A browse menu lets you see the components before you lay them down, which eliminates a lot of guess work (Figure 3). Once a device is selected, it may be repeated as many times as you wish.

Tracks may be placed manually or by using the pad-to-pad autorouter, which attempts to find an unimpeded path between two specified connecting pads, automatically switching between layers and inserting vias where needed. When routing manual-

the tracks may be ortho, free style or curved. Track width is selectable in seven increments Figure 9. PC-Trace is

from 10 to 100 mils for both manual and autorouting.

Easytrax is a great bargain that's not to be missed. It's state of the art, even after five

years, and it's free. So what's there to lose, except the cost of a phone

call? This is a must try.

#### PCAD

PCAD, a \$49.95 DOS-based PCB layout program from Micronics Technology, lets you build doublesided PC boards up to 10 by 20 inches. The library consists of saved drawing files that can't be sized or rotated. which means you have to define a separate library entry for each different orientation, like DIP 14H (horizontal) and DIP 14V (vertical).

However, you don't need to access the library for a lot of chores. For example, to place an IC outline all you have to do is click on the DIP editor (Figure 4), which brings up a menu listing dozens of standard DIP patterns, and select the IC footprint by clicking on it. You can rotate the footprint in 90-degree increments prior to placement, and it may be placed as many times as you wish using a single mouse click. It's too bad you don't have the same range of choices in track widths, which number a big four.

PCAD uses few menus. With a couple exceptions, everything is done using the keyboard. Unfortunately, the number of keyboard functions are far too numerous to commit to memory, which is why you'll want to keep the manual handy, or, better yet, have a chart of the key functions tacked on a nearby wall.

The price is good, and the program is fairly easy to learn and use. PCAD isn't a bad choice if all you need is PCB layout.

#### Circuit Layout

Although it's a DOS program, Circuit Logic has the look and feel of a

Windows application (Figure 5), which makes it extremely easy to use. This \$79.95 package can fabricate twosided circuit boards up to 10 by 16 inches in size, and comes with a 50device library that includes a hearty helping of DIPs and connectors. Once an item is selected from the library, it can be placed repeatedly.

You can place tracks manually or by using the pad-to-pad autorouter. Unlike Easytrax's router, though, the Circuit Layout router doesn't have automatic via placement. All routing is done on one side of the board only, and therefore not nearly as powerful as it could be.

When laying down tracks manually, the track is drawn as a straight line between the two pads, cutting across devices and other tracks. It's up to you to use the Corner and Move commands to route the track. A nice feature is the ability to change track width between vias - a feature that mimics necking down for scooting traces between adjacent pads. In other words, expect to do a lot of hands-on work using this program.

Circuit Layout is a newcomer to the circuit design arena, and as such is experiencing some growing pains. However, the vendor is committed to improving the program and adding schematic draw software to the list of features, including a upcoming Windows 95 version to be released later this year. This is a serious product that should improve as time goes on.

#### **Schematic Draw** With PCB Layout

Coupling a schematic draw program with a PCB layout program is a common practice. While the two programs aren't linked and can't pass information between each other, they generally have something in common, like a menu that behaves the same regardless of which program you're using.

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#### BoardMaker I

Easy to use, easy on the pocket book, and able to leap a tall building in a single bound are the trademarks of BoardMaker I from

Tsien Limited, UK. In addition to drawing schematics, BoardMaker can layout circuit boards up to 17 inches square, with up to eight layers of copper and two silk screen layers. Basically, BoardMaker I is a DOSbased PCB layout program with access to a library of symbols that are used to draw schematics. An opening menu gives you the choice between schematic draw and PCB layout. The commands are easily accessed from seven pull-down menus, and there's a keyboard shortcut for each command

BoardMaker I's schematic library includes a good sampling of analog, logic, and discrete components, but doesn't include some rather important devices, like an LM555. You'll also have to get used to viewing resistors as rectangles rather than squiggly lines because BoardMaker I uses European symbols rather than the ANSI conventions you're used to Fortunately, new devices are easily created using the library editor, which means you can easily change the symbols you don't like.

Library components are easily accessed from a pull-down menu, and schematic items can be rotated and mirrored before placement Unfortunately, PCB components don't share the same privilege, and can't be rotated or mirrored until after they're placed. After a schematic or PCB layout part is selected, you can place it as many times as you wish. laying down tracks, BoardMaker I provides layer switching, automatic via placement, and blind vias. You can mix and match eight different track widths and 16 different pad sizes per layout.

BoardMaker I is an excellent combination schematic draw/PCB layout program well worth its \$95.00

asking price.

#### **TurboCAD**

TurboCAD is an inexpensive drawing program generally used for domestic tasks, like furnishing a room or landscaping a yard. Included with TurboCAD, though, are two libraries that contain symbols that may be used to draw schematics and layout circuit boards. The advantage of using a CAD program for circuit design is that it has a wider zoom range, more layers, and a larger drawing area.

TurboCAD supports 16 drawing layers that can be used for multiplepage schematics or multilayer circuit board designs. Unlike dedicated circuit design software, TurboCAD lets you decide how to assign the layers. Symbols are placed on the drawing

from one of many library files (Figure 7). Circuit board tracks come from a library, too, because TurboCAD lacks

a line-width scaling feature.

The basic TurboCAD package comes with a limited number of schematic and PCB layout symbols that include capacitors, resistors, ICs, and a variety of PCB pads and footprints. Additional symbol libraries can be purchased for \$29.95 each; currently there are 20 design-related libraries to choose from. Or you can create new symbols yourself by assembling primitives (circles and lines) that you save to a file.

The nice thing about choosing a CAD program over dedicated circuit design software is that you can use it for a wide range of chores - like to create flow charts. However, you may find the software lacking in several areas which may be critical to circuit design. For example, TurboCAD can't do automatic via placement when changing layers, and don't expect support for Gerber or N/C Drill files.

#### **Schematic Capture** With PCB Layout

Finally, we look at schematic capture programs — software that lets you draw a schematic and link it to a PCB layout program. These programs can be used as a stand-alone application, or knit together to provide a powerful circuit design package whose value is more than the sum of its parts.

#### **Schematic Plus**

The least expensive of the schematic capture packages is a combined effort of Doug Elhers and Steven Poulsen, that's available on the Internet and select on-line services (like America Online) as shareware. The two programs, Schematic Plus schematic capture and PC-Trace PCB layout, can be purchased separately for \$45.00 and \$75.00, respectively, or together for \$95.00. Both require Windows 3.1.

Poulsen. This program has gone through a lot of changes in the last year — the most notable is the addition of netlist output. Furthermore, Schematic Plus drawings have a professional, magazine quality (Figure 8) that are easily imported into word and graphics documents, making it attractive as a stand-alone schematic draw program for desktop publishing pro-

Library devices are stored in subdirectories as individual DOS files, which makes it easy for you to sort devices by type from the File Manager or DOS prompt by simply copying and moving files from one directory to another. Parts are placed on the drawing by highlighting its name from the Tools menu. While a selected part can't be placed repeatedly, which forces you to go back to the menu each time, Schematic Plus has automatic annotation which numbers the parts in consecutive order as they're placed on the schematic (R1, R2, R3, etc.)

The editing features are excellent. For example, you can move the part values and nomenclature anyway on the screen independent of the actual device placement. Balancing the text with the symbols lends a lot to the professional appearance of the schematics.

#### **PC-Trace**

PC-Trace is the PCB layout partner to Schematic Plus. It can fabricate double-sided boards up to 7 by 10 inches in size. While PC-Trace has been around for about two years, this is its first appearance in Windows format. That's why the Help function isn't fully functional, and the program seems jerky at times.

While you can layout PC-Trace boards by hand, there's no reason to. When bundled with Schematic Plus, PC-Trace costs just \$20.00 more than the stand-alone version. Moreover, PC-Trace has a library of component outlines that's well matched with Schematic Plus's library devices, and there's an automatic part placement program in the

CD

Schematic Plus is a schematic capture program written by Steven PCDatak is an intriguing circuit-design program with as many twists and turns as an Alfred Hitchcock plot. Basically, PCDatak is a DOS-based PCB layout program that supports six layers of copper up to 30" x 30" square. To gain all of these advantages, though, you need to submit your design to IDM, a printed circuit board service house who wrote the PCDatak program. And from there, the choices are numerous,

a Fortunately, you don't need IDM to use this program if you're content with t two layers of copper and have access to a PostScript printer. I found this \$59.95 package quite easy to learn and use, once you configure it for home a use rather than IDM processing. I also discovered that despite its low parts count, the library has enough devices, both plate-through and surface mount, for most hobby projects. You select the parts from a single library using a scrolling menu, then wire them together using the Trace command. Track widths are adjustable, and you can actually achieve the equivalent of necking-down if you select

If you decide to let IDM do the work for you, the options really open up. For example, IDM does ground planes, microstrips, and thermal corners. And their prices aren't all that expensive. In fact, there is a pricing program in PCDatak that estimates about how much it'll cost you to go to the big house. But don't expect a lot of handson support. Although the phone rings, nobody answers. If you have questions about the final product, your only venue is a FAX machine.

Overall, I found the program refreshing simply because I wasn't boxed in. I could either do it myself, given the restrictions of two layers and a PostScript printer, or have somebody else do it for me. Lots of options at a low cost make PCDatak a good choice

Figure 10. SuperCAD is a schematic capture program that spawns netlists for a wide variety of circuit design utilities that includes PCB lavout, automatic part placement, autorouter, analog simulation, and digital simulation.

works.

Until the automatic part placement program arrives later this year, you have to manually place the components on the circuit board prior to running the autorouter. The netlist is imported directly from a DOS file created Schematic Plus, and doesn't require a conversion utility. The autorouter's average completion rate is about 93percent, which means you'll probably have some tracks that you have to route by hand. Fortunately, PC-Trace has a rats nest -'web" of lines that shows which pads connect together

which greatly facilitates the process (Figure 9).

Schematic Plus and PC-Trace make a great team. Although the PCB layout program is a little weak, it should improve considerably over the next year. Moreover, you don't have to wait until this package matures before you buy; both authors promise free upgrades for at least a year.

#### SuperCAD

SuperCAD. from Mental Automation, is a veteran schematic capture program that can interface with a large number of PCB layout and circuit simulation programs. The SuperCAD family of software reviewed below includes SuperCAD schematic capture, PCBoards PCB layout, PCPlace automatic part placement, and PCRoute autorouter. Also available, but not reviewed, is analog simulation and digital simulation.

While each module costs less than \$100.00, the money can add up quickly. A full-blown version will cost you \$545.00. Fortunately, SuperCAD and PCBoards can work on their own without each other or without any of the other modules, making it painlessly easy to start small and add new functions as you can afford them.

SuperCAD's numerous libraries are spread over several directories, and are stored as DOS files. Objects are selected by moving the cursor over the function box located along the left side and clicking the mouse button. Once a symbol is selected

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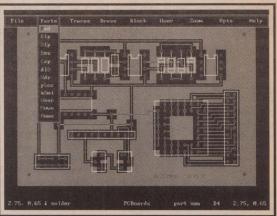


Figure 11. PCBoards is the companion PCB layout program to SuperCAD schematic capture. PCBoard's support utilities are PCPlace (automatic part placement) and PCRoute (autorouter).

from a library, it can be placed repeat-

Drawing wires is a snap — literally, if you purchased the SuperCAD+ upgrade — using the autoroute function. This feature allows you to wire together two points by simply clicking on the two points. The router then draws a wire between them, avoiding any library device it may encounter along the way (Figure 10). Even without the router, adding lines and wires is a cinch; it's just not automatic.

Mental Automation sells a more robust schematic capture package called SuperCAD+ which contains a larger parts library (about 2,500 devices) and added utilities. It costs \$199.00. If you start with SuperCAD, you can upgrade to SuperCAD+ at a later date for just the difference in price. You're even given credit for your DOS software should you decide to upgrade to the Windows version, which starts at \$149.00.

#### **PCBoards**

Companion to SuperCAD is PCBoards, a stand-alone PCB lavout program from PCBoards, Inc., that can read SuperCAD netlist files. PCBoards sells for \$99.00, and can lay out double-sided boards up to 6 by 13 inches in size. PCBoards is also available from Mental Automation and Digi-Key for the same low price.

PCBoards has a component library with over 160 devices, which includes surface-mounted devices.

as well as a good assortment of DIP footprints, that are easily accessed from a pull-down menu (Figure 11).

Once a device type is highlighted in the menu, the individual part within that group is selected using the

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SOURCES

<F1> key. For example, to choose an IC outline from the DIP option, you have to scroll through a list of DIP footprints, beginning with a sixpin device and ending with a 40-print IC, until you find it - at which point pressing <F1> places it on the circuit board.

The problem with this method is it's time consuming and subject to error through omission. Fortunately, you can buy a \$50.00 software option, called PCPlace, that will extract the parts from the SuperCAD netlist and place them on the board for you. The catch is, PCPlace can't read your mind, so you're left with the chore of arranging the parts in their proper place.

PCBoards supports a wide range of video resolutions, including 800 x 600 and 1024 x 768 — a feat unique for a DOS-based program. The conversion utility that comes with PCBoards also lets you import netlists from Tango and EEDesigner, among others, for layout and routing, should you have access to these schematic capture programs.

#### **PCRoute**

final component SuperCAD's linked PCB layout software is PCRoute, a \$99.00 autorouter sold by PCBoards and Mental Automation.

An autorouter is a program that translates the wires on the schematic

into copper tracks on the circuit board.

Which is a good deal, because manually routing tracks using PCBoards leaves a lot to be desired. For example, you can't change layers when laying down a track. You need to stop the trace, change sides, add the via, and continue on. Moreover, you only have two track widths to choose from, 20 mils and 50 mils (a mil is .001 inch).

Although PCRoute still has to work with the same track restrictions of PCBoards and manual part placement, it frees you from the chore of having to find a clear path between two pads and inserting the vias.

In fact, in my benchmark tests, PCRoute was able to finish most designs to 100-percent completion. Unfortunately, PCRoute only supports a 50-mil grid, which means it won't do well with a tightly-packed circuit board or SMD parts.

#### **Summing Up The Options**

I've been reviewing circuit design software for 10 years now, and I've never seen such a large crop of low-cost software so perfectly suited for the hobbyist. Today you can get top-notch quality schematic draw and PCB layout software for free or nearly free.

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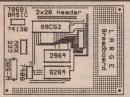
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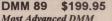
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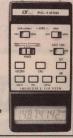
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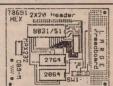
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# Magnetic Design by Fernando Garcia Made Simple

nybody who has been seriously involved with power electronics knows that digital devices may be circuit's brains. analog devices may be the circuit's muscles, but magnetic devices are THE circuit's heart. Nevertheless, it has been difficult for the experimenter to properly understand all the limitations and pitfalls of magnetic devices, as Electromagnetic theory does have some daunting mathematical background.

This should not be the case. For electronic circuit design, a person does not need to know quantum physics to be able to apply a diode or a transistor in a circuit. Likewise, you need not derive from basic physics all the equations to design a magnetic circuit. Rather, manufacturer's data and graphs, simplified equations, and a VERY BASIC understanding of magnetics are required to design some simple devices. True, advanced magnetic design can still be an awesome task, but this is also true for advanced electronic design. Leave that task to the experts, and get some hands-on experience with simple magnetic devices.

#### Magnetic Circuits and Ohm's Law

Assume for a second that you are making an extension cord. If you know the supply voltage, load current, and the amount of voltage drop you are willing to tolerate, a certain wire gauge may be selected.

Now, assume that you need to add another extension cord with identical requirements, but TWICE the length. To meet the requirements, you will need a wire gauge with TWICE the area. In other words, the wire resistance is directly proportional to its length and resistivity, and inversely proportional to its area. This is shown in Figure 1A. Resistivity is denoted by the Greek letter "Rho."

Magnetic flux does not need a "conductor" to propagate, as it may propagate even in a vacuum. However, magnetic materials conduct

magnetism so much better when compared to non-magnetic materials, that we may assume quite safely that all the flux circulates through the magnetic media. However, every magnetic material does have a magnetic "resistance," which is called reluctance. This — you may have guessed by now — is directly proportional to its length and the material's "magnetic resistivity," called permeability, and inversely proportional to its area. This is shown in Figure 1B. Permeability is denoted by the Greek letter "Mu."

Fortunately, the Ohm's law analogy does not end here. Consider the simple magnetic structure of Figure 2A. A current flows through the winding, creating a magnetomotive force (mmf), whose units are "ampereturns." The mmf induces a flux (indicated by the Greek letter "Phi") through the magnetic core. But what procedure is required to calculate the value of this magnetic flux? You need to look no further than Figure 2B. Here, the magnetic circuit has been replaced by its electrical dual. The mmf is a voltage source, the core's reluctance is the "resistance," and the flux is the "current" which may be easily found by Ohm's law.

This analogy may be carried a little further; consider Figure 3A. An air gap has been introduced into the circuit. Non-magnetic materials — of which air is one of them — have a permeability thousands of times smaller than those of magnetic materials. The net effect is that the air gap presents a reluctance in series which is much larger than that of the magnetic material, even though the gap length is smaller than the magnetic core length.

Again, this is shown electrically in Figure 3B. The air gap "resistor" is so large compared to the core "resistor" that all of the mmf "voltage" is dissipated there. Of course, with the addition of a large "resistor" in series, the flux in Figure 3 is smaller than that of Figure 2, all other conditions remaining equal.

Why would anybody, in their right mind, want to reduce the amount of magnetic flux? There are two good reasons for this, the first will be clear when we explain the hysteresis curve, but the second — and very surprising

 fact is that magnetic energy is NOT stored in magnetic material, but in the air gap.

#### The Hysteresis Curve

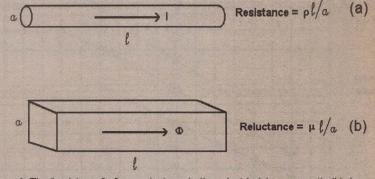
Among the great secrets in magnetic design is the hysteresis curve. To the trained eye, the hysteresis curve provides a wealth of information. A seasoned magnetics designer will take a look at the curve and understand if the magnetic material is suitable to be used for an inductor, a transformer, or a permanent magnet.

But before we plunge into a full description of the curve, we need to understand the concepts of flux density and field intensity.

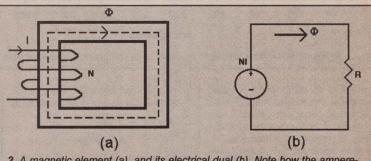
We described in the previous paragraph the concept of "magnetic current," or flux (Phi). It is advantageous to express it as flux per unit area, and thus obtain flux density, which is indicated by the letter "B." The flux density is the vertical axis of the hysteresis curve, and in the centimeter-gram-second (CGS) unit system, its units are in gauss.

Likewise, we described the concept of magnetomotive force. If it is expressed as force per unit length, we obtain magnetic field intensity, indicated by the letter "H." The field intensity is the horizontal axis in the curve, and its CGS units are in oersteds. There are other units for these variables in either the MKS or "English" systems, but I don't want to confuse

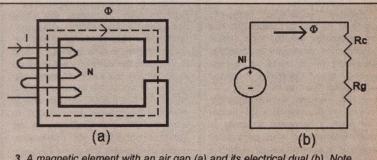
Now, let's look at the curve in Figure 4 and obtain useful informa-



1. The "resistance" of a conductor, whether electric (a) or magnetic (b), is directly proportional to its length and inversely proportional to its area.



2. A magnetic element (a), and its electrical dual (b). Note how the amperetums becomes "voltage," reluctance becomes "resistance," and flux becomes "current."



3. A magnetic element with an air gap (a) and its electrical dual (b). Note that the air gap's reluctance becomes a series resistance in the electrical equivalent.

tion from it. Assume that we have a completely degaussed material, and both "B" and "H" are at zero point. As a current is applied to the winding, the flux density "B" will start to increase very rapidly at first - as shown by the dashed curve - then gradually it will start to level off until it reaches a point - called saturation flux density - in which additional current through the winding provides very little additional magnetic flux. This is a very important characteristic of magnetic materials: they saturate. This value of saturated flux density is shown as "Bs."

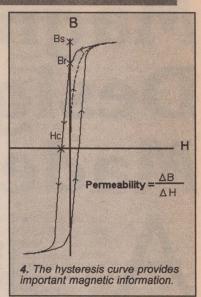
As the electrical current is reduced, the flux density does not follow its previous path and return to zero. Rather, it follows the outer perimeter of the curve. With a field intensity "H" value equal to zero, there will be some residual magnetic flux

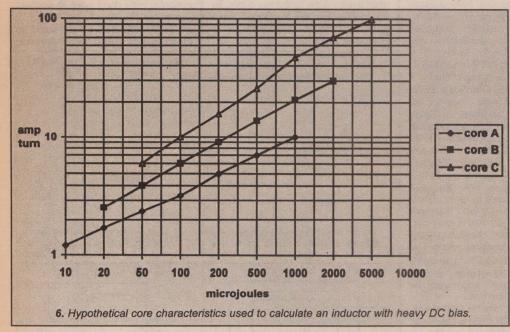
On a transformer fed by an alternating current, the magnetic flux follows the hysteresis curve as indicated by the arrows. As it cycles through, the magnetic core is alternatively magnetized and demagnetized. All of this consumes energy, which is the cause — among other things — of the heat generation on a transformer. This is called "core loss," and is an undesirable side effect. Therefore, a low coercivity is desirable in magnetic materials for transformer applications.

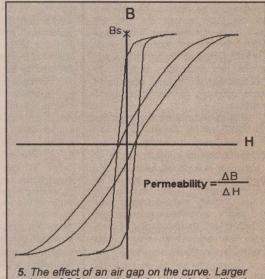
The last - and one of the most important - parameters that may be obtained from the curve is the behavior of the magnetic material's permeability. As it will be discussed in the next paragraph, inductance is a direct function of permeability. A high permeability value is desirable, to pack as much inductance with the smallest core size and minimum amount of withstand heavy currents, requires special techniques - like air gaps - to be used. The effect of an air gap may be seen in the curve in Figure 5. The magnetic device may sustain higher DC current values - which, in turn, means higher field intensity values without saturation. However, there is a compromise to be made, and it is that the permeability, and thus the inductance, decreases substantially. But this is the price to pay for the additional current that the inductor may sustain without saturation.

#### A Simple Design #1: An Inductor for DC **Applications**

Applications for inductors which must carry heavy DC currents are varied; hash suppressors in automobile electronics, ripple smoothing inductors in supplies, and energy storage







values of DC current may be sustained without saturation, but the slope, and thus the permeability, become lower.

density "Br," an effect which is called remanence. Yes indeed folks, if as a youngster you wrapped electrical wire to a steel nail, connected the wire to a battery to create an electromagnet, and then removed the battery and noticed that the nail would still be magnetized - albeit to a smaller degree - you were witnessing the effect of remanence.

Another important magnetic parameter is that of coercivity. You may be familiar with the term, which is sometimes employed to describe high-quality audio tapes as "a high coercivity tape." Coercivity, indicated by the point "Hc" in the curve, indicates how resistant to demagnetization a magnetic material is. Of course, if we want a magnetic material to remain magnetized - a permanent magnet is a good example - then a high coercivity value is a must. However, high coercivity is not desirable in all applications.

turns. Permeability is the slope of the hysteresis curve, and in equation form

$$\mu = \Delta B/_{\Lambda H}$$

We may see that at low values of "B" and "H" the slope is quite steep, almost vertical. This value is quoted in manuals as initial permeability. As the field intensity increases, the slope becomes progressively shallower, until at the saturation point, any further increases in field intensity - and therefore in the current - will produce an extremely low value of permeabilitv. In other words, the inductor LOSES MOST OF ITS INDUCTANCE. This is probably the number one "gotcha" in magnetic circuit applications. As the inductor saturates, its impedance becomes basically the wire's DC resistance, and catastrophically high currents may flow.

To design an inductor able to

elements in switchmode supplies. Whatever the application, the inductor must provide a minimum amount of inductance at a maximum DC current level.

As mentioned in the previous paragraph, an air gap may be included in the core to allow DC current without saturation. However, gapping requires very specialized tools and test equipment beyond the means of most experimenters. The better approach is to purchase a core which has a DISTRIBUTED air gap. This is not as hard as it sounds; if a magnetic material, such as very finely powdered iron, is mixed with a non-magnetic binding material, the end result will be that a minute nonmagnetic gap - filled up by the binder - will exist between each particle of iron powder and the next.

Iron powder itself has a gentle saturation curve, and therefore such a mix provides an (almost) fool-proof inductor. Several companies produce these iron powder and similar cores. The drawback for iron is that it has larger losses than ferrites, and thus is not suitable for frequencies higher than 100 KHz.

Core manufacturers provide tables, curves, and simple procedures to calculate the desired inductance. Although the individual procedures vary slightly from vendor to vendor, the overall technique is a variation of a procedure developed by C.R. Hanna, which requires calculating the amount of stored magnetic energy.

A simple example will help you to grasp the concept. Assume that an inductor of 1 millihenry minimum is required at 2 amps DC. The first step is to select a core size that will be able to store the required energy. The energy stored in an inductor is given by the formula:

 $W = \frac{1}{2} LI^2$ 

For our example, the energy would be 2,000 microjoules.

The vendor will then provide a graph similar to that shown in Figure 6. Here, we have plotted three hypothetical cores — A, B, and C — arranged from smaller to larger. It may be seen that core A is too small for the required energy storage. Both cores B and C will do the trick, but we would normally choose B, as it is smaller and usually cheaper.

From the same graph, we see that 30 ampere-turns are required to produce 2,000 microjoules in core B. To find the number of turns, we divide the ampere-turns by the DC current value, or in equation form:

$$N = \frac{NI}{I}$$

In our example, this would yield 15 turns. All we would need to provide is the proper wire gauge for 2 amps, which may be selected from a wire table.

Though the preceding procedure may vary from vendor to vendor, its basic principles remain the same. The key is to obtain a magnetic vendor's catalog and follow the procedures and tables to design with their specific materials.

#### A Simple Design #2: An Inductor for AC Applications

The inductance for a magnetic device is a function of the effective permeability and the square of the turns, among other variables. The variables are calculated for you by the core manufacturer and iumped together in a constant for the particular core size and geometry. All you need to be aware of is the behavior of inductance with varying permeability.

As shown in the hysteresis curve, the initial permeability of a magnetic material when the field intensity is very close to zero is quite large. This means that large inductance values are available if the inductor carries very small DC and AC currents. A different design approach from the previous paragraph should be followed in this instance.

The first step would be to consult the manufacturer's data book to choose the proper core material. For high frequency applications, ferrites are the best choice, but within the ferrite family there exists different varieties or "mixes" — in industry jargon — which are useable at different frequency ranges. The manufacturer's catalog will suggest a "mix" optimized for a particular working frequency range.

After the particular ferrite material has been chosen, the manufacturer will list the different core sizes and shapes, along with an inductance fac-

tor value (AL100), as Table 1 shows for some hypothetical

TABLE 1: Inductance factor

Core size	(AL100) microhenry	
X1	2500	
X2	3900	
Х3	5100	

The (AL100) value simply means that 100 turns wound in that particular core will produce the particular inductance value as shown. Some manufacturers prefer to list inductance factors for 1,000 turns, in which case it will be shown as (AL1000).

To find the number of turns required for the desired inductance value, use the following equation:

$$N = \sqrt{\frac{10^4 L}{A_{L100}}} \qquad \text{If (AL100) is used.}$$

$$N = \sqrt{\frac{10^6 L}{A_{L1000}}} \qquad \text{If (AL1000) is used.}$$

One word of caution regarding the above formula: A common pitfall is to use different units for the desired inductance value to that in which the (AL) value is expressed. If the (AL) value is in microhenries, use microhenries for the desired inductance value. This would mean that you would express 3.3 millihenries as 3300 microhenries. Although this sounds self-evident, Murphy's law states that mistakes will happen. Double check for inconsistent units if your calculation provides a ludicrous number of turns.

For a sample: 3.3 millihenry value and employing core X2 — 92 turns would be required.

Remember that magnetic materials will have tolerances like any other component. If you require a very precise inductance value, an LCR meter will allow you to "tweak" the inductor by adding or removing turns to the nominal number of turns.

#### The Applied Volt-Seconds Relationship, or "Honey, I Shrunk the Transformer"

Perhaps the most useful magnetic device is the transformer. The 60 Hz jobs (50 Hz in Europe) are simple and reliable, but are always the heaviest and bulkiest device in any electronic circuit (with the notable exception of the CRT on TV sets).

During the past two decades, switch-mode power supplies (SMPS) have been making inroads into more and more electronic appliances. Though the SMPS electronic circuitry is much more complex than a simple

rectifier-capacitor-transformer supply, it nevertheless makes economic sense due to its higher efficiency and compact size. The efficiency gain is due to the transistor-switch operating full-on and full-off, but the lightweight and small size are due to its high-operating frequency.

Which would bring a question to our mind: How much could we shrink a transformer?

The answer lies in an equation — derived from elementary magnetic equations — called the applied volt-seconds equation, which states:

$$B_{\text{max}} = \frac{10^8 \, V_{\text{RMS}}}{4.44 f \, \text{Na}}$$

where

- Bmax is the maximum flux density for the selected material in gauss.
- Vrms is the RMS applied voltage.
- is the operating frequency in hertz.
- a is the core cross-sectional area in square centimeters.
- · N is the number of turns.
- 4.44 is the form factor for sinewayes.

Since time — seconds — is the reciprocal of frequency, thus the name of "applied volt-seconds" for the equation.

Exceeding the maximum flux density will almost always result in catastrophic failure. The applied voltage is a given, as it is restricted to the available household voltage (120 VAC in North America, 230 VAC in Europe) and cannot be changed. The frequency is also a given, 60 Hz in North America and 50 Hz in Europe. Therefore, the only "variables" which may be modified are the number of turns and the core cross-sectional area. So the transformer designer has to find a compromise between the amount of copper wire and the core size in order to satisfy the equation.

The reason that airborne electronics employ 400 Hz is an attempt to substantially reduce the size and weight of magnetic devices for the same value of applied voltage. Since the frequency appears in the equation's denominator, increasing it will allow you to reduce the core size, or the number of turns, and still satisfy the equation.

Close inspection of the equation also reveals the reason a 60 Hz transformer would exceed its maximum flux density (and severely overheat) if connected to a 50 Hz supply with the same input voltage.

#### SOURCES

Ocean State Electronics P.O. Box 1458 Westerly, RI 02891 (401) 596-3080

Ocean State is one of the few hobby electronics distributors which carries a line of magnetic cores. They stock the MicroMetals iron powder cores.

MicroMetals Inc. 1190 N. Hawk Circle Anaheim, CA 92807 (714) 630-7420

MicroMetals is one of the foremost manufacturers of iron powder cores. Request catalog #4 for EMI and power inductors.

> Magnetics Inc. 900 E. Butler Road Butler, PA 16003 (412) 282-8282

Magnetics, Inc., has an impressive array of magnetic materials available. From exotic alloys to improved ferrites, Magnetics has them. Their data books and application notes are a must for anybody involved in magnetic design.

Unitrode Corp. 7 Continental Blvd. Merrimack, NH 03054 (603) 424-2410

Although Unitrode is a semiconductor company, it is very focused on the SMPS market. As indicated before, magnetic devices are crucial in successful SMPS design. Unitrode prides itself in having some of the best and most comprehensive applications notes in the industry. Many of the engineers who write the app-notes are recognized as leaders in the field. If you are interested in learning SMPS design in general, and magnetic design in particular, their books are a must.

With the advent of modern solidstate devices, the incoming voltage may be rectified and then "chopped" at a very high frequency. If the frequency is stepped up from 60 to 20,000, or even 100,000 hertz, dramatic savings in core size, weight, and cost may be achieved. The savings are so great that it helps offset the added cost of the complex electronic circuitry.

There is a small pitfall for high-frequency operation, which requires further explanation. High-silicon steel used for 50/60 Hz currents has both a very large permeability and extremely high saturation flux density. The drawback for steel is that it also has very large core and eddy losses, which are a function of frequency. Unless exotic (and expensive) alloys and very thin laminations are used, the upper frequency is restricted to perhaps 2,000 Hz.

Enter the ferrites. These magnetic materials have orders of magnitude less core losses than steel at high frequencies. Very high frequencies become feasible without undue heating. Yet ferrites have lower maximum flux density and permeability than steel, and thus the available size reduction is not as large as it could be. Nevertheless, ferrite development has steadily continued, and size continues to shrink. NV

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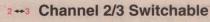
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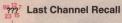
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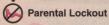
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M-80	\$65	\$59
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S-BLUE	\$65	\$59

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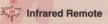
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STD/HRC Switchable





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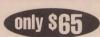


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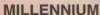
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# New FCC Commercial Radio Tests

tions are given near you!

There was also a brief period that hefty regulatory fee was being charged in addition to the examination fee. This didn't last long - the regulatory fee is now on hold, and the typical examination fee is approximately \$45.00 per element.

The most popular elements are Element 1 for the marine radio operator permit (MROP). It is a 24-question, multiple-choice test, and it is easily passed by any ship skipper that needs the three elements would allow you to work on any type of marine and aviation equipment, including shortwave transmitters. This group of three licenses is the initial package to obtain before thinking about additional global marine distress safety system licenses or commercial radiotelegraph licenses for big passenger and commercial ships. Table 3-1 illustrates all of the commercial radio license classes.

Beginning January 31, '96, FCC Element 1, 3, and 8 for the GROL, MROP, and radar have been revised from what has been previously published in training books. But don't throw out any existing Radio Shack books that you might already have on the GROL - much of the material in the older books is still valid.

Element 1, rules and regulations,

he Federal Communications Commission (FCC) general radiotelephone operator license, including radar endorsement, is a valuable ticket to have hanging on the wall. It's even more valuable on your job resume. January 31st marks the date for switching from the old question pool to the new question pool, but obtaining the license from old or new study materials is still relatively easy.

Ten years ago, the Federal Communications Commission commercial radiotelephone license was divided into three classes - first class, second class, and third class. Radio station broadcasters only needed the third class permit to operate certain radios. The second class license was necessary to repair and maintain marine radios, aviation radios and, for a time, land mobile radios. The first class license was necessary to adjust commercial radio and television transmitters

On June 15, 1984, the first class and second class radiotelephone operator licenses were discontinued. They were replaced with a lifetime GENER-AL RADIOTELEPHONE OPERATOR LICENSE, abbreviated GROL.

At the same time, the FCC also dropped the requirement that mobile two-way radio commercial, fire, and police transmitters needed to be "signed off" by a commercial GROL technician. But the law would still remain, as it is today, that every marine, aviation, and international fixed radio set may only be transmitteradjusted by a commercial GROL license holder.

Without the current GROL license, technicians working on marine, aircraft, and certain shortwave broadcast stations would be forbidden from making any adjustments to the transmitters. This is why the GROL license is an important one today - there are plenty of shortwave transmitters, thousands of aeronautical radios, and thousands of pleasure and commercial ship radiotelephones that may ultimately need service and transmitter adjustment - and it takes a GROL license holder to sign off the transmitter adjustment paperwork on this type of equipment.

Three years ago, the Federal Communications Commission turned over commercial radio licensing to privatized testing groups called Commercial Operator Examination Managers. Nine organizations would provide examination opportunities to applicants throughout the country and the world. National Radio Examiners, a division of the amateur radio W5YI Group, conducted over 3,700 exams last year (NRE, 800-669-9594, to take a test).

Elkins Institute was the largest in total examinations, conducting over 5,100 exams in '94 (Elkins, 800-944-1603, to take a test). Electronic Technician Association International and National Association of Radio Telecommunications Engineers each offered over 1,000 examinations last year. Under the relatively new COLEM system, there was no shortage of exam opportunities. Dial those two 800 numbers to find out where the commercial radiotelephone examinalicense to carry passengers for hire and operate a marine SSB or VHF marine transceiver. The MROP is only required for commercial boats - yachts-

men don't need this ticket.

Element 3 is the technical question pool for the GROL license necessary to work on marine and aviation/shortwave transmitters. This is a 76-question test with multiplechoice answers, and it takes about 30 days for the non-ham to prepare for by reading over the question and answer book. Licensed amateur operators holding the extra class license would need only about 10 days to get through the examination study because most of the old Element 3 questions came directly from the amateur radio Advanced and Extra class question pools.

Written Element 8, a 50-question test, is for the ship radar endorsement. This would allow the successful applicant to work on and sign off commercial radar equipment.

A nice "package" to have is written Element 1, written Element 3, and written Element 8 leading to the GROL with marine radio operating permit, as well as ship radar endorsement. These

#### by Gordon West

hardly changed at all. Just a little rewording here and there, and everything stays the same.

Element 3, the technical test, increased in possible questions from 720 questions to a little over 900 questions. Few of the older questions were eliminated - most of the update to Element 3 were additions in the follow-



ing area of study:

- · Voltage regulation
- · Aeronautical navigation equipment
- · Digital logic

The new questions were developed by a question pool committee, headed up by electronics expert David Caldwell. He was assisted by 17 participants to help update the old Element 3 question pool, under the close supervision of Federal Communications Commission electronics engineer Roger S. Noel, with the Wireless Telecommunications Bureau in Washington, DC (202-418-0680). Electronic experts throughout the country were encouraged to participate in the rewrite of the new questions, but participation was at the usual minimum and the major work was accomplished by Caldwell. Many of the older amateur radio Advanced and Extra class questions still remain in the new Element 3 pool, but several hundred new questions have been added from technical pages of the American Radio Relay League (published by Handbook American Radio Relay Newington, CT 06111, \$30.00 for the '95 edition).

Radar Element 8 was revised and additional questions added, thanks to the hard work of electronics expert and aeronautics instructor Roger Boettcher of Virginia Beach, VA. Until now, the only study materials for Element 8 radar were an informal study guide from Gordon West Radio School. The radar questions have now been upgraded and cleaned up, so the radar Element 8 question pool now reflects the current state-of-the-art in radar equipment, as well as current radar technology.

#### What to Do and When to Test

If you have a current general radio operator license book from Radio Shack (#62-2420) or from National Radio Examiners (800-669-9594), take your examination before Jan. 31, '96. There is no change in the questions.

However, if you want to begin to study now for rules and regulations Element 1, technical Element 3, and radar Element 8, a new book containing all of the questions, answers, and explanations on how to solve for the correct answer is available immediately with this writer as the author of the technical side of the book. All three elements are now in one updated study guide from National Radio Examiners, 800-669-9594. Use the American Radio Relay League Handbook as a resource for additional details behind all of the technical questions. The price of the new book, including radar, is under \$30.00.

It will take approximately 60 days to prepare for all three examinations. If you are already an Advanced and Extra class licensed ham, you can cut your study time in half if you can remember some of those original Advanced and Extra class ham questions and answers. If you are an electronics technician and knowledgeable about electronic circuits, you can also cut your study time in half and get all three exams out of the way within 30 days of reading the new GROL plus radar study book.

The Federal Communications Commission still issues the official license, even though the examinations are administered by private licensed examiners. You still get that official FCC license showing successful passing of Elements 1, 3, and 8 for the GROL, MROP, and radar. This also qualifies you to go on for the satellite radio system licenses called GMDSS for the big ships. You may obtain GMDSS question and answer quides by calling 800-669-9594.

As competition on the employment front increases for jobs in servicing two-way radios for aircraft and marine, the FCC GROL license with radar is an important "ticket" to show on your resume. Start your study now.

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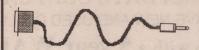
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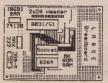
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# Questions & Answers

# TECH FORIM

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

I have a video camera head with two motors, one for vertical, the other for horizontal movement. I need an inexpensive circuit to point a solar wax melter to the sun.

1961

Jan Aerts Mesquite, TX

I bought a Bearcat 5 scanner from a garage sale. It worked on some channels in Toledo, OH, but I can't receive any channels here in Bowling Green, OH. Why? And what frequency do I need? How do I know what I need? Where do I order them from? I understand Nuts & Volts carries all sorts of items. Could you help me to find a company that still supplies parts for an old scanner? MFG-P0681; Model BC5-Bearcat; Serial #57407; 117 VAC, 50-60 Hz, 10W; eight channels. Manufactured by: Electra Company, Division of Masco Corp. of Indiana, Cumberland, IN 46229. I can't get a response from the manufacturer.

1962 **Dan Ballard** Tontogany, OH

I have a number of surplus gyroscopes that run on three phase, 400 Hz voltage. Does anyone have a schematic of a solid-state power supply with these parameters that preferably has adjustable voltage from about 25 to 75 volts? This would be greatly appreciated.

**Robert Gendron** East Haddam, CT

I have seen cheap "talking" greeting cards. Does anyone know sources for information about what chips are used? How they are programmed? Where they can be bought? I assume large quantities are necessary for such a "dedicated" application.

Lawrence Lile Columbia, MO

I need help with a system to control my satellite to receive through the IR port. I want to use my IBM/PS/2 to program the device. I want to be able to do all the things to make dish move a select time and change the channel when I am not there, \$200.00 or less. ABC Video, Inc.

Federal Way, WA

My Uniden (Bearcat) Model 50XL handheld scanner emits an annoying "beep" every 18 seconds, even with new batteries or external DC power. Does anyone know how to correct this problem, or supply a schematic so that can better troubleshoot this unit?

**Bob Nickels** Freeport, IL

I have several Hewlett Packard ThinkJet personal printers that utilize external power modules converting 120 VAC to 12 VAC. I would like to use these printers for Amateur Radio Emergency Services packet work running off a 12-volt storage battery. Can anyone tell me how to convert the 12 volt DC to 12 volt 60 cycle AC?

Ray Gilbert Sequim, WA

#### ANSWERS

As a matter of fact, extensive research was conducted on solar power previous to World War I.

It was discovered that parabolic reflectors could be fashioned into long troughs with a tubing run along the focal point. This method was proven to be quite effective in sunny areas of the world and provided sufficient power to operate turbines. The only problem presented itself on a cloudy day.

Large passive collectors seemed to be the most efficient on most any day, especially on cloudy days, but storage became a problem. The parabola could deliver the intense energy required to operate a turbine, but only on bright sunny days. Several machines with parabolic type reflectors, were assembled and demonstrated in the Middle East to produce power for generators and water pumps.

Oil was discovered and World War I began. Engineers working on the concept of solar energy left their research in the interests of their nation's involvement in the war. Oil made energy cheap, and thus, the fall of research into solar power.

My own theories into solar power generation are derived from this previous research and would have had to go through the same experimentation practiced prior to WWI.

I believe the answer lies in the storage of, and efficient conversion of, the difference of temperature between one area and the other.

A large passive collector, acting on a large volume of water for storage, seems to me to be the most practical method of collecting and converting solar energy. A thermocouple of the most efficient type would be interfaced with the collected energy to generate direct electrical power. The conversion of DC to AC would be a simple oscillator circuit. Absorption/desorption units would account for any refrigeration requirements (HVAC or otherwise) and would relieve the electrical system of those losses. Of course, theory always sounds better than practical application!

Solar tracking is as simple as two solar cells, a differential amplifier, a few gears, and a stepper motor. Again, theory over practical application.

Michael W. Wagner Mt. Pleasant, SC

#### ANSWER TO #12954 - DEC. 1995

Since your location is not in the US, it's very easy to stop cell traffic, even for miles. All you have to do is transmit any type of carrier over the cellular control channels. If you have access to an RF generator with sweep capability, stick up an antenna, power on full, and sweep from 879 to 881 MHz. Cellular phones rely on accessing a free control channel, and wait till they get one. Not only will the phones have difficulty grabbing a channel, the audio from them will also be noisy.

Breck Ricketts

#### ANSWER TO #129517 - DEC. 1995

The two DIP switches set the amount of memory installed on the board and the system address at which the memory will appear. Since there are 16,384 possible combinations, it pays to have the original manual. Magitronic items are sold by Liuski International of Melville, NY. Their number is 516-454-8220.

Joe D'Airo West Islip, NY

#### ANSWER TO #129519 - DEC. 1995

The mystery transistor in your Sharp Fax machine power supply in a TO220 package and marked "C3317" is a 2SC3317. Many Japanese transistor makers drop the first two characters of their part marking to save space. I am assuming from your question that you need to replace this part. Try MCM (1-800-543-4330). They list the 2SC3317 in their catalog. This transistor is similar to the ECG379 or ERS379 replacement, should you have trouble finding the correct part. Parts Express (1-800-338-0531) carries the NTE51, which is another replacement. You should be able to pick up the part you need for less than \$5.00.

Robert Kelly Poway, CA

#### ANSWER TO #129522 - DEC. 1995

There are several companies that specialize in defeating those irritating hardware locks. One is SafeSoft Systems, 201-1111 Munroe Ave., Winnipeg, MB Canada, R2K 3Z5, 2O4-669-4639. They specialize in electronic and CAD software.

Robert Zusman Scottsdale, AZ

#### ANSWER TO #129526 - DEC. 1995

First, adding optics or optical devices to any type of camera, be it

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- · Include the question number that appears directly below the question you are responding to.
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- 3) Problem Solving
- 2) Electronic Theory 4) Other Similar Topics

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- · 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.

film or electronic, requires some understanding of the optics involved and may be confusing to the layman.

Second, you must have reasonable engineering skill to modify the camera. Without either of these, the cost of this simple job will be exorbitant.

A simple way to combine an image from a lens assembly, to both film and video at the same time (real time) using only one input lens, is to add a quality beam splitter behind the lens assembly which will allow the light source coming in through the lens assembly to be diverted into two sepa-

### TECH FORUM

rate images. One path continues to the film surface and the other is diverted to a CCD pickup which converts this image to a standard video image of APX 6 MHz, 1 volt P/P. This image can be used to record the event or it can be sent to a miniature viewfinder like the standard camcorders have. You can add a modulator to view it remote on a large screen TV. All three are possible at the same time.

Beam splitters come in a variety of percentages, the most common being 50/50%. This will, however, reduce the light to the film by half, making an aperture of f/8 exactly half. Different percentage splitters are available and a 25/75 might be better because the CCD pick up is far more sensitive than even 1,000 ASA film and can be placed on the lesser side. This would only reduce the aperture to the film by 25%. Also, the coating used to split the image is important as this will act as a filter to different frequencies of light. Coatings come in all of the standard frequency responses that are used in both the scientific and cinematography industries. Beam splitters may also be used at the eye piece of any camera in exactly the same way. The hardest part of adapting a beam splitter will involve the engineering aspect of getting it to fit. The cavity behind the lens assembly on some cameras may simply be too small and this is where a knowledge of optics comes in handy. You may have to manufacture an extension housing that adds some room to this area while adding optics to correct for the extended focal length. All of this can be cheap or expensive depending on your knowledge and skills.

Chris Bieber, CA

#### ANSWER TO #119515 - NOV. 1995

Sony's documentation on the Control-L protocol has not been updated since the 1986 document that you have. Fortunately, the codes used for sending commands via Control-L are the same as those used for Sony's remote controls. To control a newer device, you can find the codes by connecting a scope to the IR LED on the remote. You could also capture the codes on a PC by connecting an infrared detector module (Radio Shack #276-137) to the parallel port and writing a program to poll one of the pins for data.

Doug Smith Roscoe, IL

#### ANSWER TO #129516 - DEC. 1995

A "device" known as a "muscle wire" looks like an excellent solution to your motion control dilemma where space (small figures) is extremely limited and "standard" devices such as motors and other electro-mechanical actuators simply cannot fit.

"Muscle wires" are highly processed strands of a special nickel-titanium alloy composition called NITI-NOL. These are available in several different diameters ranging from 50 to 250 micrometers.

At room temperature, they are easily stretched by up to 5% of their length.

The movement (with a considerable force of up to a few pounds, if necessary) is obtained due to the electric

current flow through a "muscle wire." When conducting an electric current, they return to their original "unstretched" shape with a force thousands of times their weight. Forces can be controlled by the appropriate length and "muscle wire's" diameter. They contract up to 5% when powered and direct linear action can be simply obtained.

The force a wire pulls with varies with size from 35 to 930 grams. Several wires in parallel can provide more strength, if necessary. "Muscle wires" contract as fast as they are heated (as quickly as 1/1000 of a second)

To relax, the wire must cool again. Rates of many cycles per second are possible with active cooling. Operating currents vary with wire diameter, length, and surrounding conditions from 50 mA to 1 A for atypical singlewire application. AC or DC or pulsed is okay.

Small size, lightweight, low power, extremely high strength-to-weight ratio, precise control, and long life make them perfect for any motorless small robots.

In your application, you are looking for the best way to control "small clay figures." "These figures resemble human dolls."

No, I have never experimented with these "little monsters" myself, but it looks like the "Little Killer Dolls" are very real!

For more information about a muscle wire, please contact:

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> Konstanty Boufal Philadelphia, PA

#### ANSWER TO #12957 - DEC. 1995

There are no "formulas or procedures" to replace a 19" color CRT with another 25" CRT. I think you are asking for the impossible, especially if you want to "keep the same components." There are no magic or hidden switches that you can flip and then simply replace the CRTs and expect everything to work normally.

What you are asking will require major redesign and modification to the video amplifier, deflection amplifiers, both vertical and horizontal (including replacing the yoke), replacing the flyback transformer, and the low and high voltage power supply. That doesn't leave much that you wouldn't need to modify or replace.

Haim Sandel Flanders, NJ

#### ANSWER TO #12952 - DEC. 1995

I'm not familiar with "Move-It," which is apparently no longer available. If you want to transfer programs directly between two IBM PC compatibles, I strongly recommend SAFFRON 6.0, available for \$24.95 postpaid from Bob Jack Software, 8371 White Road, Burbank, OH 44214.

Using only a three-wire cable, or a null-modem cable between each computer's serial port, and using the SAFFRON 6.0 DOS software on each computer, you can copy, print, and manipulate files at 115,000 bps. Either computer can remotely control the other for all the supported functions. Note that no phone line or modem is required with either computer; this is a direct-wire connection.

To use SAFFRON 6.0, you'll need two IBM PC compatible computers (PC, XT, AT, 386, etc.), each with a serial port; PC or MS-DOS 3.2 or greater, and the transfer cable. For more details, see the *Nuts & Volts* Oct. '94 issue. Back issues are available for \$5.00 each. The Oct. '94 issue contains a three-page review of SAFFRON 6.0

Fred Blechman West Hills, CA

#### ANSWER TO #129513 - DEC. 1995

Assuming that the switch chosen is rated at the correct voltage/current initially, a good way to ensure that the switch will last is to use "Cool-Amp Conductive Lubricant" from The Conducto-Lube Co., 15834 Upper Boones Ferry Road, Lake Oswego, OR 97035. Phone AC 503-624-6426. This conductive lubricant contains silver.

Mike Smith

#### ANSWER TO #129521 - DEC. 1995

The cheapest/easiest way to add a spike protector to a wall outlet is to add an "MOV" (metal-oxide varistor) to the outlet. This can be done either internally or externally. Many electronics supply companies sell such parts. For instance, Radio Shack #276-568 can be built into the existing outlet, or Radio Shack #61-2133 is a complete unit that simply plugs into the existing outlet.

Mike Smith Florence, AL

#### ANSWER TO #129520 - DEC. 1995

The value of R1 in Don Reynolds' schematic is one megohm. The same circuit is used in the D-104 microphone. The unmarked capacitor is .01 and resistor R5 (emitter of the second transistor) should be 180 ohms, not 180K as shown.

The transistors in some D-104 mics were 2N2712 and others were 2N5088. The 2N3904 transistors are similar and should work as a replacement.

