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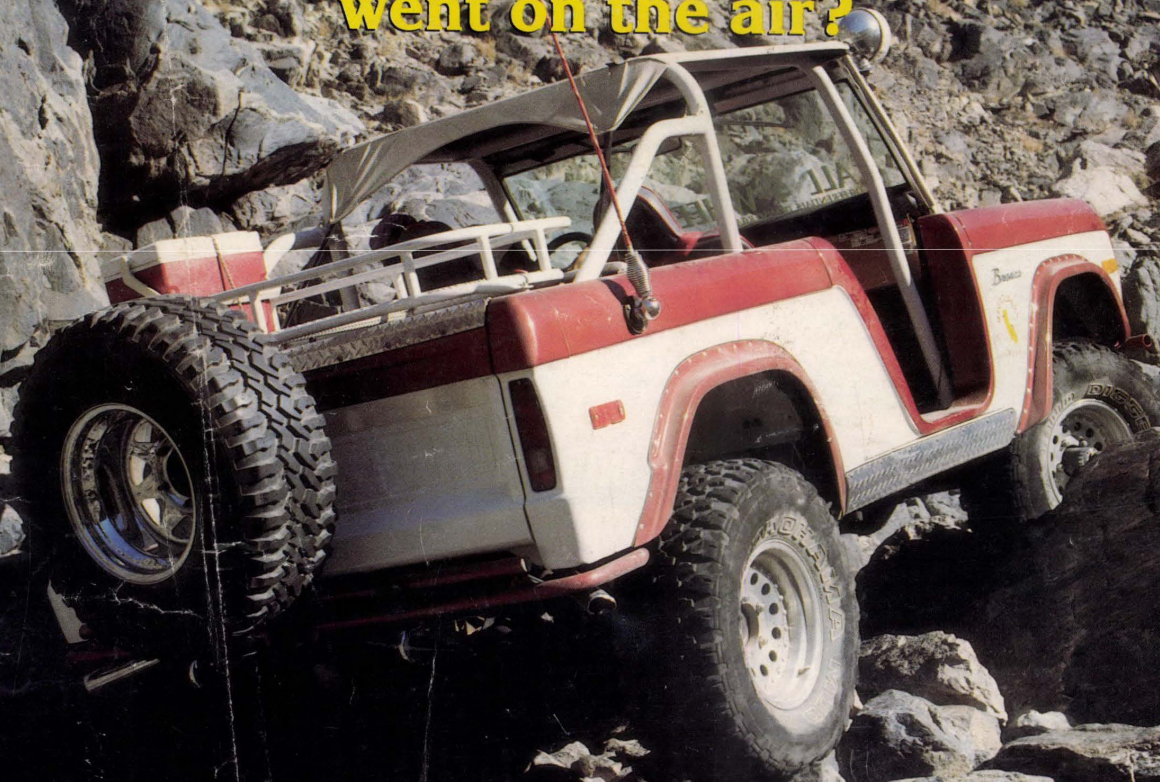
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APRIL 1994

A National Publication For The Buying And Selling Of Electronic Equipment

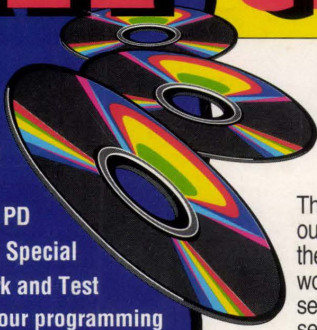
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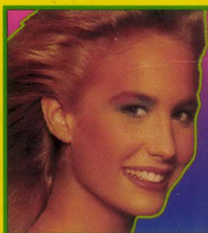
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B. "Mini-tower" power supply, same as above but 165W and 10" switch connection leads. New! HSC# 14632 \$24.95

C. 386SX Motherboard, small footprint (8.625" x 8.625") 25 MHz with five 16-bit slots, two 8-bit slots, AMI Bios, AMD processor, room for 8MB SIMM RAM's (OK installed), socket for 80387SX. Brand new in box, manual, 90-day warranty. HSC# 14666 \$49.00

D. Used, good condition 3.5" Half-height 720K Floppy disk drive, Teac FD-135HFN-411-U. Hurry, 720's are getting hard to find! 90-day warranty. HSC# 14667 \$19.95

E. Used, good condition 5.25" Half-height 360K Floppy disk drive, Teac FD-55BV-11-U. Hurry, 360's are getting even harder to find! 90-day warranty. HSC# 14667 \$14.95



F. Generic Mouse - three-button mechanical mouse for 9-pin "D-sub" type serial interface. New OEM version (sorry, no book, software or fancy box), 100% Microsoft Compatible. HSC#14673 \$4.95



G. Everex Mini Magic Card EV-138 - adds 576K RAM to your PC or XT (RAM Chips not supplied), new in box. HSC# 14593 \$4.95

Give your Mac Vision!

With MacVision (and a video camera) your Macintosh will be able to see the outside world! Capture video stills from any composite video source (camera, VCR, video disk) and you can commit a B & W image to a disk file for editing with your paint program. New in the box unit with cables and power supply. Works with Mac II, SE or Plus, System 4.1+ HSC# 80150 \$39.95



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Multi-use Mini-modem

New lower price on the PCI Travelcom "pocket" modem shown below. This tiny (2.75" x 4.75" x 1") gem is perfect for laptops on the go! It communicates at a rapid 9600 bps (V.32) with MNP error correction, and will run for 2-3 hours on a 9V battery. These are new in the box, come with a manual, AC Adaptor, telco cable and two serial adaptor cables (one for IBM and one for Mac), as well as your first battery! HSC# 14583 \$69.95



Computer Protection...

Better protection than a surge suppressor! These Sola MCR500 voltage regulators regulate line fluctuations of $\pm 15\%$ to within 3%. Provides 500VA of sinusoidal output within NEMA voltage specs with an input voltage as low as 65% of nominal! Surge suppressors can't raise low voltage in brown-outs! Filters out spikes, noise and other transients, and isolates load from power line. Used units, 40 lbs., 17" x 8.5" x 8.5", four AC outlets, heavy line cord, circuit breaker, HSC# 14642 \$95.00



One-trick Phone Friend

This little novelty was meant as an easy-access dialer for one of the off-brand long distance services. You can't change the pre-programmed access codes, but it will remember the last number you dialed with it, so you could use it as a one-number (16-digits) memory re-dialer. Handy for those midnight overseas calls! Uses three button cells which might need replacing. HSC# 14438 \$4.95



Unusual Wire for RF Work

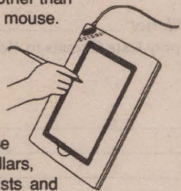
Strange wire you are unlikely to find at your usual sources...tiny bifilar wire. We are talking small! This two-conductor enameled wire is used for winding RF matching transformers and other exotic induced-voltage applications. The two color-coded conductors are each 0.08 millimeters dia. (looks like a hair!) and can be pulled apart (carefully!) and solvent-stripped for solder connection. 720 meters on a roll. Tiniest wire pair we've seen. HSC# 14376 \$7.95

Hard Disk Full? Put the Squeeze on your Data with SuperStor!

There are thousands of ironic stories in Software City, this is only one of them... Before Microsoft came out with DOS 6.0, there were dozens of thriving software companies writing all sorts of useful DOS utilities, including several varieties of Data Compression utilities. One company, Addstor, had a pair of products called SuperStor 2.0 and SuperStor PRO, which were finished, functioning, mature products. Giant Microsoft released DOS 6.0 with a data compression utility included, and Addstor saw their market evaporate. They eventually went under. The irony? DOS 6.0 had problems in the data compression utility, which required the birth of DOS 6.2...at the same time, a lawsuit by another utility provider against Microsoft was upheld, which we hear means that DOS 6.2's data compression utility may not be included anymore! Where does that leave Addstor? Still defunct, we're afraid, and no longer offering support, but we bought the remaining stock of their SuperStor and SuperStor PRO packages, and offer them at these amazing prices! A. SuperStor 2.0 will increase your disk capacity, defragment files, and make better use of your disk space. Need DOS 3.2 or later, not compatible with Zenith or Tandy DOS. HSC# 14674 \$6.95
 B. SuperStor PRO includes Windows-based JPEG/MPEG compression/expansion utility for JPG, BMP, TIF, TGA and PCX graphics files (huge benefits, 20:1 compression typically), Windows utilities, increased compression and speed over SuperStor 2.0, password protection, Tune-up Analyzer, Integral Disk Cache, Compression Preview, automatic transparent data compression, more! HSC# 14675 \$14.95

Natural Drawing on your Computer!

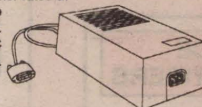
Have you ever tried to draw something with your mouse in any paint or draw program? It is nearly impossible to sketch anything other than the simplest geometric shapes with the ordinary mouse. Trackballs are even worse. They are great pointing devices, but as artist's or designer's tools, forget it! That is where graphics tablets or sketchpads take over. Calma and Summagraphics, to name two of the larger players, have made their name in this area, and no CAD user is going to be without one of these precision tools. They also can cost several hundred dollars, which takes them out of the range of most hobbyists and "thumbnail sketch" artists. Now you can move up to this technology without becoming a starving artist! The "PenMate" by Mouse Systems has a 6" x 9" drawing surface (that can be used in either "tall" or "wide" orientation) with 1000 lpi resolution that uses a pen-type stylus for position input, and a pressure tip and finger button which emulate the mouse buttons. Included software installs "Windows for Pen Computing" (you must already have Microsoft Windows 3.1) so you can experiment with handwriting recognition, and PenMate utility software lets you access frequently used Windows commands with just a touch of your pen. Mouse Systems' PenMate is 100% compatible with Microsoft mouse and Summagraphics MM Series graphics tablet protocols. And you get all this for only \$39.95! Wow, get sketching today! HSC #14672 \$39.95



Power Supply Project Starters

Nearly any electronic project you do these days is going to need 5, 12 and -12 volts in order to wake up and dance, so here are some handy powersupplies already built and ready to go:

A. Enclosed supply (illustrated at right) has small Astec switcher rated at 5VDC @ 3A, +12VDC @ .65A and -12VDC @ .15A in a case measuring 4" x 6.5" x 2.5" with a D9 female plug as the output. Uses standard IEC line cord (not included). Wired for 220 VAC input, we show you which jumper to move for 110 operation. Remove it from the case and it is similar to "C" below. HSC#14579 \$9.95



B. Open frame Protek switcher, new, similar to illustration at right, below. 110/220VAC input, 5VDC @ 3A, 12VDC @ 2A, -12VDC @ .3A output. Measures 3" x 5" x 1.5" HSC#13728 \$14.95

C. Open frame Astec switcher, new, similar to illust. at right. 110/220VAC input, 5VDC @ 2.5A, 12VDC @ 2A, -12VDC @ .1A Three output connectors for 3.5" disc drives. Size 4" x 6.25" x 1.75" HSC #14483 \$19.95



CD-ROM Bundle Blowout!

How do they get so much data on such tiny disks? This collection of seven CD-ROM disks contains a complete World Atlas by Software Toolworks, the complete Software Toolworks encyclopedia by Grolier, the Microsoft Bookshelf package with helpful writer's tools such as a Dictionary, Thesaurus, World Almanac/Fact Book, Bartlett's Quotations, the Chicago Manual of Style, Houghton Mifflin's Spelling Verifier and Usage Alert, US Zip Code Directory and Business information sources. Another disk holds the Microsoft Small Business Consultant and Stat Pack with loads of valuable financial, statistical, and management information. There is a disk that has a large database covering music CD's, complete with reviews, music samples and cover art, and a player that will let you play music CD's in your computer's CD-ROM! Yet another disk contains Hot Line, a telephone management system that contains a US phone/address directory and call management tools that let you build your own databases for telephone contact maintenance. As if that weren't enough, a game disk is included with ten games, including Black Hole, Hunt for Red October, a 3-D game with special glasses included, and more! You've seen these bundles advertised elsewhere for over \$100, but you can get this 1990 set for only \$39.95! Installation disk, CD menu system and manuals included. HSC# 14670 \$39.95

Log-on to Specials for PS2 & RS232!

- Everex Evercom II-24 Modem for PS/2 - MicroChannel Bus internal modem, 2400 bps, new in box, fully Hayes compatible, comes with free Bit-Com software (3.5" diskette), Compuserve offer, manuals, telco cable. Pull onto the Information Superhighway, don't be left in the dust! HSC#14591 \$19.95
- Everex 2400 Baud Modem PC Board (RS-232 external type) 3.25" x 6", no enclosure available, Hayes compatible, new, fully assembled PC Board, works great with ProComm, requires 8-12VDC power adaptor (we have one you can adapt for this). Data sheet & pinout incl. HSC# 14467 \$8.95

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Some younger enthusiasts may find this hard to believe, but hobbyists of yore actually used to get excited over finding circuit boards with interesting parts to unsolder! We're hoping there are still some people who appreciate this practice because we have some RF Network boards that have gobs of neat stuff...two Motorola MC145156P1 Synthesizer Chips, three Mini Circuits Labs SBL-1 Balanced Mixers, four VHF High-band Bandpass Filters, three SL560C 300MHz Lo-noise Pre-amp IC's, an FM Detector section built around an LM3089, a 3N211 FET, lots of Toko adjustable coils, etc. HSC# 14581 \$4.95

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Nuts & Volts Magazine encourages article submissions and queries.

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All submissions should be on 5-1/4 or 3-1/2 inch diskettes and include hard copy as well. If return of materials is requested, include a SASE with your submission.

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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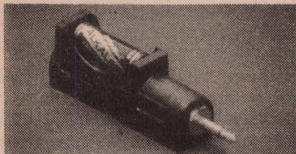
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10

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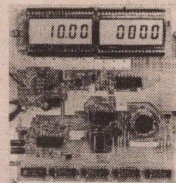
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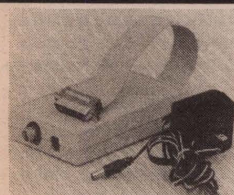
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Reader FeedBack

Dear Nuts & Volts:

We satellite dish owners would like to see more ads on satellite parts and where to buy them at competitive prices. The few that are listed in Nuts & Volts do not price or describe the make of their products.

N. Ruffini

Dear Nuts & Volts:

Richard Schroeder's cap. meter is best useable construction article yet for the following reasons: 1) Parts list from R.S. 2) Works 3) Needed by all hobbyists 4) Price — can make without PCB.

Thanks Dick, need more of this.

**James Tewmey
Harrodsburg, KY**

Dear Nuts & Volts:

I feel a deep compulsion to say my two cents' worth in defense of Lee Hart (Reader Feedback, March '94) concerning The Master Switch construction article (December '93).

Good design practice dictates that any component never be operated outside its' maximum design ratings. There is blatant disregard for this practice evidenced by Mr. Hoppe's response to Hart's letter.

To subject the LM393 output transistors to constant overvoltage when the relay is de-energized, and to overcurrent while the relay is energized is absurd and invites disaster. A simple \$.25 transistor and a \$.05 resistor would totally eliminate both conditions. The deletion of an additional \$.05 resistor which would eliminate the possibility of the unit's slave output turning on while no master current flows is equally absurd. To eliminate a \$.25 capacitor which would improve noise immunity and prevent unwanted accessory turn-on is plain silly.

Mr. Hoppe's response to Hart's comments regarding the fusing of the circuit shows a lack of clear thinking. A fuse's function is to protect in the event of circuitry failure. Consider the condition of the master output carrying only one amp or less of current. Should the slave output fail with an overcurrent of 6-8 amps, the contacts of the relay would almost certainly be damaged, but the fuse would not blow. Separate fuses for each circuit is certainly better than Mr. Hoppe's design, and would offer the user a much safer accessory.

Hoppe cites low cost as the deciding factor to eliminate several necessary components. The cost of the kit, as advertised in the article, is \$36.00. The additional cost of the deleted components which would make the circuit substantially safer and more reliable, is less than \$1.00. Maybe the safety risks and possibilities of unpredictable device operation are economical trade-offs for Mr. Hoppe, but I'd rather spend the extra \$1.00 for a safe and reliable circuit.

Mr. Hoppe agrees with most of writer Hart's criticisms, but seems obstinate in his refusal to accept Hart's obviously meritorious suggestions.

Come now, Mr. Hoppe! \$1.00 worth

of parts!!

**David Mason
Middleburg, FL**

Dear Nuts & Volts:

I am writing to point out the answer to Tech Forum #109315 on page 116-7 of the December issue. Arnold Neace has demonstrated what a clear, concise and complete answer should be, the likes of which I have never seen from the staff of any magazine.

Note that in the space of less than one page he has included the schematic, with enough detail to be useful, all of the code, which in itself is written without any unnecessary complication, and enough text to tie it all together.

Don Wilcher's Solderless Breadbox is one column that should come out of the dark ages of logic gates and adapt a "less is more" policy by featuring some projects with cheap available microprocessors which can be run in a minimum configuration as Mr. Neace has demonstrated is possible.

I have found that other columns in your magazine also tend to give a small unuseable portion of an overdone project rather than concentrating on a core to which the hobbyist could add his or her own enhancements.

You should be sensitive to the fact that readers who work on their own tend to have limited resources and cannot run out and buy a new development system every time you decide to use a different type of processor. Also details that may seem redundant to you may not be readily available to your readers. I had to spend \$30.00 on two volumes from Intel just to find out that an 8748 has instructions that don't work in single chip configuration, a detail left out of an otherwise useful project in Radio Electronics Magazine.

I hope this input is useful.

**Tom Banas
Fiskdale, MA**

Dear Nuts & Volts:

While it's interesting to read about "phreaks" and "crackers," I'm concerned that you may be glamorizing irresponsible, immature behavior. People in the "computer underground" have failed to grasp a basic principle of ethics: It's not enough to tell yourself you mean no harm; you must actually respect other people's rights and wishes. Or even more simply: Don't do to others what you wouldn't want done to yourself.

Would the typical "phreak" let a stranger wander around his house, drive his car, or tamper with his computer just because the stranger claims to mean no harm? I really doubt it.

If "phreaks" and "crackers" were really the fine citizens they claim to be, they would pay restitution to the companies from which they have stolen services. But no — they claim to be "elite" and above the level of ordinary citizens. That's what marks them as childish.

**Michael A. Covington
Athens, GA**

On The Cover

So where were you when you made your first amateur radio contact?

"N6ZTD...KD6UWV"
"Hello, Dad are you out there?" "Yeah Hi Larry, Where are you?"
"You probably wouldn't believe me if I told you, we're climbing this huge..."

I was four-wheeling in the California desert on what is affectionately known as the "Sledgehammer Trail."

With my brother John (KE6MF) at the wheel, we managed to safely negotiate the canyon you see pictured on the cover. With only minor bumps and bruises to the truck (and a very tired clutch), we successfully made several "out of the way" 2-meter contacts to Jack (N6ZTD) and Audrey (N6VXW) throughout the course of the day.

Combining amateur radio with other hobbies, such as four-wheeling, opens up new avenues to interest more people in the hobby. Not to mention the instant friends you make upon meeting a fellow ham.

Last year while camping on the north rim of the Grand Canyon, I happened to meet a gentleman (who was a subscriber) who introduced me to the North Link Repeater System. We talked for quite a while and ended up doing an article on the system in the November '93 issue.

A while back, my path crossed with a mariner who was studying for her ham license for communications during ocean voyages. She was trying to learn the Morse code, so we gave her a computer program to assist.

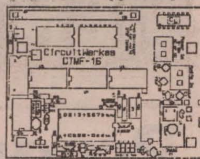
I am sure there are many of you who have had interesting encounters through amateur radio. If your first contact was, shall we say, "out of the ordinary," send us a brief story about it and we'll pick a few of the more interesting ones to print in an upcoming issue.

Also, don't forget to stop by the Nuts & Volts booth at the Dayton Hamvention to say hello to Jack and Audrey.

Larry Lemieux
KD6UWV
Editor

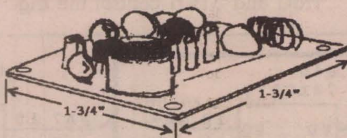
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ADDRESS CORRECTION

In the March '94 issue, in the article *Shortwave Listening With a Crystal Set*, the Xtal Set Society's address was listed as P.O. Box Z8Z41. This should have read P.O. Box 28241. However, The Xtal Set Society now has a new address. It is:

**P.O. Box 3026
St. Louis, MO 63130**

If you would like to join the society and receive the bi-monthly newsletter, just send \$9.95 to the new P.O. listing.



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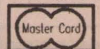
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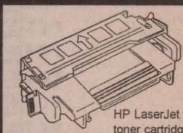
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Write in 69 on Reader Service Card.

Last month we brought you Part 1 of this three part series by Robert Brown. If you missed it, back issues are available by calling the Nuts & Volts order line at 800-783-4624 and requesting the March 1994 issue or by sending \$5.00 to:

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The main analyzer board has four main functional blocks: the PC interface, clock generation, data storage, and trigger control.

Use Programmable Logic to Build a 16 Channel Logic Analyzer

by
Robert Brown

Part 2 — The Logic Analyzer Design

THE PC INTERFACE

The PC interface consists of P1, U5, U6, U7, U8, U9, and U10. The three eight-bit ports from the 8255 on the interface board are

MR* is the master reset signal. WR* is the write enable for data acquisition. DIR is the direction control for U7 and U8; it remains low in normal (non-diagnostic) operation.

TRIG and STCH control the trig-

(a 50 MHz oscillator for a 25 MHz analyzer). The output of the oscillator is fed into the clock input (pin 1) of U15. The GAL16V8 is programmed to act as a 5 bit binary counter and a 7-to-1 MUX with a two input OR gate thrown in.

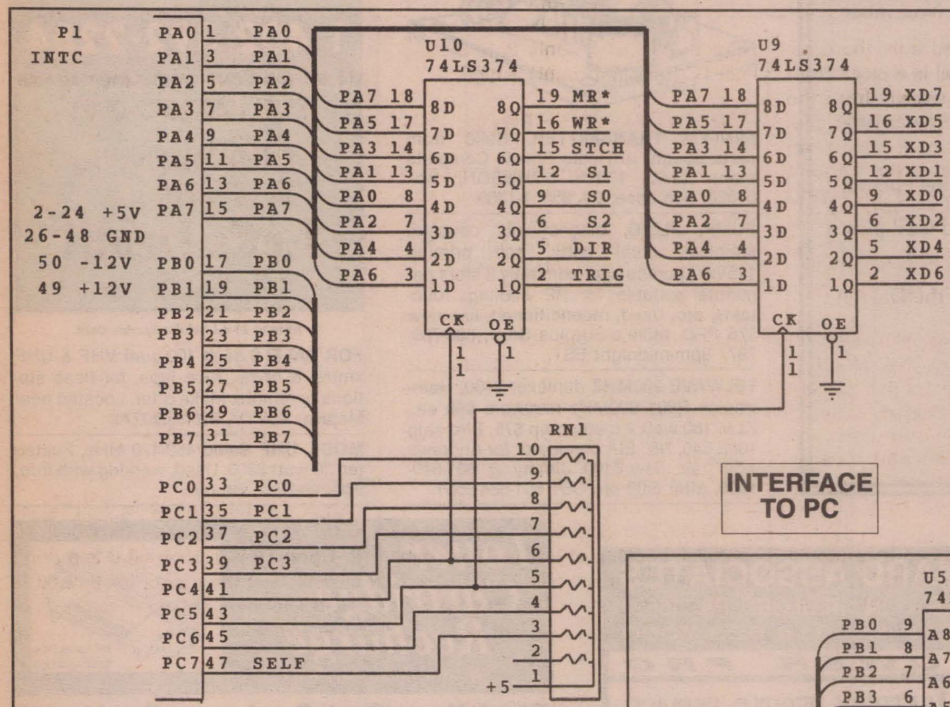
bit counter (a straight forward expansion of the two-bit counter used before).

This counter provides several reference frequencies at the outputs, Q1 is half of Q0, Q2 is half of Q1, etc. With a crystal oscillator of 40 MHz connected to pin 1, Q0 provides a 20 MHz clock, Q1 10 MHz, Q2 5 MHz, Q3 2.5 MHz and Q4 1.25 MHz.

The outputs SC0 and SC1 use identical equations, so I refer to them together as SC. The SC outputs are combinatorial; they allow the system clock to be selected from Q0, Q1, Q2, Q3, Q4, or the inputs SELF or EXT. The inputs S0, S1, and S2 select which clock is output to SC.

From the equations, you can see that if S0, S1, and S2 are all 0 then SC is the same as the input SELF. If S0, S1, and S2 are all 1 then the last product term will apply and SC will follow Q0.

The final output defined in the equations is WRDAT. This is obviously just a simple two input OR function. The source of the system clock is selected by S0, S1, and S2 as



INTERFACE TO PC

brought onto the analyzer board through P1. The three ports are expanded into two output ports (U9 and U10) and four input ports (U5, U6, U7, and U8).

The two output ports are driven by 8255 port A and controlled by port C. Data is written to port A and then strobed into either U9 or U10 as selected by port C.

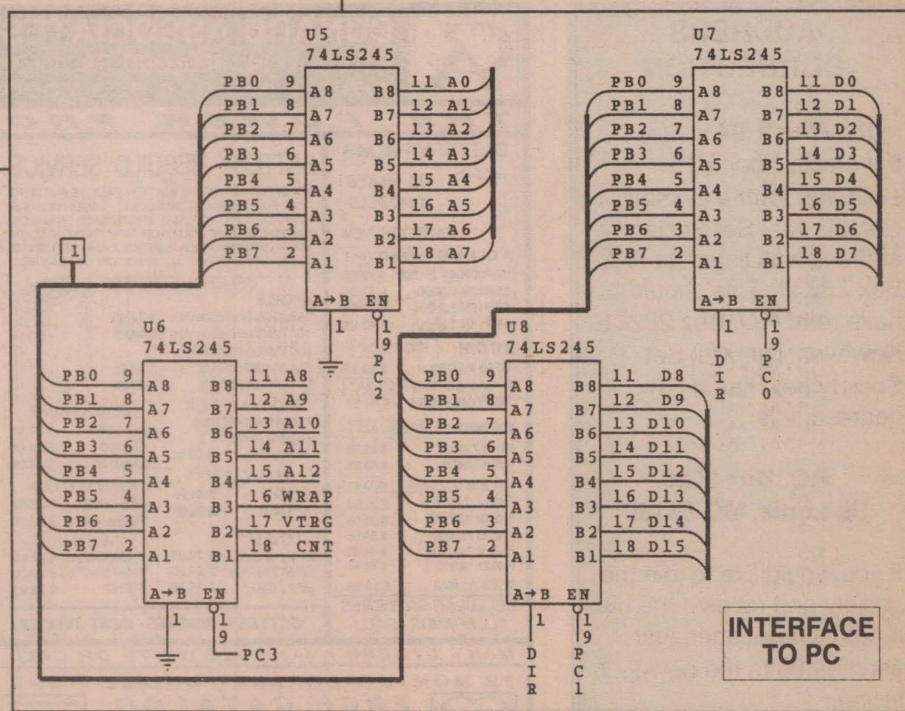
The four input ports — U5, U6, U7, and U8 — work in a similar manner. One of the ports is selected when the corresponding bit from port C goes low (PC0-PC3), then the data is read through port B.

PC7 is the signal SELF which is a software controlled clock for the analyzer. All analyzer functions are controlled by the outputs at U10. S0, S1, and S2 select the system clock source.

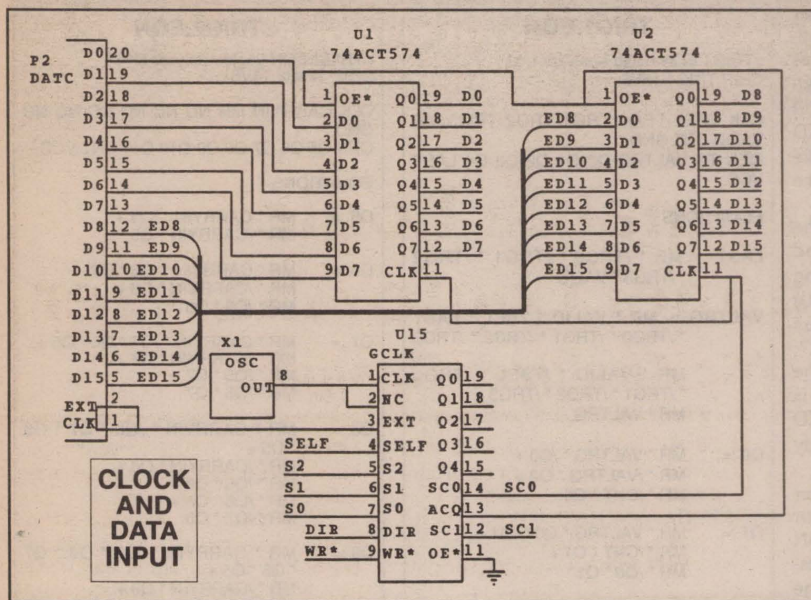
ger set-up. The outputs at U9 are the trigger words. U7 and U8 read or write (diagnostic modes only) the data bus. U5 and U6 read the address bus and some status bits.

CLOCK GENERATION

The clock generator consists of the crystal oscillator X1 and a single GAL16V8, U15. The oscillator is selected to be twice the frequency of the maximum clock rate



INTERFACE TO PC



follows:

S2 S1 S0	System clock
1 1 1	Q0 - max rate
1 1 0	Q1 - 1/2
1 0 1	Q2 - 1/4
1 0 0	Q3 - 1/8
0 1 1	Q4 - 1/16
0 1 0	disabled
0 0 1	EXT - external clock
0 0 0	SELF - software clock

The first five options select an

STAGE1.EQN

: STAGE1.EQN Logic Analyzer U11
CHIP STAGE1 16V8

CLK CNT MR NC NC NC NC NC NC NC GND
OEN TC A5 A4 A3 A2 A1 A0 VALID VCC

EQUATIONS

A0 := MR * CNT * /A0 +
MR * /CNT * A0

A1 := MR * CNT * A0 * /A1 +
MR * /CNT * A1 +
MR * A0 * A1

A2 := MR * CNT * A0 * A1 * /A2 +
MR * /CNT * A2 +
MR * A2 * /A0 +
MR * A2 * /A1

A3 := MR * CNT * A0 * A1 * A2 * /A3 +
MR * /CNT * A3 +
MR * A3 * /A0 +
MR * A3 * /A1 +
MR * A3 * /A2

A4 := MR * CNT * A0 * A1 * A2 * A3 * /A4 +
MR * /CNT * A4 +
MR * A4 * /A0 +
MR * A4 * /A1 +
MR * A4 * /A2 +
MR * A4 * /A3

A5 := MR * CNT * A0 * A1 * A2 * A3 * A4 * /A5 +
MR * /CNT * A5 +
MR * A5 * /A0 +
MR * A5 * /A1 +
MR * A5 * /A2 +
MR * A5 * /A3 +
MR * A5 * /A4

VALID := MR * VALID +
MR * A2

TC := MR * CNT * /A0 * A1 * A2 * A3 * A4 * A5

internal clock derived from the oscillator. The EXT signal is a clock from an external source usually from the system under test. The SELF signal is a software generated clock from the host PC. This allows the software to control the clock for retrieving data, control, and diagnostic functions.

DATA STORAGE

The data storage subsystem consists of U1, U2, U3, U4, U11, and U12. U1 and U2 are 74ACT574 eight-bit latches. During data acquisition, the outputs of the latches are enabled and data is strobed into the latches from the probe assembly on the rising edge of the system clock.

The data appears on the outputs of U1 and U2 within 10 ns. The system clock is connected to the CS* inputs of the 8K x 8 static RAMs (U3 and U4).

When acquiring data, the WR* input of the RAMs is always asserted, therefore data is written to the RAMs on the low half of the system clock cycle.

The RAM address generation is handled by U11 and U12. These two chips combine to form a 13-bit counter with some special control and status features. The 13 bits of the counter directly drive the 13 address lines of the static RAMs.

The WRAP output is a status bit that is set when the counter wraps around from 1FFF to 0. Once set, WRAP remains set until a reset occurs. U11 and U12 are reset on the rising edge of the system clock when MR* is asserted low. This clears WRAP and zeros the

address bits. The counting is controlled by the CNT signal from U14. As long as CNT is high, the address counting continues.

The equation files for U11 and U12 are STAGE1.EQN and STAGE2.EQN, respectively. Looking at the files, you can see that both have a counter that is similar to the counter in the clock generator chip. The main difference is that these counters have a reset input (MR) and a count enable input (CNT).

When MR is low, the count is zeroed on the next clock rising edge. If CNT is low, the count remains fixed. The two counters are cascaded as shown in the schematic by connecting TC from U11 to the CNT input on U12. This means that U12 will only count when U11 reaches its maximum count. That is the only time the signal TC (terminal count) is high.

TRIGGER CONTROL

The trigger control subsystem is the brains of the main analyzer module. It tells the data acquisition subsystem when to stop acquiring data.

The trigger control subsystem consists of U13, U14, U16, and U17. U16 and U17 check the lower eight bits of the data bus for a match to the desired trigger condition. U16 and U17 are identical. The equation file for both is LCOMP.EQN. The trigger condition is expressed in two eight-bit words: the trigger word and the "don't care" word.

The test for a trigger condition is performed on each of the data bits in parallel. Looking at just bit 0, we can see how this test works. If X0 (don't care word bit 0) is 0, then it is a valid

STAGE2.EQN

: STAGE2.EQN Logic Analyzer U12
CHIP STAGE2 16V8

CLK CNT MR NC NC NC NC NC NC GND
OEN WRAP A12 A11 A10 A9 A8 A7 A6 VCC

EQUATIONS

A6 := MR * CNT * /A6 +
MR * /CNT * A6

A7 := MR * CNT * /A7 * A6 +
MR * /CNT * A7 +
MR * A6 * A7

A8 := MR * CNT * /A8 * A7 * A6 +
MR * /CNT * A8 +
MR * A6 * A8 +
MR * A7 * A8

A9 := MR * CNT * /A9 * A8 * A7 * A6 +
MR * /CNT * A9 +
MR * A6 * A9 +
MR * A7 * A9 +
MR * A8 * A9

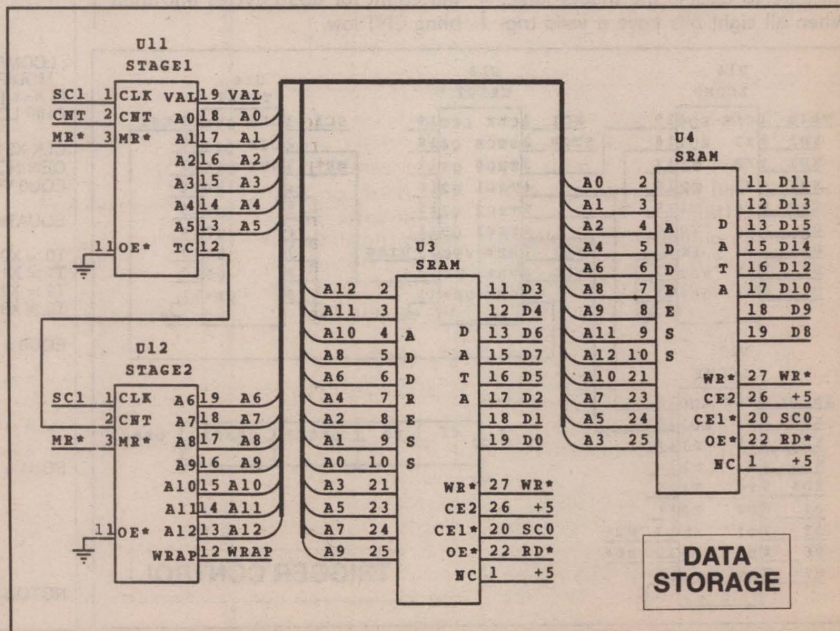
A10 := MR * CNT * /A10 * A9 * A8 * A7 * A6 +
MR * /CNT * A10 +
MR * A6 * A10 +
MR * A7 * A10 +
MR * A8 * A10 +
MR * A9 * A10

A11 := MR * CNT * /A11 * A10 * A9 * A8 * A7 * A6 +
MR * /CNT * A11 +
MR * A6 * A11 +
MR * A7 * A11 +
MR * A8 * A11 +
MR * A9 * A11 +
MR * A10 * A11

A12 := MR * CNT * /A12 * A11 * A10 * A9 * A8 * A7 * A6 +
MR * /CNT * A12 +
MR * A6 * A12 +
MR * A7 * A12 +
MR * A8 * A12 +
MR * A9 * A12 +
MR * A10 * A12 +
MR * A11 * A12

WRAP := MR * CNT * A6 * A7 * A8 * A9 * A10 * A11 * A12 +
MR * WRAP

trigger (for that bit) when T0 (trigger word bit 0) is the same as D0. If X0 is 1 and T0 is 1, then bit 0 is a don't care bit and the trigger for that bit is always valid regardless of the state of



DATA STORAGE

GCLK.EQN

; GCLK.EQN Logic Analyzer U15
; This is the declaration section
CHIP GCLK 16V8

; Pin labels here
CLK NC EXT SELF S2 S1 S0 DIR WR GND
OEN SYSCLK1 WRDAT SYSCLK0 Q4 Q3
Q2 Q1 Q0 VCC

; Next is the equation section
EQUATIONS

; Q0 - Q4 form a 5 bit binary counter

```
Q0 := /Q0
Q1 := Q0 * /Q1 +
      /Q0 * Q1
Q2 := Q0 * Q1 * /Q2 +
      Q2 * /Q0 +
      Q2 * /Q1
Q3 := Q0 * Q1 * Q2 * /Q3 +
      Q3 * /Q0 +
      Q3 * /Q1 +
      Q3 * /Q2
Q4 := Q0 * Q1 * Q2 * Q3 * /Q4 +
      Q4 * /Q0 +
      Q4 * /Q1 +
      Q4 * /Q2 +
      Q4 * /Q3
```

; SC0 and SC1 output the system clock as
selected by
; S0, S1 and S2

```
SC0 = /S0 * /S1 * /S2 * SELF +
      S0 * /S1 * /S2 * EXT +
      S0 * S1 * /S2 * Q4 +
      /S0 * /S1 * S2 * Q3 +
      S0 * /S1 * S2 * Q2 +
      /S0 * S1 * S2 * Q1 +
      S0 * S1 * S2 * Q0
```

```
SC1 = /S0 * /S1 * /S2 * SELF +
      S0 * /S1 * /S2 * EXT +
      S0 * S1 * /S2 * Q4 +
      /S0 * /S1 * S2 * Q3 +
      S0 * /S1 * S2 * Q2 +
      /S0 * S1 * S2 * Q1 +
      S0 * S1 * S2 * Q0
```

; WRDAT is a simple OR function of WR and
DIR

```
WRDAT = WR +
        DIR
```

D0. If X0 is 1 and T0 is 0, then this is
a never trigger state.

The never trigger is used by the
software to disable the trigger logic.
When all eight bits have a valid trig-

ger condition, then a valid trigger
may occur. U16 and U17 are identi-
cal dual two-bit comparators that
support the don't care and never trig-
ger conditions. U16 and U17 will
latch the trigger word so that the XD
bus can be multiplexed to handle
both the trigger and don't care
words.

To set up a trigger condition, the
trigger word is output to U9 and
appears on the XD bus. On the rising
edge of the TRIG signal (from U10)
the data is latched onto the registers
T0, T1, T2, and T3 on U16 and U17.
The trigger word is now stored in the
comparators. The don't care word is
then output through U9 onto the XD
bus. The comparators are now ready
for operation.

U13 and U14 handle post-trigger
countdown. The equation files for
these chips are shown in TRIG1.EQN
and TRIG2.EQN. They form a cas-
caded counter that is similar to the
counter in STAGE1 and STAGE2. In
this logic analyzer, data acquisition
will continue for 4096 clock cycles
after a valid trigger has occurred. For
U13 to respond to a trigger state, its
VAL input must be high. VAL comes
from the address counter and will go
high and stay high after a minimum
address value is reached. This pre-
vents an accidental trigger during ini-
tialization.

Once the VAL signal is high, a
trigger condition occurs when the
inputs TRG0, TRG1, TRG2, and
TRG3 (from U16 and U17) are all
low at the rising edge of the system
clock. If the STCH input is low, out-
put TRG will go high indicating a trig-
ger has occurred and the countdown
will start. If STCH is high, TRG0,
TRG1, TRG2, and TRG3 must remain
low for two consecutive rising system
clock edges for TRG to go active and
the countdown to start. Once the
countdown has started, U13 and U14
will count for 4096 cycles and then
bring CNT low.