Ray Shetrone Ft. Myers, FL

#### ANSWER TO #129524 - DEC. 1995

I was doubtful at first if you could reach the cellular site in Yuma, AZ from your location, 200 miles away in Mexico. It does appear that you can talk into Yuma from your mountain top

As I understand, satellite phone rates are currently running in the range of \$10.00 a minute. Even if they dropped to \$5.00 a minute with the increased competition from new satellite service providers, the cellular link is going to be much less expensive per minute. I am sure the satellite subscriber unit wouldn't be inexpensive

either

I ran some calculations assuming that the Yuma cell site antenna is at 100' and that your antenna is at 2,000' on the mountain. What I found is that you have about 140 dB of path loss to overcome at 800 MHz. Since your transmit power is lower than the cellular systems, I assumed that the Mexico to Arizona link was the limiting link. I assumed a 16 dB gain, 60 degree sector antenna at the cellular receive site. I assumed a 3 watt transmitter at your mountain top site with no gain. The answer was that your signal into the cellular site would be about -90 dBm. Around -116 dBm is the limit of receiver performance.

You have very little link margin and I have made many assumptions, but it should work propagation wise. The path from the cell site to you will be more reliable due to the higher transmit power of the cellular base station.

Before you go any further with this project, you should go to the top of the mountain and see if you can make a cellular call. Assuming that the cellular system doesn't mind the much longer-than-normal time for the phone to respond to data messages due to the long path that the radio signals must travel, you can proceed with one of the options below.

You've got two choices to make this work. One alternative is what is called a BDA or bi-directional amplifier. These are typically used to extend cellular site coverage into tunnels or a building. It is essentially a two-way amplifier that you could mount on the mountain top with one antenna pointed at you and the other antenna pointed at Yuma. TX-RX and Antenna Specialists offer products. These will probably run in the \$5,000-\$8,000 dollar range. All your friends would be able to make calls with their own cell phones, since a whole band segment would be extended into your town by this equipment.

A second solution would be to use a radio frequency (RF) link to extend the control of a mountain top cellular phone to your house. You can purchase an RJ-11 adapter for most cellular phones for \$100-\$150. This basically lets you plug a standard wireline phone into your cellular phone. This could be connected to a VHF or UHF radio repeater with telephone interconnect. This can be purchased new for around \$3,000.00 (Motorola SysTel SE) or could be built from surplus parts for next to no cost by a ham radio operator. This would then be controlled by a control station radio that you would use at home.

You've also got the problem of site security at your mountain top site, as well as site access. Is there a road available, or will you need to hike for half a day or rent a helicopter each time you need to make repairs? It would also be possible for someone to hack your RF link and make calls on your phone. Security of the RF link should be considered.

As you can see this is a complex project for an individual to undertake. I am sure that there are legal issues that would need to be considered as well.

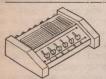
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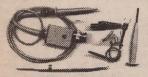


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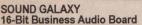
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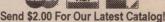


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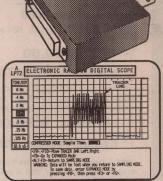


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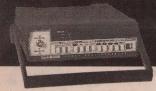
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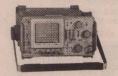
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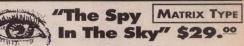
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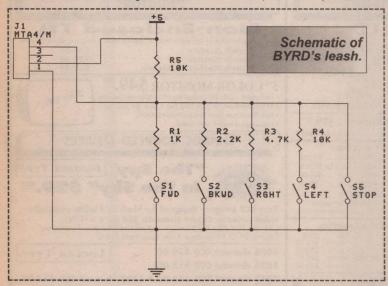
#### by Karl Lunt

ast month, I discussed the mechanics and electronics of BYRD, my Back Yard Research Drone robot. As you'll recall, I built BYRD by mounting a motor base onto the underside of a Rubbermaid roll-around beer cooler. This month, I'll describe the software needed to make

BYRD fly

The software consists of two major elements. One program, dubbed 811BUG, resides in the 2K of EEPROM in the 68hc811e2 I use in BYRD's computer board. I started a discussion of 811bug last month; this time, I'll provide the listing and more depth.

The other program, which provides BYRD's smarts, is downloaded through a serial link into the 32K



of battery-backed RAM on the computer board. This program, called BYRD04, supplies all the tele-operation functions I need to run BYRD over an RF link from my laptop computer.

#### **811BUG**

I wrote 811BUG in 68hc11 assembly language, though it could have easily been written in SBasic as well. I designed this software to solve a couple of problems specific to BYRD and its intended use.

BYRD is big; way too big to conveniently cart up and down the stairs whenever I need to download a new set of software. Therefore, I wanted 811BUG to let me download a new operating program at any time, even if BYRD was outside on the deck.

Since robot code is, by its very nature, always in the prototype stage, I needed 811BUG to serve as an emergency 'chute if my main software crashed, 811BUG must always be able to recover and at least shut off the motors.

I also wanted 811BUG to let me trigger execution of any downloaded software from my remote system. I didn't want to have to traipse out into the back 40 to change a DIP switch and press a reset button, just to run my software.

My 811BUG program meets all of these requirements, and gives me an excellent development tool.

Refer to the accompanying listing for details.

811BUG resides in EEPROM from \$f800 to \$ffff.
When the '811e2 is reset in expanded mode, it automatically fetches its reset vector from \$fffe. This starts execution of 811BUG by jumping to address \$f800.
811BUG's first task is to clear a latch on BYRD's computer board. This immediately shuts off both motors. If you modify 811BUG for your own use, this is a good place to put those panic operations that you need to have done first.

Next, 811BUG checks the state of port E, bit 7. This is connected to pin PE7 on the '811e2, an input pin

# AMATEUR ROBOTICS

that normally serves as an A/D port. In this case, however, my code just checks the pin for a logical 0 or 1.

If it detects a 1, meaning that the pin has been pulled high, 811BUG blindly jumps to address \$8000, the beginning of battery-backed RAM. Since I have wired pin PE7 to a DIP switch, I can manually set up BYRD to perform this auto-jump or not. If PE7 is

pulled low, 811BUG instead jumps to the address MAIN, which acts as the beginning of a large control loop. The first tasks performed here are to once again clear the motor latch, initialize the stack pointer, and then set up the Serial Communications Interface (SCI) for 9600 baud operation.

The top of the main loop also rewrites the RAM jump vectors. Recall that 811BUG resides from \$f800 to \$ffff. This means that all of the interrupt vectors, which run from \$ffd6 to \$ffff, contain values burned into them when I download 811BUG. If later use 811BUG to download a program into static RAM and start it up, the vectors still point into

811BUG; they cannot be modified by the download operation. To get around this problem, I designed 811BUG so most interrupt vectors point to fixed locations in the '811e2's on-chip RAM. Any other program can modify these addresses, from \$00b0 to \$00ec, to jump to the desired interrupt service routines.

Since the vectors in static RAM should always point somewhere useful, I use the routine SETVECS to modify the RAM jump vectors so they point back to the start of 811BUG. This means that even if a downloaded program fails to set up a vector and the corresponding interrupt occurs, control will still go somewhere safe and useful, namely back to 811BUG.

Note the inner workings of SETVECS. It steps through the low RAM area, writing three bytes for every interrupt vector. In each case, the first byte written is \$7e, which is the 68hc11 JMP extended opcode. The next two bytes written form the 16-bit address of the start of 811BUG. Any downloaded program that modifies the low RAM jump vectors must maintain this pattern.

If you jump ahead in the listing, you'll see the section at the end, beginning with the ORG \$ffd6 statement. This section defines the contents of the EEPROM vector area that 811BUG needs. Most of the vectors point to fixed locations in low RAM, as discussed above.

Two vectors, however, do not. I intentionally force the Illegal Opcode and COP Failure vectors to always point to 811BUG. These two hard-coded vectors serve as a last line of defense against runaway code. Since most crashes usually end up executing bogus instructions, the Illegal Opcode vector will eventually get taken. The Illegal Opcode interrupt has another valuable feature: it cannot be masked by software. Thus, even if the downloaded program had interrupts disabled when it ran away, the Illegal Opcode interrupt will still work.

Now back to the top part of the listing. After my code has set up the RAM jump vectors using

SETVECS, it waits for an incoming character from the SCI. This character serves as an action selector. If the character is an uppercase-X, 811BUG automatically jumps to address \$8000. This blind jump lets me remotely restart a downloaded program, without having to change a DIP switch or redo the download. If the character is a lowercase-x, 811BUG jumps to the address saved from the S9 record encountered during the most recent download operation. This comes in handy if I want to download multiple files. I just send the main program as the last file, then hit an 'x' and the main program starts up.

If the character is a lowercase-j, 811BUG uses the next four characters as a hex address. It saves this address for later use with an 'x' command, described above. This lets me override the execution address in a download, and jump instead to another

starting address.

Note that 811BUG is very unforgiving when it handles the 'j' command. You must immediately follow the 'j' with four hex characters. You cannot put in a space, and you cannot use a backspace to overwrite an error. 811BUG is intended to talk to some type of host-based program, though you can use a comm package such as Crosstalk in a pinch. Finally, if the character is an uppercase-S, 811BUG begins reading the characters of a Motorola S0, S1, or S9 object record. These records are generated by nearly any software that creates executables for Motorola processors, including SBasic and tiny4th.

811BUG ignores S0 records, as these usually just contain header information of use only to humans. 811BUG automatically parses any S1 records, storing the supplied data into the appropriate addresses. Finally, 811BUG saves the execution address, contained in the final S9 record, for later use with the 'x command. The rest of the code in 811BUG supports character and record parsing. This design reduces the downloading operation to very few steps. I simply turn on BYRD, start up a comm package on my laptop, and send the appropriate .S19 object file through the serial port. No monitor commands, no start-sup incantation; just send a file, then press 'x.' As you can imagine, this really makes life easy if I need to download while BYRD is sitting outside in the rain. As the human in the team, I shouldn't have to get out of my comfy chair to go reset a fallen robot.

#### The Leash

Before I start on BYRD's code, I need to discuss a hardware addition I made recently. Large robots usually need a leash, since they are too large to carry; BYRD is no exception. I could have used a standard Atari-style pushbutton joystick, but that would mean using four input lines just to get steering control. Instead, I built a network of five resistors and five switches, to give me right, left, forward, reverse, and stop commands.

The voltage developed by this network assumes one of five different values, which appears on a single A/D port of the 68hc811. Logic in the program can then translate the voltage into a specific command. The leash uses only three wires: power, ground, and signal. This, in turn, uses up minimal I/O resources, requires little power, and allows me to use a thin, flexi-

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ble cable between robot and human. See the accompanying schematic for details.

#### BYRD's Code

The listing for BYRD04.BAS is too large to show here completely. I'll instead discuss key sections, including parts of the code where appropriate. The code at the label RTIISR acts as the interrupt service routine (ISR) for the 68hc11 Real-Time Interrupt (RTI).

When properly set up, the RTI provides a timer interrupt at a fixed rate of one interrupt every 4.1 msecs. BYRD04.BAS uses this periodic interrupt as a master clock, controlling features such as the motor pulse-width modulation (PWM) speed control.

The first few lines of code simply test the variable WAIT, and decrement it if it hasn't already reached 0. WAIT serves as a typical downcounting timer variable, used to time events to 4.1 msec resolution. The next section of code is a rather juicy bit; it provides PWM speed control of BYRD's DC gearhead motors. Unlike the servo motors I normally use, a gearhead motor is either on or off, depending on the state of its control bit. Each motor has one control bit, available through the address LATCH.

To get speed control over a gearhead motor, you simply turn the motor on and off very quickly. The overall speed is roughly equivalent to the ratio of ontime to off-time, provided the frequency of the switching is fast enough. Since I put the PWM code inside

the RTI ISR routine, and since the RTI occurs once every 4.1 msecs, I end up with a PWM frequency of about 250 Hz. This is a little slow but functional, and it's free in that I was doing the RTI anyway.

The PWM code begins by setting the MTR\_MASK variable to 0, which by default will turn both motors off. Next, it rolls the variable RMTR\_PWM right one bit position. This roll operation, known in 68hc11 assembler parlance as a rotate, simply moves all the bits of RMTR\_PWN one position to the right. The low bit, shifted out of position 0, is rotated into position 15. Thus, all the original bits in RMTR\_PWN are preserved, they just change positions. After 16 successive rolls, RMTR\_PWM will contain its original value. The code then tests the value of the new bit in position 0 of RMTR\_PWM, using a logical-AND operation. If the new bit is a one, the code ORs the proper bit for turning on the right motor into the variable MTR\_MASK. If, however, the new bit is a zero, MTR\_MASK isn't changed; the right motor will be turned off.

The routine performs the same operation for LMTR\_PWM, used to control the speed of the left motor. Next, the code ORs the current direction bits for both motors, in variable MTR\_DIR, into MTR\_MASK. The direction information is updated by other sections of code; any direction changes don't occur until the next RTI, when this code actually sets up the change. This code merges the new value in MTR\_MASK with the last value written to the I/O latch, as preserved in variable LATCH\_RAM. Since

the I/O latch is write-only, the variable LATCH\_RAM serves as its memory; it should always hold a copy of the last value written.

Finally, this code uses a POKEB to update the physical latch with the value stored in LATCH\_RAM. This step actually changes the electrical signals routed to the motor controller, causing the newest speed and direction information to occur.

Based on the above description, you can see how easily BYRD's software provides speed control. If code in the main section writes \$ffff to RMTR\_PWM, the right motor will be turned on at each RTI, and it will not be turned off. Thus, the motor will run at full speed. If code writes \$0000 to RMTR\_PWM, the right motor will be turned off at each RTI, which stop it. To get speeds between full stop and full speed, just write values with varying numbers of 1s and 0s to RMTR\_PWM or LMTR\_PWM. For example, to get half speed, you could use values with eight 1s and eight 0s. But realize that some half-speed values give better performance than others. My code uses a value of \$5555 or \$aaaa to get half-speed; the alternating 1s and 0s provide a smoother speed than a value of, say, \$ff00.

I have included a table showing the various motor speed constants I use in BYRD. Note that I don't use any speed below 50%. Lower speeds provide proportionately lower torque, and anything below 50% doesn't give enough torque to be useful.

The large DO-LOOP following the label MAIN provides BYRD's functionality. What BYRD does at

```
======== motor speed values; part of BYRD04.BAS
                                                                                                                 for n = 0 to 4
                                                                                                                                                            silly wait loop
next n
                                                                                                                  print peekb(adr1); peekb(adr2); peekb(adr3); peekb(adr4)
                                                                                                                 endcase
cr?
                                                                                                                 if mwait = 0 print "Working...";
                                                                                                                  endif
                                                                                                                 print
                                                                                                                 endcase
                                                                                                                 case '5
                                                                                                                                                            stop all motors
case ' ' ' emergency stop push RMTR_FWD + LMTR_FWD' first, release the relays
                                                                                                                 gosub set_direction
gosub all_stop
print "All stopped, sir!"
if wait <> 0
                                           drop wait if not yet 0
                                                                                                                                                            now change the PWM pattern
   wait = wait - 1
endif
                                                                                                                  endcase
pokeb
         tflq2,
                     %01000000
                                          rearm the RTI subsystem
                                                                                                                                                            go forward
                                                                                                                 push RMTR_FWD + LMTR_FWD gosub set_direction
mtr_mask = 0
                                           start with motors off
rmtr_pwm = rroll(rmtr_pwm)
if rmtr_pwm and 1 = 1
                                           rotate right motor PWM if got a 1, turn motor on
                                                                                                                 print "Forward, aye!"
   mtr_mask = mtr_mask or RMTR_ON
                                                                                                                  endcase
endif
Imtr_pwm = rroll(Imtr_pwm)
if Imtr_pwm and 1 = 1
                                           now do left motor
                                                                                                                                                            go backward
                                                                                                                 push RMTR_REV + LMTR_REV
  mtr_mask = mtr_mask or LMTR_ON
                                                                                                                 gosub set_direction print "Reverse, aye!"
mtr_mask = mtr_mask or mtr_dir 'add dir
latch_ram = latch_ram and MTR_AND_MASK
latch_ram = latch_ram or mtr_mask
                                           add direction info
                                                                                                                                                            turn hard right
pokeb LATCH, latch_ram
                                                                                                                 push RMTR_REV + LMTR_FWD
                                           update latch
                                                                                                                 gosub set_direction
print "Hard a-starboard, aye!"
=================== main command loop; part of BYRD04.BAS
                                                                                                                                                            turn hard left
 key = inkey$() and $ff
                                                                                                                 push RMTR_FWD + LMTR_REV
                                                                                                                 gosub set_direction
print "Hard a-port, aye!"
 if key = 0
          gosub read_joystick
                                                                                                                  endcase
 select key
          case 'h'
                                                                                                                 case '+'
                                                      need help?
                                                                                                                                                            increase speed
                                                                                                                  if topspeed = '9'
                                                                                                                                                            'if already at top speed..
           case 'H'
                                                      both cases
                                                                                                                    print "Sorry, Captain, but she canna give no more!
           gosub help
                                                                                                                 else
           endcase
                                                                                                                     topspeed = topspeed + 1
          case '~'
                                                     return to 811 monitor?
                                                                                                                    print "Speed now up to warp "
outch topspeed
          interrupts off n = peek($fffe)
                                                      find addr of monitor
                                                                                                                    print
                                                                                                                 gosub set_topspeed endif
           gosub n
                                                      force return to 811bug
           endcase
                                                                                                                 endcase
                                                     show all a/d ports?
          pokeb adctl, $10 for n = 0 to 4
                                                                                                                    se '-' ' decrease speed opspeed = '1' ' if already at low speed... print "Sorry, Captain, but we are already at warp 1!"
                                                      convert chnls 0-3
                                                     silly wait loop
                                                                                                                 if topspeed = '1'
          next n
           print "Data (0-7):"; peekb(adr1); peekb(adr2);
print peekb(adr3); peekb(adr4);
pokeb adctl, $14 'conver
                                                                                                                    topspeed = topspeed - 1
                                                                                                                     print "Speed now down to warp ";
                                                      convert chnls 4-7
```

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any time is controlled by one of two events, either a character arriving on the serial port (SCI) or a value appearing on A/D port 3, pin PE3

The code first uses the INKEY\$() function to test for an incoming character. If no character arrived, the code then executes the READ\_JOYSTICK subroutine to see if a button on BYRD's leash has been pressed.

The READ\_JOYSTICK routine samples the joystick port and tests the value read. It then converts this value into one of six characters, simulating the arrival of steering and motor control characters. Note that one character, null or \$0, signifies that no button was pressed

This routine also uses the variable LAST KEY to record a key press. This means that the joystick buttons act as latching switches; press one, and the code remembers it as pressed until you press another.

The character saved in variable KEY, regardless of its source, acts as a selector in a large SELECT structure. A value of \$0, which signifies that no command was issued, is ignored. The program recognizes commands for stop, right turn, left turn, forward, reverse, and speed control. It also supports commands for controlling BYRD's power control port, one line of which activates the video camera and video RF

The code inside the SELECT structure executes the desired command, then prints a whimsical confirmation back to the serial port. In the cold light of reality, the link between a motorized beer cooler and the starship Enterprise seems tenuous, but the messages always get a chuckle at the SRS meetings.

Note that some commands must modify the value in the I/O latch. Since the latch can be changed in the RTI code as well, the main code must protect the value in LATCH\_RAM while using it. It does this by turning interrupts off, reading or writing the LATCH\_RAM value, then turning the interrupts back on.

This concept holds anytime your mainline code and your interrupt code must access the same variable or port. Your mainline code must ensure that the interrupt code can't muck with the variable or port at the same time the mainline code accesses it, or you'll end up with some very nasty bugs to shoot

One command is of paramount importance. The tilde character ('~') forces a return to 811bug. The command works by using a PEEK() function to find the address of 811BUG, then doing a GOSUB to that address. This lets me abandon the current version of BYRD's software and prepare to load another via the RF modem. Without the tilde command, I'd have to go find BYRD and press the reset switch to set-up the next download.

This completes my discussion of BYRD. You will probably see BYRD mentioned again in future columns; I'm having a lot of fun with my big remote 'bot. Think I'll go add a strobe and siren . . . NV

```
outch topspeed
                  gosub set_topspeed
                                                                                                                                 iobase equ $1000
                                                                                                                                                                                                   i/o regs start here
                                                                                                                                porte equ $0a
baud equ $2b
             endif
             endcase
                                                                                                                                sccr2 equ $2d
                                                                                                                                 scdr equ $2f
             case 'v
                                                                   turn camera on/off?
             case 'V'
                                                                   both cases work protect the latch
                                                                                                                                 scsr equ $2e
             interrupts off
             temp = latch_ram xor VIDEO_ON
latch_ram = temp
                                                                    switch the bit
                                                                                                                                latch equ $4000
                                                                                                                                                                                                   special output port
                                                                   save in ram copy
             pokeb latch, temp
             interrupts on if temp and VIDEO_ON = 0
                                                                   ready to go
                                                                                                                                * Define the stack address and a few vital RAM locations.
                 print "Main viewer off, sir!"
                                                                                                                                 * This program configures the low-area RAM ($00 - $ff) as follows
                 print "Main viewer on, sir!"
                                                                                                                                                                                     <- Top of low-area RAM
811bug variables reside here.
<- Top of RAM vector area
These addrs are targets of the 811bug
vectors; see fdbs at $ffc0 below.
                                                                                                                                 * Sff
             endif
             endcase
                                                                                                                                  ramvecs
             case 'z'
                                                                    turn device #2 on/off?
                                                                   both cases work protect the latch
             interrupts off
             temp = latch_ram xor DEV2_ON
                                                                   switch the bit
                                                                                                                                                                                      <- Bottom of RAM vector area
                                                                                                                                   ramvecs
                                                                                                                                                                                     <- Top of 811bug stack area
The stack grows downward from here.
Reserve at least $10 bytes for stack.
             latch_ram = Temp
                                                                   save in ram copy
                                                                                                                                   stkbeg
             pokeb latch, temp
                                                                    now send to I/O
             interrupts on
if temp and DEV2_ON = 0
print "Device 2 off, sir!"
                                                                   ready to go
                                                                                                                                   $9f
                                                                                                                                                                                      User program may use rest of low RAM
             print "Device 2 on, sir!" endif
                                                                                                                                   $00
                                                                                                                                                                                      <- Bottom of low-area RAM
             endcase
                                                                   servo to right
do both cases
             case 'r'
case 'R'
                                                                                                                                                                         $af
                                                                                                                                                                                                   top of stack
                                                                                                                                stkbea
                                                                                                                                                           equ
             temp = peek(PAN_TOC)
if temp <* PAN_MAXR
temp = temp + PAN_INC
                                                                   get current servo position if room to go...
                                                                                                                                                           stkbeg+1
                                                                                                                                                                                                   jump vectors (takes $3c bytes)
                                                                                                                                 ramvecs equ
                                                                                                                                                                         ramvecs+$3c
                                                                                                                                                                                                   addr of variables
                                                                                                                                 vars
             poke PAN_TOC, temp
                                                                                                                                 knt
                                                                                                                                                            equ
                                                                                                                                                                         vars+0
                                                                                                                                                                                                   byte variable
                                                                                                                                                                                                   word variable
                                                                                                                                 addr
                                                                                                                                                                         vars+1
             endcase
                                                                                                                                                           eau
                                                                                                                                 chk
                                                                                                                                                            equ
                                                                                                                                                                         vars+3
                                                                                                                                                                                                   byte variable
                                                                   servo to left
do both cases
                                                                                                                                                            equ
equ
             case 'l'
                                                                                                                                 xataddr
                                                                                                                                                                         vars+4
                                                                                                                                                                                                   word variable
                                                                                                                                 flag9
                                                                                                                                                                                                   byte variable
             temp = peek(PAN_TOC) if temp >* PAN_MAXL
                                                                    get current servo position if room to go...
                  temp = temp - PAN_INC
             endif
                                                                                                                                 * Start of 811bug code.
             poke PAN_TOC, temp
                                                                                                                                 * The '811e2 should be configured to have EEPROM from $f800 to $ffff.
* This puts the vector addresses in EEPROM, so 811bug is always present.
             endcase
             case 'c'
                                                                   servo to center
                                                                    do both cases
              poke PAN_TOC, $f500
                                                                                                                                              orq
                                                                                                                                                            $f800
                                                                                                                                                                                                   start of code
              endcase

* Following power-up or reset, 811bug checks the state of port E, bit 7.
* If that bit is high, control passes to the main loop in 811bug. If
* that bit is low, control automatically jumps to address $8000.

    if key <> 0
             mwait = MORE_DELAY
                                                                                                                                 * The jump to $8000 is blind; no check is made to ensure that code actually * exists there. This leaves plenty of time for the code at $8000 to alter * the time-sensitive I/O registers, if needed.
loop
* 811bug EEPROM-based S19 loader for the 68hc811e2 MCU
                                                                                                                                 start
                                                                                                                                                                                      special for my 'hc11 board must clear output port always!
* This program accepts S1-S9 records from the SCI and stores them at * the proper addresses in memory. It also accepts a minimum number of * commands from the serial port, to allow the user to execute the * downloaded commands from a comm program.
                                                                                                                                              staa
                                                                                                                                                            latch
                                                                                                                                              Idaa
                                                                                                                                                            porte+iobase
                                                                                                                                                                                      read digital port
                                                                                                                                                                                      if bit 7 is high.
                                                                                                                                              lad
                                                                                                                                                            main
                                                                                                                                 xxqt
                                                                                                                                              imp
                                                                                                                                                            $8000
                                                                                                                                                                                      force start of user's prog
```

\* Declare a few I/O register addresses

#### BOTICS . . . ROBOTICS . . . ROBOTICS . . . ROBOTICS . . . ROBOT

ì	This is the main entry point to 811bug. Each time control reaches
3	this point, the code reset the stack pointer and the SCI, then reloads
3	the low-RAM vectors. It also loads the 811bug variable xqtaddr with
3	the address found in the reset vector at Sfffe. This effectively makes

\* 811bug the default program for use with the 'x' command

\* This code then prints out a simple hello message

main

clra staa	latch	special for my 'hc11 board must clear output port always!
ldx lds ldaa staa	#iobase #stkbeg #\$30 baud.x	point to i/o always reset stack set baud = 9600
ldaa staa	#\$0c sccr2.x	turn on sci
jsr ldd std ldy jsr	setvecs \$fffe xqtaddr #hello prints	setup vectors get start of 811bug use as default S9 addr point to string print it

\* This is the main loop for accepting input from the host and processing \* commands. Commands are determined by the first letter following a CR. \* LFs are always ignored when 811bug is looking for a command.

\* Legal 811bug commands are:

marks the start of an S19 object record. The entire line is treated as an S19 record, and is parsed and loaded into memory \* S

transfers control to the last legal execution address, as passed in the most recent S9 record, or as set by the j command below.

transfers control to \$8000, regardless of any S19 object records

assigns a jump address for use with a subsequent 'x' command as above. The j must be followed immediately by a four-digit hex address, followed immediately by a CR. The input cannot contain backspaces or other cursor control characters, and it cannot contain embedded spaces or

empty line? if so, ignore it

loop lds #stkbea always reset stack ldx #iobase always point to i/o jsr make it pretty loop1 jsr getche get first char cmpa #\$0a loop1 #'S' always ignore load S19 record? beq cmpa beq loads19 if so, do it execute prog? branch if so cmpa beq iexecute at \$8000? cmpa branch if so beq xxqt set jump addr? cmpa beq branch if so

\* This code eats all incoming characters until a CR is detected. It then \* displays a '?' as an error indicator, then returns to the top of the \* loop for the next command.

cmpa beq

loop

eaterr

eatline error, waste the line bsr Idaa get error flag outch bra and leave

\* eatline — eat all characters, without echo, until a CR

\* This routine absorbs all incoming characters until a CR is reached.
\* This effectively ignores all text after an error has been detected.

eatline

eatlx

grab a char (no echo) getch #\$0d isr wait for CR cmpa loop until hit it eatlx beq echo char bra eatline do some more

rts

\* xqt — process the 'x' command

\* This routine jumps to the address stored in 811bug variable xgtaddr.

xqt

ldy xataddr get execution addr 0,9 and do it imp

\* jmp — process the 'j' command

\* This routine collects a four-digit hex address and a terminating CR. \* It then stores the address into the 811bug variable xqtaddr, for use

\* with a later 'x' command.

imp

jsr	byte	get MSB
staa	addr	save it
jsr	byte	get LSB
staa	addr+1	save it
jsr	getch	get last char
cmpa	#\$0d	better be cr
bne	eaterr	oops, that's bad
ldd	addr	OK, get real addr
std	xgtaddr	and save it
bra	loop	do another one

\* loads19 -- process an S19 record

\* This routine reads the rest of an S-record, processing the characters \* as needed.

\* This routine supports the following S-records:

S0 header record; ignored by 811bug.

\* S1 16-bit data record; 811bug stores data into assigned addresses.

\* S9 execution record; 811bug records the execution address in 811bug variable xqtaddr for later use with the 'x' command.

\* This routine automatically calculates and tests the checksum for each \* record. Illegal records and any record with a bad checksum are flagged \* to the user with an error indication.

\* NOTE: 811bug does not currently verify that data written to a memory \* address actually got there.

loads19

flag9 getche #'0' assume S1 record clr grab next char S0 record? isr cmpa bne loads1 branch if not loads0

eatline waste whole line bra loop get next line loads1 #'9' S9 record?

bne

loads2 no, try next one show S9 record flag9 loads4 continue processing

loads2

S1 record? cmpa if not, error bne eaterr

loads4

byte staa dec knt staa chk byte staa addr chk adda staa dec knt

get byte count count this byte start checksum get MSB of addr save addr add to checksum save it back

addr+1 adda chk chk staa ldv addr dec

beq I

save addr add to checksum save it back get addr count this byte

loads3

byte 0,y staa iny chk staa chk dec knt bra loads3

oads5

get data byte write to addr point to next addr add to checksum save it back count this byte go test knt

count this byte get LSB of addr

if 0, all done

get checksum

loads5

jsr byte

#### .. ROBOTICS ... ROBOTICS ... ROBOTICS ... ROBOTIC coma get one's comp does it match? and echo it bra outch cmpa loadsf eatline bne branch if fail eat the rest \* crlf - send a CR/LF sequence to the SCI isr tst flag9 was this S9 record? loadsx beq ldd branch if S1 addr get start address crif std xqtaddr save for execution #\$0d ldaa get cr loadsx outch send it bsr jmp loop do next command Idaa #\$0a get If loads send it, then exit bra outch show bad record eaterr \* outch - send a character to the SCI; polling loop. \* hexbin — convert an ASCII character in AR to its binary value \* This routine expects an ASCII character in the A register. It converts outch \* the character to uppercase, then converts it to a binary value from 0 \* to \$f. scsr,x outch get status loop until ready bpl scdr,x \* If this routine detects an illegal (non-hex) character, it automatically \* jumps to eaterr to handle the error condition. rts \* prints — print a string to the SCI hexbin \* This routine prints a text string to the SCI. The address of the \* string is passed in the Y register, which is destroyed. The string \* must be null-terminated. jsr make it uppercase ucase cmpa #'0' test low range branch if fail hexnot cmpa #'9' test decimal found hex number hexnmb #'A' test low hex cmpa prints 0,y printsx get next char in string leave if done send it hexnot branch if fail ldaa test high hex branch if fail cmpa #'F' beq bgt adda hexnot bsr outch set up for conversion bump pointer hexnmb bra prints do another #\$0f anda get binary value printsx rts hexnot fail show error jmp eaterr hexx rts \* setvecs — set up the RAM vectors \* This routine overwrites low RAM with jumps to the start of 811bug. \* This means that subsequent unexpected interrupts should automatically \* vector to 811bug, restarting the monitor. This isn't a foolproof \* ucase — convert an ASCII character in AR to uppercase \* way to save a runaway program, but it is better than nothing. ucase check for low end #'a' cmpa setvecs pshx ldx save xr point to destination leave if too low check for high end leave if too high blt ucasex #'z' #ramvecs setv1 cmpa Idaa #\$7e jump opcode put in ram 0,x #\$20 make it uppercase staa suba point to next cell ucasex rts Idd #start default vector addr std 0,x put in ram bump pointer (twice for word) inx inx collect two ASCII hex characters and convert them to a byte cpx bne #ramvecs+\$3c reached the end? branch if not setv1 rts pshb save b jsr bsr getche get a char hexhin convert it hello asla move to MSB fcb \$0a,\$0d asla fcc "811bug v1.0" asla fcb asla tab now save in b jsr bsr getche get 2nd char org \$ffd6 start of 68hc11 vectors hexbin convert it aba make a byte of them ramvecs+\$00 SC pulb rts ramvecs+\$03 ramvecs+\$06 restore b fdb spi fdh paii fdb ramvecs+\$09 paov ramvecs+\$0c toi ramvecs+\$0f ramvecs+\$12 fdb oc5i fdb \* getch — get a character from the SCI; polling loop ramvecs+\$15 ramvecs+\$18 ramvecs+\$1b oc2i fdb getch fdb ramvecs+\$1e ic3i ic2i Idaa get status ramvecs+\$21 db anything there? #\$20 fdb ic1i anda ramvecs+\$24 getch beq ramvecs+\$27 rtii ramvecs+\$2a ramvecs+\$2d Idaa scdr.x get the data fdb xirq ramvecs+\$30 swi illegal op cop failure fdb

start

start

start

fdb

end

ramvecs+\$39

cop monitor failure

reset

getch

bsr

\* getche — get a character, with echo, from the SCI; polling loop.

get a char

byte

rts

getche

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HP 3575A-002 Phase-Gain Meter, 1 Hz-13 MHz, dual display	\$900.00	HP 8350A/86290B-H08 Programmable Sweep System,	\$5,500.00	HP 11692D Dual Directional Coupler, 22 dB, 2-18 GHz	\$900.00 \$135.00
KROHN-HITE 3202 Dual High-Pass/Low-Pass		HP 8601A Generator/Sweeper, 0.1-110 MHz, +20 dBm levelled	\$500.00	0.01-26.5 GHz, APC3.5(m/f)	
Filter, 20 Hz-2 MHz, 24 dB/oct KROHN-HITE 3342 Dual HP/LP Filter,	\$1,100.00	HP 8620C Sweep Oscillator Frame HP 8620C-011 Sweep Oscillator Frame, HPIB programmable	\$550.00 \$675.00	HP 33330D Detector, 0.01-33.0 GHz, APC3.5(m)/SMC(f) HP 775D Dual Directional Coupler, 20 dB, 450-940 MHz	\$275.00 \$275.00
0.001 Hz-99.9 kHz, 48 dB/octave		HP 86220A RF Plug-in, 10-1300 MHz, +10 dBm levelled	\$800.00	HP 776D Dual Directional Coupler, 20 dB, 940-1900 MHz	\$275.00
TEK AM502 Differential Amplifier, 0.1 Hz-1 MHz, TM500 series	\$575.00	HP 86222A-002 RF Plug-in, 10-2400 MHz, 70 dB step attenuator HP 86222B-002 RF Plug-In, 10-2400 MHz,	\$1,750.00	HP 777D Dual Directional Coupler, 20 dB, 1.9-4.1 GHz HP 778D Dual Dir.Coupler, 20 dB, 100-2000 MHz, N(m/f/f/f)	
RF & MICROWAVE		crystal markers, 0-70 dB atten HP 86230B RF Plug-in, 1.8-4.2 GHz, +10 dBm unlevelled		HP 778D-011 Dual Dir.Coupler, 20 dB, 100-2000 MHz,	\$400.00
THE WHOTIOWAVE		HP 86240A RF Plug-in, 2.0-8.4 GHz, +16 dBm levelled	. \$1,000.00	APC7/N(f/f/f) HP 8472A Crystal Detector, 10 MHz-18 GHz, neg. pol., SMA(m)	\$150.00
SPECTRUM ANALYZERS		HP 86240B RF Plug-in, 2.0-8.4 GHz, +13 dBm levelled HP 86241A-001 RF Plug-in, 3.2-6.5 GHz, +8 dBm levelled	\$1,000.00	HP K422AWR42 Flat Broadband Detector, 18.0-26.5 GHz	\$350.00
EATON/AILTECH NM-17/27A Measurement	\$3,250.00	HP 86242D-004,008 RF Plug-In, 5.9-9.0 GHz, +10 dBm levelled	\$500.00	HP K532AWR42 Frequency Meter, 18.0-26.5 GHz HP Q752DWR22 Directional Coupler, 20 dB, 33-50 GHz	\$650.00
Receiver, 10 kHz-30 MHz, 0.1/1/10/50 kHz BW HP 11970A WR28 Harmonic Mixer, 26.5-40 GHz	\$1,100.00	HP 86245A RF Plug-in, 5.9-12.4 GHz, +16 dBm levelled	\$1,100.00	HP R422A WR28 Flat Broadband Detector, 26.5-40 GHz HP R532A WR28 Frequency Meter, 26.5-40.0 GHz	
HP 11970KWR42 Harmonic Mixer, 18.0-26.5 GHz	\$1,100.00 \$1,400.00	HP 86250D RF Plug-in, 8.0-12.4 GHz, +10 dBm external levelling. HP 86250D-001 RF Plug-in, 8.0-12.4 GHz, +10 dBm levelled	\$700.00	HUGHES 45342H-1110WR22 Dual	\$875.00
HP 11970U WR19 Harmonic Mixer, 40-60 GHz	\$1,400.00	HP 86260A RF Plug-in, 12.0-18.0 GHz, +10 dBm unlevelled HP 86260A-H04 RF Plug-in, 10.0-15.0 GHz, +10 dBm unlevelled	\$1,100.00	Directional Coupler, 10 dB, 33-50 GHz KRYTAR 202020016 Directional Det.,	\$200.00
HP 11971AWH28 Harmonic Mixer, 26.5-40.0 GHz, for 8569B HP 11971KWR42 Harmonic Mixer, 18.0-26.5 GHz, for 8569B	\$1,100.00	HP 86290A RF Plug-in, 2.0-18.0 GHz, +7 dBm levelled	\$1,750.00	2-20 GHz, SMA(f/m)/SMC(f), 10 uV/uW M/A-COM 3-19-300/10 WR19 Directional	6450.00
HP 5371A Modulation Domain Analyzer, 125 mHz-500 MHz	\$5,900.00	HP 86290C RF Plug-in, 2.0-18.6 GHz, +13 dBm levelled	\$350.00	Coupler 10 dB 40-60 GHz	
HP 8406A Comb Generator, 1/10/100 MHz increments, to 5 GH HP 8443A Tracking Generator, for 8553B, LED display	z \$450.00 \$700.00	WAVETEK 1067 Sweep Generator, 1-400 MHz,	\$500.00	MAURY MW. J320-series WR22 Calibrated	\$375.00
HP 8443A Tracking Generator, for 8553B, LED display HP 8444A Tracking Generator, 0.1-1300 MHz, for 8554B HP 8444A-059 Tracking Generator,	\$1 500.00	WAVETEK 2002A Signal/Sweep Generator,	\$1,650.00	Mismatch, VSWR values 1.1-2.0 MICA T-317S Isolator, 15 dB, 17.0-24.5 GHz, SMA	
0.5-1500 MHz, for 8554, 8568, etc.		1-2500 MHz, +10 dBm levelled WAVETEK 907 Sweep/Signal Generator,	\$1,000.00	MILLIWAVE S91-1777B Amplifier, 2.7 dB,	
HP 8445B Preselector, 1.8-18.0 GHz, for HP 8555A HP 8552B IF Section	\$800.00 \$750.00	7.0-11.0 GHz, 0 dBm levelled WAVETEK 954 Signal/Sweep Generator,		MINI-CIRCUITS ZHL-2000 Amplifier, 20 dB,	\$85.00
HP 8553B RF Section, 1 kHz-110 MHz	\$500.00	3.7-7.6 GHz, +7 dBm unlevelled		10-2000 MHz, +15 dBm Po, 15 VDC NARDA 26298 20 dB Attenuator, 150 Watts, DC-1 GHz, N(f/f)	\$200.00
HP 8554B RF Section, 0.1-1250 MHz HP 8554B/8552B/141T Spectrum Analyzer,	\$2,000.00	WAVETEK 962 Sweep Generator, 1.0-4.0 GHz,	\$2,000.00	NARDA 3000-SERIES Directional Couplers	\$150.00
100 kHz-1250 MHz, 100 Hz resolution		markers, +12 dBm unlvld. WILTRON 6619A-003 Prog. Sweep Gen.,	\$1,900.00	NARDA 3022 Bi-Directional Coupler, 20 dB, 1-4 GHzNARDA 3024 Bi-Directional Coupler, 20 dB, 4-8 GHz	\$300.00
HP 8555A RF Section, 0.01-18 GHz	\$950.00	2.0-8.0 GHz, +10 dBm levelled, GPIB WILTRON 6647A-40,02 Sweep Gen.	00 500 00	NARDA 3090-SERIES Precision High Directivity Couplers	\$225.00
System, 10 MHz-18 GHz, 100 Hz res. HP 8555A/8552B/8445/141 As above,	92,200.00	WILTRON 6647A-40,02 Sweep Gen.,	\$6,500.00	NARDA 369BNF High Power Termination,	\$325.00
HP 8555A/8552B/8445/141 As above,	\$3,000.00	POWER METERS		NARDA 4000-SERIES SMA Miniature Directional Couplers	\$75.00
w/1.8-18 GHz Preselector, opt.003 freq.display HP 8558B/181TR Spectrum Analyzer, 0.1-1500 MHz,	\$2,250.00	BOONTON 4200-01B/-4G Power Meter w/sensor,	\$1,500.00	NARDA 4203-6 Directional Coupler, 6 dB, 2-18 GHz, SMA(f/f/f) NARDA 4246B-10 Directional Coupler, 10 dB, 6-18 GHz, SMA(f)	\$225.00 \$100.00
1 kHz res., w/display HP 8559A/853A-001 Spectrum An., 0.01-21 GHz,	\$6,000.00	1 MHz-26.5 GHz,-60 to +10 dBm,GPIB BOONTON 42B/41-4E Analog Power Meter,	\$650.00	NARDA 5070-SERIES Precision Reflectometer Couplers	\$300.00
1 kHz res., rackmount display		with 1 MHz-18 GHz sensor		NARDA 769-30 30 dB Attenuator, 150 Watts, DC-6 GHz, N(t/m) NARDA 792FF Variable Attenuator, 0-20 dB, 2.0-12.4 GHz	\$375.00
TEK 496P Spectrum Analyzer, 10 kHz-1.8 GHz,		BOONTON 42B/42A-S3 Analog Power Meter,	\$375.00	OMNI-SPECTRA 2082-5810-02 Adj. Phase Trimmer,	\$50.00
TEK 7L12/7613 Spectrum An.,	\$1,875.00	with 1 MHz-8.4 GHz N(f) sensor GENERAL MICROWAVE 476/4240A	\$375.00	8-18 GHz, 10 deg./GHz range,SMA(m/f) PRD N233A/232 Slotted Line, 3-12 GHz,	\$175.00
100 kHz-1.8 GHz, 300 Hz min.res.,w/display TEK 7L18/7603 Spectrum Analyzer,	\$3,400.00	Power Meter & Sensor, 0.01-18 GHz, -35 to +10 dBm HP 11683A Range Calibrator, for HP 435/6/7/8		N(m/f), w/carriage & detector SPACEK LABS DQ-1 WR22 Flat Broadband	
1.5-18.0 GHz, 30 Hz res., w/display		HP 432A/478A Power Meter, 0.01-10 GHz, -20 to +10 dBm f.s	\$375.00	Detector 33-50 GHz	
TEKTR503 Tracking Generator, 0.1-1800 MHz, for 492/4/5/6	\$1,750.00	HP 432A/8478B Power Meter, 0.01-18 GHz, -20 to +10 dBm f.s HP 432C Autoranging Digital Power Meter, 10 uW-10 mW f.s	\$500.00 \$425.00	TRG V510 WR15 Precision Rotary	\$1,000.00
NETWORK ANALYZERS HP 11590A Bias Network, 1.0-12.4 GHz, N(f/f)	\$375.00	HP 435A/8481A Power Meter, 10 MHz-18 GHz, -30 to +20 dBm	\$1,000.00	TRG V551 WR15 Frequency Meter, 50.0-75.0 GHz	\$600.00
HP 11590A-001 Bias Network, 1.0-18.0 GHz, APC7	\$450.00	HP 435A/8482H Power Meter, 0.1-4200 MHz, -15 to +34 dBm HP 435A/8483A Power Meter, 0.1-2000 MHz,	\$1,150.00 \$1,000.00	TRG V559-10 WR15 Directional Coupler, 10 dB, 50-75 GHz	\$400.00
HP 11665B Modulator, 0.15-18.0 GHz, for use with 8755/6/7 HP 8407A/8412A/8601A Network Analyzer,	\$375.00	-30 to +20 dBm, 75 ohms		0-180 deg.,gage read, 18-26.5GHz	
100 kHz-110 MHz, with sweep generator		HP 435A/8484A Power Meter, 10 MHz-18 GHz, -70 to -20 dBm HP 436A Digital Power Meter		WEINSCHEL 1515 Power Divider, DC-18 GHz, SMA(f/f/t)	
HP 85021A Directional Bridge, 0.01-18.0 GHz,	\$1,200.00	HP 436A-022 Digital Power Meter, HPIB option	\$1,400.00	0-127 dB, DC-2 GHz, SMA *NFW*	
HP 85027E Directional Bridge, 10 MHz-26.5 GHz,	\$2,000.00	HP K486A WR42Thermistor Mount, 18.0-26.5 GHz,		WILTRON 60A50-opt.1 SWR Bridge, 5-2000 MHz,	
for 8757 series HP 85050D APC7 Calibration Kit, for 8510 series	\$1,100.00	HP Q8486A Power Sensor, 33.0-50.0 GHz,	\$1,500.00	WILTRON 60N50 SWR Bridge,	\$475.00
HP 8505A-005/8503A Network An.,	\$6,000.00	HP R486A WR28 Thermistor Mount,	\$400.00	5-2000 MHz, N(m) test port, 40 dB dir. WILTRON 60NF50 SWR Bridge,	\$475.00
0.5-1300 MHz, w/S-Parameter & phase lock HP 8755C/(3)11664A/181T Scalar Network An	\$1,750.00	26.5-40.0 GHz, for 432 series		5-2000 MHz, N(f) test port, 40 dB dir. WILTRON 87A50 VSWR Bridge,	¢050.00
w/3 detectors, 10 MHz-18 GHz & frame HP 8756A/(3)11664A Scalar Network		RFMILLIVOLTMETERS	4075.00	2-18 GHz, 35 dB dir., APC7 test port	\$950.00
Analyzer, w/(3) detectors, 0.01-18 GHz		RACAL 9303 TRMS Level Meter,	\$875.00		
NARDA 7000A/7202/7206 Microwave		AMPLIFIERS, MISCELLANEOUS		LOGIC	
WILTRON 560/ 3x-7S50 Scalar Network Analyzer,	\$2,000.00	AILTECH 7616 Noise Source, 1.0-12.4 GHz, N(m), 15 dB ENR		UD FOOF A Cioneture Multimates	\$350.00
w/3 detectors, 0.01-18.5 GHz WILTRON 640/G50/E(2)/7B50(2) Network An.,	\$1,675.00	AILTECH 7618E Noise Source,		HP 5005A Signature Multimeter	\$1,400.00
w/1-1500 MHz source, (2) log amp, (2) det.	THE RESERVE AND ADDRESS OF THE PARTY OF THE	AMPLIFIER RESEARCH 1W1000 Amplifier,	\$650.00	2 MB/s, address driver option TEK 1240 Logic Analyzer, w/(36) 50 MHz channels	
SIGNAL GENERATORS	TOTAL INCOME.	30 dB gain, 1-1000 MHz, 1 Watt output BOONTON 82AD FM/AM Modulation Meter, 10-1300 MHz	\$1,000.00	1 2.17 12-10 Logic Palatyzer, W(30) 30 WITZ Channels	. \$1,500.00
FLUKE 6060A/AN Synthesized Signal Gen.,		ENI 403LA Amplifier, 37 dB gain, 150 kHz-300 MHz, 3 Watts ENI A300 Amplifier, 55 dB, 0.3-35.0 MHz, 300 Watts	\$700.00	COMMUNICATIONS	
FLUKE 6060B-488 Synth. Signal Gen.,	\$3,750.00	HP 11720A Pulse Modulator, 2-18 GHz, >80 dB on/off ratio	\$950.00	AND THE RESIDENCE OF THE PROPERTY OF THE PROPE	
10 kHz-1050 MHz, 10 Hz res., GPIB GIGATRONICS 600/10-18, opt.06 Synthesized Source,	\$3,000.00	HP 8447A-001 Dual Amplifier, 0.1-400 MHz HP 8901B-001,003 Modulation Analyzer, 150 kHz-1300 MHz	\$500.00	HP 3551A Transmission Test Set	\$750.00
10-18 GHz, 1 MHz res., OCXO, GPIB	SALES OF SALES AND ADDRESS OF THE PARTY OF T	HP 8970A Noise Figure Meter, 10-1600 MHz, 0.1 dB accuracy	\$7,000.00	HP 59401A HPIB Bus Analyzer TEK 1410R-opt 04 NTSC Test Signal Gen. w/	\$2,750.00
GIGATRONICS 605/0.01-8.0, opt.3 Synthesized Source,		HUGHES 1177H01F000TWT Amplifier, 30 dB, 2-4 GHz, 10 Watts	\$1,750.00	SPG2,TSG1,TSP1,TSG3,TSG5,TSG6 TEK 1411R-opt.04 PAL Test Gen. w/	\$2 750 00
GIGATRONICS 875/50 Levelled Multiplier,	\$3,500.00	HUGHES 1177H02R000TWT Amplifier, 30 dB,	\$1,750.00	SPG12,TSG11,TSP11,TSG13,TSG15,TSG16 TEK 144 NTSC Test Signal Generator	Ψ2,700.00
x4, 50.0-75.0 GHz output, -3 dBm GIGATRONICS 875/86 Levelled Multiplier,	\$7,000.00	4-8 GHz, 10 Watts M.P.D. LAB2-1020-2A Amplifier, 34 dB, 1.0-2.0 GHz, 2 Watts	\$1,000.00	TEK 144 NTSC Test Signal Generator TEK 147A NTSC Test Signal Generator, with noise test signal	\$675.00 \$950.00
26.5-40.0 & 50.0-75.0 GHz outputs GIGATRONICS 910/12-18,opt6,14,16 Synthesized		M.P.D. LAB2-714-3A Amplifier, 34 dB, 0.7-1.4 GHz, 3 Watts	\$1,000.00	TEK 1485R Dual Standard Waveform Monitor, NTSC & PAL	. \$1,850.00
Source/Sweeper, 12-18 GHz, 1 Hz res., OCXO	90,000.00	MARCONITF2304 AM/FM Modulation Meter,		TEK 520A NTSC Vectorscope	\$1,250.00
Source/Sweeper, 12-18 GHz, 1 Hz res., OCXO HP 85100V Frequency Mult.,	\$4,250.00	MICROWAVE SEMI.CORP. MC5112 Noise Source,	\$325.00	MISCELLANEOUS	
10-15 GHz in / 50-75 GHz out > 0 dBm HP 8640B Signal Generator, 0.5-512 MHz, AM, FM	\$1,500.00	25.5 dB ENR, 1.0-12.4 GHz, N(m), +28 VDC	NAME OF A	WISCELLANEOUS	
HP 8640B-001,002,003 Signal Gen.,	\$2,750.00	COAXIAL & WAVEGUIDE		HP 59307A HPIB VHF Switch P.A. R. 5205-94,95,96,98 Lock-In Amp,	\$200.00
0.5-1024 MHz, AM, FM, var. audio osc.  HP 8654A Signal Generator, 10-520 MHz,	\$625.00	COAXIAL & WAVEGUIDE	THE REAL PROPERTY.	P.A.R. 5205-94,95,96,98 Lock-In Amp,	\$2,750.00
calibrated AM & uncal. FM HP 8660C/86602B/86633B Synthesized Signal		AMERICAN NUCLEONICS AM-432 Cavity Backed	\$95.00	P.A.R. 5206 Two-Phase Lock-In Amplifier, 2 Hz-200 kHz	\$3,000.00
Generator 1-1300 MHz AM FM		Spiral Antenna, LHC, 2-18 GHz, TNC(f) "NEW" AVANTEK 290116P3-5 Amplifier, 35 dB gain,	\$275.00	TEK TM5006 5000-series 6-slot Programmable Power Module TEK TM503 500-series 3-slot Power Module	\$600.00
HP 8660C/86603A/86633B Synth. Sig. Gen.,	\$4,500.00	8-18 GHz +20 dBm Po. 17V 600mA		TEKTM504 500-series 4-slot Power Module	\$175.00
1-2600 MHz, AM, FM, digital sweep HP 8683B Signal Generator, 2.3-6.5 GHz, AM, WBFM, Pulse	\$5,000.00	BIRD 8325-30 30 dB Attenuator, 500 Watts, DC-500 MHz	\$325.00	TEK TM506 500-series 6-slot Power Module TEK TM515 500-series 5-slot Traveller Power Module	\$250.00
HP 8684B Signal Generator, 5.4-12.5 GHz, AM, WBFM, Pulse	\$5,000.00	200-1000 MHz, 100 Watts max., N(m/f)	Andrew Wales	The state of the s	



# MARLIN P. JONES & ASSOC.INC.

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**MONDAY - FRIDAY** 







Circuit designed around a single TDA7052 IC, Idealpartforlarger projects. Drives 8 ohm speaker (not supplied) Ideal for battery powered circuits, Oper-ates on 3-15 VDC solder pads for all connections. Circuit designed around a recently developed IC. Circuit utilizes PIR detector, & a light dependent resistor to provide a optimized circuit that will detect motion in the 3-4 meter range. Operates on 9-12 VDC L: 3" W: 2" H: 1-1/4" WT: .1

1 WATT AMPLIFIER KIT

6027-	KTN	1W Amp Kit	\$7.95
STO	CK#	DESCRIPTION	PRICE
L: 1-1		/: 1-1/8" H: 7/8"	WT: .05



LOW VOLTAGE AMPLIFIER KIT

Circuit designed around the National LM386 IC. The LM386 is a variable gain audio amp. Use this kit as a building block for other projects. Operates on 4-12 VDC. Solder pads for all connections. L:1-1/4" W:1-1/4" H:3/4" WT: .06

STOCK # DESCRIPTION | PRICE

6017-KTN Amplifier Kit \$6.95

#### SUPPLY KIT

POWER



Basic circuit designed around 2 fixed TO-220 regulators. Provides fixed output of +5V & a variable from +5 to 2V under the input voltage. Terminal strip output, solder pads & 3.5mm mini phone jack for input. 7-30V DC or 7-20V AC input.

L: 3-1/8" W	/: 2" H: 1"	WT: .22
STOCK #	DESCRIPTION	PRICE
6004-KTN	Linear P/S Kit	\$18.95



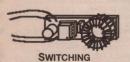
Designed using a single IC that contains Analog & Digital sections to provide a simple yet versatile LCD meter. Other components convert the basic meter to read Temperature (degrees "C"). With power switch. Runs on 9V battery.

+1888

an HOO AL

O. H

L: 3-3/4" V	V: 2-1/4" H: 3/4"	WT: .3
STOCK #	DESCRIPTION	PRICE
6002-KTN	Temp. Meter Kit	\$29.95



**POWER SUPPLY KIT** 

STOCK # DESCRIPTION | PRICE

6030-KTN PIR Motion Kit \$34.95

Basic step-up switching supply circuit designed around single IC. Selectable 1.5 or 3 VDC input. Provides a fixed output of 9V@ 18mA from a 1.5 V "AA" cell. Solder pads for input & output. 1 cell & 2 cell "AA" holders supplied. L: 1.5/8" WT: 08

L. 1-3/0 V	V: 3/4 N: 1/2	AA 1: .00
STOCK #	DESCRIPTION	PRICE
6035-KTN	Switching P/S	\$8.95



Circuit designed around a Quad Op-Amp connected as oscillator & wave shapers.
Oscillator generates a Square Wave over 6Hz to 6KHz, range. The other amps then produce the Triangle & pseudo Sine outputs. Solder pad outputs. Runs on 9V

	<b>V:</b> 1-5/8" <b>H:</b> 7/8"	WT: .07	
STOCK #	DESCRIPTION	PRICE	
6023-KTN	Function Gen.	\$8.95	



#### RELAY BOARD KIT

Allows your P.C to control lights, sole-noids, etc in the real world. Kit supplies the external relay board, eight 12V, SPDT relays with 5A contacts & a Software disc supplied for control under DOS or Win-dows 3.1, 36 Pin Centronics female input port with terminal strips for relay con-tacts. Coaxial connector & terminal strip for external 12V DC relay power (not supplied). Connects to printer port. L:8-1/2" W:2-3/4" H:1" WT:5

	*** *** *** ***	******
STOCK #	DESCRIPTION	PRICE
6074-KTN	P.C. Relay	\$59.95



#### **VOX SWITCH FM TRANSMITTER KIT**

Sound activated circuit with FM Xmitter Sensitive electret mike picks up audio which is amplified & used to modulate FM RF Xmitter. Circuit require the ability to "Tweak" RF circuits by stretching/compressing coils. Operates on 6V DC. 4 cell "84" hattery holder supplied. 4 cell "AA" battery holder supplied.

6028-KTN	FM VOX Xmitter	\$12.95	
STOCK #	DESCRIPTION	PRICE	
		111.00	



#### ULTRASONIC MOTION DETECTOR KIT

boards; one with Matched pair of Ultrasonic transducers to detect motion from 4-7m away. 2nd board contains Xtal controlled osc. & all circuits. Switchable latch, red LED indicator. Solder pad output to drive external relay or circuits. Runs on 9V battery. Main Board: 2-3/4" X 2" X 3/4" Transducer Board: 3-2/4" X 6/8" Y 7/8"

Transducer Board: 2-3/4" X 5/8" X 7/8"

6020-KTN	DESCRIPTION  Motion Detector	\$29.95
STOCK #	DESCRIPTION	PRICE



Kit features a suction cup pick-up coil

The second		TO 4 4 4 4 1
6055-KTN	Phone Pickup	\$15.95
STOCK #	DESCRIPTION	PRICE
	1.2-1/0 1.1-1/4	



Small FM Xmitter teaches basic con-Kit features a suction cup pick-up coil Small FM Xmitter teaches pasic conand sensitive amplifier. Cup attaches to struction & setup of tuned circuits. Transphone handset to pick up your phone mits over 100 Meters in building & over
conversations. Use as speaker phone 500 Moutside. Circuit requires the ability
so all in room can hear. Runs on 4 "AA" to "Tweak" RF circuits by stretching/
cells. Pick-up coil, speaker, & "AA" holder
compressing coils. Operates on 3-9V
supplied.
L:4-1/2" W:2-1/8" T:1-1/4" WT:.26
L:1-3/4" W:3/4" H:1/2" WT:.1

	3V FM Xmitter	\$9.95
STOCK #	DESCRIPTION	PRICE



Runs on 6-12VDC.

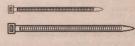
SIREN KIT

6015-KTN	"Screamer"	\$16.95
STOCK #	DESCRIPTION	PRICE
L.4-1/2 V	V. 2-1/0 1: 1-1/4	44120



Kit produces a 108-110dB wail from 2 piezo tranducers. Uses 556 dual timer to generate the tones required. Board fits in the back of the piezo transducer case. "Y" adaptors allow two pieces of phone equipment to share one outlet. One RJ-11 type "Mod" plug to two RJ-11 type "Mod" jacks.

7363-TTN	"Y" Adaptor	\$0.50	\$0.39
STOCK #	DESC.	PRIC 1	E per 50+
		AA	1:.005

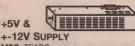


#### TY-RAPS

Natural color Nylon ties sold in packs of 100 & 1000

STOCK #

	0199-TYN	4" Ty-wrap	\$1.10	\$9.00
7	0200-TYN	5.5" Ty-wrap	\$1.70	\$15.00
	4529-TYN	7.5" Ty-wrap	\$2.80	\$20.00
	4530-TYN	11" Ty-wrap	\$5.00	\$39.00
7		Married Labour		



MFG: TEAPO P/N: TP331B-2 Input: 115 VAC

Input: 115 VAG.

Output #1: -5V @ 25A #2: +12V @ 3.5A #3: -12V @ 1A

Specifications/Features:
Enclosed switching supply. 18 Pin (2X9) .187" space output connector, IEC power connector, Power on LED & Switch. UL/ CSA/TUV Listed.

7365-PSN	Teapo Supply	\$6.95
STOCK #	DESCRIPTION	PRICE
L: 16" V	V: 4-3/8" H: 3-1/4"	WT: 5.4



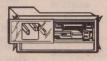
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	<b>V:</b> 5-1/4" <b>H:</b> 3-1/2"	
STOCK #	DESCR'TION	PRICE
5383-PSN	4A Bench P/S	\$19.95



Compact 3-1/2 Digit LCD DPM with black plastic bezel & face plate. 1/2" character height, 200mV DC input, adj. decimal point, auto polarity, >100Mohm input imp. 2 readings/sec., 9 VDC powered, 5% accuracy. Through panel mounting. Holes on board to add scale

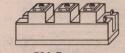
W: 2-5/8" H	l: 1-3/4" <b>D</b> : 3/8"	WT: .1
STOCK #	DESCRIPTION	PRICE
6929-MEN	LCD Meter	\$9.95



#### POWER INPUT MODULE

Potter 7100-0002, snap-in power inlet. Rated: 6A @ 250VAC. Standard male 3 blade IEC cord connector, 6A line filter, fuse holder & input voltage program-ming card (used to select power trans-former taps). UL/CSA listed

W: 2-3/4" I	H: 1-1/8" D: 1-3/	4" WT:.17
STOCK #	DESCRIPTION	PRICE
7313-FHN	IEC Module	\$3.50



#### **50A BIPOLAR** MOTOR DRIVER MODULE

Fuji 2DI-50A-120A Hi-Current NPN 1/2 bridge module. Rated: Ic= 50A, Vc=1200V. Vb= 10. Base Current 3A. 2.5KV Isolation. For motor control, in-

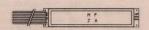
L: 4-1/4" V	V: 1-1/4" H: 1-3/8"	WT: .6
STOCK #	DESCRIPTION	PRICE
7307-QTN	Fuji 50A Driver	\$29.95



#### BAZOOKA SPEAKER

Plastic tube type case enclosing a 3" mini speaker. Speaker has Ferrite magnet, & a paper cone with foam edge. Rated 6 ohm, 20 Watts. Polyester packing inside. Used to provide full range sound in a small form factor. 24in wire

			STATE OF THE OWNER, OR HOLD DESIGNATION OF THE OWNER, OWN
l	7361-SPN	Tube Speaker	\$4.95
	STOCK #	DESCRIPTION	PRICE
ļ	L: 8-1/2" W	<b>V</b> : 3-3/4" <b>T</b> : 3-1/2"	WT: 1.41



#### 40 CHAR. X 2 LINE INTELLIGENT LCD DISPLAY

Optrex DMC40218, 5 X 8 X .21" char. ht. dot matrix display, on-board CPU, RAM & ASCII char. generator IC, C-MOS/TTL signal level, 11 instructions, +5 VDC for logic & -12 (Max) VDC for contrast adj., 14 I/O/power pins. 8" flat cable leads,

		District Control of the last
5120-OPN	2X40 Display	\$9.95
STOCK #	DESCRIPTION	PRICE
L: 7-3/16"V	/: 1-5/16" <b>T</b> : 3/8"	WT: .2



STOCK # DESCRIPTION

\$3.95



#### THERMOELECTRIC MODULE

Pocket" BLACK LIGHT"

Pocket sized "Black Light" used to detect fluorescent inks, paints etc. Unitruns off 2 "AA" cells. With belt clip & Push button switch for convience in use Light" W: .1-3/4" T: 1" W: .1

STOCK # DESCRIPTION | Peltier Effect cooling module with 71 Pairs of couples. When powered hot. With proper heat sink & insulation will cool below 0 C. 3.4 A max, 8.0V max, 59 C. Max temp. Differential, 18W heat pumped (-55 BTU). Similar to Melcor CP-1.4-71-10L.

Dimn:1-3/16"Sq. T-10"

	6"Sq. T: .18"	WT: .03
STOCK #	DESCRIPTION Peltier Module	PRICE
7075-PMN	Peltier Module	\$16.95



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MFG: Teapo for Intel
P/N:TP-425DN
Input: 110/220 VAC 50-60Hz
Output #1: +5V @ 23A #2: +12V @ 8A
#3: -5V @ 5A #4: -12 @ 5A
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systems. Standard IEC input power connector, power switch, Female IEC power
connector for monitor, P-1 & P-2 mother board connectors & 4 molex 4 pin connectors for drives etc. Internal fan. UL/ CSA /VDE LIsted.

STATE OF THE PARTY				
7349-PSN	P.C. Supply	\$29.95		
STOCK #	DESCRIPTION	PRICE		
L: 9-3/8" W	1:6" H:5-7/8"	WT:7.1		

7231-MIN "Black Light"

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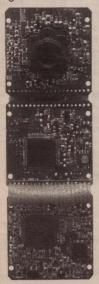
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# THE LASER

Conducted by Anthony Charlton

# EXPERIMENTER

Video Project, designing an optical system for transmission and reception of the laser beam.

# Noise: A Critical Factor in Communications

A noiseless video link is impossible; even if we resorted to the Phase Conjugate techniques discussed back in the March and April issues of this year, it wouldn't remove ALL the noise. However, this highly advanced technique will probably be used on a commercial basis in the near future. So, we seek to eliminate as much noise as easily as possible, because of the simplified equation: Noise = Snow. Snow of course, is the name for bad picture quality.

How do we solve the contributing noise problems? Let's take a look at them one at a time and show how:

A. Power Supply noise at the transmitting or receiving end. We covered the design of two well-bypassed power supplies in our last installment which all but eliminates this problem.

**B.** Receiver noise. This problem is minimized using low-distortion, high-speed amplification ICs; my upcoming design has finally settled on a terrific, inexpensive 500 MHz bandwidth video amp (!) IC manufactured by Maxim which we'll see in our circuit in the next column or two.

C. Beam-path noise. This is any distortion introduced in the laser's point-to-point communication path. Such distortions are as follows:

 Effects of weather. (We can't help this. Except possibly to use an infrared laser which is less distortionaffected by the weather. Or do our communications inside or on a clear day or night.)

Thermal distortion caused by air currents (who change the refractive index of the air randomly). (Like how the image of a distant car is distorted by a hot highway.)

Experimentation with the Optical System's focus can help a great deal here. Chiefly by sending out the most concentrated and intense laser beam at the transmitter, and then adjusting its optical brightness and power density at the receiver. Equivalent to having a strong RF transmitter, and adjusting the gain of the receiver, so as to minimize the distortion of the signal between two points.

Another remedy is to mount both the transmitter and receiver on posts, like you would any antenna. That greatly reduces the refractive distortion caused by installations close to the ground.

3. "Popcorn" noise from the sun. This is readily observed with a fairly simple amplifier such as the optical amp circuit nicknamed "LAD" that appeared in Laser Experimenter Sept. '93; you can hear the popcorn sound in the headphones! A wise installation tip for the transmitter and receiver is: Use a good shield about both, even a simple and cheap PVC pipe setup can work wonders to reduce this problem.

**4.** All wavelengths of light that are not at the laser's color, including those from buildings, cars, and the sun. A narrow-bandpass laser filter solves this problem.

5. Weakening of the beam at

the receiver over distance. A well-designed and properly focused optical system, plus using a higher-power laser is the answer to this distortion effect.

6. Light-attracted insects, at the time of the year they are around. During nighttime use, some insects will be quite attracted to the red color of a He-Ne or diode laser. They can get quite thick, as anyone can attest to who operates a laser during the bug's active months. The solution to this — and unfortunately, it's not a 100% one — is to use a blacklight bug-electrocution trap positioned to draw their attention away from the laser, and then kill them. Plus, mount the laser transmitter as high off the ground as practical, since insects tend to concentrate close to ground-level height.

# Components of the Optical System

Figure 1 and 2 show the components of one configuration of an optical system. Both transmitter (Figure 1) and receiver (Figure 2) are shown in a block-diagram style. We'll describe these in detail in a moment. Although there are several configurations that may be adapted to this use, this figure shows one of the simpler and least expensive forms it can take. Plus, I have designed it so it can be made with off-the-shelf inexpensive optics, available from Edmund Scientific. The one financial exception is the narrow-bandpass filter, which is mandatory for operation in daylight and under strong ambient light conditions. That filter will set you back about \$50.00, and it is the most expensive individual optical component, sans the laser itself.

Low-power (1-5 mW) He-Ne lasers have dropped drastically in price over the years, and you can now get one that is operated by a 12-volt, "epoxy-block" kind of portable power supply. This is by far the easiest to work with. I don't like AC supplies for this type of application, as they are more likely to create excess high-voltage spikes upon ignition of the laser. Plus, they are a greater shock hazard. But regardless of which type is used, a good earth ground connected to the ground of the power supply is mandatory. Expect to pay anywhere from \$30-\$75 for a laser in the 1-5 mW range, the more powerful ones being the more costly of course.

Figure 1, the optical transmitter system, consists of the following individual components:

A) The video-modulated laser. In this case, it's a He-Ne type, but a diode laser is actually more efficient and easier to work with. Semiconductor diode lasers, their advantages and disadvantages, will be discussed in a future column, as we develop that type of laser light transmitter.

B) A double-concave lens that serves to expand the

beam. For good collimation, the beam must first be expanded by this lens, then adjusted to the correct profile for reception using the next optical component.

C) A plano or double-convex lens. This is designed to narrow down the beam from (B) and focus it at a desired intensity at the optical detection system, regardless of range. It is really interesting to watch this happen as you adjust the spacing of the two lenses. The beam can be made anywhere from very wide down to a pinpoint at a distance.

D) A telescoping, close-fitting assembly of two tubes that enables free adjustment of the relative distances of the two transmitting lenses. It must be in axial alignment across its useable traverse so that the beam doesn't get off-axis and distort or fail to collimate properly. If necessary, drill and tap holes for #5-40 or #6-32 screws in three equally spaced places arranged along the diameter of the tube, in one or more locations down the length of the tube. This is a simple step that will save a lot of hassle, especially if you intend to have a long beam path, which mandates the laser and its optical system be in precise alignment.

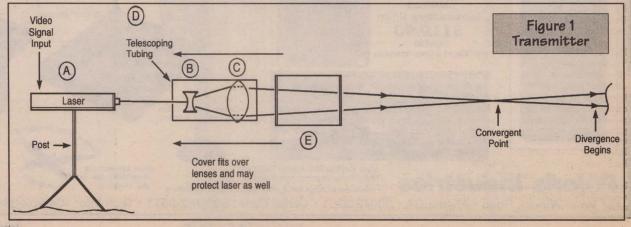
E) Is a suitable enclosure that prevents stray light from being interposed upon the desired He-Ne or diode laser beam. Its length is suggested in the Parts List, but you may have to make it longer if the nature of your installation is subject to extraneous light. Examples of such are: reflections or headlights from passing cars, building lights, and certainly, the sun.

Next, refer to Figure 2 for the receiver.

**F)** Is a similar enclosure at the receiver's end, larger in diameter to accommodate the large receiving lens.

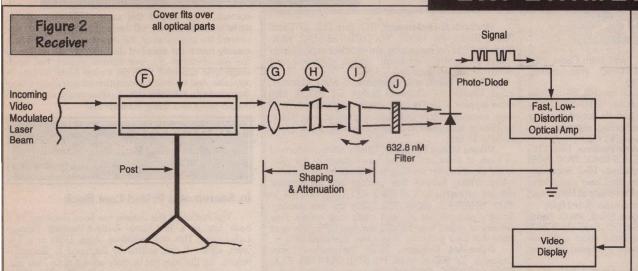
G) Is a large, educational-grade, inexpensive DCX lens. The large diameter is used since we may wish to gather light from a laser beam somewhat off-center at the detector at substantial distance. In addition, the generous input area aids initial alignment. You will see the alignment factor is a critical one to achieve at long distances. This is very similar to a rifle bullet that will not place in the bulls-eye if is has to travel too far. Use a white sheet to detect the beam placement if you have a long traverse. Use of binoculars or a telescope — AT THE TRANSMITTING END ONLY — is helpful to track the beam and where it's going towards the receiver. The experimenter should NEVER look back at the transmitter laser from the receiver using a magnifying optical component!

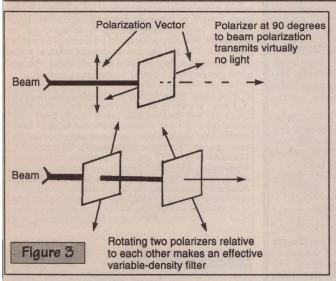
Our optical noise problems mostly originate at the transmitter and across the air-link beam path. So, an expensive lens at the receiver is a waste of money. Edmunds has designed a matrix of inexpensive lenses, which by the way, not only are a super buy, but are very good quality for our experimenter-level projects. What was chosen is a 50 mm diameter (2 inch) DCX lens with



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200 mm (7.9 inch) focal length. This lens must be mounted so that it can be moved back and forth inside its protective cover, in order to adjust the beam intensity upon the photodiode.

This lens must be aligned properly (within our capa-

bilities), and not be askew. Elsewise vibrations at the receiver will be magnified more intensely and serve to distort the beam more greatly. That is because an off-axis simple lens, like this one, distorts an incoming beam because of SPHERI-CAL ABBERATION and CHROMATIC ABBERATION.

Those two effects are the result of the non-linear propagation of light equally through all areas of a len's geometry, and also since light of different colors will always focus to the finest sharp point at slightly different focal lengths, dependent upon the wavelength.

A likely solution to this problem, which I haven't explored as of yet, is to use a COMPOUND lens. That is an array of several lenses, usually cemented together, that corrects each other's optical faults. Compound lenses are among the most expensive lenses around, and for that reason, are likely to put off the laser experimenter from using them, hence the design of this inexpensive optical system

in the first place.

H) & I) Are a pair of polarizers that serve to adjust the intensity of the beam on the photodiode. When crossed to each other or to the beam's angle of polarization at 90 degree right angles, the beam attenuation is

nearly 100% (See Figure 3). When in alignment, the transmission jumps to the 10% - 15% chose Edmunds level #E34,881 Glass Mounted Round Polarizing Filter (package of two) as superior to the kind which is unmounted. Reason being they are sturdier and far more easily incorporated into your optical system, having been already mounted to a 20 mm (0.79") glass disk. The price, at about \$12.00 per pair, isn't bad considering the quality of this optical component.

J) Is a narrow-bandpass laser light filter, the last optical component we'll discuss in this month's column.

K) & L) Are the photodiode sensor and amplifier, respectively, each of which demands a more lengthy explanation. J is

paramount to attaining the best performance of the entire system. There really isn't a way to get around this part if you're going to send video while sunlight or strong ambient light is present. The component chosen for this project is Edmunds #E30,717 He-Ne Laser Bandpass Filter that measures 3/4" x 3/4" which is plenty large for the job. Its center wavelength is 632.8 nM, plus or minus two percent. I wish there was a smaller, cheaper model, but there isn't save the next recommendation. Occasionally I have seen He-Ne filters on the surplus market which are less pricey, but you run the risk of having scratches in them, which will admit extraneous light. If so, the purpose of the filter is negated, of course.

The half-bandwidth of this precision optical device is 11.1 nM, a mere fraction of the total spectral range of interfering light sources. A half-bandwidth can be simply described as the optical area where 50% of the selected wavelength is transmitted. In other words, 5.5 nM to either side of the center wavelength, and other wavelengths rapidly fall off from this value. The blocking value for other wavelengths (green, blue, yellow, infrared, and so on, across the visible spectrum) is less than 0.01% transmission, so almost nothing gets through other than the 632.8 nM wavelength. Just a little bit of light adjacent to each side of this selected He-Ne wavelength gets

There is another filter that would certainly be adequate which is \$9.00 cheaper, and that is Edmunds #E43,081 Optical, Multi-Layer Dielectric Interference Filter. It is 11.8 mm in diameter (about 1/2") with a clear

#### **1995 INDEX**

January - Detecting flaws in materials using lasers - Detecting wobble in shafts and wheels aids balancing them -Measuring the diameter of a fine wire or hair - Discussion of how a fiber optic gyroscope works — 1994 Laser Experimenter Index — Laser News and Developments: Diagnosing cancer optically - slowing down light waves.

February - Debut of the Laser Helpline feature, a free reader service -Visible demonstration of refractive index of substances vs. light using a fishtank and dyed sugar solution — Determining a len's focal length - Laser plus weather creates a natural art display — Homebuilt pulse-width modulated helium-neon power supply basics — Remotely measuring the height of a pole or tower — Laser News and Developments: Solid plastic laser rods may replace lasing liquids.

March - How laser light can "travel back in time" using phase conjugate techniques — Fixing distortion in a data signal using phase conjugation - A deadly

hypothetical satellite destroyer Introduction to organizing one's personal laboratory or workplace.

April - Laser brightness explained More on phase conjugate techniques including a homebrew distortion removing experiment - Introduction to The Society for Amateur Scientists. Step-bystep method to achieve total organization of one's lab or workplace - Laser News and Developments: Viewfinder prevents deliberate laser-induced blindness of soldiers by the enemy.

May - Explanation of a hi-tech eavesdropping surveillence method using a laser to hear what's going on inside a building, by bouncing the beam off a windowpane - Laser News and Developments: Experiments on extracted teeth reveal a laser may someday be used to harden teeth in the dentist's office against cavities.

June - Tutorial on how the very first semiconductor lasers, called infrared single heterostructure pulsed laser diodes work. Table of some single heterostruc-ture lasers and their working characteristics - Operating a transistor in an avalanche mode for fast risetime, short duration, high-current pulses - A 120 VAC power supply with PCB pattern for lasers -Laser News and Developments: Miniscule superconducting magnetic charge observed using laser techniques.

July - Single heterostructure semiconductor lasers, continued - A pulse width modulated, portable nine-volt power supply for S.H. lasers. Chart showing various S.H. laser diodes vs. the value of the components used to drive them. Slit diffraction experiment — Beam collimation experiment - Remotely firing a Xenon strobe using a S.H. laser (with

August - Measuring the speed of light - Schematic and source for the speed of light apparatus - Update on the availability and properties of silicon carbide blue LEDs.

September - Discussion of gravitation and gravity waves - Amazing celestial gravity effects - Laser gravity (mass) detector proposal.

October - Gravitation and gravity waves continued - Cosmological and relic gravitational waves - Further discussion of LIGO, the Laser Interferometric Gravity Wave Observatory - Lasers are everywhere: in hardware stores, to die-cut model airplane parts and more! — Laser Experimenter P.O. Box Refresher: What small parts the author can provide FREE

to build laser projects.

November — "On-Paper" sensor improvement for the laser gravity detector Beginning of a project for transmitting video over a laser beam - Discussion of the properties and performance of a readily available and inexpensive blackand-white CCD camera - Schematic of a basic circuit to modulate a helium-neon laser with a video signal.

**December** — Two power supplies presented for the Laser Video project; one operating off the AC line and the other using a rechargeable battery -Locating a video signal on a CCD carnera High powered laser safety caution Reader questions answered.

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#### SOURCES

Small Parts, Inc., 13980 N.W. 58th Court, P.O. Box 4650, Miami, FL 33014-0650. Free catalog. Catalog requests: (305) 558-1255

LNS Technologies, 20993 Foothill Blvd, Suite 307, Hayward, CA 94541. Inquiries: (510) 886-9296, orders: (800) 886-7150. Visible laser diodes and a driver kit, also carries a line of high-technology electronic kits.

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Geo-Monitor, 65 Washington Street, #400, Santa Clara, CA 95050. Ph: (408) 749-6770, FAX: (408) 249-3780. Publishes a technical newsletter about earth science, and may be useful to those interested in using

lasers to record seismic activity.

Edmund Scientific Company, 101 East
Gloucester Pike, Barrington, NJ 00807-1380. Ph. (609) 573-6250, FAX: (609) 573-6295. Free catalog. Supplier of a wide variety of educational and scientific equipment including lasers and an extremely comprehensive line of

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Amateur TV Quarterly, 1545 Lee Street, Des Plaines, IL 60018. Voice: (708) 298-2269, FAX: (708) 803-8994. Publisher of a magazine and several books geared to amateur TV. Mentioned here because of the general interest to experimenters and the parallel to our laser video endeavor. Contact them for the current pricing of a sample issue and brochure.

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tact the above suppliers so your request goes to the

right department.

aperture (the area in which the specifications of the filter are guaranteed effective) of 9.45 mm. This filter has a half-bandwidth of 10 nM. At \$40.95, the pricing is better, although the percent of transmittance at the He-Ne wavelength appears to be less than the specially designed He-Ne Laser Filter. However, this shortcoming could easily be compensated for by hiking the transmitting laser's

power up a milliwatt or so, which considering all factors,

might be the wiser choice.

Again, the "Sources" list is a great shop-at-home supermarket for your experimental, hobbyist, or professional supermarket for your experimental supermarket for your experiment sional needs. Let's mention again Small Parts, Inc., as a source for telescoping tubing of various metals, as well as taps and screws and many, many other neat precision items which should prove useful for this and other pro-

#### Conclusion

Next month, we hope to be able to present an integrated schematic of the completed video project. By "hope" we mean this is contingent upon obtaining some more electronic part samples. I have found with the devel-

opment of this project that some of the components, while available, are not "off the shelf." This is where I discovered the eagerness of the experimenter doesn't necessarily match the speed of dispensation of samples by the manufacturer! So, our current project has taken longer than expected. We'll get it done ASAP for you, in any case. And we'll do a description for you about a laser that produces powerful output pulses using superheated copper vapor as a lasing medium! NV

#### CLOSING QUOTE:

"Science and Art belong to the whole world, and the barriers of nationality vanish before them. - Goethe

#### In Search of a Prized Lost Book

The Author of this column has been searching for a book lost in a fire titled: Build-It-Yourself Science Laboratory. This was published about 1970 or a few years earlier. It was written by Raymond L. Barrett, believe, but this may not be quite correct since I am relying on a boyhood memory distanced by 25 years. Also, I believe it was published by Prentice-Hall; again this is a bit foggy. I would be extremely grateful if some reader has a copy they might consider loaning or selling to me, or information that may prove useful for locating this out-ofprint book. This title also has sentimental value, as it was given to me by a very kind and wise old friend who was a first-rate Amateur Scientist. — Anthony Charlton

he Laser Experimenter is a reader-interactive column. We like to hear from the reader, and in many cases the best projects have come directly from your suggestions. If there is some particular facet of laser science that interests you, we would welcome hearing from you at: The Laser Experimenter, P.O. Box 74, Cornwall Bridge, CT 06754. Questions, comments, suggestions, and material relating to lasers are all welcome. We would like to publish letters in Reader Feedback occasionally. Indicate whether using your name and address is okay. We can now respond to your letters personally on an "as time permits" basis. Your FAX number, which will be kept confidential, will

#### PARTS LIST

#### **Transmitter**

- 1 He-Ne Laser with a DC power supply and video modulation capability.
- Double-concave lens, approximately 1" diameter, 100 mm focal length.
- Double-convex lens, approx. 1" diameter, 100 mm focal length.
- 1-1.25" ID (or diameter to suit) telescoping aluminum, plastic, or brass tubing, 12" long, chosen
- for a close fit and your choice of available lenses. Homemade PVC plastic pipe enclosure, 12"-18" long, diameter and length to suit.
- 1 Post or mount as discussed in the text.

#### Receiver

- 1 Double-convex lens, 50 mm diameter x 200 mm FL, #E37,785.
- Narrow bandpass filter, #E30,717 or #E43,081. pair — Polarizing filters, #E34,881.
  — 3" (nominal) ID PVC plastic pipe, black, 18"
- long, diameter and length to suit.
- PVC or other type of pipe, of suitable length, to adjust the focus of the receiving lens upon the photodiode (see text).
- Post or mount as discussed in the text.

Numbers prefixed with a pound (#) sign are Edmund Scientific stock numbers. Exact specifications for the lenses are not possible, since the optical system is built around experimental and educational grade lenses that may not always be in stock. Adjust your system to lens 'specs close to that called for, using your ingenuity.

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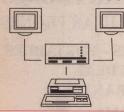
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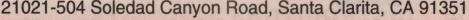


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### **Old Business First**

I have received many responses requesting a second article on using and interfacing multiple stepper motors to the IBM PC. I am planning to write a second article that will make a standard X-Y table in the next few months.

The response from the article I wrote on recombinant DNA has not yielded much positive attention. Some readers question having a biology-chemistry experiment in this magazine without an obvious electronic hook. The few biological articles I had planned to write on are permanently shelved. My apologies to all offended. Now onto new business . . .

t's not often I have the opportunity to write on a new product. Especially one as interesting as the air muscle. The air muscle is a new type of device that achieves linear motion with the application of pressurized air. Like a human muscle it contracts when activated. You may think, well, this is nothing new,

fast. Strength and overall power comparison are difficult. The small air muscle can lift 6.5 pounds, much more than standard Nitinol wire. Nitinol wire is weaker, but only because the wire diameter (.006) is so small. Thick gauge Nitinol wire (not made and would be very expensive) would have hundreds of pounds (if not thousands of pounds) Powerful — Has lift approximately 6.5 lbs. @ 42 psi.

Pliable - Soft pliable construction, able to be bent around curves and still function properly.

#### Uses

The air muscle lends itself to robotics and automation. In some cases, it can replace servos and DC motors. Its unique properties, lightweight, strong, and pliable can be capitalized in many applications and used to improve existing pneumatic designs.

In a nutshell, the air muscle may be used in many applications that require linear or contractive motion. In many cases, pneumatic cylinders can be replaced.

#### **How the Air Muscle Works**

The air muscle looks like a

the metal clips. The loops are used for fastening the air muscle to devices. When the air muscle is pressurized, the soft inner tube expands. The inner tube pushes against the black plastic mesh which also expands. As the plastic mesh expands, it shortens in response to the expansion. This causes the overall length of the air muscle to contract.

To operate properly, it is important that the air muscle be in a stretched or pulled out position when it's deactivated or in a resting state. If not, there will not be any movement or contraction when it is activated (see Figure 1). When air pressure is applied, the muscle contracts.

#### Components of the Air **Muscle System**

Figure 2 illustrates the compo-

# uscle

by John lovine

pneumatic cylinders have been around for decades and can do the same thing. But the low cost, ease of use, and effectiveness of the air muscle far exceeds standard pneumatic cylinders. Its ease of use allows it to be quickly adapted by robotists and hobbyists for immedi-

In some ways, the air muscle is similar to Nitinol wire. Mainly in its ability to contract when activated. A quick comparison yields these results: Nitinol wire only contracts 5-7% of its length. The air muscle contracts 25% of its length. Nitinol wire is a power hog. It consumes large amounts of electric current to function. While its response time may be quick, its cycle (heatingcooling-heating) time is quite slow. The air muscle operates off of air pressure.

While efficiency is lost using

of contractive force.

This month, we will build two manually operated air muscle demo devices. We will then interface the devices to the computer. If you are like me when I first encountered the air muscle, I thought a pneumatic system would be too much of a hassle to build, regardless of how innovative the product is. I was wrong - the pneumatic system can be put together for about \$20.00.

To control the air muscle via the IBM parallel port adds another \$25.00 to the cost.

#### **Advantages of the Air Muscle**

Lightweight — Six-inch air muscle with 18" of 5/32 diameter air tubing, weighs approximately 10 grams. Contraction — Six-inch air muscle contracts approximately 1" (about 25% of its length, ends not inclusive)

long tube constructed out of black plastic mesh. Inside of it is a soft rubber tube. Metal clips are fastened on each end. The plastic mesh is formed into loops on each end, tucked into and secured by

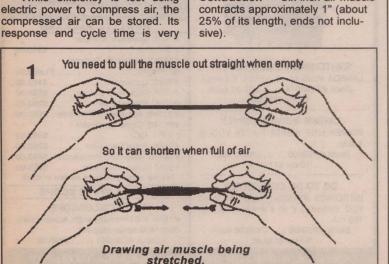
nents needed to use the air muscle

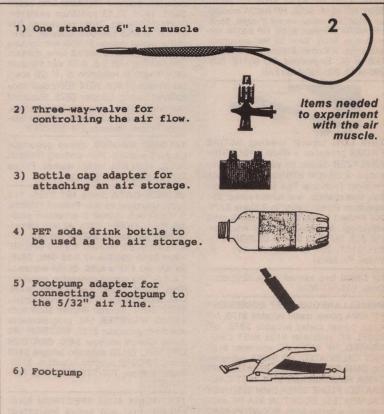
Item 1 — The air muscle itself (of course).

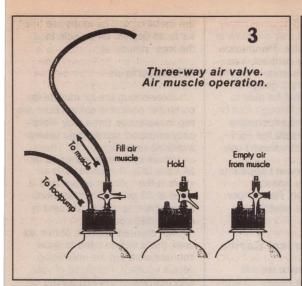
Item 2 — Three-way air valve. The

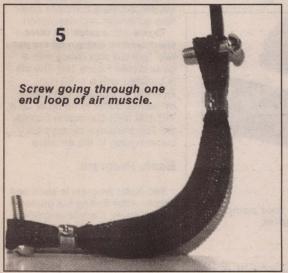
7) Nylon cable ties, to attach the air muscle

to your device.









three-way air valve allows one to manually operate the air muscle (see Figure 3).

Item 3 — A bottle top adapter, with a pressure release valve (set around 60 psi). The bottle top adapter allows one to use a standard plastic PET soda bottle for air storage.

Item 4 — PET soda bottle (used for air storage). A plastic soda bottle can hold 50 psi easily. I have static tested plastic PET bottles to 100 psi. NEVER USE ANY TYPE OF GLASS BOTTLE FOR AIR STORAGE! A slight fracture in a glass bottle, or dropping it accidentally, may cause the bottle to suddenly explode sending tiny glass fragments all over. Plastic PET bottles elongate when over-pressurized.

Item 5 - Foot pump adapter.

Item 6 — Foot Pump. Simple foot pump with air pressure gauge can charge air storage up to 100 psi. Because of the low volume of the PET bottles, air storage is brought to 50

psi with three or four strokes of the air pump. The air muscle uses so little air, that a small PET bottle holds enough air for four to five complete cycles of the air muscle.

> Item 7 - Nylon cable ties. These are used to quickly connect the air muscle to a mechanical device.

Figure 4 illustrates a general overview of how the parts are put together. In some cases, you may want to

epoxy glue some components together to prevent them from popping off. For instance, if you will just be using the three-way air valve on one bottle adapter for air muscle experiments, you may want to glue the three-way valve to the adapter permanently.

#### Attaching the Air Muscle to Mechanical Devices

As stated, the air muscle is made of a soft inner tube surrounded by a strong plastic mesh. The assembly is held together by metal

clips on each end. The plastic mesh is looped at each end, making a hole. This plastic mesh hole is very strong mechanically, and can be used to attach the air muscle to any device. Figure 5 shows a machine screw inserted through the mesh hole.

#### Using the Air **Pump Adapter**

When you receive your foot pump, the nozzle will appear as in Figure 6. Lift the locking lever as shown in Figure 7. Remove the standard nozzle (Figure 8), and insert the air pump adapter (Figure 9). Close the locking lever by pressing it back down.

#### Have a Coke or Pepsi

You need to acquire a plastic PET bottle. The easiest way to do so is to buy a soda. Make sure the soda bottle is plastic. Don't purchase a soda larger than a one liter bottle. A half liter bottle is ideal. I've tried the adapter bottle cap on all sizes of soda bottles up to two liters, and it fit all of them.

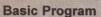


This is how they all fit together..

General overview -

how parts fit together.

Air Muscle



5 REM Solenoid Air Valve Controller

10 REM John lovine

15 REM Find Printer Port Address

20 DEF SEG = 0

25 a = (PEEK(1032) + 256 \* PEEK(1033)) 30 REM Next line activates the air muscle

35 OUT a,1

40 REM Next line deactivates the air muscle 45 OUT a.0

Empty the PET bottle of soda and clean it out with tap water. The bottle should be completely dry before using. It's interesting to note, that if a full bottle of soda is dropped, the resulting pressure caused by the release of the car-

Lift locking

lever (foot pump nozzle).



stretches the air muscle when it is in its relaxed state.

Connect the balance of components as shown in Figure 4. At times, I've had difficulty connecting the 5/32" diameter tubing to some of the components. Here are a few tips.

First, if the tube refuses to go onto an adapter, place the tubing under running hot water from the faucet. This softens the plastic, making it easier to fit onto the components. Another trick is to use some clear plastic tubing. The plastic tubing is snug enough to fit onto the adapter nozzles properly

using

Open the three-way air valve to charge the air muscle. The muscle should immediately contract. You can measure the distance it moves in proportion to the psi gauge on the pump. You should be able to operate the muscle through four or five contractions and expansions before you need to refill the PET bottle. The air muscle doesn't use much air.

If the muscle doesn't appear to contract, it probably wasn't stretched far enough. Remember, the muscle must be stretched to operate.

#### Second Mechanical Device

The second device we will build is a lever (see Figure 13 and

device using the three-way air valve as before. When activated, the lever moves up.

#### **IBM** Interface

Connecting the air muscle for computer control is easy. There are two inexpensive three-way electrically operated solenoid air valves available (see Figure 15). These air valves operate at either 12 or 24 volts DC. The 12-volt DC air valve is the cylinder shape and is rated at 50 psi. The rectangle air valve operates at 24 VDC and is rated at 100 psi.

For frequent readers of this column, that's all you need to know. You can work out the interfacing details yourself. For those of you who are new or are just joining us,

we will provide a complete interface schematic and description.

To operate a single air valve, we only need one pin off the parallel (printer) port, along with a ground (see Figure 16). The pin is buffered with a 4050 noninverting hex buffer. The output of the hex buffer turns on or off a TIP 120 NPN Darlington transistor. The transistor controls the current going to the air valve.

#### **Basic Program**

The basic program is short and simple. After finding the printer port address, the following lines control the valve of pin 2.

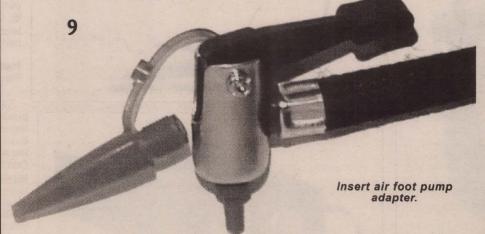
By bringing the DB25 pin 2 high, the air valve is opened, allowing air pressure to the air

muscle. Bringing pin 2 low closes the air valve to the muscle, and vents the air from the air muscle.

#### More Air

The air muscle, as outlined, uses compressed air from a PET plastic air storage bottle

and foot pump. One can use compressed air from just about any source that's available. For instance, you can purchase small





bonate greatly

exceeds the 50

Remember, no glass bottles should be used in the air muscle pneumatic system.

# Building the First Demo Device

The first mechanical device we will build is a simple instrument that can be used to measure the contraction of the air muscle (see Figure 10). The base is 1" x 2" lumber, 11" long. I used this material simply because I had it lying around. You can just as easily use metal or plastic. At each end, I drilled a hole to accept an 8-32 machine screw 1-3/4" long. The machine screws are inserted and held in place using two 8-32 nuts, one nut on each side of the wood. The head of the screw and shaft protrude about 3/4" above the wood.

The top screw is threaded through the top opening of the air muscle, before inserting the screw into the wood. A rubber band is looped through the bottom opening of the air muscle looped around the bottom screw. The rubber band

(see Figure 11). In addition, it is pliable enough to fit the 5/32" tubing inside the tubing itself (see Figure 12). The soft tubing acts like an adapter and quick release for changing air muscle devices.

First mechanical device.

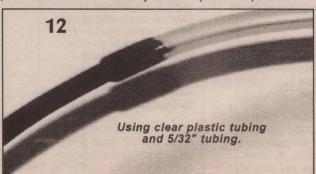
10

To operate the device, first pressurize the system using the foot pump. This only takes about four strokes to reach 50 psi. Your mileage may vary depending upon the size of the PET bottle you are

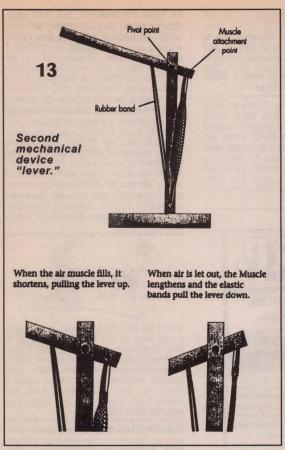
Figure 14). The lever I made is constructed out of wood and plastic. Machine screws secure the air muscle and rubber bands to the

lever arm. A wood screw through the plastic arm is the pivot.

A second wood screw holds both the air muscle and rubber band. Operate this









compressed air canisters used for

list of suitable tubing and fittings to

pressors available on the market.

The more expensive ones, made

for air brush painting, have metal

sure regulators. At the other end of

the market, are the inexpensive 12

used for tire inflation. These compressors typically do not have an

air pressure regulator or air stor-

age. However, these items may be

storage containers and air pres-

VDC portable air compressors

There are a few small air com-

air brushing. In fact, air brushing

supplies may provide you with a

experiment with.

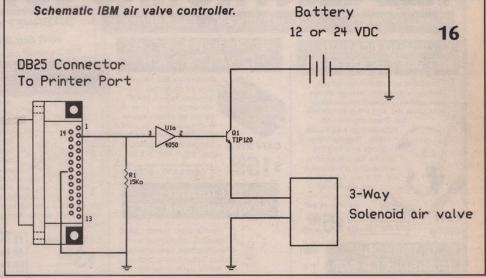
purchased to make an inexpensive pneumatic system. Do not use plastic PET bottles for air storage with any kind of automatic air compressor. The plastic PET bottles are only suitable for air storage with hand (or foot) operated air pumps.

#### Safety First

Since this is a new product, not too many people may be familiar with working with pneumatic systems. Therefore, a few safety guidelines should be followed:

- 1. Always wear goggles when prototyping a new design.
- 2. Never connect a plastic PET soda bottle to an air compressor.
- 3. Never use a glass bottle for air storage.
- 4. Limit PET bottle size to one liter (or quart) or less.
- 5. Do not unscrew the bottle top, pull off an air fitting or valve when the system is still pressur-





ized. Bleed the system of air first.

#### **Going Further**

The air muscle is imported from England, where it has been under development for a number of

Some of the applications found for the air muscle are interesting.

Here are a few:

- · Six legged robotic walker.
- Easy-open jar clamp for people with arthritis.
- · Robotic hands.
- · Robotic arms.

In the future, we will return with more projects for the air muscle.

**Parts List** 

Air muscle 6" length with 5/32 tubing — \$15.95 PET bottle top adapter with pressure release valve — \$4.00 Three-way air valve — \$4.00 Air pump adapter — \$2.00 Foot air pump with 100 psi air pressure gauge — \$12.95 5/32" diameter air tubing — 25¢ ft. 7/32" diameter clear air tubing 25¢ an inch (for making quick releases) **IBM** Interface

12VDC Three-way Solenoid air valve 50 psi maximum — \$20.00 24VDC Three-way Solenoid air valve 100 psi maximum — \$20.00 DB25 pin connector — \$3.50 4050 Non-inverting Hex Buffer — \$1.00 TIP 120 NPN Darlington Transistor — \$1.25

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LOGIC ANALYZERS: HP 1630D logic analyzer (100MHz timing, 25MHz state) \$900. Pods for HP 1600A, 1607A \$20 each. Tek 7D01/DF1 logic analyzer plug-in (to 100MHz) \$225. Tek DAS 9129 color systems up to 660MHz, call. Analyzers sold with pods, warranty. Pepper Systems, 214-353-0257

TEKTRONIX INSTRUMENTS: 454 464.466. 475. 545B. 575.577 1480C 5A48. 5B42. 7603. R7603. 7613 R7633. 7704A \$199. 7904. 7A11. 7A13 LED \$195. 7A15AN11 \$59. 7A24. 7B53A \$99. 7B92A. 7D01/DL2. 7D20. 7L14 1.8GHz SPECTRUM ANALYZER \$2,575. 7S11/7T11/S6. 7S12/S4. 90-day warranty.

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HP 5004A signature analyzer \$150. HP 180A oscilloscope w/1801A, 1820A, plugins \$200. Tek DC 503, w/manual \$100. Tek DM 501, w/manual \$100, Tek RG 501 \$200. Fluke 8000A multimeter w/manuel \$150, Tek 7603 mainframe \$300, Tek 7623A mainframe \$300, WALL SUR-PLUS, 908-681-2032, PH/FAX.

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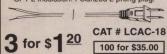
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Detector III \$27.50

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Nuts & Volts Magazine/January 1996



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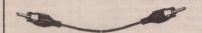
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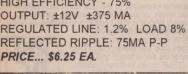
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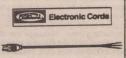


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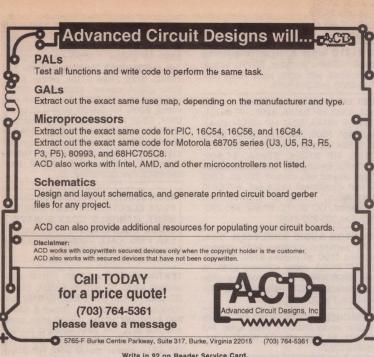
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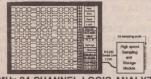


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The model 4842 is an IEEE-488.2 compatible device and uses SCPI commands to control the relays. The relays may be controlled individually, grouped together as multi-pole scanner, or grouped randomly for sequential control applications. GPIB triggers are used to step the scanner relays to their next position.

For more information, contact:

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3 dBi or a 6 dBi model. These antennas are white fiberglass, 200 watts dissipation, all stainless steel hardware and mounting hardware included.

The antennas come factory tuned, so you don't have to adjust the SWR. The SWR is adjustable for out-of-band use. Just add coax cable and you're on the air!

The cost: \$54.60 for any 3 dBi, and \$85.00 for any 6 dBi. Plus \$5.00 for S & H.

For more information, contact:

BOZAK ANTENNA 100 CHURCH HILL, DEPT. NV WATERFORD, NY 12188 518-373-8069 FAX: 518-373-0701

#### **NEW GPS FIRMWARE**



Advanced Electronic Application's PK-232MBX and PK-900 multimode data controllers are now shipping with Global Positioning System (GPS) firmware.