TRIG1.EQN

; TRIG1.EQN Logic Analyzer U13
CHIP TRIG1 16V8

CLK TSEL TRG0 TRG1 TRG2 TRG3 MR
VALID CNT GND
OEN TC VALTRG Q0 Q1 Q2 Q3 Q4 LAST
VCC

EQUATIONS

```
LAST := MR * /TRG0 * /TRG1 * /TRG2
      * /TRG3 * VALID

VALTRG := MR * VALID * TSEL * LAST
      * /TRG0 * /TRG1 * /TRG2 * /TRG3
+
      MR * VALID * /TSEL * /TRG0
      * /TRG1 * /TRG2 * /TRG3 +
      MR * VALTRG

Q0 := MR * VALTRG * /Q0 +
      MR * /VALTRG * Q0 +
      MR * /CNT * Q0

Q1 := MR * VALTRG * Q0 * /Q1 +
      MR * /CNT * Q1 +
      MR * /Q0 * Q1

Q2 := MR * CNT * VALTRG * Q0 * Q1
      * /Q2 +
      MR * /CNT * Q2 +
      MR * Q2 * /Q0 +
      MR * Q2 * /Q1

Q3 := MR * CNT * VALTRG * Q0 * Q1
      * Q2 * /Q3 +
      MR * /CNT * Q3 +
      MR * Q3 * /Q0 +
      MR * Q3 * /Q1 +
      MR * Q3 * /Q2

Q4 := MR * CNT * VALTRG * Q0 * Q1
      * Q2 * Q3 * /Q4 +
      MR * /CNT * Q4 +
      MR * Q4 * /Q0 +
      MR * Q4 * /Q1 +
      MR * Q4 * /Q2 +
      MR * Q4 * /Q3

TC := MR * CNT * VALTRG * /Q0 * Q1
      * Q2 * Q3 * Q4
```

TRIG2.EQN

; TRIG2.EQN Logic Analyzer U14
CHIP TRIG2 16V8

CLK CARRYIN MR NC NC NC NC NC NC
GND
OEN Q5 Q6 Q7 Q8 Q9 Q10 Q11 CNT VCC

EQUATIONS

```
Q5 := MR * CARRYIN * /Q5 +
      MR * /CARRYIN * Q5

Q6 := MR * CARRYIN * /Q6 * Q5 +
      MR * /CARRYIN * Q6 +
      MR * /Q5 * Q6

Q7 := MR * CARRYIN * /Q7 * Q6 * Q5 +
      MR * /CARRYIN * Q7 +
      MR * /Q5 * Q7 +
      MR * /Q6 * Q7

Q8 := MR * CARRYIN * /Q8 * Q7 * Q6
      * Q5 +
      MR * /CARRYIN * Q8 +
      MR * /Q5 * Q8 +
      MR * /Q6 * Q8 +
      MR * /Q7 * Q8

Q9 := MR * CARRYIN * /Q9 * Q8 * Q7
      * Q6 * Q5 +
      MR * /CARRYIN * Q9 +
      MR * /Q5 * Q9 +
      MR * /Q6 * Q9 +
      MR * /Q7 * Q9 +
      MR * /Q8 * Q9

Q10 := MR * CARRYIN * /Q10 * Q9 * Q8
      * Q7 * Q6 * Q5 +
      MR * /CARRYIN * Q10 +
      MR * /Q5 * Q10 +
      MR * /Q6 * Q10 +
      MR * /Q7 * Q10 +
      MR * /Q8 * Q10 +
      MR * /Q9 * Q10

Q11 := MR * CARRYIN * /Q11 * Q10 * Q9
      * Q8 * Q7 * Q6 * Q5 +
      MR * /CARRYIN * Q11 +
      MR * /Q5 * Q11 +
      MR * /Q6 * Q11 +
      MR * /Q7 * Q11 +
      MR * /Q8 * Q11 +
      MR * /Q9 * Q11 +
      MR * /Q10 * Q11

/CNT := MR * CARRYIN * Q5 * Q6 * Q7 * Q8
      * Q9 * Q10 * Q11 +
      /CNT * MR
```

Bringing CNT low signals the
end of data acquisition and stops
both the trigger countdown and the
address counters (U11 and U12).

LCOMP.EQN

; LCOMP.EQN Logic Analyzer U16 and U17
; MODIFIED COMPARATOR DON'T CARE
IS X=1 T=1, X=1 T=0 NEVER IS EQUAL
CHIP LCOMP 16V8

CLK X3 X2 X1 X0 D0 D1 D2 D3 GND
OEN NOTOUT INVERT T0 T1 T2 T3 EQU1
EQU0 VCC

EQUATIONS

```
T0 := X0
T1 := X1
T2 := X2
T3 := X3

EQU0 = X0 * /T0 +
      /X0 * /D0 * T0 +
      /X0 * D0 * /T0 +
      X1 * /T1 +
      /X1 * /D1 * T1 +
      /X1 * D1 * /T1

EQU1 = X2 * /T2 +
      /X2 * /D2 * T2 +
      /X2 * D2 * /T2 +
      X3 * /T3 +
      /X3 * /D3 * T3 +
      /X3 * D3 * /T3

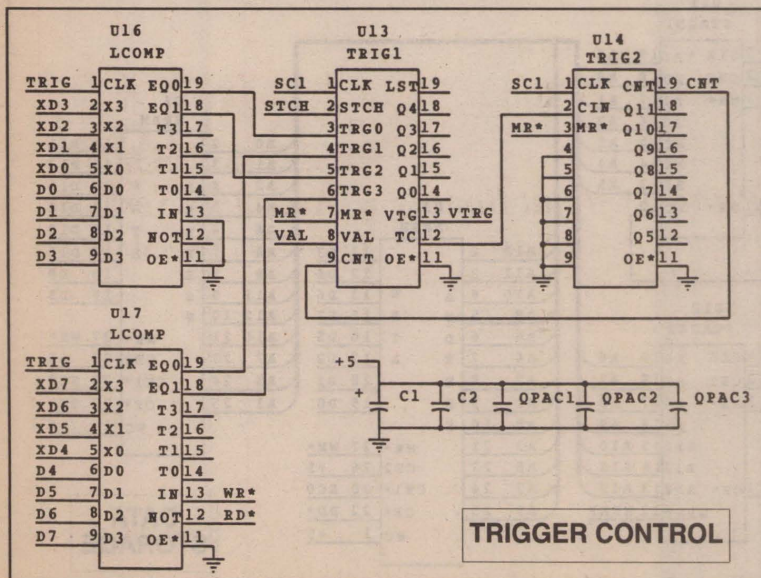
NOTOUT = /INVERT
```

The PC software on seeing CNT low
begins retrieving the acquired data
from the RAMs. U13 and U14 are
reset by MR*, this reactivates CNT.

When data is to be retrieved by
the host PC, U16 and U17 are pro-
grammed to never trigger. U1 and
U2 are disabled, WR* is made inac-
tive, the counters are reset making
CNT active, and the address 0. S0,
S1, and S2 are brought low making
SELF the clock source. The data is
read through U7 and U8 when SELF
is low. The address increments when
SELF goes high. In this manner, the
data is retrieved into the PC.

WRAPPING UP

As you can see, a great
deal of logic is packed into
these seven GALs. They
replace about 20 high
speed TTL chips. Next
time, we will look at the
assembly and testing of
the main analyzer module.
NV

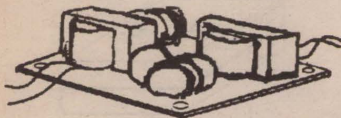


#10 HAM GEAR FOR SALE cont.

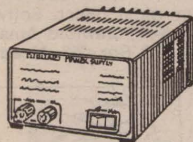
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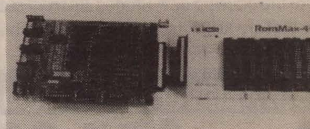
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Nuts & Volts Magazine/April 1994

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1994 CATALOG. Low cost ferrites, powdered iron cores, RFCs, wire, capacitors, semiconductors, more. 36 page, 8x11 listings. Please include two stamps. Johnson Shop Products, Box 160113, Cupertino, CA 95016.

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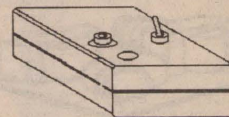
COLLINS, 651S-1 \$550 or both, \$1000. Ameritron 811 80-10 amplifier, mint condition \$365. Psitech Plus, 707-745-4804, FAX: 707-745-1060.



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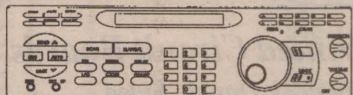
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76,000 - 107,995 MHz. (WFM), 108,000 - 136,995 MHz. (AM),
137,000 - 173,995 MHz. (NFM), 174,000 - 215,995 MHz. (WFM),
216,000 - 224,995 MHz. (NFM), 225,000 - 399,995 MHz. (AM),
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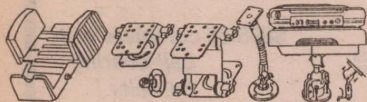
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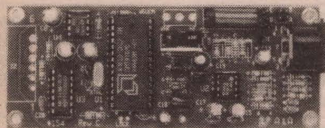
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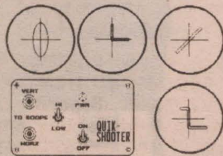
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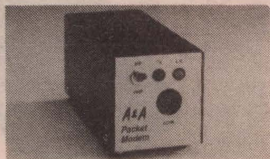
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COLLINS 651S1, Collins HF 8054A receiver and HF 8014A exciter, WJ 861B VHF/UHF receiver, Sunair GSR-920 synthesized HF/SSB receiver, Sunair GSE-924 synthesized HF/SSB exciter, Sunair GCU-1935 antenna coupler, Collins R388, Collins R390-A (like new), Collins 618T-3 with 490T-1, 635V-1, 426T-1, 426U-2, and 714E-5 in cabinets. 110 volts, 60Hz or 28V input power. Motorola R-1481/SRN-12 Omega receiver. George, 801-462-3083.

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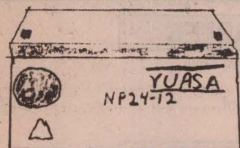
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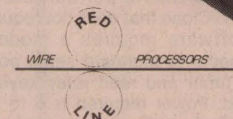


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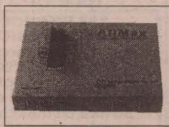
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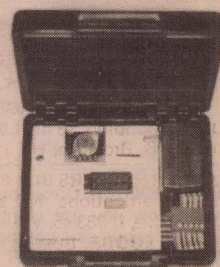
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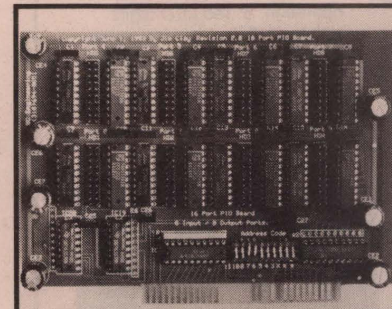


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Zenith Cosmetic Repair Parts Call for specifics	CALL	CALL	CALL	CALL	CALL
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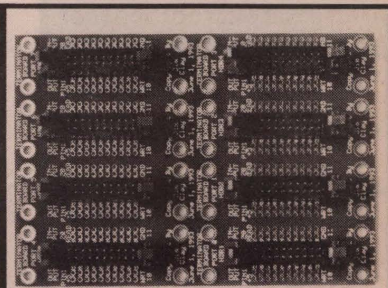
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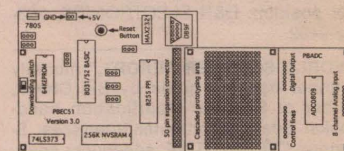
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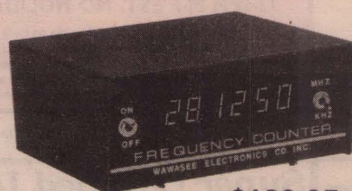
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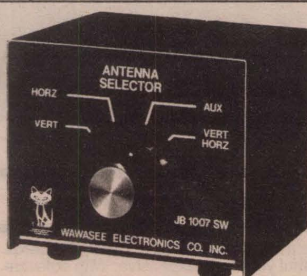
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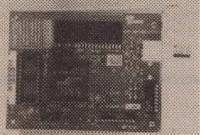
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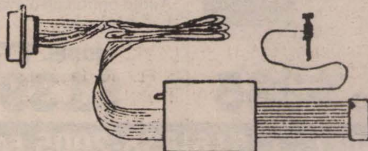
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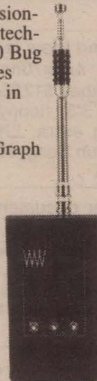
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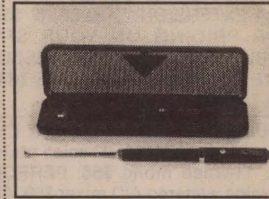


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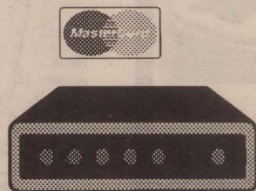
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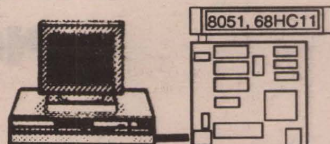
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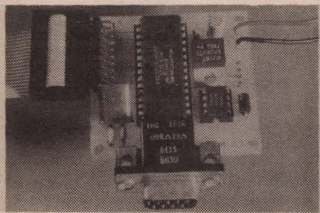
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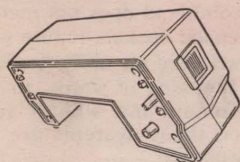
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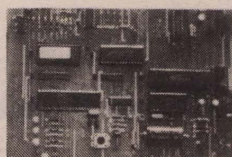
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Speech Recognition will become a popular method for controlling appliances, toys, tools, and computers. Because of the far reaching potential of this interface technology, companies are

hard at work developing speech recognition. Successful companies will gain a foothold in the voice recognition market. The ability to control and command by speaking directly to a computer (or appliance) will increase the efficiency and effectiveness of working with that device.

At its most basic level, a speech controlled device allows the user to perform parallel tasks (i.e., hands and eyes are busy elsewhere) while continuing to work with the computer or appliance.

The project outlined in this article is an easy-to-build programmable speech recognition circuit. Programmable, in that you program up to 40 words you want the circuit

to recognize. This circuit allows you to experiment with many facets of speech recognition technology. The heart of the circuit is a single IC, the HM2007 speech recognition chip. The chip provides the options of recognizing either .96 second or 1.92 second word lengths.

Using .96 second word length enables the chip to recognize 40 independent words using an 8K x 8 static RAM. You have the option to switch to the longer 1.92 second word length. While this reduces the word recognition count to 20 words, the longer length can be used for phrases instead of isolated words. The circuit, as described in this article, uses the .96 word length, 40 word recognition library.

The chip can operate in a manual mode or in a CPU mode. The CPU mode is designed to allow the chip to work under a host computer. Using the HM2007 chip for speech recognition in computers is attractive because the chip operates as a co-processor to the main CPU. The jobs of listening to sound and speech recognition don't occupy any of the computer's CPU time. When the HM2007 recognizes a command, it can signal an interrupt to the host CPU and then relay the word code. In addition, the HM2007 chip can be cascaded to provide a larger word recognition library.

The circuit we are building operates in the manual mode. The full data sheets on the chip are available for those of you who wish to interface the chip to a computer.

Applications

There are several major areas for application of voice recognition technology:

- Command and control of programs and equipment
- Speech-to-Text conversations
- Telephone Assistance Systems
- Data Entry
- Speech-controlled Appliances and Toys
- Voice Recognition Security

Build This Speech Recognition Circuit

by John Iovine

• Speech-to-Speech Translation

As voice recognition technology develops more fluency, we can look forward to an increase in voice controlled appliances, typewriters, instruments, and toys.

AUI "Aural User Interface" Technology

Most speech recognition systems available today use personal computers. They are add-on programs and hardware (soundcards) that connect to graphic user interfaces (GUIs), such as Windows. The programs operate continually in the background of DOS or Windows, waiting for speech input. While this approach works, it takes up CPU time, making any program that is running slower and more sluggish. A number of companies are actively pursuing aural user interfaces (AUIs). The AUI would allow computers to accept speech as a direct input and to confirm that input with an oral response. Our speech recognition

chip is a good AUI chip.

Mixing visual and aural information is not always effective. Voice Powered Products (Canoga Park, CA) produces a voice control VCR programmer. The reviews of the VCR Voice Programmer are good. The device does a good job recognizing commands after it has been trained by the user (speaker dependent).

The problem with the controller is that it mixes aural and visual information. For instance, to change the TV to channel 12 you must first press the voice button, then say "1" and wait for the numeral to appear on the LCD. Once it appears say the number "2" and again wait for this number to appear. Once it appears, release the voice button and the command is sent to change the channel.

The procedure works, but it is ineffective. Why? Because it takes too long to push-speak-look-speak-look-release. It becomes apparent that mixing aural and visual information

reduces the efficiency. Products are needed that can understand (recognize) commands given in the unstructured and efficient methods in which people communicate verbally.

To this end manufacturers, designers, and programmers should strive for effective AUI's that do not require secondary visual checking or input.

Learning to Listen

We take our speech recognition abilities for granted. Listening to one person speak among several at a party is beyond the capabilities of today's speech recognition systems. Speech recognition systems have a hard time separating and filtering out extraneous noise.

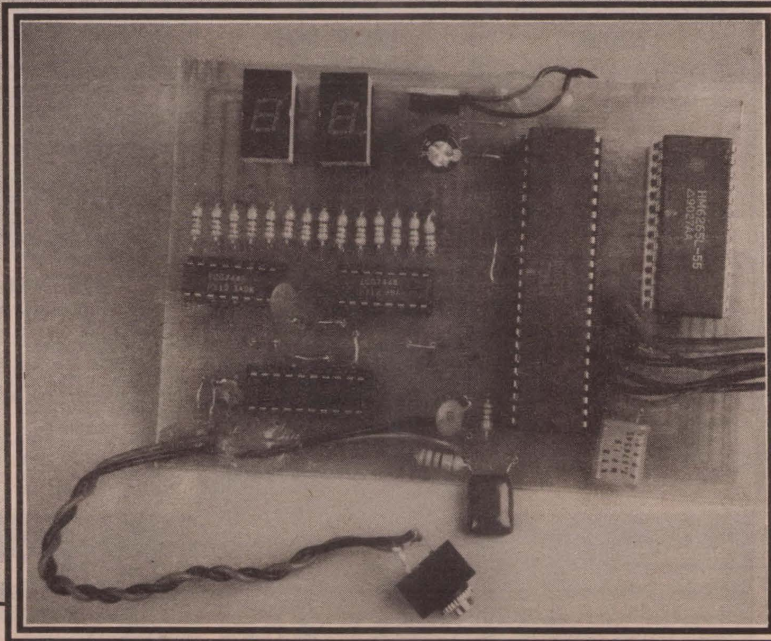
Speech recognition is not speech understanding. Understanding the meaning of words is a higher intellectual function. Because a computer can respond to a vocal command does not mean it understands the command spoken. Future voice recognition systems will have the ability to distinguish nuances and meaning of words, to "Do what I mean, not what I say!" However, those systems are still being developed.

Speaker Dependent / Speaker Independent

Speech recognition is classified into two categories: speaker dependent and speaker independent.

Speaker dependent systems are trained by the individual who will be using the system. These systems are capable of achieving a high command count and better than 95% accuracy for word recognition. The drawback to this approach is that the system responds accurately only to the individual who trained the system. This is the most common approach employed in software for personal computers.

Speaker independent is a system trained to respond to a word regardless of who speaks. Therefore,



the system must respond to a large variety of speech patterns, inflections, and enunciations of the target word. The command word count is usually lower than the speaker dependent. However, high accuracy can still be maintained within processing limits. Industrial requirements more often need speaker independent voice systems, such as the AT&T system described later.

Recognition Style

Speech recognition systems have another constraint concerning the style of speech they can recognize. There are presumed to be three styles of speech: isolated, connected, and continuous.

Isolated. These speech recognition systems can just handle words that are spoken separately. This is the most common speech recognition system available today. The user must pause between each word or command spoken. The speech recognition circuit is set up to identify isolated words of .96 second lengths.

Connected. This is a halfway point between isolated word and continuous speech recognition. It allows users to speak multiple words. The HM2007 can be set up to identify words or phrases 1.92 seconds in length. This reduces the word recognition dictionary number to 20.

Continuous. This is the natural, conversational speech we are used to in everyday life. It is extremely difficult for a recognizer to shift through the text as the words tend to merge together. For instance, "Hi, how are you doing?" sounds like "Hi, howyadoin." Continuous speech recognition systems are on the market and are under continual development.

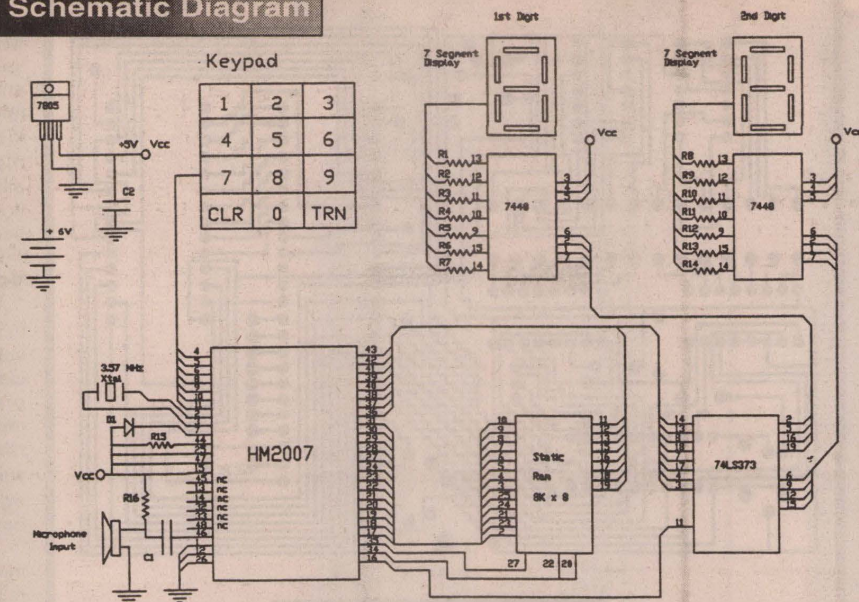
AT&T Reach Out & Chat

AT&T has begun installing voice recognition-based services throughout the country. These systems replace human telephone operators for credit card and collect calling.

AT&T developed the technology called "word spotting." This algorithm ignores all words except for a targeted word or phrase. The statement "Hello, operator I'd like to make a collect call to N.Y." contains a keyword "collect." This word recognition system would, upon hearing this statement, activate and branch the user down a tree architecture to a "Collect-Call" subroutine. The system then asks for the caller's name. This information is recorded digitally. Then the information is merged into another recorded message asking for acceptance of the call and charges. The recognition software at this point is looking for the target words "yes" or "no" in response. Afterward the automatic operator signs off.

This system is called the BT-100. The system contains 16 to 128 processors based on AT&T's Digital Signal Processing

Schematic Diagram



tems for computers are implemented in software. The hardware required is one of the many available sound cards. There are quite a few companies marketing voice recognition software. Let's look at a typical software package.

VoiceType Control for Windows cost is \$99.00. This software is capable of responding to commands, but is not useful for continuous speech to text conversion. VoiceType Control is programmed to recognize 350 spoken commands out of the box. It can be programmed to recognize up to 4,000 words. Minimum hardware required to run VoiceType is a 386SX computer equipped with a sound card.

As with all software

approaches, the recognition program operates in the background of the DOS or Windows environment. While the systems work, they use the main CPU processing time. This makes any program operating with voice recognition slower and more sluggish. As the word recognition library increases, the problem becomes more pronounced.

In contrast, when the HM2007 is interfaced to the computer, it doesn't use any of the CPU's processing time. It operates independently, signalling the CPU only when it has recognized a word or phrase. Programs operating with a HM2007 speech recognition board will not suffer any decrease in performance. The HM2007 can be cascaded to provide larger word recognition libraries.

Speech Recognition Circuit

The demonstration circuit operates in the HM2007's manual mode. This mode uses a simple keypad to communicate and program the HM2007 chip.

Keyboard:

The keyboard is made up of 12 normal open switches:

1	2	3
4	5	6
7	8	9
Clear	0	Train

When the circuit is turned on, the HM2007 checks the on-board static RAM. If the RAM checks out okay, the board displays "00" on the segmented displays, lights the LED (READY), and waits for a command.

To Train:

Press "01" (display will show "01"), then press "T" (Training).

Speak into the microphone, saying the training word. If the circuit accepted the input, the LED will flash. The word spoken (entered) is now identified as the "01" word. If the LED did not flash start over by pressing "01" then "T."

Continue training new words in the circuit. Press "02" then "T" to train the second

(DSP) 32 chip. The voice recognition system follows a branching tree architecture that moves the user in the system depending upon the recognition of key words.

The voice recognition systems utilized in these applications are speaker independent. AT&T uses over 1000 word samples to create a speaker independent word.

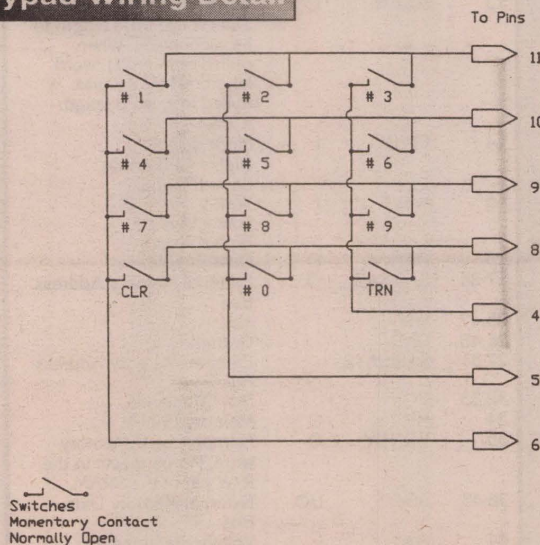
AT&T hopes to develop this technology into speaker dependent voice recognition security systems for ATM and credit card usage. The card will contain a microchip that is trained to recognize only its proper user's speech.

NYNEX is introducing a new service called Voice Dialing. This system allows the user to dial the number of someone just by stating the name (or ID) of the person. The numbers are contained in a personal voice activated speed dialing database. Each personal database is tailored to the user's voice.

PC Software Approach

Most approaches to speech recognition sys-

Keypad Wiring Detail



Switches - Momentary Contact, Normally Open

word. The circuit will accept up to 40 words.

Testing Recognition:

Repeat a trained word into the microphone. The number of the word should be displayed on the segmented display. For instance, if the word "directory" was trained as word number 25, saying the word "directory" into the microphone will cause the number 25 to be displayed.

Error Codes:

The chip provides the following error codes:

- .55 = too long
- .66 = too short
- .77 = no match

Clearing Memory:

To erase RAM memory (Training), press "99" then "C."

More About the HM2007 Chip:

The HM2007 is a single chip CMOS voice recognition LSI (Large Scale Integration) circuit. The chip contains an analog front end, voice analysis, recognition, and system control functions. The chip may be used in a stand alone or CPU connected.

Features:

- Single chip voice recognition CMOS LSI
- Speaker-dependent
- External RAM support
- Maximum 40 word recognition
- Maximum word length 1.92 seconds
- Microphone support
- Manual and CPU modes available
- Response time less than 300 milliseconds
- 5V power supply

Circuit Construction

Please refer to the schematic diagram. The components can be mounted and wired on a standard PCB board.

The keypad is constructed using 12 normally open switches. Pay particular attention in wiring the keypad. If soldered correctly, according to the keypad wiring detail, you will have just seven (7) wires from the keys to connect to the rest of the circuit. This is accomplished by soldering and connecting the switches together. This simplifies the keypad wiring, preventing a rat's nest of wires.

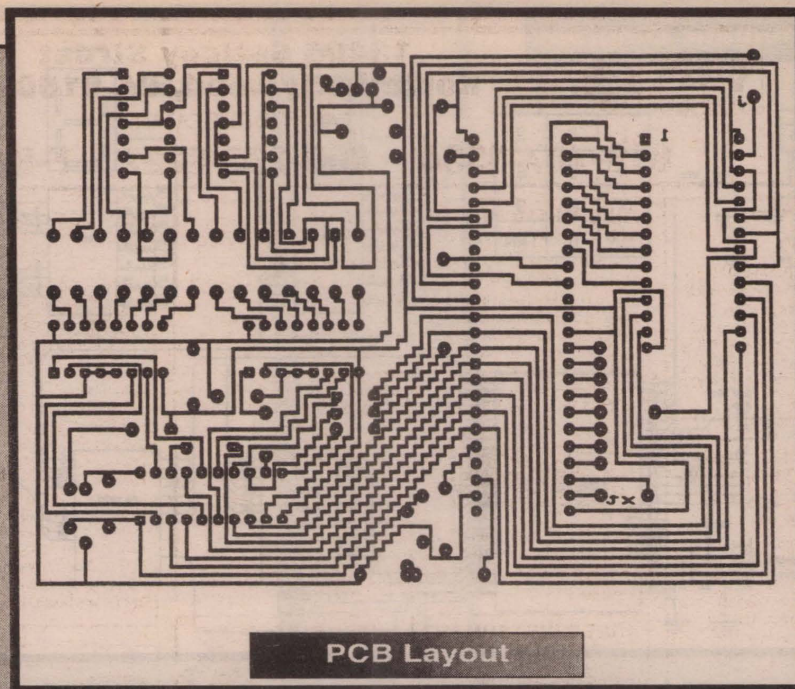
Volatile versus Non-Volatile Memory

The demo circuit design calls for static RAM (SRAM) for memory. Static RAM is okay as long as you don't mind re-training the circuit every time it's been turned off. Turning off the power erases the memory held in the static RAM.

The traditional solution to this type of problem is to use non-volatile memory such as an EPROM or EEPROM. Dallas Semiconductor sells a 8K x 8 EEPROM (70 ns) that is pin-by-pin compatible to the standard Static RAM chip used in this circuit. It may be possible to switch to the Dallas's non-volatile chip with little or no modifications.

Independent Recognition System

This demo circuit allows you to experiment with dependent as well as independent systems.



PCB Layout

The system is typically trained as speaker dependent, meaning the voice that trained the circuit also uses it.

To train the system for independent recognition/multi-user word recognition, choose five word numbers that will be used to identify the same target word. Say word numbers 01-05 are allocated for recognizing the word "yes." Use five separate enunciations of the word "yes" for each training

HM2007 Pin Functions:			
No.	Name	I/O	Description
1	GND	-	Ground
2,3	X1,X2	I	Crystal Pins, A 3.57 crystal is connected to these pins.
4,5,6	S1,S2,S3	I/O	Keypad scanning pins for manual mode.
7	RDY	O	Voice Input Indicator. Active Low. If HM2007 is ready for voice input, a low signal is output. If chip is busy, signal is high.
8-11	K1-K4	I/O	Keypad scanning pins for manual mode.
12	Test	I	"H" = Test Mode. "L" = normal mode
13	WLEN	I	Word length select pin. Selects the word length to be recognized. When pulled high (+5V), word length = 1.92 second. Pulled low, word length = .96
14	CPUM	I	Mode select. High = CPU mode. Low = Manual
15	Wait	I	Wait. Low = Wait. High = Active
16	DEN	O	Data Enable
17-24	SA0-SA7	O	External Memory Address Bus
25,47	Vdd		+5V
26,48	GND		Ground
27-31	SA9-SA12		External Memory Address Bus
32,33	NC		Not Connected
34	ME	O	Memory Enable
35	MR/MW	O	Memory read/ Memory write. Pin connects to the R/W pin of the SRAM.
36-43	D0-D7	I/O	External Memory Data Bus
44	Vref	I	Voltage Ref input for internal ADC.
45	Line	O	For testing only.
46	MicIn	I	Microphone connect pin.

word. If possible use a different person speaking the word. This will enable the system to recognize different voices, inflections, and enunciations of the target word. The more system resources that are allocated for independent recognition, the more robust the circuit will become.

Voice Security System

The chip isn't designed for a voice security system in a commercial application, but that should not prevent anyone from experimenting with it for that purpose. You may want to use three or four keywords that must be spoken and recognized in sequence in order to open a lock or allow entry.

Bandpass filtering the audio input could make the system more reliable.

CPU Mode

The HM2007 speech recognition chip is made to be connected to a host computer system. Actually, connecting the chip to the IBM PC bus isn't a problem. The driver software needed to control training, storing, and recognition will present

Parts List

QUAN	ITEM	COST
1	IC1 HM2007 IC	\$20.00
1	IC2 SRAM 8K x 8	\$4.00
1	IC3 74LS373	\$2.00
2	IC4 & IC5 7448	\$2.00 ea
1	XTAL 3.57 MHz	\$3.00
1	PCB	\$20.00
12	Pushbutton Switch normally open	\$1.00 ea
7	7 Segment Displays	\$3.00 ea
	HM2007 Data Sheets	\$5.00

Complete Speech Recognition Kit minus battery holder, microphone, microphone jack, keypad board — \$75.00 plus \$5.00 postage & handling.

Above parts available from:

Images Company

P.O.B. 140742, Staten Island, NY 10314
(718) 698-8305

Shipping add \$5.00

NYS residents add 8.25% sales tax

Misc Parts available from local Radio Shack

1	R1	22K 1/4 watt resistor
1	R2	5.6K 1/4 watt resistor
1	C1	100 uf 16V cap
1	C2	.01 uf cap
3	C3-C6	200 pf cap

Battery Holder
Microphone and Jack
Keypad board

more of a challenge. When the circuit is interfaced to a computer, it is possible to store trained words in a program file that can be uploaded into the circuit's static RAM when started. Of course, non-volatile RAM can be used instead of uploading the word library from a file.

For anyone wanting to interface the HM2007 to a PC bus, I strongly recommend purchasing the data sheets. **NV**



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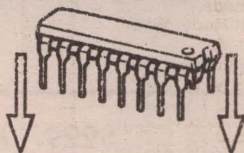
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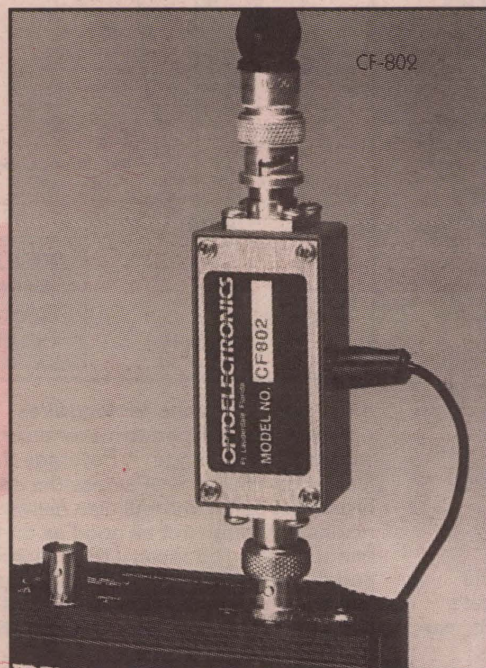
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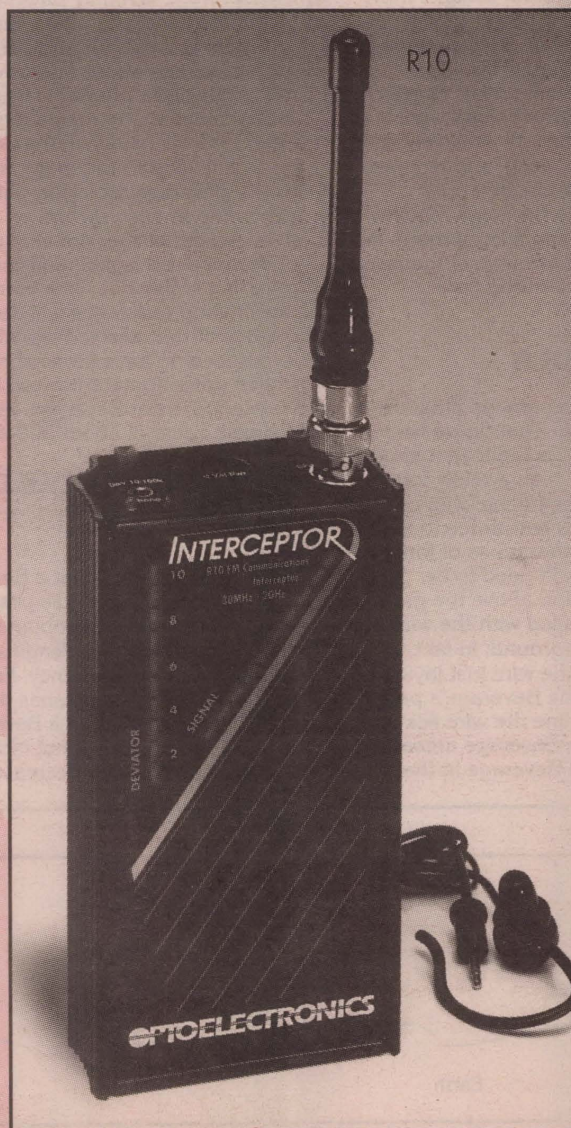
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THE SUPER SIGNAL SNATCHER

There is an antenna design which is legendary among hams and shortwave listeners looking for rare DX on frequencies below 5 MHz. Rumors have circulated about an antenna that lets listeners in Florida hear AM broadcast band stations from Australia, or listeners in Oregon hear AM band stations from India.

Well, those rumors are true. This super-antenna is called the Beverage, after Harold Beverage, its inventor. Nothing rivals its effectiveness at pulling in extremely weak signals at low frequencies. Even better, it's relatively easy to construct, surprisingly cheap, and requires no complicated electronic circuitry.

But there's a catch. The Beverage requires a lot of room . . . and we mean a lot of room. In fact, you'll probably need a couple of thousand feet of clear, open space to string up a Beverage!

BEVERAGE DETAILS

Figure 1 shows the schematic diagram of a Beverage antenna. That figure isn't in error! The Beverage is really that simple! A Beverage is little more than a really long longwire, placed in a straight line, with one end terminated through a resistance to a good ground system. Unlike other types of longwires, the Beverage doesn't need to be installed at a high elevation above the ground. Most Beverages are installed with the wire only five or six feet above the ground; in fact, a Beverage will work with the wire just laying on the ground! The key to the Beverage's performance is how straight a line the wire lies in.

The theory behind the Beverage antenna was described by Harold Beverage in the

Beverage; this is why the Beverage is sometimes referred to as a "signal summing" antenna.

This wave starts at the distant (terminated) end of the Beverage and travels toward the end of the Beverage where the receiver is located. There is another wave traveling along the length of the Beverage in the opposite direction, but it is sent to ground at the far end through the resistance connected to ground. Only waves arriving from the direction of the terminated end can induce traveling waves; waves arriving from the sides are largely "ignored" by the Beverage. The result is that the Beverage is highly directional toward the terminated end and offers very high gain.

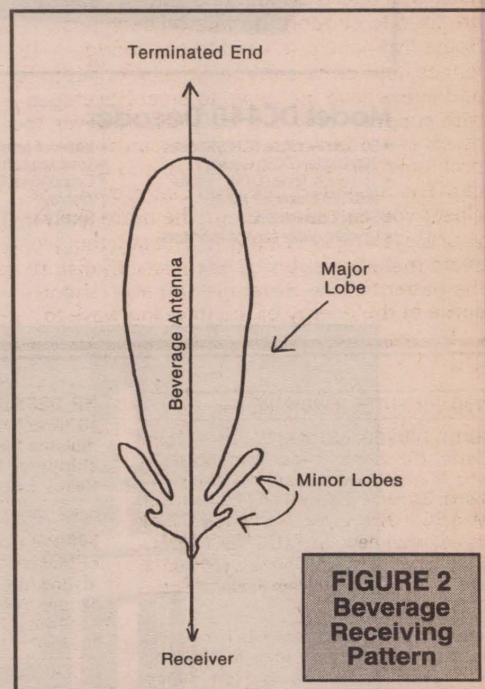
Figure 2 shows a typical receiving pattern for a Beverage about one wavelength long at the receiving frequency. The Beverage will receive best in one main direction (the major lobe) and will usually have two or more minor lobes adjacent to the major lobes. In the real world, Beverage receiving patterns will vary according to such factors as ground conductivity, length of the wire versus the wavelength of the received signal, and the value of the terminating resistance. The correct value of the terminating resistance will depend on the frequency of the received signal. Since it's impractical to have some sort of remote-controlled potentiometer to vary the terminating resistance, most Beverage designs use a compromise value of about 500 at two watts.

HOW LONG SHOULD A BEVERAGE BE?

You might think that a Beverage should always be as long as possible, but that's not the case. The optimum length will usually be two to four wavelengths long at the desired receiving frequency. Fortunately, it's possible to get by with antennas that are shorter. Increasing the length of a Beverage beyond four to five wavelengths will not increase its performance. Instead, it will decrease the performance

at least equal to the wavelength of the signal it intercepts. Because of this vast length, the wavefront of the received signal sets up a series of voltage all along the length of the Beverage. These voltages, in turn, set up a traveling wave along the length of the

length between 1200 to 2000 feet will typically work well. The shorter lengths will work best at the upper end of the AM band while the longer Beverages will be more effective on the lower end of the band. If the Beverage is to be used on shortwave frequencies up to about 5 MHz, then lengths of 800 to 1000 feet can be used. The upper frequency limit for "Beverage effects" varies with each Beverage, but is usually somewhere between 6 to 7 MHz. Above this limit, the directionality of a Beverage disappears and it behaves like an ordinary longwire, although one that obviously captures



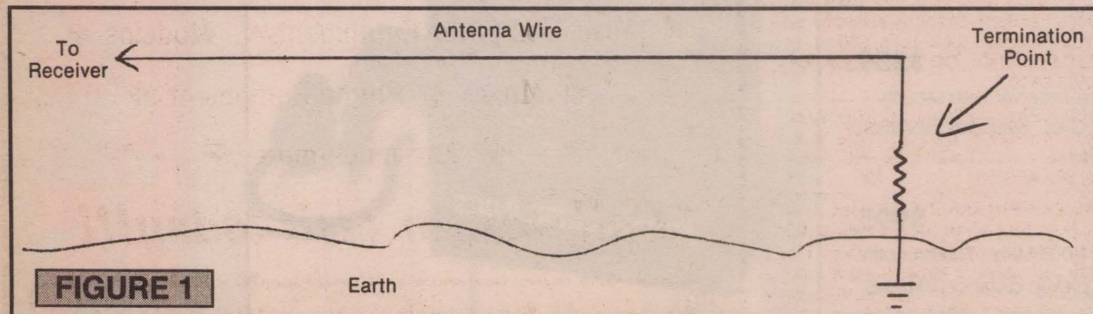
more signal than shorter longwires.