The new GPS firmware incorporated in both the PK-232MBX and PK-900, automatically detects if there is a GPS receiver connected upon power-up. If a GPS receiver is detected, an initialization string will be sent and the TNC will be ready for GPS work; if no GPS receiver is detected, the TNC will be ready for traditional packet data work.

The biggest new feature of AEA's PK-232MBX and PK-900 is that GPS commands can be remotely programmed, so in standalone tracking applications where a TNC, GPS receiver, and radio (no computer) are installed in a vehicle—the unit does not need to be removed and connected to a computer to change GPS parameters—it is all done remotely.

The data controllers automatically transmit their position information at user-defined intervals and can also be remotely polled for GPS location information at any time. This remote polling is great for those who use the TNCs in a Pete Bros. ULTIMETER-II™ weather set-up. Each member of an amateur radio group in a region can set-up a weather station in the backyard, then other members can poll (at any

time) the various weather stations for information. Doing this forms a picture of the region's weather on the Automatic Packet Reporting System map (APRS TM).

News

In addition, certain GPS receivers can be remotely programmed via the PK-232MBX or PK-900. You can even configure the system to transmit location information when a button on the radio control head is pushed.

Other new GPS firmware features include time and date setting from the GPS receiver, remote programming of the GPS receiver itself, and the ability to operate as a WIDE and RELAY digipeater. Exact time and date information can be extracted from the GPS receivers to set the PK-232MBX's and PK-900's internal clocks.

The ability to operate as a WIDE and RELAY digipeater means that mobile packet users can be transmitting their position information in a stand-alone tracking configuration and still act as a message forwarding mailbox — all while mobile.

For more information, contact:

ADVANCED ELECTRONIC APPLICATIONS, INC. P.O. BOX C2160, DEPT. NV LYNNWOOD, WA 98036 206-774-5554 EXT. 306 FAX: 206-775-2340

#### **ENVIROLINK-50**



SensorMetrics, Inc., introduces a new line of environmental instrumentation modules for sensing and logging meteorological conditions.

The EnviroLink-50 series modules are powerful, stand-alone instrumentation modules that are designed for remote site sensing and control applications. They are ideally suited for commercial, industrial, municipal, military, and academic applications where cost-effective remote measurement of temperature, humidity, barometric pressure, solar radiation, rainfall, wind speed, and direction are required.

Additional modules are offered with (0-1, 0-2.5, 0-5, 0-10 volts, and 4-20 mA) input ranges for remote sensing using other input sensor or signals.

Applications for the EnviroLink modules include: weather forecasting, environmental data logging, energy management, agricultural automation, remote environmental sensing, factory automation, environmental data monitoring, and academic research.

The EnviroLink-50 series of modules provide real-time monitor, logging, and control of a multitude of various conditions remotely and independently from a personal computer. Each module is powered by a single 7-24 VDC power supply. An optional interface kit is available that allows modules to be connected serially. Up to 32 modules can be linked to one serial port of any PC. Full RS-232/485 multi-drop capability is incorporated in each module.

Each module offers 32K of non-volatile memory while the ENV-50-VOL has 64K. The module's memory allows for collecting data and provides security should power failure occur. Collected data can be uploaded to any PC either directly or via a modem for viewing and chart-

Each module can accommodate up to four specific sensors. All EnviroLink-50 modules come equipped with digital I/O and programmable set point capability allowing user control of a wide range of machinery at user predetermined values. All functions are performed using simple ASCII command sets.

The SYS50 graphical software package is available for DOS or Windows applications. This package allows users of EnviroLink modules to interface directly with a PC for real-time display or data retrieval. The package comes with programming examples for users that wish to write their own code in either Basic or C language.

The EnviroLink-50 module systems are priced at \$379.00.

For additional information, con-

SENSORMETRICS, INC. P.O. BOX 1049, DEPT. NV LAKEVILLE, MA 02347 508-946-4904 FAX: 508-947-1373 WEB PAGE:

http://www.spinners.com/sensormetrics/

### PC-BASED TOTAL INTERNET TURNKEY SYSTEM™

ogicom, Inc. announces that they will begin selling the Logicom Total Internet Turnkey System. Organizations wanting to set up their own independent online service on the Internet, now have a plug-and-play solution. The Total Internet Turnkey System is one of the industry's first turnkey systems to combine a web server, independent online service, internet server, and fax broadcast server all in one

## New Product News

package.

The Logicom Total Internet Turnkey System comes preloaded with all the necessary hardware, software, and services needed to establish a company's presence on the Internet. The plug-and-play system consists of a Pentium-based AST Bravo Tower computer, enhanced with the following features

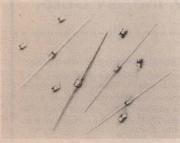
Galacticomm's worldgroup for 20 users; Vircom's major TCP/IP; add on software: Menu Magician by High Velocity Software, Bulletins Pro by the Labyrinth, Galacticomm's Ad Ticker, DataSafe Publication's VisaMan, Fax/Online by Galacticomm, EZ Fax by ProDesign, Fax Blaster by ProDesign, Quick Credit 900 by Logicom; an AST P-100 tower computer with 16 megs of RAM, 1.2 gig hard drive, enhanced IDE, video card w/1M VRAM, two internal/three external bays, two 16550 UART serial ports, five ISA, two ISA/PCI bus, three-year warran-ty on PC, NE2000 network interface card, and CTX SVGA 14" monitor; 16 line Stallion Intelligent serial kit; eight modems (six USR Sportster 28.8K modems, two Supra 28.8 fax/modems); preconfigured FastComm Frame Relay Adapter (FRAD), 50-ohm terminator, basic installation and customization; and 30 days free support.

Not only does the system come bundled with all the needed products, but Logicom has also bundled all of the necessary services involved as well. In a relationship with DataXchange, a national Internet Service Provider who sells mostly to BBS, independent online services, and web servers, Logicom is able to provide customers with anywhere from a direct 56K connection up to full T1 access, if necessary. The basic package comes with the necessary hardware for the 56K connection. If more bandwidth is needed, Logicom will provide the needed hardware as well.

For more information, contact:

LOGICOM, INC. 1-800-764-4266 305-726-3868 telnet: logicom.com www.logicom.com hmf@logicom.com

#### **MILITARY SCHOTTKY DIODES**



DI Schottky diodes are available in both surface mount and lead-

ed packages featuring hermetically sealed, metallurgically bonded, glass-to-metal seal construction. A glass-to-metal seal construction. A full range of leaded parts can be supplied as JAN, JANTX, AND JANTXV, 1N5711-1, 1N5712-1, 1N5819-1, 1N5822, and 1N6877-1.

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JANTXV, 1N5711UR-1, 1N5712UR-1, 1N5819UR-1, 1N5819-1 and 1N6677UR-1. The 1N5819-1 and 1N5819UR-1 devices are also offered in the JANS reliability level.

CDI Schottky diodes are priced according to part number, screening level, quantity, and packaging requirements.

For more information, contact:

COMPENSATED DEVICES INC. 166 TREMONT ST., DEPT. NV MELROSE, MA 02176 617-665-1071 617-665-7379

#### SUPER PORTABLE ANALYZER



VCOM introduces a super Aportable spectrum analyzer, model SPA-20A. The new SPA-20A turns any TV into a powerful 950-2050 MHz spectrum analyzer. The SPA-20A allows the satellite system owner to find and identify satellite downlink signals, maximize antenna performance, and troubleshoot system failures. The SPA-20A is as easy to install to an existing TVRO system as a VCR.

For more information, contact:

AVCOM OF VIRGINIA, INC. 500 SOUTHLAKE BLVD. DEPT. NV RICHMOND, VA 23236 804-794-2500 FAX: 804-794-8284

#### TICKIT MICROCONTROLLER

'he TICkit microcontroller uses a PIC16C57 programmed with an efficient FBASIC language interpreter and an 12C EEPROM to implement a two IC microcontroller. The TICkit system is designed to make microcontroller development fast and painless. The TICkit is a perfect solution for data logging, prototyping, robotics, and slower real-time control.

A suite of library functions implemented in the interpreter provides a wide variety of I/O options. LCD module interface, 32-bit, 16-bit, 8-bit mathematics, 8-bit RTCC, pulse measurement and generation, PWM squarewave generation, RC time measurement, 4 and 8 bit buss emulations, RS232 serial up to 19.2K baud, two-wire and three-wire

serial interfaces, etc., are examples of the functions built into the interpreter.

The FBASIC language is a pow-erful upper level language. Familiar BASIC keywords are combined with block oriented grammar to yield an easy to use, but comprehensive control language. A standard tool for the TICkit development kit is a runtime source level debugger com-plete with break-points, watchpoints, single-step, and pass-over abilities

Cost for the TICkits range from \$49.00 for 2K EEPROM and 4 MHz interpreter to \$65.00 for 8K EEPROM and 20 MHz interpreter. The development kit is sold separately for \$45.00. The interpreter chip is available at low cost for embedding in final products.

For more information, contact:

**VERSATECH ELECTRONICS** P.O. BOX 18476, DEPT. NV BOULDER, CO 80308-1476 303-440-5590 FAX: 303-440-9467

#### SHIELDED RJ45 BREAKOUT BOX



-com now offers an inexpensive means of making wiring changes to modular cabling utilizing RJ45 plugs. The DXR45S utilizes two high-grade shielded RJ45 keyed modular jacks, a nine-position DIP switch, and dual nine-position header sockets. This allows the user to make any combination of crosses, shorts, and opens just by flipping the DIP switches and adding jumpers.

The unit comes complete with an ample supply of jumper wires that store in the unit's rear compartment. Outside dimensions are 3.8" x 2.4" x 1.1" and the retail price is just

For more information, contact:

L-COM, INC. 1755 OSGOOD ST., DEPT. NV NORTH ANDOVER, MA 01845 508-682-6936 FAX: 508-689-9484

#### ANALOG TEMPPLATE™

ATP-1000 TempPlate™ is a Decora style temperature sensing wall plate designed to monitor temperature inside a home or office building. It is a low-voltage device which is easily installed in a common, single-gang electrical junction box or ring plate. The plastic body contains a low-profile metal probe to accurately sense local temperature. The internal sensor element is thermally isolated from the inner wall temperature, which may be significantly warmer or cooler than the actual room temperature.

When provided with power from +5 VDC to +24 VDC, the Analog TempPlate outputs an analog signal proportional to temperature. The output signal is linear and scaled to produce +10 mV per degree Fahrenheit. The unit is capable of measuring temperatures from +3° F to +212° F with an accuracy of ±1° F at 77° F. The analog TempPlate is designed to drive a high-impedance load through hundreds of feet of cable for true remote applications.

For more information, contact:

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#### **TE-32 MULTI-TONE ENCODER**



ommunications Specialists, Inc. announces a new variation of their SS-32P CTCSS tone encoder. The model TE-32 provides direct access from a front dial rotary switch to all EIA CTCSS tones from 67.0 to 203.5 Hz, allowing users to access repeaters that require CTCSS tones.

The TE-32 is housed in a highimpact plastic case that measures 5.25" x 3.3" x 1.7" and is supplied with mounting bracket, hardware, and 3' long shielded cable. Great for mobile or test bench applications!

Priced at \$49.95, the unit is available from stock and comes with our standard "no hassle" one-year warranty

For further information, contact:

COMMUNICATIONS SPECIALISTS, INC. 426 W. TAFT AVE., DEPT. NV ORANGE, CA 92665-4296 714-998-3021 FAX: 714-974-3420 1-800-854-0547 FAX: 1-800-850-0547

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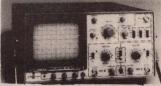
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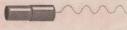
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he FBASIC Tickit single-board computer (SBC) from VersaTech Electronics offers unique advantages for engineers and hobbyists with ambition. This PIC-based SBC features expandable program memory that can grow with your application, and a programming environment designed to tame the complexity (and perplexity) of working

with large programs.

This article is a hands-on evaluation of the Tickit and its programming language, FBASIC. There are several configurations of Tickit; I checked out the top-ofthe-line model. See the Sources sidebar for information on the complete line.

#### **Setting the Stage**

Before we get started with the Tickit, I should explain a bit about microcontrollers, SBCs, and PICs Even if you're familiar with these terms, there are still some surprises. Imaginative engineers have been changing the rules lately.

A microcontroller is essentially a microcomputer that's specialized for working with things rather than people. For example, you type letters, access the

Internet, and play Doom on a desktop microcomputer; an embedded microcontroller (actually more than a dozen of them) controls the engine and dashboard of your new Corvette. While the Vette's microcontrollers do interact with a person - the driver - much of their work involves interfacing

with hundreds of sensor inputs and actuator outputs under the hood. It's the emphasis on electronic input/output (I/O) that distinguishes the controller from

Oddly, the term "single-board computer" generally refers to a controller, not a computer in the traditional sense. Although controllers, with their emphasis on I/O, usually require fewer peripherals than computers, they still need a power supply, clock source, external memory (if required), etc. When an engineer designs a system from scratch, he or she incorporates these goodies into the design. However, many control projects can't justify the expense and fuss of a full-custom design. They start with an SBC.

Finally, PICs are single-chip microcontrollers. Aside from power and a clock crystal, everything they need is inside their IC package. They're cheap and fast, but are generally programmed in assembly language to squeeze the most out of limited resources. This can be pretty

tedious, but a finished application is the equivalent of a brand-new IC with totally custom functions, and a low enough cost to make a decent profit for its creator. Pry open PC peripherals (mice, keypads, modems), electronic toys, and industrial devices, and you're likely to find one or more PICs inside.

#### What Came Before: The BASIC Stamps

Given the above definitions, a PIC-based SBC doesn't seem to make sense. The SBC provides support circuitry for a chip that doesn't require support circuitry? Look at this another way: What if a little hardware could relieve the burden of writing assemblylanguage code? This was the premise behind the

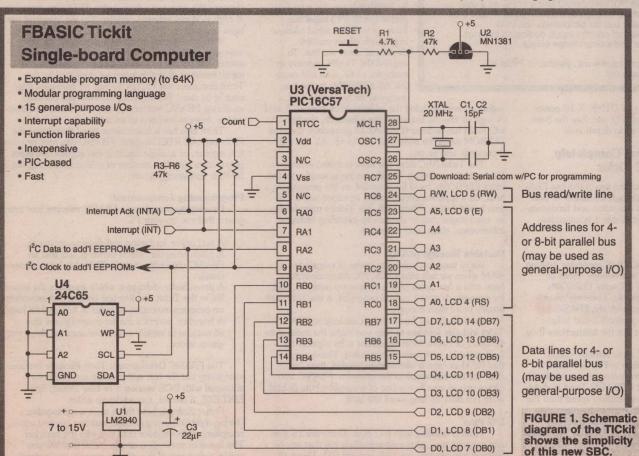
BASIC Stamp, the original PIC-based SBC by Parallax,

The Stamp's PIC, instead of containing the user's program, is factory programmed with the BASIC language. The user's program, written in BASIC, is stored in external memory. In operation, the PIC retrieves BASIC instructions from the external memory, interprets them, and executes appropriate machine-language code. One BASIC instruction may represent dozens - even hundreds - of machine-language instruc-

So the Stamp SBC contains the power-supply. clock crystal, and external memory required to support interpreted BASIC. A bit of hardware buys you faster and easier program development.

The Stamp now comes in two flavors: the BS1 (original) with eight I/O lines, 14 bytes of RAM, and storage for a 70-line program; and the BS2 with 16 I/O lines, 26 bytes of

RAM, and storage for a 500-line program. The BS2 also has enhancements to the BASIC language with support for arrays, more math opera-



#### Table 1. Features and Capabilities of the FBASIC Tickit PIC 16C57XT controller 20-MHz clock 24C65 EEPROM Hardware/Speed Available as component package (\$29.00), PIC processor alone (\$16.00), or complete SBC (\$65.00). PC-hosted tools (\$45.00) required for programming. 8K, expandable to 64K by adding up to seven more 8K EEPROMs. Program memory may also be used as non-volatile storage for constants, logging data, or as a diskless filing system. **Program Memory** Variable Storage (RAM) 48 bytes of RAM, which may be defined as byte (8-bit), word (16-bit), or signed long-word (32-bit) variables. 15 general-purpose I/Os, plus download/console I/O, interrupt input I/O Pins interrupt-acknowledge output, and high-speed counter input Programming Environment Programming tools include a token compiler (checks program for errors, converts text to FBASIC object code), a debugger (transfers programs to Tickit; shows status of memory), and a launcher (control panel that switches between editor, compiler, debugger). **FBASIC Language** Function-oriented dialect of BASIC with parameter passing and local variables. Unsigned 8- and 16-bit, and signed 32-bit arithmetic. Size conversions between bytes, words, and long words. Logic operations on Math/logic individual bytes. 300 to 19,200 baud; 8 bits, no parity; **Serial Data** optionally detects framing errors, allowing stop bit to be used as a ninth data bit for Reception network applications. Programmable timeout prevents hang-up if no data arrives. 300 to 19,200 baud; 8 bits, no parity; optionally generates framing errors, allowing stop bit to be used as a ninth data bit for **Serial Data Transmission** network applications. Special Digital Pulse I/O; console I/O using of PC as a user interface through downloading pin; 4- and 8-bit parallel bus for peripherals like LCD; dedicated counter input; dedicated interrupt input and acknowledge output. Special Analog Reads resistance, generates PWM for voltage out.

tions, pseudo-sinewave tones and DTMF, X-10 powerline remote control, faster serial I/O, etc. See the Sept. '95 issue of Nuts & Volts for an in-depth look.

#### And Now for Something Completely **Different: The FBASIC Tickit**

Table 1 lists the features of the top-of-the-line FBA-SIC Tickit that I evaluated. Although it's similar in principle to the BASIC Stamps, in execution and fundamental philosophy it's very different. Table 1 is an outline for the rest of this article.

The Tickit uses a PIC 16C57HS controller running at 20 MHz to execute BASIC instructions stored as tokens in one or more 24C65 8K serial EEPROMs (electrically programmable, erasable, read-only memory). The 16C57 is programmed with the FBASIC language interpreter which reads symbols called tokens from the EEPROM and carries out the instructions they represent.

Because the FBASIC PIC must retrieve tokens from EEPROM, programs written in FBASIC execute slowly compared to their assembly-language equivalents. My bench testing showed that a 20-MHz Tickit is slightly faster in terms of raw token-execution speed than the BASIC Stamp II. Of course, different instructions may take more time than the average; division involving signed 32-bit integers (with a range of ±2,147,483,648) takes longer than incrementing a byte (range 0-255). **Program Memory** 

Tickit uses EEPROM to store programs. EEP-

LISTING 1. SIMPLE FBASIC PROGRAM

Program: SIREN.BAS (Demonstrate FBASIC loops) This program drives a speaker on Tickit pin 0 with a wailing siren sound. It's intended to show how small programs, especially those involving loops, look in FBASIC. Note that FBASIC has no FOR/NEXT loop. Instead, it has several keywords that make up a loop construction set that can build any kind of loop: endless, fixed repetition, condition for entry, or condition for exit.

LIB fbasic.lib GLOBAL word freq 300w FUNCTION none main BEGIN pin\_low( 0B ) REP WHILE <=( freq,500w ) cycles(0b, 10w, 200w, freq) =( freq, +( freq, 10b ) )

LOOP

WHILE >=( freq,300w ) cycles(0b, 10w, 200w, freq)

=( freq, -( freq, 20b ) ) LOOP LOOP **ENDFUN** 

; Use standard library. ; Global word variable, start value 300. : Main function is the program itself.

Start with pin 0 low and in output mode. Outer, endless loop. While freq is less than or equal to 500. Output 10 cycles of PWM (squarewave

sound).

; Add 10 to freq. ; Loop until the "while" is no longer true.

While freq is greater than or equal to 300. Output 10 cycles of PWM (squarewave sound).

Subtract 20 from freq.
Loop until the "while" is no longer true.
Loop back to REP endlessly.

End of main function definition.

ROM retains data without power, but can be reprogrammed many times (up to a million or more), making it an ideal storage medium for SBC programs. When the Tickit is first powered up, it looks for a program in EEPROM. If it finds one, it automatically executes it. So a programmed Tickit requires no additional fiddling to run a program-connect power, and it goes

One of Tickit's strengths is its potential for memory expansion. Its EEPROMs use the inter-integrated circuit (I2C) serial bus. Inherent in I2C is serial addressing, which allows multiple devices to share the bus. To expand the Tickit's memory in multiples of 8K, you add more 24C65 EEPROMs to the bus, assigning each one the next

higher address by tying the address lines (pins 1, 2, and 3) high or low. As shown in the schematic, the first EEPROM has address 0 (A0-A2 all grounded); the next EEPROM would be address 1 (A0 to +5, A1 and A2 grounded), and so on.

The Tickit SBC does not have onboard provisions for expansion memory. But the wiring is simple, so the extra EEPROMs could be mounted on the prototyping area, on a separate circuit board, or added into a custom board design. (VersaTech, the Tickit's manufacturer, encourages custom designs by providing technical information, chips, and chipsets.)

Variable Storage (RAM)

We're used to thinking in terms of megabytes of RAM when we talk about PCs; PIC microcontrollers have only a few bytes of this temporary memory. Still, for properly designed control programs, a few bytes are usually more than enough.

As we'll discuss further when we look at FBASIC, Tickit includes features to help you make the most of its 48 bytes of RAM. Most significant is its support for local variables and parameter passing. These ensure that RAM storage is allocated as needed, then "recycled" for use elsewhere in the program. FBASIC also allows you to specify the size of a variable: byte (8 bits), word (16 bits), or long word (32 bits).

Tickit is bristling with I/O pins. There are 15 general-purpose pins, plus a downloading pin that can be pressed into service as a 16th general I/O. These all have the outstanding characteristics of the PIC-series

controllers: as outputs, they'll source or sink 20 to 25 mA; as inputs, they draw less than 1  $\mu$ A.

FBASIC lets you read and write the data direction of I/O pins on the fly. You can read or write pins' states individually (as single bits) or collectively (as bytes). In addition, FBASIC lets you configure the 15 I/Os as an eight- or four-bit parallel bus. This gives you convenient support for traditional microcontroller peripherals, like LCDs, memory, serial (UART) chips, parallel I/O devices (PIOs), timers, latches, etc.

Tickit has two pins to manage a hardware interrupt. When the interrupt is enabled, a low (0) on the INT pin causes FBASIC to go to a designated interrupthandling subroutine. Once in the handler, FBASIC changes the interrupt-acknowledge (INTA) line from low to high to signal external circuitry that the interrupt has

With a minimum of external hardware, Tickit's interrupt can be used to monitor and handle urgent events, like button presses or timing pulses. Bear in mind, however, that this interrupt is created by the Tickit firmware; the PIC16C57 has no hardware interrupt of its own. Tickit checks the interrupt between executing FBASIC instructions, so it will take a millisecond or more to respond to an interrupt.

Tickit also has a fast counter input that drives the PIC's eight-bit RTCC register. FBASIC can read or write this register; or a single function can accumulate input pulses for a specified number of milliseconds, creating a 50-KHz frequency counter.

**Programming Environment** 

Developing programs in FBASIC requires four programs that run on your PC:

- A text editor for typing and revising programs.
- A token compiler, which converts text into an FBASIC object file that the Tickit hardware under-
- A downloader/debugger, which transfers the object file to the Tickit and lets you control and eavesdrop on program execution in order to find and fix bugs.
- A launcher, sort of a master-control panel that allows you to rapidly switch between the three programs above.

The FBASIC Development Tools Package includes everything but the text editor, since any computer equipped with DOS version 5 or later already has

EDIT.EXE, a decent, mouse-driven editor.
Figure 2 shows how these tools work together. During a programming session, quitting the text editor, compiler, or downloader puts you into the launcher. The launcher presents a simple menu that lets you quickly select any of the other programs and instantly run it with the current program file loaded. The effect is

#### LISTING 2. MORE COMPLEX FBASIC PROGRAM **DEMONSTRATING A FUNCTION** Program: LTC1298.BAS (Demonstrating Tickit interface with LTC1298 12-bit analog-to-digital converter) LIB fbasic.lib ; Requires standard FBASIC library. DEF cs 0b DEF clk 1b ; Pin 0 to LTC1298 chip select line. ; Pin 1 to " "clock. ; Pin 2 to " "data in/out lines. DEF data 2b This function accepts a channel number (0 or 1) and returns a 12-bit; A-to-D conversion result from the LTC1298 ADC. Optionally, adding 2 to the channel number returns a differential reading. In this case, the channel number specifies the + pin for the differential measurement. So a channel value of 2 would return a differential measurement with channel 0 as + and 3 a differential measurement with channel 1

as +. The program that uses this function should DEFINE the CS, CLK, and DATA pins, and initialize CS high and CLK low.

This function could be made available to any FBASIC program by saving it as a text file with the ".LIB" extension, then adding the line LIB <filename>.lib

to the beginning of programs that needed an LTC1298 interface.

FUNCTION word adConve
PARAM byte config
LOCAL byte count 0b
BEGIN
pin_low( clk )
pin_high( data )
pin_low(cs)
pulse_out_high( clk, 10w)
IF and(config,2b)
pin low( data )
ELSE
pin_high( data )
ENDIF
pulse_out_high( clk, 10w)
IF and(config,1b)
pin_high(data)
ELSE

; Configuration byte: channel and mode. ; Bit counter with starting value of 0.

Start with clock low. Place a start bit (1) on data line. Activate the LTC1298. Start bit = 1.

Copy inverse of sglDif bit flag to data.

; Pulse the clock line. ; Copy the oddSign bit flag to data.

pin\_low(data) ENDIF pulse\_out\_high( clk, 10w) ; Pulse the clock. Set data to 1 for msbf bit. pin\_high( data ) pulse\_out\_high( clk, 10w) ; Pulse the clock. delay( 10w ) =( exit\_value,0w ) ; Clear output value for ADC result.

REPEAT pulse\_out\_high( clk, 10w) ; Toggle clk to get bits.
=( exit\_value, \*( exit\_value, 2b ) ) ; Shift bits left.
=( exit\_value, +( exit\_value, and( pin\_in( data ), 1b ))) ; Add new bit.
++( count ) ; Next bit.

UNTIL ==( count, 12b ) pin\_high( cs ) ENDFUN For a total of 12 bits. Deactivate the LTC1298. End this function.

; The function named "main" is the body of an FBASIC program. In this

; Main sets up the chip-select and clock pins to the LTC1298, then takes ; a series of readings from the ADC at 0.5-second intervals. By XORing the channel number (0 or 1) with 1, the program toggles back and forth between the two ADC channels.

FUNCTION none main LOCAL byte channel 0b ; Main function. Local byte variable with a starting value

pin\_high( cs ) pin\_low( clk )

; Begin the body of the function. ; Deactivate ADC. ; Put clock line into starting condition.

REP delay( 500w ) con\_out( channel ) con\_out\_char( ':' )
con\_out( adConvert(channel) ) con\_out\_char('') =( channel, xor(channel,1b)) LOOP **ENDFUN** 

; Delay 500 milliseconds (1/2 sec). Write the channel number to the console. ..followed by a colon (:).
Send the console ADC conversion result. ..followed by a space.
Toggle to other channel.

Loop (back to REP) endlessly. Mark end of Main function.

#### Table 2. Alphabetical Listing of FBASIC Keywords

#### Description

Alias Allocate Break Call (Exit) Definition Function (Prototype)

Global (Local)

Keyword

Gosub (Return) Goto Include, Library If (Else, Endif) Ifdefined (Ifnotdefined)

Indirect Initial Macro Operation Record, Field Repeat (While, Loop, Until)

Size Type Assign an extra name to a previously declared variable (or piece of one). Reserve space in EEPROM for storing data.

Assign a break point for debugging.

Assign a break point for debugging.

Evaluate an expression; exit a procedure to line after Call.

Assign a name to a piece of text (usually used to define constants).

Mark a section of code defining a function; or refer to a function defined later in the pro-

gram. Create a variable that's available to entire program (Global) or one that's used just within a function (Local).

Execute a subroutine and, when done, return to the line following Gosub.

Jump to the code beginning with the specified label.

Specify separate text files that are to be treated by the compiler as part of this program.

Act on the results of logic/relational operators.

Determine whether or not to compile a line based on whether or not a symbol is defined.

Used to create variations of a program by changing one or more Definitions. Allocate a two-byte variable that can call functions. Set an initial value for EEPROM storage locations.

Create a shorthand representation of a commonly used piece of program code.

Define a operation in terms of internally implemented functions. Create database-style structures for EEPROM storage.

Create a variety of different repeating loops with different conditions for executing, repeating, and exiting.

Define an alternative name for one of the data sizes (none, byte, word, long word).

Restrict assignment of different types of data to specified variables.

that the three programs work together as one big program with three different screens. Keeping the modules separate allows you to customize your FBASIC environment by choosing your own editor, or writing programs or batch files to make things work just the way you want them to.

FBASIC Programming Language

This is the aspect of Tickit that will make or break it for most users. FBASIC is a daring departure from the look and feel of traditional dialects of BASIC.

The "F" in FBASIC stands for "function."

Functions are the foundation of the language, since every operation — from adding two numbers to an entire program — is structured as a function.

You've seen functions in other dialects of BASIC In QBASIC for DOS you might write:

theSine = SIN(theAngle)

to have QBASIC compute the sine of an angle and put it into a variable named "theSine." QBASIC also lets you write your own functions that work the same way. In fact, there's nothing to prevent you from writing

functions that work like subroutines — simply carrying out a sequence of instructions. These functions might or might not accept parameters (inputs) or generate return values (outputs).

When you start looking for opportunities to use them, functions can be used in place of just about any construction in the BASIC programming language. That's the idea behind FBASIC For example, to add 26 and 47 together and put the result into a variable called "Sum" you'd

= (Sum, + ( 26, 47)) ; FBASIC version of "LET Sum = 26 + 47"

The expression +(26,47) returns 26 + 47 in exactly the same way that SIN(theAngle) returns the sine. Another function, =(, assigns that value to the variable

At this point in my evaluation of FBASIC, I started to have misgivings. Why tamper with BASIC? As I kept at it and got

used to the appearance of the code, I realized that there are serious advantages to this approach, especially when you consider the size of Tickit's program memory (large, and expandable) and its variable memory (small, and fixed):

Functions have a built-in mechanism for passing parameters - that is, moving data between different portions of a program. They use memory for such transfers only as long as it's needed. When they're done, the memory is returned to a shared pool for use by other parts of the program.

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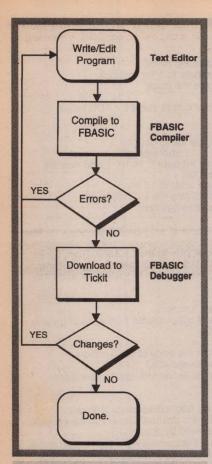


FIGURE 2. The FBASIC programming process. Thanks to a control-panel program called the Launcher, switching between the text editor, compiler, and debugger is automatic.

Functions can use local variables to conserve memory just as with parameter passing. Locals have the additional effect of making functions less bugprone than traditional BASIC subroutines using shared (global) variables. Since local variables exist only within the function that uses them, they can't be contaminated by errors elsewhere in the program.

Functions help hide the complexity of a program. Programmers modifying, maintaining, or expanding old software can easily be overwhelmed with the shear volume of detail contained in a program. Well-documented functions tucked away in library files help combat code shock.

Functions lend themselves to the creation of reusable software modules, especially when coupled with FBASIC's library capabilities (discussed later on). For example, once you've written a function to interface with a peripheral chip and gotten it just right, you need never look at that code again. Furthermore, commercial developers can create and sell software modules for incorporation into other's programs. These modules would be true software ICs, in that users would need to understand only how to use them, not necessarily how they work.

VersaTech, manufacturer of Tickit, has taken advantage of that last idea to expand FBASIC itself. The language includes many extensions, such as an eight-bit ADC interface, LCD driver and formatting code, and additional math functions that are written in FBASIC and tucked away in library files. These are ordinary text files of FBASIC program code. To add library extensions to the language, all you have to do is include the directive LIBRARY and a file name, as in:

LIBRARY math32.lib; Add 32-bit math functions to this program.

	Table 3. FBASIC Standard Library Functions
Function	Description
Math: +, - , *, /, =, ++,, %	Add, subtract, multiply, and divide; assign value to variable (=); increment and decrement (++,); compute remainder of division (%).
Size conversion: trunc_byte, trunc_word, to_word, to_long	Convert from one variable size (byte, word, long word) to another.
Bit manipulation/logic: AND, OR, XOR, NOT, >>,<<	Perform logic operations on bytes. Also shift the bits of a byte right (>>) or left (<<).
Logical Relations: ==, >=, <=, >, <, <>	Compare two values and return byte representing true (1) or false (0).
Data Direction: atris_get, dtris_get, pin_in	Read or write the direction (input or output) of the specified port (a or d).  measure atris_set, dtris_set, pin_in, pulse_in_low, pulse_in_high, rc_
Input Functions:	Read pin status, measure pulses, measure resistance via R/C circuit.
Output Functions: pin_high, pin_low, cycles	Write 1 or 0 to a pin; output squarewaves of specified duty cycle and frequency.
External Bus: buss_setup, buss_read, buss_write	Establish and read or write a 4- or 8-bit parallel bus to communicate with peripherals.
Timing and Counting: delay, sleep, rtcc_get, rtcc_set, rtcc_rs_cont, rtcc_count	Pause program execution for a specified number of milliseconds; power down for specified time; read, write, or configure internal 8-bit counter; count pulses on dedicated counter input for a specified number of milliseconds.
RS232 Communications: rs_param_set, rs_param_get,rs_send rs_receive,rs_delay	Read or write serial configuration; send or receive data serially; delay on switchover from serial send to receive.
Console Functions: con_test, con_in_char, con_in_byte, con_in_word, con_in_long, con_out_char, con_out	Check for the presence of a console device (usually a PC) with a screen and keyboard, and accept input or send output to it.
Interrupt Control: irq_on, irq_off	Turn the hardware interrupt on or off.
System:	Turn the debugging communication on or off; reset the interpreter chip (without physically

To give you a better feel for the language, Listings 1 and 2 show a pair of example programs written in FBASIC. Don't expect to understand them completely without the FBASIC documentation. By the way, the function in Listing 2 is a useful one; as an exercise, I wrote driver code for the LTC1298 12-bit ADC. I can save it as a library file and add LTC1298 access to any future FBASIC programs I write.

pressing the reset button).

The sections that follow, and Tables 2 and 3, summarize the rest of FBASIC's features.

Math/Logic

debug\_on, debug\_off,

FBASIC can multiply, divide, add, subtract, increment, decrement, and compute division remainders on any combination of bytes, words, and long words. An interesting product of the language's function-based structure is that it picks the smallest, fastest routine to do the job at hand. In other words, instead of using 32-bit math to multiply two bytes, it selects a smaller, faster byte-times-byte function with the same name as the functions that multiply other combinations of data sizes. It includes functions that can convert any size value into any other by padding or discarding bits. FBASIC's 32-bit long words not only handle very large values, they are signed, meaning they'll deal with negative numbers, too.

FBASIC includes a standard arsenal of comparison functions (equal, less, greater, not equal, less-or-equal, and greater-or-equal) that produce byte-sized results meaning false (0) or true (255). FBASIC regards any non-zero value as meaning true. Its logic functions (and, or, exclusive-or, not, shift left, shift right) operate on bytes, including, but not limited to, the results of comparisons. These operators are useful for making deci-

sions, working on individual bits, or writing synchronous serial I/O routines.

Serial Data Reception and Transmission

FBASIC can be set up to receive serial data at 300 to 19,200 baud through any general-purpose I/O pin. Additional configuration data can tell it to wait a certain amount of time for the data, or to detect so-called "framing errors" in the timing of the serial stop bit. Clever networking software can be written to deliberately generate and detect framing errors as a label to distinguish (for instance) network addresses from data.

Serial transmit capabilities can also utilize any I/O pin at the same data rates. The transmit function can be set to generate the telltale framing error that the reception function detects for networking purposes.

FBASIC also supports a batch of specialized serial I/O routines called console functions. These use a PC as a dumb terminal to send and receive data. The console functions are useful for prototyping, developing PC peripherals, and debugging.

Special Digital I/O

In addition to reading and writing 1s and 0s on its I/O pins, Tickit includes functions for measuring the duration of positive- and negative-going pulses, or generating pulses of specified durations. It can also designate its I/O ports as a conventional four- or eight-bit parallel bus. For example, VersaTech includes a useful assortment of bus-oriented functions that drive common LCD modules.

Special Analog I/O

PICs are purely digital creatures, but some digital

operations can masquerade as analog ones. For example, to read an unknown resistance, you can charge up a capacitor through it, then measure the time required to discharge the cap below the digital-logic threshold (the boundary between 1 and 0). FBASIC's rc\_measure function does just this. (It can also be used with a known resistance to measure an unknown capacitance.)

Another semi-analog function called cycles lets you control the duty cycle (ratio of high-to-low time) of an output waveform. This pulse-width-modulation (PWM) can control the brightness of a light or the speed of a motor. With filtering through a resistor and capacitor, it can also generate a variable voltage. Finally, it's handy for making an assortment of beeps and squawks through a speaker.

#### **Other Functions**

This instruction summary just scratches the sur-

face of FBASIC. Even if it were complete, FBASIC's extensible nature means that VersaTech and Tickit users will probably have enlarged the language further by the time this is published.

#### Summary

Throughout this article, a lot of you have no doubt been waiting for me to draw direct comparisons between the Tickit and the reigning champs of PIC-based SBCs, the Stamps. I can't. I've worked with the Stamps too long to be objective, and I'm not convinced that direct comparisons are appropriate. I have tried to structure this article in a way that helps you draw your own conclusions based on the requirements of your particular application or project and on your personal taste in programming languages.

I predict that Tickit will be very attractive to the extremes of the SBC user

community. Novices, with no old programming habits to unlearn, will appreciate the possibility of obtaining professionally written software modules that they can use right away. Pros, especially those with some formal training in programming, will appreciate the advanced structural features of FBASIC, the customizable programming environment, and the opportunities offered by expandable program memory.

Those in the middle will probably scour FBASIC's list of features for something that they feel is missing (interrupt, 32-bit signed math, large memory) from familiar devices. If they need these things badly enough to get over the unfamiliar look of the language, they'll make a move. I've already sketched the FBASIC interpreter chip into some of my own plans—it takes more than some parentheses to scare me!

#### Sources

The Tickit line of SBCs is manufactured and sold by VersaTech Electronics, P.O. Box 18476, Boulder, CO 80308-1476; Phone 303-440-5590; Fax 303-440-9467; BBS 303-440-7828. They offer the following Tickit variants:

Speed	<b>Program Memory</b>	Configuration	Price
4 MHz 20 MHz 4 MHz 20 MHz 4 MHz 20 MHz 4 MHz 20 MHz	2K (fixed) 2K (fixed) 8K (expandable) 8K (expandable) 2K (fixed) 2K (fixed) 8K (expandable) 8K (expandable)	components components components components assembled board assembled board assembled board	\$24.00 \$25.00 \$28.00 \$29.00 \$49.00 \$55.00 \$59.00 \$65.00

To program the Tickit, a one-time purchase of Tickit Development Tools (including a manual, programming software, and downloading cable) is required; price \$45.00. All prices are subject to additional shipping and handling charges. VersaTech accepts Visa and MasterCard.

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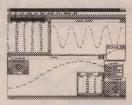
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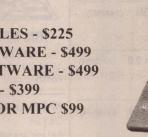
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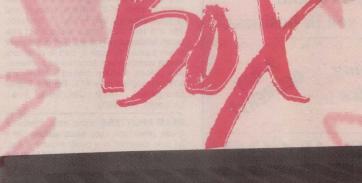
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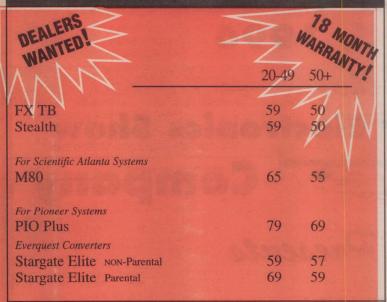
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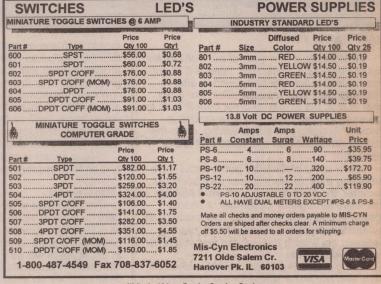
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### SHOELIX SIRING COMMUNICATION?

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# FULL DUPLEX COMMUNICATION

with Damien Thorn

"Full Duplex" is an interactive column with Nuts & Volts writer Damien Thorn We'll be reprinting the more interesting letters from readers along with Damien's responses. Questions, comments about his articles, or ideas for future issues are all welcome. Correspondence should be sent directly to Damien Thorn, c/o Phoenix Rising Communications, 3422 W. Hammer Lane, Suite C-110, Stockton, CA 95219. He can also be reached electronically at Damien@prcomm.com via the Internet. Names will not be published if anonymity is requested.

#### HAPPY NEW YEAR!

Welcome to a new year of our Full Duplex column in Nuts & Volts. And, believe it or not, this column is actually being written after Thanksgiving. That may not seem like a big deal at first, but is truly of great benefit both to me as a columnist and you as a reader, in terms of bringing you late-breaking, up-to-theminute information on the topics that are of

While some electronics publications were preparing their January issues way back last summer, the Nuts & Volts staff were building this issue throughout December. It should please you to know that when I seriously push a deadline, there is only about a 25 day lag between me writing this column and you holding it in your hands.

Being aware that this is an interactive column, and not just a space for me to stand up and speak my mind on an issue, let's start the year off with a bang. If you've had questions or comments about cellular communications, the scanning hobby, personal computers, or just about anything else, take a few minutes and write us a letter. Don't sweat the grammar and spelling (we can clean that up), just share your thoughts.

#### MAILBAG

Dear Damien:

I would like to ask you for help. I need the pin-out info on the Motorola Flip expansion/power jack. Where do I look? Motorola reps are not user-friendly when I ask for what they think is "inside info.

I'm going to buy a modem adapter for my cellphone and want to modify it to power the

Sharper Image and other places offer a neat speaker phone adapter which is also a power adapter and the whole thing plugs into

a cigarette lighter socket.

l like these toys and would like to have them all in a small box with a simple switch: "PHONE-SPKR-MODEM." I spend most of the day on the road (field service) and a notebook computer and cellphone are my necessities.

**Dusan Benko** New York, NY

#### Dusan:

Obtaining information from some manufacturers can indeed be difficult. What I'd like to find out about Motorola flip-style phones is the data format used between the phone and the various modems and adapters available from different companies. Somehow these adapters are able to convert the DTMF dialing tones from modems and fax machines into data which the phone understands. Since different vendors make these adapters, there must be public knowledge about the signalling format required. Despite this, I probably get a letter every

month from some small company asking for this information so they can develop a new product for use with these phones. It would be

great to get over this hump.

Your question is simple in comparison. The answer can be found by either looking at the power cable itself, or by looking at the cable diagrams accompanying software designed to assist in programming these phones.

The diagram is of the connector on the end of an accessory cable, facing the pins.

#### Hello Damien:

I'm interested in cellular radio. I've been a ham for several years and work aboard ship as a Radio-Electronics Officer. We are getting close to the point where a new Safety of Life at Sea system will go into effect called GMDSS — Global Marine Distress and Safety System. It will do away with my radio watch standing requirements and likely my job all together, since there will no longer be a law requiring the carriage of an REO. The shipping companies are very bottom-line oriented, and I doubt they will keep us on as technicians by our technical merit alone (no law requirement).

In any case, I may have to look for another career, and I'm interested in cellular radio. I have a friend who used to be an REO and is now working for US West Cellular as a technician. It seems to be a field that is growing and I like the radio/computer architecture of it. I'm not all that familiar with telephones, at least not with the telephone company side of it. The same goes for cellular, and I was wondering if you could suggest some good books to bring

me up to speed.

My friend says they are now putting in CDMA systems, so something with coverage into that would be good. He showed me a cell site. It was very interesting. I think the CDMA stuff was Motorola. Do you know of any good books covering the phone system and cellular radio — something good for would-be technicians of cell sites? I didn't know who else to ask, and thought this would be right up your alley.

Jerry, E-Mail

Jerry:

If you have to make a career transition, I guess the cellular or emerging PCS industries would be a good choice. Technicians within the industry tend to either lean toward specialization in digital switching systems and circuits, or the RF side of these services. In all honesty, I haven't really read any textbooks on either subject. Most of what I've learned has been assimilated through osmosis or asking questions of people who know their stuff.

Since I'm not familiar with the texts that exist, let me suggest a related resource. In a previous column, I've mentioned a small magazine called Private Line. This magazine is pretty much a one-man show put together by my associate, Tom Farley. Since meeting Tom at the DefCon II convention in 1994, I'm continually impressed by his efforts to explain the inner workings of the telephone system, including coverage of things like the Digital

Telephony Bill.

Private Line comes to mind in this instance because Tom has compiled a long list of telecom related magazines along with the subject covered and subscription information. These lists were published in Volume #2, issues #2 and #4. By obtaining single copies of some of the magazines in Tom's list, you'll find ads for many training aids and textbooks that cover the subjects of interest to you. Some of these telecom publications may also be available from a local university library.

While putting this column together, I called Tom regarding your letter and he offered his opinion that you shouldn't get too hung up on CDMA since any large scale deployment of that technology in the United States is still pending. He suggested the following book, indicating that it gets quite technical with all of

its charts and graphs.

"It's not for the faint of heart, but if you want to understand the cellular system, this is the best, most current publication about cellular that has been written. It goes into AMPS, TDMA, GSM, and covers everything from planning the system through actually carrying it out," said Tom.

Cellular Radio: Principles and Design by Raymond Macario ISBN: 0-07-044301-7. The telecom magazine list will be available on the Internet fairly soon. Printed copies of both the issues mentioned can be ordered by mail for a total of \$9.00, which includes postage. Since Tom just moved (taking Private Line along with him), here's the new address:

#### Private Line Magazine P.O. Box 1059 Isleton, CA 95641

Dear Damien:

I was wondering if you might be able to provide some assistance with my TR5E800-9A cellphone (such as programming info/test info). It is currently on ROAM, but it seems to work just fine. I also wanted to say I used to listen to your show on KROQ a lot. You've got good taste in music! Cassandra/Elvira is coming to Knott's and I look forward to seeing her again too. Any help you can offer would be greatly appreciated!

Roger, E-Mail Santa Ana, CA

Roger:

The technical question is easy enough to answer, and the NEC information has been compiled and may be found in the sidebar. The rest of Roger's letter left me scratching my

Although I've been employed as a radio personality prior to diving into the broadcast engineering angle of commercial radio, I've never worked at a major market station like KROQ. Further correspondence revealed that Roger's friend was pulling his leg, telling him that I was the same person who hosted the "Damien Show" on that station in the past.

Rumors are a funny thing. While recently talking to an investigator close to a number of cellular fraud investigations, he mentioned that he had heard a rumor alleging that a court order existed which prohibited me from coming within 100 feet of a cellular phone. We both got a laugh from the absurdity of such a notion. Such a restraining order would not only be impossible to obtain, but would have little effect on my efforts to chronicle the lesser-know aspects of cellular technology. We simply report on the various holes that exist within the system, we certainly play no part in their creation.

#### Dear Damien:

I am writing to you in hopes of obtaining a working drawing or kit to build a device that I can attach to a private phone line that will enable me to log the numbers called from that phone, be it rotary or touch tone. A friend of mine is being unduly harassed because of [reason deleted], but we can't find the source of harassment. However, whenever he walks into certain establishments, they run to a phone and make a call. I've personally witnessed what he's going through and it's absolutely despicable.

If I could construct a device to clip on their line, we could find the low lifes and put a stop to it. I know it's illegal, but so is what [my

friend has been subjected to].

I'm not connected with any government agency, I'm just trying to help a friend who has been through hell! Any suggestions, plans, kits, or whatever would be greatly appreciated.

P.S. The people at *Nuts & Volts* were kind enough to give me your address.

[name withheld]

#### Dear Nameless:

Interesting letters such as this occasionally give rise to the feeling that I'm sometimes viewed as the Ann Landers of the technology crowd. For obvious reasons, identifying information has been removed from this letter, and it is included in the column because it provides an interesting look at how technology is sometimes applied to real-life situations. Much to my regret, it became buried under pending work at my office and has no doubt been answered too late to be of benefit to the writer.

Back in the "old days" such devices were used by law enforcement and known as "pen registers" based upon the pen and chart paper method of documenting the digits dialed on the phone line to which it was connected. In today's world, such a unit is known as a "DNR" which stands for Dialed Number Recorder. The good ones are completely digital and store the information using internal memory. When placed within a central office, such a unit will often be connected to a second phone line and automatically dial the number to a central "intelligence point" and dump the stored information via built-in modem.

Most of the digital switching equipment used by the telephone companies also has the capability to record this type of information. Switches can be programmed to "trap" certain information, and the process can be triggered

by either the number from which the call is originating, the number to which the call is placed, or based upon the number being dialed.

Since logging dialed numbers is of interest to other people outside the law enforcement community and the telco personnel, there are a large number of dialed number logging devices available to just about anyone. Naturally, these are intended more to track usage of one's own phone line than to be used as described in the letter above. In fact, connecting such a unit to a phone line without authorization from the subscriber is no doubt a violation of both state and federal law. Readers are therefore advised against any such activity.

Sources of these devices are numerous. Radio Shack stores have sold them in the past, and they have shown up in discount catalogs such Damark. Some are equipped with memory and a LCD display that allows the user to scroll through the contents. Others have a small printer that use rolls of paper, much like a calculator or cash register tape. Good ones will also log the date, time, and possibly the duration of each call. The best one I've reviewed was produced by International Micropower in Camarillo, CA. I'm not certain that the company still markets these, however.

Flipping through the pages of this magazine, there are several security and surveillance equipment suppliers that no doubt offer similar units at various prices. My recollection is that Viking International sells the standard display model at a reasonable price. Viking also offers a number of fascinating products, including cassette recorders that will record 10 to 16 hours of audio on a single cassette.

Viking International has been around quite some time, and their 32-page catalog is free. Just let them know that you heard about them

here when inquiring.

Viking International 150 Executive Park Blvd., #4600-N San Francisco, CA 94134 (415) 468-2066 voice (415) 468-2067 FAX

If building a unit yourself is more to your liking, Weeder Technologies sells a "DTMF Decoder/Logger" kit that will store the last 240 digits dialed in nonvolatile memory. The stored digits can be scrolled across an LCD display. Cost of the kit is \$54.50. Ramsey Electronics, Inc., also has a DTMF decoder available in kit form at \$99.95. Ramsey's decoder stores 256 digits, and scrolls them across an eight-digit LED display. The Ramsey unit will insert a "dash" character between any group of digits that were decoded more than two seconds apart. A matching case and fully assembled unit are also available if desired. NV

Weeder Technologies P.O. Box 421 Batavia, OH 45103 (513) 752-0279

Ramsey Electronics, Inc. 793 Canning Parkway Victor, NY 14564 (800) 446-2295 orders (716) 924-4560 information

#### NEC P9000 PROGRAMMING TEMPLATE

The following information pertains to the programming of NEC P9000 portable cellular phones. These units are also identified by the transceiver model of TR5E800-9A. NEC provides a special programming battery with an extra contact for use with these phones. An industry work-around is reported to exist which allows programming with a standard battery. To emulate the programming adapter, the right-most black metal button-style contact on the back of the phone can be grounded with a flat conductor or small wire. The antenna connector is commonly used as the grounding point with this procedure.

Additionally, NEC modified the firmware of this phone at some point in time, adding some parameters that were not previously user-programmable. As such, there are two possible programming sequences. The change from sequence #1 to sequence #2 is alleged to have taken place on units with a mechanical serial number after approximately 7Y-101800. Other than the extra fields such as GIM and ICPH, there are no programming differences between the two.

Also note that there may be some interesting functions within the unit's test mode aside from the ability to program the phone. Keying RCL,#,x,x (where x,x represent two-digit numbers) appears to activate the functions. Some experimentation would be required to determine the nature of the debugging facilities residing within the firmware.

1. Ground test mode contact.

2. Power up phone.

3. Key RCL,# [display says 'test mode'].

4. Key 0,1 [display shows blocks].

**5.** Key RCL,#,7,6,0,# for NAM #1 or RCL,#,7,6,1,# for NAM #2.

6. Key RCL,#,7,1 [some documents indicate that 7 and 1 should be pressed simultaneously].

At this point, the phone will display the data stored in the first location from the sequences below. To keep the current data and step to the next location, press #. To enter new information, key in the new data and then press #. Momentarily press CLR to erase an entry. Hold the CLR key longer to exit programming mode and return to test mode. All data will be saved. Exiting test mode is accomplished via the RCL,#,0,2 sequence which reinitializes the phone.

Sequence #1		Sequence #2		
Field	Digits	Field	Digits	
MIN	10	MIN	10	
Lock	4	Lock	4	
Home Are	a	SIDH	5	
Pref. Sys.	5	GIM	2	
[unknown]	1 1	PCH	3	
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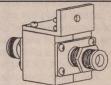
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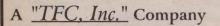
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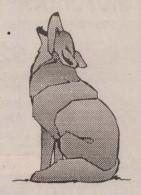
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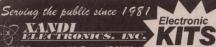
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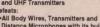
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# Today's Electronics

by Anthony Charlton



his month, we look at more new integrated circuits and focus on another transient protection device, which

can, in all but the most severe cases (like a direct lightning strike), save our delicate electronic equipment from

#### **More Neat Maxim Integrated Circuits**

Maxim produces and releases so many new and useful analog integrated circuits every year,

More new IC's and another transient protection device tially electrically stable regardless of their input

voltage. Of course, temperature drift is a factor, but

the less temperature drift, the better. The second voltage input to a comparator is called, logically enough, its INPUT VOLTAGE.

#### **How a Comparator Works**

The math way to relate how a comparator works is expressed thusly:

Let two input terminals = V{in+} and V{in-} Let one output terminal = V{out} Then: When  $V\{in+\} > V\{in-\}\ then \ V\{out\} =$ 

feedback resistor. Plus a relatively small value input resistor, the combination of both allowing a change of output state to occur rapidly with no

Why? There is nothing more irritating than a piece of equipment, say a battery charger, that starts broadcasting copius RF signals instead of doing what it's supposed to. And those oscillations can exceed the maximum power dissipation of the comparator and destroy it, with who knows what consequences to the attached

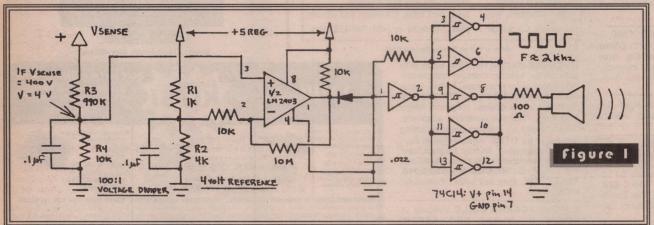
equipment. This is especially true at higher input voltages and ambient temperatures.

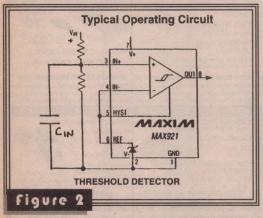
Figure 1 shows a comparator circuit that is configured to activate a small speaker or buzzer once the input voltage at V{sense} exceeds 400 volts. This is a good introductory "Hobbyist All-Purpose Circuit" to comparators, since the values can be altered to activate the buzzer for virtually any input voltage. And the parts are avail-

able anywhere - they aren't, in this case, a Maxim product, which is greatly superior (we'll get to that in a moment). Keep in mind the reference voltage is derived from a regulated +5 volt source (not shown), and a resistive divider sets the reference at +4 volts at the (-) input terminal. The input voltage is from another resistive divider at the left hand part of the circuit. This is a dual comparator, so you can actually monitor two voltages simultaneously. If the second comparator is not used, tie input pins #5 (+) and #6 (-) to ground, and leave output pin #7

The other IC is an inverting 74C14 Hex CMOS Schmitt Trigger, configured as an oscillator. If the input to the single gate is high, it will oscillate (correctly in this case!) according to the RC time constant connected to it. Then the five paralleled gates multiply the current so it can drive a small speaker. If you use a piezoelectric buzzer, you can omit the 100-ohm series resistor. That buzzer should be the type that requires an external oscillator source, rather than have its own internal oscillator.

Normally the output of the comparator is at Logic 0, so the buzzer stays off, as the input gate to the oscillator is pulled low through the blocking diode. Once V{sense} rises above 400 volts (in this case), the comparator changes state, and its Logic 1 output is pulled high by the 10K resistor. Then the buzzer sounds off. By the way, this circuit was originally designed to detect when a giant strobe light and its powerful capac-





it is truly amazing. One of many is the MAX921-MAX924 Ultra Low-Power, Single/Dual-Supply Comparator. A COMPARATOR is an integrated circuit configured to compare two voltages, one at each of its two inputs. Depending upon which input is at a higher potential and how the device is wired, it will produce either V+ or ground at its output terminal, with no intermediate states allowed!

One input voltage is called a REFERENCE voltage; a stable and unchanging voltage derived from say, a reference diode (Zener or other type) or an IC. Voltage references are designed with this in mind: For whatever application they are to service, references are essen-98 January 1996/Nuts & Volts Magazine

logic 1 or V+ When  $V\{in+\} < V\{in-\}\$ then  $V\{out\} = logic 0$  or

The output voltage level is dependent upon the response of the individual comparator. In some cases, it will be a TTL (+5 volts or ground) level, but in the case of the Maxim comparators, output will be either to ground or within 1.3 volts of the positive supply rail. These comparators feature:

- Supply current of only 4 uA.
- 40 mA continuous source current.
- +2.5 to +11 volt power supply range.
- Dual  $\pm$  1.25 volt to  $\pm$  5.5 volt supply capability.
- Adjustable internal hysteresis with the MAX921 and MAX923.
- Internal 1.182 volt, 1% precision voltage reference.
- 12 uS response time.
- Glitch-free switching.

All practical comparator circuits that I'm aware of should have a feature added called HYSTERESIS (pronounced hiss-tear-ree-sis) if there is any point where the two input voltages are close or equal to each other, and if they may change states slowly. Since this is almost always the case, the hysteresis is added by using a small amount of feedback through a large value itor bank were ready for another picture-taking shot, so hence the high voltage involved. But there is one important detail to remember, and that is: The input voltage to either comparator input must not exceed the supply voltage by more than 0.3 volts, or the comparator may be destroyed. In this case, you can add protection diodes to the V{sense} input. Germanium diodes are the best since they offer the lowest voltage drop.

A typical device would be 1N34 or 1N60. However, Germanium devices are getting scarce these days. But Schottky rectifiers are a good substitute, and I've had good luck with 1N4148s which are ultrafast, silicon-based switching diodes. Even though their maximum voltage drop, measured at maximum input current, can be 0.7 to 0.9 volts, this parameter is lessened at less than the maximum current input. They seem to do the job A-okay. However, it is suggested to use a Schottky rectifier IF the expected input current approaches 30% or so of the switching diode's maximum continuous current rating.

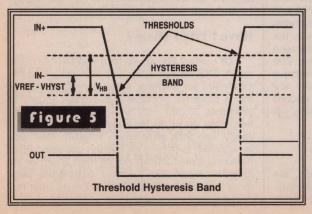
## Let's Look at Maxim's Comparator Data

The BIG advantages of the Maxim comparators are the inclusion of a precision on-chip voltage reference, and on-chip adjustable hysteresis, contained in the MAX921 and MAX923. The MAX924, a quad comparator, has an internal reference, but lacks the internal hysteresis. Using these, one needn't bother with an external voltage reference, plus you can set the hystere-

1% PRECISION REFERENCE	COMPARATORS PER PACKAGE	INTERNAL HYSTERE- SIS	PACKAGE
YES	1	YES	8-PIN DIP/SO
NO	2	NO	8-PIN DIP/SO
YES	2	YES	8-PIN DIP/SO
NO	4	NO	16-PIN DIP/SO
	YES NO YES	PRECISION REFERENCE         PACKAGE           YES         1           NO         2           YES         2	PRECISION REFERENCE         PACKAGE         SIS           YES         1         YES           NO         2         NO           YES         2         YES

fi	91	J f	e	4

Ordering Information					
PART	TEMP. RANGE	PIN-PACKAGE			
MAX921CPA	0°C +70°C	8 Plastic DIP			
MAX921CSA	0°C +70°C	8 SO			
MAX921C/D	0°C +70°C	Dice*			
MAX921EPA	-40°C to +85°C	8 Plastic DIP			
MAX921ESA	-40°C to +85°C	8 SO			
MAX921MJA	-55°C to +125°C	8 CERDIP**			



sis anywhere you want within the parameters available within these devices, and using just a couple of passive components. Figure 2 shows a functional diagram of the MAX921CSA, an eight-pin Small Outline (SO) surface mount device, also available in DIP versions. At the current price of \$3.22 in one-piece lots, it is within our budgets, and readily available from Digi-Key. The on-chip 1.182 volt band-gap reference is shown in the figure as tied to the hysteresis pin (#5) and thusly, the hysteresis in this configuration is none. This reference sports a precision of 1%, so that's impressive by itself. and incidentally cheaper than many references of that precision with no comparator!

In a moment, we'll see how to adjust the hysteresis. The point of the figure is to show how simple a circuit can be made. Note the two resistors at V{in} and connected to V{in+}. This divider is what the on-chip reference will compare to. Add a capacitor. C{in}, if the input voltage fluctuates to avoid the comparator switching states irrationally. We'll leave its value up to you. But a suggestion is a tantalum or electrolytic 'cap of one to several microfarads if the signal has low-frequency parasitic fluctuations (like a not-too-well filtered DC souce derived from an AC-input bridge rectifier), or a 0.001 uF to .1 uF ceramic disc capacitor if the signal has high-frequency parasitic oscillations.

Figure 3 shows the various functions of this series of comparators, and Figure 4 shows the ordering options available for the MAX921. Normally, we'd order the MAX921CSA-ND or the extended temperature range MAX921ESA-ND, which are Digi-Key part numbers for SO-8 surface mount devices. The other numbers are given in case OEMs want to obtain samples from Maxim, who are listed in the Supplier List.

Figure 5 shows the hysteresis aspect of this series of comparators. Note the stable IN{-} parameter against which the other parameters are compared to in the figure. The IN{-} value would be the reference voltage, although the reference can be at either pin (convention suggests the reference should be at the {-} pin). We also see the HYSTERESIS BAND. What that means is the "no-man's

land" where the comparator won't trip to either output state. Note, however, once this band is exceeded by the input signal, at the arrowed points labeled "thresholds," the comparator changes state. V{hb} is the range of

the hysteresis band, and that range is governed by where we choose to set this parameter. Just two resistors are required, as shown in Figure 6.

To add hysteresis to the MAX921 or MAX923, connect resistor R1 between REF and HYST (pin #6 and #5 on the MAX921, respectively). Connect another resistor, R2, between HYST and V{-},

#### SUPPLIER LIST

Circuit Board Express, 2 Avco Road, Haverhill, MA 01835. Ph: (508) 521-9288, FAX: (508) 521-9388, Modem: (508) 373-9272, E-Mail: fastpwb@tiac.net Time crucial manufacturer for industry. Produces prototype circuit boards in 24 to 48 hours. Not a hobbyist supplier.

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Datak Corporation, 55 Freeport Blvd, Unit #23, Sparks, NV 89431. Ph: (702) 359-7474, FAX: (702) 359-7494. Dry transfers for PWB fabrication, chemicals, Circuit-Fix™ products. Free catalog. Digi-Key Corporation, 701 Brooks Avenue South, P.O. Box

677, Thief River Falls, MN 56701-0677. Ph: (800) 344-4539, FAX: (218) 681-3380. Top-of-the-line supplier of SMT components; features a large selection. Free catalog.

DynaArt Designs, 3535 Stillmeadow Lane, Lancaster, CA 93536-6624. Ph: (805) 943-4746. Provider of and seller (through distributors as well) of the Toner Transfer System (TTS) method of PCB fabrication. Also sells a desk-top integrated package for small OEM and prototype PCB fabrication.

**Electronic Goldmine,** P.O. Box 5408, Scottsdale, AZ 85261. Ph: (602) 451-7454, FAX: (602) 451-9495. SMT surplus PWBs and SMT components. Some great values here. Free catalog.

ESP Solder Plus, 14 Blackstone Valley Place, Lincoln, RI 02865-1145. Ph: (401) 333-3800, FAX: (401) 333-4954. Small manufacturer, educational, and industry SMT repair kits and solder cream.

Garrett/IEU, Inc., 3130 Skyway Drive #104, Santa Maria, CA 93455. Ph: (805) 922-0594, FAX: (805) 922-3643. Small and bulk quantities of surface mountable components.

Hobby Lobby International, Inc., 5614 Franklin Pike Circle, Brentwood, TN 37027. Ph: (615) 373-1444, FAX: (615) 377-6948. Supplier of all kinds of hobby kits and supplies; mentioned here because of their large selection of instant-setting glues and some tools that are useful to any precision endeavor such as with electronics. Catalog \$2.50.

Maxim Integrated Products, Inc., 120 San Gabriel Drive, Sunnyvale, CA 94086. Ph: (408) 737-7600, FAX: (408) 737-7194. Specialty analog and digital integrated circuits of amazing diversity and use. Call for nearest distributor, or sales rep (in the case of OEMs). Will give out free information and samples to qualified companies.

Micro-Mark, 340 Snyder Avenue, Code 340-1892, Berkeley Heights, NJ 07922-1595. Ph: (800) 225-1066, FAX: (908) 665-9383. This company calls itself "The Small Tool Specialists" and indeed they are. Listed here because of the many precison hand and power tools they offer that are useful in SMT and other electronic work. Also carries hard-to-find supplies for model making. Full-color catalog \$1.00.

Pace, Inc., 9893 Brewers Court, Laurel, MD 20723-1990. Ph: (301) 490-9860, FAX: (301) 498-3252. Manufacturer of SMT soldering/desoldering equipment and workstations.

**Techni-Tool,** 5 Apollo Road, P.O. Box 368, Plymount Meeting, PA 19462. Ph: (215) 941-2400, FAX: (215) 828-5623. Soldering/desoldering equipment and electronic tools of all types.

All Electronics Corporation, P.O. Box 567, Van Nuys, CA 91408-0567. Ph: (800) 826-5432, FAX: (818) 781-2653. Some SMT parts and occasional surplus SMT boards useful for parts salvage and experimentation. Free catalog.

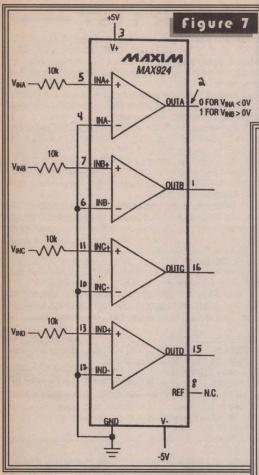
Capital Advanced Technologies, Inc., 309-A Village Drive, Carol Stream, IL 60188. Ph: (708) 690-1696, FAX (708) 690-2498. Manufacturer of the Surfboard™ breadboarding medium for SMT, sells mostly through distributors such as Digi-Key. OEMs can contact Capital directly for large quantity pricing.

Carolina Biological Supply Company, 2700 York Road, Burlington, NC 27215. Ph: (919) 584-0381, FAX: (503) 656-4208. Laboratory supplies including test tubes, plastic and glass vials handy for use categorizing SMCs. Contact for current price of their 30,000 item, full-color catalog.

PRB Line, P.O. Box 176, Whitewater, WI 53190. Ph: (800) 533-9654, FAX: (800) 635-8101. Carries the ChipQuik SMC removal kit.

Be sure to mention Nuts & Volts when you contact the above suppliers so they can process your requests properly.

which are pins #5 and #2 with the MAX921. If hysteresis is added, the V{hb} band shown in Figure 5 increases equally in both the upper and lower directions. The V{hb} band is approximately equal to twice the voltage between REF and HYS, and 100 mV is the greatest hysteresis amount, according to the manufacturer. The REF output is typically capable of sourcing 15 microamps, and sinking 8 microamps. The



manufacturer says not to bypass the REF terminal with a capacitor. The equations for adjusting hysteresis are as follows:

where:

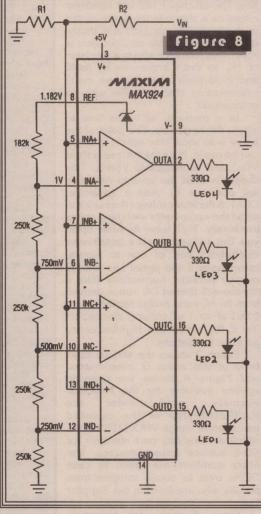
- · R1 and R2 are the adjustment resistors.
- V{hb} is the voltage of the hysteresis band.
- · 1.182 is the on-chip band-gap reference voltage.
- · I[ref] is the current source by the refer
- · I{ref} values between 0.1 uA and 4 uA according to the manufacturer: "usually appropriate. If a 2.4 meg ohm resistor is chosen for R2 ( $I{ref} = 0.5 \text{ uA}$ ), the equation for R1 and VB{hb} can be approximated as:"

R1, in Kohms =  $V\{hb\}$ , in mV

Both the MAX921 and MAX923's response are the same when hysteresis is applied according to the above equations.

#### **Two Real-World Uses** for Comparators

Figure 7 shows a level shifter, where a ±5 volt input is converted to be compatible to mate with a CMOS integrated circuit. A MAX924 quad comparator is employed to achieve the voltage translation. In this case, the MAX924 device is wired so that its GND terminal functions as a Logic-0 reference, its V{-} terminal is hooked up to the power supply of the circuit which requires the level translation, and the inputs are channeled through 10K resistors. Since the positive input voltage is a 5-volt TTL, or CMOS level, the Logic-1 output is +5 volts compatible with any CMOS or TTL circuit, considering the large sink/source capability of

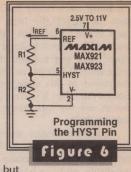


this chip and the others in its series. Note there is no use of the REF pin in this application.

Figure 8 shows a circuit that will light the four LEDs sequentially as the input voltage goes up. Such a circuit is very handy for monitoring charging of a battery, etc., or the input of almost any type of transducer if that is buffered properly. This circuit uses the on-chip bandgap reference, and an external resistive divider network to set the reaction levels of the comparators. LED1 lights up and stays on at 250 mV and higher, LED2 lights at 500 mV, LED3 at 750 mV, and LED4 at 1.000 volts, if R1 and R2 are omitted and the inputs are connected directly to the voltage source. R1 and R2 are used if you want the circuit to react to voltages other than 250 mV-1.000 volts, and the values of this resistive divider can be chosen to react to virtually any voltage. Just make sure the input can't exceed the positive supply, or the comparator likely will be destroyed.

#### **Zinc Oxide Non-Linear Resistors**

These devices, called ZNRs for short, are another breed of transient surge protectors. Examples of surge protectors include Zener diodes (not to be confused with ZNRs), shunt diodes, specialized semiconductor devices, transistors connected in a breakdown mode, Metal Oxide (MOVs), Varistors gas-filled quenching tubes, and fast-blow fuses. I am sure there are others that have been missed, but



the point is protecting what needs to be protected, whether it ranges from a computer system to a phone answering machine to countless numbers of other electronic/electrical devices. Figure 9A shows a ZNR protecting a DC source or a single-phase AC source. Figure 9C shows three ZNRs protecting a three-phase AC source. This could also be applied to a three-wire 240volt AC source by connecting a ZNR across each hot wire and connecting two ZNRs, one from each hot, to the neutral.

Last month, we discussed Sidactors, which are similar to two back-to-back SCRs. While a Sidactor has to have current removed once it is tripped, a ZNR does not. So ZNRs are superior in applications where you might not be able to turn off the power right away, yet still demand overvoltage and transient protection. ZNRs are quite fast, with a response time of 50 nS, equivalent to 20 MHz. They also have very high surge current ratings.

Figure 9B shows the relationship between an incoming test signal and the ZNR's response. Observe the maximum clamping voltage at 100% of the applied current. Exceeding this value by forcing more current through the device will destroy it. Note that ZNRs, like other semiconductor devices, have a somewhat flexible range of their ratings. Plus or minus 10% of the nominal voltage is the norm. They are available as leaded technology, with short tabs for high current/fast acting applications and also as SMT, where they are mounted to a PWB as "chips."

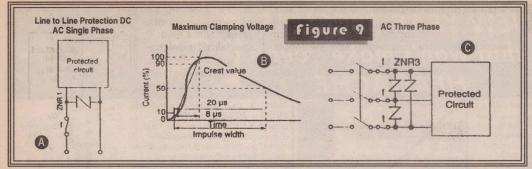
Of the types of ZNRs carried by Digi-Key, one model's maximum current goes up to 25,000 amps! This is a surge rating, and not continuous duty. The rating is derived from the application of one pulse train, which is at the top-rated current for 20 microseconds times eight repetitions. Allowing the device to cool after the application of its maximum rating is

required.

Also very logical, just like you wouldn't apply full power to a transistor continuously without proper heatsinking or it would burn out. While the 25,000 ampere, kilovolt-level devices are in the \$50.00 range, lesser volt and amp ratings are far less expensive and into the hobbyist and professional's price range.

#### **Have I Tried Them?**

Of course! For an exciting real-life tale, read on. A ZNR device was used in a design which converted an ordinary automobile ignition coil into a powerful, portable high-voltage source. It produces 20,000 volts with controllable repetition rates up to 50 Hz (very scary to watch; a zappy one inch plus spark length!). One can accomplish switching an ignition coil with either Kettering (mechanical) points from a car, or an ignition control unit. However, both those were more expensive and more of a hassle than the design parameters permitted.



Just a SPST power switch and a 12-volt battery was mandated as the only external components to operate the power supply; all else was logic and passive components. We couldn't get complex with motor-driven points and their associated control circuits, that's what our device was designed to replace!

Here's where a ZNR saved the day; although I used an internal-diode protected power switching transistor to energize the primary winding,

So what was a few dollars of extra parts compared to peace of mind and not burning out an expensive oscilloscope? (There is a practical lesson here: Cut-and-try is often used in electronic design by people who recognize math isn't all that counts when choosing components to function in a real-life design.) Ultimately, the ZNR of choice had a 2500-amp rating with a nominal breakdown voltage of 470 volts. (Digi-Key #P7097-ND.) The result was, for a mere 63 your questions uncomplicated due to time restrictions.

#### **SMT Transistor Arrays Save Space**

Again, we present another useful, simple, and adaptable circuit from Capitol Advanced Technologies (please see the Supplier List). If you've been following this series of articles, we've mentioned Capitol offers SMT breadboards called Surfboards<sup>TM</sup>, available through Digi-Key in small quantities and through Capitol in OEM lots. These breadboards enable completion of your SMT prototype (or production) designs with a minimum of time and effort.

The two schematics shown in Figure 10 depict a plan for creating transistor array circuits. With these two figures, the top one shows a control circuit for a common anode display multiplexer circuit.

I like this idea, since, even though specific ICs are available for doing the same thing, the flexibility of parameters in those ICs are not as

great. Which means you can change your display and tailor your components to adjust to the particular display without having to resort to a LARGE area to do that. Just use SMT technology. This is particularly useful where a relatively large LED display is needed, but the control circuitry must be harbored in a small space.

#### Conclusion

Next month, I am looking forward to presenting more state-of-the-art integrated circuit technology. Plus, we already received some interesting reader inputs about our questions presented last month. Those questions concerned two proposed build-it-yourself articles:

- 1. A project about a 0.000 volt to 200 mV sensitivity, 2,000-count digital voltmeter circuit which is adaptable to various transducer inputs.
- 2. A mini-course on the internal workings of a microprocessor system including an inexpensive commercially-produced kit you can build yourself to learn about MPUs and, once completed, control a few simple devices.

Result: Aha! The feedback is you want BOTH! So these two articles are in the works, and will appear in the months ahead. And that doesn't eclipse any other ideas you have; we'd be glad to hear your suggestions at the Today's Electronics Reader Helpline. NV

#### **BUILD SURFACE MOUNT TRANSISTOR** ARRAYS ON STANDARD SURFBOARDS

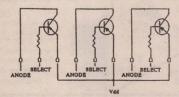
ASSEMBLIES CAN CONTAIN ADDITIONAL COMPONENTS AND SAVE SPACE

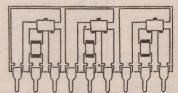
6000 AND 6100 SERIES SURFBOARDS PROVIDE THE PERFECT PLATFORMS

Interface, control, display multiplexing and amplifier circuits are just a few of the applications where groupings of transistors are commonly used. While many commercial arrays are available, they often do not perfectly fit your requirement, and they rarely contain the additional components such as resistors that form part of the circuit. With Surfboards you can build your own custom arrays to match your specifications.

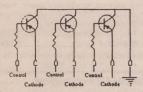
#### WHY GO SURFACE MOUNT?

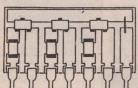
Because your custom arrays will be smaller, plug compatible with sockets, and can be easily moved around the breadboard when prototyping. Best of all, you can add the resistors and other components needed onto the same module. Surfboard 6100 series support a wide range of applications from 1 to 5 transistors. Minor foil modifications can provide additional device footprints as needed





3 DIGIT COMMON ANODE DISPLAY MULTIPLEXER CIRCUIT ARRAY SURFBOARD MODEL 6109 FILLS ROLE WITH ONLY MINOR FOIL MODIFICATIONS LARGER ARRAYS OF THIS TYPE CAN BE BUILT ON SURBOARD MODELS 6112 OR 6115





3 DIGIT COMMON CATHODE MULTIPLEXER CONTROL CIRCUIT CIRCUIT BUILT ON MODEL 6007. LARGER ARRAYS CAN BE BUILT ON OTHER MODELS As you can see in the examples shown, the 6000 series Surfboards support isolated collectors and the 6100 series supports common collector arrangements. With foil modifications and jumpers you can confiqure Surfboards for hundreds of applications.

SEE APPLICATION NOTE SM-EZ-101 FOR INFORMATION ON BASIC ASSEMBLY, EASY FOIL MODIFICATIONS, SIMPLE SOLDERING METHODS, AND BASIC COMPONENT DATA

#### figure 10

the voltage flyback effect of the coil kept toasting those - at \$2.50 apiece. And once the transistor went, the pulse reflected back through it somehow and took out the two CMOS integrated circuits that shaped the switching pulse and regulated its frequency. Another dollar down the drain. Well, after a few dozen incidents, this was getting rather expensive! And annoying.

CIRCUIT UTILIZES FOIL STRUCTURE OF 6000 SERIES FOR COMMON COLLECTORS

I ordered several types of inexpensive ZNRs. We used the "cut-and-try method" to select the ZNR that worked best. Considering our transistor experiences, we did not want to risk an expensive oscilloscope (to observe the high voltage waveform) and select the EXACT transient absorption device beforehand.

cents, the circuit was protected from the transients that were repeatedly destructing the control circuitry. The 20,000 volt supply is alive and well as we speak (write?).

Anyone encountering this kind of problem with his or her design, especially if it's a high voltage one, is urged to check out the remarkable transient protection that ZNRs exhibit.

Plus, I'd be willing to give some simple advice here at the Today's Electronics Reader Helpline (see address box elsewhere) and I'll do this for FREE. either personally or in print. Please keep

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## NEW YEAR SPECIALS that won't make your HEADACHE



#### THERMAL IMAGING SYSTEM, INFRA METRICS model 525.

pact and portable, Features: line scan and isotherm modes, seven temp. difference ranges 10.20.50.100.200.500.1300 °C. Electronic 4x zoom, selectable white or black "hot", Displays grey scale image on any Video monitor. LN<sub>2</sub> cooled via it's internal 30ml dewar. AC power supply, Thermal calibration source and 9" monitor included. Can be operated from 12VDC. Operating range -20 to +1300 °C

•Sensor: HgCdTd

- •250 elements per line.
- •FOV 14 x 18
- •Spectral range: 8-12um, •Head size: 6"x4"x5", Processor size: 8"x8"x5" with operating manual

NOW \$3995

and transit case originaly \$30K

#### COVERT IR FLOODLIGHT with 168 LED's !! erful, not power hungry PLASMA ects up to 40 meters. wered by 24V DISPLAY wall adapter, incl. MONITOR Size:4.5"Wx6.6"Hx1.5"d

BM type 3290-2, w/o camera \$159ea. Hi Resolution, They power With INTERNAL up and self test but we have PINHOLE

Onl;y 5" dee A fantastic unit Very limited quantity \$249ea.

CAMERA \$329ea. Original cost >\$5000

FLIP PHONE VIDEO

A real Motrola flip phone

with micro video camera

Models start at \$599

Range 1/4-2miles,

Call for info.

#### MINI 1/3" CCD CAMERA TRANSMITS VIDEO + AUDIO TO ANY TV.

amera with Mic. Transmitter. Receiver. Powe adapters, cables and illustrated instruction manual.Even an adjustable tilt and swivel camera mount! Everything you need in one simple package. Ready to operate in minutes. Even has RCA style A/V jacks for direct connection to a VCR!

- ▼1/3" CCD, 380 lines, 0.3lux, Black and White ▼Transmits on 900MHz up to 120 ft.
- ▼Clear high resolution picture and quality audio. ▼Perfect for Childs room or office/warehouse
- ▼IR Sensitive. Can be used in total darkness with our invisible IR FLOOD shown at left ▼Size: Camera: 1.25H" x 2.25W" x 5.25"L

Receiver 4.25" x 4.25" x 1"H

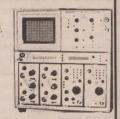


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#### TEKTRONIX 7104, 1GHz bandwidth with MICRO CHANNEL PLATE CRT

Has the highest bandwidth and highest writing speed, unsurpassed single shot capability, trace brightness 1000x brighter than conventional CRT. 350ps risetime! 200 ps per division fastest calibrated sweep rate. Includes two 7A29 1Ghz vertical amplifiers, one 7B10 and one 7B15 Hoizontal amplifiers. Complete operating manual. 90 day warranty

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#### ESCAP SWISS GEARMOTOR

Superior quality brand new motors. Both the motor and 64:1 gearbox are ball bearing. Able to deliver over 14oz/in of torque @ 112RPM, 6VDC @100mA! Can be operated from 1.5VDC to 12VDC. Stainless steel

case. Size: 58mmL x 23.8mm diam. With 3mm diam. shaft. Perfect as a drive motor for our linea slides or for robotics. theirs \$200ea. ours \$15.95ea. 3/\$45

\$79ea.

NEW!



NEW!

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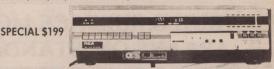
RESISTANT

CAMERA HOUSING

Solid extruded aluminum Size:3.5"wx3.7"Hx14"L

#### TIME LAPSE, VHS VIDEO SECURITY RECORDERS from RCA

We removed these from a large security installation and can pass the saving on to you most have alarm inputs as wll as all the standard features. Most are RCA type: 3290-2 Some have selectable recording speeds up to 300 hours. Call early for best selection. Limited quantity Sorry we have no othe specifications or manuals.



#### GM600 HIGH RES. B/W 1/2" CCD

425K pixels, 600 Lines resolution, 0.02LUX sensitivity. Access all operating parameters from outside the camera! 12VDC pwr. Dual threaded mounts on rugged extruded aluminum housing. Sony CCD! This camera provides true scientific quality for half the price! \$449ea. w/o lens



#### SUPER SENSITIVE, C-MOUNT, MINI CCD CAMERA

GM-410, B&W camera, 38mm SQ. x40mmD, 1/3" CCD, over 270,000 Pixels, 410 Lines Res., Sens. 0.05 LUX., AGC and Electronic Shutter. 12VDC @100mA power. Three lens options fully exploit its superior performance. Composite out. IR SENSITIVE, RCA video connector and jack for DC power. When you need

performance not hype, there is no substitute for a good lens! This camera will out-perform any era in this magazine guaranteed! NEW!, w/o lens... .\$189ea. w/16mm, f1.6,(15° FOV)...\$219ea., w/8mm, f1.3,(30° FOV)... w/4mm, f1.4,(56° FOV)....\$239ea., w/4mm, f1.4 AUTO IRIS LENS..\$325ea.

#### EXPLOSIVE LABEL! CLASS 1.1E 1 AIRPAX assembled 12V STEPPER

10 for \$20

and Size: 2.25"diam.x1'deep /4"dx5/8"L shaft, 1.8deg. per step 2 for \$5 or

5 for \$5.00

NEW

\$15ea

#### "MOTION DETECTOR" or "SMOKE DETECTOR"

#### CCD CAMERAS,

Now, place video cameras almost anywhere! 0.3 lux. 380 lines, 1/3" CCD, 4mm, fl.8, 78° FOV lens, 9VDC @100mA, auto shutter and AGC, smoked lexan face makes "motion" camera almost invisible The smoke det. camera uses a pinhole camera!

Motion detector.....\$159ea. Smoke detector.....\$169ea.



#### NEW! SCIENTIFIC 1/2" COLOR CCD CAMERA with YC/SVHS out Achieves Superior Picture Quality.

380K Pixels, 460 Lines Resolution, 1.5 Lux Sensitivity All operating parameters are adjustable from outside the camera! Perfect for microscopy and

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Truly this camera has it all. Aluminum housing. Size: 50.5mm W x 50.5mm H x 145mm New, boxed. w/o lens..\$529ea.w/16mm, f1.6,..\$569ea.w/8mm, f1.3.\$589ea

#### 12V@8AH GATES GEL CELL PACK NEW! Arrainged as a 1X6 cell pack

MERCURY DISPLACEMENT

Pack size:2"Wx4"Hx11"l Dayton 6X598 RELAY \$10.00ea, Metal Hermetic, class "B box of four, Coil volts:120VAC AC contact rating: up to 5Amps @480V or Tungsten packs \$29

35A @120 V, NEW, BOXED \$15ea or 2/\$25

#### ACTUAL SIZE



1.25" Sq. x .99"D

CCD MICRO CAMERA, Black and White, 1/3 CCD, with a full 250,000 PIXELS!, 380 Lines Resolu tion. Sens. 0.3 LUX. AGC and Electronic Shutter. Low Power 9VDC @100mA ALL lenses incl. pinhole, can be focused! FOV,4mm, 78°, 3mm 110°, Pinhole 91° 10mm to infinity) A real glass lens! You get what you pay for. A little more, for a lot more quality. Standard video out. 1/2 once! IR SENSITIVE! A brand name camera. Mating Connector w/cable incl.

with 3 or 4mm.Lens..... with PINHOLE lens.....\$149ea.

Mini Camera Housing, Black, textured ABS. 1"x1.5"x2" ...\$15.95

#### Don't get "BURNED" Super Bright, 635nm LASERS COMMERCIAL QUALITY at "HOME MADE" PRICES.

#### The Choice is Yours?

We offer 24K GOLD for less than their PC board! Our lab models are priced even lower. 24K Gold plated, laser pen, operates from 2 AAA cells. Lab style has internal X/Y adjustment screws. The wide input voltage laser module as internal SMT pwr supply! All provide 800 Yard range and 1.5mrad ivergence. Performance you can afford One year warranty!

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#### Easy to use, WIDE Input 5mW, LASER with 3V to 6VDC power!



670nm, \$3900 650nm, \$4900 635nm, \$9900 SPECIFICATIONS: DC Power, 3 - 6Vdc, @65mA Power out, 5mw max. Range, 100-800 Meters Glass Collimator (fixed @ inf.) Size, 0.41"diam. x 0.7"L

Absolutely the best value and best quality available on our commercially made, 670nm, 650nm and 635nm subminiature, laser diode modules. A glass collimating lens provides adjustment free <1.5mRad performance. (comparable to HeNe lasers.) NEW wide input range, internal surface mount power supply operates from 3 to 6 Volts DC. The package is machined brass for excellent thermal characteristics. These are THE auglity laser modules

#### 100Kohm 1% DIGIPOT BOURNS 36825-1 VME 2 .decades. 1K per step &

10K per step. size, 1" x .8" x 1.2"d MVME 222-2 NEW MOTOROLA Hard to find surplus what it costs.\$39ea. 2/\$70

BIG CAP 0.1uf Sprague 36DX @3KVDC 3500uf @450VDC PLASTIC 3"diam x.8.6"H trand New! CAPACITOR \$15ea size: 1'diam x 1.75"L Stud terminal on each end. Perfect for amatuer radio work.

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C-MOUNT, CCD IMAGE INTENSIFIER Now a MINI HAND HELD VIEWER AS WELL OUR EXCLUSIVE GM-15K, U.S.

made 2nd GEN. I<sup>2</sup> system provides **15,000X gain**. True night vision and super IR capability to any quality CCD camera. Simply install between camera and your Cmount lens! Now you can use your GM-15K as a hand held viewer with our new eveniece with battery holder. your intensifier twice as usefull. Provides you with one of

the smallest viewers available! ONLY 2"D x 3.4L Truly fits in the palm of your hand GM-15K COMPLETE SYSTEM.....\$999

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Recorder, Regulated AC power supply, Charger, 12V, 1100mAH NiCad DIN to RCA A/V input cable. Wired remote control pendant with 18' cable. (duplicates front panel. Size: 2.25"H x 6.4"W x 7.5" D, weight 3.2lbs. less battery. Uses standard 8mm Video Cassettes.

Up to 150 min. record time with P6-150 Cassette, LCD displays for tape counter, index and battery state. FM quality sound, provides 30Hz to 14kHz freq. response. With operating manuals. Limited quantity. Our price.....

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### **EPROM & CPU/MPUs SOCKET PULLS**

AM486DX-33 (PGA) \$49.95	8742 \$4.95
8087 \$9.95	8748 \$4.95
80287XL \$24.95	8748H\$6.50
80387SX-16 \$17.95	8749 \$5.95
80387SX-20 \$19.95	8749H \$6.50
80387SX-25 \$22.95	8751 \$8.95
80387DX-20 \$17.95	8751H\$9.95
80387DX-25 \$24.95	8752 \$13.95
80486SX-25 (PGA) . \$34.95	8755 \$6.95
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All parts all socket pulls (must be Cle	aned & Frased), "Note: Speed selec-

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EPROMS				
2516	\$0.65	27C256	\$2.25	
2716	\$0.65	27512	\$2.45	
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27C64		27C1001	\$6.50	
27128	\$1.45	27C1024	\$3.95	
27128A	\$1.45	27C020	\$5.95	
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All DRAMS are clean socket pulls and have full leads. ..\$0.18 Ea. 41256-15. ..\$0.25 Ea. 41256-12

#### NEW 8 MEG 70NS 72 PIN SIMM MODULES

New 2MX32-70 (double sided, 16 chip) SIMM memory module. Perfect for upgrading current machines for Windows 95. 30-day guarantee. (Mixed manufactureres)

2X32-70 (8 Meg SIMM) .

#### NEW 170 MEG 2.5" IDE HARD DISK DRIVE

Laptop replacement or up-grade 2.5" hard drive. Logical Translation 989 Cy1./10 heads/34 Sec. Check your BIOS. 15ms +5Vdc 0.5 Amp. (P/N 84G1745).

IBM-H2172-A2/(84G1745)

#### **NEW MATSUSHITA 4X CD-ROM DRIVE** (CR-504-B SCSI INTERFACE)

New four speed CD-ROM drive with motoriz tray. (Caddy less design) Interface: SCSI 5-1/4" half height: Face plate color: Cream. Supported directly by OS/2, Windows 95, Windows NT. Note No software included.

CR-504-B 4X CD-ROM MAT.

#### NEW VICTOR/HONEYWELL ENHANCED 101 KEYBOARD



4 ft. coil cord with PS/2 type 6 PIN MINI DIN connector. AT and XT DIP switch selectable

Model #101WN

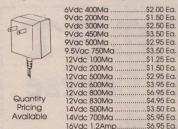
#### **NEW MICROSOFT** TWO-BUTTON PS/2 MOUSE

The old-style type, but old reliable. Note: No software included with mouse.

\$19.95 Ea.

#### WALL PLUG WALL ADAPTERS

Input: 117 Vac 50/60 Hz. Outputs Available.



#### NEW 80486SX-25 **BABY MOTHERBOARDS**

Supports up to 32MB of RAM on-board. 256KX9/1Megx9/4Megx9/(80NS) 30 Pin type SIMM Five 16 Bit Slots and One 8 Bit Slot, AMI BIOS/Supports loadable hard drive parameters 720K/1.2Meg/1.44Meg/ 2.88Meg (with proper controller) 8K Internal cache only 486SX-25 Baby Motherboard (CPU included) .. PRICE REDUCED \$74.95 Ea.

## NEW NISCAN/GS PLUS OCR/ 256 GRAY SCALE SCANNER

Brand New True 256 Gray Scale Hand Scanner Resolution: 25-400 DPI. Scan Width: 4.2 In. Scan Length: 11 In. Interface: 16 Bit high speed (ISA) card, 64K SRAM. System Requirements: 286/386/486 PC Compatible



(16MHz). Available 16-Bit Interface slot. Windows 3.1, 4 Meg RAM, 10 Meg of Available HD space (Min.),

Mouse or Other pointing device.

Software Included: Picture Publisher LE 3.1, (Imaging Software), Perceive Personal 2.1, (OCR Software) Niscan/GS Plus ..

#### **USED 150MEG SCSI TAPE BACK-UP DRIVE**

Pulled from working equipment 150Meg SCSI Cipher P/N ST150-II. 30-Day Guarantee. 5-1/4" Half Height, off-white color faceplate. Interface: SCSI/1

Cipher ST150S-2.

#### **NEW AST 101 ENHANCED KEYBOARD**

Brand new AST 101 keyboards with 4 ft. coil cord to 5 pin male DIN. AT compatible only. Available in

AST 101 KB (black or 0/white)...

## NEW OEM/DEC ATI VGA WONDER 512K ISA VGA VIDEO BOARD W/BUS MOUSE

This board was made for DEC's line of PCs by ATI. It is the ATI wonder ISA bus with three button mouse included. (Plugs into the back of the video board.) 640x480/256 color: 800x600: 1024 x 768/16C. Note: Software included with board and bus mouse. OEM/DEC ATI PS1XG-AA.

#### NEW CYRIX FASMATH COPROCESSOR CX-83D87-33-GP

New Cyrix FasMath coprocessors for 80386DX16-33 systems. This FPU unit is used in place of Intel's 80387DX16-33 part. Originally priced at \$100.00, a steal \$10.95. Case: 68 pin grid array. Cyrix CX-83D87-33-GP.....

## USED 80 MEG 3.5" SCSI HARD DISK DRIVE

Pulled from working equipment. 80 Meg SCSI Quantum P/N ProDrive 80S. 30-day guarantee. 3-1/2", 1/3 Height (1-5/8"). Interface: SCSI/2, 50 pin. Quantum 80\$ SCSI......\$49.95 Ea

#### NEW SQUARE EQUIPMENT FANS

115 Vac	3.1" or 4.7"	\$7.95 Ea.
12 Vdc	3.1" or 4.7"	\$6.00 Ea.
12 Vdc	2-3/8"	\$4.95 Ea.
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#### **NEW PANASONIC 360K** 5-1/4" FLOPPY DRIVE

5-1/4" half height Panasonic M# JU-455. Black face plates only. P/N: JU-455.

#### NEW PORTABLE 14.4 FAX/DATA MODEM WORLDPORT BY USROBOTICS

Brand new portable 14.4 V.42bis Fax/Data Modem. Attaches directly to portable or desktop computer (Standrd DB9S on Cable end.) Battery powered 9V or with wall adapter included. Includes integrated Fax/Communications software for Windows and DOS WorldPort 14.4 USR......\$79.95 Ea.

#### **NEW 200W BABY SWITCHING POWER SUPPLY**

Input: 120V-220V 50Hz/60Hz UL & CSA Output: +12 Vdc @ 8 Amp, +5 Vdc @ 22 Amp -5 Vdc @ 0.5 Amp, -12 Vdc @ 0.5 Amp Model #SA201-3440 Astec ..

#### NEW AA HIGH CAPACITY NI-CAD BATTERY

1.2Vdc 800Ma/Hr. Charge Rate 15 Hours @ 80Ma. Manufacturer Kenwood/Batteries have nippled end Kenwood NB-88 (KR-AA) ..... Kenwood NB-88 (KR-AA) 4 or more.

#### **NEW 250 MEG 2.5" IDE** HARD DISK DRIVE

Laptop replacement or upgrade 2.5" hard drive. Logical translation 723 Cyl./11 heads/63 sec. Check your BIOS. 17ms +5VDC 0.5 Amp.

#### **USED ADAPTEC 1540A** ISA SCSI-2 CARDS

Pulled from working equipment. The Adaptec's first generation 1540A SCSI-2 ISA BUS card. Includes 2 Device 50 Pin SCSI cable. (NO Software) (No Floppy support) 30-Day Guarantee. ADPTEK 1540A ......\$34.95 Ea.

## PULLED 1 MEG X 9 70NS 30 PIN SIMM MODULES

Pulled and tested 1 Meg x 9 70ns (3 chip type) SIMM memory module. Great for upgrading older machines for Windows 95. (Mixed Manufacture & Third party types.) 30-Day Guarantee

1 MEGX9-70 30P SIMM.

#### **NEW ADAPTEC EISA SCSI/2** CONTROLLER BOARD

High Performance board supports two floppies and up to seven SCSI devices. Note: No manual or software supplied with card. Adaptec AHA-1742A

## PULLED NEC DUAL SPEED SCSI CD-ROM 5-1/4" DRIVE

Pulled dual speed SCSI interface CD-ROM drive in excellent condition. 5-1/4" half height with cream face plate. Caddy less design with 30-day guarantee. NFC M# CDR210 2X ..... \$49.95 Fa NEC M# CDR510 3X \$59.95 Fa

#### NEW EXTERNAL 3-1/2" 720K FLOPPY DISK DRIVE



Made by Tandy for Tandy 1000EX Computer Unit enclosed with cable for hook-up. Drive inside is a Teac Corp. Model #FD-35 FN-10-U. Color: White

Tandy Model #25-1061

.\$24.95 Eq.

**WIRE TIES** 

4" Black Plastic, Packs of 100

\$1.00

#### **NEW ATI MACH 64 2 MEG** VRAM UPGRADE MODULE

#### **NEW SYTOS PLUS** TAPE BACK-UP SOFTWARE)

Works SOLD PAT/130/320 or Wangtek 150/5. Adaptec Hosi Patron Patron System Syst nment supporting

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We buy all defective Memory Boards/Modules from IBM, as well as computer scrap. Please contact Mr. Wiley Burke.

Write in 177 on Reader Service Card.

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PAGEMATE CALLS your pager when messages are left on your answering machine. Don't miss another important call! Win/DOS. \$35. Check/MO/Visa/MC. R. Matter, PO Box 9042, Highland, IN 46322. 219-845-5247. robert7063@aol.com



UJ'S@, EMULATOR-TEST INSTRU-MENT. (REFURBISHED-DEACTIVATED-MODIFIED, CELLULAR PHONE) EFFORTLESS 5 STEP, 5 MINUTE PRO-GRAMMING (FOR COMMERCIAL USE) MOTOROLA'S FIRMWARES FROM 9122
TO 94XX. EMULATOR-TEST SET,
AUTOMATICALLY ADJUSTS FOR
MODEL, FIRMWARE, ETC., BEING PROGRAMMED, EXTENDS MOST POPULAR
AMPS SOFTWARE 9122 BELOW) TO AMPS SOFTWARE 9122 BELOW) TO PROGRAM FIRMWARES TO 94XX, ALSO REPAIRS 0000FFFF. COMPLETE UJME-94XX. EMULATOR PROGRAMMING SYSTEM WITH PORTABLE PC, FITS DEEP ATTACHE CASE, OPERATES ON 12VDC, 117VAC. UJME-99XX ASSEMBLED, TESTED, READY TO OPERATE, INCLUDES PROGRAMMING HANDSET, EMULATOR 4 MODE CONTROL BOX, 3 FT. INTERFACE CABLE, SOFTWARE MAMPS-15: (AMPS 9122) SOFTWARE MAMPS-1E: (AMPS 9122 BELOW, MAMPS, ETAC & AMPS G2E PROGRAMS) POWER ADAPTER, INSTRUCTIONS, MODEL UJME-94XX, \$369.95 COMBINATION OFFER A: \$669.95 (SAVE \$60) INCLUDES EMULA-TOR MODEL UJMÉ-94XX WITH 3 SETS MOTOROLA COMPATIBLE, PHONE-EMULATOR-COMPUTER, INTERFACE
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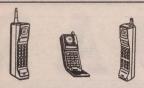
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RING DECODER. Decodes up to 4 unique rings purchased from your local phone company. Not available in all areas. Have up to four phone numbers on one line. FCC 68 cert. Save big monthly bills. \$79.95. \$5 UPS. Accept VISA. Call for COD. LOGICAL DESIGN TOOLS, INC., 5403 Everhart, Box 55, Corpus Christi, TX 78411. Phone 512-888-4535.

ESN READER connects between AR3000 scanner and personal computer, reads and logs to disk. Scanner and computer not included. \$995 US postal money order to Keith Perry, PO Box 816, Leander, TX 78646-0816. SASE for info. 512-259-4770.

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Nuts & Volts Magazine/January 1996 105

# cuents

#### **WESTERN REGION**

#### JANUARY 6

CA - FRESNO - MarketPro Computer Show & Sale. LOCATION: Fresno Fairgrounds. HOURS: 10am-5pm. ADMISSION: \$6, free w/membership. FEA-TURES: C. CONTACT: MarketPro Computer

CA - SANTEE - Ham Radio, Computer & CA-SANIEE – nam Radio, Computer 6 Electronics Swap Meet. SPONSOR: ARC of El Cajon. LOCATION: Santee Drive-In, 10990 N. Woodside. HOUIRS: 6:30am-? ADMISSION: 50¢, TALK-IN: 146.520. FEATURES: C - E - FM - F/R H. DEALER INFO: \$7 vehicle. CONTACT: Pat WA6MHZ, ARCEC, Box 50, El Cajon CA 92020. 619-

#### JANUARY 7

CA - LANCASTER — MarketPro Computer Show & Sale. LOCATION: Antelope Valley Fairgrounds. HOURS: 10am-5pm. ADMISSION: \$6, free /membership. FEATURES: C. CONTACT: MarketPro Computer Shows.\*

CA - LIVERMORE — East Bay Area Amateur Radio/Electronics/Computer Swap Meet SPONSOR: Livermore Amateur Radio Klub (LARK), LOCA-TION: Las Positas College, N of 1-580 at Airway Blvd exit. HOURS: 7am-12noon, rain or shine. ADMIS-SION: Free. TALK-IN: 147.045+ (PL 94.8) from W. 145.350- (PL 100) from E. FEATURES: E-H-FP F/R. DEALER INFO: Set-up after 7am only. \$10 space fee. Covered spaces avail if rain. CONTACT: Noel Anklam KC6QZK, 510-447-3857 eves or 510-783-2803 message days.