Beverages can perform over a surprisingly wide frequency range. A Beverage that's 1500 feet long will work well across the entire AM broadcast band, and will also deliver good results (although not as good as on the AM band) on the 160 meter (1800 to 2000 KHz) and 80 meter (3500 to 4000 KHz) ham radio bands, as well as the 120 meter (2300 to 2500 KHz) and 90 meter (32- to 3400 KHz) tropical broadcasting bands.

BUILDING A BEVERAGE

When you get a case of "Beverage fever," it's tempting to go out and buy a couple thousand feet of wire and string up a Beverage. However, planning your Beverage can prevent a lot of grief.

The biggest problem of any Beverage, whether it's laying on the ground or supported in the air, is keeping the antenna wire in a straight line. It doesn't matter too much if the height of a Beverage above ground varies (although some Beverage users disagree), but it is crucial that the antenna wire be as straight as possible. Even a minor bend or "kink" in the wire's straightness can destroy the directivity of a Beverage and greatly reduce its gain. Do like building or contractors do: Some kite twine or string can be a handy way to get a



November '92 issue of QST magazine. He referred to his invention as a "traveling wave" antenna. The length of a Beverage is typically

because the antenna will lose its directional characteristics and become unidirectional.

For reception on the AM broadcast band, a

straight line made for installation of the wire or its supports.

While a Beverage will work with the wire laying on the ground, getting it a few feet in the air will improve performance by reducing ground losses. If you do install it above ground, the exact height is not that important. However, you should install it high enough to get it out of the way of animals, kids, and adults who might trip over it or break it. Most successful "elevated" Beverages are supported every 10 feet or so by wooden posts driven into the ground; stand-off insulators (like those used with television antenna lead-in cables) are used to support the wire on each post. Some listeners have used trees, wooden fences, and other existing objects for support, and some have managed to erect Beverages with supports only every 50 feet. However, too much space between supports can create problems with sag, wind stress, and ice loading. The more supports you can use and the closer you can space them, the more likely your Beverage is to survive! The key thing is to avoid metallic supports, as these can distort the pattern of the Beverage and even shunt some of the energy of the traveling wave to

ground. If you use widely spaced supports, allow sufficient "slack" between supports for wind stress, ice loading, etc.

Use a heavy gauge insulated wire for the Beverage. Speaker cable is popular with many Beverage enthusiasts; it is strong and the insulation prevents kinking and snags. Solid wire is better than stranded. If the wire is installed close to the ground, try tying ribbons on the wire or attaching high visibility (orange, yellow, etc.) tape at regular intervals along the wire.

A good ground system at the terminated end is important for good directional characteristics. Forget driving a single ground rod a few feet into the soil and letting that be your ground; instead, you need multiple ground rods connected by heavy "grounding braid" or a similar flattened conductor. Extensive ground radials and copper mesh can also help secure a good ground. All connections should be soldered, and the ground rods should be lengthy and driven into the ground as deeply as possible. (Some Beverage enthusiasts use eight foot ground rods, for example.) The soil at the termination point should be as moist and conductive as possible, and some Beverage users regularly wet down the soil

where their antenna is terminated. The ideal Beverage termination point would be a spot along the ocean that is covered at high tide!

IS IT WORTH THE EFFORT?

YES! Things can be heard on a Beverage antenna that are simply impossible otherwise.

One avid Beverage user is Pat Martin of Seaside, OR. During the past fall and winter "DX season," Pat was able to receive AM band stations from such countries as Australia, New Zealand, Jamaica, Thailand, Philippines, Guam, Montserrat, South Korea, India, Nepal, Taiwan, Western Samoa, along with numerous stations in Japan and China. Another Beverage user, Oklahoma's John Bryant, bagged AM band stations in Senegal, Spain, Yugoslavia, and other parts of Europe and Africa. Most successful 160 meter ham band DXers use Beverages for receiving even when they use verticals for transmitting.

A Beverage antenna is plainly not for the faint of heart! But if you've got the space and the urge to hear things that others might find fantastic, try a Beverage. **NV**

#50 COMPUTER HARDWARE *cont.*

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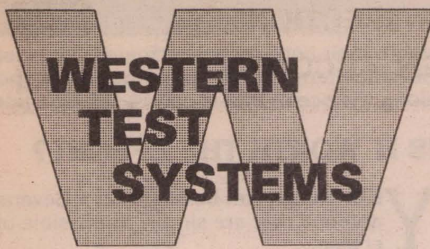
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TEK 7D14 525 MHz Frequency Counter, 7000 series	\$175.00
TEK DP501 Digital Prescaler, to 1.3 GHz, TM500 series	\$400.00

STANDARDS

AUSTRON 2010B Disciplined Oscillator; 0.1, 1.0, 5.0 MHz	\$550.00
VECTRON FS-323 Crystal Frequency Standard; 0.1, 1.0, 5.0 MHz	\$400.00

AUDIO & BASEBAND

SPECTRUM ANALYZERS

DATA PRECISION 6000/620 FFT Spectrum Analyzer / Digitizing O'scope	\$950.00
HP 3581A Wave Analyzer, 15 Hz-50 kHz	\$900.00



90 DAY WARRANTY PARTS AND LABOR • 10 DAY INSPECTION TEST EQUIPMENT WANTED CALL OR FAX LIST • OPEN ACCOUNTS



HP8556A LF Section, 20 Hz-300 kHz	\$500.00
TEK 5L4N Spectrum Analyzer, 20 Hz-100 kHz, 10 Hz res., 5000-series	\$850.00
TEK 7L5-OPT25/7603 Spectrum Analyzer, 20 Hz-5 MHz, w/tracking gen., display	\$2,250.00

DISTORTION ANALYZERS

HP 331A Distortion Analyzer, 5 Hz-60 kHz, -60 dB	\$225.00
HP 333A Distortion Analyzer, 5 Hz-600 kHz, -60 dB, auto nulling	\$500.00
TEK AA5001-OPT.02 Programmable Distortion Analyzer, TM5000 series	\$2,250.00
TEK DA4084 Programmable Distortion Analyzer, 0.0025% THD, w/frame	\$1,750.00

RMS VOLTMETERS

FLUKE 8920A True RMS Voltmeter, 180 uV-700 V, 10 Hz-20 MHz	\$700.00
HP 3400A RMS Voltmeter, 10 Hz-10 MHz	\$250.00

OSCILLATORS

HP 204D Audio Oscillator, 5 Hz-1.2 MHz, 80 dB step atten.	\$200.00
HP 3335A Synthesizer/Level Generator, 20 Hz-20 MHz	\$3,250.00
HP 3336C Synthesizer/Level Generator, 10 Hz-21 MHz, 50 & 75 Ohms	\$1,250.00
HP 4204A Synthesizer, 10 Hz-1 MHz, 1 mV-30 V / 600 Ohms	\$350.00
KROHN-HITE 4300 Sine / Square Oscillator, 10 Hz-10 MHz	\$250.00
TEK SG502 Audio Oscillator, 5 Hz-500 kHz, TM500 series	\$300.00

FILTERS, MISCELLANEOUS

GR1381 Random Noise Generator, 2 Hz-50 kHz	\$300.00
GR1383 Random Noise Generator, 20 Hz-20 MHz	\$500.00
HP 3575A-002 Gain-Phase Meter, 1 Hz-13 MHz	\$1,000.00
KROHN-HITE 3202R Dual HP/LP/BP/BR Filter, 20 Hz-2 MHz, 24 dB/octave	\$500.00
KROHN-HITE 3343 Dual Bandpass Filter, 0.01 Hz-100 kHz, 48 dB/octave	\$950.00
KROHN-HITE 6500 Precision Digital Phasemeter, 3 Hz-5 MHz	\$950.00
P.A.R. 189 Filter/Amplifier, 0.1 Hz-110 kHz, variable Q & gain	\$350.00
TEK AM502 Differential Amplifier, 0.1 Hz-1 MHz, TM500 series	\$575.00
WAVETEK/ROCKLAND 752A-002 Dual Low Pass Filter, 1 Hz-100 kHz, 115 dB/octave, GPIB	\$1,100.00

RF & MICROWAVE

SPECTRUM ANALYZERS

HP5371A Modulation Domain Analyzer, 125 mHz-500 MHz	\$5,900.00
HP8443A Tracking Generator, 0.1-110 MHz, LED display	\$700.00
HP8444A Tracking Generator, 0.1-1300 MHz, for 8554B	\$800.00
HP8444A-059 Tracking Generator, 0.5-1500 MHz, for 8554, 8568, etc.	\$1,500.00
HP8552B IF Section	\$750.00
HP8553B RF Section, 1 kHz-110 MHz	\$500.00
HP8554B RF Section, 0.1-1250 MHz	\$800.00
HP8555A RF Section, 0.01-18 GHz	\$950.00
HP8555A/8552B/141T Spectrum Analyzer System, 10 MHz-18 GHz, 100 Hz res.	\$2,375.00
HP8557A/182T Spectrum Analyzer, 0.01-350 MHz, 1 kHz res., w/display	\$1,450.00
HP8558B/853A Spectrum Analyzer, 0.1-1500 MHz, 1 kHz res., w/display	\$4,250.00
TEK 1401A/323 Portable Spectrum Analyzer/Oscope, 1-500 MHz, AC/Batt.	\$900.00
TEK TR501 Tracking Generator, 0.1-1800 MHz, for 7L12, 7L13	\$700.00
TEK TR503 Tracking Generator, 0.1-1800 MHz, for 4924/5/6	\$1,750.00

NETWORK ANALYZERS

HP11590B-001 Bias Network, 0.1-18.0 GHz, to 100V, 500mA, APC7	\$450.00
HP11665B Modulator, 0.15-18.0 GHz, for use with 8755/6/7	\$400.00
HP8405A Vector Voltmeter, 1-1000 MHz	\$700.00
HP85020A Directional Bridge, 0.01-4.3 GHz, N(f), for 8755/6/7	\$750.00
HP85021A Directional Bridge, 0.01-18.0 GHz, N(f), for 8755/6/7	\$1,200.00
HP85050D APC7 Calibration Kit, for 8510 series	\$1,100.00
HP8755C/11664A/2/182T Scalar Network Analyzer, w/(2) detectors, 10 MHz-18 GHz	\$1,250.00
NARDA 7000A/7202/7206 Microwave Multimeter System: scalar analysis 0.1-18 GHz	\$1,950.00
WAVETEK 1038N10/D14A Scalar Network An., w/(2) 1 MHz-26.5 GHz detectors, GPIB	\$1,250.00
WAVETEK 80504 Directional Bridge, DC-40 GHz, 30 dB directivity, K(f)	\$2,200.00
WILTRON 63A50-1 VSWR Autotester, 10-4000 MHz, APC7, 46 dB directivity	\$600.00

SIGNAL GENERATORS

BOONTON 102C Signal Generator, 0.45-520 MHz, AM, FM	\$850.00
COMSTRON FS-2000-4 Synthesizer, 10 MHz-4 GHz, 1 uS speed, -140 dBc noise	\$15,000.00
HP11720APulse Modulator, 2-18 GHz, Tr<10ns, >80 dB	\$1,200.00
HP8403A-002 Modulator, 800-2400 MHz, 80 dB D/R, pulse 0.1-100 uS	\$500.00
HP8640A Signal Generator, 0.5-512 MHz, AM, FM, analog readout	\$950.00
HP 8640B-001, 002 Signal Generator, 0.5-1024 MHz, variable audio osc.	\$2,600.00
HP 8640B-001, 002, 003 Signal Gen. 0.5-1024 MHz, var. audio & rev. pwr. prot.	\$2,900.00
HP 8640B-002, 003 Signal Generator, 0.5-1024 MHz, reverse power protected	\$2,600.00

HP8640B-003 Signal Generator, 0.5-512 MHz, reverse power protected	\$1,400.00
HP8640B-323 Signal Generator, 0.5-512 MHz, AM, FM, Pulse	\$750.00
HP8654B Signal Generator, 10-520 MHz	\$750.00
HP8656A Synthesized Signal Generator, 0.1-990 MHz, AM, FM	\$3,500.00
HP86631B Aux. Modulation Section, external AM/Pulse, for 8660	\$250.00
HP86632B AM/FM Modulation Section, for 8660 series	\$650.00
HP86633B AM/FM Modulation Section, for 8660 series	\$750.00
HP86635A FM/OM Modulation Section, for 8660 series	\$950.00
MARCONI 2019A Synth. Signal Gen., 1.5-1040 MHz, 100 Hz res., AM/FM/OM	\$3,500.00
WILTRON 6742A Synthesizer/Sweep Generator, 18.0-26.5 & 26.5-40.0 GHz	\$9,000.00

SWEEP GENERATORS

BOONTON/INTEGRA VTS-100 VCO Test Set, 2-18 GHz	\$1,750.00
EIP 928-OPT.9201 Sweep Gen., 1.0-18.6 GHz, step atten., power sweep, GPIB	\$4,000.00
HP8620A Sweep Oscillator Frame	\$300.00
HP8620C Sweep Oscillator Frame	\$550.00
HP8620C-011 Sweep Oscillator Frame, HP1B programmable	\$675.00
HP86222A RF Plug-In, 0.01-2.4 GHz	\$1,500.00
HP86222B RF Plug-In, 10-2400 MHz, crystal markers 1, 10, 50 MHz	\$1,900.00
HP86222B-002 RF Plug-In, 0.01-2.4 GHz, crystal markers & 70 dB atten	\$2,250.00
HP86235A RF Plug-In, 1.7-4.3 GHz, +16 dBm	\$500.00
HP86240A RF Plug-In, 2.0-8.4 GHz, +16 dBm	\$1,000.00
HP 86242D-004, 008 RF Plug-In, 5.9-9.0 GHz, optimized for M.L.A.	\$500.00
HP86290B RF Plug-In, 2.0-18.6 GHz, +10 dBm levelled	\$2,250.00
HP8709B Synchronizer, for 8620B, 8690 series	\$250.00
WAVETEK 1001A Sweep/Signal Generator, 0.5-300 MHz	\$350.00
WAVETEK 1067 Sweep Generator, 1-400 MHz, +10 dBm, 75 ohms	\$500.00
WAVETEK 1801B Signal/Sweep Generator, 1-950 MHz, 75 Ohms	\$500.00

POWER METERS

BOONTON 4200A-01A-03+4B Digital Power Meter, GPIB, w/(1) 1 MHz-12.4 GHz sensor	\$900.00
BOONTON 42B/41-4B Analog Power Meter, with 1 MHz-12.4 GHz sensor	\$475.00
BOONTON 42B/41-4E Analog Power Meter, with 1 MHz-18 GHz sensor	\$650.00
BOONTON 42B/42A-S3 Analog Power Meter, with 1 MHz-8.4 GHz N(f) sensor	\$375.00
HP432A-001 Power Meter, with AC/battery power option	\$300.00
HP432A/478A Power Meter, 0.01-10 GHz, -20 dBm to +10 dBm F.S.	\$375.00
HP432B/478A Digital Power Meter, 0.01-10 GHz, 10 uW-10 mW F.S.	\$450.00
HP435A/8481A Power Meter, 10 MHz-18 GHz, -30 to +20 dBm	\$1,000.00
HP435A/8482A Power Meter, 0.1-4200 MHz, -30 to +20 dBm	\$1,000.00
HPK486A WR42 Thermistor Mount, 18.0-26.5 GHz, for 432 series	\$400.00
HPQ486A Power Sensor, 33.0-50.0 GHz, WR22 waveguide	\$1,500.00
WAVETEK 1034A Portable Analog Power Meter, 1 MHz-18 GHz	\$375.00

MILLIVOLTMETERS

BOONTON 9200A-01 RF Millivoltmeter, 10 kHz-1.2 GHz, GPIB	\$950.00
HP3406A Broadband Sampling Voltmeter, 10 kHz-1.2 GHz	\$350.00
RACAL 9303-OPT.15 TRMS Level Meter, 10 kHz-2 GHz, -77 to +23 dBm, dual ch, GPIB	\$1,100.00

AMPLIFIERS, MISCELLANEOUS

ALITECH7009 Hot/Cold Noise Source, DC-9.0 GHz, GR900 connector	\$300.00
ALITECH7615 Noise Generator, 0.01-1.3 GHz, 15 dB ENR	\$350.00
BOONTON 82AD FM/AM Modulation Meter, 10-1300 MHz	\$1,000.00
DRAKE R-7 Receiver, 0.1-30 MHz, IF filters 0.5, 1.8, 2.3, 4.0 kHz	\$800.00
ENI 500LA Amplifier, 24 dB, 1.5-520 MHz, 300 mW	\$350.00
ENI 503L Amplifier, 40 dB, 2-510 MHz, 3 Watts	\$850.00
ENI 600L Amplifier, 24 dB, 0.8-1020 MHz, 150 mW	\$450.00
HP11975A Amplifier, 2-8 GHz, +6 to +16 dBm levelled output	\$1,200.00
HP8447A Amplifier, 0.1-400 MHz, NF<7 dB, +6 dBm output	\$300.00
HP8447F-H64 Dual Amp., 9 kHz-50 MHz/28 dBG & 0.1-1300 MHz/25 dBG	\$1,100.00
HUGHES 11770H1F000 TWT Amplifier, 10 Watts, 2.0-4.0 GHz	\$1,500.00
HUGHES 11770H4R000 TWT Amplifier, 10 Watts, 12.4-18.0 GHz	\$1,500.00
MICROWAVE POWER DEV. SSPA 0240-22/6140 Amplifier, 2-400 MHz, 200 Watts, 12 suboctave passbands	\$4,000.00
PANASONIC VP-8125A AM/FM/Stereo Gen. 0.1-110 MHz, 0.1 Hz res., 0.05% dist.	\$850.00

COAXIAL & WAVEGUIDE

ANZAC AM-109 Amplifier Module, 10 dB, 0.5-60 MHz, Pos=+27 dBm, NF<7dB	\$100.00
FXR/MICROLAB U155A WR28 Variable Attenuator, 0-20 dB, 26.5-40.0 GHz	\$250.00
GENERAL MW. F192A High Speed Switch, 0.2-18.0 GHz, 80 dB isol., 10 nS Tr	\$125.00
GR900-LB Precision Slotted Line, 0.3-8.5 GHz, 50 Ohms 0.1% tol.	\$450.00
HONEYWELL SMD-1024 Freq. Doubler, 10-24 GHz, <11 dB loss, >+9 dBm Po	\$300.00
HP11566A 10cm Standard Air Line, APC7	\$100.00
HP11567A 20cm Standard Air Line, APC7	\$125.00
HP11667A Power Splitter, DC-18 GHz, SMA(f/f/f)	\$500.00
HP11691D Directional Coupler, 22 dB, 2-18 GHz	\$500.00
HP11692D Dual Directional Coupler, 22 dB, 2-18 GHz	\$1,000.00
HP776D Dual Directional Coupler, 20 dB, 940-1900 MHz	\$250.00
HP778D-011 Dual Directional Coupler, 20 dB, 0.1-2.0 GHz	\$400.00

HP779D Directional Coupler, 20 dB, 1.7-12.4 GHz	\$375.00
HP8497K-004 Programmable Attenuator, 0-90 dB, DC-26.5 GHz, APC3.5	\$600.00
HP8532A WR28 Frequency Meter, 26.5-40.0 GHz	\$500.00
HUGHES 41214H Tunable IMPATT Source, 37-39 GHz, 100 mW, FM/AF	\$1,250.00
HUGHES 45714H-1000 WR15 Frequency Meter, 50-75 GHz	\$800.00
HUGHES 45716H-1000 WR10 Frequency Meter, 75-110 GHz	\$875.00
HUGHES 45722H-1000 WR22 Precision Variable Attenuator, 0-50 dB, 33-50 GHz	\$750.00
HUGHES 41734H-1105 52 GHz IMPATT Source, with FM/AF, WR15	\$1,500.00
LORCH FC-325-FC Mixer, RF/LO=2-6 GHz, IF=10 kHz-2 GHz, LO=+5 dBm, SMA	\$50.00
M/A MA-86841 WR42 Gunn Osc., 21.0-21.6 GHz, >+21 dBm, +6.5 V 700 mA	\$200.00
MAURY 8045D Double Stub Sliding Tuner, 1.8-18.0 GHz, APC3.5 (m/f)	\$350.00
MIDWEST MW. 3537 DC Block, 0.1-12.4 GHz, SMA(m/f)	\$35.00
NARDA 26298 20 dB Attenuator, 150 Watts, DC-1 GHz	\$225.00
NARDA 3000-SERIES Directional Couplers	\$150.00
NARDA 3090-SERIES Precision High Directivity Couplers	\$225.00
NARDA 4000-SERIES SMA Miniature Directional Couplers	\$75.00
NARDA 5070-SERIES Precision Reflectometer Couplers	\$300.00
RLC D-1089 4-Way Power Divider, 2-8 GHz, SMA	\$100.00
TRG A526 WR28 Phase Shifter, 26.5-40.0 GHz, round flanges	\$200.00
TRG B510 WR22 Precision Attenuator, 0-50 dB, 33.0-50.0 GHz	\$700.00
TRG B551 WR22 Frequency Meter, 33.0-50.0 GHz	\$550.00
WEINSCHEL 1515 Power Divider, DC-18 GHz, SMA(f/f/f)	\$125.00

LOGIC

FLUKE 9010A Microsystem Troubleshooter, with 6809 & 68000 probes	\$1,250.00
HP5004A Signature Analyzer	\$150.00
HP5005A Signature Multimeter	\$350.00
HP5005B Signature Multimeter, TTL/CMOS/ECL, HP1B	\$750.00
HP5006A Signature Multimeter, HP1B	\$675.00
TEK P6408/P6109 Word Recognizer Probe Set	\$225.00

COMMUNICATIONS

HEKIMIAN 3900 Communication Test Set, various plug-ins available	\$350.00
HP2867A LAN Wire Test Instrument, for 25 pair cable	\$750.00
HP3336B-001 Synthesizer/Level Generator, 10 Hz-21 MHz	\$650.00
HP3551A Transmission Test Set: voice, program & data to 50 KB/S	\$750.00
HP3717A-012 70 MHz Modulator-Demodulator, 60 channel CCIR emphasis	\$1,500.00
HP 3780A-001, H39 Pattern Generator/Error Detector, DS1/1.544 MHz & up	\$1,100.00
HP59401A HP1B Bus Analyzer	\$700.00
HP653A Test Osc., 10 Hz-10 MHz, WECO connectors	\$150.00
HP83001A Microwave Repeater, 3.7-4.2 GHz CCR 25 channels, 1 Watt	\$750.00
KSVOETICS ATG-PC IRIG-B Synchronizable Time Base Gen. for PC/AT	\$250.00
RACON 10075-100/101 23 GHz Video Link Tx+Rx Pair, 65 mW to 42 dB/27 feed	\$1,500.00
SCIENTIFIC-ATLANTA 4647 JF Noise Insertion Test Set, 70 MHz	\$1,250.00
TEK 1410R-OPT.04 NTSC Test Signal Gen. w/SPG2, TSG1, TSP1, TSG3, TSG5, TSG6	\$2,750.00
TEK 1411R-OPT.04 PAL Test Gen. w/SPG12, TSG11, TSP11, TSG13, TSG15, TSG16	\$2,750.00
TEK 1430 Video Random Noise Measuring Set	\$750.00
TEK 144 NTSC Test Signal Generator	\$675.00
TEK 1480R-OPT.06 NTSC Waveform Monitor, 124 ohm (WECO) bal. input	\$850.00
TEK 521A PAL Vectorscope	\$1,500.00
WANDEL & GOLTERMANN RM-40 Radiolink Measuring Set, 70 MHz	\$1,750.00

MISCELLANEOUS

FLUKE 2190A/2300A/1120A 10-Chan Scanning Thermometer, types J,K,T,R,C, GPIB	\$875.00
FLUKE 2190A/2300Y2001 Temperature Calibration System	\$950.00
HP37204A-002 HP1B Extender, 2 port fiber-optic	\$600.00
HP59307A HP1B VHF Switch	\$200.00
HP7015B Analog X-Y Plotter	\$250.00
HP82937A & 82939A HP1B & Serial Interfaces for 80-series computers	\$50.00
P.A.R. 5206 Two-Phase Lock-In Amplifier, 2 Hz-200 kHz	\$3,000.00
TEK J16/J8502 Photometer, with Irradiance Probe	\$450.00
TEK J16/J8503 Photometer, with Luminance Probe, 500-650nm	\$450.00
TEK TM5003 5000-series 3-slot Programmable Power Module	\$400.00
TEK TM5006 5000-series 6-slot Programmable Power Module	\$600.00
TEK TM501 500-series single slot Power Module	\$175.00
TEK TM503 500-series 3-slot Power Module	\$175.00
TEK TM504 500-series 4-slot Power Module	\$175.00
TEK TM506 500-series 6-slot Power Module	\$250.00
TEK TM515 500-series 5-slot Traveller Power Module	\$275.00
TEK TS8150 Test System Interface, w/(4) TSS40 scanner controllers	\$900.00
TEK TSS41 Low Level Scanner	\$175.00
TEK TSS45 RF Scanner	\$175.00

#50 COMPUTER HARDWARE cont.

486 MOTHERBOARDS with 3 VLB slots, 256K cache, ZIF socket, handle any 486 and P24T CPUs, AMI Bios, Opti Chipset \$129; DTC 2278 VLB IDE 2H/2F/2S/P/G controller with 14550 UARTs \$45; VLB IDE controller 2H/2F/2S/P/G w/DUAL 16550 UARTs \$75; one meg VLB accelerated video card \$99. All items brand new. DAYTON TECHNOLOGIES, Marion Way, Carmel, NY 10512. 914-228-0431 M-F 8:00am-3:00pm, Sat. & Sun. 8:00am-1:00pm.

POWER CONDITIONERS: Oneal model CP1110 8.4A/1KVA 120V in/out \$125. Sola model LR44950 6.25A/750VA 120V in/out \$100. 503-227-0577.

SMART DUAL serial buffer with 32K battery backed buffer RAM. Don't throw away your slow computer because it can't keep up with fast instruments. Our buffer will automatically transmit, receive, and store information until it is needed by your CPU. Send and receive data at your leisure. Zif EPROM and Bus based expandability. \$450. Robotic Electronics, Inc., 4387 Swamp Rd., Suite 263, Doylestown, PA 18901.

IN STOCK, rare and odd Apple and IBM accessories, motherboards, memory, CD ROMs, robotic parts. Complete systems also available. 386 to pentium multimedia complete \$1700. Data recovery available. Call 717-387-6499 or for orders call 800-336-9065.

EVERYTHING BRAND new with warranty! IBM 486-33 motherboards with CPU \$100. 486-66 \$265. 386SX40 \$65. Memory \$42.50/megabyte, CPU fans \$14.50 DOS 3.3, WIN 3.0 \$10. SVGA monitors \$185. Hard drives 540 Megabyte \$495. 1.2 gigabyte \$850. Minitor/mid tower case 220 watts PS \$45 modems 14,400 BPS \$125. Notebooks 386 with 120 Meg hard drives \$950. Complete 486 systems from \$595. Sound cards with speakers and microphone \$65. Call for items not listed. CCI, 714-778-0450.

PC/PC COMPUTER Supply, 408-464-2667. Brand new with full Apple warranty, 14" Apple Performa Display, 640x480, .39mm dot pitch, useable with all Macintosh and Powerbook products. \$149.95.

40MB IDE Hard Drive \$59. Mounting kit \$5. IDE Multifunction Controller for 2HDs and 2FDs, includes serial, printer and game ports \$25. To order, send check or money order for amount + \$5 shipping to: PowerDisk, 6813 Lotus Way, West Jordan, UT 84084.

EPSON PRINTER ribbon #8750 fits MX80, FX80, LX810 & more, new & fresh, 4 for \$10 PPD. Quantity price available. Mike's Surplus Stuff, 800-769-7977 9pm-midnight EST.

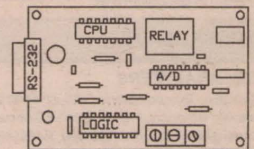
PROLOG MODEL 980 EPROM programmer with module 9076, 9059, 9068, 9075. \$500 for all. Mike's Surplus Stuff, 800-769-7977 9pm-midnight EST.

AT TYPE 20 Meg hard drive with MFM controller preformatted and ready to go. \$69 plus \$9.75 shipping & handling. Finley Digital Equipment, 1010 Columbia Ave., Lancaster, PA 17603.

POWER SPLITTERS \$1, 4AA batt. holders \$1, 3.5 drive power ext./90 cents & more, plus S&H. 910-867-3446.

CD-ROM KIT. Phillips CM205 (drive, cables, and controller). IBM AT compatible. \$135! Very special pricing for dealers. Call John, 404-339-9089, 7-10 pm Eastern time only. No answer, call 404-736-0335.

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HEWLETT PACKARD 7475A 11"x17" color plotter \$199. Call us regarding all of your HP equipment needs. Thousands of HP plotters, printers, computers, drives and more in stock. We buy HP, too. THUS, Inc., Route 1, Box 228, Keezletown, VA 22832. Phone: 703-269-2500, FAX: 703-269-2302. The name Hewlett Packard is the property of that company.

MONITORS RCA RC1303 SVGA 0.31DP 800 x 600 \$120, Sony CPD-1302 Multi-Sync \$245, PC-VGA to BNC-RGB adapter \$45, NEC 1201 comp. green \$25, hard drives \$1.50/MB refurbished guaranteed. Rich, Pikul & Associates, 101 Glenfield Dr., Festus, MO 63028, 314-937-0335.

COMPUTER REPAIRS for Atari, Commodore, Coleco, Sinclair/Timeux, Osborne, TI, TRS-80 and IBM compatibles. Reasonable flat rate plus parts and shipping. Buy, sell, trade, upgrade. SASE appreciated. Computer Classics, RT-1, Box 117, Cabool, MO 65689. 417-469-4571.

SIMMS WANTED: (Eight) four Meg SIMMS wanted. Will pay cash. Please call 705-292-5509 or FAX 705-292-7970.

OPTICAL SYSTEM. Two IBM model 3363 worm drives (new), two MCA adapters (new) for IBM 8560 and 8580 computers, manuals, cables, and 13 optical cartridges (new) 200MB. \$500, Al Alfano, H-87 Hunter Court, Torrington, CT 06790-2818. 203-496-9269.

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HIGH QUALITY TEST EQUIPMENT
BEST PRICE

DMM 89 \$199.95

Most Advanced DMM

All Purpose & Communication
-80.7 to 81.4 dBm with 40-1200Ω
20 reference impedances
True RMS
Frequency counter: 0.01Hz-10MHz
Capacitance: 1pF-50,000pF
Measure AC volt to 20kHz
5000 counts, 0.1% accuracy
Auto/manual range, fast bar graph
Min/Max/Ave/DH/Relative/Zoom
Auto power off
Input warning
Splash proof
Volt, amp, ohm, logic, diode, continuity
Ruggedized case
Rubber holster included



ALFA 2360

DMM 2360 \$119.95

DMM+LCR Meter

Very Versatile DMM

Inductance: 1μH-40H
Capacitance: 1pF-40μF
Frequency: 1Hz-4MHz
Temperature: -40-302 °F
TTL Logic Test: 20MHz
Diode, Continuity
Volt, Amp, Ohm
3999 count display
Peak Hold
Auto power off
Ruggedized case
Rubber Holster \$8.00
Temperature probe \$7.00



DMM 21

\$74.95

Inductance: 1μH-40H
Capacitance: 1pF-200μF
Frequency: 1Hz-1MHz
Volt, amp, ohm, diode, continuity
3999 count display
TTL logic, HFE
Peak hold
Ruggedized case
Rubber holster \$8.00



Fluke Multimeter

Fluke 12 \$84.95
Holster C-10 \$10
Fluke 70 II \$67.5
Fluke 73 II \$94
Fluke 75 II \$129
Holster C-70 \$16
TTL 77 II \$149
Fluke 79 II \$169
Fluke 29 II \$169
Fluke 83 \$225
Fluke 85 \$259
Fluke 87 \$287
Fluke 97 Scope Meter \$1785

LCR Meter 131D \$229.95

Most Advanced LCR

Dual display: L/R or C/D
Inductance: 0.1μH-1000H
Capacitance: 0.1pF-10,000μF
Impedance: 1mΩ-10MΩ
0.7% basic accuracy
Dissipation factor & Q factor
Serial & parallel mode
Relative mode for comparison
and to remove parasitics
Statistics, tolerance,
Best for design, incoming
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SMD and chip component
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LCR Meter 814 \$189.95

Best Resolution LCR

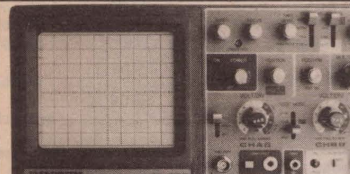
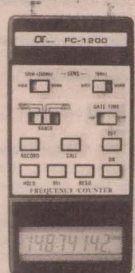
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Capacitance: 0.1pF-20,000μF
Resistance: 1mΩ-20MΩ
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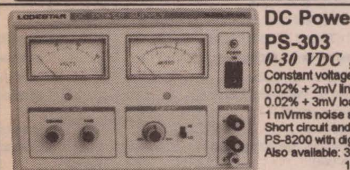


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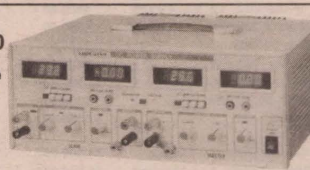
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100 kHz-150MHz sine wave in 6 ranges
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Synchronization: ±3% of oscillation
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Output distortion:
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0.2 Hz - 2 MHz in 7 ranges
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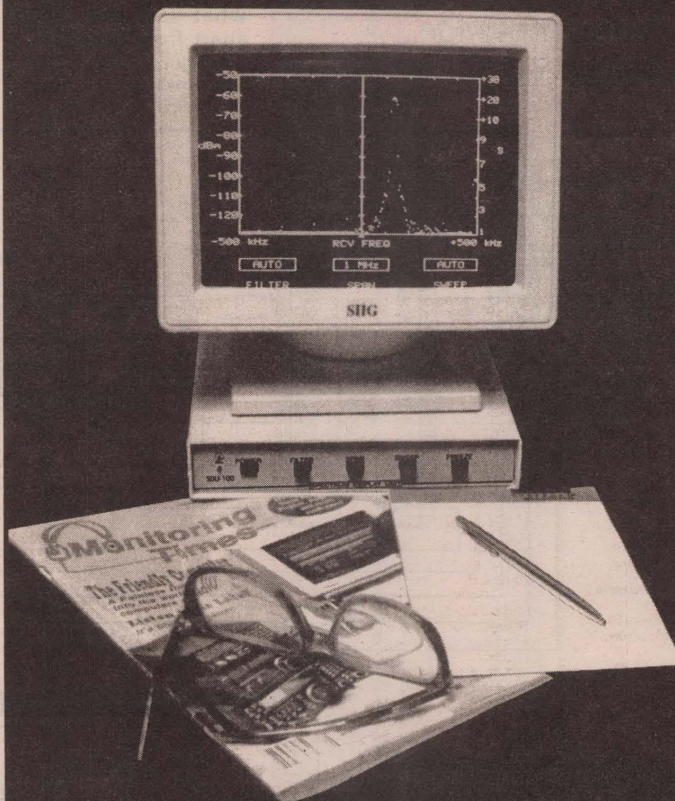
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** Appearance of monitor may vary

Intelligent Memory Display

Puts Your Message Up in Lights

by Scott Edwards

Combine a surplus bargain and an inexpensive custom IC, and you can build a scrolling text display for about \$50.00.

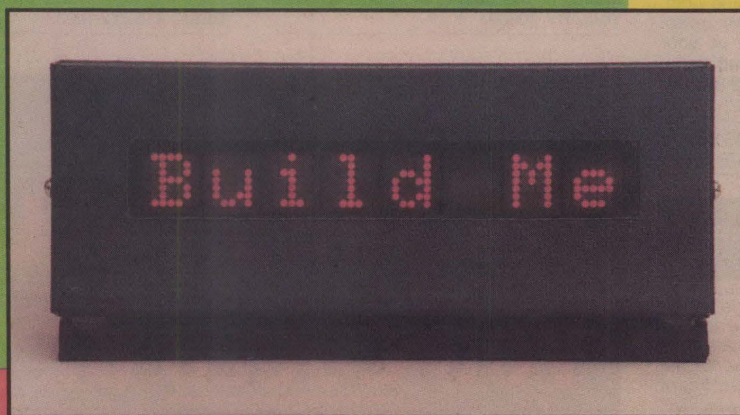
The Intelligent Memory Display includes these advanced features:

- Eight bright, 3/4-inch-tall LED characters.
- Easy data entry via your PC's serial port.
- Storage for a 245-character message.
- Memory retains message up to 10 years with the power off.

How It Works

From the user's standpoint, the Intelligent Memory Display (IMD) works like this: Use a standard modem cable to connect the unit to the PC serial port. Boot up a terminal communication program or the QBASIC program that accompanies this article. Turn on the IMD. It automatically senses the computer connection and displays "Loading." Type your message of up to 245 characters and download it to the display. The display begins scrolling your message. Disconnect it from the PC. Whenever the IMD is powered up, it will display the message. Want to change the message? Just reconnect the PC and repeat the programming procedure.

The IMD is almost as simple to build as it is to use. As the schematic in Figure 1 shows, the IMD uses a minimum of parts, consisting of just a controller, memory, and eight LED display modules. Although the controller is the brains of the outfit and the memory is indispensable, the display modules are really what



LEDs in 96 different character patterns based on inputs at its data pins (D0 through D6). Figure 2 shows a block diagram of the electronics embedded in each of the display's plastic cases. Impressive, huh?

Even more impressive is the current surplus bargain. The DLO-7135 was probably intended for use in money-is-no-object industrial applications, and its price of about \$20.00 per digit reflected it. However, the surplus dealer in the parts list has obtained a batch of these devices, and is selling them for \$2.95 each.

Figure 3 is a timing diagram of the signals required to write a character to the '7135. You may recognize this sequence as being basically the same as writing to a static RAM, except that no address lines are required, since each display holds only one

character. Let's start our circuit description with them.

Each of the Siemens DLO-7135 Intelligent Display™ modules contains 35 high-brightness red LEDs arranged in five columns by seven rows. What sets the '7135 apart from other LED displays is that it also contains all the logic required to drive the

character.

As simple as its interface is, the DLO-7135 requires the kind of care and feeding that's most easily provided by a computer. U2, the PIC 16C55 microcontroller fills that role. The 16C55 is an extremely simple computer-on-a-chip, containing 32 bytes of RAM and 512 instruction words of ROM. It executes one instruction every fourth clock cycle. At the 2-MHz rate set by CR1, it performs 500,000 instructions per second.

The 16C55 and related PICs

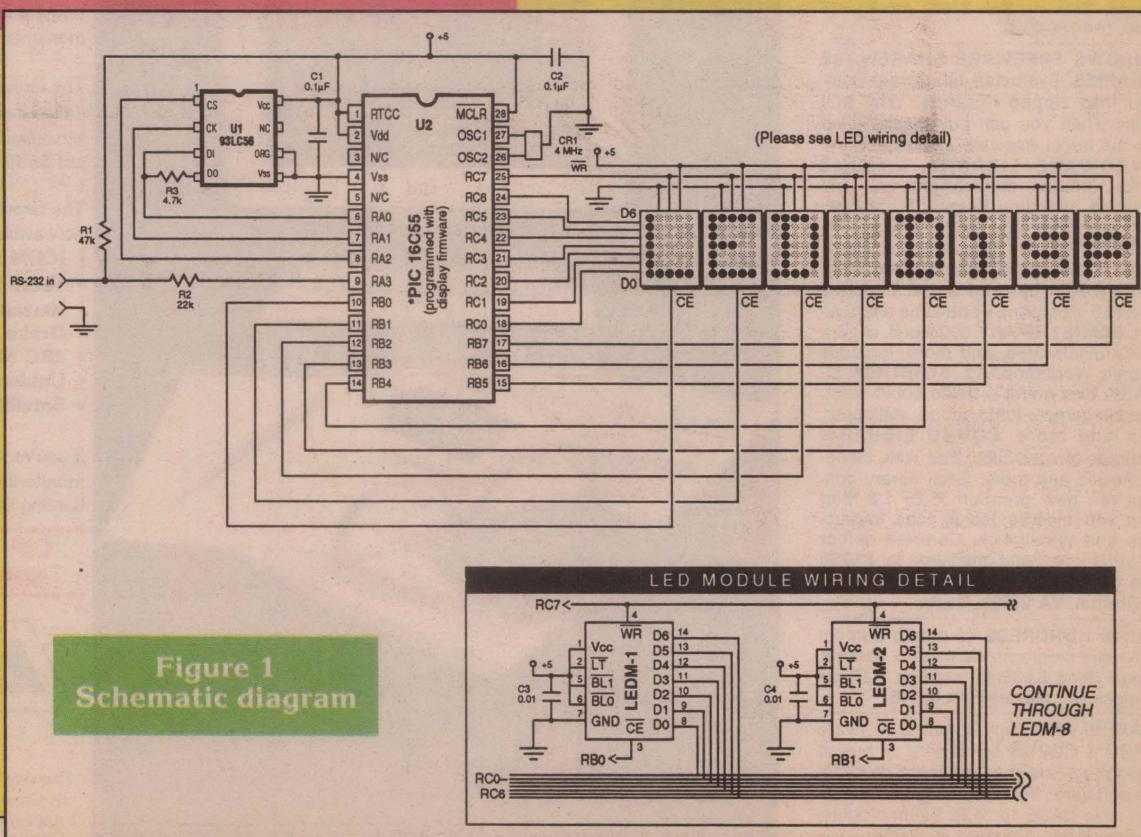
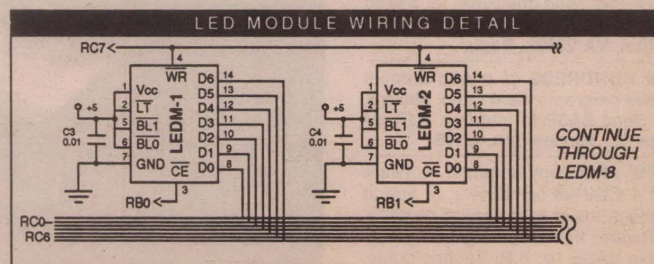
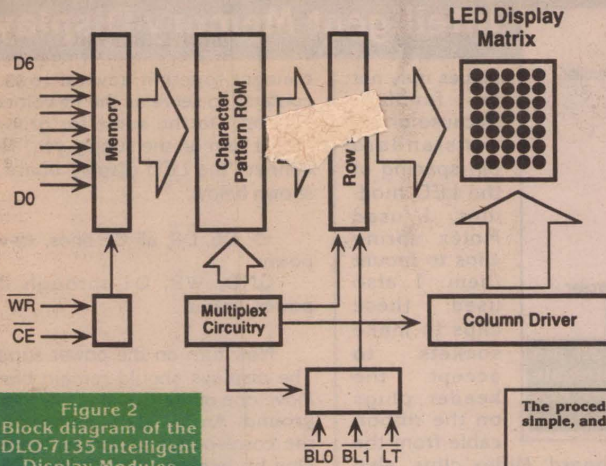


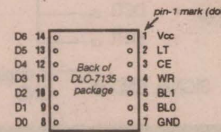
Figure 1
Schematic diagram



Intelligent Memory Display



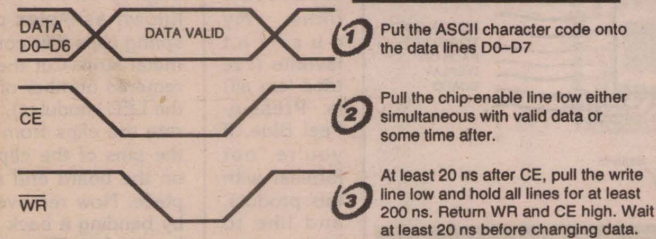
Pin Functions and Pinout
D0—D6: Character data
CE: Chip enable (low)
WR: Write (low)
BL0, BL1: Blanking (00 = off, 11 = full brightness)
LT: Lamp test (all LEDs on)



The procedure for writing data to the display modules is simple, and very similar to writing static RAM.

Figure 3

Writing data to the DLO-7135



occupy the middle ground between simple logic gates and complex computer hardware. It has the advantages of programmability, and a reasonable price tag (less than \$10.00 each for blank devices in small quantities). To program PICs, you need some relatively inexpensive tools consisting of PC software (to edit and assemble programs) and hardware (to burn the program into the PIC's ROM). An aspiring cottage manufacturer who already owns a PC can break into the custom PIC business for \$200.00 to \$600.00, depending on the speed and convenience of the development tools. If you're curious about PIC design and programming, contact the source in the parts list.

The PIC 16C55 required for this project is available from the author programmed, tested, and ready to go. See the parts list.

The final major component of the IMD is the 93C56 electrically erasable programmable ROM (EEPROM). This device holds 256 bytes of data. It is similar to an EPROM in that it retains data when the power is turned off, but is different in two important ways: (1) an EPROM requires a special programming device and high programming voltages (typically 12.5 volts) while the EEPROM does not; (2) an EPROM must be exposed to ultraviolet light for several minutes to erase it, while the EEPROM can be erased or modified by commands issued to it by the PIC.

These characteristics make EEPROMs the memory of choice for many long-term storage applications, like storing the speed-dial numbers in your phone, or the number-of-pages and maintenance data in laser printers.

There are two minor prices to pay for EEPROM convenience: speed and durability. The EEPROM's internal

programming process takes 1 millisecond; 10,000 times longer than "slow" conventional memory. And the EEPROM eventually wears out. After about 100,000 write or erase cycles, it's time to replace the EEPROM. EPROMs can be read an unlimited number of times.

Neither of the drawbacks bothers the IMD. The fastest that data can arrive through its 1200-baud serial link is one byte every 8.33 milliseconds, so speed is not a consideration. And if you changed your

the description of the major components. Before we get into the assembly details, let's look at some of the bit players. First, resistors R1 and R2 allow the PIC, a 5-volt logic device, to directly receive RS-232, a ± 10 -volt signal. R2 limits the amount of current into or out of the PIC's pin 9, while diodes inside the PIC limit the voltage to 0 to 5 volts. R1 helps the PIC to determine whether or not a computer is con-

message 10 times a day, it would take 27 years for the EEPROM to wear out! By that time, the year 2021, you'd be ready to replace the IMD with one of the new holographic-reality signs available for \$3.00 from your neighborhood K-Wal-Mega-Sears-Mart.

That wraps up

connected to J1. If a computer is connected, the -10-volt resting signal of its RS-232 port is seen as 0 volts (logical 0) by the PIC. When a computer is not connected, R1's connection to +5 volts ensures that the PIC sees a logical 1.

R3 allows the 93C56's data inputs and output to share a single PIC data line without a problem known as bus contention. This condition occurs when the PIC is sending a logical 1 at the same time the 93C56 is trying to send a 0. The resistor on the 93C56's data output ensures that the PIC wins these little tussles. Without it, data in and data out would have to be connected to different pins on PIC ports RA, RB, or RC. As Figure 1 shows, there aren't any pins left.

Finally, there are capacitors C1 through C10. These are bypass capacitors. They serve to filter noise on the power supply rails that might disrupt operation of either the PIC or the LED modules.

Construction

Before you begin this project, you will need to obtain a programmed PIC 16C55 and eight of the LED display modules from the sources in the parts list. Next, fabricate the pair of printed circuit boards, which, when connected with ribbon cable, make up the project. The first board connects eight LED modules together in bus fashion, with common lines for data (D0

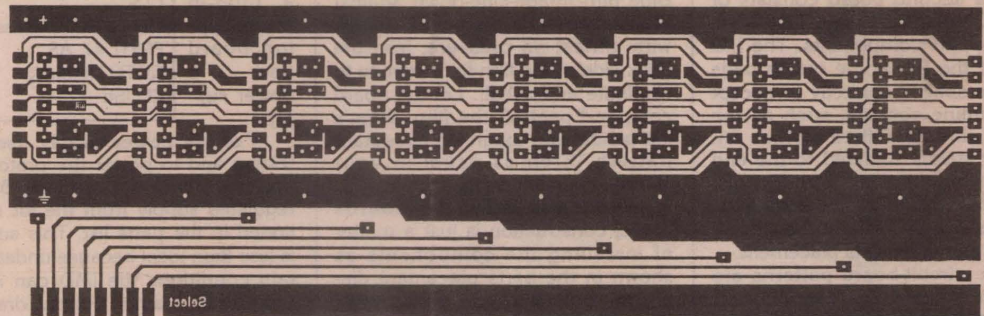
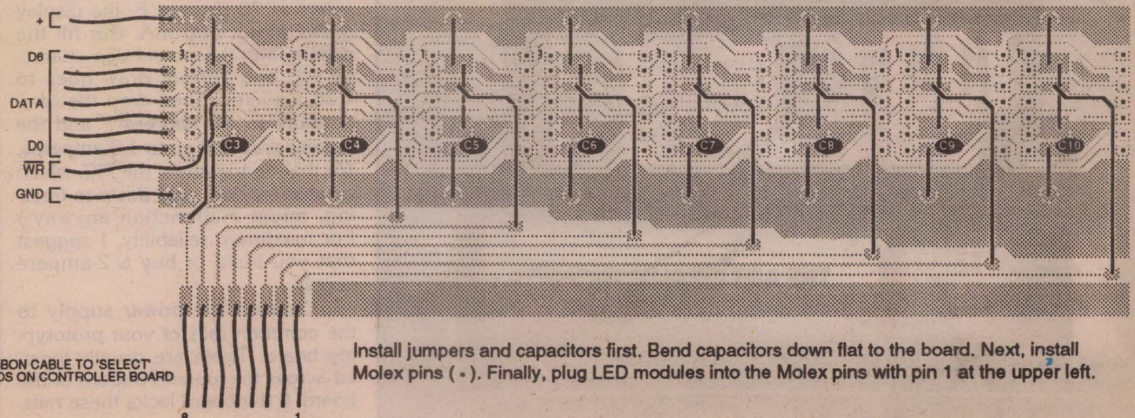


Figure 4 - PCB layout and parts placement diagram for display board.



Install jumpers and capacitors first. Bend capacitors down flat to the board. Next, install Molex pins (-). Finally, plug LED modules into the Molex pins with pin 1 at the upper left.

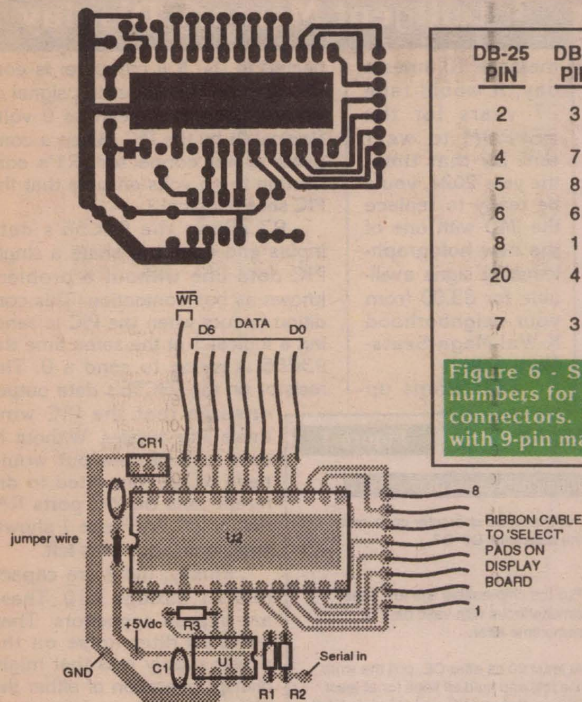


Figure 5 - PCB layout and parts placement diagram for controller board.

through D6), write enable (WR), and power. Each of the modules' chip-enable (CE) lines is brought out separately. This board could be connected to any controller with 16 output bits available. Those of you who wish to experiment with directly driving the LED modules with a single-board computer or digital I/O card could use this board design alone.

The second board consists of the PIC microcontroller, EEPROM, and support components. The I/O lines of the PIC come out to pads that are spaced correctly to accept single-inline sockets, such as the Molex pins described further on. Header stakes soldered to the end of the ribbon cables from the display board plug into these sockets. Figures 4 and 5 show the circuit boards and their parts placement.

The circuit-board patterns are reversed for ease of use with iron-on

magazines, you really should check it out. Briefly, the process goes like this: Laser print or photocopy reversed artwork onto the dull side of the P-n-P Blue film. Clean a circuit board blank thoroughly with scouring powder and blot it dry. Heat a clothes iron to just over 200 degrees (low end of the cotton range) with the steam turned off. When the iron is hot, place the P-n-P Blue film image-side-down against the copper foil of the board. Gently, with almost no pressure, iron the back side of the film for a minute to a minute and a half. Let the board cool, and peel off the film. What's left behind is a tough, etch-resistant pattern. Etch as usual in your favorite chemical bath.

Once you have the boards made, construction is just a matter of installing the components as shown in the parts placement diagrams. However, one of the tech-

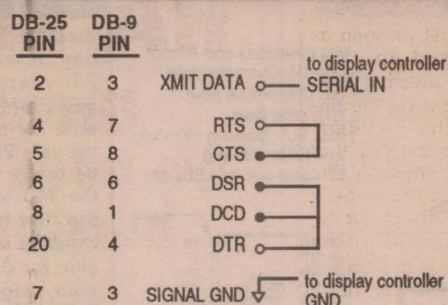


Figure 6 - Serial hookup. Use the DB-25 pin numbers for XT's and clones with 25-pin female connectors. Use the DB-9 pins for newer PCs with 9-pin male connectors

circuit-board films. My current favorite (I've tried 'em all) is Press-n-Peel Blue. If you're not familiar with this product, and like to make projects from plans in

display board. Molex clips, also known as Molex pins, are tinned spring clips that come attached to a metal strip. Cut the strip to get the required number of clips (seven for the LED modules), but do not separate the clips from the strip. Insert the pins of the clips into the holes on the board and solder them into place. Now remove the metal strip by bending it back and forth until it breaks free. The important thing to remember is this: *Don't separate the clips from the strip until they are soldered into place.*

I recommend that you construct and test the display board before starting on the controller. This will make troubleshooting much easier if the project doesn't work on the first try. To test the display, you'll need a plug-in prototyping board and a power supply.

For the power supply used in testing and to power the prototype project, I built a 1-ampere, 5-volt regulated supply from the kit mentioned in the parts list. This supply is less than ideal because under certain conditions the IMD can draw more than 1 amp. Current draw is primarily dependent on two factors: the number of LEDs lit at a given time, and the ambient temperature. With a normal mixture of text characters at 70 degrees F, the display draws about 800 mA. But fill the display with the pound-sign character (#) and current draw goes to 1.28 amperes. Then drop the temperature to -40 degrees F and the current draw will go to 1.6 amperes. (At that temperature, the PIC, which is rated for duty only down to freezing, might malfunction anyway.) For maximum reliability, I suggest that you build or buy a 2-ampere supply.

Connect the power supply to the common rails of your prototyping board. These are usually located across the top and bottom of the board. If the board lacks these rails,

Intelligent Memory Display

niques may not be familiar. Because of the nonstandard pin spacing of the LED modules, I used Molex spring clips to mount them. I also used these clips to make sockets to accept the header plugs on the ribbon cable from the

connect together several rows of contacts to serve as the +5-volt connection. Do the same for ground. (Don't turn on the supply yet.) Now connect the LED display board as shown below.

+5: D6, D0, all CE lines, +5-volt power

GND: WR, D1 through D5, power ground

Now turn on the power supply. The displays should remain blank. Move one of the CE lines from +5 to ground. An 'A' should appear on the corresponding display module. One by one, repeat this procedure for each of the modules. Each of them should display an A. If they do, you have confirmed that the display board is working properly. If they don't, recheck your wiring. Your first suspect should be the mounting of the modules in the Molex pins. It's easy to miss a pin.

Once the display module is working, you can assemble the controller and connect it to the display board via the ribbon cables. Sockets are optional for the ICs on the controller board, but I strongly recommend using them. Be sure to orient the ICs as shown in the figure.

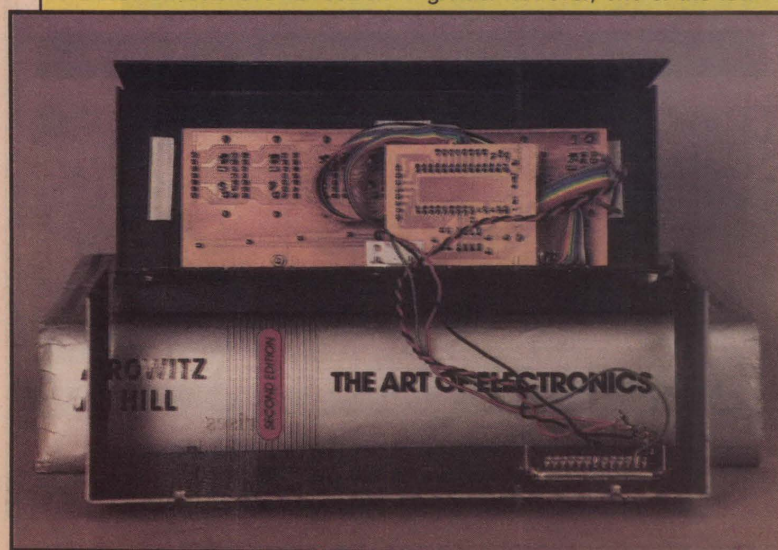
You'll probably want to run through the procedures under

QBASIC PROGRAM TO DRIVE SCROLLING DISPLAY

```
' Set com1 to 1200 baud, disable all handshakes
OPEN "com1:1200,N,8,1,CD0,CS0,DS0,OP0" FOR OUTPUT AS #1
New.msg:
CLS
LINE INPUT "Message: "; AS$
PRINT #1, AS$
GOTO New.msg
CLOSE
```

"Checkout and Use" once before mounting the boards in a permanent enclosure. The choice of enclosure is up to you. For best results, your enclosure should completely surround the display. This will shade the LEDs from ambient light and make them appear even brighter. Secondly, consider using a piece of tinted transparent plastic in front of the display. This further increases the display's contrast. I used a piece of 1/4-inch acrylic glazing with a dark "bronze" tint that I found in my local hardware store. You can cut and drill this material with woodworking tools, but go easy. Too much pressure will melt or crack the plastic.

When you are ready to install the boards in your enclosure, here's an important hint for reliable operation: Run the ground and +5 leads for both boards to a single point. If you use a socket, switch, or terminal strip to connect the power supply to your project, bring separate wires from each of the boards to these connections. Do not, for example, connect the controller



Intelligent Memory Display

board to power and run the display board connections to the controller board. The LEDs draw enough current to cause local, temporary "brownouts" on the controller board. These can reset the controller, causing the display to freeze, jump to the beginning, or even alter the contents of the EEPROM memory. Running separate power leads will prevent this.

Checkout and Use

If you obtain the EEPROM from the source in the parts list,

you can test your unit as soon as everything's hooked up. Just apply power, and a greeting from the author will appear on the display. If you got the EEPROM somewhere else, it's unlikely that there's a greeting or anything else stored in its memory, so you'll have to start your checkout by programming the EEPROM. The first step in doing so is to connect your IMD to a PC or other computer equipped with an RS-232 serial port.

Figure 6 shows how to make the two-wire serial connection between a PC and the display. Some of the PC's pins are shown connected together to disable hardware handshaking. This is one process by which the PC can determine whether a peripheral is ready for data. The PC sends a ready-to-send (RTS) signal (for instance) and waits for a clear-to-send (CTS) response. Since the IMD doesn't use handshaking, the PC could end up waiting forever for a response. By connecting RTS and CTS together, the PC answers its own question, and sends the data without delay.

If you're using terminal software, such as Procomm, set the communication parameters to 1200 baud, 8 data bits, no parity, 1 stop bit, half duplex. Otherwise, type in the program shown in the listing and run it in QBASIC. Note that with the QBASIC program, the hardware handshaking signals are disabled in software. The only connections needed in this case are XMIT DATA and SIGNAL GND.

Connect power to the display after the PC is on and the serial port is connected. If you turned it on before, just turn it off and back on to ensure that the IMD wakes up knowing that it's connected to a computer. The word "Loading" will appear on the display. Type in a test message and press return. The IMD will store the message in memory and start scrolling its display. That's all there is to it. Before removing power from the IMD, disconnect it from the PC. This ensures that you don't accidentally erase your message.

One final tip on using the display. If you power up the display with the serial port connected and get the "Loading" prompt, but don't want to erase your message in memory, disconnect the power before pulling the serial connection. If you remove the serial cable without disconnecting power first, your message will be replaced with random bits from the electrical noise of pulling the cable. If you remove power first, the display won't disturb the contents of its memory. NV

PARTS LIST

U1 — Microchip 93LC56 256-byte serial EEPROM (Do not substitute units made by National Semiconductor; the part number is the same, but they function differently. See Note below for source.)

U2 — Programmed PIC 16C55 microcontroller (See Note below for source.)

LED1 through 8 — Siemens DLO 7135 Intelligent Displays (See Note below for source.)

CR1 — 2 MHz ceramic resonator with integral capacitors (Digi-Key PX200)

C1, C2 — 0.1 uF ceramic disk, 50 WVDC

C3 through C10 — 0.01uF ceramic disk

R1 — 47k, 1/4-watt

R2 — 22k, 1/4-watt

R3 — 4.7k, 1/4-watt

Miscellaneous:

Ribbon cable; Molex pins; regulated 5-VDC, 1-ampere power supply; snapable header stakes; 14- and 28-pin IC sockets; suitable enclosure; tinted acrylic; machine hardware; solder; hook-up wire; etc.

Notes: You can obtain information on PICs and PIC programming tools from Parallax Inc., 3805 Atherton Road No. 102, Rocklin, CA 95765; phone: 916-624-8333.

The DLO 7135 displays are available through Tanner Electronics, 1301 W. Beltline Road No. 105, Carrollton, TX 75006; phone: 214-242-8702. Price was \$2.95 each at the time of this writing. These items are surplus and subject to availability.

A suitable 5-VDC, 1-ampere power supply is the JE200 kit available from Jameco, 1355 Shoreway Road, Belmont, CA 94002-9864; phone: 1-800-831-4242.

The author will supply the following parts to support this project:

93LC56 EEPROM (U1) with programmed message: \$3.00

Programmed PIC 16C55 (U2) and ceramic resonator (CR1): \$18.00

U1, U2, and CR1: \$20.00

All prices are postpaid. Send check or money order to Scott Edwards Electronics, 964 Cactus Wren Lane, Sierra Vista, AZ 85635. Send comments or questions via E-mail to CompuServe mailbox 72037,2612.

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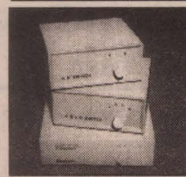
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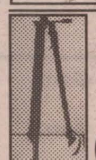
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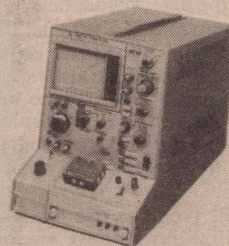
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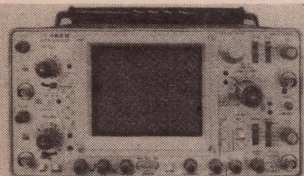
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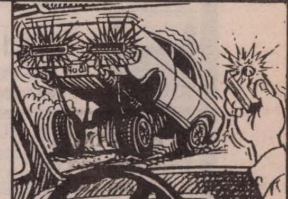
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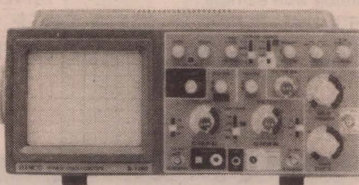


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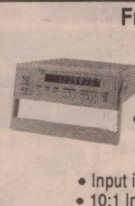
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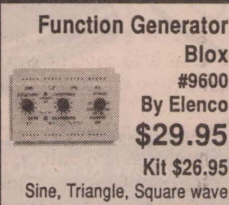
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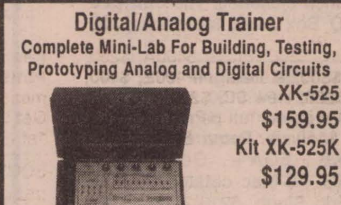
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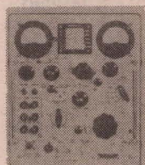
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Nuts & Volts Magazine/April 1994

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THE SOLDERLESS BREADBOX

by Donald Wilcher

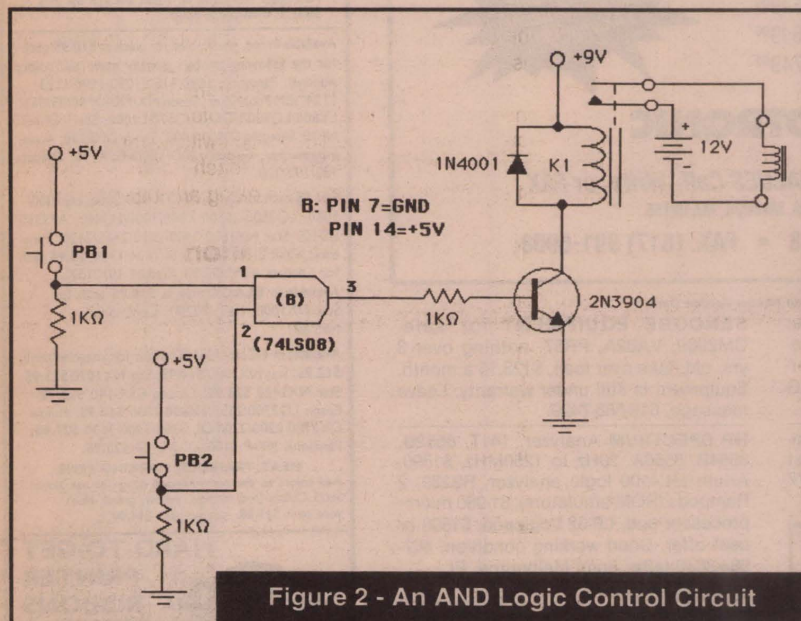


Figure 2 - An AND Logic Control Circuit

Logic Gates and Machines: Part 1

Logic gates are simple building blocks used in digital devices such as computers and calculators. They are easy to use and require very few components to make them operate.

Some logic gates find their way into circuits where they control when other functions will be switched on or off. By combining several of these gates, more sophisticated circuits and control systems can be created.

In this month's Solderless BreadBox, digital logic gates will be explored. We will take a look at the methodology of how gates can be used to switch on/off simple machines. This topic, of course, will be illustrated through the use of some simple circuits and machines.

Before we begin our discussion of logic gates and machine control, let's have an overview of binary logic and its impact on digital electronics.

Binary Logic and Digital Electronics

The field of digital electronics makes use of many devices which have only two possible conditions or states. Some familiar devices having only two states are: a doorbell (either rings or is silent); a light switch (either completes the circuit or opens it); and the light bulb (which is wired to the switch is either on or off). These devices illustrate the basic principles of digital electronics which is to generate either a HIGH or LOW input/output condition.

The property of having two possible states is called binary. A logic device may or may not have a property called memory. For example, a bell which rings as a fire alarm when an automatic sprinkler system is set off might be designed so that once it rings, it will continue to ring until it is manually turned off. Such a bell has the property of memory. It keeps ringing even after the condition that caused it to ring is removed. A doorbell, on the other hand, will ring when you press the button but will stop immediately when you remove the input — your finger. It has no memory. Both of these types of binary devices are used extensively in computer and machine control applications.

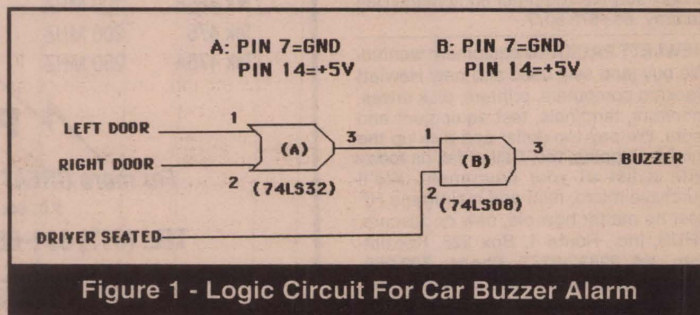


Figure 1 - Logic Circuit For Car Buzzer Alarm

The term "logic" is generally used to define a decision-making process. If someone was asked to make a decision, they must be told what factors should be entered into the decision. Each factor must be examined to determine its state or condition, the facts are assembled, and a decision is then made.

Binary logic is a name given to the process where the factors or variables being considered are capable of being in only one of two states. The resultant output is determined by the inputs and decision-making activities of the gate. With binary logic, gate circuits can be created to perform a variety of useful functions.

Gate Circuit Example

The task: to sound a buzzer if either car door is opened AND the driver is

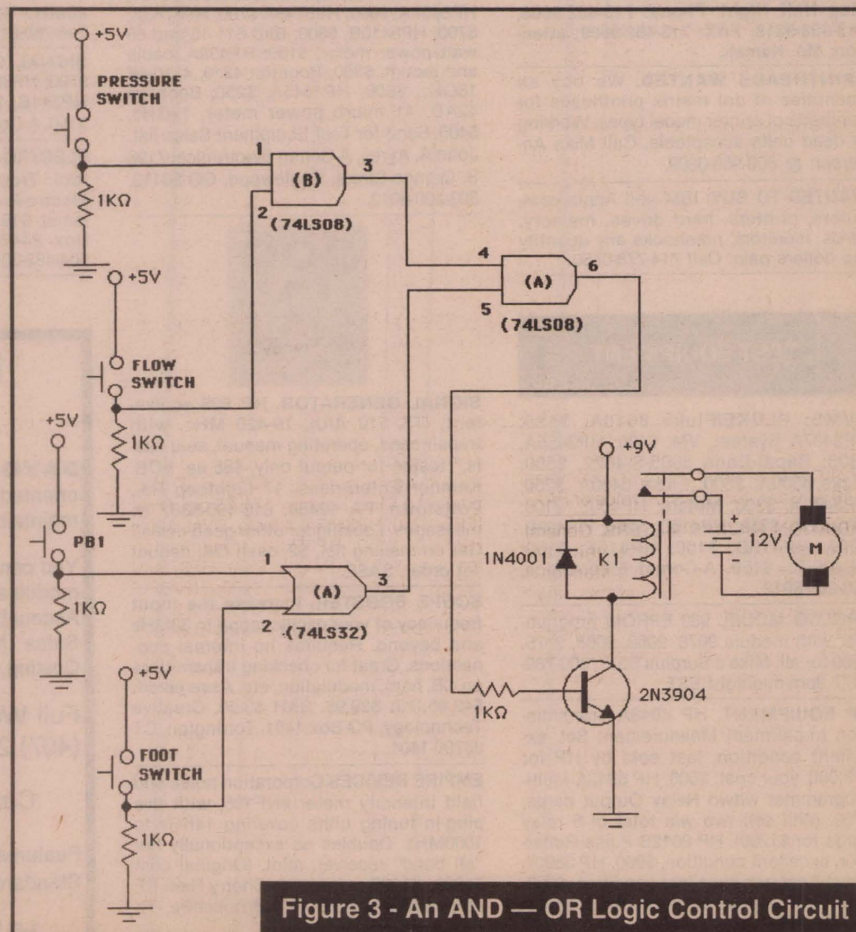


Figure 3 - An AND — OR Logic Control Circuit

THE SOLDERLESS BREADBOX

seated. The answer is obvious if you restate the problem as output HIGH, if either the left door OR the right door is open, AND driver is seated. Figure 1 shows the car buzzer circuit. The output of the OR GATE is HIGH if one OR the other door (or both) is open. If that is so AND the driver is seated the output will go HIGH. With an additional transistor, this circuit could be made to drive a buzzer or close a relay.

Machine Control Using Logic Gates

As stated in the beginning of this column, logic gates can be used to create controls for machines. In this section, we will explore how logic gates can be used to control simple machines. To kick off this discussion, let's see how the AND GATE can be used in an industrial application.

An example of AND logic used in an industrial control circuit is shown in Figure 2. In this circuit, two pushbuttons are connected to the gate for controlling the solenoid. Before the solenoid is energized, both pushbuttons one and two must be pressed. The logic function makes up the decision part of the AND circuit.

In this example, a safety feature is built into the circuit for the operator. If the solenoid was operating a punch press or shear, the pushbuttons would be spaced far enough apart so that the operator would have to use both hands to make the machine function.

AND logic can be simplified by saying the machine will be on only if all the control signal contacts are closed. As with any logic function, the signals may be manually, mechanically, or automatically controlled. Any control

device with normally open contacts (such as pressure switches and photoelectric controls) can be used with the AND logic gate for controlling the machine automatically.

Sometimes the decision of a circuit may contain one or more logic functions. An example of a circuit that contains both AND and OR logic gates is shown in Figure 3. In this circuit, both pressure and flow switches must be present in addition to the pushbutton or foot switch being engaged to energize the machine. This provides the circuit with the advantage of both AND logic and OR logic. The machine is protected because both pressure and flow switches must exist before it is started, and there is a choice between using a pushbutton or a foot switch for final operation. The action taking place in this circuit is energizing a coil in a magnetic motor starter. The signal inputs for this circuit would have to be two automatic switches and one manual. As you can see from the circuit of Figure 3, each control device will respond to its own input signal and is capable of making an output decision.

Further Thoughts and Experimentation

Well, I hope you can see how useful logic gates can be in controlling simple machines. Next month, we will continue our discussion of logic gates and controls with some interfacing techniques to Erector Set designed machines. As a design challenge, see if you can add photoelectric devices such as photocells and transistors to give the circuits in Figures 2 and 3 automatic control over the electromechanical loads as described in those circuits. Enuf said, see ya next month in the breadbox !! NV

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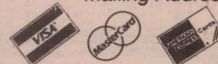
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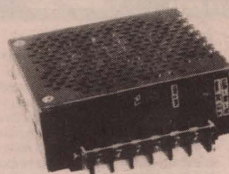
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SWITCHING SYSTEMS INTERNATIONAL #SQV402-1444-1. Four Output - 5 VDC @ 50 amps. Aux. 1 - 24 VDC @ 10 amps. Aux. 2 - 24 VDC @ 5 amps. Aux. 3 - 24 VDC @ 5 amps. Aux. 2 & 3 can be series to produce 48 VDC @ 5 amps.

Stock #PS9404 \$99.50 each
10 for \$750.00



SWITCHING POWER SUPPLY

LAMBDA #LUS-8A-12. 12 VDC 1.3 amps.

Stock #PS93514 \$20.00 each
10 for \$175.00

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POWER ONE #HB28-1-A. 28 VDC @ 1 amp.

Stock #PS9400 \$20.00 each
10 for \$175.00

DC TO DC CONVERTER

INTRONICS #S1635-1. Input: 30 to 60 VDC. Output: 5 V @ 4 amps ± 15 V @ 150 mA.

Stock #PS9405 \$20.00 each
10 for \$150.00

TEST EQUIPMENT

HEWLETT PACKARD

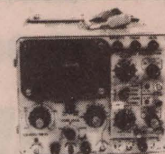
#140T. Spectrum Analyzer. Mainframe \$500.00
#8555A. Spectrum Analyzer. RF Plug-in \$1,000.00
#204C. Oscillator \$125.00
#333A. Distortion Analyzer \$695.00
#432C. Power Meter \$250.00
#3330B. Automatic Synthesizer. \$650.00
#8614B. Signal Generator. 0.8-2.4. GC \$695.00
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#180A. 100 MHz bandwidth. Accepts standard 1800 series plug-ins.

Stock #OS8901 \$395.00



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#AN/USM-117A. Fully transistorized portable oscilloscope. Vertical amplifiers bandpass is 5 MHz. Horizontal bandpass is DC to 500 KHz. Probes, accessories, and technical manual included.

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WANTED: MILLIMETER microwave equipment. Wave-Guide, mixers, test equipment, amplifiers, sources, WR-28 and equipment near 30GHz preferred. Call Ted Hartson, 602-483-0842 or FAX: 602-596-0180.

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WANTED: EQUIPMENT CATALOGS. HP, Tracor, Fluke, etc. 1970's, 80's, 90's. Call Bill, 800-526-0388.

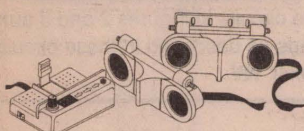
TEST EQUIPMENT SALE: HP8601A, .1-110 MHz sweeper, \$800; HP8690B, \$250; HP8690A, \$200; Cushman CE-21 Selective VM, \$250; Tektronix NTSC Color Sync Generator, \$800; Tektronix 7A13 LED display 100MHz comparator, \$450; HP4260A RCL Bridge, \$350; HP8698B, \$300; Noise/Com 10Hz-20KHz 20 MW, noise generator, \$200; HP5004A Signature ana, \$200; Singer M-5, VR-4 1KHz-27MHz Spectrum ana, \$550; ESI 250DA, universal Z bridge, \$200; freed 1620 megohmmeter, \$200; GR1390A Random noise generator, \$150; HP86601A 110MHz RF plug-in, \$800; HP200AB oscillator, \$100; HP5257A Transfer osc. 50MHz-18GHz, \$400; HP5300B, 5303A 500MHz counter and display, \$250; HP5363A, Time interval probes, \$250; HP6291A, 0-40V, 5A power supply, \$400. A-Comm Electronics, 7198 South Quince Street, Englewood, CO 80112. Phone: 303-290-8012, FAX: 303-290-8133.

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ULTRASONIC PROXIMITY DETECTOR



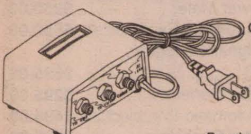
The ED-100 was designed for use as an auto/truck/RV back-up alarm. A digital display and audible beeper inside the vehicle inform the driver of the distance to impact beginning when the vehicle is within 14 feet of another object. Two 40 kHz ultrasonic emitter/detector modules, measuring 5.81" long X 1.9" wide, 2.05" thick, attach to the rear of the vehicle. The device operates on 12 or 24 Vdc.

These units are new, in original cartons and include instructions. The company that marketed this device is no longer in business, and no manufacturer's guarantee is in effect.

We offer these ultrasonic detectors for experimentation only, and in no way wish to promote their usefulness as a driving aid.

Originally sold for over \$100.00. **CAT# ED-100**
\$24.95 per set

EXPERIMENTER'S DELIGHT VHF TO UHF BLOCK CONVERTER



Channel Master #0746
This is one of those deals that's too good to be true.

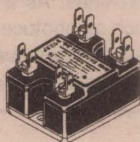
Brand new, in the box, Channel Master block converters. They used to be quite popular back in the early days of cable television, before there were a lot of cable-ready TVs. Somewhere in the world we know there is still a demand for them—especially at this price. Designed to convert television VHF channels 2 through 13 and A through W to UHF channels 36 through 76. The box alone, is a great project box. The 10 ft. AC power cord, the interior components, F connectors and AC receptacles are well worth the price.

CAT# CM-0746

10 pieces for **\$18.50**
\$2.00 each

10 AMP SOLID STATE RELAY

Teledyne Relays# 615-8500
Control voltage: 3-32 Vdc
Load: 10 amp, 250 Vac 50/60 Hz
Standard "hockey puck" size:
2.27" X 1.72" X 0.95".
Screw and q/solder terminals.
UL and CSA listed.



\$10.50 each
10 for **\$95.00**

CAT# SSRLY-14

240 X 128 DOT LCD DISPLAY

Optrix# DMF660N-S
240 X 128 dot LCD module with on-board drivers. Will display graphics, figures and characters.
Module size: 5.68" X 4.1" X 0.5" thick.
Viewing area: 4.1" X 2.52".
Dot size: 0.4mm X 0.4mm. High contrast, wide viewing angle. Low voltage drive and low power consumption. Uses fitting controllers LS1MS6255, HD64646, SED1330, SED1351. Includes hook-up instructions and specs.



\$29.95 each
CAT# LCD-15

10 BUTTON MEMBRANE KEYPAD



10 button, matrix encoded keypad. Peel-and-stick backing for easy mounting. Originally designed for use on a satellite TV tuner, the keys have satellite names and related text on them in addition to numerals 0 through 9. Overall dimensions are 9" X 1.625", but half of the strip can be cut off with a knife or scissors, leaving a self-sticking keypad of 4.5" X 1.625". Silver keys with charcoal numerals and background. 6.5" flexible ribbon cable, terminated with 7 pin socket connector - 0.1" spacing.

CAT# KPM-10
\$1.25 each
10 for **\$10.00**

ULTRABRIGHT LED

Toshiba # TLRA180AP
High brightness
T-1 3/4 LED. Water-clear,
lights red. 3000 mcd @ 20 mA.
Great for indoor or outdoor displays.



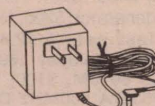
CAT# LED-19

2 for \$1.00
100 for **\$45.00**

11 Vdc @ 500 ma. WALL TRANSFORMER

SPECIAL!

We have lots of these brand new wall transformers rated 11 Vdc @ 500 ma., but they work fine at 12 volts. With no load they put out 16.2 Vdc. 2.1mm id power plug center positive. White case - U.L. listed

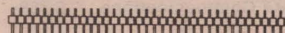


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\$2.00 each
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36 PIN SNAPPABLE HEADER



Arks Corp. # 25MSS2A36GG030
Special purchase of 36 pin, single row 0.1" spacing headers. Snappable to smaller lengths. Sold only in bags of 100 pieces. Our regular price on a 40 pin header is \$120.00 per 100 pieces.

CAT# SHS-36

\$40.00 for 100 piece bag

\$350.00 for 1000 pieces

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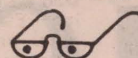
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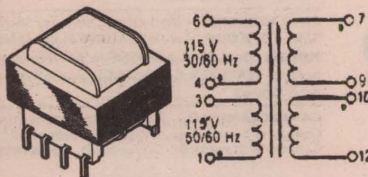
SPLIT BOBBIN PC BOARD TRANSFORMER

MFG: SIGNAL TRANSFORMER
PART# 14A-10-12

- PRIMARY: 115V 50/60HZ
- SECONDARY RMS RATING 12.6V CT @ .8A SERIES 6.3V @ 1.6A PARALLEL
- SIZE: 1 1/2" L X 1 9/16" W X 1 3/8" HIGH
- PINS SIZE: .038" SQUARE
- SPECIAL PRICE \$3.95 EA.

MFG: SIGNAL TRANSFORMER
PART # 14A-56-20

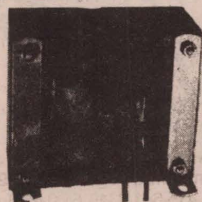
- PRIMARY: 115V 50/60HZ
- SECONDARY RMS RATING 20V CT @ 2.8A SERIES 10V @ 5.6A PARALLEL
- SIZE: 3" L X 2 1/2" W X 1 1/4" H
- PINS: .045" SQ - WEIGHT 1.70 LB
- PRICE \$4.95 EA.