CA - SAN DIEGO — MarketPro Computer Show & Sale. LOCATION: Scottish Rite Center. HOURS: 10am-5pm. ADMISSION: \$6, free w/membership. FEATURES: C. CONTACT: MarketPro Computer

#### JANUARY 13

AZ - PHOENIX - WestFest, SPONSOR: Amateur Radio Council of Arizona & Thunderbird ARC.

LOCATION: Glendale Community College, North lot, 6000 W Olive (Dunlap & 59th Ave). HOURS: 6am-4pm. ADMISSION: Free, parking \$2. TALK-IN: 146.76-600, 162.2 PL. FEATURES: CB - F/R-RV-S. DEALER INFO: Tailgaters \$5. CONTACT: Morgan N7DLW, 602-938-4356, Mark N7KKQ, 602-843-0960

CA - FONTANA - Amateur Radio & Electronic Equipment Swap Meet. SPONSOR: Inland Empire ARC & A.B. Miller High School ARC. LOCATION: A.B. Miller High School 6821 Oleander Ave. HOURS: 7am-? ADMISSION: Free. FEATURES: E - FP - F/R - H. **DEALER INFO:** Tailgate space \$6. Set-up 6am. **CONTACT:** Bill Gruber 909-822-4138 eves. VE exams are now on the first Sat of each month at 8am; contact Ken Canfield, 685-7694.

CA - SACRAMENTO — MarketPro Computer Show & Sale. LOCATION: Scottish Rite Center. HOURS: 10am-5pm. ADMISSION: \$6, free w/membership. FEATURES: C. CONTACT: MarketPro Computer

#### JANUARY 14

- OXNARD - MarketPro Computer LOCATION: Community Center. HOURS: 10am-5pm. ADMISSION: \$6, free w/membership. FEA-TURES: C. CONTACT: MarketPro Computer

CA - SANTA ROSA — MarketPro Computer Show & Sale. LOCATION: Sonoma Co. Fairgrounds. HOURS: 10am-5pm. ADMISSION: \$6, free w/membership. FEATURES: C. CONTACT: MarketPro Computer Shows.\*

#### JANUARY 20

CA - BAKERSFIELD - MarketPro Computer Show & Sale. LOCATION: Kern Co. Fairgrounds. HOURS: 10am-5pm. ADMISSION: \$6, free w/membership. FEATURES: C. CONTACT: MarketPro Computer

CA - SANTEE - Ham Radio, Computer & Electronics Swap Meet. SPONSOR: ARC of El Cajon. LOCATION: Santee DriveIn, 10990 N. Woodside. HOUIRS: 6:30am-? ADMISSION: 50¢, TALK-IN: 146,520. FEATURES: C - E - FM - F/R -H. DEALER INFO: \$7 vehicle. CONTACT: Pat WA6MHZ, ARCEC, Box 50, El Cajon CA 92020. 619-

'he Events Calendar is a free service limited to electronic events such as computer shows, hamfests, flea markets, etc. If your organization is sponsoring an event and would like a free listing, contact us at least 60 days prior to the event. 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 91719 Phone 909-371-8497

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Internet

74262.3664@compuserve.com

#### JANUARY 20-21

CA - VALLEJO - MarketPro Computer Show & Sale. LOCATION: Solano Co. Fairgrounds. HOURS: 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer

#### JANUARY 27-28

CA - SACRAMENTO - MarketPro Computer Show & Sale. LOCATION: Cal Expo. HOURS: 10am-5 ADMISSION: \$6, free w/membership. FEATURES: C. CONTACT: MarketPro Computer Shows.\*

CA - VENTURA — MarketPro Computer Show & Sale, LOCATION: Ventura Fairgrounds. HOURS: 10am-5pm, ADMISS10N: S6, free w/membership, FEATURES: C. CONTACT: MarketPro Computer

#### JANUARY 28

CA - SANTA ANA — ACP Computer Swap M SPONSOR: Advanced Computer Products. LOCA-TION: 1310 E. Edinger. HOURS: 8am-2pm, rain or shine. ADMISSION: Free. FEATURES: C - E - FP. DEALER INFO: All spaces \$75 in advance. Call for multiple pricing. CONTACT: Mary Russo, 714-558-

#### JANUARY 30-31-FEBRUARY 1

CA - SANTA CLARA — SoftExpo '96. SPONSOR: Webcom Communication Corp. LOCATION: Santa Clara Convention Center. CONTACT: Webcom Communication, 303-745-5711.

#### FEBRUARY 3

CA - ANTIOCH - MarketPro Computer Show & Sale. LOCATION: Contra Costa Fairgrounds. HOURS: 10am-5pm. ADMISSION: \$6, free /membership. FEATURES: C. CONTACT: MarketPro Computer Shows.\*

CA - SANTEE - Ham Radio, Computer & Electronics Swap Meet. SPONSOR: ARC of El Cajon. **LOCATION:** Santee Drive-In, 10990 N. Woodside. **HOURS:** 6:30am-? **ADMISSION:** 50¢ H. DEALER INFO: \$7 vehicle. CONTACT: Pat WA6MHZ, ARCEC, Box 50, El Cajon CA 92020. 619-561-0052

#### FEBRUARY 4

CA - LANCASTER — MarketPro Computer Show & Sale. LOCATION: Antelope Valley Fairgrounds. HOURS: 10am-5pm. ADMISSION: \$6, free w/membership. FEATURES: C. CONTACT:

CA - LIVERMORE — East Bay Area Amateur Radio/Electronics/Computer Swap Meet SPONSOR: Livermore Amateur Radio Klub (LARK). LOCA-TION: Las Positas College, N of I-580 at Airway Blvd exit. HOURS: 7am-12noon, rain or shine. ADMIS-SION: Free. TALK-IN: 147.045+ (PL 94.8) from W, 145.350- (PL 100) from E. FEATURES: E - H - FP F/R. DEALER INFO: Set-up after 7am only. \$10 space fee. Covered spaces avail if rain. CONTACT: Noel Anklam KC6QZK, \$10-447-3857 eves or \$10-783-2803 message days.

CA - SANTA ROSA - MarketPro Computer Show & Sale. LOCATION: Sonoma Co. Fairgrounds. HOURS: 10am-5pm. ADMISSION: \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.\*

#### FEBRUARY 10

CA - FRESNO - MarketPro Computer Show & Sale. LOCATION: Fresno Fairgrounds. HOURS: 10am 5pm. ADMISSION: \$6, free w/membership. FEA-TURES: C. CONTACT: MarketPro Computer

CA - FONTANA — Amateur Radio & Electronic Equipment Swap Meet. SPONSOR: Inland Empire ARC & A.B. Miller High School ARC. LOCATION:
A.B. Miller High School, 6821 Oleander Ave.
HOURS: 7am-? ADMISSION: Free. FEATURES: E - FP - F/R - H. **DEALER INFO**: Tailgate space \$6. Set-up 6am. **CONTACT**: Bill Gruber 909-822-4138 eves. VE exams are now on the first Sat of each month at 8am; contact Ken Canfield, 685-7694.

#### FEBRUARY 11

CA - SAN DIEGO - MarketPro Computer Show & Sale, LOCATION: Scottish Rite Center. HOURS: 10am-5pm. ADMISSION: \$6, free w/membership. FEATURES: C. CONTACT: MarketPro Computer

#### FEBRUARY 17

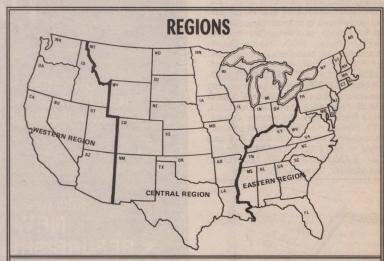
AZ - TUCSON - Fest West '96. SPONSOR:

SouthWest Ninety Niners User Group. LOCATION: Quality Inn, University. HOURS: 9am-6pm. ADMIS-SION: \$4, under 15 free w/adult. FEATURES: C. CONTACT: Tom Wills, 520-886-2460, twills@inderect.com, or twills@pima.gov

CA - SANTEE — Ham Radio, Computer & Electronics Swap Meet. SPONSOR: ARC of El Cajon. LOCATION: Santee Drive-In, 1999 0 M. Woodside. HOURS: 6:30am-? ADMISSION: 50 C. TALK-IN: 146-520. FEATURES: C - E - FM - F/R H. DEALER INFO: \$7 vehicle. CONTACT: Pat WA6MHZ, ARCEC, Box 50, El Cajon CA 92020. 619-561-0052

CA - STOCKTON — MarketPro Computer Show & Sale. LOCATION: Civic Auditorium. HOURS: 10am-5pm. ADMISSION: \$6, free w/membership. FEA-TURES: C. CONTACT: MarketPro Computer

OR - RICKREAL — 1996 Salem HamFair. SPON-SOR: Oregon Coast Emergency Rptr. Assn. 8 Salem Rptr. Assn. LOCATION: Polk County Fairgrounds. HOURS: 9am-4pm. TALK-IN: 146.86. FEATURES: CB - FM - H - RV-S. CONTACT: Evan Burroughs N7IFJ, PO Box 784, Salem OR 97308. 503-585-5924.



#### **FEATURES KEY**

- Air Conditioned

- Banquet

Computers - Commercial Booths

DP - Door Prizes

AC

B

CB

E Electronics

EX FCC Exams - Forums

FM Flea Market FP Free Parking

F/R - Food & Refreshments

Amateur Radio RV/H RV Parking w/hookups

RV/S - RV Parking Self Contained S

Seminars

- Tailgating

#### **COMPUTER SHOW PROMOTER INFO**

AGI Computer Fair - 317-299-8827 KGP Computer Shows - 908-297-2526

MarketPro Computer Shows

West (CA) - 415-388-8893

East (MD, OH, PA, VA) - 301-365-9696

N.E. (CT, MA, NJ, NY, RI) - 201-265-1075

NARISAAM Computer Shows - 800-436-6707

Northern Computer Shows - 508-744-8440

## ECCEPTED CALENDAR

#### FEBRUARY 17-18

CA - VENTURA - MarketPro Computer Show & Sale. LOCATION: Ventura Fairgrounds. HOURS: 10am-5pm. ADMISSION: \$6, free w/membership. FEATURES: C. CONTACT: MarketPro Computer

#### FEBRUARY 18

CA - SACREMENTO - MarketPro Computer Show & Sale. LOCATION: Scottish Rite Center. HOURS: 10am-5pm. ADMISSION: \$6, free w/membership. FEATURES: C. CONTACT: MarketPro Computer

#### FEBRUARY 24-25

CA - VALLEJO - MarketPro Computer Show & Sale. LOCATION: Solano Co. Fairgrounds. HOURS: 10am-5pm. ADMISSION: \$6, free w/membership. FEATURES: C. CONTACT: MarketPro Computer Shows.1

#### FEBRUARY 24

CA - MONTEREY - ARRL Hamfest, SPONSOR: Naval Postgraduate School ARC. CONTACT: Max Cornell KOMC, 199 Linde Cir, Marina CA 93933-2206. 408-883-0491.

#### MARCH 2

CA - SANTEE — Ham Radio, Computer & Electronics Swap Meet. SPONSOR: ARC of El Cajon. LOCATION: Santee Drive-In, 10990 N. Woodside. HOURS: 6:30am-? ADMISSION: 50¢. TALK-IN: 146.520. FEATURES: C - E - FM - F/R -H. DEALER INFO: \$7 vehicle. CONTACT: Pat WA6MHZ, ARCEC, Box 50, El Cajon CA 92020. 619-561-0052

#### MARCHS

CA - LIVERMORE — East Bay Area Amateur Radio/Electronics/Computer Swap Meet SPONSOR: Livermore Amateur Radio Klub (LARK), LOCA-TION: Las Positas College, N of I-580 at Airway Blvd exit. HOURS: 7am-12noon, rain or shine. ADMIS-SION: Free. TALK-IN: 147.045+ (PL 94.8) from W, 145.350- (PL 100) from E. FEATURES: E-H-FP-F/R. DEALER INFO: Set-up after 7am only, \$10 space fee. Covered spaces avail if rain. CONTACT: Noel Anklam KC6QZK, \$10-447-3857 eves or \$10-783-2803 message days.

#### MARCH 9

AZ - SCOTTSDALE — ARRL Hamfest, SPON-SOR: Scottsdale ARC. CONTACT: Ron Reynolds N7WTF, 2514 E Turney Ave, Phoenix AZ 85016-5617. 602-240-0473.

CA - FONTANA - Amateur Radio & Electronic Equipment Swap Meet. **SPONSOR:** Inland Empire ARC & A.B. Miller High School ARC. **LOCATION:** A.B. Miller High School, 6821 Oleander Ave.
HOURS: 7am-? ADMISSION: Free. FEATURES: E - FP - F/R - H. **DEALER INFO**: Tailgate space \$6. Set-up 6am. **CONTACT**: Bill Gruber 909-822-4138 eves. VE exams are now on the first Sat of each month at 8am; contact Ken Canfield, 685-7694.

WA - PUYALLUP - 15th Annual Electronics Show & Flea Market. SPONSOR: Mike & Key ARC. LOCATION: Pavilion Exhibition Hall, Western Washington Fairgrounds. HOURS: 9am-? DEALER INFO: 206-854-4031, eves. CONTACT: Mike & Key ARC, 637 2nd Ave S, Kent WA 98032-

#### MARCH 12-13-14

CA - LOS ANGELES - Computer Telephony Conference & Exposition. LOCATION: Los Angeles Convention Center. HOURS: Tues 3pm-7pm, Wed 10am-6pm, Thurs 10am-4pm. DEAL-ER INFO: 215-355-2886. CONTACT: 212-691-8215 or fax-back 212-645-1478.

#### MARCH 15-16

AR - LITTLE ROCK - Hamfest & State ARRL Convention. LOCATION: Little Rock Expo Center, 1-30, exit 126. FEATURES: CB - F - FM - H - T. CONTACT: Jim Blackmon KB5IFV, 1008 Pine St, Arkadelphia AR 71923-4919. Wk 501-246-6734, Hm 501-246-7833

#### MARCH 16

CA - SANTEE - Ham Radio, Computer & Electronics Swap Meet. SPONSOR: ARC of El Cajon. LOCATION: Santee Driveln, 10990 N. Woodside, HOURS: 6:30am-? ADMISSION: 50¢. TALK-IN: 146,520. FEATURES: C - E - FM - F/R - H. DEALER INFO: \$7 vehicle. CONTACT: Pat WA6MHZ, ARCEC, Box 50, El Cajon CA 92020. 619-

#### MARCH 17

OR - MILTON-FREEWATER — ARRL Hamfest. SPONSOR: Walla Walla Valley ARC. CONTACT: David Pence KB7WRT, 810 E Sumach St, Walla Walla WA 99362-1348, 509-525-2529.

#### MARCH 31

CA - SANTA ANA - ACP Computer Swap Me SPONSOR: Advanced Computer Products. LOCA-TION: 1310 E. Edinger. HOURS: 8am-2pm, rain or shine. ADMISSION: Free. FEATURES: C - E - FP. DEALER INFO: All spaces \$75 in advance. Call for multiple pricing. CONTACT: Mary Russo, 714-558-

#### **CENTRAL REGION**

#### JANUARY 6

MI - KALAMAZOO - Super Computer Sale. LOCA-TION: Kalamazoo Co. Fairgrounds, of Exit 81. **HOURS:** 10am-3pm. **ADMISSION:** Adults \$4; seniors & students w/ID \$3; under 12 free w/adult. **FEATURES:** C - DP. **CONTACT:** Computers & You, 313-283-1754.

#### JANUARY 6-7

MI - DETROIT - Computer & Hi Tech Electronic Show. **SPONSOR:** Target Productions. **LOCATION:** Michigan State Fairgrounds, Coliseum Bldg. **ADMIS**-SION: \$7, under 12 free. FEATURES: C - DP - E - F/R. DEALER INFO: Space \$45, set-up Fri 4pm-8pm, Sat 6am-8am. **CONTACT:** Target Productions, POB 1634, Monroe MI 48160.

OH - CINCINNATI - Computer Show & Sale. SPONSOR: MarketPro. LOCATION: Cincinnati Gardens. HOURS: 9:30am-4pm. ADMISSION: \$6. FEATURES: C - FP. CONTACT: MarketPro Computer Shows.\*

#### JANUARY 7

IN - SOUTH BEND — 19th Annual South Bend Hamfest & Computer Expo. SPONSOR: Michiana Valley Hamfest Assn. LOCATION: Century Center, US 33 N @ Jefferson Blvd. HOURS: 8am-3pm. ADMISSION: Adv \$4, door \$5. FEATURES: C - DP - FM - H. DEALER INFO: Tables \$5-\$20, set-up 6am. CONTACT: Denny KA9WNR, 219-291-0252 eves. MVHA, 21970 Kern Rd, South Bend IN 46614.

MI - DEARBORN - Super Computer Sale. LOCA-TION: Dearborn Civic Center, 15801 Michigan Ave. HOURS: 10am-4pm. ADMISSION: Adults \$4; seniors & students w/ID \$3: under 12 free w/adult. FEATURES: C - DP. CONTACT: Computers & You, 313-283-1754.

#### JANUARY 13

CO - LOVELAND — Winter Superfest Swapmeet. SPONSOR: Northern Colorado ARC. LOCATION: Larimer County Fairgrounds, 700 S Railroad.
HOURS: 9am-3pm. ADMISSION: \$3. FEATURES: C - CB - DP - E - EX - FP - F/R - H. **DEALER INFO:**Tables \$8. **CONTACT:** Jeanene Gage N0YHY, 970-351-7327 for tables, Michael Robinson AA0UB, 970-282-1167 chairman.

MI - NOVI — Super Computer Sale. LOCATION: Novi Expo Center, 43700 Expo Center Dr, I-96 & Exit #162 Novi Rd. HOURS: 10am-3pm. ADMISSION: Adults \$4; seniors & students w/ID \$3; under 12 free w/adult. FEATURES: C - DP. CONTACT: Computers & You, 313-283-1754.

#### JANUARY 14

IL - DESPLAINES - Computer Show and Sale LOCATION: Oakton Community College in DesPlaines. HOURS: 10am-3pm. ADMISSION: \$6. FEATURES: AC - C - FP. CONTACT: ComShow

IL - ORLAND PARK - The Orland Park Computer Show. **LOCATION:** Orland Park Civic Center, 147th St & LaGrange Rd (Rte 45). **HOURS:** 9:30am-3pm. ADMISSION: Adults \$5 - \$1 off with copy of this ad, 8-12 yrs \$2, under 8 free. FEATURES: AC - C - CB -FP - F/R - All indoors. CONTACT: 24-hour Hotline 708-974-3123.

IN - FT. WAYNE - Computer Show & Sale. SPON-SOR: MarketPro. LOCATION: Allen County Fairgrounds. HOURS: 9:30am-4pm. ADMISSION: \$6. **FEATURES:** C - FP. **CONTACT:** MarketPro Computer Shows.\*

MI - GRAND RAPIDS - Super Computer Sale LOCATION: Holiday Inn Crown Plaza, 5700 28th St SE, E of I-96, Exit #43B. HOURS: 10am-4pm. ADMISSION: Adults \$4; seniors & students w/ID \$3; under 12 free w/adult. FEATURES: C - DP. CONTACT: Computers & You, 313-283-1754.

MI - KALAMAZOO — Computer/Camera Swapmeet. LOCATION: Kalamazoo County Fairgrounds. HOURS: 10am-3pm. ADMISSION: under 12 free. DEALER INFO: 8' tables, \$50. CONTACT: Roger L. Smith, 8863 E. Black Point Rd, Syracuse IN 46567, 219-856-3863 VM/FAX.

OH - DOVER — Hamfest. SPONSOR: Tusco ARC. LOCATION: Ohio National Guard Armory, 2800 N Wooster Ave. HOURS: 8am-? ADMISSION: \$2. FEATURES: F - F/R - H. DEALER INFO: Tables \$8, set-up 6am. CONTACT: Howard Blind KD8KF, 6288 Echo Lake Rd NE, New Philadelphia OH 44663. 216-364-5258.

WI - WAUKESHA — 24th Annual Midwinter Swapfest. SPONSOR: West Allis RAC. LOCATION: Waukesha County Expo Center Forum. HOURS: 8am-2pm. ADMISSION: Adv \$3, Door \$4. FEA-TURES: C - E - EX - H. DEALER INFO: 4' tables: adv \$4, door \$5, elec \$8. CONTACT: WARAC Swapfest, POB 1072, Milwaukee WI 53201.

#### JANUARY 20

LA - SPRINGFIELD — Hammond Hamfest. SPON-SOR: Southeast Louisiana ARC. LOCATION: Southeastern Louisiana University, upper level of the SLU "University Center," HOURS: 8am-2. ADMIS-SION: Free. TALK-IN: 147.000 - FEATURES: C-DP - EX - F - FP - H. DEALER INFO: Tables \$15, swap space \$8, CONTACT: SELARC, POB 442. Springfield LA 70462.

MI - FLINT - 4th Annual Swap & Swap. SPON-SOR: Amateur Radio and Youth (ARAY) & Southwestern Academy Radio Club. LOCATION: Southwestern Academy, I-69 @ Hammerburg Rd. HOURS: 8am-1pm. ADMISSION: \$4. ADMIS-SION: 147.26, 145.29, 224.18. FEATURES: C - CB F/R - H. CONTACT: Keith N8QNA, 810-635-4123.

MI - LIVONIA - Super Computer Sale. LOCATION: Livonia Elks Lodge Hall, 31117 Plymouth Rd, of Merriman. HOURS: 10am-3pm. ADMISSION: Adults \$4; seniors & students w/ID \$3; under 12 free w/adult. FEATURES: C - DP. CONTACT: Computers & You, 313-283-1754.

MO - ST. JOSEPH - Northwest Missouri Winter Hamfest. SPONSOR: Missouri Valley, Green Hills & Ray-Clay ARCs. LOCATION: Ramada Inn. I-29 Exit Frederick Ave exit. HOURS: 9am-4pm. ADMIS SION: Adv \$2, door \$3. TALK-IN: 146.85, 444.925. FEATURES: CB - DP - EX - FM - FP. DEALER INFO: Tables: \$8 ea for first two, \$20 table #3 & above. CONTACT: NMWH, POB 182, Cameron MO 64429

OH - DAYTON - Computer Show & Sale. SPON-SOR: MarketPro. LOCATION: Montgomery County Fairgrounds. HOURS: 9:30am-4pm. ADMISSION: \$6. FEATURES: C - FP. CONTACT: MarketPro Computer Shows.\*

#### **JANUARY 20-21**

OH - DAYTON - Computer Fair. SPONSOR: Trade Show Promotions. LOCATION: Dayton Convention Center. HOURS: Sat 10am-5pm, Sun 10am-3pm. ADMISSION: \$5. CONTACT: Mark Hanslip, 143 Schloss Ln, Dayton OH 45418.

#### JANUARY 21

IL - GLEN ELLYN — Computer Central. LOCATION: College of DuPage, Park Blvd & College Rd. HOURS: 9:30am-3pm. ADMISSION: Adults \$6, 8-12 \$2, under 8 free. \$1 off reg adult admission w/this ad. FEATURES: AC - C - FP. CONTACT: Computer Central, Jay B. Robinson, 708-940-7547.

MI - LANSING — Super Computer Sale. LOCA-TION: Holiday Inn South Convention Center, 6820 S Cedar St, Exit #104 off of I-96. HOURS: 10am-4pm. ADMISSION: Adults \$4; seniors & students w/ID \$3; under 12 free w/adult. FEATURES: C - DP. CONTACT: Computers & You, 313-283-1754.

MI - SOUTHFIELD — 30th Annual Swap & Shop. SPONSOR: Southfield High School's Technology Dept. LOCATION: Southfield High School, 24675 Lahser Rd. HOURS: 8am-3pm. ADMISSION: \$5. FEATURES: C - DP - E - H. DEALER INFO: 8' table \$17. CONTACT: Gerald Kocsis, Southfield High School, 24675 Lahser Rd, Southfield MI 48034, 810-746-8853.

OH - COLUMBUS - Computer Show & Sale. SPONSOR: MarketPro. LOCATION: Ohio
Expositions Center. HOURS: 9:30am-4pm. ADMIS-SION: \$6. FEATURES: C - FP. CONTACT: MarketPro Computer Shows.\*

OH - NELSONVILLE - ARRL Hamfest. SPONSOR: Sunday Creek AR Federation. CONTACT: Allan Withern KC8VR, Old St Rte 78, Glouster OH 45732. 614-767-2766.

#### JANUARY 27

IN - INDIANAPOLIS - Indianapolis Computer Fair. LOCATION: Beech Crest Center, 3655 E Raymond St, corner Sherman, E of I-65 Exit 109. HOURS: 10am-4pm. ADMISSION: \$6, under 12 free. FEA-TURES: C - DP. CONTACT: Ben Yanto, AGI Computer Fairs.\*

MI - TAYLOR — Super Computer Sale. LOCATION: Democratic Club of Taylor, 23400 Wick Rd, 4 blks E of Telegraph. **HOURS:** 10am-3pm. **ADMISSION:** Adults \$4; seniors ε students w/ID \$3; under 12 free w/adult. FEATURES: C - DP. CONTACT: Computers & You, 313-283-1754.

MO - ST. CHARLES — ARRL Hamfest. SPON-SOR: St. Louis Repeater. CONTACT: James Welby WB0ZJW, 6059 Sutherland, St. Louis MO 63109-2247. 314-353-2000.

#### JANUARY 28

IL - VILLA PARK - ARRL Hamfest, SPONSOR: Wheaton Community Radio Amateurs, WCRA, PO Box QSL, Wheaton IL 60189. 708-545-9950.

MI - MADISON HEIGHTS — Super Computer Sale. LOCATION: UF8CW Hall, 876 Horace Brown Dr, 1 blk E of 1-75, 1 blk S of 13 Mile Road, HOURS: 10am-4pm. ADMISSION: Adults \$4; seniors & students w/ID \$3; under 12 free w/adult. **FEATURES:** C - DP. **CONTACT:** Computers & You, 313-283-1754.

MI - MIDLAND — Five Star Productions Computer Shows. SPONSOR: Five Star Productions. LOCA-TION: Holiday Inn-Midland, US-10 @ Eastman Rd. HOURS: 10am-4pm. ADMISSION: \$4. FEA-TURES: C - DP - FP. DEALER INFO: \$35 tables negotiable. CONTACT: Five Star Productions, 810-230-0988

#### FEBRUARY 3

TX - AMARILLO — ARRL Hamfest. SPONSOR: Potter County ARES & Amarillo RACES. CON-TACT: Ben Pollard WS5R, PO Box 5378, Amarillo, TX 79117, 806-381-8810.

#### FEBRUARY 10

MN - BLAINE - Midwinter Madness. SPONSOR: Robbinsdale ARC. LOCATION: National Sports Center, N of Minneapolis/St Paul. HOURS: 7:30am-2:30pm. ADMISSION: \$7. FEATURES: C - CB - FM H. CONTACT: RARC, POB 22613, Robbinsdale MN 55422. 612-537-1722.

WI - WAUKESHA — Computer Show and Sale. LOCATION: Waukesha County Expo Center. HOURS: 10am-3pm. ADMISSION: \$6. FEA-TURES: AC - C - FP. CONTACT: ComShow 414-961-6003

#### FEBRUARY 11

DESPLAINES - Computer Show and Sale. LOCATION: Oakton Community College in DesPlaines. HOURS: 10am-3pm. ADMISSION: \$6. FEATURES: AC - C - FP. CONTACT: ComShow 312-665-4817.

IN - SOUTH BEND — Computer/Camera Swapmeet. LOCATION: Century Center. HOURS: 10am-3pm. ADMISSION: \$5, under 12 free. DEALER INFO: 8' tables \$50. CONTACT: Roger L. Smith, 8863 E Black Point Rd, Syracuse IN 46567, 219-856-3863 VM/FX.

OH - MANSFIELD - Mid-Winter Hamfest/Computer Show. SPONSOR: InterCity ARC. LOCATION: Richland County Fairgrounds. HOURS: 7am-?. ADMISSION: Adv \$4, door \$5. TALK-IN: 146.34/94. FEATURES: C - DP - FM - H. DEALER INFO: Tables adv \$9, door \$12. CONTACT: Pat Ackerman N8YOB, 63 N Illinois Ave, Mansfield OH 44905. 419-589-7133.

#### FEBRUARY 17

IN - INDIANAPOLIS - Indianapolis Computer Fair. LOCATION: Beech Crest Center, 3655 E Raymor St, corner Sherman, E of I-65 Exit 109. HOURS: 10am-4pm. ADMISSION: \$6, under 12 free. FEA-TURES: C - DP. CONTACT: Ben Yanto, AGI Computer Fairs.\*

TX - SMITHVILLE - ARRL Hamfest. CONTACT: Bastrop County ARC. CONTACT: Charlie Claiborne N5JWP, PO Box 556, Smithville TX 78957. 512-237-

Continued on page 140

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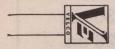
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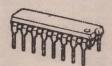
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For example, one of my favorite local AM broadcast stations broadcasts on 630 KHz. During the day, I get interference-free reception. But after the sun goes down, the situation changes. Even though the station transmits the same power level, it fades into the background din as stations to the west and south of us start skipping into my area.

Another easily seen example is the 3 to 30 MHz shortwave bands. Indeed, even those bands behave very differently from one another. The lower frequency bands are basically groundwave bands during the day, and become skywave bands at night (similar to the AM BCB). Higher shortwave bands work just the opposite: during the day they are long distance "skip" bands, but some time after sunset, become groundwave bands only.

The VHF/UHF bands are somewhat more consistent than the lower frequency bands. But even in those bands Sporadic-E skip, meteor scatter and a number of other phenomenon cause propagation anomalies.

Several articles that I've written, published both in *Nuts & Volts* and in Europe, have dealt with what I call "RadioScience Observing." This field concerns radio astronomy, SID hunting on VLF, and whistler hunting (all covered in this column). Those articles proved very popular. Understanding these signals requires one to understand a little bit about how radio signals propagate.

# The Earth's Atmosphere

The electromagnetic waves do not need an atmosphere in order to propagate, as you will undoubtedly realize from the fact that space vehicles can transmit radio signals back to earth in a near vacuum. But when a radio wave does propagate in the earth's atmosphere, it interacts with the atmosphere and its path of propagation is altered. A number of factors affect the interaction, but it is possible to break the atmosphere into several different categories according to their respective effects on radio signals.

The atmosphere, which consists largely of oxygen (O<sub>2</sub>) and nitrogen (N) gases, is broken into three major zones: *troposphere*, *stratosphere*, and

ionosphere (Figure 1). The boundaries between these regions are not very well defined, and change diurnally (over the course of a day) and seasonally

The troposphere occupies the space between the earth's surface and an altitude of 6 to 11 kilometers (four to seven miles). The temperature of the air in the troposphere varies with altitude, becoming considerably lower at altitude compared with ground temperature. For example, a +10° C surface temperature could reduce to -55° C at the upper edges of the troposphere.

The stratosphere begins at the upper boundary of the troposphere (6 to 11 km), and extends up to the ionosphere (≈50 km). The stratosphere is called an *isothermal region* because the temperature in this region is somewhat constant despite altitude changes.

The ionosphere begins at an altitude of about 50 km (31 miles) and extends up to 300 km (186 miles), or so. The ionosphere is a region of very

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Channel

thin atmosphere. Cosmic rays, electromagnetic radiation of various types (including ultraviolet light from the sun), and atomic particle radiation from space (most of it from the sun), has sufficient energy to strip electrons away from the gas molecules of the atmosphere. The freed electrons are called negative ions, while the O2 and N molecules that lost electrons are called positive ions. Because the density of the air is so low at those altitudes, the ions can travel long distances before neutralizing each other by recombining. Radio propagation, on some bands, varies markedly between daytime and nighttime because the sun keeps the level of ionization high during daylight hours, but the ionization begins to fall off rapidly after sunset, altering the radio propagation characteristics after dark. The ionization does not occur at lower altitudes because the air density is

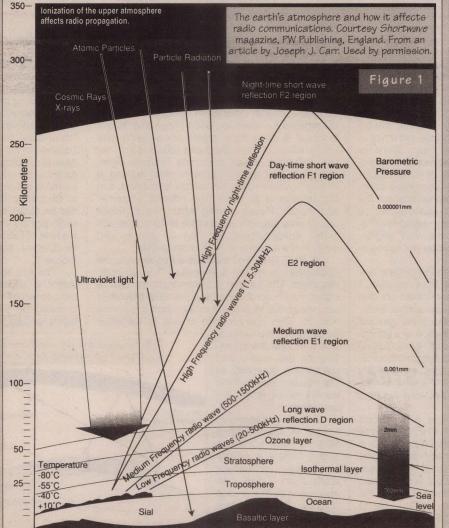
such that the positive and negative ions are numerous and close together, so recombination occurs rapidly.

# **Propagation Paths**

There are four major propagation paths: surfacewave, spacewave, tropospheric, and ionospheric. The ionospheric path is important to MW and HF propagation, but is not important to VHF, UHF, or microwave propagation. The spacewave and surfacewave are both groundwaves, but behave differently enough to warrant separate consideration. The surfacewave travels in direct contact with the earth's surface and it suffers a severe frequency dependent attenuation due to absorption into the ground.

The spacewave is also a groundwave phenomenon, but is radiated from an antenna many wavelengths above the surface. No part of the spacewave normally travels in contact with the surface; VHF, UHF, and microwave signals are usually spacewaves. There are, however, two components of the spacewave in many cases: direct and reflected (see Figure 2).

The tropospheric wave is lumped with the direct space-wave in some texts, but has properties that actually make it different in practical situations. The troposphere is the region of earth's atmosphere



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between the surface and the stratosphere, or about four to seven miles above the surface. Thus, most forms of groundwave propagate in the troposphere. But because certain propagation phenomena caused mostly by weather conditions only occur at higher altitudes, we need to consider tropospheric propagation as different from other forms of groundwave.

The ionosphere is the region of earth's atmosphere that is above the stratosphere. The peculiar feature of the ionosphere is that molecules of air gas (O<sub>2</sub> and N) can be ionized by stripping away electrons under the influence of solar radiation and certain other sources of energy (see Figure 1 again). In the ionosphere, the air density is so low that ions can travel relatively long distances before recombining with oppositely charged ions to form electrically neutral atoms. As a result, the ionosphere remains ionized for long periods of

remains ionized for long periods of the day even after sunset. At lower altitudes, however, air density is greater and recombination thus occurs rapidly. At those altitudes, solar ionization diminishes to nearly zero immediately after sunset or never achieves any significant levels, even at local noon.

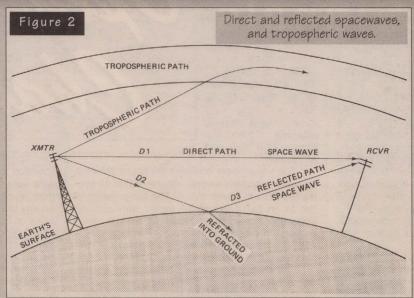
Ionization and recombination phenomena in the ionosphere add to the noise level experienced at VHF, UHF, and microwave frequencies. The properties of the ionosphere are important to microwave technology because of the noise contribution. In addition, in satellite communications, there are some transionospheric effects.

# **Groundwave Propagation**

The groundwave, naturally enough, travels along the ground, or at least in close proximity to it (Figure 3). There are three basic forms of groundwave: spacewave, surfacewave, and tropospheric wave. The spacewave does not actually touch the ground. As a result, spacewave attenuation with distance in clear weather is about the same as in free space (except above about 10 GHz where H<sub>2</sub>O and O<sub>2</sub> absorption increases dramatically). Of course, above the VHF region, weather conditions add attenuation not found in outer space.

The surfacewave is subject to the same attenuation factors as the spacewave, but in addition, it also suffers ground losses. These losses are due to ohmic resistive losses in the conductive earth. In other words, the signal heats up the ground! Surfacewave attenuation is a function of frequency, and increases rapidly as frequency increases. Both of these forms of groundwave communications are affected by these factors: wavelength, height of both receive and transmit antennas, distance between antennas, terrain, and weather along the transmission path.

Groundwave communications also suffers another difficulty, especially at VHF, UHF, and microwave frequencies. The spacewave is like a surfacewave, but is radiated many wavelengths above the surface. It is made up of two components (see Figure 2 again): direct and reflected waves. If both of these components arrive at the receive antenna, they will add algebraically to either increase or decrease signal strength. There is always a phase shift between the two compo-



nents because the two signal paths have different lengths (i.e., D1 is less than D2 + D3). In addition, there may be a 180 degree ( $\pi$  radians) phase reversal at the point of reflection (especially if the incident signal is horizontally polarized).

Multipath phenomena exists because of interference between the direct and reflected components of the spacewave. The form of multipath phenomenon that is, perhaps, most familiar to many readers (at least those old enough to be "pre-cable") is ghosting in television reception. Some multipath events are transitory in nature (as when an aircraft flies through the transmission path), while others are permanent (as when a large building or hill reflects the signal). In mobile communications, multipath phenomena are responsible for reception dead zones and "picket fencing." A dead zone exists when destructive interference between direct and reflected (or multiple reflected) waves drastically reduces signal strengths. This problem is most often noticed at VHF and above when the vehicle is stopped, and the solution is to move the antenna a quarter wavelength. Picket fencing occurs as a mobile unit moves through successive dead zones and signal enhancement (or normal) zones, and sounds like a series of short noise bursts.

At VHF, UHF, and microwave frequencies, the spacewave is limited to so-called "line of sight" distances. The horizon is theoretically the limit of communications distance, but the radio horizon is actually about 15 percent further than the optical horizon. This phenomenon is due to refractive

bending in the atmosphere around the curvature of the earth, and makes the geometry of the situation look as if the earth's radius is 4/3 the actual radius.

The surfacewave travels in direct contact with the earth's surface and it suffers a severe frequency dependent attenuation due to absorption by the ground (Figure 3). The zone between the end of the groundwave and where

the skywave touches down is called the skip zone, and is a region of little or no signal. Because of this phenomenon, I've seen situations on the 15-meter band (21.390 MHz) where two stations 40 miles apart (Baltimore, MD and Fairfax, VA) could not hear each other, and their communication has to be relayed via a ham station in Lima, Peru!

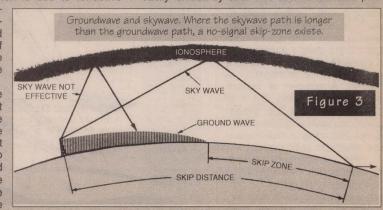
The surfacewave extends to considerable heights above the ground level, although its intensity drops off rapidly at the upper end. The surfacewave is subject to the same attenuation factors as the spacewave, but in addition, it also suffers ground losses. These losses are due to ohmic resistive losses in the conductive earth, and to the dielectric properties of the earth. In other words, the signal heats

up the ground. Horizontally polarized waves are not often used for surfacewave communications because the earth tends to short-circuit the E-field component. On vertically polarized waves, however, the earth offers electrical resistance to the E-field and returns currents to following waves. The conductivity of the soil determines how much energy is returned.

# **Ionospheric Propagation**

Now let's turn our attention to the phenomena of skip communications. Ionospheric propagation is responsible for the ability to do intercontinental broadcasting and communications. Long distance radio transmission is carried out on the high-frequency (HF) bands (3 to 30 MHz), also called the "shortwave" bands. These frequencies are used because of the phenomena called skip. Under this type of propagation, the earth's ionosphere acts as if it is a "radio mirror." Although the actual phenomena is based on refraction (not reflection, as is frequently believed), the appearance to the casual observer is that shortwave and low-VHF radio signals are reflected from the ionosphere as if a kind of radio mirror. The actual situation is a little different, but we will deal with that issue in a moment

The key lies in the fact that a seeming radio mirror is produced by ionization of the upper atmosphere. The upper portion of the atmosphere is called the "ionosphere" because it tends to be easily ionized by solar and cosmic radiation phe-



# Open Channel

nomena. The reason for the ease with which that region (30-300 miles above the surface) ionizes is that the air density is very low. Energy from the sun strips away electrons from the outer shells of oxygen and nitrogen molecules. The electrons become negative ions, while the remaining portion of the atom forms positive ions. Because the air is so rarified at those altitudes, those ions can travel great distances before recombining to form electrically neutral atoms again. As a result, the average ionization level remains high in that region.

Several sources of energy will cause ionization of the upper atomosphere. Cosmic radiation from outer space causes some degree of ionization, but the vast majority of ionization is caused by solar energy. The role of cosmic radiation was first noticed during World War II when British radar operators discovered that the distance at which their equipment could detect German aircraft was dependent upon whether or not the Milky Way was above the horizon (although it was theorized 10 years earlier). Intergalactic radiation raised the background microwave noise level, thereby adversely affecting the signal-to-noise ratio.

The ionosphere is divided for purposes of radio propagation studies into various layers that have somewhat different properties. These lavers are only well-defined in textbooks, however, and even there we find a variation in the location above the earth's surface where these layers are located. In addition, the real physical situation is such that layers don't have sharply defined boundaries, but rather fade one into another instead. Thus, the division into layers is somewhat arbitrary. These layers (shown in Figure 1) are designated D, E, and F (with F being further subdivided into F1 and F2 sub-layers).

D-Layer: The D-layer is the lowest layer in the ionosphere, and exists from approximately 30 to 50 miles above the surface. This layer is not ionized as much as higher layers because all forms of solar energy that cause ionization are severely attenuated by the higher layers above the D-layer. The reason for this is that the D-layer is much denser than the E and F layers, and that density of air molecules allows ions to recombine to form electroneutral atoms very quickly.

The extent of D-layer ionization is proportion-

al to the height of the sun, so will achieve maximum intensity at midday. The D-layer exists mostly during the warmer months of the year because of both greater height of the sun above the horizon and the longer hours of daylight. The D-layer almost completely disappears after local sunset. Some observers have reported sporadic incidents of D-layer activity for a considerable time past sunset. The D-layer exhibits a large amount of absorption of mediumwave and shortwave signals to such an extent that signals below 4 to 6 MHz are completely absorbed by the D-layer.

E-Layer: The E-layer exists from approximately 50 to 70 miles above the earth's surface, and is considered the lowest region of the ionosphere that is important to radio communications. Like the D-layer, this region is ionized only during the daylight hours with ionization levels peaking at midday. The ionization level drops off sharply in the late afternoon, and almost completely disappears after local sunset.

During most of the year, the E-layer is absorptive so will not reflect radio signals. During the summer months, however, E-layer propagation does occur. A phenomena called "short skip" (i.e., less than 100 miles for mediumwave and 1,000 miles for shortwave signals) occurs in the E-layer during the summer months, and in equatorial regions.

A propagation phenomena associated with the E-layer is called sporadic-E propagation. This phenomena is due to scattered zones of intense ionization in the E-layer region of the ionosphere. Sporadic-E phenomena varies seasonally, and is believed to be caused by bombardment of solar particles. Sporadic-E propagation affects the upper HF and lower VHF region. It is observed most frequently in the lower VHF (50 to 100 MHz). but is also sometimes observed at higher frequencies. The VHF bands occassionally experience sporadic-E propagation. Skip distances on VHF can reach 500 to 1,500 miles on one hop, especially in the lower VHF region (including the six-meter ham band).

F-Layer: The F-layer of the ionosphere is the region that is the principal cause of long-distance shortwave communications. This layer is located from about 100 to 300 miles above the earth's surface. Unlike the lower layers, the air density in the F-layer is low enough that ionization levels remain high all day, and decay slowly after local sunset. Minimum levels are reached just prior to local sunrise. Propagation in the F-layer is capable of skip distances up to 2,500 miles on a single hop. During the day, there are actually two identifiable, distinct sub-layers in the F-layer region, and these are designated the "FI" and "F2" layers. The F1 layer is found approximately 100 to 150 miles above the earth's surface, while the F2 layer is above the F1 to the 270-300 mile limit. Beginning at local sundown, however, the lower regions of the F1 layer begin to de-ionize due to recombination of positive and negative ions. At some time after local sunset, the F1 and F2 layers have effectively merged to become a single reduced layer beginning at about 175 miles.

The height and degree of ionization of the F2 layer varies over the course of the day, with the season of the year, and with the 27 day sunspot cycle. The F2 layer begins to form shortly after local sunrise and reaches maximum shortly before noon. During the afternoon, the F2 layer ionization begins to decay in an exponential manner until, for purposes of radio propagation, it disappears sometime after local sunset. There is some evidence that ionization in the F-layer does not completely disappear, but its importance to HF radio communication does disappear.

# Connections . . .

This month's column (and the next) is the result of people contacting me either by US postal mail or E-Mail. I can be reached at P.O. Box 1099, Falls Church, VA 22041, or by Internet at carrjj@aol.com

# Next Month . . .

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Next month, we will finish discussing ionospheric communication by looking at some of the anomalies . . . in other words, how things can go

Joe has written a lot about antennas and propagation. Two of his related books are Joe Carr's Receiving Antenna Handbook (HighText, \$19.95, 1-800-247-6553) and Practical Antenna Handbook (TAB/McGraw-Hill, \$26.95, 1-800-233-

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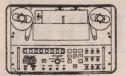
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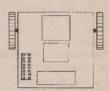
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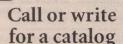
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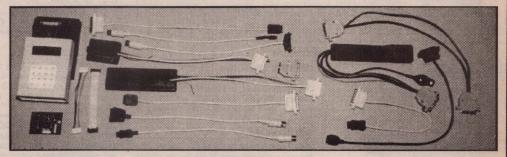
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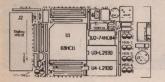
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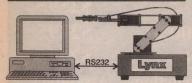
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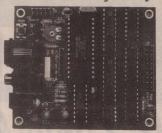
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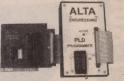
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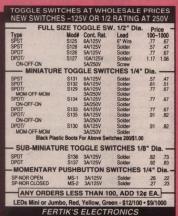
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number forty-eight

# Solar and Alternate Energy Resources

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A portion of my PSRT RoundTable on GEnie has also been set aside for you Nuts & Volts readers. This is the place you go for instant tech answers. Among the many files in our library, you will find complete reprints for all the Resource Bin columns.

I did manage to wrangle one super special sign-up deal for you Resource Bin readers. Ten free hours.

GEnie now offers far lower daytime rates, a direct Internet access, plus a Windows graphics interface, so it's an even better deal than ever. See the trailer blurb for details.

# **Solar Energy Today**

I guess we are long overdue for an update on solar and alternate energy. Certain recent developments (such as passive solar, construction alternates, and control films) are really coming along just fine. Others (like solar hot water) are more or less cost-effective in some regions, some of the time. But the big one — off-grid solar electricity — still has serious problems.

Ferinstance, the largest solar power plant in the world shut down a few years ago. All of their panels are now getting retailed to the hobby market. Today, there is *much* more money to be made in selling surplus junk than there ever was in solar electricity.

Now, out here on any hot Arizona afternoon, there's up to 1,200 watts per meter of peak incoming solar energy. Given an efficient enough converter, an average house roof could produce \$45,000.00 worth of electricity a year. Around 30 times what is normally used by the folks living inside.

But efficient converters do not exist. And any solar rooftop system

whose amortized yearly cost is \$45,000.01 can end up less than useless.

The first key problem is that silicon solar cells only respond well to one particular frequency of light. The light energy is proportional to wavelength. Longer wavelengths do not generate electricity and are thus wasted as low grade heat. And all the "spare change" excess energy from any shorter than needed wavelength also burns up as useless heat. Thus, your best possible theoretical efficiency of a silicon cell is only 28 percent.

The second thing that really gets to you is what I call the *nickel* and dime effect. Start with a less than perfect solar cell, losing "a little." Production yields often lose "a little" more, giving less than expected results.

You'll lose "a little" if your cells are made from amorphous silicon rather than single crystals. And then lose "a little" because of your anti-reflection coating. You lose "a little"

# NEXT MONTH: Don looks at the very fundamentals of nutting and volting.

because the cell wires shade themselves.

You'll lose "a little" because of your protecting glass. You'll lose "a little" because the cells don't fully cover the expected area. You lose "a little" as the cells age. You lose "a little" because of tracking losses.

You'll lose "a little" in your system wiring. You lose "a little" in the series protection diodes. You'll lose "a little" because the AC power converter costs money and is not 100 percent efficient. You lose "a little" because any storage batteries also cost money, and are not anywhere near totally efficient.

You'll lose "a little" because, if you have a utility buyback arrangement, they sell you electricity retail, but buy it from you wholesale.

You'll lose "a little" because of your time and bureaucratic zoning hassles

And "a little" because of repairs. Thus, individual cells do not a solar system make.

The third key problem is set by the economic break even limit. If someone gave you all the five percent efficient solar cells in the world, there is no way you could generate useful (110 VAC at 10 cents per KWH) electricity using them. Your costs of structure, land, AC conversion, labor, maintenance, and (above all) the time value of the money involved guarantees a net loss.

I have posted some interesting new solar conversion alternatives as my files HACK46.PDF and HACK53.PDF.

One uses direct conversion "crystal set" or "antennaifier" techniques. The other is a dye-based solar conversion whose key ingredients are white paint covered by a thin magic dye layer.

Now, I have personally done solar research. And am developing closely with several others in the field. My magic sinewaves should significantly improve the cost and the efficiency of solar inverters.

But going off starry-eyed in a "save the world" mode simply will not hack it. Never did and never will.

Here, as I see it, are the key realities of solar power today . . .

- (1) Solar is a rather diffuse energy resource. It is extremely difficult to efficiently gather and convert into any useful final electrical power form.
  - (2) You can now buy an *awful* lot of electricity for a mere 10 cents off of your local power company.
    - (3) Solar success takes bunches of long term effort and continuous hard work. Frustration is guaranteed.
- (4) Any effort that does not build upon the existing resource base and the already done research is doomed to failure. Fer sure.
- (5) The "nickel and dime effect" will eat you alive. Every time.
- (6) Alternate energy projects must include a total economic efficiency analysis. Including time to break even and the net return on investment. Plus fully take into account all subsidies, both obvious and hidden.

Nonetheless, I strongly encourage you to go out and explore solar and other energy options on your own.

Let's look at some great places to get you started . . .

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# **Home Power**

Richard and Karen Perez publish Home Power magazine. Off grid and off line in rural Oregon. This is by far your first and foremost resource for low-end, shirtsleeves "them that's doing" info. Besides solar, they are into wind and small scale hydro. Plus electric cars, lifestyles, insulation, the electronic fundamentals, lower priced home construction, and much more.

There are several other solar and alternate mags. Home Energy is mostly on how to insulate trailers. It's more of an industry trade journal than an end user publication. The original Muddle Earth News has long since yuppified. Its solar stuff now seems in the same league as Popular Science. Both seem useful. but big bucks, yuppy-oriented, and ad driven.

Much of the original mother crew have set out on their own, publishing a fine Backwoods Home magazine. Still in the spirit of the original.

Backwoods Cabin is one imitator

My most preferred ongoing "access to tools" resource of all time still is the quarterly Whole Earth Review, who've recently published their Whole Earth Millenium Catalog.