PRIMARYS ARE DESIGNED TO BE USED SIMULTANEOUSLY
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THAT IS, THEY MUST BE USED EITHER SERIES OR PARALLEL
CONNECTED (AS ONE WINDING)

CONTROL TRANSFORMER #522013, 60 HZ

PRIMARY: 120VAC
SECONDARY: 12V C.T. @ 4 AMP
Size: 3 1/4" W X 3 1/8" H X 3 3/4" Deep
Weight: 7 1/2 LBS. - Base Mount.
BRAND NEW \$ 7.95



CONTROL TRANSFORMER #522007 60 HZ

PRIMARY: 120VAC
SECONDARY: 24V C.T. @ 8A
Size: 4 1/8" W X 3 1/2" H X 3" D
Weight: 5 1/2 lb - Base Mount
SALE PRICE \$ 9.95



HEWLETT PACKARD GREEN RECTANGULAR LED

PART# HLMP-S500 DIFFUSED
SIZE: 5MM X 2MM 200,000 PCS. IN STOCK
SALE PRICE 100 @ .10EA. 1000 @ .05 EA.

MAGNETIC LATCHING RELAY

DPDT 24 VDC

ALLIED CONTROL #T351X-41

DUAL COIL MAGNETIC LATCHING RELAY
OPERATING COIL 600 OHMS 24VDC,
RELEASE COIL 1.6K 24VDC. CONTACTS
GOLD FLASHED RATED 2.0AMPS 28VDC.
CLEAR PLASTIC CASE WITH TERMINALS
& STUD FOR P.C. BOARD MOUNTING OR
CAN BE USED WITH SOCKET. O/A DIM:
3/4" X 15/16" X 1 3/16" H BRAND NEW!

PRICE \$ 1.39 EA.

10 FOR \$ 12.50

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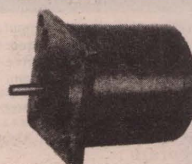
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IN3741 (A190N) 800 PIV 250AMPS

- SIZE: 1 1/4" DIAM. X 2 1/4" LONG
- LEAD LENGTH: 5 1/4" COPPER LEAD
- PRICE \$9.95



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STEPPING MOTORS

SUPERIOR ELECTRIC SLO-SYN SYNCHRONOUS STEPPING MOTOR - TYPE M063-CS-501

OZ. IN. : HOLD 150 AMP: 4.6
STEPS PER REV.: 200 VOLTS DC: 2.25
CONT. DUTY 65OC RISE - CLASS B INSUL.
IMPEDANCE PROTECTED.
DIMENSIONS: 4" L X 2 1/4" DIA. WITH
2 1/4" SQUARE FLANGE.
SHAFT: .250" X 3/4" LONG WITH FLAT
BRAND NEW FACTORY BOXED.
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FILING TRAY. CONVENIENT
DESKTOP STORAGE FOR
UP TO 60 DISKETTES. INCL-
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SNAP CLOSURE LID, FRONT
HANDLE AND ADJUSTABLE
DIVIDERS. LIST PRICE \$9.00
BRIGAR PRICE \$4.00ea.
5 @ \$3.50ea. 10 @ \$3.00ea.



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CURTIS INDUSTRIES # F1200AA20 RFI FILTER

10AMP/250VAC - 20A/115VAC
50/60HZ - SIZE: 2" W X 2 1/2" L X 1 1/2" H
.250" QUICK CONNECT TERMINALS
FOR LINE & LOAD: BRAND NEW
FACTORY BOXED.
BRIGAR SALE PRICE \$3.00

PC MOUNT OR AS PLUG IN

OMRON

GENERAL PURPOSE RELAY

OMRON MY4-02 4PDT

CONTACT: 5A 240VAC

5A 28VDC

COIL: 24VDC

UL & CSA - CLEAR POLY. COVER

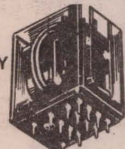
SIZE: 1 1/8" X 1 1/16" X 3/4" STANDARD

ICE CUBE RELAY. BRAND NEW

FACTORY BOXED.

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50 PCS. & UP \$1.95 EA.



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NIDEC/TORIN TA450

12 VDC 100 CFM FAN

.42AMP Size: 4.72" sq.

x 1.5" Thick. Noise 34dB

Quick connect terminals.

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- Absorb Destructive Overloads
- Dissipate Noise

Protects home appliances and home computers from voltage surges and EMI/RFI noise
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damaged. Noise protection will reduce, or eliminate, static on audio equipment, snow on TV's and
data problems on computers.

WALL PLUG-IN SURGE SUPPRESSORS

SPECIFICATIONS:

Electrical Rating	15 Amp, 120 VAC 60 Hz
UL1449 Suppressed Voltage Rating	400 Volts (H-N)
Protection Services	Metal Oxide Varistors
Maximum Energy Dissipation	90 Joules (2 x 45 Joules)
Full Line Protection	H-N, H-G, N-G
Clamping Response Time	< 5 nsec
EMI/RFI Noise Rejection	up to 15 db



\$3.00 EA.

10 AMP MINIATURE PCB RELAY

ZETTLER #AZ2692-560-2

10 AMP 24VDC, 115VAC RES.

10AMP 250VAC

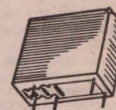
1/4 HP @ 120VAC SPDT

SIZE: 1 1/16" W X 7/16" D X 1" H

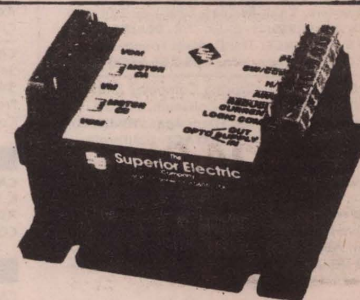
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Heavy Duty Miniature Power Relay
Withstands Large Breakdown and Surge Voltages
Conforms to International Security Standards —
Meets UL 508, 372, 873, CSA, VDE TV 5 Rating
Slim and Light Weight
Isolation Distance — 8mm min.
Flux Free or Washable Enclosures



TYPE 230-T

SLO-SYN MICRO SERIES
MOTION CONTROLS
MODULAR TRANSLATOR DRIVE

TYPE 230-T 2AMP 30V
Description: BI Polar, 2 phase
Stepping motor Drive with
Translator. Power Semiconductor
type: H-Bridge power IC Translator:

Internal IC
PERFORMANCE:
RESOLUTION: HALF-STEP OR FULL STEP
STEP RATE: 0 TO 10,000 FULL STEPS/SEC.
0 TO 10,000 HALF STEPS/SEC.

CHOPPING FREQ: 20 kHz NOMINAL
SPEED/TORQUE: ALL SPECS USE TYPICAL
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DIRECTION: CW/CCW
MOTOR COMPATIBILITY: M061-M092
NO OF LEADS: 4, 6, 8
SIZE: 3.15" L X 2.70" W X 1.31" H WEIGHT: 1 LB
BRAND NEW-INDIVIDUALLY FACTORY
PACKED. COMPLETE WITH INSTRUCTION
MANUAL AND SPEC SHEETS
BRIGAR SPECIAL PRICE \$79.95
2 FOR \$140.00



Events CALENDAR

WESTERN REGION

APRIL 2

CA - SAN MATEO — California Computer Show & Sale. **LOCATION:** San Mateo Expo Center, 2495 S. Delaware. **HOURS:** 10am-4pm. **ADMISSION:** Free. **FEATURES:** C - DP. **CONTACT:** California Computer Show.*

CA - SAN RAFAEL — MarketPro Computer Show & Sale. **LOCATION:** Marin Civic Center Exhibit Hall, Civic Center Dr. (Exit San Pedro East off Hwy 101). **HOURS:** 7am-12noon, rain or shine. **ADMISSION:** Free. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

CA - SANTEE — Ham Radio, Computer & Electronics Swap Meet. **SPONSOR:** Amateur Radio Club of El Cajon. **LOCATION:** Santee Drive-In, 10990 N. Woodside. **OPENS:** Appx. 6:30am, rain or shine. **ADMISSION:** 50 cents. **TALK-IN:** 146.520. **FEATURES:** C - E - F - R - H. **DEALER INFO:** \$6/vehicle. **CONTACT:** N6RGM Sonny 619-444-6532; WA6MHZ Pat 619-561-0052; ARCEC, Box 50, El Cajon CA 92020.

APRIL 3

CA - LIVERMORE — East Bay Area Amateur Radio/Electronics/Computer Swap Meet. **SPONSOR:** Livermore Amateur Radio Klub (LARK). **LOCATION:** Los Positas College, N of I-580 at Airway Blvd. exit. **HOURS:** 7am-12noon, rain or shine. **ADMISSION:** Free. **TALK-IN:** 147.045 + fr west, 145.350-1100Hz fr east. **FEATURES:** H - E - FP - F/R. **DEALER INFO:** Setup after 6am only. \$10 space fee. Covered spaces avail. if rain. **CONTACT:** Noel Ankilam KC6QZK, 510-447-3857 eves or 510-783-2803 message days.

APRIL 9

CA - LOS ALTOS HILLS — Foothill College Amateur Radio Flea Market. **LOCATION:** Foothill College, Hwy 280, exit El Monte Rd West. Parking Lot A. **HOURS:** 6am-7. **ADMISSION:** Free. Parking fee \$2, bring quarters. **TALK-IN:** 145.270(-) or 224.360 (PL-100). **FEATURES:** H - E - EX - F/R. **DEALER INFO:** \$10-\$15. **CONTACT:** The Perham Foundation, 408-734-4453. Exam info: 408-255-9000 24/Hr.

CA - OAKLAND — California Computer Show & Sale. **LOCATION:** Oakland Coliseum, I-880 & Hegenberger Rd. **HOURS:** 10am-4pm. **ADMISSION:** Free. **FEATURES:** C - DP. **CONTACT:** California Computer Show.*

CA - OCEANSIDE — Swap Meet - Special Section for Ham Radio, Electronics & Computers. **SPONSOR:** Palomar Ham Radio Club. **LOCATION:** Oceanside Drive-In, 3480 Mission Ave. **HOURS:** 6:30am-3:30pm. **ADMISSION:** 50¢. **FEATURES:** C - E - H. **DEALER INFO:** \$13 per space, 6am setup. **CONTACT:** 619-757-5286 vendors.

APRIL 10

CA - PLEASANTON — California Computer Show & Sale. **LOCATION:** Alameda County Fairgrounds, 4501 Pleasanton Ave. **HOURS:** 10am-4pm. **ADMISSION:** Free. **FEATURES:** C - DP. **CONTACT:** California Computer Show.*

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.*

CA - VENTURA — MarketPro Computer Show & Sale. **LOCATION:** Ventura County Fairgrounds Commercial Bldg., Ventura Ave. **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

APRIL 16

CA - DALY CITY — California Computer Show & Sale. **LOCATION:** Cow Palace, corner of Geneva and Santos. **HOURS:** 10am-4pm. **ADMISSION:** Free. **FEATURES:** C - DP. **CONTACT:** California Computer Show.*

CA - NORTHBRIDGE — California Computer Show & Sale. **LOCATION:** CSUN, North Campus, 18000 Devonshire Blvd. **HOURS:** 10am-4pm. **ADMISSION:** \$6 - \$1 off with copy of this ad. **FEATURES:** C - DP. **CONTACT:** California Computer Show.*

CA - SANTEE — Ham Radio, Computer & Electronics Swap Meet. **SPONSOR:** Amateur Radio Club of El Cajon. **LOCATION:** Santee Drive-In, 10990 N. Woodside. **OPENS:** Appx. 6:30am, rain or shine. **ADMISSION:** 50 cents. **TALK-IN:** 146.520. **FEATURES:** C - E - F - R - H. **DEALER INFO:** \$6/vehicle. **CONTACT:** N6RGM Sonny 619-444-6532;

The 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 person to contact and phone number. Complimentary issues are available upon request for distribution to your attendees. A street address for UPS shipment is required.

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

WA6MHZ Pat 619-561-0052; ARCEC, Box 50, El Cajon CA 92020.

APRIL 16-17

CA - SAN DIEGO — MarketPro Computer Show & Sale. **LOCATION:** Scottish Rite Center (tentative), 1895 Camino Del Rio So. (Exit Mission Center off I-8). **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

APRIL 17

CA - GLENDALE — California Computer Show & Sale. **LOCATION:** Glendale Civic Auditorium, 1401 N. Verdugo Rd. **HOURS:** 10am-4pm. **ADMISSION:** Free. **FEATURES:** C - DP. **CONTACT:** California Computer Show.*

CA - SACRAMENTO — California Computer Show & Sale. **LOCATION:** Arco Arena, One Sports Parkway. **HOURS:** 10am-4pm. **ADMISSION:** Free. **FEATURES:** C - DP. **CONTACT:** California Computer Show.*

APRIL 23

CA - ANAHEIM — California Computer Show & Sale. **LOCATION:** Anaheim Stadium - Indoors, 2000 State College Blvd. **HOURS:** 10am-4pm. **ADMISSION:** Free. **FEATURES:** C - DP. **CONTACT:** California Computer Show.*

CA - SAN JOSE — California Computer Show & Sale. **LOCATION:** Santa Clara County Fairgrounds, 344 Tully Rd. **HOURS:** 10am-4pm. **ADMISSION:** Free. **FEATURES:** C - DP. **CONTACT:** California Computer Show.*

APRIL 23-24

CA - SACRAMENTO — MarketPro Computer Show & Sale. **LOCATION:** Cal Expo. **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

APRIL 24

CA - OXNARD — MarketPro Computer Show & Sale. **LOCATION:** Community Center. **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

APRIL 30

CA - SONOMA — Hamfest. **SPONSOR:** Valley of the Moon ARC. **LOCATION:** Sonoma Veterans Memorial building, 126 1st St. West. **HOURS:** 8am-7. **ADMISSION:** Free. **TALK-IN:** 147.47 simplex, 145.35-600, 146.205 + 600. **FEATURES:** EX - FM - F/R. **DEALER INFO:** Swap spaces \$10, breakfast \$5, exams \$5.75 w/walk-in registration begins at 10am, testing at 11am. **CONTACT:** Darrel, WD6BOR, 707-996-4494.

APRIL 30-MAY 1

CA - DEL MAR — MarketPro Computer Show & Sale. **LOCATION:** Del Mar Fairgrounds. **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

CA - VALLEJO — MarketPro Computer Show & Sale. **LOCATION:** Solano County Fairgrounds, 900 Fairgrounds Dr. (Exit Hwy 37 off I-80). **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

MAY 1

CA - LIVERMORE — East Bay Area Amateur Radio/Electronics/Computer Swap Meet. **SPONSOR:** Livermore Amateur Radio Klub (LARK). **LOCATION:** Los Positas College, N of I-580 at Airway Blvd. exit. **HOURS:** 7am-12noon, rain or shine. **ADMISSION:** Free. **TALK-IN:** 147.045 + fr west, 145.350-1100Hz fr east. **FEATURES:** H - E - FP - F/R. **DEALER**

All listing information should be sent to:

**Nuts & Volts Magazine
EVENTS CALENDAR
430 Princland Court
Corona, CA 91719
Phone 909-371-8497
FAX 909-371-3052**

\$10-\$15. **CONTACT:** The Perham Foundation, 408-734-4453. Exam info: 408-255-9000 24/Hr.

CA - OCEANSIDE — Swap Meet - Special Section for Ham Radio, Electronics & Computers. **SPONSOR:** Palomar Ham Radio Club. **LOCATION:** Oceanside Drive-In, 3480 Mission Ave. **HOURS:** 6:30am-3:30pm. **ADMISSION:** 50¢. **FEATURES:** C - E - H. **DEALER INFO:** \$13 per space, 6am setup. **CONTACT:** 619-757-5286 vendors.

MAY 14-15

CA - SACRAMENTO — MarketPro Computer Show & Sale. **LOCATION:** Cal Expo. **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

MAY 15

AZ - PHOENIX — Computer & Electronic Swap Meet. **SPONSOR:** Electronic Materials & Computers. **HOURS:** 8am-3pm. **ADMISSION:** Free. **FEATURES:** FP. **DEALER INFO:** Vendor spaces \$10. **CONTACT:** 3102 W Thomas Rd. #902, Phoenix AZ 85017. 602-272-3200.

CA - LANCASTER — MarketPro Computer Show & Sale. **LOCATION:** Antelope Valley Fairgrounds. **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

CA - SACRAMENTO — Amateur Radio/Electronics/Computer Swap Meet. **SPONSOR:** Student ARC of California State Univ.-Sacramento. **LOCATION:**

REGIONS



FEATURES KEY

- | | |
|------|-----------------------------|
| AC | — Air-conditioned |
| B | — Banquet |
| C | — Computers |
| CB | — Commercial Booths |
| DP | — Door Prizes |
| E | — Electronics |
| EX | — FCC exams |
| F | — Forums |
| FM | — Flea Market |
| FP | — Free Parking |
| F/R | — Food & Refreshments |
| H | — Amateur Radio |
| HV-H | — RV Parking w/hookups |
| RV-S | — RV Parking Self-contained |
| S | — Seminars |
| T | — Tailgating |

COMPUTER SHOW PROMOTER INFO

AGI Computer Fair - 317-299-8827
California Computer S & S, Robert Austin
415-347-0100
CMA Computer Shows - 804-272-1570
KGP Computer Shows - 800-631-0062
MarketPro Computer Shows - 415-388-8893
NARISAAM Computer Shows - 404-565-9889
800-436-6707
Northern Computer Shows - 508-744-8440
Starware - 800-523-0702
The Intertech Group, Ltd. - 800-741-7469
(Formerly PC Fest)
UniCorp, Inc. - 305-731-4971

EVENTS CALENDAR

North parking lot Calif. State Univ.-Sacramento, US 50 & Howe Ave. **HOURS:** 7am-noon. **ADMISSION:** Free. **TALK-IN:** 145.230 (dup PL 162.2). **FEATURES:** C - E - FP - F/R - H. **CONTACT:** Gary Webbenhurst KC6URB, 916-381-6602 evenings.

MAY 21

CA - ANAHEIM — California Computer Show & Sale. **LOCATION:** Anaheim Stadium, 2000 State College Blvd. **HOURS:** 10am-4pm. **ADMISSION:** Free. **FEATURES:** C - DP. **CONTACT:** California Computer Shows.*

CA - CARMICHAEL — Hamswap. **SPONSOR:** North Hills Radio Club. **LOCATION:** Carmichael Elks Lodge. **HOURS:** 8am-3pm. **TALK-IN:** 145.190. **FEATURES:** CB - DP - FP - F/R - T. **DEALER INFO:** Outdoor (tailgate) & indoor (table) spaces \$10. **CONTACT:** NHRC, POB 41653, Sacramento, CA 95814-0635.

CA - SANTA ROSA — MarketPro Computer Show & Sale. **LOCATION:** Sonoma County Fairgrounds, 1350 Bennet Valley Rd (exit Hwy 12 E off Hwy 101). **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

CA - SANTEE — Ham Radio, Computer & Electronics Swap Meet. **SPONSOR:** Amateur Radio Club of El Cajon. **LOCATION:** Santee Drive-in, 10990 N. Woodside. **OPENS:** Appx. 6:30am, rain or shine. **ADMISSION:** 50 cents. **TALK-IN:** 146.520. **FEATURES:** C - E - F - F/R - H. **DEALER INFO:** \$6/vehicle. **CONTACT:** N6RGM Sonny 619-444-6532; WA6MHZ Pat 619-561-0052; ARCEC, Box 50, El Cajon CA 92020.

MAY 22

CA - SAN RAFAEL — MarketPro Computer Show & Sale. **LOCATION:** Marin Civic Center Exhibit Hall, Civic Center Dr. (Exit San Pedro East off Hwy 101). **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

MAY 28

CA - GLENDALE — California Computer Show & Sale. **LOCATION:** Glendale Civic Auditorium, 1401 N. Verdugo Rd. **HOURS:** 10am-4pm. **ADMISSION:** Free. **FEATURES:** C - DP. **CONTACT:** California Computer Shows.*

CA - VALLEJO — MarketPro Computer Show & Sale. **LOCATION:** Solano Co. Fairgrounds. **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

MAY 28-29

CA - SAN DIEGO — Computer Show. **SPONSOR:** American Mega Shows. **LOCATION:** Del Mar Fairground — Exhibit Hall. **HOURS:** 10am-5pm. **ADMISSION:** \$6, \$1 off w/coupon or ad. **FEATURES:** C. **CONTACT:** American Mega Shows, 800-800-9188.

CA - VENTURA — MarketPro Computer Show & Sale. **LOCATION:** Ventura Fairgrounds. **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

MAY 29

CA - CITY OF INDUSTRY — California Computer Show & Sale. **LOCATION:** Industry Hills Sheraton, 1 Industry Hills Parkway. **HOURS:** 10am-4pm. **ADMISSION:** Free. **FEATURES:** C - DP. **CONTACT:** California Computer Shows.*

CA - SACRAMENTO — MarketPro Computer Show & Sale. **LOCATION:** Scottish Rite. **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

CA - SANTA ANA — ACP Computer Swap Meet. **SPONSOR:** Advanced Computer Products. **LOCATION:** 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 - 714-558-8813.

JUNE 3-4-5

OR - SEASIDE — SEAPAC Ham Convention. **SPONSOR:** Oregon Tualatin Valley ARC. **LOCATION:** Seaside Convention Center. **ADMISSION:** \$8 door, \$6 adv., under 12 free. **TALK-IN:** 146.660 - 600. **FEATURES:** B - CB - DP - EX - F - FM - F/R - S. **CONTACT:** OTVARC, Box 219142, Portland OR 97225-9142.

JUNE 4

CA - SANTEE — Ham Radio, Computer & Electronics Swap Meet. **SPONSOR:** Amateur Radio Club of El Cajon. **LOCATION:** Santee Drive-in, 10990 N. Woodside. **OPENS:** Appx. 6:30am, rain or shine. **ADMISSION:** 50 cents. **TALK-IN:** 146.520. **FEA-**

TURES: C - E - F - F/R - H. **DEALER INFO:** \$6/vehicle. **CONTACT:** N6RGM Sonny 619-444-6532; WA6MHZ Pat 619-561-0052; ARCEC, Box 50, El Cajon CA 92020.

JUNE 5

CA - LIVERMORE — East Bay Area Amateur Radio/Electronics/Computer Swap Meet. **SPONSOR:** Livermore Amateur Radio Klub (LARK). **LOCATION:** Los Positas College, N of I-580 at Airway Blvd. exit. **HOURS:** 7am-12noon, rain or shine. **ADMISSION:** Free. **TALK-IN:** 147.045 + fr west, 145.350. (100Hz) fr east. **FEATURES:** H - E - FP - F/R. **DEALER INFO:** Setup after 6am only. \$10 space fee. Covered spaces avail. If rain. **CONTACT:** Noel Ankham KC6QZK, 510-447-3857 eves or 510-783-2803 message days.

CA - SAN DIEGO — MarketPro Computer Show & Sale. **LOCATION:** Scottish Rite Center Fairgrounds. **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

JUNE 11

CA - LOS ALTOS HILLS — Foothill College Amateur Radio Flea Market. **LOCATION:** Foothill College, Hwy 280, exit El Monte Rd West. Parking Lot A. **HOURS:** 6am-7. **ADMISSION:** Free. Parking fee \$2, bring quarters. **TALK-IN:** 145.270(-) or 224.360 (PL-100). **FEATURES:** E - EX - H - F/R. **DEALER INFO:** Sellers: \$10-\$15. **CONTACT:** The Perham Foundation, 408-734-4453. Exam Info: 408-255-9000 24/Hr.

CA - OCEANSIDE — Swap Meet - Special Section for Ham Radio, Electronics & Computers. **SPONSOR:** Palomar Ham Radio Club. **LOCATION:** Oceanside Drive-In, 3480 Mission Ave. **HOURS:** 6:30am-3:30pm. **ADMISSION:** 50¢. **FEATURES:** C - E - H. **DEALER INFO:** \$13 per space. 6am setup. **CONTACT:** 619-757-5286 vendors.

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.*

CA - SANTEE — Ham Radio, Computer & Electronics Swap Meet. **SPONSOR:** Amateur Radio Club of El Cajon. **LOCATION:** Santee Drive-in, 10990 N. Woodside. **OPENS:** Appx. 6:30am, rain or shine. **ADMISSION:** 50 cents. **TALK-IN:** 146.520. **FEATURES:** C - E - F - F/R - H. **DEALER INFO:** \$6/vehicle. **CONTACT:** N6RGM Sonny 619-444-6532; WA6MHZ Pat 619-561-0052; ARCEC, Box 50, El Cajon CA 92020.

OR - HILLSBORO — Northwest Computer Show & Sale. **SPONSOR:** Access Marketing. **LOCATION:** Hillsboro Fairplex. **HOURS:** 9am-4pm. **ADMISSION:** \$4, under 12 free. **FEATURES:** C - DP - FP - F/R. **CONTACT:** Access Marketing, 206-573-4301.

JUNE 12

CA - BURBANK — California Computer Show & Sale. **LOCATION:** Pickwick Center, 1001 Riverside Dr. **HOURS:** 10am-4pm. **ADMISSION:** Free. **FEATURES:** C - DP. **CONTACT:** California Computer Shows.*

CA - FRESNO — MarketPro Computer Show & Sale. **LOCATION:** Fresno Fairgrounds. **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

CA - OXNARD — MarketPro Computer Show & Sale. **LOCATION:** Community Center. **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

JUNE 18

CA - ANAHEIM — California Computer Show & Sale. **LOCATION:** 2000 State College Blvd. **HOURS:** 10am-4pm. **ADMISSION:** Free. **FEATURES:** C - DP. **CONTACT:** California Computer Shows.*

CA - RIVERSIDE — MarketPro Computer Show & Sale. **LOCATION:** Riverside Convention Center. **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

JUNE 18-19

CA - VALLEJO — MarketPro Computer Show & Sale. **LOCATION:** Solano Co. Fairgrounds. **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

WA - SPOKANE — Inland Northwest Hamfest. **LOCATION:** Spokane Interstate Fairgrounds. **HOURS:** Sat: 9am-5pm Sun: 9am-1:30pm. **ADMISSION:** \$6 adv., \$7 door, under 12 free. **FEATURES:** F/R RV-S. **DEALER INFO:** 8' tables \$12, dealer & one helper fee. Setup Jun 17. **CONTACT:** Ivan Brown, E. 537 Nebraska, Spokane WA 99207. 509-489-2667.

JUNE 19

CA - LANCASTER — MarketPro Computer Show & Sale. **LOCATION:** Antelope Valley Fairgrounds (tent). **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

JUNE 25-26

CA - SACRAMENTO — MarketPro Computer Show & Sale. **LOCATION:** Scottish Rite Center Fairgrounds. **HOURS:** 10am-5pm. **ADMISSION:** \$6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

CA - SAN DIEGO — Computer Show. **SPONSOR:** American Mega Shows. **LOCATION:** Jack Murphy Stadium, Concourse area. **HOURS:** 10am-5pm. **ADMISSION:** \$6, \$1 off w/coupon or ad. **FEATURES:** C. **CONTACT:** American Mega Shows, 800-800-9188.

CENTRAL REGION

APRIL 2

CO - LONGMONT — LARCFEST. **SPONSOR:** Longmont ARC. **LOCATION:** Boulder County Fairgrounds, Hover & Nelson Rds. **HOURS:** 8am-3pm. **TALK-IN:** 147.27/87, 146.52. **FEATURES:** EX. **CONTACT:** Randy Stevens, N0NMD, 5280 Cypress Dr., Boulder CO 80303. 303-499-1106.

IN - COLUMBUS — Hamfest. **SPONSOR:** Columbus ARC. **LOCATION:** Bartholomew County 4-H Fairgrounds, Family Arts Building (heated) on State Rd. 11. **HOURS:** 8am-2pm. **ADMISSION:** \$3.50 adv., \$4 door. **TALK-IN:** 146.790/146.190. **DEALER INFO:** 8' tables \$6. **CONTACT:** Marion Winterberg WD9HTN, 11941 W. Sawmill Rd., Columbus IN 47201. 812-342-4670.

IN - INDIANAPOLIS — Computer Show. **SPONSOR:** National Computer Fairs. **LOCATION:** Holiday Inn East, 6990 E. 21st St. **HOURS:** 10am-3pm. **ADMISSION:** \$3. **FEATURES:** C - CB. **DEALER INFO:** Setup 8am-10am. Tables: 1-4/\$25 ea., 5+/\$20 ea. Reservations paid one week prior to event get \$5 per table discount. **CONTACT:** National Computer Fairs, POB 501403, Indianapolis IN 46250. 317-843-9201.

IN - INDIANAPOLIS — Indianapolis Computer Fair. **LOCATION:** Quality Inn East, 3525 N. Shadeland, near Pendleton Pike. **HOURS:** 10am-3pm. **ADMISSION:** \$4, under 12 free. **FEATURES:** C - DP. **CONTACT:** Ben Yanto, AGI Computer Fairs.*

APRIL 3

OH - DAYTON — Dayton Computer Fair. **LOCATION:** Days Inn South (I-75 Exit 44/SR725, about 12 miles south of Dayton & 40 miles north of Cincinnati). **HOURS:** 10am-3pm. **ADMISSION:** \$4, under 12 free. **FEATURES:** C - DP. **CONTACT:** Ben Yanto, AGI Computer Fairs.*

APRIL 9

IN - HIGHLAND — Computer Possibilities Unlimited. **SPONSOR:** Bee Software. **LOCATION:** Lincoln Center, 2450 Lincoln. **HOURS:** 10am-3pm. **ADMISSION:** \$5, under 12 free. **FEATURES:** AC - C - DP - FP - F/R - S. **CONTACT:** Info/Discount tickets: 219-931-3761.

MI - LIVONIA — Computer Trade Show. **LOCATION:** Livonia Elks Lodge Hall, 31117 Plymouth Rd, 1 Blk E 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

MN - FERGUS FALLS — Lake Region Amateur Radio Hamfest. **SPONSOR:** LRARC. **HOURS:** 8am-3pm. **CONTACT:** Keith McKay, 218-826-6274.

MN - ROCHESTER — Rochester Area Hamfest/Computer & Electronic Show. **SPONSOR:** Rochester ARC. **LOCATION:** John Adams Jr. H.S., 1525 31st St. NW. **HOURS:** 8am-7. **TALK-IN:** 146.22/82 (WOMXW Repeater). **CONTACT:** Colleen Vaneps, NOZDY, 707 11-1/2 St. SW, Rochester MN 55902. 507-280-9102.

MO - BRANSON — Hamfest. **SPONSOR:** Skaggs Amateur Radio Club. **LOCATION:** Skaggs Parking Garage, Business Hwy 65 (3 blocks E of 65). **CONTACT:** Steve Kris, K&S Communications, 417-779-3800.

OH - CLEVELAND — Micro Mania! **SPONSOR:** National Computer Exposition. **LOCATION:** Marriott Hotel, 4277 W 150th St. at I-71. **HOURS:** 10am-4pm. **ADMISSION:** \$5 w/ad, under 12 free. **FEATURES:** FP. **DEALER INFO:** Setup 8am-10am. 80-100 tables. Sellouts are common, early booking advised. **CONTACT:** Joe Bowen, 216-442-1776 or Ronald Nelson, FAX: 216-292-7746. National

Computer Exposition, 30799 Pinetree Rd. #230, Cleveland OH 44124.

OK - LAWTON — 48th Annual LFSARC Hamfest. **SPONSOR:** Lawton Ft. Sill ARC. **LOCATION:** Comanche County Fairgrounds. **HOURS:** 8am-5pm. **ADMISSION:** \$4 adv., \$5 door. **TALK-IN:** 146.91/31. **FEATURES:** EX - F. **DEALER INFO:** Tables \$8 adv., \$10 door. Includes admission. **CONTACT:** Bob Morford KA5YED, 1415 NW 33rd St., Lawton OK 73505. 405-355-6120.

APRIL 10

IL - ORLAND PARK — The Orland Park Computer Show. **LOCATION:** Orland Park Civic Center, 147th St & LaGrange Rd (Rt. 45). **HOURS:** 9:30am - 3:00pm. **ADMISSION:** Adults \$5 - \$1 off with copy of this ad. 8-12 yrs \$2, under 8 free. **FEATURES:** AC - C - CB - DP - FP - F/R - All indoors. **CONTACT:** 24-hour Hotline 708-974-3123.

IL - WINTHROP HARBOR — Lake County Computer Show & Sale. **SPONSOR:** EDI. **LOCATION:** Schlader Bldg., 2700 9th St. **HOURS:** 9am-3pm. **ADMISSION:** \$3, under 12 free. **FEATURES:** AC - C - FP - F/R. **DEALER INFO:** Setup 7am. Tables: 1/\$35, 2/\$30 ea., 3+/\$25 ea. **CONTACT:** P.O. Box 73, Wadsworth, IL 60083. 708-680-7262, FAX 708-680-4141.

MI - MADISON HEIGHTS — Computer Trade Show. **LOCATION:** UF & CW Hall, 876 Horace Brown Dr. 1 blk E of I-75, 3 blks S. of 13 Mile Rd. **HOURS:** 10am-4pm. **ADMISSION:** Adults \$5; Seniors & Students w/ID \$3; under 12 free w/adult. **FEATURES:** C - DP. **CONTACT:** Computers & You, 313-283-1754.

OH - CLEVELAND — Micro Mania! **SPONSOR:** National Computer Exposition. **LOCATION:** Holiday Inn/Hudson, 240 Hines Hill Rd., at I-80 Ohio Tpk (N Exit 12). **HOURS:** 10am-4pm. **ADMISSION:** \$5 w/ad, under 12 free. **FEATURES:** FP. **DEALER INFO:** Setup 8am-10am. 80-100 tables. Sellouts are common, early booking advised. **CONTACT:** Joe Bowen, 216-442-1776 or Ronald Nelson, FAX: 216-292-7746. National Computer Exposition, 30799 Pinetree Rd. #230, Cleveland OH 44124.

WI - MADISON — 22nd Annual Madison Swapfest & Computer Fair. **SPONSOR:** Madison Area Repeater Association. **LOCATION:** Dane County Expo Center Forum Bldg. **HOURS:** 8am-7. **ADMISSION:** \$4 adv., \$5 door, 10 & under free. **TALK-IN:** 147.15 Repeater. **FEATURES:** CB - E - F/R. **DEALER INFO:** Tables \$10 adv. (does not include admission). **CONTACT:** MARA, Box 8890, Madison WI 53708-8890. 608-249-7579.

APRIL 16

IN - EVANSVILLE — Computer Show. **SPONSOR:** National Computer Fairs. **LOCATION:** Holiday Inn East, 100 S. Green River Rd. **HOURS:** 10am-3pm. **ADMISSION:** Free. **FEATURES:** C - CB. **DEALER INFO:** Setup 8am-10am. Tables: \$20 ea. Reservations paid one week prior to event get \$5 per table discount. **CONTACT:** National Computer Fairs, POB 501403, Indianapolis IN 46250. 317-843-9201.

IN - MERRILLVILLE — Computer Possibilities Unlimited. **SPONSOR:** Bee Software. **LOCATION:** Michelangelo Hall, 6220 Broadway. **HOURS:** 10am-3pm. **ADMISSION:** \$5, under 12 free. **FEATURES:** AC - C - DP - FP - F/R - S. **CONTACT:** Info/Discount tickets: 219-931-3761.

MO - JOPLIN — Joplin Hamfest. **SPONSOR:** Joplin ARC. **LOCATION:** John Q. Hammons Convention Center, I-44 & US-71. **HOURS:** 8am-3pm. **TALK-IN:** 147.21. **FEATURES:** EX. **CONTACT:** Call 417-782-5848 or write POB 2983, Joplin MO 64803.

APRIL 17

IL - GLEN ELLYN — Computer Central. **LOCATION:** College of DuPage, Physical Education Bldg. Main Arena, 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.

IL - ROCKFORD — Hamfest/Computerfest. **SPONSOR:** Rockford ARA. **LOCATION:** Rockford Metro Center, 300 Elm St. **HOURS:** 8am-7. **ADMISSION:** \$4.50 adv., \$5.50 door. **FEATURES:** C - CB - DP - E - EX - FM - FP - F/R - H. **DEALER INFO:** Tables \$10 & 12.50. **CONTACT:** Rockford Amateur Radio Assn., POB 8465, Rockford IL 61126-8465.

IL - SULLIVAN — Hamfest. **SPONSOR:** Moultrie Amateur Radio Klub. **LOCATION:** 4-H Fairgrounds, 4 miles E of Sullivan on Cadwell Rd. **HOURS:** 7am-1pm. **TALK-IN:** 146.055/146.655 & 449.275/444.275. **FEATURES:** EX. **CONTACT:** M.A.R.K., POB 91, Lovington IL 61937 or call Dave Duggins, KF9NB, 217-234-3283.

IN - COLUMBUS — Computer Fair. **SPONSOR:** MEKA enterprises, Inc. **LOCATION:** Holiday Inn, Crystal Ballroom. **HOURS:** 10am-3pm. **ADMISSION:** \$4. **DEALER INFO:** Tables: 1-3 \$35 ea., 4 or more \$30 ea. **CONTACT:** William Ibarra, Meka

Continued on page 119

INTRODUCING THE UNIVERSAL M-400

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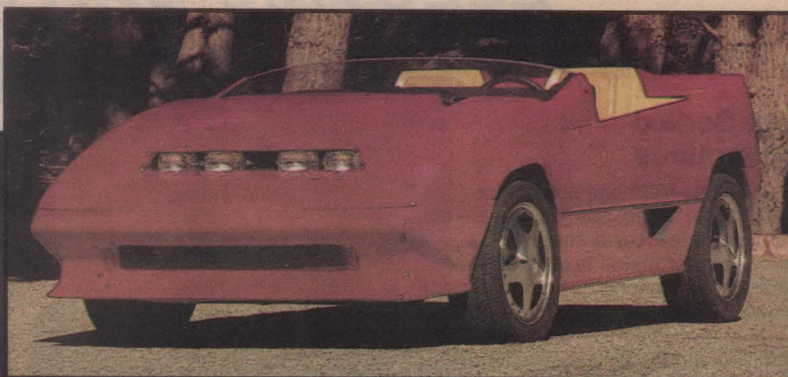
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Choosing



A small sedan, such as a VW Rabbit, is a practical electric family car.



A Car

by
Shari
Prange

You've decided you want to build an electric car, and you can't wait to get started. And come to think of it, there's that old Citroen with a dead engine that your brother has . . .

Stop! A donor car should be chosen for its merits as an electric, not for its availability. If you grab the first available dead body you find and electrify it into new life, you may end up with the automotive equivalent of Frankenstein's monster. Take a little time to weigh the pros and cons, and search for the right car.



The Porsche 914 is a popular high-performance sports car.

For



This Jackrabbit, from Herb Adams VSE, was converted into an eye-catching electric.

Electric Conversion

Building From Scratch

In theory, the best electric car would be one that was designed from the ground up to be electric. That's true in theory, but unfortunately, we have to live in reality.

Building an entire car is a monumental undertaking. Unless you are a professional industrial designer with serious hands-on automotive experience, your final product is likely to be less than satisfactory. It

will also absorb your entire social life for a year or more, and require a budget equal to the gross national product of a small country.

It's not that difficult to build a vehicle that works. It's considerably more difficult to build one that works well, looks good, and is street legal. And it still won't have the safety of a commercially built chassis.

If you really want the experience of building the whole car, at least

start with a set of professionally produced plans. These are available commercially, including plans for a car that was designed from scratch to be electric.

Kit Cars

If you're not quite that ambitious, but still want something more challenging and unusual than a conversion, you can build a kit car. These include swoopy sports mod-

els, hot rods, and replicas of classics.

In a kit car, someone else has done the critical design work for you, but there is a considerable challenge to the assembly, and your conscientious workmanship will show. There is also plenty of room for you to customize the design and make it your own.

When buying a kit car, be sure you are dealing with an established reputable company. Study the kit

ELECTRIC CAR CONVERSION

car magazines, and talk to the members of a local club for advice.

Steel-Bodied Conversions

Most of us will end up converting existing gas or diesel vehicles, and there is a good reason for that. It takes Detroit 3.1 million engineering design hours to design a car that is 70% new. This includes small but important things like doors that latch properly and windows that roll up and down easily. You might as well take advantage of all that expensive engineering expertise, and concentrate your efforts on the electric drive system.

Body Style

The first decision you must make is what kind of body you want. Will the car be a commute car that only needs to carry you and your lunch? Do you need to haul the kids in it, or the week's groceries? Do you need some serious cargo space?

Small sports cars and other two-seaters can make fun, high-performance electrics. The deciding factor is battery space. In a typical conversion, you need room for 16 to 20 6-volt deep cycle lead acid batteries. To further complicate matters, you will be trying to install these cubes into areas that are anything but square. Cars like the Honda CRX and GEO Metro can be done, but they require some design creativity.

There is now a 12-volt battery available that is a true deep cycle electric vehicle battery, not a marine or standby power battery. This is the model #1450 from U.S. Batteries, available through Interstate dealers. This battery makes smaller cars more do-able, since you only need half as many of them, but they are a strange shape: 11 1/2" high by 6 3/4" wide by 13 1/2" long.

As important as battery space is battery accessibility. You must be able to reach your batteries easily to check the terminals and water. If they are too hard to check, human nature being what it is, they won't get checked, and performance and reliability will suffer. Old VW Bug batteries, hidden under the back seat, were notoriously ignored and tended to grow some really impressive formations on their terminals before anyone noticed.

Two-door and four-door sedans and hatchbacks make good practical conversions. Batteries can be placed under the hood, in the trunk, and under the hatchback. With a careful design, all



Light pickup trucks, such as this Datsun, make good utility conversions.

the original seating and almost all the cargo area can be preserved.

Light pickup trucks make excellent conversions. Obviously, the truck bed has plenty of room for the batteries. However, an even better plan is to install a tilt kit on the bed, and place the batteries under the bed, thus maintaining all the cargo space. This has the added benefit of keeping the center of gravity low, which improves handling and stability.

Vans are marginally do-able, and need to be evaluated on a case-by-case basis. Many of them are simply too heavy, and of course, none of them are really aerodynamic. For a van, you will need to use as large a motor and battery pack as possible, and you should not expect heroic performance from it. An electric van will be best suited for use as an in-town surface street vehicle with a short range.

Weight

This brings us to the subject of weight. The car will gain 800-1,000 lbs. in the course of the conversion, so it's important to start with as light a vehicle as possible. There are complex formulae for calculating the weight limits, but there are also some easy rules of thumb.

A typical conversion has a 96-volt system and a motor with a continuous rating of 19 hp. As long as the original donor weighs less than

2,500 lbs., this car will be suitable for extensive freeway use, and can climb steep but short hills.

A larger vehicle should use a larger motor and at least a 120-volt system. (In the very near future, 144-volt systems will be possible.) This car should not weight more than 3,000 lbs. before conversion. It will be capable of extended freeway use, and will be able to climb moderate but lengthy grades, in addition to short steep slopes.

The weight we are talking about is the "curb weight," which means what the car actually weighs with a full tank of fuel. This number may be in the owner's manual, but frequently is not. The dealer may be able to supply this number, or you can weigh the car at a public scale.

The number more often seen is the "gross vehicle weight." This is the maximum weight the car is rated to carry, fully loaded with passengers and cargo. Although it's desirable for the finished conversion to stay below the gross vehicle weight (GVW), this isn't always possible, and isn't strictly necessary. The critical factors relating to GVW are braking and suspension. The original brakes are capable of handling considerably more weight than the GVW. The suspension will require beefing up, but that is not difficult to do.

It is preferable when possible to use a donor car with a wide spread between the curb weight and the

GVW. The wider the spread, the less likely you are to exceed the GVW in the conversion process. Pickups are especially good in this respect, since they were designed for heavy payloads.

Make & Model

Look for a make of car that has a strong dealer presence in this country, and in your area. If the car is an orphan, you will have problems finding basic parts like brake cylinders.

Choose a model that had a long production run, and sold a lot of units. This will guarantee that there are a lot of them still on the road, which means ready parts availability at aftermarket parts stores. It will also mean good availability of parts in wrecking yards.

The most popular models for conversion are the VW Rabbit, Honda Civic, Ford Escort, Porsche 914, Ford Ranger, and Chevy S10.

Transmission & Drive Axle

At this time, a good conversion needs a manual transmission. Automatics are complicated, not cost-effective, and give poor performance.

The automatic transmission has power and efficiency losses that an electric car simply cannot afford. Also, it is dependent on a continually idling engine to provide fluid pressure. Without it, there is an unsafe time lag between applying the throttle to pull away from a stop, and the engagement of the transmission bands. And when they do engage, they do so with a jerk.

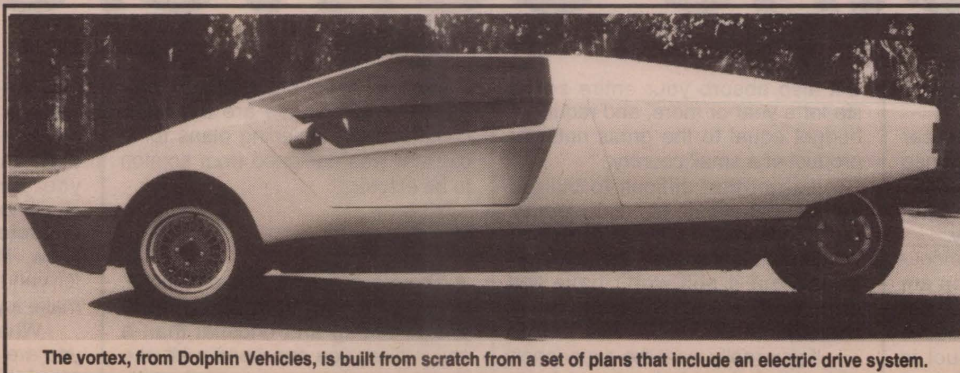
Also, the automatic transmission has shift points that were engineered to match the original engine. They will not correspond to the optimum shift points for the electric motor.

Both front wheel drive and rear wheel drive cars make good conversions. There is a slight advantage to having both the motor and the drive wheels at the same end of the car, whichever end that may be. This minimizes drive train power losses, and makes it easier to package the components in the car.

Options

Power brakes are definitely desirable, and easily accommodated. This can be done with a small electric vacuum pump, a vacuum reservoir, and a vacuum switch. The reservoir will give you several applications of the brakes before the switch triggers the pump to turn on briefly.

Power steering is not



The vortex, from Dolphin Vehicles, is built from scratch from a set of plans that include an electric drive system.

recommended, as it uses a lot of horsepower. Also, most cars in the appropriate weight range don't really need it.

Air conditioning is another option that uses lots of horsepower — almost as much as it takes to move the car! Conventional automotive air conditioning is not practical in an electric car. However, air conditioning technology is in a state of transition in order to eliminate the environmentally-harmful CFC's. In the process, the units are also becoming smaller, lighter, and more efficient. In the near future there will probably be air conditioning suitable for use in electric conversions.

Age & Condition

In general, it's best to pick a car that is less than 15 years old. Parts availability for many cars decreases sharply after 15 years. Also, the cars manufactured in the last 15 years have benefited from government safety and fuel economy regulations. They tend to have better crash protection, while at the same time being lighter and more aerodynamic.

Age is, of course, often related to condition. An older car may require more "point and paper" than can really be justified.

If you're going to invest the time and money in a conversion, you want the finished product to be reliable and something you can be proud to drive. Avoid cars needing substantial body or interior work.

You also want to avoid cars that have been crashed. A slight tweak in the frame that isn't apparent to the eye can cause measurements to be out of true, and make it extremely challenging to fit a square battery rack in a slightly non-square space. It can also affect things like alignment, which will affect performance and efficiency.

The ideal donor car is the one in the classifieds that says, "Great body, needs eng. \$500 OBO."

Talk to specialty repair shops. They may be able to clue you in to a model that has a design flaw and tends to blow engines. Also, spread the word through your local repair shops, parts stores, and wrecking yards that you are looking for a good body and interior with a dead engine. These people are generally the first to find out about such cars.

Well Begun Is Half Done

An electric car conversion can be fun to build and fun to drive, so be sure you get the most out of it. Don't invest your time and money in the first dead car that happens to be available. Take the time to find the right car for your needs. The results will be worth it.

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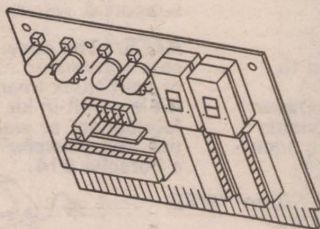
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TEST EQUIPMENT: Cushman service monitors: CE-5, \$600, CE-3, \$400. HP 851B/8551B spectrum analyzer, \$500. Also General Microwave 460B w/head, AN/ASM-23 test set, HP8960B sweeper frames, Northeast TTS-58A noise test set, make offers. Call 214-516-4868.

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LOGIC ANALYZERS: Tek 1240/D1, D2, D2, D2 fully loaded logic analyzer with pods, performance pack, RAM pack, and two COMM packs \$1200. Tek 308 data analyzer with pod \$350. Tek DAS 9129 color systems, up to 660MHz, new low prices. HP 1615A with pods \$425. Tek 7D01/DF1 logic analyzer plug-in, up to 100MHz, with pods \$225. Tek 7D02 logic analyzer plug-in, with PM 101 \$225. Sold with warranty. **Pepper Systems**, 214-353-0257.

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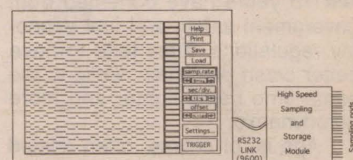
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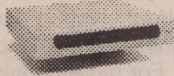
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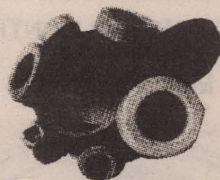
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Individually lighted control switches. Lighted master on/off switch. Five heavy duty grounded power outlets controlled individually by front panel switches (Computer, Monitor, Printer, Aux1, Aux2). 15A circuit breaker. Fits between computer and monitor. Info model SP-PC1.

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Popular sizes and styles used in electronics. (92J007) **100 for \$4.95**



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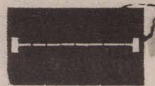


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Two of these trapezoid-shaped magnets are cemented to a single substrate. Each magnet is approx. 1.75" x 0.375", and is approx. 1000 Gauss. By far the most powerful magnets we've seen. (92N006)

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12 V, 1 W, 6" x 12". (92E002)

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12VDC, 1A, ball bearing.
4.625" x 4.625" x 1.5". Boxer
P/N 4715ML-04T-B40.

(94F002)

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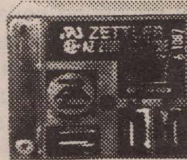
With power supply and SCSI cable for 5.25" drive. (94C007)

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\$2.50 each or 10 for \$22.95

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Gordos #F81-1570-13, 5V at 4mA SPDT contacts. Large quantity available. (92B005)

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LF412 (94I015) **\$1.95 each**
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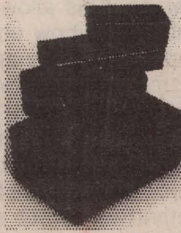
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Your Choice (94P013) \$45¢ each

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Slotted walls to accept PCB's. ABS black plastic. Screws included. Will not crack or split when drilled or punched.

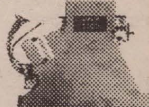
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FDBB-200W-1 POWER SUPPLY

By Condor, Inc. Input 115 or 230 VAC. Outputs: +5V @ 10A, 12A peak, overvoltage @ 6.2 ± 0.4V; +24V @ 7.5A, 8.5A peak; -12V @ 1.5A, 2.0A peak. (92E055)

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Includes IR laser diode assembly, polygon scanner, photo detector, 8.25" x 0.5" front surface mirror. New. (94L004)

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SOLAR POWERED FLASHLIGHT KEYCHAIN

Find that keyhole at night! (92L035)

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HP35828E TRANSISTOR

General purpose microwave transistor. Usable to 6 GHz. Noise figure 2 dB @ 2 GHz. Gain 13 dB. Output power @ 1dB compression is 17.5 dBm. Pillpack. (94S004)

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300V @ 1A. (93S029)

45¢ each - 25 for \$9.95

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1KB EEPROM

93C46P. (94I014)

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REVERSIBLE DC GEAR HEAD MOTOR

41 RPM @ 12 VDC, 0.9A (no load), 5/32" diameter shaft is 1-1/4" long, drilled for crosspin and provides 12" pounds of torque. 3.25" square x 4.5" long. (92M007)

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Perfect for communications equipment, power supplies, test equipment, computer switch boxes, and more. Features include: Units split apart for easy working; self-adhesive feet and screws included; plastic used for flexibility and strength; and grey body complete with black front and rear panels.

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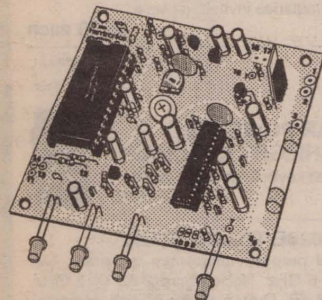
New Product

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**NEW PRODUCT EDITOR, 430 PRINCELAND CT,
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News

VOICE-ID REPEATER CONTROLLER



The new COR-6 module from Hamtronics combines COR circuits and a real-voice ID on one board. It can be used with transmitter and receiver modules to make a simple, low-cost repeater.

A Digital IC records up to 20 seconds of your voice, using audio from the repeater receiver. The unit includes tail and time-out timers, courtesy beep, and solid-state relay to key transmitter.

The 20 seconds of recording time can be broken up any way you like. You can enhance the basic circuitry by adding a switch to select any of several messages, for instance. You can even use the TD-4 DTMF Controller to allow remote control of recording.

The unit has a kit price of \$99.00 and is also available wired & tested for \$149.00.

For more details, call or write:

HAMTRONICS, INC.
65-F MOUL ROAD, DEPT. NV
HILTON, NY 14468-9535
716-392-9430
FAX 716-392-9420

ADD SERIAL I/O CAPABILITY TO ANY PC APPLICATION

T.A.L. Enterprises is now shipping new Professional versions of their Software Wedge!!! for both DOS and Windows. The Software Wedge

adds complete, 2-way, serial I/O capabilities to any DOS, Windows, OS/2 or NT application. Communicate with any serial device directly from within your favorite PC programs.

The Software Wedge offers a solution for interfacing devices like electronic scales, measuring tools, laboratory instruments, bar code readers, or other data collection instruments to any PC program. Input data directly into Lotus 123, FoxBase, Excel, Access, Paradox, WonderWare, etc.

The Software Wedge works by converting incoming serial data to keystrokes so data appears as if it were being typed in. The Windows version also supports Dynamic Data Exchange so you can place serial input and output buffers directly in other Windows or OS/2 apps. Serial data can also be logged directly to a disk file in the background while you work with other programs in the foreground. Eliminate manual data entry, expensive hardware additions or custom programming.

The Professional Editions of Software Wedge have many advanced features including the ability to parse and filter incoming data as well as add in additional keystrokes or date/time stamps. This allows you to control exactly how and where data appears in other application programs. You get complete control over all I/O directly from within all your favorite programs.

Other features include timed automatic output strings, hot key activated output strings, input data translation tables, support for 16550 UARTs, and full control over all COM parameters and serial hardware lines.

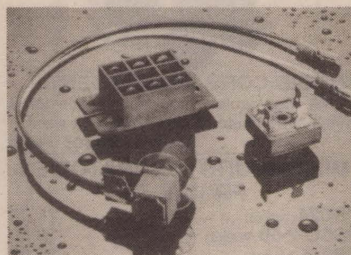
The DOS and Windows versions both include powerful serial I/O diagnostic utilities for debugging communications problems. A configuration program with intuitive menus and dialog boxes make setup and

installation of the Software Wedge easy. The Professional Edition for DOS is \$295.00 and the Pro version for Windows is \$395.00, and both include a clearly written users manual and unlimited free phone support.

For more details, contact:

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215-763-2620 OR 800-722-6004
FAX: 215-763-9711

AC/DC MOTOR CONTROL FOR HUMID ENVIRONMENTS



Electramation, Inc., is now offering the MOTORSTAT, an AC or DC motor control for humid environments.

The MOTORSTAT is a fully integrated thick film hybrid circuit with a self-contained speed potentiometer, power SCR pack, and fullwave power diode bridge (for DC applications). All components connect with 1/4" fast-on connectors. The MOTORSTAT accepts input voltages of 120 or 240 VAC and will control AC or DC motors from 1/8 to 10 HP.

This unit has an advantage over PC board based motor controls in humid environments, because it is contained in a molded package. There is no corrosion of busses or components. High density molded package provides high thermal conductivity for trouble-free operation, and 1600 VAC isolation is standard.

The MOTORSTAT comes ready to use. No other external components are needed. It is easy to mount and wire — quick connect terminals are molded into the unit for wiring ease. Dimensions are 1-1/4" x 2.5".

For further details, write or call:
ELECTRAMATION, INC.
11752 GARDEN GROVE BLVD
SUITE 110, DEPT. NV
GARDEN GROVE, CA 92643
714-638-9599
FAX 714-638-9597

LOW-COST TEMPERATURE REGULATING SOLDERING STATION



The Hexacon HTR 3320 soldering station is now available from The Tool Resource. This station, priced at \$74.99, is designed to give temperature regulation from 350 degrees F. to 850 degrees F.

The Thermal compensating element increases the iron's output as the work rate increases.

The station solders a wide range of electronic connections and multi-layer boards, making this an economical and practical choice.

There are no movable parts or elaborate circuitry for simple maintenance and dependability. The station also adapts to a wide range of surface mounted tips.

For more information contact:

THE TOOL RESOURCE
P.O. BOX 1106, DEPT. NV
WEST DUNDEE, IL 60118
PHONE/FAX: 708-468-0849.

CUT PC ELECTRICITY USE

Green Keeper!!!, a new product now available from B&B Electronics, automatically turns off computer monitors thereby helping reduce electric bills.

Green Keeper is similar to a screen saver. However, screen savers only blank the screen during inactivity; they do nothing

New Product News

to save electricity. Instead of just blanking your monitor's screen, Green Keeper will also turn off the power. (This has no effect on your computer — it remains on.)

Green Keeper connects in series with the keyboard of any IBM compatible PC. The PC monitor is plugged into Green Keeper's AC outlet. Both DOS and Windows software are included. This software communicates with the Green Keeper unit to turn off the monitor after a user specified period of inactivity. A simple touch of the keyboard or mouse instantly restores power to the monitor. The CPU is not affected.

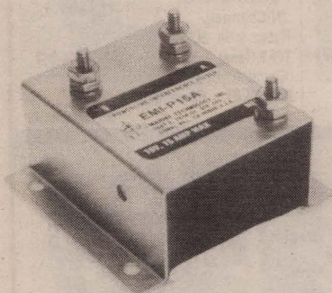
The turn off time can be different depending on the time of day. Up to nine different time-outs can be preset. For instance: you could set Green Keeper to turn off after 15 minutes of inactivity between 8 AM and 12 noon. During your lunch hour, set it to a one minute time-out. Then set Green Keeper to a 15 minute time-out for the afternoon. Finally, set it back to 1 minute at 5 PM. You can also set different time-outs on different days. For example: Saturday and Sunday could be set to 1 minute all day.

The suggested retail price for Green Keeper is \$69.95.

Further inquiries should be directed to:

B & B ELECTRONICS
4000 BAKER ROAD DEPT. NV
P.O. BOX 1040
OTTAWA, IL 61350
815-434-0846
FAX 815-434-7094

COMMUNICATIONS NOISE FILTER



Marine Technology, Inc., has developed the EMI-P15A noise filter.

The noise filter protects com-

munications equipment from power-line interference and isolates noise producing accessories.

The EMI-P15A 12-volt, 20 Amp electrical interference power-line filter is designed to eliminate alternator whine and other interference to communications equipment such as: Commercial AM/FM/SSB/VHF radiotelephone equipment; ham radio transmitters; auto sound equipment; and public address systems.

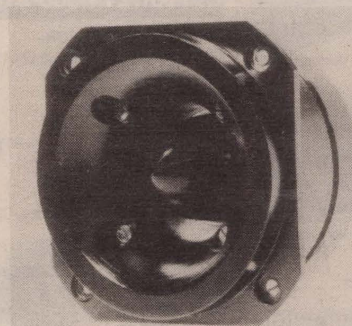
The EMI-P15A will also prevent interference developed in noisy accessories from entering the vehicles' electrical system. Such devices include: 12 VDC to 120 VAC inverters; large 12 volt motors in fans, pumps and blowers; and strobe lights and signals.

The EMI-P15A is 2-3/4 inches long by 3 inches wide and 1-3/4 inches high, and can be easily attached to any clean surface with its pressure-sensitive mounting strips. The suggested retail price is \$34.95.

For additional information, contact:

MARINE TECHNOLOGY, INC.
2667 E. 28TH STREET #505,
DEPT. NV
SIGNAL HILL, CA 90806
800-772-0796

"BULLET" TWEETER



ProSystems announces the release of the new professional tweeter, the 30HM2. This small, "bullet" tweeter is perfect for use in sound reinforcement systems that require a cost effective alternative to piezoelectric devices.

The ProSystems 30HM2 is a true diffraction ring radiator, with a housing made of die-cast zinc, and is designed for durability and reliability in the field. It has a

duraluminum diaphragm, and a 1-1/4" diameter copper clad aluminum voice coil for exceptional high frequency response.

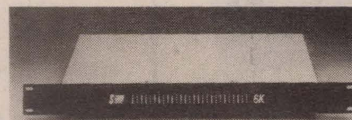
The 30HM2 can easily handle 30 watts (AES) of power, and has a typical efficiency of 110dB 1w/1m. The unit has a 14 ounce magnetic assembly, and has an overall weight of nearly 4 pounds (1.8 kilograms).

The 30HM2 is designed for front mounting in nearly all types of enclosures. One of its key features is exceptional unit-to-unit consistency through careful manufacturing and attention to detail. Recommended crossover for the 30HM2 is 5KHz at 18dB per octave.

Further information is available through:

PROSYSTEMS
THE AWS GROUP, INC.
65 36TH STREET, DEPT. NV
WHEELING, WV 26003-1946
304-233-2223
FAX 304-233-2258

6K REPEATER CONTROLLER



S-COM Industries is now shipping a powerful software upgrade with all 6K Repeater Controllers.

Features include:

A 100-setpoint Scheduler to execute tasks at programmed times and dates. Uses include changing the repeater's access mode based on day and night; generating special identifier messages for holidays or special events; announcing nets; charging batteries; weekly pager tests; and so on. Setpoints include specific times and dates, such as midnight, December 31st, or recurring events, such as 9:00 AM on the first Saturday of each month.

An Antikerchunk feature with programmable delay and re-arm timers to reduce annoying key-ups.

DTMF Decoder improvements, including Long Tone detection for all digits. This is compatible with the ARRL Long Tone Zero (LiTZ)

program. DTMF Priority and DTMF Scanning are programmable.

Repeater Monitoring and Talkout from the phone line was added.

Macro Expansion was accomplished to allow 280 macros of 100 characters each.

Run-Time Variables allow CW time and date stamping to be added to any programmable message.

The 6K Repeater Controller with Autopatch is priced at \$395.00. Older 6K controllers may be upgraded with a 6K V2.0 Kit for \$49.95 plus \$3.00 for shipping and handling.

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MRE-03	SRUT-SH-112DM	12VDC SPST N.O.	2A@120VAC	1.95	15.00
MRE-04	CD#701-387S	24VDC SPDT	3A@120VAC	1.95	15.00
MRE-05	ALLIED#T154X-1276	24VDC 6PDT	2A@25VDC	4.95	39.95
MRE-06	PBKA-4474-1	24VDC 3PDT	10A@120VAC	5.95	49.95
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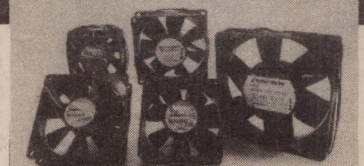
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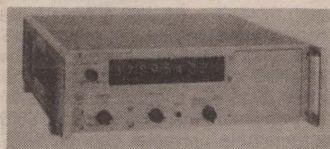
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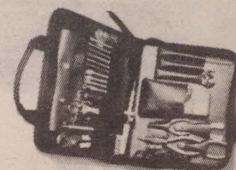
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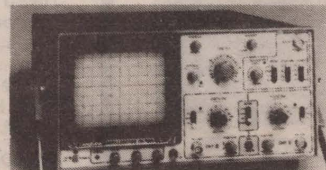


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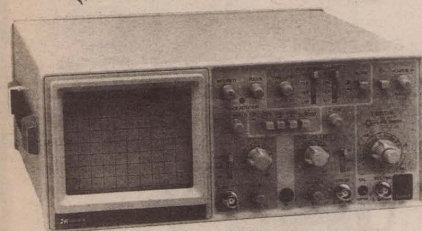
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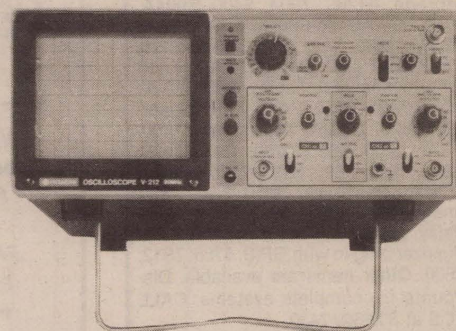
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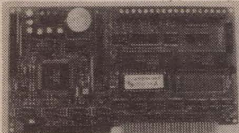
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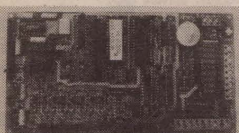


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68HC11

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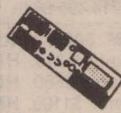
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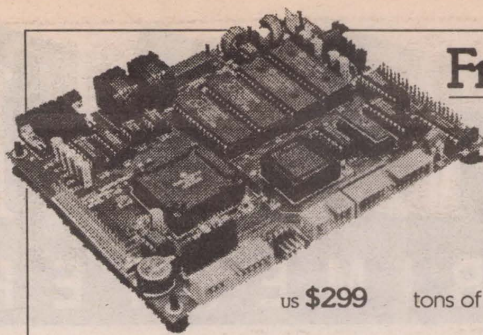
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THE LASER

EXPERIMENTER

by Anthony Charlton

Welcome! We have seen how lasers can be used for many applications. We've discussed how they can be used as weapons, as surgical scalpels, for measuring things with great precision, in data storage applications, for detecting minute vibrations, and even as a means for generating artificial stars in the outer regions of the atmosphere to help calibrate astronomers' optical telescopes. This time we'll have a look at a down-to-earth, practical application.

Imagine that you want to protect your property from the threat of intruders. For example, you may own a nursery whose trees are vulnerable to theft or you wish to protect an industrial site from vandalism. You could put up a chain link fence like I did long ago when I wanted to protect my fireplace wood from "help-yourselfers." (Wood was \$100.00 a cord then and I got sick of supplying free wood to lazy campers at that price). In that case, a thief had to climb the fence and over a strand of barbed wire on its top to rip off firewood — not a task worth the risk! But such a fence costs a great deal of money to purchase and install, and a determined crook with a pair of bolt cutters can make short work of such a fence. Were I to put up another fence, I'd choose a high-tech approach now — a Laser Fence!

The principle behind the Laser Fence is simple. You take a laser, bounce the beam off a few inexpensive mirrors called reflectors, and guide the beam to a detector. The detector remains in an off state until someone or something blocks the beam. Should that occur, an alarm goes off.

This device may be easily adapted to provide security for a single room or the perimeter of an entire estate.

The Laser Fence consists of three sub-assemblies which are:

- 1) The laser
- 2) The beam path optical system
- 3) The alarm electronics

Let's take a look at each sub-assembly in detail.

The Laser

The laser must be a reliable device capable of operating over long periods of time without overheating. If located out-of-doors, it must also be impervious to changing environmental conditions. The power level must be high enough to keep the alarm electronics from false alarms (called falsing). A small laser such as a 1/2 milliwatt could not be expected to develop enough power to protect an estate with a complex arrangement of reflectors, but a 5 milliwatt certainly should.

Another aspect is whether the Laser Fence is to be used just during nighttime or all the time. Daylight usage require a stronger

beam so that the laser is capable of overcoming the effects of bright daylight. However, the laser is much brighter than the sun at the precise wavelength at which it operates (this is why we don't stare at the sun or look into a laser beam); therefore, if the Laser Fence is used during daytime, be sure to increase the power twice over the value that provides reliable nighttime operation.

The laser must be mounted to a sturdy base since the reliability of the alarm is greatly related to how stable the mounting is. This is another manifestation of the "optical lever" principle, where a small movement at the laser will result in a large movement at a distance.

The beam path should be clear. Kids, pets, tree branches, or, locating the optical

and shine the beam out the window. Another suggestion is to be sure you have back-up power for the alarm. This system is designed to run from a 12 volt power supply, so you can simply use a rechargeable 12 volt battery as a back-up. The circuit actually will work with up to +15 volts DC, so you don't have to worry about damage if you keep the battery in a fully charged state. If you are dealing with a really sinister intruder, chances are one of the first things he will do is cut line power so as to disable AC powered alarm systems. Hence, the battery back-up is essential if you anticipate this type of intruder.

You can make your Laser Fence either visible or invisible as you deem effective. For an invisible fence, use a 780

nanometer (nm) laser diode. This would apply especially to an estate's perimeter alarm since you don't want to advertise the fact the beam is there, or the intruder could blow smoke in the beam

path (at night) and show up a place where he could step through. Fog will also show up the beam at night.

The 780 nm laser is nice since it's just SLIGHTLY visible, which makes alignment a lot easier than trying to do it with an invisible laser! It has a very deep, ruby color that you can see reflected off a white card at nighttime. Helium-neon and visible diode lasers may be used in situations where visibility doesn't matter, or where you actually want to advertise the fact your property is protected by a sophisticated Laser Fence.

Regarding the laser itself: You can use a He-Ne laser if the installation warrants it. Off-spec lasers may be used that are no longer suited for say, holography. Many surplus lasers will work just fine. Before purchasing, ask what the original power was when the laser was manufactured, and have the power tested as the laser is now. Allow it to warm up for 10 or 15 minutes so you get an accurate reading. If the power has dropped a great deal since the laser was manufactured, it's probably nearing the end of its useful life.

An example would be a 5 mW laser that now tests at 2 mW. It won't have much life left. But a 5 mW laser that tests at 4 or 4.5 mW, or better, will have a sub-

stantial portion of its expected 20,000 hour life left. Since there are 8,766 hours per year, a laser that has a full 20,000 hour life would last about 2-1/4 years before needing replacement.

A tip: Operate your laser 20% BELOW the normal current level. Thus, if a laser requires 5 mA, operate it at 4 mA and it will last longer, just like a light bulb will if the voltage to it is reduced. Also, I would be suspicious if the tube wouldn't operate at 20% below normal current level. My experience is that, if this is the case, the laser has aged considerably. As it ages in your installation, you may have to raise the current level a little to accommodate.

The Beam Path Optical System

This actually begins with the collimation. Assuming that's working properly, the next consideration is the reflectors. They should be front surface mirrors ideally. That is, they should be silvered on the face so as to avoid spurious reflections. Reflectors should be placed in strategic locations that afford maximum protection of your property.

Figure 2 shows an example installation. Note that the beam protects the entire house, garage, and most of the property, and prevents vehicles from approaching via

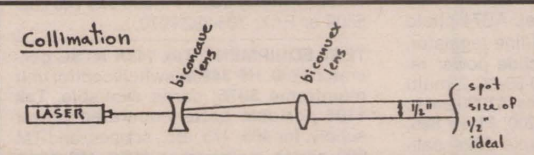


FIGURE 1

system in a known pathway of wildlife will all cause trouble and need to be anticipated. The beam path should be located out of reach of inquisitive eyes as well.

With long beam paths, the beam will require collimation. This is because the beam will spread out to the point where it isn't intense enough for the alarm electronics. Figure 1 shows a method of collimation that is entirely satisfactory. A stationary double concave (DCV) lens is used to first expand the beam, and a moveable double convex (DCX) lens is used to focus the beam at a distance. By moving the DCX lens, you can adjust the beam to its optimum diameter at the alarm electronics package.

That diameter should lie between 1/4" and 1" with most installations. You will discover that the larger spot sizes give more latitude than the smaller ones while aligning the system.

Mounting the lenses inside telescoping tubing is a good idea, since that way the DCV lens can be easily moved. Secure the tubing after alignment so the lenses won't move or vibrate and throw the system out of alignment.

One possible mode of failure should

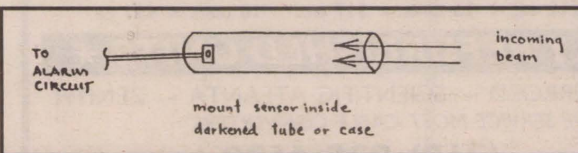


FIGURE 3 — Sensor shielding

be noted early: Mounting the mirrors to trees. Even if they are sturdy, it is a mistake, since the slight flexing in the breeze will trigger false alarms if there is a long beam path.

It is suggested that you mount the laser on a sturdy platform inside the house,

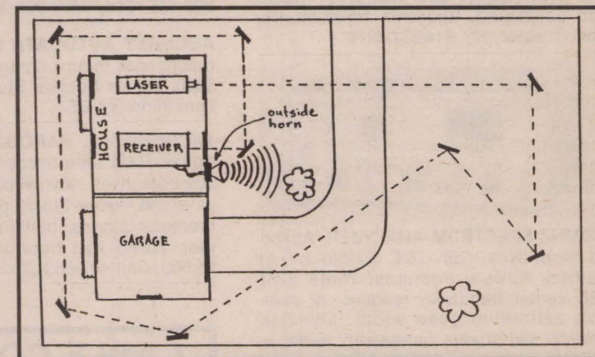


FIGURE 2 — A well protected property!

the driveway unnoticed. The mirrors are located a good distance from any vegetation both for reasons of the bushes interfering with the beam, and for the fact that bushes frequently are homes for birds, which conceivably could cause the alarm to false. However, we'll see in a moment that the circuit contains a Beambreak Delay feature which prevents falsing by small critters.

In positioning the mirrors, one has to take into consideration the height at which they should be placed. If they are too close to the ground, they could be stepped over or small animals, like cats, could cause falsing. If the beam is too high, an intruder could crouch under it. It is suggested that you place the beam height at about 3'6", which is about the height of an average man sneaking at a low crouch. This is also above the height of all but the largest breeds of dogs, and even so, they would have to be walking with their head held

high to activate the alarm.

Take into account the lay of the land. If you intend to protect land that has hills and valleys, it may be wiser to go to the trouble of putting in a few extra reflectors so that the beam stays more or less at the same height at all points relative to the land, rather than risk the beam getting too high or too low.

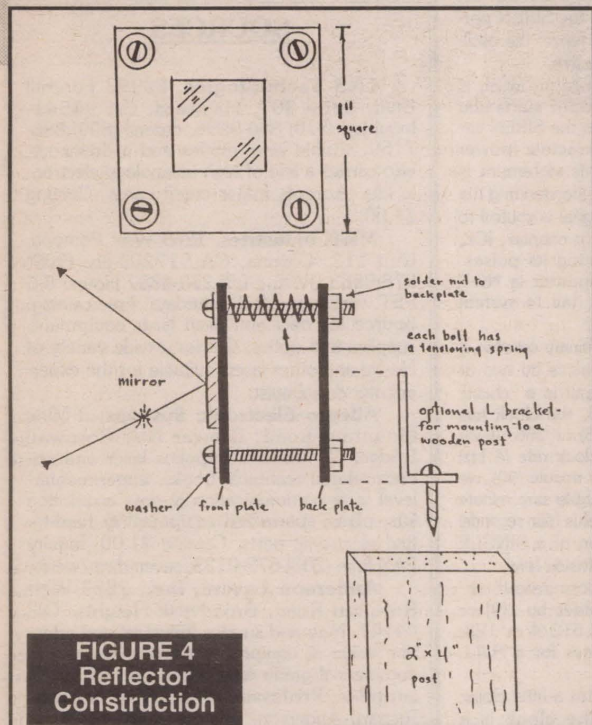


FIGURE 4
Reflector
Construction

When you place the mirrors, keep in mind the mentality of the intruder. Burglars wishing to break into a property or home will often "case" the place in the daytime, perhaps driving by looking for telltale signs of an alarm system. These criminals can be well-equipped, so it's not unlikely they would have a good pair of binoculars. You will have to use your own ingenuity at disguising the mirror mounts and the mirrors themselves.

Ideally, the mirrors should be quite small, perhaps 1/2" or 3/4" square so as not to be obvious. Some possible ideas for disguising mirrors and mounts: Make them look like part of a lawn sculpture; hide them inside a lawn ornament; or attach them to a permanent sturdy fixture such as a metal mailbox post, posts of an existing fence, or a metal lawn chair that's anchored to a concrete patio.

Perhaps you could make them look like a decorative planting; a trellis for vines or roses. Or you could locate them atop a small post that is sheltered from view by a tree. Of course, you'll have to keep up with trimming the plants if you do this!

The laser and the alarm electronics should be disguised as well. In the latter case, this is easy since the sensor can be located inside a small tube that looks at the beam (see Figure 3). The tube is connected to the alarm electronics with a piece of shielded cable, which prevents electrical interference and also enables you to locate the electronics (and backup battery) away from the window where it might be recognized as an alarm. Without the shielded cable, it's conceivable that ham or CB

radio operators could false the alarm if they key their mikes and are close by.

To wrap up the mirror location, just keep in mind that you don't want to advertise the fact (usually) you have an alarm because such knowledge is the first step in defeating it. One should also not talk about the alarm to anyone, as hi-tech and exotic devices always generate considerable gossip and speculation, and you don't know who will ultimately hear about your Laser Fence — maybe the person(s) you are trying to guard against!

Regarding the mirror mounts themselves, a simple and practical plan is shown in Figure 4. In this case, the mounting plates were made from copper roof flashing, the kind you get from the hardware store. Nuts will easily solder to this material, and that makes the usage of an adjuster bolt easy. Fine thread bolts were used in the

(Hardware stores often have springs or assortments of them. Another source is called *Small Parts*, which mail orders many useful materials for the experimenter, tinkerer, and those wishing to build mechanical prototypes from scratch). Then paint each assembly with an appropriate color of weatherproof paint. The object here is to choose a color that will aid in camouflaging the mirror mount.

The next step is to glue the mirror to the front plate. Here Silicone RTV is very useful, and has a lifetime outdoors of at least 10 years. It will stick to most paints without any problem.

You may also rough up the surface of the front plate until the copper shows through where the mirror will go. The mirror can also be the acrylic type. This kind of mirror can occasionally be found in hobby stores.

The Alarm Electronics

Figure 5 shows a block diagram of the alarm. The alarm may be built in two configurations. One is where it's just an alarm that will blast off if it detects an intruder and keep running until manually reset.

The preferential way to build this project is to include an automatic alarm cut-off that can be programmed to allow the siren to run for a pre-selected duration and then cut it off. However, you must reset the system manually to presume protection again. The circuitry within the dotted lines at Figure 6 shows the extra electronics needed to implement this feature. Figure 7 contains additional circuitry as well, and you can ignore it if you don't build the alarm in the second configuration that resets itself.

Two modes are available in each configuration. They are: silent or VERY LOUD. Silent alarms have the advantage of surprise, however it must be stressed that NO UNTRAINED INDIVIDUAL SHOULD TAKE ACTION AGAINST AN INTRUDER NO MATTER HOW TEMPTING IT MAY BE. AN INTRUDER IS LIKELY TO BE ARMED AND DANGEROUS. Leave all encounters to the police. That's what they are trained for.

It is recommended that the alarm be used in the super loud yelping mode since that's more likely to scare off an intruder. Referring to Figure 8, a SIREN ENABLE

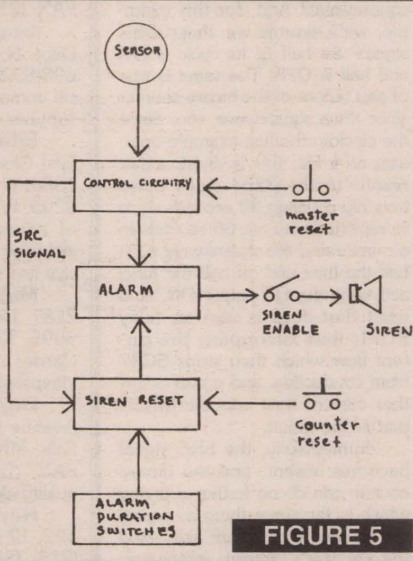


FIGURE 5

prototype. I used #10 bolts with a 32 thread per inch pitch which gave adequate sensitivity during adjustment. The front plate should have a hole larger than the bolt drilled in it, and a washer under the bolt head prevents it from slipping through the hole. The extra clearance gives room for fine tuning the adjustment of the mirror on two axes.

CAUTION: When drilling copper sheet, clamp it in a vise. Drills have a tendency to grab the sheet as it's almost drilled through, spinning it around. With the sharp edges of the sheet, this is equivalent to having a spinning razor blade, and we Laser Experimenters presumably want to keep all our fingers, eh?

Assemble each mirror mount, using a light tensioning spring on each bolt.

SWITCH AND ALARM FUNCTIONS FOR THE LASER FENCE

S1 — Master Reset Switch. Resets everything: Must be pressed after alarm is tripped to resume complete protection.

S2 — Sensor Shunt. Mimicks condition of untripped fence. Used while aligning the system to prevent alarm from being tripped.

S3 — This is used to reset the binary counter, IC2, from its jammed on, intruder-activated state so that the alarm is capable of being retriggered. Either S1 or S3 must be pressed to re-activate the alarm. However, if only S3 is pressed, LED1 will remain on, indicating a trip, until the Master Reset Switch, S1 has been pressed, at which point the entire system will reset itself.

S4 — Selects the audible profile of the siren. Left open, the siren sounds European, with an "aaahhh-eeee!" sound. Closed, it sounds like American police and most USA emergency vehicles with a "whoop! whoop!" sound.

S5 — Enables the siren when closed. Disables it when open.

***** NOTE:** The following switches are to have only one closed at once, or else the alarm will malfunction! ***

S6 — Closing this switch sets the siren duration for 30 seconds.

S7 — Sets siren duration for 1 minute.

S8 — Sets siren duration for 2 minutes.

S9 — Sets siren duration for 4 minutes.

S10 — Sets siren duration for 8 minutes.

Indicators:

LED1 — Indicates alarm has been triggered and not manually reset yet.

LED2 — Indicates alarm is in its ON cycle. May be used to visually show an intruder has penetrated the Laser Fence. When S5 is open, it may be used as a silent alarm indicator. Another use might be to connect an optotriac at this point in the circuit, and use it to energize a relay which switches on a bank of lights when the alarm is triggered to help scare off intruders. This lamp and any optional connected circuitry goes off after the siren has timed out.

LED3 — Power Valid Indicator. Remains on at all times unless S1 is being pressed.