One good source for many listings of those labor-of-love alternate energy newsletters is Factsheet Five. Another "must have" favorite of mine

# Solar II CD

The Home Power folks have also just published a new Solar II CD. This one is a large collection of highly useful solar energy resources. Acrobat files, color, and sound. Cost is around \$29.00.

Don't miss this one. It has to be the most outstanding product in alternate energy research today.

# World Renewable **Energy Directory**

This one appears to be the standard industry reference. The full title is The World Directory of Renewable Energy Suppliers and Services 1995. This is a European publication from James and James Science. ISBN is 1-873936-40-0. I do not know the price. It is free to at least some industry insiders.

Included are 6,000+ suppliers from 100 countries. Plus hundreds of solar organizations worldwide.

The topics covered include general articles, biomass, rational energy use, energy storage, geothermal, hydro and wave, instrumentation, photovoltaics, solar thermal, and wind power.

# **Real Goods**

The highest profile retail direct mail supplier of alternate energy products does appear to be Real Goods. They do have everything from solar panels to efficient lights, to books to control films, to warm clothes. All in their free catalog. The catalog also includes lots of solar reference information and other tips and techniques.

Speaking of efficient lighting, I've just posted a fundamental review of lighting efficiency tradeoffs as my file MUSE95.PDF to GEnie PSRT.

# Solar Energy

The leading scholarly publication is Solar Energy. It's British and "a little" expensive at \$1,200.00 per year. As the official journal for that International Solar Energy Society.

Subscriptions are much cheaper if you are a society member.

This is the place to go for first rate technical research. A larger technical library should stock these. My favorite journal for theoretical energy fundamentals is Science. Their Dec. 1, '95 issue shows what may end up a major breakthrough in fuel cells. On page 1440.

Nature is another superb scientific journal on energy fundamentals.

Both Power Engineering and World Cogeneration are trade journals. Both are free to qualified sub-

Another free trade journal I have found to provide useful solar stuff is HVAC News. An oversized shopper for air conditioning contractors.

Solar Today is the "gee whiz" solar publication from the American Solar Energy Society. Sorry, but I feel that, at best, this one is second rate.

The free NASA Tech Briefs also has some government solar stuff in it. The overwhelming majority of its content seems to me to "just barely"

With the exception of Sandia Labs who do offer outstanding solar design services, much of government solar power has ended up less than stellar. A largely counterproductive waste.

At least out here in California and Arizona, an alarming fraction of all those outrageous solar subsidies from a decade back were simply gobbled gone by boiler shops and fast buck artists as investment scams.

One federal demonstration school solar cooling project in the southeast found it worked "a little" better if you added a five-ton evaporative cooler to the output. But then somebody asked how big an evaporative cooler they would have needed without the feds solar cooling involvement.

The answer: Three tons! Oh

# **Online Resources**

There's bunches of online solar and alternate energy resources. Many are listed in the Solar II CD. You can also use the usual directories and guides to get a complete listing. One good choice is vahoo.com

Let's look at two samples . . .

solstice.crest.org provides an older collection of traditional solar reports and pubs. Apparently a DOE effort, its last update was in 1992.

umbra.gsfc.nasa.gov/sdac.html holds a Solar Data Analysis Center data base providing information relating to the study of the sun. Astronomical stuff like eclipses and solar flares.

By the way, these two have been excerpted from the new Gale Guide to Internet Databases. One of many new printed Internet guides. In general, those online guides, CDs, and search services have more listings and more current information than printed ones.

I have also posted a long list of electrical and electronic Internet sites to my *GEnie* PSRT as MUSE94.PDF. And, of course, the Dialog Information Service can be used to instantly find information on any solar or alternate energy topic. By way of your nearby library, on GEnie, on a CD-ROM, or from the other online services.

# Solarjack and Zomeworks

You will find lots of solar suppliers listed in Home Power magazine and on their Solar II CD-ROM. A pair I can heartily recommend are Jim Allen's Solarjack and Steve Baer's Zomeworks. Both

> have been hard workers clearly in it for the long haul.

Solarjack is one of the scant few successful tech industries here in the Gila Valley. Their specialty is ultra high efficiency water pumps. All fully solar compatible. All made locally on fancy CAM production machines

Jim also sells the Solec panel modules and similar products.

Jim's first secret to survival is to address the "Uh -Compared to what?" markets where solar power is the only solution. Locations like Bolivia, the Narobi desert, and a few remote sites on Arizona Indian reservations.

His second secret is inte-

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Home Power PO Box 520 Ashland OR 97520 (916) 475-3179

HVAC/Contractor 1350 E Touhy Ave Des Plaines IL 60018 (708) 635-8800

Inti Solar Soc USA 2400 Central Avenue G-1 Boulder CO 80301 (303) 443-3212

James & James Science Waterside House 47 Kentish Town Road London NW1 8NZ, UK

Mother Earth News PO Box 70 Hendersonville NC C Hendersonville NC 28793 (704) 693-0211

**NASA Tech Briefs** 41 E 42nd St #921 New York NY 10017 (212) 490-3999

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Nature 65 Bleecker St New York NY 10012 (212) 477-9628

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Solar Industries Assn 122 C Street NW 4th FL Washington DC 20001 (202) 383-2600

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US Dept of Energy 1000 Independence Ave SW Washington DC 20585 (202) 586-1720

Whole Earth Review 27 Gate Five Rd Sausalito CA 94965 (415) 332-1716

World Cogeneration 84-54 118 St Kew Gardens NY 11415 (718) 847-0230

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# RESOURCE BIN

grating the components into an entire workable system. Pumps get fully optimized to panels. While minimizing the nickel and dime effect.

Zomeworks has been in business since solar year one. In fact, Steve's labor-of-love *Sunspots* publications long ago defined the opening spasms of the alternate energy revolution.

Today, Steve recycles those "gold" Carizzo Solar panels. He also provides efficient and effective solar trackers, energy control systems, passive solar products, and new Cool-Cell battery coolers for remote utility sites.

## **EPRI** and AEE

The Electric Power Research Institute, or EPRI for short, has all sorts of solar and alternate energy videotapes and publications. Their membership is a tad pricey at a quarter mil per year. That's for an individual. I didn't ask what their family rate was. But most of their research materials are offered on a cash-and-carry basis.

They also publish an EPRI Journal.

Most of their research is first rate. They are basically a consortium of big electric utilities. Grants are issued to study just about any and all energy options. Ranging from coal, oil, and nuclear on up through solar, wind, and conservation.

The Association of Energy Engineers is a professional trade group. They have an outstanding bookstore on just about any and all energy issues. They also do get

involved in seminars and industry shows

Yet another major energy resource is the *Rocky Mountain Institute* run by Amory Lovins. Thorough studies about everything from economics of home energy conservation to new options in hybrid electric vehicles.

# **Straw Bale Homes**

There's a lot of fresh new interest in straw bale house construction. The bales are potentially cheap and offer fine insulation qualities. And they are more manageable than they might first seem. At least around here, zoning officials seem surprisingly receptive.

A really superb series of videos on straw bale homes gets distributed by *Black Range Films*. Including guided tours and detailed step-by-step and hands-on construction details.

Be sure to check these vids out. The same people do alternate construction seminars and run an outstanding (and reasonable cost) wilderness bed and breakfast lodge. Hidden deep in the top secret portion of New Mexico that you can't get to. I'd be happy to meet you there most any time.

Free brochures are offered. Be sure to tell Cathy I sent you.

# **Magic Sinewaves**

My own in-process contribution to solar energy is a brand new technique called *magic sinewaves*. Compared to older PWM pulse width modulation, the magic

sinewaves greatly simplify solar inverters and make them much more efficient.

Magic sinewave AC power inverters can run much cooler, using lower cost output transistors and more compact heatsinks. Related magic sinewaves can work with induction motor speed controls and electric autos.

I've got full consulting services and co-developer programs available on these. All the tools are functional and in place. Including source code and working chips. If you write, E-Mail, or call, I'll be happy to send you a free tutorial reprint on magic sinewaves. You can also pick this one up as file MAGSINT.PDF on my Genie PSRT. Or, for scads more detail, search the PSRT library by using "magic" or "Fourier." Dozens of the latest files are offered on this billion dollar opportunity.

# **This Month's Contest**

For our contest this month, just tell me about some solar resource I don't already know about. Or tell me about some alternate energy story you have been involved in.

Or tell me about most any solar or alternate energy online resources you happen to have discovered.

There will be a largish pile of my new Incredible Secret Money Machine II books going to the dozen or so better entries, plus an all-expense-paid (FOB Thatcher, AZ) tinaja quest for two that will go to the very best of all.

Send all your written entries to me here at Synergetics, rather than to Nuts & Volts editorial.

To be fair to everyone, all entries must be printed and mailed.

Acrobat quality reprints of all my Nuts & Volts columns are available on GEnie PSRT. This particular one is called NUTS48.PDF. Another alternate energy resource summary appears as my HACK28.PDF file.

A reminder: I have just bought an entire community college electronics department at auction. So I have got some great surplus buys. Especially Tek logic analyzers. You could write, call, or E-Mail for a free catalog. Or grab it as SURP-CAT1.PDF.

Let's hear from you. NV

Microcomputer pioneer and guru Don Lancaster is the author of 33 books and countless tech articles. Don maintains his nocharge tech helpline found at (520) 428-4073, besides offering all of his own books, reprints, and all of his consulting services. He also has a free catalog full of his resource secrets waiting for you. Your best calling times are 8-5 on weekdays, Mountain Standard Time.

Don is now the sysop of GEnie PSRT, where a special Resource Bin topic has been reserved for Nuts & Volts readers. For modern access: (800) 638-8369.

When prompted, enter JOIN-GENIE. When asked for an offer code, enter DMD524.

You can also reach on at Synergetics, Box 809, Thatcher, AZ 85552. Or send any messages to his Internet address of: SYNERGETICS@GENIE.COM

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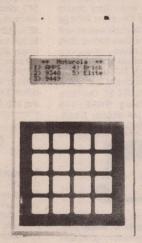
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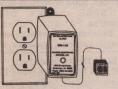
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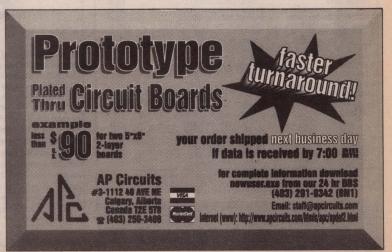
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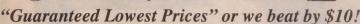
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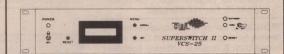
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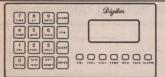
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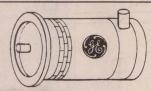


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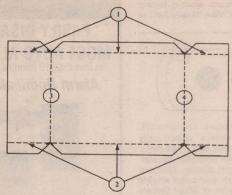
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Over the years, you've probably built and displayed many projects. Has anyone ever asked: "Did you make the cabinet, too?" If your answer was no, you've yet to feel the pride one gets in constructing his or her own project case. Nor, perhaps, do you realize doing so gives you the ultimate control over your project's appearance. Furthermore, today's commercial cabinets costing "real" bucks, your pocketbook hasn't yet had the chance to thank you for taking the do-it-yourself approach. All that could change. Read and find out how easy it is to "box your project in," in your own style.

## The Design Phase

When beginning your design, keep purpose upper most in mind. What is the cabinet to be used for? A power supply? A color organ? A stereo amplifier? What? All subsequent design criteria stem from this one factor. Let's begin by examining such design elements as material, size, shape, and appearance.

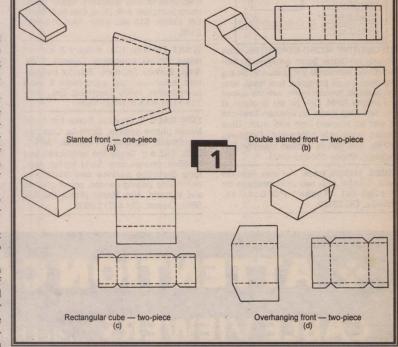
The most common material used to house projects is 16-gauge (1/16") aluminum alloy sheet (5052K32 or 3003-H14). It's durable, easy to use, and readily available.

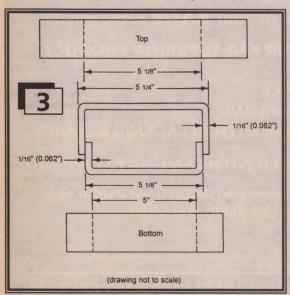
Size is determined primarily by the bulk of electronic circuitry. The cabinet should be no larger than necessary to house and mount the electronics. Yet thought must also be given to component parts access, heat dissipation, and project han-

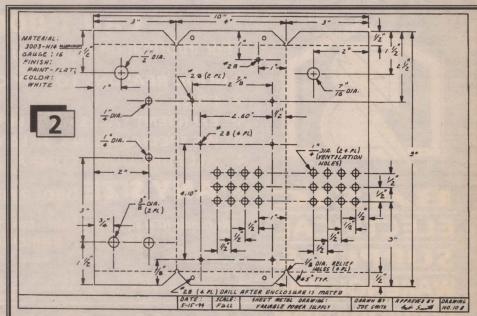
In choosing the cabinet, shape, function, ease of repair, and fabrication are factors to consider. Figure 1 shows common sheet metal cabinet patterns and styles. The idea is to keep it simple.

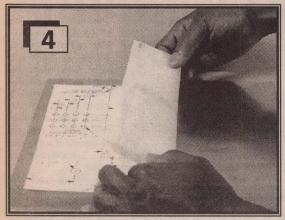
You also want a cabinet with great appearance. What type of paint or vinyl coating you'll apply will be a factor in the aesthetics of your project. In addition, attention must be given to the labeling (lettering, numbers, lines, etc.) to be used. Such labeling should be

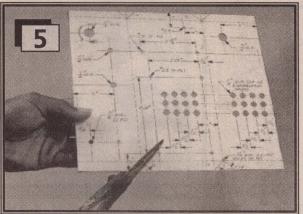
durable, as well as attractive.



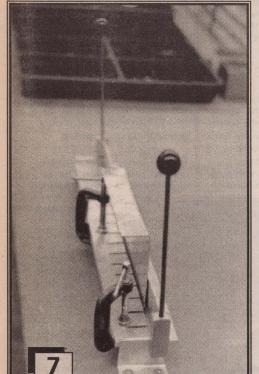












dotted lines.

4. Very important relief holes, 1/8" in diameter, are provided at fold intersections. Such holes prevent bulging or fracturing of the metal at fold points of high stress.

5. Hole sizes are given in diameter, or when rectangular, by a width x length dimension.

6. Holes are usually located on center from a sheet metal edge or fold line.

A completed sheet metal drawing gives enough information to fabricate and surface finish the cabinet. From the drawing, you'll create a sheet metal template to be glued to the sheet metal and used as a guide for cutting, drilling, punching, and folding the box. But before discussing the template, let's examine the "bending allowance" problem. You need to make sure separately folded sheets of

metal fit together correctly.

When sheet metal is bent, the thickness of the metal must be taken into account when arriving at the new overall folded dimension. As shown in Figure 3, the 5" width of the bottom base becomes 5-1/8" when the sides are bent at right angles (the base width of 5 inches, plus the two metal thicknesses of 1/16 inch). In designing the top piece to fit over the bottom, its base width must be 5-1/8" before the bend takes place. The final overall project width will be 5-1/4".

Figuring sheet metal bend allowances is easy; just take into account the metal thickness. Failure to do so will result in an improper fit. You will be forced to fabricate at least one of the sheets again.

Finally, photocopy the sheet metal drawing to create a sheet metal template. Paste the template down onto the metal to be cut, drilled, and punched (Figure 4).

# **The Fabrication Process**

Let's now examine how the sheet metal is cut and how holes are drilled, punched, or notched. Then we'll find out how the sheet metal is folded into

Two tools are used for cutting or shearing the sheet metal: a footoperated squaring shear and a handheld tin snip. You're unlikely to own the former, though if you have access to one, use it. Nothing cuts sheet metal as smoothly as a shear.

A large handheld tin snip can do the shearing job if it is designed to produce a straight cut. The tin snip will also be used to cut notches and corners (see Figure 5).

You can make round holes in sheet metal by drilling or punching them. Generally, holes up to 1/4" in diameter are drilled; anything larger is punched.

The procedure for drilling a small hole in sheet metal is as follows:

1. Center punch all holes that require drilling.

2. Back up the sheet metal with a piece of wood, at least 3/8" thick.

3. Fasten the sheet metal and wood backing securely to a drill press table, preferably with a C-clamp.

4. Drill the hole with a slow speed and a steady feed.

5. Remove any burrs with a file or

For round holes larger than 1/4", good, clean (burr-free) holes should be cut with a chassis punch.

The chassis punch (Figure 6, left) comes in many sizes, from 3/8" to 2" in diameter. It consists of three parts: a punch, die, and draw screw. Explaining how the chassis punch is used will also describe how it works.

1. A hole is drilled in the sheet metal large enough to accept the draw screw.

2. The top end of the chassis punch (known simply as a punch) is secured in a vise.

3. The sheet metal is positioned over the punch at the point where the hole is to be formed.

4. The die is positioned over the sheet metal in line with the punch.

5. The draw screw is inserted through the die, the sheet metal, and into the punch.

6. The draw screw is tightened down with a wrench.

As the screw turns, it draws the die and punch together. When the sheet metal pops through, the screw is loosened and the die and punch separated. The sheet metal can then be lifted off, and the blank punched piece of metal extracted from the punch. The result is a burr-free hole.

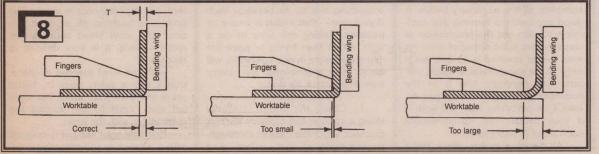
Rectangular holes, slots, and notches are best made with a nifty, inexpensive handheld mini-shear known as a nibbler (Figure 6, right). With each squeeze of the handles, the tool cuts away a small piece of metal in front of it. Operation is quite sim-

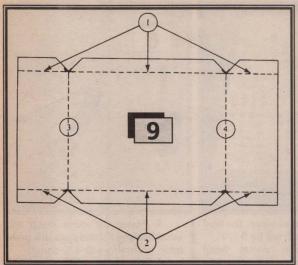
1. A hole is drilled or punched (when cutting internal shapes) large enough to accept the tool's cutting head. A 3/8" hole is usually ade-

2. The tool is inserted up through

After selecting the appropriate sheet metal pattern, create a sheet metal drawing (Figure 2). Produce the drawing with traditional drafting tools or with a computer aided design (CAD) program. Note the following:

- 1. The drawing is made full scale.
- 2. The view is from the inside or bottom of the cabinet. The box thus folds up, toward the drafter.
  - 3. Fold lines are indicated with

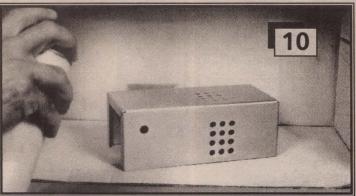




the hole until the metal to be cut rests on a platform directly below the cutting blade.

3. The handles are squeezed as the tool is guided along, nibbling the metal to the size and shape desired.

Although you'll find the nibbler easy to use, it is best to practice on a sheet of scrap metal before taking a bite out of the cabinet you are fabricating.



assembly together with two C-clamps. Finally, rotate the bending

wing against a portion of the metal, causing it to bend at the desired

It is important the correct distance be set between the plate edge (fingers) and the edge of the worktable (Figure 8). For an optimum bending radius, this distance should be the thickness of the sheet metal to be bent. If the distance is less than the metal thickness, gouging of the metal will take place. If the distance is on the size of a sheet of metal that can be formed. The width, height, and depth of the folded sheet metal are limited, in turn, by the width, height, and depth of various elements that make up the machine.

# **Cabinet Finishing**

With the sheet metal cut, drilled, punched, and folded into shape, you're now ready to apply the proper surface finish. You need to lay on a protective and attractive coating to the aluminum cabinet, and you must label the appropriate areas with numbers, letters, and graphic indicators.

grease. These contaminants must be eliminated. No way will paint primer adhere to filthy surfaces. When the cabinet is completely clean, dry it with a paper towel. In some cases, use a handheld drier to remove all traces of moisture hard-to-reach areas.

2. Apply a primer. The primer, available in an aerosol can, is

used to seal and fill the metal prior to the application of paint. Choose a primer with a zinc chromate base. Construct a "quick-and-dirty" spray booth from a cardboard box (Figure 10). After shaking the can for a minute or two, hold it 10 to 12" from the surface to be sprayed and, in a back and forth motion, apply a thin, even coat, working from the top to the bottom. Let the primer thoroughly dry, then apply two or three additional coats, as necessary.

3. Apply the spray paint. Enamel paint is also available in an aerosol can. Choose flat or semigloss. Apply as you did the primer, in

two or three thin coats. Allow complete drying between each spraying operation.

Do not be concerned if, after drying, the paint seems a bit "flat," or dull. A protective acrylic coating, to be applied after the labeling is done, will restore luster to the painted sur-

An attractive alternative to paint is self-adhesive vinyl. This contact paper comes in a variety of printed patterns, with wood grain being the most popular. When applied correctly, it provides a durable surface and professional look to any cabinet.

Self-adhesive vinyl is easy to

use. After the cabinet is cleaned, cut the vinyl sheet slightly larger than the size necessary to cover the cabinet surface. Next, peel away a small section of the protective backing, position the vinyl in place, and press down (Figure 11). Then, slowly, as the protective backing is pulled away, smooth down the vinyl coating over the cabinet sur-

protective backing all at once, for once the vinyl sheet touches the metal surface, it is very difficult to reposition. With the vinyl pressed in place, trim it with a safety razor or, better

face. It is important not to remove the

nal slots, carefully cut around the inner edges with the knife. Now that your cabinet is covered with a protective and attractive coat-

vet, a sharp X-Acto® knife. For inter-



set greater than the thickness of the metal, too wide a radius will be formed.

In forming your sheet metal cabinet, the correct bending sequence must be followed (Figure 9). If you don't follow a planned succession of steps, it may become impossible to complete all the necessary bends. A good approach to forming any cabinet is to plan out the progression of steps in your mind ahead of time. An even better method is to cut out a copy of the sheet metal template pattern and carefully fold it in the sequence to be followed. As you do, note if the particular order will work if your bender can accommodate each bend in succession.

All bending brakes place limits

Spray painting is the most common approach to cabinet finishing. With any spray painting operation, the key to success is the continual application of a strong dose of patience. The willingness to apply two or three coats of primer and two or three coats of paint, and find something else to do between each drying time — that's what is meant by patience. Taking the time to do it right, rather than trying to paint the entire enclosure in one operation, will result in a professional job, every time. Here's how it's done:

1. Clean the metal surface. Using a sponge and ordinary kitchen cleanser, scour the cabinet thoroughly, removing all dirt, grime, and





sis, you'll need a bending brake. They can cost hundreds of dollars. There's good news for the hobbyist, however. A company called BAC Industries, Inc., makes a mini-bender that can do the job we want almost as well as the industrial units (Figure 7). Selling for around \$30.00 at distributors such as Enco of Glendale, CA (213) 245-0813, it will bend 16 gauge aluminum (though that's pushing the limit) up to 18" wide with flange edges up to

The bender consists of a worktable, a metal plate (finger), and a movable bending wing. First, sandwich the sheet metal to be bent between the worktable and metal plate. Second, hold the three-part

ing, all that remains is to make it literate: supply it with the letters, numbers, and symbols necessary to explain the project's function and operation. The traditional dry-transfer lettering system is ideal for this task.

Dry-transfer lettering that consists not only of letters, but numbers and graphic symbols, is available in a wide variety of sizes and styles at electronics, stationery, and art supply stores. Inexpensive sheets containing letters, words, phrases, numbers, and index marks specifically designed for electronic projects are easy to obtain and use.

Only a few simple items are necessary to get a good transfer of lettering to the cabinet surface. In addition to the lettering sheets, you will need a burnishing tool (a dull pencil will do), masking tape, graph paper, and a can of clear acrylic protective spray. With these materials in hand, follow this six-step process for applying dry-transfer lettering:

1. Lay out design on paper. Using graph paper, lay out the overall design for the panel. Get everything in order on paper first. Know exactly where each symbol is to go before starting the rub-on process.

2. Use masking tape as a guide. To line up a row of letters or numbers, place a strip of masking tape on the painted surface a fraction of an inch below where the lettering is to go. The tape will act as a guide to help keep your letters straight.

3. Position transfer sheet and rub on with burnishing tool. With the symbols positioned over the desired spot, rub over the surface with a burnishing tool. Start with light pressure, then increase the force as time goes on (Figure 12).

4. Remove unwanted lettering with plastic tape. If you make a mistake, simply use a piece of plastic tape to pull up the undesired symbol.

5. Apply index marks carefully. When applying index marks for rotary switches, meters, and the like, be sure of the spacing ahead of time. Carefully plan the placement of each mark.

6. Apply a clear protective coating. In order to protect the dry transfers from chipping and rubbing off in normal handling, apply a clear acrylic protective spray coating. Available in an aerosol can, spray it on in the same manner as with the primer and enamel paint. Again, it is best to apply two or three thin coats, rather than trying to do it all at once with one thick coating.

If you follow the procedures outlined in this article, you should have little trouble creating a top-quality, professional-looking enclosure for any project. Then, when some asks if you built the cabinet, too, you can answer with a big yes! **NV** 

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# THE SOLDERLESS BREADBOX

by Donald Wilcher

# **Experimenting With RC Timing Circuits**

Every consumer product that touches our lives involves some form of timing. VCRs have programmable timers which allow us to tape our favorite TV shows. Microwave ovens have a timing circuit for cooking our foods correctly. Alarm clocks definitely have timing circuits for keeping correct time.

Some examples of timing circuits, that are not obvious, are the delay wipers on an automobile, turn signal flashers, central processing units (CPUs), and calculators. The examples listed use timing circuits for performing mechanical actuation/control, safety, and arithmetic operations. Timing circuits can be carried out in many different forms, such as hardwired circuits, mechanically controlled cams, and software.

The old "flip" style digit alarm clocks used AC synchronous timing motors for displaying the time. Integrated circuits such as the popular 555 Timer can provide time delays from microseconds up to several hours.

The use of this chip in a timing device is definitely a "hardwiring" experience, to say the least. Microprocessors and microcontrollers allow hardwired I/O (Input/Output) devices to perform timing activities simply by changing its assembly language code stored in RAM (Random Access Memory).

The complexity in each method starts from the extreme — which is the physical hardwired connections to delay electron flow in an electrical circuit — to the ease of editing a couple lines of code in a micro. Which method to use, you may ask. Well, it depends on the complexity of the project you're building. Simple projects should use simple designs. Therefore, hardwired circuits might be the best alternative for problem resolution and construction.

Sophisticated devices need precise timing for correct output response. Software is definitely the way to go for complex system applications and performance. But in this month's column, we're going to explore the basic element behind all timing methods conceivable, for both IC and software design solutions. The RC (Resistor-Capacitor) timing network can provide simple timing solutions to circuit design problems in a crunch. We will examine the key component in an RC timing circuit, the capacitor from construction to function. But this column will not be complete without a few "hands-on" circuit applications for experimental exploration of this fascinating network. So without further "delay," let's start our discussion with the fundamentals of a capacitor.

# **Capacitor Fundamentals**

In 1746, a method of storing large static charges was discovered. Electric shocks were produced from glass jars coated inside and out with metal foil. These devices were known as *Leyden* jars. Figure 1 illustrates the construction of a Leyden jar. Benjamin Franklin was knocked unconscious by the discharge of this jar. In the late 20s to the mid 40s, Leyden jars were made much smaller and not of glass. They were known as condensers.

Condensers came in many sizes and were always made of two conductors separated by an insulator. Capacitors are the second generation of condensers. They, too, come in many sizes and have the ability to

store large amounts of energy. These devices are constructed with two metal plates separated by an insulator known as a "dielectric." The dielectric can be paper, plastic film, mica, glass, ceramic, vacuum, or even air. Aluminum discs or foil can be used as the plates for the capacitor.

Figure 2 shows the construction of a capacitor. This conductor-dielectric-conductor sandwich can be rolled into a cylinder or a flat disc. One important item to remember about the capacitor is that the larger value of a capacitance, the more charge or electrical

trical energy it can store.

There are three types of capacitors hobbyists use in their electronic creations. They are the *variable*, *polarized*, and *non-polarized* capacitors. Variable capacitors allow their capacitance value to change by merely rotating a shaft that has movable plates. The insulator that separates the stationary from the movable metal plates is air. This type of capacitor is used in radios because they allow the radio frequency to change with its variable capacitance value. Variable capacitors fall in the picofarad (1 x 10 ^-12) capacitance range. Non-polarized caps find uses in low/hi pass filters and noise suppression applications. The unit of capacitance for these devices range from microfarads (1 x 10 ^-6) to picofarads.

Non-polarized caps are usually of the ceramic disc persuasion. The polarized capacitors, better known as electrolytic capacitors, have applications in DC power supply filtering, and RC timing networks. The unit of capacitance for this "true" energy storage device is the microfarad. Special precaution should be taken when using the electrolytic capacitor in an electronic circuit, whereby the positive lead of the component

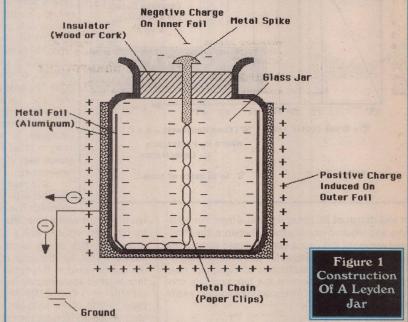
should be wired to the most positive part of the circuit. If not, damage to the rest of the circuit or yourself is possible.

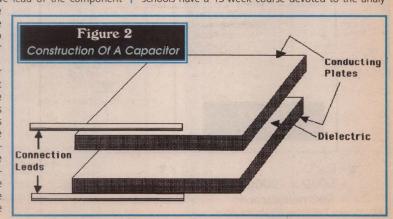
The way the capacitor works in an electrical circuit is by accumulating positive and negative charges on its metal plates. The charges are provided by the voltage source (battery) of the electrical circuit. Once the plates are completely saturated with these negative and positive charges, the capacitor is ready to release

this "stored" energy to the connected electrical load. Therefore, the time it takes for the capacitor to charge and discharge its energy is known as the Time Constant. The greek letter "tau" is used to represent the time constant. See Figure 3 for its greek letter representation. Figure 3 shows the charging curve of a capacitor. As one can see, for a capacitor to be fully charged, it takes five time constants. This time constant concept is very important when it comes to designing or analyzing RC timing circuits. The equation in Figure 3 provides a tool for determining the time at which the capacitor has reached a certain charging capacity. The discharge curve is the inverse of the charging graph.

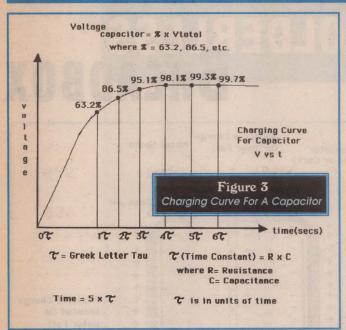
Generally speaking, in electronics, the emphasis is placed on charging, then on discharging; therefore, this curve will not be illustrated. For those individuals who are interested in seeing this graph, at the end of the column there is a book listed in the resource section which will have this information available.

Well, I know that was a mouthful of information to swallow in only a few hundred words. Engineering schools have a 13-week course devoted to the analy-





# THE SOLDERLESS BREADBOX



sis and design of RC networks with differential equations and required examinations. Therefore, the shortened version of this course was presented without the examinations and equations for your entertainment!

Now that the fundamentals of capacitors have been reviewed, let's examine this time constant concept associated with RC networks via hands-on examples.

# **RC Timing Circuit Examples**

Figure 4 shows a simple RC timing circuit to build for time constant analysis. As discussed earlier, the product of resistance and capacitance establishes the charging/discharging of electrical energy in the circuit. The time constant for this circuit equates to 56-milliseconds. That's a relatively short period of time for it to charge and discharge the stored potential of 9 volts.

The time associated with this tau value is 280-milliseconds. An application for this type of time duration would be used in suppressing noise coupled into an electronic control module's (ECM) discrete input of an automobile. For example, detecting low oil pressure using a low oil pressure switch. Alternator EMI (Electromagnetic Interference) might find its way into this input causing erroneous readings to the ECM. The telltale on the cluster, inside of the vehicle, will be illuminated telling the driver that there is a problem with

the oil pressure. If this input has an RC network, it will suppress any noisy signal that is 280 milliseconds in length from reaching the micro of the ECM.

As an experiment, wire the 56ohm resistor in series with an LED and make note of the charging and discharging characteristics of the circuit. The time delay for this circuit is quite fast which, in our automobile example, is neces-

sary in order for it to suppress EMI noise with a pulse signature of 280 milliseconds.

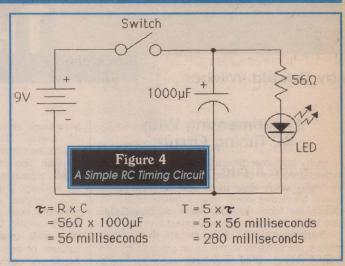
Our next example is more obvious because of its true delay functionality. The circuit in Figure 5 has a

tau of 496 ms with a time delay of 2.5 secs. The resistor has been replaced with a 500-ohm value in order to produce this timing factor. To make this circuit more practical, an additional 1,000 microfarad capacitor can be wired to this circuit in parallel to create a time delay of approximately five seconds. The value of capacitance is now 2.000 microfarads which, multiplied by 500 ohms, produces a tau of 500 milliseconds. NOTE: To increase the capacitance value, capacitors are wired in parallel. Therefore, two 1,000 microfarad capacitors wired in a parallel have a total capacitance value of 2,000 microfarads. Just a simple reminder! This time delay circuit is analogous to the seatbelt warning chime in a Chrysler Grand Cherokee. This warning system will alert the driver that his/her seatbelt is unbuckled and will continue to chime for about six seconds. To defeat this chime, the seatbelt must be buckled, or the ignition turned off. So, here is a practical application for our modified circuit. But to make it truly practical, we need to change the output circuit by replacing it with an electromechanical relay. The relay can then drive whatever type of output load is required for the appropriate application.

# **Further Thoughts and Experimentation**

RC timing networks are truly interesting circuits for experimentation and analysis. The 555 Timer IC would not be able to carry out its timing functions

without the RC network. Time delays for several minutes can be created using the two equations outlined in Figure 3 and this simple circuit combination. One application that this circuit can be used in is to illustrate the jogging control function found in industrial control applications. Electrical conveyors used to transport parts from various areas in the vehicle assembly plants have a "jog" button on the control panel for manually actuating the drive motor of the conveyor system. The motor will turn on a few secs/minutes at a time after each switch depression. The RC circuit described in Figure 5 can be used to create the same effect for a small DC

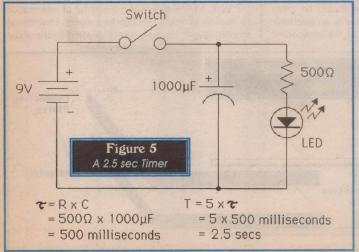


motor. To test this motor "jogging" feature, I always like to create a "physical" mechanical model of the system I'm trying to understand or control. The construction of the motor gearing assembly model was built using Meccanos Erector set. This construction set has small DC motors, gears, and various parts to create any mechanical system you can dream up. Legos Techincs or Capselas can be used as appropriate substitutes for those individuals who have such construction sets available.

This method of combining mechanical with electronic controls allows the circuit to illustrate how systems are designed and constructed to the electronics hobbyist. So, in this example of constructing a motor jog controller, I created a simple motor gear box using my Erector components as the electromechanical load that the RC timing circuit will control. Another application that the RC timing circuit can be used in is a simple stop watch. This circuit could be used to drive a seven-segment counting circuit. The output contacts of the relays in Figure 5 would be used to turn on/off the decimal counting unit. The number on the display should show the time delay associated with the RC network. This output display and control is quite useful in timing of science experiments. This timer/controller will provide a safe and accurate means of performing experiments where data collection related to time is very important. Potential/Kinetic Energy studies, and Free Falling calculations are examples of science experiments that depend on critical timing factors. Speaking of science.

To get the most out of this application or any other science activity, the folks from the Society For Amateur Scientists are a good source of science projects. Shawn Carlson, the Executive Director, has been quite busy in running this organization devoted to promoting the sciences via the contributions of amateur scientists. Yours truly is also an active participant of this organization. The Electronic Forum is a computer interactive media for meeting and sharing science ideas with both professional and amateur scientists/hackers. Membership is \$35.00 per year and it includes the quarterly newletter, *The Amateur Scientist Bulletin*, and access to the Electronic Forum. For more information on the SAS, contact Shawn Carlson at (619) 239-8807. You'll be glad that you did. Well enuf said, see ya next month in the breadbox! NV

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# Resources

Basic Electronics by Bernard Grob (McGraw Hill, 4th ed., 1977) with information about the discharge characteristics of capacitors.

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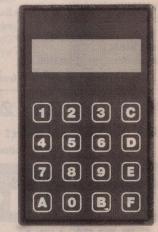
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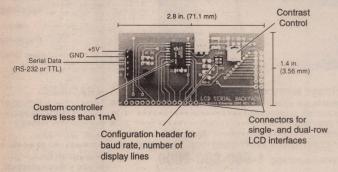
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AUDIX, SYDNEY, PHODE MAIL, CIDNY
SPERRY LINK, etc. An absolute must for all
users, sysops and security personnell \$29.

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How answering machines are hacked to isten to - even erase - messages, and to convert them into mini-VMBs. And counternessures - project source. measures - protect yourself from snoop stalkers, burglars and pranksters! \$29.

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PHREAKING
CALLER ID & ANI
Details on how they work and dozens of
effective ways of defeating Caller ID, ANI,
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and CF Boxes, ESS, SST, E-911, various
CLASS services, CMA, NON PUB DA,
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STOPPING

POWER METERS
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watthour meters - while loads draw full
power! Device plugs into one outlet and
normal loads into other outlets. Also describes mater crean, overland droop, etc. Plans \$29. THE I.Q. MANUAL: Ex-Frains 24. 114. MANUAL: Ex-ternal magnetic ways (applied to meter it-self) to slow down and stop watthour me-ters while drawing full loads. Plans. \$19. KW-HR METERS: How watthour meters work, calibration, error modes (many), ANS (Standards, etc. Demand and Polyphase Meters, Other experimental results to slow and stop meters by others. \$19. Any 2, \$38. All 3, \$59.

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RADIONICS MANUAL Exciting electrical, electronic and electro-magnetic therapeutic, diagnostic and pre-ventive devices (mostly experimental). His-tory, descriptions, plans (dozens), avail-abilities of Radionics Devices from early to abilities of Radionics Devices from early to modern. While drugs cost \$ Hundreds, electricity costs pennies! \$29. HEAL THYSELF: Plans for 3 major electronic therapeutic devices of types approved by FDA. \$24. EMF. B. LIGHT THERA-PLES. Systematic study of the germicidal properties of EMFs and lights in vitro and in vivo. Bands include µwaves, 4 IR, 6 visible and 3 UV, using continuous, single-pulse, strobe, random pulse rate and width exposures. \$29. Any 2. \$48. Ali 3. \$69.

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Design and construction of solid-propellant
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CRYPTANALYSIS TECHNIQUES

5 powerful menu-driven crypto programs (in .COM and .BAS source codes) to ana-lyze, decrypt "secure" ciphertexts. Worked-out examples. Recommended by prestiglous "Computers & Security." Manual + Disk" \$29.

MI - FLINT - Five Star Productions Computer Shows. SPONSOR: Five Star Productions. LOCA-TION: Holiday Inn-Gateway Centre, US-23 at Hill Rd Exit. HOURS: 10am-4pm. ADMISSION: S4. FEA-TURES: C - DP - FP. DEALER INFO: \$35 tables negotiable. CONTACT: Five Star Productions, 810-230-0988.

#### FEBRUARY 24

IN - LAPORTE - Mid-Winter "Cabin Fever" Hamfest. SPONSOR: LaPorte ARC. LOCATION: LaPorte Civic Auditorium. HOURS: 8am-1pm. TALK-IN: 146.610, 131.8 PL. CONTACT: LaPorte ARC, POB 30, LaPorte IN 46350.

#### FEBRUARY 24-25

OH - CINCINNATI - ARRL Great Lakes Division 1996. LOCATION: Cincinnati Gardens Exhibition Center, 2250 Seymour Ave @ Langdon Farm Rd.
HOURS: 8:20am-5pm. ADMISSION: Adv \$6, door
8. FEATURES: CB - DP - EX - F - FP. CONTACT
Stan Cohen WD8QDQ, 513-531-1011, 2301 Royal Oak Ct. Cincinnati OH 45237.

# FEBRUARY 25

IL - GLEN ELLYN — Computer Central. LOCATION: College of DuPage, Park Blvd 6 College Rd. HOURS: 9:30am-3pm. ADMISSION: Adults \$6, 8-12 \$2, under 8 free. \$1 off reg adult admission w/this ad. FEATURES: AC - C - FP. CONTACT: Computer Central, Jay B. Robinson, 708-940-7547

MI - DEARBORN — 26th Annual Swap 'N Shop. SPONSOR: Livonia ARC. LOCATION: Dearborn Center, 15801 Michigan Ave. HOURS: 8am-ADMISSION: \$5. TALK-IN: 145.350, 146.52. FEATURES: DP - EX. DEALER INFO: Tables \$15 + \$ adm. CONTACT: Neil Coffin WA8GWL, Livonia ARC, POB 2111, Livonia MI 48151, 313-261-5486.

OH - CUYAHOGA FALLS - 42nd Annual Hamfest, Computer Show & Flea Market. SPONSOR:
Cuyahoga Falls ARC, LOCATION: Emidlo & Sons,
48 Bath Rd. ADMISSION: Adv S4, door \$5. FEATURES: C - DP - FM - H. DEALER INFO: Tables \$8, adv only. CONTACT: Carl N8JLQ, 216-497-7047.

ND - BISMARCK — 6th Annual Hamfest. SPON-SOR: Central Dakota ARC, LOCATION: Radisson Inn. HOURS: 8am-? ADMISSION: Adv \$5, Door \$6. TALK-IN: 146.85. FEATURES: C - CB - EX H - S. **DEALER INFO:** Swap table \$5, set-up 6:30am. **CONTACT:** CDARC, POB 7162, Bismarck ND 58507-7162

#### MARCH 8-9-10

LA - LAFAYETTE — ARRL Hamfest. SPONSOR: Acadiana ARA. CONTACT: Nolen Griffith K5ARH 123 Normandy Rd, Lafayette LA 70503. 318-989-

NE - NORFOLK — Nebraska State Convention. CONTACT: Patrick Adams NOAZC, 2002 Sunset Ave, Norfolk NE 68701. 402-371-7295

#### MARCH 10

IL - ORLAND PARK - The Orland Park Compute Show. LOCATION: Orland Park Civic Center, 147th St & LaGrange Rd (Rte 45). HOURS: 9:30am-3pm. ADMISSION: Adults \$5 - \$1 off with copy of this ad, 8-12 yrs \$2, under 8 free. FEATURES: AC - C - CB -- F/R - All indoors. CONTACT: 24-hour Hotline

OH - CONNEAUT — 10th Annual Hamfest.
SPONSOR: Conneaut ARC. LOCATION:
Conneaut Human Resource Center, 327 Mill St.
ADMISSION: \$5. TALK-IN: 147.39. FEATURES: C - EX - F/R - H. DEALER INFO: Tables
\$8. CONTACT: Jack Marttila 216-593-3353. Clarence Baugher 216-593-3038

WI - WAUKESHA — Sewfars Swapfest. SPON-SOR: Southeastern Wisconsin FM ARS. LOCA-TION: Waukesha County Expo Center Arena. HOURS: 8am-2pm. ADMISSION: Adv \$4, Door \$5. TALK-IN: 146.820, 145.070, 444.125. FEA-TURES: C - E - EX - H, DEALER INFO: 4' tables: Adv \$5, Door \$6, set-up 6am. CONTACT: Sewfars, POB 102, Delafield WI 53018. 414-789-

# MARCH 16

MI - MARSHALL — 35th Annual Crossroads Hamfest. LOCATION: Marshall High School. HOURS: 8am-3pm. ADMISSION: Adv 53, Door \$4. TALK-IN: 146.66, 146.52. FEATURES: C - FP - F/R - H. **DEALER INFO:** Tables \$1 per ft, 4' min, set-up 6am. **CONTACT:** SMARS, POB 934, Battle Creek MI 49016. Wes Chaney N8BDM, 616-

TX - MIDLAND - ARRL Hamfest. SPONSOR: Midland ARC. CONTACT: Larry Nix N5TQU, 3900 Douglas Ave, Midland TX 79703. 915-699-

# MARCH 23-24

IN - INDIANAPOLIS — Indianapolis Computer Fair. LOCATION: Beech Crest Center, 3655 E Raymond St, corner Sherman, E of I-65 Exit #109. HOURS: 10am-4pm. ADMISSION: S6, under 12 free. FEA-TURES: C - DP. CONTACT: Ben Yanto, AGI Computer Fairs.\*

MI - MIDLAND — Five Star Productions Computer Shows. SPONSOR: Five Star Productions. LOCA-TION: Holiday Inn, US 10 @ Eastman Rd. HOURS: 10am-4pm. ADMISSION: 54. FEATURES: C - DP FP. **DEALER INFO:** \$35 tables negotiable. **CONTACT:** Five Star Productions, 810-230-0988.

TX - VICTORIA — Swapfest 1996. SPONSOR: Victoria ARC. LOCATION: Knights of Columbus Hall, 3610 N Ben Wilson. HOURS: 8am-? ADMISSION: \$5. TALK-IN: 145,190-, 145,130-. FEATURES: EX - H. DEALER INFO: Tables Adv \$4, Door \$5. **CONTACT:** Victoria ARC, 121 S Main St #205, Victoria TX 77901, 512-573-0821

# **EASTERN REGION**

#### JANUARY 6

MA - WEST SPRINGFIELD - Computer Show & Sale. SPONSOR: MarketPro. LOCATION: Eastern

States Expostion, HOURS: 9:30am-4pm, ADMIS-SION: \$6, under 12 free w/adult. FEATURES: C FP. CONTACT: MarketPro Computer Shows.\*

MD - BALTIMORE — Computer Show & Sale. SPONSOR: MarketPro. LOCATION: Martin's West. HOURS: 9:30am-4pm. ADMISSION: \$6. FEA-TURES: C - FP. CONTACT: MarketPro Computer Shows.\*

PA - NEWTOWN — Computer Show & Sale. SPON-SOR: MarketPro. LOCATION: Bucks County Community College. HOURS: 9:30am-4pm. ADMIS-SION: \$6. FEATURES: C - FP. CONTACT: MarketPro Computer Shows.\*

TN - MORRISTOWN — Hamfest & Computer Show. SPONSOR: Lakeway ARC. LOCATION: Talley Ward Recreation Center. HOURS: 8am-3pm. ADMIS-SION: \$4. TALK-IN: 147.030+. DEALER INFO: Tables \$7.50. CONTACT: Dealers: Perry Hensley KS4QK, 423-828-4848, Gen'l Info: Ken Bowie KC4YDQ, 423-581-1258.

#### JANUARY 6-7

FL - FORT MEYERS — Southwest Florida Hamfest. SPONSOR: Fort Meyers ARC. LOCATION: Araba e Temple, 2010 Hanson St., 1 blk E of US 41. HOURS: Sat 9am-5pm, Sun 9am-3pm, ADMIS-SION: Adv \$5, Door \$6, good both days. TALK-IN: 147.345+. DEALER INFO: 8' tables \$15, elec \$2. Set-up: Fri 6pm-9pm, Sat 7am. CONTACT: Jackie Kampfert KR4NZ, 941-542-6675. Southwest Florida Hamfest '96, POB 61183, Ft Meyers FL 33906

NJ - PENNSAUKEN - Computer Show. LOCA-TION: South Jersey Expo Center, off NJ Toke Exit #4 on Rte 73. HOURS: Sat: 10am-4pm, Sun: 10am-3pm. FEATURES: C. DEALER INFO: 500+ tables. CONTACT: KGP Computer Shows.\*

#### JANUARY 7

CT - WATERBURY - Computer Show & Sale SPONSOR: MarketPro. LOCATION: Waterbury Sheraton, HOURS: 9:30am-4pm, ADMISSION: \$6, under 12 free w/adult. FEATURES: C - FP. CONTACT: MarketPro Computer Shows.\*

DE - NEWARK — Computer Show & Sale. SPON-

SOR: MarketPro. LOCATION: University of



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Delaware. HOURS: 9:30am-4pm. ADMISSION: \$6. FEATURES: C - FP. CONTACT: MarketPro Computer Shows.\*

VA - VIRGINIA BEACH— Computer Show & Sale. SPONSOR: MarketPro. LOCATION: Virginia Beach Pavilion. HOURS: 9:30am-4pm. ADMISSION: \$6. FEATURES: C - FP. CONTACT: MarketPro Computer Shows.\*

#### JANUARY 13

NJ - SOMERSET — Computer Show & Sale. SPON-SOR: MarketPro. LOCATION: Garden State Exposition Center. HOURS: 9:30am-4pm. ADMIS-SION: 56, under 12 free w/adult. FEATURES: C -FP. CONTACT: MarketPro Computer Shows.\*

NY - MARATHON — ARRL Hamfest. SPONSOR: Skyline ARC. CONTACT: Barb Mudge KB2TIK, 3364 Rte. 221 W., Marathon NY 13045. 607-849-6751.

PA - HARRISBURG — Hamfest. SPONSOR: Harrisburg RAC. LOCATION: Oberlin FC Social Hall, Exit #1 1-283, follow PA #441 N 1 mi to site. HOURS: 8am-noon. ADMISSION: 52. TALK-IN: 146.76, 146.52/52. FEATURES: F/R - H - T. DEAL-ER INFO: Tables S8, tailgating \$1, WX permitting, Tom Hall WU3X, Box 418, Hallfax PA 17032. CON-TACT: 717-232-6087.

SC - GREENWOOD — Hamfest, SPONSOR: Greenwood ARS. LOCATION: Greenwood Civic Center, Hwy 72 E. HOURS: 9am-5pm. ADMIS-SION: \$5, under 12 free, TALK-IN: 147.165. FEATURES: CB - EX - FM - FP - F/R - T. DEAL-ER INFO: Tables \$8, flea market & tailgating free, w/admission, set-up 6am. CONTACT: Frank Kolar WA9FWO, 803-229-5639, Bob Skutt 803-229-9545.

VA - ANNANDALE— Computer Show & Sale.

SPONSOR: MarketPro. LOCATION: Northern
Vision Community College. HOURS: 9:30am-4pm.

ADMISSION: \$6. FEATURES: C - FP. CONTACT:
MarketPro Computer Shows.\*

# JANUARY 13-14

FL - SARASOTA — 17th Annual Sarasota Hamfest 6 Computer Show. LOCATION: Sarasota fairgrounds, Robarts Sports Arena, 3000 Ringling Bl. HOURS: Sat 9am-5pm, Sun 9am-3pm. ADMIS-SION: Adv \$5, door \$7. TALK-IN: 146.31/91, 444.925. FEATURES: DP - EX - F - FP - F/R - RV-H -T. DEALER INFO: Tables \$20-\$25 + admission, tailgating space \$10 (includes 1 admission). CON-TACT: Sam Everts KE4BXF, 941-927-8999.