Configurations and Modes:

Alarm may be built in two configurations. #1 is a straight "no frills" alarm with no reset on the siren. That means once triggered, the siren sounds indefinitely until a manual reset is done. Omit the circuitry of Figure 7, RLY1, and the 4 Hz Schmitt Trigger oscillator for this configuration.

Configuration #2 is where the alarm will sound for a pre-programmed amount of time, then shut off. However, the system still has to be reset manually to resume its ability to protect. Include the circuitry of Figure 7, RLY1, and the 4 Hz Schmitt Trigger oscillator for this configuration.

Mode #1 is where the siren is the super-loud version that performs in accordance with the configuration you choose to build. Furthermore, the audible profile of the siren may be chosen as European "aaahhh-eeee" or American "whoop! whoop!" sound via switch S4. Mode #1 is selected by leaving S2 closed and adding the circuitry of Figure 8.

Mode #2 is where there is no audible alarm. Just an LED light and whatever peripheral device(s) you would care to add on are activated. Mode #2 is selected by omitting the siren circuitry of Figure 8 or leaving S2 open.

switch lets you choose which mode to employ. Once triggered, the alarm continues to sound until it is reset by one of two methods: First is Manual Reset. The alarm MUST be reset manually to resume its protection. The second method of turning off the alarm involves an Auto-Siren-Off feature. This uses a timer to time-out the blast from the siren speaker and shut it off after a preset interval. It DOES NOT reset the alarm. Why? Imagine this scenario: You're away on vacation, and a storm blows a limb off a tree, shattering a mirror. The Laser Fence thinks it's an intruder, and the alarm keeps resetting and then triggering again instantly. Think of how popular you would be with the neighbors when you returned after your alarm was going constantly with an ear-shattering blast for days on end!

LASER NEWS AND DEVELOPMENTS

Laser Gyroscope May Guide Mammoth Robotic Mining Machines

Imagine deep inside the earth, a gigantic computer controlled, laser guided robot grinds away at the rock, day after day, week after week unceasingly wrestling coal or valuable minerals from the earth. Sounds like science fiction? Not if the U.S. Bureau of Mines is successful in instrumenting its continuous mining machines with a new hi-tech system. The problem is, of course, to guide the machines accurately without on-site human intervention. Several systems are used to accomplish this task. First is a transmitter-receiver combination that relays the commands, operating at 318 MHz. Commands are then sent to a Data Acquisition system within the machine. They are mixed with real-time data gathered by the robot's sensors which include an infrared distance measuring device, appendage sensors, and a ring laser gyroscope (RNG). The RNG is built by Honeywell, who calls the integrated guidance package the Modular Azimuth and Positioning System (MAPS).

Laser gyroscopes are more accurate, reliable, and durable than their mechanical counterparts since no moving parts are used. MAPS provides data on elevation, pitch, roll, X & Y position, and azimuth reference from true north, enabling the human operator to know exactly where the machine is and if it's on proper track. Even if the machine's treads slip while it's mining, the operator can still see if it's performing correctly since the guidance system will determine position from a reference mark placed in the area and thus calculate the real-time location. Two other parameters are used in determining the machine's position. One is called the TRACK, or the distance along the centerline from the reference mark to the end of the robot's forward movement, and the other CROSSTRACK, which is the deviation to the right or left of the centerline. These parameters are displayed in real-time on the control center's computer, and stored for later analysis.

The first full test, called Phase I, was successfully conducted in a West Virginia coal mine. In this test, a human operator guided the machine's work from the control center. During Phase I, the robot did two digs, removing a total of 444.3 tons of coal. The theoretical amount that could have been removed in this test was 472.6 tons, so the robot performed at 94% of theoretical efficiency, the difference being due to relatively minor problems with the navigational system because of vibration of the cutting head throwing off the readings. However, engineers are confident that the efficiency should reach the theoretical level after improving upon the navigational system.

An exciting future project involves INTELLIGENT CUTTING, in which the machine works entirely from a program with little human supervision. Improvements in the MAPS and other systems aboard the robot will no doubt make this idea a reality one day, and thus not only improve the efficiency of underground mining operations, but greatly reduce the overall hazard to human miners. Until relatively recently, miners have had to be directly exposed to the mining face, or the dangerous area in which coal or minerals are hewn from the underground veins. Uncertainties in the strata offer the threat of a deadly cave-in. But the laser-guided mining robot is expected to eliminate this particular hazard from mining operations, considering a machine is far more expendable than human lives.

Source: Sensors, January 1994

So there is really no reasonable way to have the circuit work other than to manually reset it once it's tripped. However, this shouldn't be a drawback. It would take an awfully dedicated intruder to stick around after this baby sounds off! The Auto-Alarm-Off feature is programmable with a 5 gang DIP switch, and allows SIREN duration of the following times: 30 seconds, 1 minute, 2 minutes, 4 minutes, 8 minutes. It is very important to mention that NO MORE THAN ONE SWITCH AT A TIME MAY BE SELECTED. If more than one switch is selected, the alarm will jam up and not reset the SIREN.

Local ordinances will determine how long it's permissible to have the siren run. Set the switches in accordance with this ordinance. Someone at the local city hall

upon its surface. In this condition, Gate A of a 74C14 hex Inverting Schmitt Trigger IC is kept low, and its output is thus high. This is inverted by two gates, B and C, connected to its output. In this condition, both SCR1 and SCR2 see a zero voltage at their gate terminal and thus remain off. All indicators and the siren are off except LED3, the Power Valid Indicator.

Along sneaks an intruder, and breaks the laser beam. Q1 will immediately turn off. Current now flows through R1 and VR1, the Sensitivity Adjust potentiometer. Capacitor C1, the Beambreak Delay capacitor, charges up, and once it reaches the trip point of the first Schmitt Trigger, produces a zero voltage at its output which is inverted by the two Schmitt Trigger gates to a positive signal.

Now, the action starts. Both SCR3 see a positive signal at their gates, and thus immediately turn on. SCR1 lights the Triggered Indicator LED which stays lit, and SCR2 supplies power to the SIREN circuit through the part of the circuit energized by SP+ ((S)iren (P)ower positive) (depicted by a solid black arrow).

Two things happen at this point. Immediately, the siren begins to sound, power goes to a 556 dual timer/oscillator circuit (IC3) and a power transistor (Q2), which steps up the current to a point to loudly sound the siren. SIR1, the speaker, should be a weather-

proof outside horn "PA" type CB speaker. It also should be capable of handling at least 7.5 watts.

The next thing that happens is the Siren Reset Clock (SRC), consisting of another Schmitt Trigger gate, starts to oscillate, producing a squarewave at a nominal 4 Hz rate. Normally, this oscillator is stopped by diode D4 and the fact that no power is in the SIREN portion of the circuit. Hence, the oscillator is normally inactive.

However — once an alarm is triggered, the oscillator starts and continues as long as the SIREN circuit remains in an active (power supplied) state. This statement is very important to understanding the circuit! The SRC signal is routed to the input of a binary counter, IC2, which starts counting its pulses. Note the binary counter is NOT connected to SP+, but to system power V+.

Since IC2 is a binary counter, it divides the SRC pulses by two at each successive output in a "chain" fashion. So, at Q8, the clock has been divided by 2⁸ or 256. If we divide this by the clock rate (4 Hz) and the seconds per minute (60), we get 64, which is roughly one minute (OK, OK, a minute plus four seconds) for the full duration of a SINGLE cycle at this binary division level.

Should we choose instead output Q9, which divides by 2⁹ or 512, that would be 512/4 or 128, or about two minutes for a FULL cycle.

Okay, follow this a little closely: Remember, the clock is a squarewave? And, for this example, we'll assume we chose Q8's signal? So half of its cycle is ON and half is OFF. The same is true of any output of the binary counter since it's a squarewave, too. Since the clock in the first example operates at 4 Hz, this is division that results in the 32nd clock pulse (roughly equaling 30 seconds since to repeat: There are 60 seconds to a minute and the squarewave is on half the time and off half the time) activating the Q8 output ON. And what that does is turn on relay RLY1, thus interrupting the current flow which then stops SCR2 from conducting, and prevents further current flow into the SIREN part of the circuit.

Immediately, the SRC signal becomes absent, and the binary counter can do no further counting which is the same thing as saying it's jammed at a STOP sign. And the counter's output, whichever one was selected, remains at a positive level until the circuit is reset or the switch S3 is tapped. So, the alarm cannot be fully reset until S1 is pressed for a second or two, which resets everything.

You can re-trip the alarm if you tap S3 to reset the counter, but the Triggered Indicator will remain on. S3 is primarily included as an aid to testing and calibration, and normally the circuit would be reset by S1 and the R-C network at the counter, which is connected, appropriately enough, to the RESET terminal of the counter.

Assembly

Assembly is not crucial and the circuit works just fine if put together on

Experimenter board (obtainable at Radio Shack) or perfboard. If you are a stickler for exact alarm duration, you may want to change R8 to 470 K-Ohms and include a 1 megohm potentiometer in the circuit. That way, the Schmitt Trigger oscillator that generates the SRC signal can be adjusted to provide an exact 4 Hz pulse. Also, I've

SOURCES

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. Accepts major credit cards. Catalog \$1.00.

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noticed different manufacturers of Schmitt Triggers have different specs, so one manufactured by National Semi probably won't oscillate at the same rate in an R-C circuit as one manufactured by Harris, so expect to encounter this.

You may add additional devices to the alarm part of the circuit provided they

Suggestions for future columns, questions, constructive criticisms, and laser related material are most welcome. Send all to: The Laser Experimenter, P.O. Box 74, Cornwall Bridge, CT 06754. We would like to publish letters in "Reader Feedback" occasionally. Indicate if using your name and address is okay. Individual replies to questions regrettably are not possible due to time constraints, but we will answer some questions in the column.

should help you find out about alarms. Referring to the main circuit diagram in Figure 6, let's trace the operation of the circuit.

Q1 is a NPN phototransistor which is normally saturated by the laser beam shining

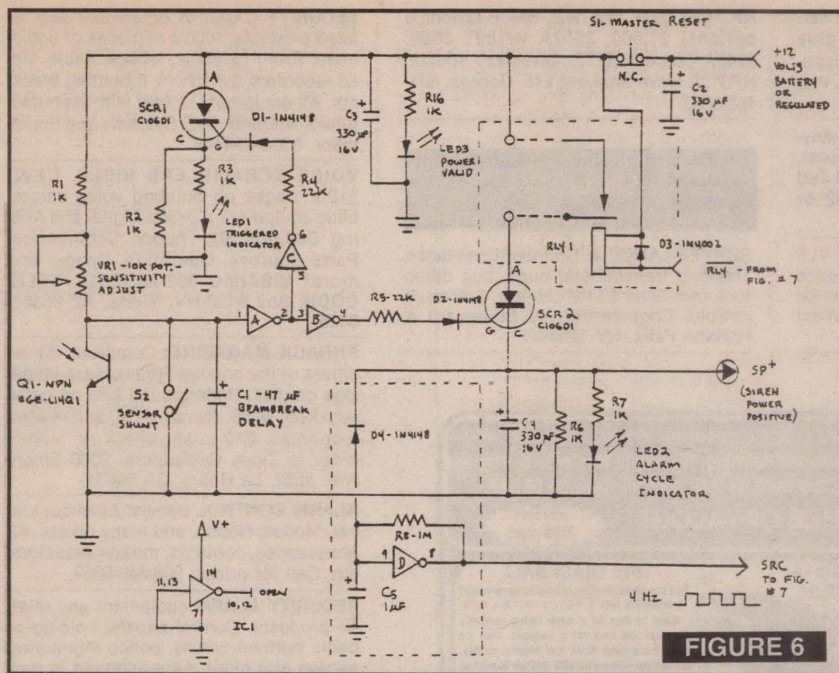


FIGURE 6

open S2. Take a voltage reading at pin #1 of IC1. It should read less than 1 volt. LED1 and 2 should remain off. If they came on, or the voltage at Pin #1 of IC1 is greater than 1 volt, there is a problem with the phototransistor or the alignment of the laser beam on Q1.

Adjust VR1 until the voltage at Pin #1 of IC1 is about 1 volt. This corresponds to a state ready to activate the alarm. Now, with a speed equal to a slow wave, pass your hand in the laser beam. The alarm should come on, as evidenced by LED2, the Alarm Cycle Indicator lighting (or an ear-shattering blast from the siren if you forgot to open S2).

If the LED didn't come on, you will have to adjust VR1 until it comes on reliably. It should not come on if you pass your hand quickly through the beam, imitating a flying bird, or the alarm will

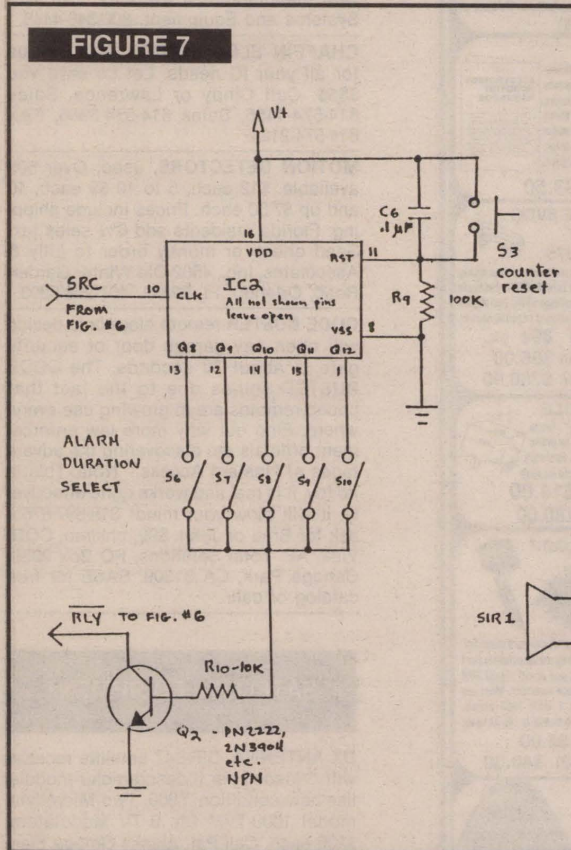


FIGURE 7

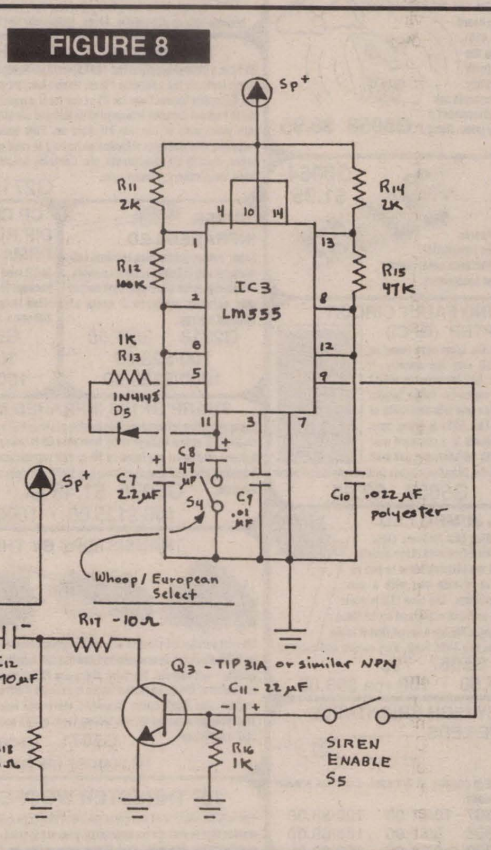


FIGURE 8

don't draw more than 4 amps, or SCR2 will be ruined. Additional loading will also cause this part to heat up, so you will likely need heatsinking. Another characteristic of this device is it's got to have a minimum value of current to stay on once it's triggered. That value is 3.0 mA which can easily be used by a LED lamp.

Regarding the sensor, use of the #GE-L14Q1 phototransistor is recommended, but not crucial to the project. One useful addition is a colored filter that preferentially lets in the light at the operating wavelength of your laser. For maximum effectiveness, you can purchase a narrow-passband laser filter from Edmund Scientific. Although they cost about \$30.00 and up, it's a good idea for use in critical installations in daytime. It

lets through just the laser frequency and light only a few nanometers in bandwidth to each side of this, thus eliminating almost all the effect of sunlight on the system.

Next, line up the optical system, and arrange it so the laser spot rests on the sensor. This may take some time, so have patience with the process. You may want to anchor a 2" x 4" stud or other solid support for the mirrors in concrete so that it will remain unmoveable. Close S2, the Sensor Shunt switch, and apply power to the circuit. LED's 1 and 2 should be off and LED3 on. Open S5, the Siren Enable switch. Close S4, the Whoop/European Siren Switch, and S6-S10, the Alarm Duration Select switches as needed.

Set VR1 to maximum resistance. Now

be tripped by birds and falling leaves. The delay should be set so that if you walk briskly through the beam, the alarm will trigger. The object is to find a setting that will not be falsed by flying birds (say at least 20 feet per second) and will trigger at the speed of a sneaking person (probably no more than 10 feet per second). Of course, any pace slower than that will trigger the alarm.

We hope you will enjoy the peace of mind the Laser Fence will bring you. As always, we are happy to get your letters at the Laser Experimenter's P.O. Box, and would like to hear from any builders of this system or any of the other projects that appear in this column. Coming up next month, we shall look at how to make our

PARTS LIST

Resistors

All resistors are 1/4 W, 5% carbon film unless otherwise specified

- R1 - 1,000-ohm
- R2 - 1,000-ohm
- R3 - 1,000-ohm
- R4 - 22,000-ohm
- R5 - 22,000-ohm
- R6 - 1,000-ohm
- R7 - 1,000-ohm
- R8 - 1 megohm
- R9 - 100,000-ohm
- R10 - 10,000-ohm
- R11 - 2,000-ohm
- R12 - 100,000-ohm
- R13 - 1,000-ohm
- R14 - 2,000-ohm
- R15 - 47,000-ohm
- R16 - 1,000-ohm
- VR1 - 10,000-ohm, 15 turn potentiometer

Capacitors

Voltages other than those given may be used provided they are above 16 WVDC

- C1 - 47 µF, 16 WVDC electrolytic
- C2 - 330 µF, 16 WVDC electrolytic
- C3 - 330 µF, 16 WVDC electrolytic
- C4 - 330 µF, 16 WVDC electrolytic
- C5 - 1 µF, 50 WVDC electrolytic
- C6 - .1 µF, ceramic disc
- C7 - 2.2 µF, 35 WVDC electrolytic
- C8 - 47 µF, 16 WVDC electrolytic
- C9 - .01 µF, ceramic disc
- C10 - .022 µF, polyester or mylar
- C11 - 22 µF, 16 WVDC electrolytic
- C12 - 470 µF, 16 WVDC electrolytic

Other Parts:

- Q1 - NPN phototransistor, #GE-L14Q1 or similar (available from Digi-Key)
- Q2 - NPN, PN2222 or similar
- Q3 - NPN, TIP-31A or similar power transistor

IC1 - CD4584 or 74C14 hex Schmitt Trigger integrated circuit

IC2 - CD4040 12 stage binary counter integrated circuit

IC3 - LM555 dual timer integrated circuit

D1 - 1N4148 or 1N914 signal diode

D2 - 1N4148 or 1N914 signal diode

D3 - 1N4002 rectifier

D4 - 1N4148 or 1N914 signal diode

D5 - 1N4148 or 1N914 signal diode

LEDs - High brightness LEDs, color of your choice

SCR1 - C106D1, 4-A sensitive gate silicon controlled rectifier

SCR2 - C106D1, 4-A sensitive gate silicon controlled rectifier

RLY1 - SPDT relay, Digi-Key #Z721-ND or similar

S1 - Normally closed pushbutton switch

S2 - SPST toggle switch

S3 - SPST toggle switch

S4 - SPST toggle switch

S5 - SPST toggle switch

S6-S10 - DIP SPST switches

SIR1 - Weatherproof CB "PA" type speaker, 7.5 or more watts

Miscellaneous:

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Microlynx trackball made by Honeywell for XT IBM compatible computers with MS-DOS up to version 3.0. These feature easy installation as it connects between your keyboard and your computer so no serial I/O card is needed. Features graphics driver, ergonomic design, self contained menu for user programming of ball and button definitions, text and graphics modes, fast direct cursor motion, etc. Comes complete with cable, instruction manual, software on 5 1/4" floppy. Brand new in boxes. NOTE: For XT computers only! Blowout Price:

G3649 \$4.50

G5514 \$2.95
This is probably the finest trackball ever made! It measures only 1 1/16" L x 1 1/16" W x 1/2" H. Made by Alps for a major laptop computer maker that went out of business. They are very precision made and highest quality. The components are all SMD with an IC marked 3JA1DT002/T80012CF and a tiny 8 position connector. They appear to be complete, new and very recent in manufacture. We have no hookup info or schematic. Hurry, these may not last long!

HANDBOOK OF KIT PLANS
We have a limited supply of the 1991 Electronic Hobbyist Handbook which features the complete Plans, Parts Lists, PC Board Layouts and Assembly Instructions for 31 of our most popular kits. Allows you to find out detailed information on many of our kits. Build them with your parts or buy the kit from us. This handy 100 page magazine also contains information on how to read resistor color codes, identify kit components, etc. Contains articles on Geigers, Amps, Sequencers, Alarms, etc.

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G5071 1 SCOOP \$5.00
10 SCOOPS (ABOUT 5,000) \$40.00

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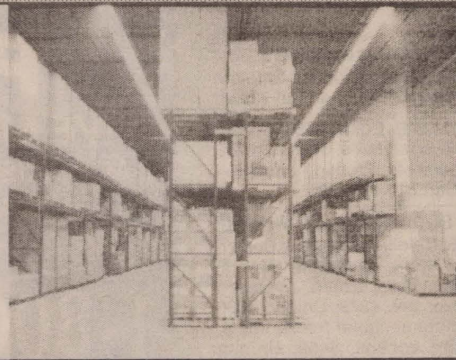
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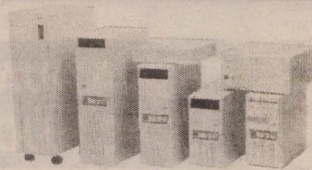
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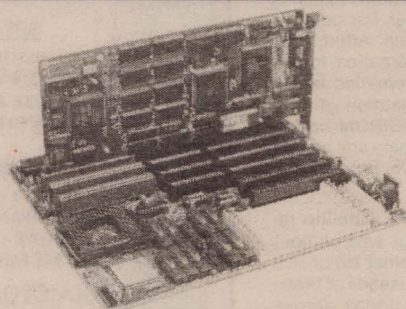
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386DX	40 AMD 128K 119 159 N/A N/A	
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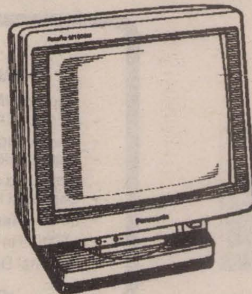
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Panasonic Office Automation

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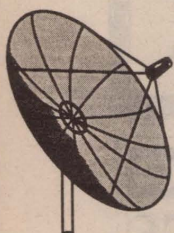
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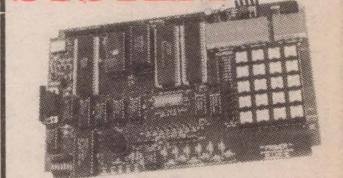
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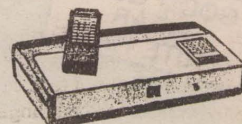
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Build a Voltage Meter

by Fred Blechman

This article covers four different voltage monitors, describing one in detail. These expanded scale voltmeters use different colored light-emitting diodes arranged in a vertical layout to show voltage steps above and below the desired voltage.

The schematic, basic theory of operation, and a complete parts listing, are provided for the 12-volt DC monitor, with information on the modifications for other voltage ranges. All the parts and a printed circuit board are available as a kit, or you can order just the printed circuit board. An optional pre-drilled cabinet is also available.

You can build this project with parts you might already have available, or you can obtain the parts from various suppliers that advertise in *Nuts & Volts*.

If you tinker at all with electricity or electronics, at home or for your car, you certainly have had occasion to measure voltages. It's simple enough to use a multimeter for this purpose if all you want is a spot check of a voltage at a particular time. But what if you want to monitor a changing voltage? And what if that voltage is only changing a relatively small amount from its normal voltage?

It can be expensive to dedicate a multimeter, which has many functions and ranges, to just monitor a specific circuit voltage. Furthermore, since multimeters invariably begin at a zero reading, it's hard to spot small variations within its broad range. This is when "expanded scale" meters are used.

The four "Voltage Monitors" described in this article have a number of advantages: they are small and inexpensive; they are designed to show voltage variations in relatively small

steps within a specific voltage range; you don't need to interpret a meter needle or numbers since they use light-emitting diodes (LEDs) of different colors to indicate normal, caution, and abnormal voltages.

If you want to closely monitor typical battery or circuit voltage, for example, the 5-volt and 8-volt versions of this design will monitor within .25 volts of the center voltage. These would be particularly useful for checking rechargeable batteries under load when used in radio-controlled model race cars and model airplanes, where minimum operating voltage must be maintained to prevent loss of control.

The 12-volt version can be built to monitor in 1-volt, .5-volt or .25-volt steps around the center 12-volt reading. This is particularly useful for monitoring car battery and voltage regulator performance.

The 110-volt AC version is used to monitor normal house voltage in approximately 5-volt variations centered on 118-volts. This can be used to monitor a home emergency AC generator, or the AC generator in a motor home. It can also indicate sagging home voltage during "brown-outs" to allow you to shut off computers or other equipment that might be adversely affected.

Circuit Operation

The schematic for the 12-volt direct current "12VDC Voltage Monitor" is shown in Figure 1. Figure 2 shows the component changes for operation at 5VDC, 8VDC and 110VAC.

The 12VDC circuitry, as shown in Figure 1, will be described in detail. The theory of operation is the same for the other units, although most voltages are different. As an indication of the similarity of all the units, the SAME printed circuit board, shown in Figure 3, may be used! The parts layout,

Figure 4, is also the same for all units, except that a jumper is used in place of D10 for the 5VDC unit, which does not use D10.

Looking at Figure 1, you'll see that we have seven LEDs arranged in a vertical line, each controlled ON or OFF by an operational amplifier (op-amp). Each of the op-amps is a section of either integrated circuit U1 or U2, LM324 quad op-amp integrated circuits (ICs).

The LEDs at the very top and bottom are red to indicate range limits. The next LEDs are yellow to indicate caution. The three center LEDs are green to indicate normal voltage. It is important to understand that the LEDs begin lighting at the bottom (LOW voltage) and keep lighting upward as the voltage increases to the top (HIGH), somewhat like a vertical bar graph. Of course, the unit may also be physically mounted horizontally, so the lighted LEDs progress conventionally from left to right instead of bottom to top.

To explain circuit operation, it is necessary to make a few assumptions. For example, assume the unit has been built for 1-volt steps, as shown in the chart with Figure 1. This means R1 is 2200 ohms (2.2K) and R15 is 680 ohms. All other values are as shown in the schematic. Also assume exactly 12 volts DC is connected to the input terminals, polarity as shown.

The input voltage follows several paths. The most direct path is to power the two ICs at pin 4 of each, with pin 11 of each grounded. This is the power to light the LEDs, as you'll see later.

A second path for the input voltage is through current-limiting resistor R18 and forward-biased signal diodes D8 and D9 to ground. These diodes are biased in the forward direction and have a characteristic approximate .7-volt drop each, so the total voltage drop across the two

diodes is about 1.4-volts. This acts as a voltage regulator for the resistor "ladder" consisting of R12, R10, R8, R6, R4, R2, and R1. In other words, the voltage at the junction of R18 and R12 is held at 1.4-volts regardless of the input voltage.

This also means that the voltage, which "divides" at each resistor ladder junction, is constant. Therefore, each junction becomes a reference voltage for its associated op-amp. This will become clearer later on with an actual example calculation.

Yet another input voltage path is through reverse-biased zener diode D10, R17, R16, and R15 to circuit ground. At any input voltage greater than the zener value — in this case, 7.5-volts — current flows through the zener and its series components to ground. The zener diode effectively maintains a constant 7.5-volt drop regardless of input voltage. This means that at the junction of D10 and R17 the voltage will be the input voltage minus 7.5-volts. This will also become clear with an example calculation.

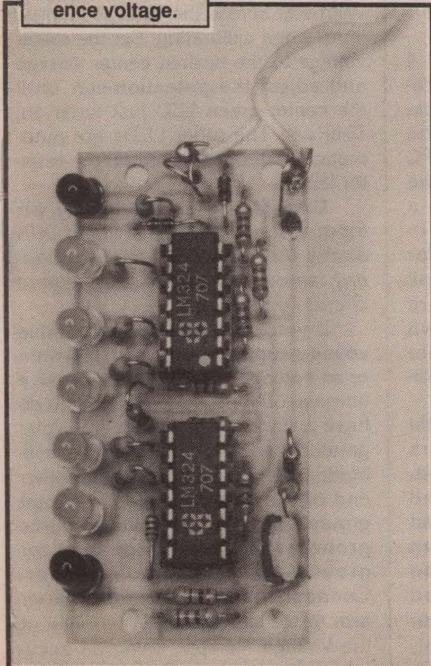
The op-amps, also commonly called "differential amplifiers," can be used in many ways, but most commonly are used as analog (signal) amplifiers. In this circuit, however, the op-amps are used as "comparators." Each op-amp has a plus and a minus terminal. As long as the positive terminal has a lower voltage than the minus terminal, there is no output. However, when the plus terminal voltage exceeds the minus terminal voltage, positive voltage appears at the output. As shown in Figure 1, the output of each op-amp goes through a resistor and LED to ground. Each resistor keeps its series LED from "avalanching" and exceeding its allowable current.

Let's do some actual calculations to explain how this all works together. With the assumed 12-volts DC at the input to the circuit, the

Four expanded-scale voltmeters can be made from the same basic design: 5VDC, 8VDC, 12VDC, and 110VAC.



Two quad op-amp ICs drive seven LEDs based on a resistor ladder with a set reference voltage.



junction of R18 and R12 is held at 1.4-volts by diodes D8 and D9. At the junction of each of the ladder resistors, a specific voltage appears based on a simple "voltage divider" calculation — a ratio of resistances.

To calculate the voltage at any point on the ladder, first determine the total resistance from the junction of R18 and R12 to ground. Then divide that into the total resistance from the desired ladder point to ground. Then multiply by the 1.4-volt ladder reference voltage.

For example, to calculate the voltage at the top of R6, add the values of R12 to ground, a total of 8.2K. Now add the total of R6, R4, R2, and R1 — a total of 5.2K. Divide 5.2 by 8.2 and you get .634. Now multiply by 1.4, and the voltage at the top of R6 calculates out to .888-volts. This is the reference voltage at the minus terminal of op-amp U2d. Since the divider ratios are lower at the junctions lower on the ladder, each of the op-amps below U2d on the schematic have lower reference voltages.

Now look at the voltage division between zener diode D10 and ground. Assume the R16 potentiometer is set exactly at center, which would be 500 ohms, and calculate the voltage at this point (the wiper arm), since this is the voltage that appears at the positive terminal of ALL the op-amps. The total resistance of R17, R16, and R15 is

4300+1000+680, or 5980 ohms. The resistance from the potentiometer wiper arm to ground is 500+680, or 1180 ohms. The ratio is 1180 divided by 5980, or .19732. The assumed 12-volt input voltage is dropped 7.5-volts by D10, so the voltage at the top of R17 is 12 minus 7.5, or 4.5-volts. Multiply .19732 by 4.5 and you get .888-volts, the voltage applied to the positive terminal of U2d — and the same as the voltage at the negative terminal, calculated in the previous paragraph.

Since the voltage on the positive terminal of the op-amp is now equal to the negative terminal, a slight increase in the 12VDC input causes voltage to appear on the output of U2d, turning on LED D4 through R9. Since LEDs D1, D2, and D3 are "lower" on the divider ladder, and therefore have lower reference voltages, they are already turned on.

As the input voltage increases above 12-volts, the voltage at the positive terminal of U2a increases until it reaches the fixed reference negative terminal voltage, at which time LED D5 lights — and so on, until at 15-volts input D7 lights.

The chart of Figure 1 shows the values to substitute for R1 and R15 to have the 12VDC Voltage Monitor LEDs light in .5-volt or .25-volt steps instead of 1-volt steps.

That's the theory. However, in the real world, it's not quite that sim-

ple. For one thing, the 5% resistor tolerances create some inaccuracy. Furthermore, the nominal resistor values are standard values, not special calculated values. To some degree, you can set potentiometer R16 to at least get the center LED, D4, to turn on at the center voltage, but the other LEDs will not necessarily turn on at the exact "steps" intended.

Also, silicon diodes don't all have exactly the same forward bias voltage drop, and zener diodes have tolerances, so the voltages created at the anodes of D10 and D8 are probably not exact, and vary with temperature, humidity, and possibly even the phases of the moon! My point is that this is not intended to be an accurate laboratory instrument, but is excellent as a guide to approximate voltages within its range.

Construction

Fortunately, these Voltage Monitors are not sensitive to your understanding, or lack of understanding, the theory of operation. A single printed circuit (PC) board

(Figure 3) will accommodate all four versions — 5VDC, 8VDC, 12VDC, and 110VAC. All you need to do is decide in advance which version you want to build, and select the components from the charts in Figure 1 and Figure 2.

Figure 4 shows the placement of the parts if you use the specified PC board. With the exception of a jumper used in place of D10 for the 5VDC unit, all components are placed as shown — and all require the jumper to the right of U2.

You can build these monitors using any insulated or perforated board, or you can make your own PC board using Figure 3. Lead lengths or position are not critical, since this design

CHANGES FOR OTHER VOLTAGES...

5VDC	<ul style="list-style-type: none"> REPLACE ALL 470-OHM RESISTORS WITH 330-OHM R1=18K R15=1.5K OMIT D10 ZENER DIODE .25-VOLT STEPS
8VDC	<ul style="list-style-type: none"> REPLACE ALL 470-OHM RESISTORS WITH 330-OHM R1=18K R15=1.5K USE 5.1-VOLT ZENER (1N4733) .25-VOLT STEPS
110VAC	<ul style="list-style-type: none"> REPLACE ALL 470-OHM RESISTORS WITH 330-OHM R1=8.2K R15=680-OHMS USE 5.1-VOLT ZENER (1N4733) APPROXIMATELY 5-VOLT STEPS

FIGURE 2 — Other Voltages

does not operate at radio frequency.

In assembly, be particularly cautious of the orientation of the ICs, diodes, and LEDs. If using the PC board, the ICs should be placed with the notch on the left; the diodes with the banded cathode as shown; and the LEDs with the flat spot on their base to the right. And don't use too hot a soldering iron, or one with a large point; a 30-watt iron with a 1/8-inch diameter tip shaped to a point or wedge is best.

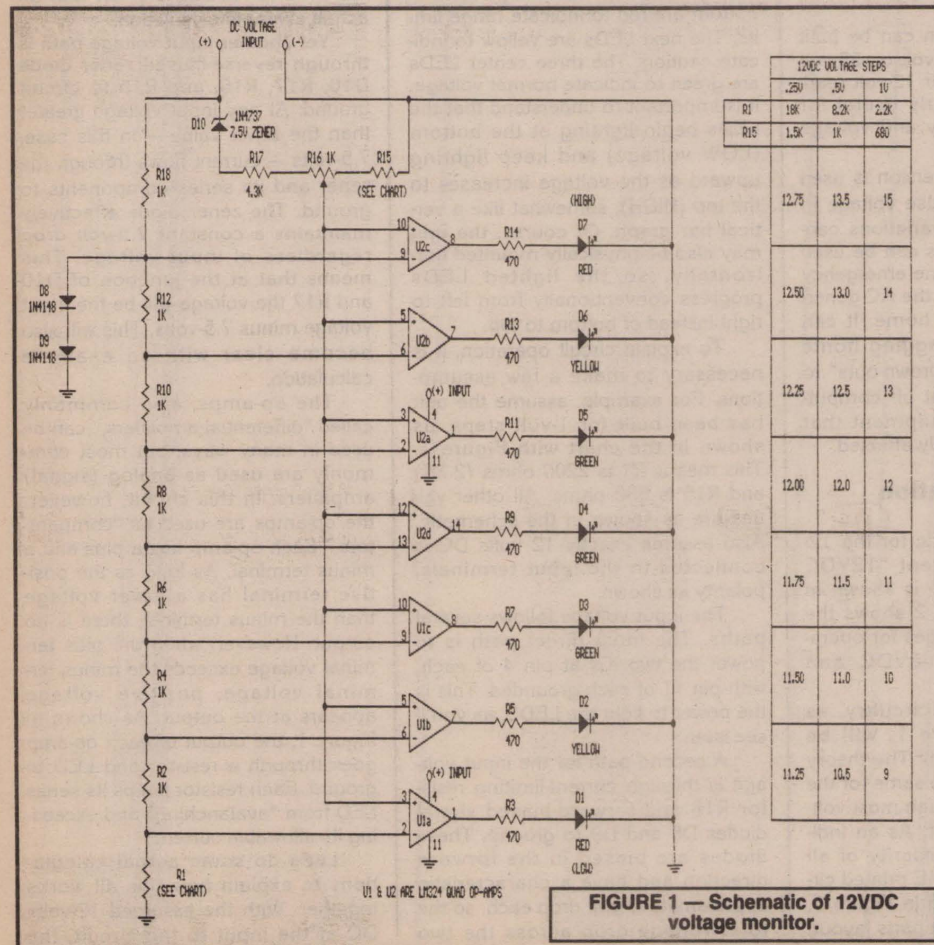
A cigarette lighter plug is included with the 5/8/12VDC kit offered. This makes it convenient to use the 12VDC unit for automobile use.

Calibration and Operation

The Voltage Monitor circuit includes a miniature potentiometer (R16) to allow you to set the center green LED to the nominal voltage to be monitored. The calibration is easy if you have a variable voltage supply. For best accuracy, connect a digital voltmeter across the Voltage Monitor input when calibrating. Set the meter voltage to the desired center voltage and adjust the potentiometer until the center green LED just turns on. That's it! The other LEDs are automatically stepped based on the resistor ladder.

CAUTION: Don't apply an input voltage more than about 30% above the high LED voltage reading, since this might harm some circuit components.

If you don't have an adjustable voltage supply, connect a 100-ohm or so potentiometer from the positive terminal of the voltage source you do have (which must be several volts greater than the desired center calibration point) and connect the other end of the potentiometer to circuit ground. Be sure the voltage source ground and the Voltage Monitor ground are connected together. Connect the potentiometer wiper arm to the positive input terminal of the Voltage Monitor. Using an accurate voltmeter, set the wiper of the



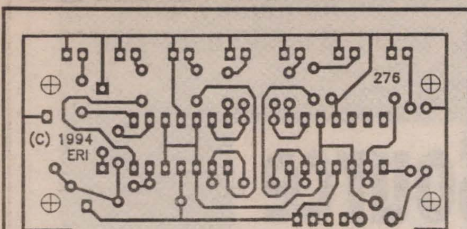


FIGURE 3 — Printed circuit board layout for all four versions of Voltage Monitors.

potentiometer to the desired center Voltage Monitor voltage and adjust R16 until the center LED just turns on.

The AC unit uses a wall transformer that delivers about 9-volts DC from a 118-volt AC source when operating. Most DC wall transformers (including the one supplied with the 110VAC kit) are not regulated, and their output voltage drops as more current is supplied. To calibrate the 110VAC unit, plug in the wall transformer, measure the AC voltage with an accurate AC voltmeter, and set R17 so the appropriate LEDs light.

In operation, just connect the Voltage Monitor terminals to the voltage being measured, observing input polarity for the DC units. If you are using the 12VDC unit, the cigarette lighter plug should be wired with the polarity of the car — usually the center terminal on the plug is "hot" (positive voltage).

The most common usage of the 12VDC unit is to monitor car battery voltage. When the car is at rest, probably all the LEDs up to the second green LED will be lighted. As you start the car, these will go out, leaving the yellow and red LEDs, or just the red LED, lighted. This is because starting the engine temporarily lowers the battery voltage. As soon as the car starts, the generator or alternator and charging regulator become active, and the lights move up scale. When idling, all three green lights should be lighted. If the top red light comes on at idle, either your regulator is set too high, or your Voltage Monitor is not properly calibrated.

Remember, although the Voltage Monitor can alert you to a problem, this is not a laboratory instrument, and car voltages can vary with load, especially when idling.

Troubleshooting the Voltage Monitor

The four most common problems with do-it-yourself projects are parts put in the wrong place, polarity sensitive parts installed backwards, poor solder joints, and solder bridges. Check to see that all the parts are

installed as shown in Figure 4, and that you haven't omitted the jumper to the right of U2 (and the jumper that replaces D10 for the 5VDC unit). Make sure the diodes have the banded ends (cathodes) as shown, and that the notched end of each IC is on the left. The flat part of the base of each LED should be on the right side.

Solder joints are best checked with a magnifying glass. Any solder joint that looks grainy rather than shiny is suspect, and may be worth touching again with a hot soldering iron. Be sure solder hasn't jumped across points that should not be connected together. The PC board layout shows all the connections.

Packaging

A custom-drilled black plastic cabinet is available (see the Parts List). This has pre-drilled holes for each of the LEDs. If you use this case, make sure when assembling the project that the LEDs are placed high enough above the board to fit through the holes.

Labelling the LED voltages is up to you. I made a paper label using a desktop publishing program with my computer and laser printer, punched holes for the LEDs to poke through, and then rubber cemented it to the top of the custom cabinet, as shown in the photo.

Any cabinet can be used, depending on your application. You may want to package your 12VDC Voltage Monitor, for example, to fit on — or in — your car dashboard. You may want to build it into a custom battery charger.