MA - MARLBOROUGH — Computer Show. LOCA-TION: Royal Plaza Trade Center, take MA Tpke to I-495 Exit #24-B. HOURS: Sat: 10am-4pm, Sun: 10am-3pm. FEATURES: C. DEALER INFO: 500+ tables. CONTACT:KGP Computer Shows.\*

PA - ALLENTOWN — Computer Show & Sale.

SPONSOR: MarketPro. LOCATION: Allentown
Fairgrounds. HOURS: 9:30am-4pm. ADMISSION:
\$6. FEATURES: C - FP. CONTACT: MarketPro
Computer Shows.\*

## JANUARY 14

MD - GREENBELT — Computer Show & Sale. SPONSOR: MarketPro. LOCATION: Martin's Crosswinds. HOURS: 9:30am-4pm. ADMISSION: S6. FEATURES: C - FP. CONTACT: MarketPro Computer Shows.\*

NJ - PARSIPPANY — Computer Show & Sale. SPONSOR: MarketPro. LOCATION: Parsippany Hilton. HOURS: 9:30am-4pm. ADMISSION: S6, under 12 free w/adult. FEATURES: C - FP. CON-TACT: MarketPro Computer Shows.\*

VA - HAMPTON — Computer Show & Sale. SPON-SOR: MarketPro, LOCATION: Hampton Coliseum. HOURS: 9:30am-4pm. ADMISSION: \$6. FEA-TURES: C - FP. CONTACT: MarketPro Computer Shows.\*

# JANUARY 20

MA - BOSTON — Computer Shows & Sales. SPON-SOR: Northern Computer Shows. LOCATION: Boston College High School, Morrissey Blvd, 1-93, Exit 15 or Exit 14. HOURS: 10am-3:30pm. ADMIS-SION: \$7, under 14 free w/adult. FEATURES: C -FP. DEALER INFO: Set-up 8am. CONTACT: Northern Computer Shows.\*

VA - RICHMOND — Computer Show & Sale. SPON-SOR: MarketPro. LOCATION: The Showplace. HOURS: 9:30am-4pm. ADMISSION: \$6. FEA-TURES: C - FP. CONTACT: MarketPro Computer Shows.\*

# JANUARY 20-21

NJ - HACKENSACK — Computer Show. LOCA-TION: FDU/Rothman Center, near Geo. Wash. Bridge to NYC, Rte 4 to Hackensack Ave South, left In Temple Ave. HOURS: Sat: 10am-4pm, Sun: 10am-4pm, FEATURES: C. DEALER INFO: 600+ tables. CONTACT:KGP Computer Shows.\*

NY - STONY BROOK — Computer Show & Sale. SPONSOR: MarketPro. LOCATION: SUNY Stony Brook. HOURS: '9:30am-4pm. ADMISSION: S6, under 12 free w/adult. FEATURES: C - FP. CON-TACT: MarketPro Computer Shows.\*

Ander 12 free wyduli. FEATURES: C - FP. CONTACT: MarketPro Computer Shows.\*

PA - KING OF PRUSSIA — Computer Show & Sale. SPONSOR: MarketPro. LOCATION: Valley Forge Convention Center. HOURS: 9:30am-4pm. ADMISSION: \$6. FEATURES: C - FP. CONTACT: MarketPro Computer Shows.\*

#### JANUARY 21

NY - YONKERS — Giant Electronic Flea Market. SPONSOR: Metro 70cm Network. LOCATION: Lincoln High School, Kneeland Ave. HOURS: 9am-3pm. ADMISSION: \$6, under 12 free. TALK-IN: 440.425 MHZ PL 156.7, 223.760 MHZ PL 67.0. FEA-TURES: DP - EX. F/M. FP - F/R. DEALER INFO: Table setup 7am. Call for prices. CONTACT: Otto Supliski WB2SLQ, 914-969-1053.

VA - RICHMOND — Frostfest '96. SPONSOR: Richmond Amateur Telecommunications Society. LOCATION: The Showplace, 3000 MechanicsVIIII Tmpk. HOURS: 8:30am-3:30pm. ADMISSION: \$5. TALK-IN: 146.88 - FEATURES: C - CB - DP -E - F - FM - FP - F/R - H - RV-S. CONTACT: Craig Spain 804-526-9838 eves., POB 932, Chester VA 23831.

#### JANUARY 27

AL - GREENVILLE — Hamfest '96. SPONSOR: Butler County & Pike County RACES, LOCATION: Butler County Fairgrounds, HOURS: 8am-3pm. ADMISSION: \$2. TALK-IN: 146.07–.67. FEA-TURES: F/R. DEALER INFO: Tables \$10, tailgate space \$5, set-up Fri 4pm-8pm & Sat 6:30am. CON-TACT: Randolph Walters KW4B, 334-382-3496 between 2pm-6pm.

FL - FORT LAUDERDALE — Narisaam Computer Fair. LOCATION: Holiday Inn-West, 5100 N State Road 7. HOURS: 10am-4pm. ADMISSION: 55, 54 with this ad, under 12 free. FEATURES: AC - C -FP. CONTACT: Fred Ahmadi, Narisaam Computer Shows.\*

NH - SALEM — Computer Shows & Sales. SPON-SOR: Northern Computer Shows. LOCATION: Rockingham Park Racetrack, I-93 Exit 1, next to 175 store Mall. HOURS: 10am-3:30pm. ADMISSION: \$7, under 14 free w/adult. FEATURES: C. DEALER INFO: Set-up 8am. CONTACT: Northern Computer Shows.\*

NY - SETAUKET — Hamfest. SPONSOR: Ward Melville ARC. LOCATION: Ward Melville High School, 380 Old Town Rd N. HOURS: 8am-2pm. ADMISSION: \$5. TALK-IN: 146.940-, 136.5. FEATURES: EX - F/R - H. DEALER INFO: Tables \$20, 8' x 4' space \$15, set-up 6:30am. CONTACT: John Pomfret W2AAF, 516-751-8236, Sharon Rosenfeld (SG) 516-689-6350.

NY - WHITE PLAINS — Computer Show & Sale. SPONSOR: MarketPro. LOCATION: Westchester County Center. HOURS: 9:30am-4pm. ADMIS-SION: \$6, under 12 free w/adult. FEATURES: C -FP. CONTACT: MarketPro Computer Shows.\*

TN - GALLATIN — Hamfest/Computer Show. SPON-SOR: Tennessee Valley ARN. LOCATION: Civic Center, off Hwy, 31E on N side of town. HOURS: 8am-4pm. ADMISSION: 55, XYLs & under 16 free. FEATURES: EX. DEALER INFO: Tables S10, setup Fri 4pm-9pm, Sat 5am-8am. CONTACT: Gen'l Info: Bill Ferrell, 1032 Hidden Woods Tr, Gallatin TN 37066, 615-452-7246. VE Exams: Ronnie Gilley, 510 Hillside Dr, Gallatin TN 37066.

## JANUARY 27-28

MD - GAITHERSBURG— Computer Show & Sale.
SPONSOR: MarketPro. LOCATION: Montgomery
County Fairgrounds. HOURS: 9:30am-4pm. ADMISSION: 56. FEATURES: C - FP. CONTACT:
MarketPro Computer Shows.\*

NC - CHARLOTTE — Charlotte Area Computer Show. LOCATION: Metrolina Expo Center, 7100 North Statesville Rd, 1-77 N to Exit 16A, first exit N of I-85/I-77 intersection. HOURS: Sat: 9am-5pm, Sun: 10am-4pm. ADMISSION: \$5 both days, \$4 Sun only, FeATURES: AC - C - DP - FP - F/R. DEALER INFO: 8' tables \$45. CONTACT: Computer Show, POB 295, Riverdale, GA 30274. 770-907-6225.

PA - MONROEVILLE — Computer Show & Sale. SPONSOR: MarketPro. LOCATION: Pittsburgh Expo Mart. HOURS: 9:30am-4pm. ADMISSION: \$6. FEATURES: C - FP. CONTACT: MarketPro Computer Shows.\*

#### JANUARY 28

FL - WEST PALM BEACH — Narisaam Computer Fair. LOCATION: Palm Beach Airport Hilton, 150 Australian Ave. HOURS: 10am-4pm. ADMISSION: \$5, \$4 with this ad, under 12 free. FEATURES: AC -C -FP. CONTACT: Fred Ahmadi, Narisaam Computer Shows.\*

MA - SWANSEA — Computer Shows & Sales.
SPONSOR: Northern Computer Shows. LOCATION: Venus de Milo, Rte 6, Exit 3 off I-195.
HOURS: 9:30am-2:30pm. ADMISSION: \$7, under
14 free w/adult. FEATURES: C. DEALER INFO:
Set-up 8am. CONTACT: Northern Computer
Shows \*

MD - ODENTON — Post Holiday Swapfest & Flea Market. SPONSOR: Maryland Mobileers ARC. LOCATION: Volunteer Fire Dept. Hall, 1425 Annapolis Rd, Rte 175, 9 mi E of I-95. HOURS: 8am-2pm. ADMISSION: S3. TALK-IN: 146.205/805. FEATURES: EX - FM - FP - F/R. DEALER INFO: Tables \$7. CONTACT: Tom Wilkison KA3OMU, 592 Eason Dr, Severn MD 21144, 410-969-2639 eves.

NY - POUGHKEEPSIE — Computer Show & Sale. SPONSOR: MarketPro. LOCATION: Mid-Hudson Civic Center. HOURS: 9:30am-4pm. ADMISSION: \$6, under 12 free w/adult. FEATURES: C - FP. CONTACT: MarketPro Computer Shows.\*

# FEBRUARY 3

MA - FITCHBURG — Computer Show & Sale. SPONSOR: MarketPro. LOCATION: Royal Plaza Trade Center. HOURS: 9:30am-4pm. ADMISSION: \$6, under 12 free w/adult. FEATURES: C - FP. CONTACT: MarketPro Computer Shows.\*

NH - SEABROOK — Computer Shows & Sales.
SPONSOR: Northern Computer Shows. LOCATION: Seabrook Greyhound Park, 195, Exit 1.
HOURS: 10am-3:30pm. ADMISSION: \$7, under 14
free w/adult. FEATURES: C. DEALER INFO: Setup 8am. CONTACT: Northern Computer Shows.\*

TN - KNOXVILLE — Kerbela Hamfest. SPONSOR: The Shriners of Kerbela AR Service. LOCATION: Kerbela Shrine Temple. HOURS: 8am-4pm. ADMIS-SION: \$4. TALK-IN: 144.83/145.43. FEATURES: EX - T. DEALER INFO: Tables \$8 + admission, tailgate space \$3 + adm. Set-up Fri 4pm-9pm, Sat 5am-8am. CONTACT: Paul Baird KY4A, 1500 Coulter Shoals Cir, Lenoir City TN 37772. 423-986-9562. FCC Exams: Ray Adams N4BAQ, 423-688-7771.

# FEBRUARY 3-4

FL - MIAMI — 36th Tropical Hamboree. SPONSOR: Dade Radio Club of Miami. LOCATION: Dade County Youth Fair & Exposition Center, SW 112 Ave & Coral Way (SW 24 St). ADMISSION: Adv \$5, door \$7. TALK-IN: 146.925. FEATURES: Swap tables: \$25, elec \$10 per user. CONTACT: Evelyn Gauzens WAWYR, 2780 NW 3 St, Miami FL 33125-5059, 305-642-4139.

MS - JACKSON — Mississippi State Convention. CONTACT: Travis Cliett AB5ZE, 117 Beechtree Ln, Florence MS 39073. 601-939-9236.

# FEBRUARY 4

MA - ANDOVER — Computer Show & Sale. SPON-SOR: MarketPro. LOCATION: Ramada Rolling Green. HOURS: 9:30am-4pm. ADMISSION: \$6, under 12 free w/adult. FEATURES: C - FP. CON-TACT: MarketPro Computer Shows.\*

ME - PORTLAND — Computer Shows & Sales. SPONSOR: Northern Computer Shows. LOCA-TION: Verillo's Conv. Ctr., @ Howard Johnson Motor Lodge, I-95 Exit 8. HOURS: 10am-3:30pm. ADMISSION: \$7, under 14 free w/adult. FEATURES: C. DEALER INFO: Set-up 8am. CONTACT: Northern Computer Shows.\*

# FEBRUARY 10

FL - ARCADIA — Hamfest. SPONSOR: Desoto ARC, LOCATION: Desoto County Fairgrounds, 1/2 mi S of Hwy 70 on US 17. HOURS: 9am-?. ADMISSION: S3. TALK-IN: 147.075. FEA-TURES: H - RV-S - T. DEALER INFO: Tables \$10, tallgating free w/admission, set-up; Fri 3-8pm, Sat 6am. CONTACT: Doug Christ KN4YT, POB 1352, Nocatee FL 33864, 941-494-5070.

FL - PENSACOLA — ARRL Hamfest. SPONSOR: Pensacola Area Hamfest Association. CONTACT: Bill Behrends WA4YRN, 1050 W Cartton Rd, Pensacola FL 32534-1130. 904-476-8537.

RI - SMITHFIELD — Computer Show & Sale, SPON-SOR: MarketPro, LOCATION: Bryant College, HOURS: 9:30am-4pm, ADMISSION: \$6, under 12 free w/adult. FEATURES: C - FP, CONTACT: MarketPro Computer Shows.\* SC - CHARLESTON — 23rd Annual Charleston Hamfest & Computer Show, SPONSOR: Charleston ARS, LOCATION: Stall High School. HOURS: 8:30am-4pm. ADMISSION: \$5, under 12 free. FEATURES: C - DP - EX - F/R - H - T. DEALER INFO: Tables \$8, set-up Fri after 5pm. CONTACT: Jenny Myers WA4NGV, 2630 Dellwood Ave, Charleston SC 29405-6814, 803-747-2324.

#### FEBRUARY 10-11

MA - WILMINGTON — Computer Show. LOCA-TION: Shriner's, N of Boston at I-93, Exit #39. HOURS: Sat: 10am-4pm, Sun: 10am-3pm. FEA-TURES: C. DEALER INFO: 500+ tables. CON-TACT:KGP Computer Shows.\*

#### FEBRUARY 11

NY - STONY BROOK — Computer Show & Sale. SPONSOR: MarketPro. LOCATION: SUNY Stony Brook. HOURS: 9:30am-4pm. ADMISSION: S6, under 12 free w/adult. FEATURES: C - FP. CONTACT: MarketPro Computer Shows.\*

PA - LATROBE — Winterfest, SPONSOR: Chestnut Ridge ARC, LOCATION: Latrobe American Legion, 1811 Ligonier St. HOURS: Bam-3pm, ADMISSION: S2, TAILK-IN: 145,150-, FEATURES: DP - F/R. DEALER INFO: Tables \$10, CONTACT: CRARC, POB 175, Loyalhanna PA 15661-0175, Chris Weiss, 412-537-6068.

#### FEBRUARY 16-17-18

FL - ORLANDO — Florida State Convention. CONTACT: John Lenkerd W4DNU, 1046 Turner Rd, Winter Park FL 32789. 407-645-2026.

#### FEBRUARY 17

MA - MARLBOROUGH — ARRL Hamfest. SPON-SOR: Algonquin ARC. CONTACT: Ann Weldon KA1PON, POB 258, Marlborough MA 01752. 508-481-4988.

NY - GOSHEN — Hamfest. SPONSOR: Orange County ARC. LOCATION: John S Burke Catholic HS, Rte 17 to exit 122A (Fletcher St). HOURS: 9am-3pm. ADMISSION: \$3. TALK-IN: 146.760, FEATURES: CB - EX - F - F/R - H - T. CONTACT: Steve Voorman KBZTRG, 914-496-8710.

# FEBRUARY 17-18-19

NJ - EDISON — Computer Show. LOCATION: Raritan Center Exposition Hall (NJ Convention Center), NJ Tpke Exit #10. HOURS: Sat: 9:30am-4pm, Sun & Mon: 10am-4pm. FEATURES: C. DEALER INFO: 500+ tables. CONTACT:KGP Computer Shows.\*

## FEBRUARY 18

MA - TAUNTON — Computer Shows & Sales. SPONSOR: Northern Computer Shows. LOCA-TION: Taunton Holiday Inn, Exit 9 off I-495, between Rte24 & I-95. HOURS: 10am-3:30pm. ADMISSION: \$7, under 14 free w/adult. FEATURES: C. DEALER INFO: Set-up 8am. CONTACT: Northern Computer Shows.\*

NC - ELKIN — ARRL Hamfest. SPONSOR: Briarpatch & Foothills ARCs. CONTACT: Dave Nicholson N4VMB, PO Box 162, Cana VA 24317-0317. 703-755-4669.

# FEBRUARY 19

MA - ROCKLAND — Computer Shows & Sales. SPONSOR: Northern Computer Shows. LOCA-TION: Sons of Italy, Rtes 123 & 139, Rte 3 Exit 14 to Rockland Center. HOURS: 10am-330pm. ADMISSION: \$7, under 14 free w/adult. FEATURES: C. DEALER INFO: Set-up 8am. CONTACT: Northern Computer Shows.\*

# FEBRUARY 24

FL - BROOKSVILLE — ARRL Hamfest. SPONSOR: Hernando County ARA. CONTACT: Glenn Brown AC4QH, 31188 Park Ridge Dr, Brooksville FL 34602. 904.7904.755

NY - TROY — Computer Show & Sale. SPONSOR: MarketPro. LOCATION: Troy Armory. HOURS: 9:30am-4pm. ADMISSION: \$6, under 12 free W/adult. FEATURES: C - FP. CONTACT: MarketPro Computer Shows.\*

VT - MILTON — Northern Vermont Winter Hamfest. SPONSOR: Radio Amateurs of Northern Vermont. LOCATION: Milton High School, Rte 7, 5 m in 7 of 149, exit 17. HOURS: 8am-3pm. ADMISSION: \$3, under 18 free. TALK-IN: 145.15-. FEATURES: C - E - EX - F- FM - FP - F/R - H - T. DEALER INFO: Tables free first come first served. CONTACT: WBZJSJ. 802-

# CALENDAR

879-6589.

#### FEBRUARY 24-25

GA - ATLANTA — Atlanta Area Computer Show, LOCATION: Cobb County Civic Center, 548 S Marietta Pky, Exit 112 at I-75, Hwy 120 W. HOURS: Sat: 9am-5pm, Sun: 10am-4pm, ADMISSION: S5 both days, 54 Sun only, FEATURES: AC - C - DP-FP - F/R. DEALER INFO: 8' tables \$45. CONTACT: Computer Show, POB 295, Riverdale, GA 30274. 770-907-6225

#### FEBRUARY 25

CT - CROMWELL - Computer Show & Sale. SPON-SOR: MarketPro. LOCATION: Radisson Cromwell. HOURS: 9:30am-4pm. ADMISSION: \$6, under 12 free w/adult. FEATURES: C - FP. CONTACT:
MarketPro Computer Shows.\*

PA - PITTSBURGH — ARRL Hamfest. SPON-SOR: South Hills ARC. CONTACT: Steve Lane N3RNY, POB 11626, Pittsburgh PA 15228. 412-341-1043.

# MARCH 2

NJ - ABSECON - Springfest '96. SPONSOR: Shore Points ARC. LOCATION: Holy Spirit High School, on Rte 9, 3/4 mi S of Rte 30. HOURS: 9am-?. ADMISSION: \$5, XYL's & children free. TALK-IN: 146,385/,985. FEATURES: FM - FP - F/R - H - T. DEALER INFO: 8' indoor tables \$7, tailgating \$5, set-up 7am. CONTACT: SPARC, POB 142, Absecon NJ 08201.

# MARCH 9

FL - LAKE WORTH - Semi-Annual Free Flea SPONSOR: West Palm Beach ARC, LOCATION:
John Prince Park @ Mound Circle. HOURS: 8am2pm. ADMISSION: Free. TALK-IN: 147.135+.
FEATURES: FP - F/R - T. DEALER INFO: Free
to sellers. CONTACT: Marvin Kaskawits, KD2CK
@ KB4VOL, 407-683-2930.

## MARCH 9-10

NC - CHARLOTTE - ARRL Hamfest, SPONSOR: Mecklenburg ARS. CONTACT: Mary Hunt KA4EXP, 3213 Bridgemere Terrace, Matthews NC 28105. 704-841-HAMS.

NJ - PENNSAUKEN - Computer Show. LOCA-TION: South Jersey Expo Center, off NJ Tpke, Exit #4 on Rte 73. HOURS: Sat: 10am-4pm, Sun: 10am-3pm. FEATURES: C. DEALER III.
CONTACT: KGP Computer Shows.\* FEATURES: C. DEALER INFO: 500+ tables.

# MARCH 16

- ENGLEWOOD - ARRL Hamfest. SPON-**SOR:** Englewood ARS. **CONTACT:** Dennis Babcock NT9K, 1960 Mississippi Ave., Grove City FL 34224. 941-698-0248.

GA - MARIETTA - ARRL Hamfest. SPONSOR: Kennehoochee ARC. CONTACT: Margaret Durham KB4QKW, 1097 Seven Springs Cir, Marietta GA 30068, 770-977-4405.

# MARCH 16-17

FL - FORT WALTON BEACH - ARRL Hamfest. SPONSOR: Playground ARC. CONTACT: Scott Stowell KE4BFT, 134 Bryn Mawr Blvd, Mary Esther FL 32569. 904-243-3182.

GA - PERRY — Middle Georgia Computer Show.
LOCATION: Georgia National Fairgrounds &
Agricenter, 401 Larry Walker Pky (1-75 at Exit 42).
HOURS; Sat: 9am-5pm, Sun: 10am-4pm. ADMISSION: 55 both days, \$4 Sun only. FEATURES: ACC-DP-FP-F/R. DEALER INFO: 8' tables \$40. CONTACT: Computer Show, POB 295, Riverdale, GA 30274, 770-907-6225.

NJ - WAYNE — Computer Show. LOCATION: William Paterson College, Recrreation Center, Near I-80, Rte 23 and Rte 46, on Pompton Rd. HOURS: Sat: 10am-4pm, Sun: 10am-3pm. FEATURES: C. DEALER INFO: 500+ tables. CONTACT:KGP Computer Shows.

# MARCH 17

MA - BRAINTREE — Ham Radio Flea Market. SPONSOR: South Shore ARC. LOCATION: Dav #29 Hall, Liberty St. HOURS: 9:30am-2:00pm. ADMISSION: \$2. TALK-IN: 146.67-. FEA-TURES: DP - EX - F/R - H. DEALER INFO: Tables, Adv: \$12, Door \$15, set-up 8:00am. CON-**TACT:** William Morgan, 25 Helena Rd., Boston MA 02122. 617-288-6906.

PA - DOVER — 9th Annual York Springfest. SPON-SOR: Keystone VHF Club. LOCATION: Dover

Firehall. HOURS: 8am-4pm. ADMISSION: \$3, 142 January 1996/Nuts & Volts Magazine under 12 free. TALK-IN: 146.37/.97. FEATURES: C - EX - FP - F/R - H - T. DEALER INFO: Tailgate space \$5, includes one admission.. **CONTACT:** York Springfest, POB 266, East Berlin PA 17316-0266. Ted Rodes KE3SO, 717-259-8063, FAX 717-259-

# **FOREIGN**

#### FEBRUARY 3

CANADA - ST. CATHARINES, ONTARIO — Hamfest. SPONSOR: Niagara Peninsula ARC. LOCATION: Canadian Auto Worker's Hall, 124 Bunting Rd. HOURS: 9am-2pm. ADMISSION: \$6. **DEALER INFO:** Tables \$15-\$20, set-up 7:00am. **CONTACT:** Marg Sewell VE3HOX, NPARC, PO Box 20036, Grantham Postal Outlet, St. Catherines ONT L2M 7W7, 905-680-1211.

# EVENTS CALENDAR Month at a Glance

#### JANUARY 1996

CA - Fresno - MarketPro Computer Show\*
CA - Santee - Ham/Computer/Electronic Swapmeet

MA - West Springfield - MarketPro Computer Show\*
MD - Maryland - MarketPro Computer Show\*

MI - Kalamazoo - Computers & You Computer Show

NH - Portsmouth - Northern Computer Show\*
OH - Cincinnati - MarketPro Computer Show\*

PA - Newtown - MarketPro Computer Show\* TN - Morristown - Hamfest & Computer Show

#### JANUARY 6-7

FL - Ft Meyers - Southwest Florida Hamfest MI - Detroit - Computer & Hi Tech Electronic Show

#### NJ - Pennsauken - KGP Computer Show\* JANUARY 7

CA - Lancaster - MarketPro Computer Show\*

CA - Livermore - Swapmeet
CA - San Diego - Computer Show & Sale
CA - San Jose - MarketPro Computer Show

CT - Waterbury - MarketPro Computer Show\* DE - Newark - MarketPro Computer Show\*

IN - South Bend - 19th Annual Hamfest

ME - Augusta - Northern Computer Show\* MI - Dearborn - Computers & You Computer Show

OH - Cincinnati - MarketPro Computer Show\* VA - Virginia Beach - MarketPro Computer Show\*

# **JANUARY 13**

AZ - Phoenix - WestFest CA - Fontana - Amateur Radio/Electronics Swapmeet CA - Sacramento - MarketPro Computer Show\*

CO - Loveland - Winter Superfest MI - Novi - Computers & You Computer Show

NJ - Somerset - MarketPro Computer Show\* NY - Marathon - ARRL Hamfest

PA - Allentown - MarketPro Computer Show\* PA - Harrisburg - Hamfest

SC - Greenwood - Hamfest VA - Annandale - MarketPro Computer Show\*

# JANUARY 13-14

FL - Sarasota - 17th Annual Hamfest/Computer Show

MA - Marlborough - KGP Computer Show\*

JANUARY 14

CA - Oxnard - MarketPro Computer Show\*
CA - Santa Rosa - MarketPro Computer Show\*
IL - Des Plaines - Computer Show & Sale
IL - Orland Park - Computer Show

IN - Ft Wayne - MarketPro Computer Show\* MD - Greenbelt - MarketPro Computer Show\*

MI - Grand Rapids - Computers & You Show MI - Kalamazoo - Computer/Camera Swapmeet

NJ - Parsippany - MarketPro Computer Show\* OH - Dover - Hamfest

PA - Allentown - MarketPro Computer Show\* VA - Hampton - MarketPro Computer Show\*

WI - Waukesha - 24th Annual Midwinter Swapfest

# JANUARY 20

CA - Bakersfield - MarketPro Computer Show\* CA - Santee - Ham/Computer/Electronic Swapmeet LA - Springfield - Hammond Hamfest

MA - Boston - Northern Computer Show\* MI - Flint - 4th Annual Swap & Shop

MI - Livonia - Computers & You Computer Show MO - St Joseph - Winter Hamfest

OH - Dayton - MarketPro Computer Show\*

PA - King of Prussia - MarketPro Computer Show\* VA - Richmond - MarketPro Computer Show\*

# **JANUARY 20-21**

CA - Vallejo - MarketPro Computer Show\*
NJ - Hackensack - KGP Computer Show\*

NY - Stony Brook - MarketPro Computer Show\*

OH - Dayton - Computer Fair

#### JANUARY 21

IL - Glen Ellyn - Computer Central Computer Show
MI - Lansing - Computers & You Computer Show
MI - Southfield - 30th Annual Swap & Shop
NY - Yonkers - Giant Electronic Swapmeet

OH - Columbus - MarketPro Computer Show

OH - Nelsonville - ARRL Hamfest

PA - King of Prussia - MarketPro Computer Show\* VA - Richmond - Frostfest '96

#### JANUARY 27

AL - Greenville - Hamfest '96

AL - treetwise - namest 90
FL - Ft Lauderdale - Narisaam Computer Show\*
IN - Indianapolis - AGI Computer Fair\*
MD - Gaithersburg - MarketPro Computer Show\*
MI - Taylor - Computers & You Computer Show
MO - St Charles - ARRL Hamfest

NH - Salem - Northern Computer Show

NY - Setauket - Hamfest

NY - White Plains - MarketPro Computer Show\*

PA - Monroeville - MarketPro Computer Show\*

TN - Gallatin - Hamfest/Computer Show

**JANUARY 27-28** CA - Sacramento - MarketPro Computer Show

CA - Ventura - MarketPro Computer Show\*

NC - Charlotte - ComputerShow

JANUARY 28 CA - Santa Ana - ACP Swapmeet

FL - West Palm Beach - Narisaam Computer Show\*
IL - Villa Park - ARRL Hamfest

IL - VIIIA PAIK - ANKL Hamiles MA - Swansea - Northern Computer Show\* MD - Gaithersburg - MarketPro Computer Show\* MD - Odenton - Post Holiday Swapfest & Flea Market MI - Madison Heights - Computers & You Show

MI - Midland - Five Star Computer Show NY - Poughkeepsie - MarketPro Computer Show

PA - Monroeville - MarketPro Computer Show\*

JANUARY 30-31 FEBRUARY 1

CA - Santa Clara - SoftExpo '96

# FEBRUARY 1996

**FEBRUARY 3** 

CANADA - Ontario - St Catherines - Hamfest

CA - Antioch - MarketPro Computer Show\* CA - Santee - Ham/Computer/Electronic Swapmeet
MA - Fitchburg - MarketPro Computer Show\*
NH - Seabrook - Northern Computer Show\*
TN - Knoxville - Kerbela Hamfest
TX - Amarillo - ARRL Hamfest

FEBRUARY 3-4 FL - Miami - 36th Tropical Hamboree

## MS - Jackson - ARRL State Convention

FEBRUARY 4

CA - Lancaster - MarketPro Computer Show\* CA - Livermore - Swapmeet

CA - Santa Rosa - MarketPro Computer Show\*
MA - Andover - MarketPro Computer Show\*
ME - Portland - Northern Computer Show\*

FEBRUARY 10

CA - Fontana - Amateur Radio/Electronics Swapmeet

CA - Fresno - MarketPro Computer Show\*

FL - Arcadia - Hamfest FL - Pensacola - ARRL Hamfest

MN - Blaine - Midwinter Madness RI - Smithfield - MarketPro Computer Show

SC - Charleston - Hamfest & Computer Show WI - Waukesha - Computer Show & Sale

FEBRUARY 10-11 MA - Wilmington - KGP Computer Show\*

FEBRUARY 11

CA - San Diego - MarketPro Computer Show\* IL - Des Plaines - Computer Show & Sale IN - South Bend - Computer/Camera Swapmeet

NY - Stony Brook - MarketPro Computer Show\* OH - Mansfield - Mid-Winter Hamfest/Computer Show

PA - Latrobe - Winterfest

# **FEBRUARY 16-17-18**

FL - Orlando - ARRL State Convention

## FEBRUARY 17

AZ - Tucson - Fest West '96

CA - Santee - Ham/Computer/Electronic Swapmeet
CA - Stockton - MarketPro Computer Show\*

IN - Indianapolis - AGI Computer Fair\* MA - Marlborough - ARRL Hamfest

NY - Goshen - Hamfest

OR - Rickreal - 1996 Salem HamFair TX - Smithville - ARRL Hamfest

#### FEBRUARY 17-18 CA - Ventura - MarketPro Computer Show\*

FEBRUARY 17-18-19 NJ - Edison - KGP Computer Show\*

# FEBRUARY 18

CA - Sacramento - MarketPro Computer Show\*

IL - Orland Park - Computer Show IL - Rock Island - 25th Annual Davenport Hamfest MA - Taunton - Northern Computer Show\*

MI - Flint - Five Star Computer Show NC - Elkin - ARRL Hamfest

#### **FEBRUARY 19**

MA - Rockland - Northern Computer Show\*

# FEBRUARY 24

CA - Monterey - ARRL Hamfest

FL - Brooksville - ARRL Hamfest

GA - Dalton - ARRL Hamfest IN - LaPorte - Mid-Winter "Cabin Fever" Hamfest

NY - Troy - MarketPro Computer Show<sup>a</sup>

# VT - Milton - Northern Vermont Winter Hamfest

#### FEBRUARY 24-25

CA - Vallejo - MarketPro Computer Show\*
GA - Atlanta - ComputerShow

OH - Cincinnati - ARRL Great Lakes Division 1996

# FEBRUARY 25

CT - Cromwell - MarketPro Computer Show\*
IL - Glen Ellyn - Computer Central Computer Show
MI - Dearborn - 26th Annual Swap N Shop

OH - Cuyahoga Falls - Ham/Computer/Flea Market PA - Pittsburgh - ARRL Hamfest

# MARCH 1996

MARCH 2

CA - Santee - Ham/Computer/Electronic Swapmeet ND - Bismarck - 6th Annual Hamfest

NJ - Absecon - "Springfest '96"

#### MARCH 3

CA - Livermore - Swapmeet

MARCH 8-9-10
LA - Lafayette - ARRL Hamfest
NE - Norfolk - ARRL State Convention

MARCH 9
AZ - Scottsdale - ARRL Hamfest CA - Fontana - Amateur Radio/Electronics Swapmeet

FL - Lake Worth - Semi-Annual Free Flea TX - Victoria - Swapfest 1996

WA - Puyallup - Electronics Show & Fleamarket

MARCH 9-10 NC - Charlotte - ARRL Hamfest
NJ - Pennsauken - KGP Computer Show\*

# MARCH 9-10-11

FL - Orlando - 50th Annual Orlando HamCation

MARCH 10 IL - Orland Park - Computer Show

OH - Conneaut - 10th Annual Hamfest WI - Waukesha - Sewfars Swapfest

MARCH 12-13-14

#### CA - Los Angeles - Computer Telephony Conference MARCH 15-16

AR - Little Rock - Hamfest & ARRL State Convention MARCH 16

CA - Santee - Ham/Computer/Electronic Swapmeet

FL - Englewood - ARRL Hamfest GA - Marietta - ARRL Hamfest

MI - Marshall - 35th Annual Crossroads Hamfest

MARCH 16-17 FL - Fort Walton Beach - ARRL Hamfest

GA - Perry - Middle Georgia ComputerShow

NJ - Wayne - KGP Computer Show\* TX - Midland - ARRL Hamfest

MARCH 17

MA - Braintree - Ham Radio Flea Market

MI - Flint - Five Star Computer Show OH - Maumee - 41st Annual Hamfest/Computer Fair

# OR - Milton-Freewater - ARRL Hamfest PA - Dover - 9th York Springfest

WI - Jefferson - Hamfest MARCH 23

FL - Sebring - 3rd Annual Hamfest IN - Indianapolis - AGI Computer Fair\* MO - Kansas City - ARRL Hamfest

MARCH 23-24
AL - Huntsville - ComputerShow
OK - Tulsa - ARRL Section Convention
PA - Fort Washington - KGP Computer Show

MARCH 24 IL - Glen Ellyn - Computer Central Computer Show

IL - Sterling - 36th Annual Hamfest MI - Ann Arbor - Colossal Computer Sale MI - Midland - Five Star Computer Show

NJ - Trenton - Hamcomp '96 NY - Yonkers - ARRL Hamfest OH - Madison - ARRL Hamfest

#### WV - CHarleston - ARRL Hamfest **MARCH 29-30** GA - Columbus - ARRL Hamfest

MARCH 30

KY - Elizabethtown - 17th Annual Hamfest NJ - Upper Saddle River - Annual Flea Market

# MARCH 30-31 GA - Norcross - Atlanta Area ComputerShow MD - Timonium - Ham/Computerfest & State Conv.

CA - Santa Ana - ACP Swapmeet

TN - Tullahoma - ARRL Hamfest

IL - Gravslake - LAMARSFEST '96

\*See Computer Show Promoter Info Box

MARCH 31

# reader FeedBack

Continued from page 6

Dear Nuts & Volts:

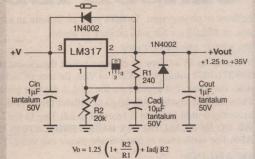
fine. Total \$34.95.

In regards to the Apr. '95 question #49515 (answered). I have an IBM PC2 that I have been upgrading. I purchased an 1.2M-5.25" FD and a 3.5" and 5.25" FD controller card from Alltech Electronics. The FD and the controller works

The controller was made by DTK and supports two FD and has an EPROM Bios. Also, FD controllers are carried by JDR Microdevices at 1-800-538-5005. Be sure to order a controller or FD that comes with the instruction book only.

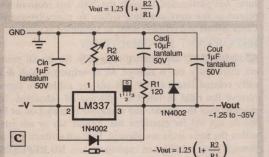
I have to write regarding the question in your Apr. '95 issue #4955, the answer was already published in a later issue. However, I have been doing work with high-gain audio amps and the power supply was always the stumbling block because the supply introduced noise. I have often resorted to a battery for high-gain audio amps until l

B



Iadj < 100μA

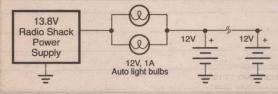
(negligible in most apps)



prototyped the power supply I'm now using. Figures A, B, and C The power supply is simple and I got all the parts from Digi-Key. The variable regulators will output ±1.25V to ±35V using the 24 VAC 400A transformer. The diode bridge is rated for 100V as are the 220 uF caps. The front end uses a doubling scheme for reaching the desired voltage of about 75 VDC from -V to +V at point Vb, at point Val is the desired voltage of about 37.5V. Which is perfect for the 1.25-35V variable regulators. This approach allows using a smaller transformer with a higher rating in the same space. You can use two 1-amp regulators in place of one regulator on the schematic (re. +24V and +12V), if the regulators are rated greater than or equal to 37.5V. Both regulators use protection diodes as described in the Motorola linear and interface integrated circuits manuals, which will protect from an input or output short circuit. "A must for prototyping." Also the ICs are heatsinked using clip-on heatsinks, but should be heatsinked using mountable heatsinks. The power supply is mounted on a 2" x 3" protoboard as in schematics A, B, and C

The SU series caps and the tant caps have a low ESR which the older caps don't have. It seems to reduce the noise when the newer caps are substituted for the older versions.

And last, the best way I've seen to charge the 12V batteries, which seems to be a common question is in the following schematic:



Or, using a 10 amp battery charger designed for charging 6V or 12V automobile batteries.

Wayne Chesser Sandy, UT

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# CLASSIFIED ADS

# READ BY 80,000 QUALIFIED ELECTRONIC BUYERS, SELLERS, AND TRADERS EVERY MONTH!

# **HOW TO PLACE A CLASSIFIED AD**

TYPE or PRINT your ELECTRONICALLY RELATED ad copy CLEARLY (not all caps) on the form provided or on a separate piece of paper. 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 photo 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). Enclose your name, address, and Nuts & Volts account number from your mailing label (if available) for identification purposes. Include full payment — CLASSIFIEDS ARE RUN ON A PRE-PAID BASIS ONLY — and mail your completed order to: NUTS & VOLTS MAGAZINE, 430 Princeland Court, Corona, CA 91719.

# RATE PER WORD

The ad rate for current PAID subscribers is 30¢ per word. All others pay 60¢ per word. These rates apply to the first 150 words of your ad. From 151-200 words, the rate per word doubles to 60¢ and \$1.20 respectively. We do not accept ads over 200 words. There is a \$4.50 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 (e.g., Ohio = OH). A phone number is one word. It will be most helpful if you would spell out words when submitting handwritten copy.

# 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. Add a one-time charge of \$5.00 to enlarge, reduce or duplicate line art, or \$8.00 for

halftone of photographs. To BOX your ad, include an additional \$25.00 for copy-only ads, or \$50.00 for ads with artwork or photos.

# **FAXING IN AD COPY**

You may fax in ad copy or changes before the closing date (5:00pm on the 10th) at 909-371-3052 using MasterCard or Visa. Be sure to include the credit card expiration date, the name that appears on the card, a daytime phone number, and your *Nuts & Volts* account number. Ads faxed in without credit card information will not be listed as received until payment is received in full. Due to the large number of ads received, **WE DO NOT CALL OR FAX BACK VERIFICATION OR QUOTES OF FAXED-IN ADS.** For verification of faxed-in ads, please call 909-371-8497.

#### DEADLINE

Prepaid ads received by 5:00pm on the closing date (10th of the month) will appear in the following month's issue. For example, ads received by May 10th will run in June. Ads postmarked through the 10th, but received after the closing date, will be placed in the next available issue. No cancellations or changes after the 10th. 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. The magazine is mailed on or before the 1st of the month. 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 30¢ 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 copy.

# CHOOSING A CLASSIFICATION

Select the appropriate classification for your ad(s) to appear in and mark it in the space provided below. If no classification is indicated, the ad(s) will be placed in the Misc. Section or wherever we deem most suitable. Available classifications to choose from are:

- 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

AD #1 CLASSIFICATION	AD #2 CLASSIFICATION
	Services and poster exponed by solder of dented to the design of the services and the services are the servi
Andrew Market State Company	
X = + + = X	=

PLEASE TYPE OF PRINT CLEARLY \_\_\_ ONE WORD PER SPACE

NV Account # \_\_\_\_\_ MC/Visa \_\_\_\_\_ Exp. \_\_\_\_ Name \_\_\_\_\_

# Now you can get far greater range and networking features in a 900 MHz phone!

Introducing the Micro 900ES cordless phone that operates on the 900 MHz frequency for clean, crisp sound and greatly extended range. Its superior range and unique lightweight, pocket-sized handset make it the ultimate in home or small office communications systems!

by Travis Hughes The Micro 900ES outperforms traditional cordless phones in clarity, range and convenience!

We have all seen and used cordless phones before. The complaints are all the same—bad reception, short range and just poor sound quality. I have a cord-



less phone that will only work 10 feet from the base unit. And every time I turn my head in a certain direction, I either get static or I can hear

someone else's conversation.

Now there is a cordless phone, the Micro 900ES, that uses 900 MHz technology to give you the mobility of a cordless phone, but without the complaints. Not only will you get far greater range and incredible sound quality, you can create a home office environment by adding up to three remote handsets and charger bases to each base model. You can transfer calls between these phones with music on hold, and with 40-channel auto-scanning you will be assured of crystal-clear static-free conversations!

More than just a cordless phone. The Micro 900ES system operates on the 900 MHz frequency for clean, crisp sound and greatly extended range. It also has many more features that make it more than just a

One of the smallest in the industry, the Micro 900ES offers a lightweight, pocketsized handset.

- The MultiLink™ feature is a multi-handset capability that lets you add up to three additional handsets and chargers to each Micro 900ES phone base-without the need for additional phone jacks.
- The two-way paging/intercom lets you page between baseset to handsets and handsets to baseset.
- 40-channel Auto-Scanning automatically chooses the clearest of 40 channels for clarity and static-free conversations.
- Direct Call Receiving allows you to receive incoming calls even with the flip cover closed by pressing the line engage/disengage key.
- Auto-Talk feature enables the line to automatically engage to receive incoming calls when the handset is removed from the baseset.
- QuickDial<sup>™</sup> provides one-touch dialing for a pre-programmed number for each handset.

Additional features. The Micro 900ES system has 65,000 digital security codes to prevent unauthorized long distance charges. It has a Call Timer Display that activates after a call is received or dialed. And if you want an office telephone system, you can call transfer between handsets with music on hold. There is also privacy—no eavesdropping on transferred calls.



ave you ever wanted to put a phone in your garage or have additional phones for your small business, but didn't have enough phone jacks? The Micro 900ES lets you add up to three additional handsets and chargers to each Micro 900ES phone base—with only one phone jack!

Risk-free. The Micro 900ES system is backed by our risk-free home trial. If you are not satisfied, return it within 90 days for a full "No Questions Asked" refund. It is backed by a oneyear manufacturer's limited warranty.

# The future of cordless products can be found in 900 MHz technology...

technology

The FCC recently allocated a band of frequencies, from 903-926 MHz, specifically for

cordless products. Most other cordless products use 49 MHz technology, from 46-49 MHz. Interference and shortened range are common side effects of this cluttered frequency range, which is shared by garage door openers, remote controls, home security systems and many other cordless phones. But because the 900 MHz range is still virtually unused, it gives

clarity and long-range power.

Extended range. Range depends upon many factors, including frequency. Because the Micro 900ES phone system uses the uncluttered 900 MHz frequency range, you get clarity and range not available from other cordless phones. In fact, with Micro 900ES you can expect a range two to three times

that of ordinary cordless phones.

The Micro 900ES system operates in the newly-approved frequency range, from 903-926 MHz. You get incredible sound quality and longrange power!

Micro 900ES phone.....\$279 \$19 S&H Additional handset and charger base \$179 \$9.50 S&H

Please mention promo code 1242-NV-5820.

For fastest service, call toll-free 24 hours a day





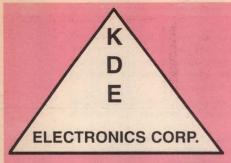




To order by mail, send check or money order for the total amount including S&H (VA residents add 4.5% sales tax). To charge it, enclose account number and

# COMTRAD INDUSTRIES

2820 Waterford Lake Drive, Suite 106 Midlothian, Virginia 23113



 PERSONALIZED ASSISTANCE COMPETITIVE PRICING •

Please have the make and model number of your current cable box so that we could give you the best available systems in your area.

# **CATV SYSTEM COMBOS**

SA-M-80 -COMBO:	150.00	NOVA-5700:	245.00
SA-M-80-DECODER ONLY:	85.00	NOVA-5800:	245.00
ON WOOD BEGODEN ONEN	00.00	NOVA-5600:	245.00
PIO-COMBO:	165.00	8580:	250.00
DIO DECODED.	05.00	8590:	CALL
PIO-DECODER:	95.00	8600:	CALL
DIGITAL J-COMBO	150.00		

DIGITAL J-DECODER 85.00

# 235.00 ZENITH COMBO: (RECONDITIONED)

ZENITH DECODER: (RECONDITIONED) 170.00

OAK COMBO 135.00

OAK DECODER 70.00

SOME BRANDS NOT LISTED

(ALL COMBOS CONSIST OF TUNER, REMOTE, AND DECODER + PATCH CORD )

# NO ILLINOIS SALES:

TECHNICAL HELP: 1-708-889-0281



CATV 1 PC. SYSTEMS

( 1 PC. UNITS CONSIST OF A CONVERTER WITH BUILT IN DESCRAMBLER & REMOTE )

# **FILTERS**

CHANNELS	#2 THRI	1 #23	20.00
CHAMINELS	#Z 11111	J #23	20.00

# CONVERTERS: (PARENTAL LOCKOUT)

PANASONIC	89.00
NOVA CENTURY:	79.00
VOL - CONTL:	105.00
REMOTE A/B SWITCH:	35.00
PATCH CORDS:	1.25

- ANY COMBO WITH PANASONIC CONVERTER ADD 10.00 PER UNIT
- \* 30 DAY MONEY BACK GUARANTEE
- \* 6 MONTH WARRANTY

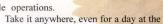
PRICES EFFECTIVE AS OF APRIL 95 PRICES SUBJECT TO CHANGE WITHOUT NOTICE!

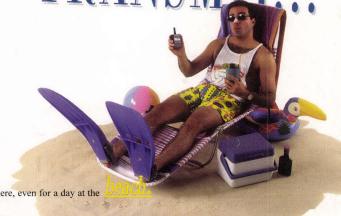
P.O. BOX 1494 ADDISON, IL 60101 INFO 1-708-889-0281 FAX 1-708-889-0283 HOURS - Mon. thru Fri. 9-6, Sat. 10-2 **TOLL FREE ORDER LINE -**1-800-361-4586

KNOW WHEN A is going to TRANSM

Kelax. There's no need to get uptight about missing that important frequency. With Scout Reaction Tune, capturing frequencies is like a day at the beach. Pure bliss! Interface the Scout to the AOR AR8000 and the Scout will not only show you which frequency is being transmitted, but you'll be able to instantly hear the conversation from the AR8000 as well. The Scout can record 400 frequencies into memory, with up to 255 hits per frequency (From 10MHz - 1.4GHz). The Scout distinctively beeps indicating frequency hits, or switch to a pager style vibrator for discreet recording. Built-in rapid charge NiCads provide a full ten hour discharge time.

Portability, functionality and the hand-held size of the Scout make it great for mobile operations.









Scout shown with AOR AR8000, Scanner not included Minor modification to the AR8000 required Scanners not sold by Optoelectronics

# ·Specifications ·

- •16 segment RF signal strength bargraph.
- •10 digit LCD display w/ EL backlighting.
- •Reaction Tune<sup>TM</sup> the AOR AR8000/2700, ICOM R7000 R7100, and R9000 and Realistic Pro 2005/6 w/OS456 Pro 2035 w/OS535 Scanners not sold by Optoelectronics.
- •Download frequencies into PC using optional CX12AR.
- •Beeper / Vibrator to indicate frequency capture.
- •Full on screen function annunicators.
- •Memory Tune Scroll through Scout memory to tune receiver.

omputer control For Your

The only universal converter with both CI-V and full duplex modes, a dedicated squelch status input, and dedicated software controlled tape output relay. Use for hassle free computer control of the AOR AR8000, as well as the ICOM R7000, R7100, and the R9000. Downloads Scout data to a PC. Includes all cables adaptors, and demo software.

(Supported by ScanCat, ScanStar and ScannerWear for Windows)

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# **BASIC STAMP® MODULES**

# Stamp II has many useful new instructions

BASIC Stamps are perfect for many applications, from controlling model trains to monitoring factory sensors. They have 8 or 16 I/O lines, which can be used for a variety of digital and analog purposes. And to keep life simple, they're programmed in BASIC. Our special "PBASIC" language includes familiar instructions, such as GOTO, FOR...NEXT, and IF...THEN, as well as instructions for serial I/O, button debounce, DTMF tone generation, etc.

The BASIC Stamp Programming Package contains everything you need to program Stamps using your PC. The package includes our editor software, programming cables, manuals, application notes, and free technical support. The package is available for \$99; Stamps and carrier boards must be purchased separately.



# **DTMFOUT** \*

Generates DTMF tones with just one I/O pin, two capacitors, and a speaker. Another related instruction, **FREQOUT**, generates one or two tones simultaneously. Each tone is programmable in 1-Hz increments from 0-Hz to 32767-Hz.





#### XOUT \*

Generates standard X-10 powerline control signals using two I/O pins and an inexpensive TTL-to-AC convertor module. Signals are received by small modules that control lights and appliances. Receiver modules are available from Parallax, Radio Shack, and other convenient sources.

\* Only available on the Stamp II.



# 9000 8000 RPM

#### **COUNT \***

Counts cycles on an I/O pin. Makes tachometer and other count/time programs simple.

# BASIC Stamp II Module (BS2-IC)

16 general-purpose I/O lines 2048-byte program space (600 instructions) 20-MHz clock (38400 baud serial, etc.) \$49, \$69 with optional carrier board



Uses two I/O pins to control common serial-to-parallel shift registers. Can be used as a means of controlling many devices without using too many of the Stamp's I/O pins.



	1		
OUT1	1	16	VCC
OUT2	2	15	OUTO
OUT3	3	14	SERIN
OUT4	4	13	OE
OUT5	5	12	RCLK
OUT6	6	11	SCLK
OUT7	7	10	SCLR
GND [	8	9	OUT7



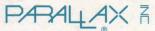
If you have an interesting Stamp application, please consider sending us a photo for placement in this box. You can be in the photo, if you like, or just your project. We'll show the photo and a brief sentence or two describing it. If your photo is used, you'll receive free Parallax products, as well as a month or two of fame.



# BASIC Stamp | Module (BS1-IC)

8 general-purpose I/O lines 256-byte program space (100 instr.) 4-MHz clock (2400 baud serial, etc.) **\$34**, \$49 with optional carrier board





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