Summary

While certainly not intended to replace a digital multimeter or a precision analog meter with an expanded scale, the Voltage Monitors described here can be built quickly, easily and inexpensively to provide a

variety of uses. They especially lend themselves to installation in customized equipment. With a quick-reading visual readout indicating safety, caution, or danger, these Voltage Monitors are unique. NV

Fred Blechman has written over 650 magazine articles and five books about electronics and microcomputers since 1961.

12VDC Voltage Monitor PARTS LIST

D1, D7: Red LED
D2, D6: Yellow LED
D3, D4, D5: Green LED
D8, D9: 1N4148 or 1N914 silicon signal diode
D10: 1N4737 7.5V zener diode
R1: See text
R2, R4, R6, R8, R10, R12, R18: 1K 1/4-watt 5% resistor
R3, R5, R7, R9, R11, R13, R14: 470 ohm 1/4-watt 5% resistor
R15: See text
R16: 1K miniature potentiometer
R17: 4.3K 1/4-watt 5% resistor
U1, U2: LM324 quad operational amplifier IC
MISCELLANEOUS: 14-pin IC sockets, cigarette lighter plug. Optional: printed circuit board, drilled plastic cabinet with mounting hardware.

NOTE: The following items are available from Electronic Rainbow, Inc., 6254 LaPas Trail, Indianapolis, IN 46268. Phone: (317)291-7262. All orders in the continental U.S.A. must include \$4.00 shipping and handling per order, except as noted. (For more than two kits, or Alaska/Hawaii/Canada, call for shipping and handling.) Indiana residents add 5% sales tax.

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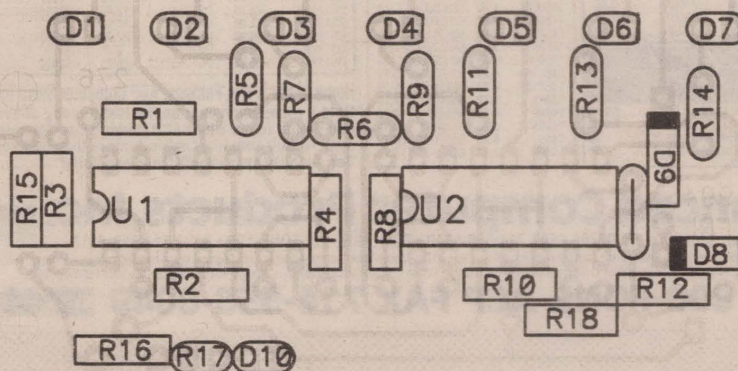


FIGURE 4 — Parts layout. For 5VDC unit, use jumper in place of D10.

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27C401-12	120ns	32pin	29.49	28C16-25	250ns	28pin	7.79

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4016	.35	4069	.25
4017	.45	4070	.25
4023	.55	4071	.25
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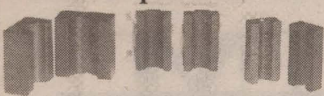
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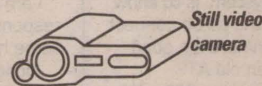
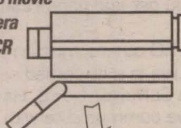
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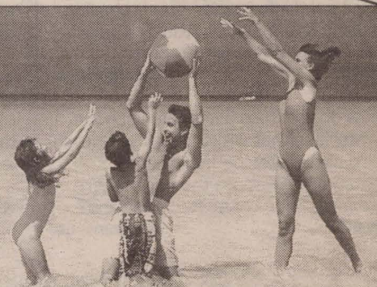
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Nuts & Volts Magazine/April 1994

Questions & Answers

TECH FORUM

This is a READER TO READER Column. All questions AND answers will be provided by Nuts & Volts readers and are intended to promote the exchange of ideas and provide assistance for solving problems of a technical nature. All questions submitted are subject to editing and will be published on a space available basis if deemed suitable to the publisher.

QUESTIONS

I have a serious scanner habit and a not so serious amateur radio habit. [5 scanners, 3 2-way (10-12 meters, VHF-FM, & CB)]. My backyard is very small. Should I have my 2-way antennas mounted above my scanner antennas (they're all mounted separately on poles) or vice-versa. Can this close proximity damage my scanning receivers? If so, how can I change this? I sometimes transmit 200 watts.

#4941

Jos F. Heleringer
Pompano Beach, FL

If any readers have information on how to back-up the EPROMS in Super Nintendo game cartridges please let me know. I used a 27C040 and it appeared to program correctly, but it did not work. If the game chip has a different pin configuration, please let me know how to make adjustments.

#4942

Anonymous

I was given a motherboard out of an original IBM 286 AT. I also have all of the necessary peripheral interface cards, but the system is not operational because there is no clock chip on the motherboard. The board came with a turbo card which was disconnected and I don't know how to reconnect it. All I need, for a workable system, is to know where the leads from the turbo connect on the motherboard. Where's a good samaritan who owns an old AT?

#4943

Mike Wax
Reseda, CA

Can anyone give a simple, logical troubleshooting outline for TVs (dead), including picture tube or IHVT, without schematics, or picture tube checker?

#4944

Ralph Weimer
Cincinnati, OH

I need to prevent people from examining the design of a board. I have seen other projects that are encased in black epoxy. I need information on purchasing and using this material. Also, is it possible to defeat the epoxy protector?

#4945

Anonymous

How do you build a simple telephone line interface that will tell you if you have a third party listening? Voltmeter (ammeter)? What are the parameters for testing 1-line volts? 2nd open line?

#4946

Anonymous

How do you find out what a component is when the real part number isn't on the part (such as when they don't want you to know)?

Is it possible to split the top of the IC exposing the silicon and going from there, find out what it is and pin out?

How can you replace sync on an IF signal without demodulating it if you

already have the correct sync regenerated for base band? Want to add sync prior to demodulation.

#4947

Derrick Baker
Los Angeles, CA

I would like to obtain information, hardware and software, to down-load and upload automotive computer data.

#4948

Dan Perkins
Holbrook, NY

I need a better performing cell-phone antenna than my 3dB gain roof mount. Would the old CB antenna tricks like co-phasing or better yet, something like the "Super-Scanner" in omni-mode. At 900 MHz this should be compact enough to run on a mag mount, have low wind drag and great gain.

#4949

Grant Maxwell
Nanaimo, British Columbia
Canada

Does anyone have any info and/or schematics on an ET-Tronics Model PR-30 scintillator? If I could get the hi-voltage to work, it would operate OK.

Also, does anyone know where to get a DP8473 or UM8398 Floppy Disk Controller chip?

#49410

Dan Smith
Cotati, CA

I am impressed with the quality of responses you get and hope I can get some help.

Along with 50 others, mostly retired Americans, I live in a dispersed settlement in, Baja California Norte. Having no telephones we communicate with Radio Shack TR 503 49-50 MHz \$30.00 Walkie Talkies. They work surprisingly well! Security is something of a problem especially when owners are absent.

To help overcome this problem I have married a JM Electronics Digital Voice Board with a 16 second EPROM, to a Radio Shack TR 503 (board only) tied together with a 555 and Reed Relay to provide a one minute power-up cycling of a call for help at the beginning of each alarm cycle. When the alarm triggers, 12 volts from the back-up battery, then an auxiliary relay provides power to the timer board which is further regulated to 9 volts and 5 volts. Effectively the system is isolated from the siren circuit.

The three boards are sandwiched into a plastic box 3x7x2 with aluminum cover with the antenna oriented to the TRC board approximately like it was in the original package. A small unit that can be easily located for best radiation, it has worked rather well, with neighbors turning out in the middle of the night "foiling the banditoes" even when they cut power and/or siren lines.

My problem is that I get slight distortion, and I am wondering if I am inputting the signal to the transmitter in the best way. The 8 Ohm output from the voice

board is being directly fed to the transmitter board from a 220uF capacitor from an LM 386 amp. A 50K W VR is set to limit the signal on the input pin 3 of the LM386.

The speaker/mic is not used and the output of the voice board is tacked to wiper of 10K W VR that goes from the emitter of an NPN transistor and ground. The preceding circuit is not disconnected. It consists of an LP filter and mic IC amplifier.

When I have experienced distortion in testing between the alarm transmitter and another receiver, I found that I was able to transmit from another Walkie Talkie from that location without any distortion. I have made this test with a number of different alarm units and TR 503 in different locations.

Could the problem be caused by the functioning of the digital switching?

How do I solve this problem? It's ruining my image! I will be happy to send information to any reader who can help. Maybe one of your experts might address this.

#49411

Clem Beck
Chula Vista, CA

I would like to know if anyone really has a good reason why the FCC does not allow frequency modulation on CB radios. From speaking with a representative I gathered that the rules and articles are not up to date. Those articles were written, who knows when!

#49412

Johnson Munakwa
Waltham, MA

ANSWERS

ANSWER TO #29410 - FEB. 1994

Converting a scanner with plug-in crystals to receive mobile phone conversations is possible but not practical. Until scanners with 800 MHz frequencies build in became popular, many devices existed to down convert the 800 MHz phone frequencies down 400 MHz to accommodate most programmable scanners. The device was sold as a way to listen to public service bands on the 800 MHz band on scanners without 800 MHz. You could buy one of these down converters and plug it into the antenna jack of your scanner and program your scanner to frequencies between 400 MHz and 512 MHz. The scanner would then receive frequencies between 800 MHz and 912 MHz.

Technologies improved and programmable scanners in the 800 MHz range were made available, and the down converters slowly disappeared. These new scanners had the cellular frequencies blocked out but could easily have them restored by cutting a resistor or diode going to the microprocessor.

Since last year, though, new scanners sold in this country could no longer have

QUESTION INFO TO BE CONSIDERED FOR PUBLICATION

All questions should relate to one or more of the following:

- 1) Circuit Design
- 2) Electronic Theory
- 3) Problem Solving
- 4) Other Similar Topics

INFORMATION/RESTRICTIONS

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

HELPFUL HINTS

- Be brief but include all pertinent information. If no one knows what you're asking, you won't get any response (and we probably won't print it either).
- Write legibly (or type). If we can't read it, we'll throw it away.
- Include your Name, Address and Phone Number. Only your name will be published with the question, but we may need to contact you.

ANSWER INFO

- Include the question number that appears directly below the question you are responding to.
- Payment of \$25.00 will be paid within four weeks of publication if your answer is printed.
- Only one answer per question will be printed.
- If you do not want your name, address, or phone number available to the reader please so indicate or it will be assumed that you have no objection.
- In the event that more than one person submits the same solution, the choice will be made at the discretion of the publisher.
- Due to space limitations, we can not reprint the original questions with the answer. The question number and the issue it appeared in are printed above the answer.
- Unanswered questions from a past issue may still be responded to.

the cellular frequencies available to them even if blocked out. The down converters as a unit were also made illegal to sell on the open market, but kits of these down converters were not made illegal.

So, if you could obtain one of these down converters, and a whole bunch of crystals (i.e., every available crystal for the frequencies between 400 MHz and 512 MHz that was 400 MHz less than the cellular phone frequencies) you could receive cellular phones on your plug-in crystal scanner. I know that receiving 800 MHz frequencies on a plug-in crystal scanner and down converter is possi-

ble because I used this method to listen to my local police department when they went to 800 MHz. I had a difficult time obtaining the crystal 400 MHz below the desired frequency but the method worked.

Although it is possible to receive the 800 MHz cellular phone frequencies on a crystal scanner, the price of the crystals alone makes it not worth considering. If you figure that the cost of a crystal is about \$10.00 and a down converter is about \$50.00, you could spend as much on five crystals and a down converter as you would on a good used scanner capable of receiving mobile phones.

Tim Naami
Cary, IL

ANSWER TO #2948 - FEB. 1994

One source for the MPSH81 transistor is Newark Electronics. Newark stocks almost everything, and there are branches in nearly every state. A free catalog can be obtained from: Newark Electronics, Attention Catalog Department, 4801 N. Ravenswood Ave., Chicago, IL 60640-9944.

The NTE replacement guide suggests an NTE-106 as an acceptable substitute (similar to ECG-106). The SK replacement guide suggests an SK-3118. However, an NTE-106 will cross to an SK-3984.

Arnold Neace
Frankfort, KY

ANSWER TO #2941 - FEB. 1994

I have a JVC VCR Model HRD670U that exhibited the same intermittent symptoms in play and record modes of

operation anywhere from 5 minutes to 1 hour to not shutting down after 2 or 3 hours. In my case I replaced a \$10.00 relay controlled by the stop button. If you are handy, you can remove the top cover and try to determine if your VCR is similar and locate this relay by starting and stopping the VCR operation until you locate the relay.

Julius Finkel
Northridge, CA

ANSWER TO #3946 - MAR. 1994

TV amplifiers installed at the antenna frequently cause reception problems when there is a strong off-channel RF source nearby. These amplifiers seldom have any selectivity built in, and when they are "hit" by a strong signal, they generate "crud" that extends from DC to light, interfering with whatever channel the crud lands on. Once the crud is generated, a notch filter will not eliminate it. This is called "fundamental overload" interference.

It makes a big difference where in the system you put your filter. Of course, the amplifier has to be near the antenna, or coax losses will sap the signals you want to look at. But if you put the filter between the antenna and the amplifier, the strong off-channel signal never gets to the antenna amplifier, and the crud never gets generated. For every dB you knock down the off-channel signal, you'll get a 3 dB reduction in crud, as a rule of thumb.

A fairly deep, sharp, single frequency filter can be made with just a coaxial T connector and a resonant coax stub. See most any good amateur radio antenna book for dimensions.

Denton Bramwell
St. Joseph, MI

ANSWER TO #3948 - MAR. 1994

There are a couple of approaches you can try to end the co-channel interference you are experiencing on your scanner. The first thing to do is make sure the interfering service (the cemetery) is in fact on the same channel as your local police. It would be unusual for the FCC to license two stations in close proximity to the same channel. You can either consult a channel directory (Radio Shack "Police Call," or whatever) or just call the cemetery and ask. If they turn out to be on a different band (e.g., 150 MHz), a notch filter for that band (from Grove Electronics or another supplier) may solve the problem.

If they are located close to each other (12.5 KHz apart, for example), you may want to consider a scanner with better adjacent channel rejection than the one you use now. Try a Realistic PRO-2006 which is designed for dense metropolitan signal environments.

If they are truly on the same channel, then the police department and the cemetery must be doing something to keep themselves from hearing each other. They are likely using a CTCSS tone squelch system. Briefly, this system transmits a low frequency (60-200 Hz) tone along with the user's speech. All the associated radios look for this particular tone. If they don't see it in a transmission, they won't break squelch. (This is also referred to as a "PL" tone system.)

If the police are using PL tones, this will be listed in a good scanner guide

(Scanner Master, for example). If you can't get this information from a publication, you can call the radio shop that services your police department's radios and ask (nicely!) if they will help you out. Sometimes a personal visit, with your scanner in tow, works better. A last resort is to buy, beg, or borrow a "tone finder" and attach it to your scanner and check the transmissions yourself. These cost a couple of hundred bucks from suppliers like OptoElectronics, so you may want to try the "borrow" approach first. You may even be able to sniff out a PL tone using an O-Scope, but it's a hassle.

Once you get the tone frequency, you can either buy a scanner that will check for the tones (e.g., ICOM 2SRA, R-100 or Uniden 890XLT) or get an external tone recognizer for your scanner. Hooking up the latter will require a bit of digging in your scanner.

If the interferer is considerably lower in power than the police channel, you could add an RF attenuator to the input (or just turn up the squelch knob!), but this will cause you to lose weak signals on other channels as well. One true hacker approach is to use a "sense antenna." This is a highly directional antenna pointed at the interfering transmitter. The signal from this antenna is then fed 180 degrees out of phase with the signal from your main antenna. If this is done properly, it will cancel only the interfering signal. It's cool when it works, but pretty finicky to set up and may well cost more than a new scanner.

George R. Scott
Alexandria, VA

Continued on page 134

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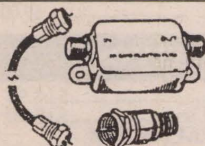
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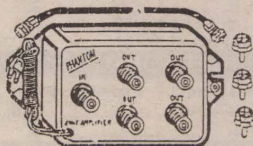
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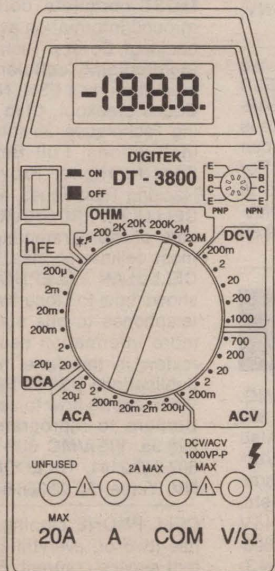
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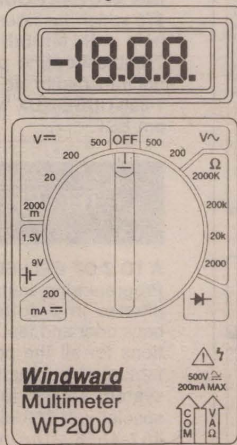
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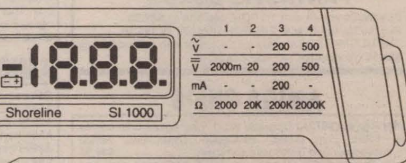
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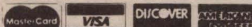
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ROBOTICS

by Karl Lunt

A few months ago, the Seattle Robotics Society (SRS) agreed to build a set of robots for use in an upcoming Pacific Science Center exhibit. The Pacific Science Center (PSC), located in downtown Seattle, offers many large, hands-on and interactive science exhibits for kids and adults alike.

As I write this, several members of the SRS are gathered around a work table in my living room, finishing up six sets of electronics for powering our robots. Dubbed the PSC-bot, each machine uses four simple circuit boards to provide an interesting and educational display of autonomous robotics.

I described the PSC exhibit in some detail in my column two months ago. Interested readers should leaf through that issue for a full explanation on what we have planned. The following paragraphs will discuss the robot, but will likely not provide a full description of the exhibit's workings.

Each robot consists of a clear plastic frame standing about 14" tall overall, topped with a 6" diameter clear plastic dome. This dome sits on a clear, hollow column about five inches tall. The bottom of this column is fastened to a 10" diameter base containing the robot's battery, circuitry, and bumper switches.

The robot is driven by two modified Futaba S148 servo motors, and contains a set of sensors such as IR object detectors, a Hall Effect sensor, and a sensor for detecting an external IR beacon signal.

The robot also contains a large collection of LEDs. Some are just for show, others serve as IR emitters for the object detection circuitry or as power-on or behavior indicators.

The robots motor around on a 5' x 10' table, which is enclosed in Lexan and framed in hardwood. The table was designed and drafted by Andy Olney and Martin Sloan, two of the many SRS members involved in this project. The PSC wood shop actually built this beautiful exhibit; I hope some of you get a chance to visit Seattle soon and see it.

The PSC-bot electronics

We used Marvin Green's 68hc11 BOTBoard for the brain of our robot. I have already described Marvin's board in previous columns. The low price and large list of features make this board an excellent foundation for very small 'bots.

Its small size was also a compelling reason for

choosing the BOTBoard. At just 2" x 3", it helps minimize the amount of frame space devoted to holding electronics.

Each BOTBoard holds a 68hc811e2, providing a total of 2K of EEPROM for code space. Adding in the 256 bytes of on-chip RAM gives enough room for writing all our control software.

One circuit board contains circuitry for detecting the associated IR beacon signal, emitted by a special IR LED mounted at each end of the exhibit table. This board, known as the tone detector board, measures about 1.5" x 2.5" and was designed by Frank Haymes. Refer to the accompanying schematic.

Frank's circuit uses an IR phototransistor to drive a LM386 amplifier IC. The LM386 provides a gain of about 20, yielding enough signal to properly drive a following NE567 tone detector.

The NE567 samples the provided signal and compares it to an internal reference oscillator. Whenever the NE567 sees a signal of the same frequency as its reference signal, it pulls its output line low, indicating it is locked to the incoming signal.

This signal is fed back via J1, a 4-pin MTA-style male connector, to the BOTBoard, where the controlling software can sense when the PSC-bot is facing the selected beacon.

We can select either the red or green beacon by changing the NE567's reference oscillator. The red beacon emits an IR signal of 3281 Hz, while the green beacon emits a 7109 Hz frequency signal.

this lock range.

This circuit has proven quite sensitive. Preliminary tests showed that the NE567 can reliably lock onto the beacon from over 12 feet away; not bad for a simple, two-IC design.

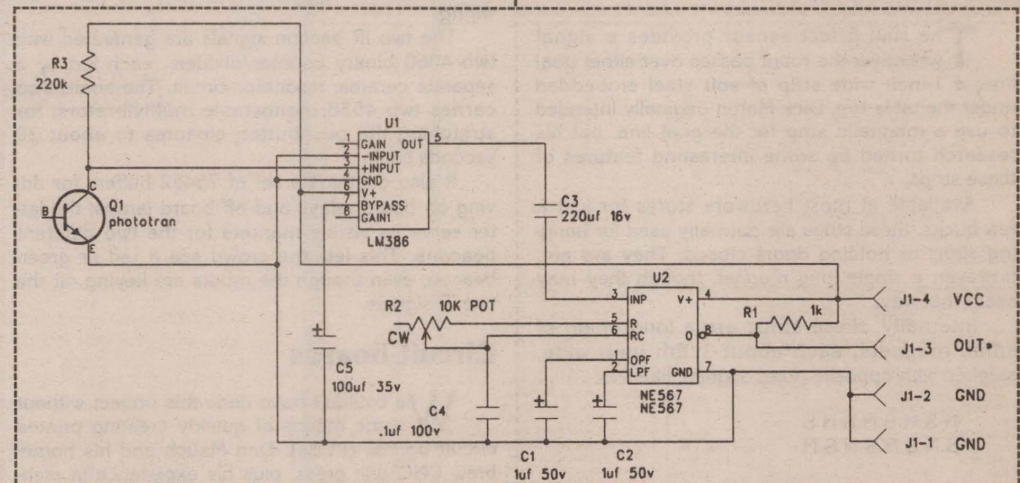
Another circuit board houses all of the display electronics, as well as the 40 KHz IR object detector circuitry. This 2" x 3" board, known as the control board, represents a joint effort between Tom Dickens and me. Refer to the accompanying schematic.

U1, a 74hc138, uses three signals from the 68hc11 to select a single red LED (D1 through D8). Thus, the 68hc11 can use the three lines ETL0, ETL1, and ETL2 to activate any one of the eight LEDs, known as thinking lights.

The 68hc11 software cycles through these lines in a binary fashion, so each LED is on momentarily. This results in a group of eight flashing LEDs, intended to make the robot appear to be thinking.

U2, a 74hc04, forms the now familiar 40 KHz IR object detector circuit. This circuit originally appeared in the book, *Mobile Robots*, by Joe Jones and Anita Flynn. Refer to one of my earlier columns for a review of this excellent book.

The 68hc11 uses the two lines labeled IRRGT and IRLFT to activate the right and left IR emitters, respectively. Used in conjunction with the robot's IR detector (mounted facing forward), the software can detect objects to the right, left, or straight ahead.



We can align one of these tone detector boards using either one of two techniques. One method involves hooking up an oscilloscope to the reference oscillator of the NE567 (pin 6) and adjusting the timing potentiometer until the 'scope shows a waveform of the proper frequency.

Another method requires a pulsed IR source of the proper frequency. In this case, we would set a robot in sight of the proper beacon, then adjust the timing potentiometer until we get a lock indication.

The NE567 will show a lock condition through a considerable range of the timing pot, so we would simply set the pot to the middle of

It does this by turning on the right IR emitter, then looking for a return with the IR detector. If it sees a return, the software notes that an object exists on the right side.

Performing the same test with only the left IR emitter on checks for an obstacle on the left side. If an obstacle appears on both the right and left sides, the software assumes there is something straight ahead.

The 74hc139 at U3b activates one of three LEDs, depending on the state of the two input lines from the 68hc11. These three LEDs are known as behavior LEDs, and are used by the 68hc11 to pro-

vide a visual clue as to the robot's current behavior.

For example, the 68hc11 will light the green LED when the robot is scanning around, looking for its beacon. It will light the yellow LED whenever the robot needs to avoid an oncoming obstacle. Finally, the 68hc11 turns on the red LED to signal that it is backing away from an object that it contacted with its bumper switches.

Although not shown on the schematic, these LEDs are wired to J2, a 4-pin MTA-style male connector. This cable terminates with a cluster of three LEDs, one of each color, that is inserted inside a ping-pong ball and mounted inside the robot's dome. This ping-pong ball changes color, based on which LED is on at any time.

The rest of the circuitry is wiring for the IR detector, filtering and a power-on indicator, and protective wiring for the unused half of the 74hc139.

The fourth board in the set is the switch board, which also measures 2" x 3". Refer to the accompanying schematic.

I designed this board as a common point for all wiring and cables. Power comes into this board through J3, a 2-pin MTA-style male connector that runs to a 6 VDC 4 AHR gel-cell battery and switch.

A 26-pin ribbon cable connects this board's J1 to the BOTBoard's large I/O connector. Similarly, a 16-pin ribbon cable runs from this board's J2 to the control board.

J9, a 4-pin MTA-style male connector, takes a cable from the tone detector board. The switch board also carries a few 10K ohm pullup resistors for the switches, and a filtering capacitor.

This board also contains four 2-pin MTA-style male connectors (J4 through J7) that accept wires from the four bumper switches. Finally, J8, a 3-pin MTA-style male connector, accepts wiring for the Hall Effect sensor, used to detect the inch-wide goal line buried at either end of the exhibit table. Time for a slight digression...

Hall Effect sensor

The Hall Effect sensor provides a signal whenever the robot passes over either goal line, a 1-inch wide strip of soft steel embedded under the table top. Dick Martin originally intended to use a magnetic strip for the goal line, but his research turned up some interesting features of these strips.

Available at most hardware stores for just a few bucks, these strips are normally used for hanging signs or holding doors closed. They are not, however, a single long magnet, though they may seem that way.

Internally, these strips are a long chain of small magnets, each about 1/8th inch wide, stacked with opposite poles aligned, like this:

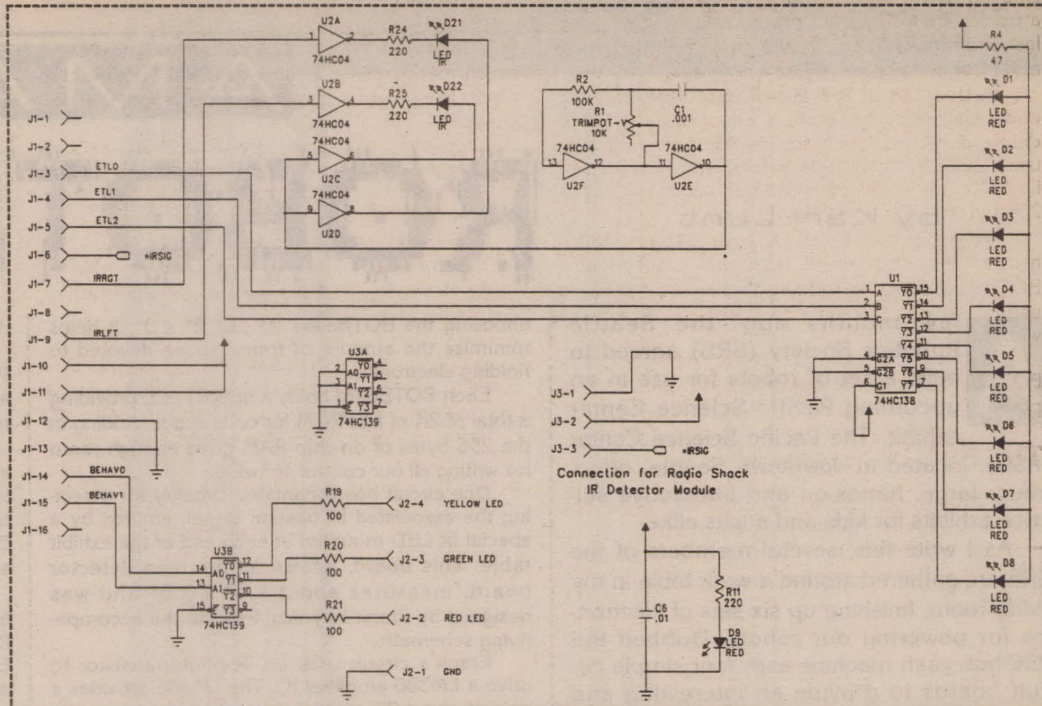
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SNSNSNSN

where the magnets run vertically. This arrangement works fine for holding signs up, but it really confuses Hall Effect switches.

Since the Hall Effect switch is only about 1/16th inch wide, it can return nearly any signal level when it contacts the magnetic strip, depending on exactly where it hits one of these internal magnets.

In fact, the signals returned in Dick's tests were so unpredictable that he had to abandon using the magnetic strip as a goal line.

Instead, he stuck a small magnet directly to the back side of a Hall Effect sensor, then passed this magnet-sensor pair over a piece of soft steel. Now he could get a consistent 350 mV signal at



each pass.

Granted, this is only about 16 counts when read by a 68hc11's analog port, but the sensor signal is very quiet (no electrical noise), so he doesn't expect any problems using the sensors this way. Okay, back to the electronics...

More electronics

Besides the 4-board set of electronics for Beach robot, this project uses a single box with circuitry for driving the IR beacons and related lights. This box, designed and built by Keith Payea, fits inside the exhibit table and accepts wiring for pushbutton switches, 120 VAC power, and other wiring.

The two IR beacon signals are generated with two 4060 binary counter/dividers, each fed by a separate ceramic resonator circuit. The board also carries two 4538 monostable multivibrators, for stretching the pushbutton closures to about 30 seconds each.

It also contains a set of 75452 buffers for driving on board relays and off board lamps; the latter serve as visible markers for the two different beacons. This lets the crowd see a red or green beacon, even though the robots are keying off the two IR signals.

Circuit boards

We couldn't have done this project without some means of quickly creating printed circuit boards (PCBs). Dan Mauch and his homebrew CNC drill press, plus his experience in etching photoresist PCBs, proved invaluable.

You may have already seen the article, in a previous issue of Nuts & Volts, describing Dan's homebrew drill press. Dan normally uses the Easytrax and DANCAM public domain CAD software to create his PCBs.

In this case, however, Frank and I did our designs with the shareware version of PADS. No matter, Dan simply downloaded our job files via modem, created a drill file for the circuit boards, then drilled the photosensitive PCB stock out as needed.

Next, he plotted the board's artwork out on his laser printer, using a transparency film. Finally, he exposed the film onto the drilled PCB stock, then

PSC ROBOT CONTROL BOARD

developed and etched it.

Dan's help really made this project go. During the development phase of some of these circuits, Dan was providing one and two hour turnaround for test boards. It was so cool having that type of support in developing robotics projects.

Despite the success of the project, Dan wants to improve the quality of boards he makes. He has already paid to get a photo transparency of one of his own boards. Circuit boards made from this film are, according to Dan, "commercial quality."

Dan feels we can get all of our robot artwork onto a single 8.5" x 11" film, which means we can do high-quality robot boards for about \$10.00 for a set of master artwork. Not bad!

The PSC-bot software

We wanted our robots to exhibit several behaviors, based on their environment. Behaviors include scanning for the beacon, moving towards the beacon, avoiding an object sensed with the IR detectors, fleeing an object that hits the bumper skirt, and resting at the goal area.

Each behavior carries an associated LED color or pattern, so the crowd can pick up on the robot's current state.

Additionally, the eight thinking LEDs have to cycle through their pattern, lighting in an interesting sequence.

The PSC-bot must also control the IR object detector LEDs, and monitor the IR detector, the Hall Effect sensor, four bumper switches, and the beacon tone detector signal.

All of these functions have to fit into the 2K of EEPROM available in a single-chip 68hc811e2.

Although the code could have been written in assembly language, Kevin Ross decided to try his hand at writing the software in tiny4th. I was especially impressed by this, as Kevin is a C/C++ guru working for Microsoft. I have found most C programmers either don't know about Forth, or know about it and hate it.

Even though Kevin had no prior experience with Forth, he grabbed a copy of Leo Brodie's *Starting Forth*, my tiny4th package, and a BOTBoard, and went at it.

We started the code on the flight home from

Boston at the end of January, where we both attended the MIT LEGO robot design contest (see last month's column). Kevin continued the work, and finished the code in just a few days.

Besides all of the above functions, Kevin's code also includes quite a bit of serial I/O for debug purposes. Even so, his final program only uses about \$7c0, or 1984 bytes. Removing the serial I/O code would probably free up an additional 256 bytes.

We use pbug11 and a special serial cable to move the robot code from a PC into each BOTBoard. Refer to earlier columns for details on using pbug11, building the cable, and working with the BOTBoard.

All that remains is to reconfigure the BOTBoard to run the new program, then turn on power.

The PSC-bot frame

These robots are real show-stoppers, due largely to the excellent plastics work done-

This means that the #4 solvent needs plastic machined with very accurate cuts; it will not work if your joints have large gaps or cracks in them. Bill recommends using a table saw with a triple-chip blade for plastics, available from specialty saw shops.

You need to use the proper drill bits as well. Bill suggests you get a special drill bit intended for use with plastic. Check the plastics shop for recommendations.

Carefully read and follow the instructions on both of these adhesives, as well as the instructions in the two recommended manuals. Plan on a long learning curve, but the final results are well worth the extra time and effort.

Bill notes that you can usually get surplus plastic from scrap bins at the local plastic shop. Normally sold by the pound, this will save you lots of bucks as you build up your plastic stockpile.

And most important — **wear eye AND face protection while working with plastic!** Flying chips and splashes of solvent can cause serious injury. Be extra careful working with this stuff!

careful construction.

Ken Birdwell, Zack Moore, Kevin Ross, and I spent several hours at impromptu soldering parties, wiring up and testing the electronics. Bill Harrison then drilled the boards and mounted them to the frames, bolted on the remaining hardware, and created a robot.

A typical SRS meeting runs about 60 people, while this PSC robot effort only involved about a dozen members. But everyone in the club followed the monthly progress reports with interest, and really got a kick out of watching the robot design evolve.

This has been an excellent learning experience for all of us. Each contributed to the project his special skills and talents, and we all got a chance to work on a large team project.

You will hear more of the PSC-bot in future columns, as I will refer to some of these elements again.

For now, however, I want to close with special thanks to Ken Williams, Jennifer Lewis, and David Taylor of the Pacific Science Center staff. They

have been very supportive and very patient in working with us. Hopefully, this is the beginning of a long relationship between the PSC and the SRS.

Special mentions

As usual, Digi-Key proved to be a great source of quality components, delivered quickly to our doorsteps. Keith and I both turned to Digi-Key for some of our PSC-bot electronics. They can be a bit pricey, but if time is more of an issue than money, I recommend looking through a Digi-Key catalog. Give them a call at (800) 344-4539 and ask for the latest catalog.

This project has required us to quickly locate large quantities of hard-to-find parts. Often, we didn't have a detailed specification for exactly what we wanted. We just knew we needed "LEDs about this bright" or "bumper switches shaped kinda like this."

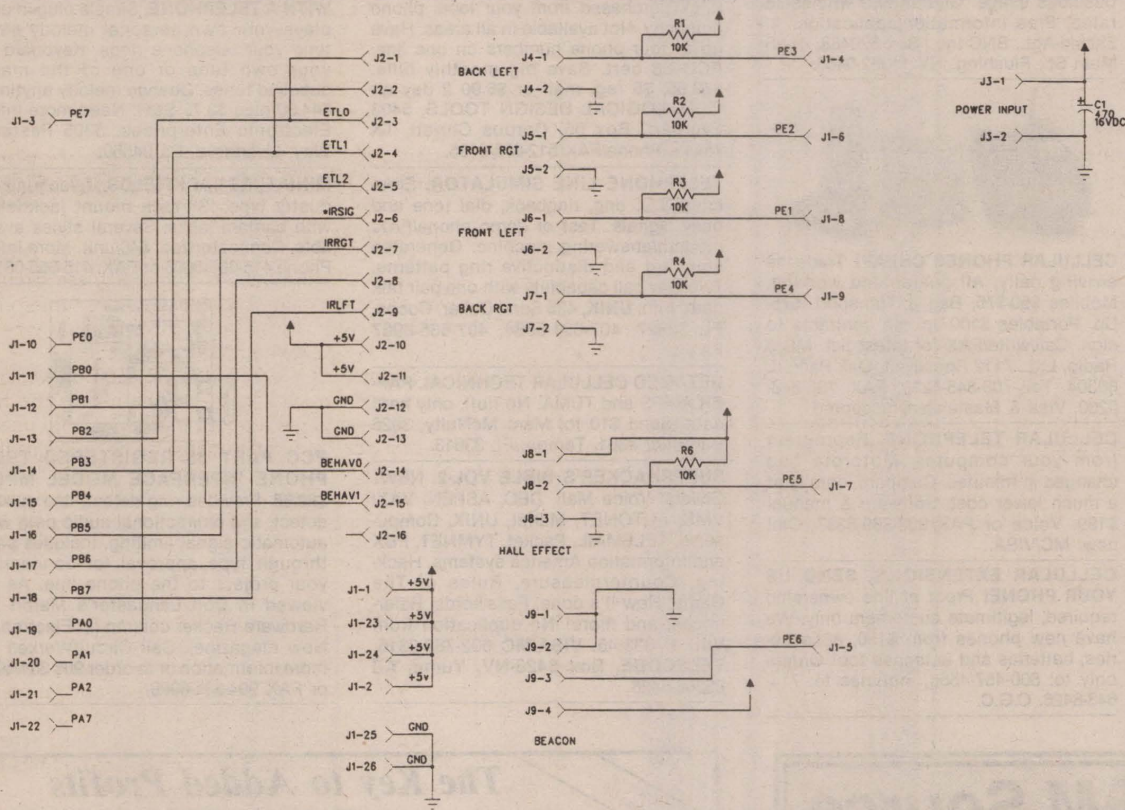
In my case, Electronic Goldmine has proven to be exactly that: a goldmine. Their catalog #221, for example, offers Stanley "high brightness" LEDs at 10 for \$1.00 in red and 8 for \$1.00 in green or yellow.

I had a heckuva time locating matched brightness LEDs in three colors, so I ordered some of these devices from EQ. They arrived on schedule, were exactly what I wanted, and the price was unbeatable. Call them at (602) 451-7454 and get a catalog.

While I'm handing out mini-recommendations of companies, I want to include Public Brand Software (PBS). This company specializes in mail-order public-domain or shareware software at about \$5.00 per disc.

While you can find BBSs all over the country for downloading such software, PBS' catalog contains comments and ratings of each program on a disc. PBS rates software from one to four stars, and the several four-star discs I have ordered so far have proven to be well done and solid.

You can get anything from games to C libraries, GIF viewers to Windows utilities. It all runs on PCs, and each catalog entry details any special system requirements. Call (800) 426-3475 and ask for a catalog. **NV**



PSC ROBOT SWITCH BOARD

by Bill Harrison, working from a design developed by David Adams and himself. Bill worked with clear acrylic plastic and two different adhesives to fashion the robot bases.

He suggests getting two manuals from Plexiglas, "Forming Manual" and "Fabrication Manual." The latter will likely prove more useful, as it deals with machining and gluing acrylic. Note that these are geared for industrial users, but much of the info can be applied by the home builder. Check with your local plastics shop.

The thicker of the two glues is called WELD-ON #16, available in a tube from most large plastics houses. It works well for fitting together roughly cut joints.

The solvent-type adhesive, which Bill prefers using, is WELD-ON #4. This solvent is very thin, evaporates quickly, and holds by wicking into a tight joint between two pieces of cleanly cut plastic.

Bill was also responsible for creating the only truly dependable bumper skirt I have ever seen, anywhere. He formed a complete ring of plastic, wide enough to go completely around the base of the PSC-bot. He added four thick plastic tabs, fastened to the inside of the ring at 90-degree intervals.

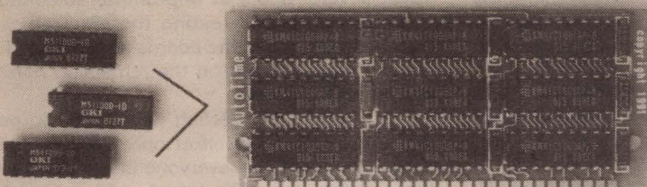
These tabs, in turn, fit inside slots cut into the robot's frame. The back end of each tab (towards the robot's interior) rides against the leaf of a microswitch.

Inward pressure on the outside wall of this skirt, at any point on the ring, will trip at least one switch. Yet the skirt is so solidly mounted that you can lift the entire robot by the skirt.

Putting it all together

All of these pieces do not a robot make. You have to get all the boards wired, mount them onto the frame, and add on the switches, motors, and other goodies. This takes time and

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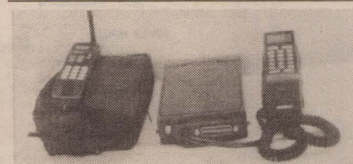
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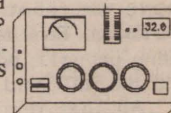
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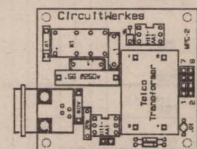
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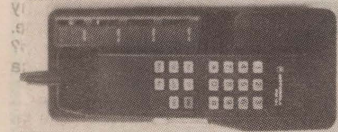
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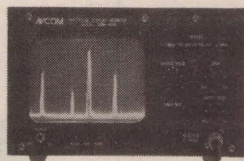
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Nuts & Volts Magazine/April 1994

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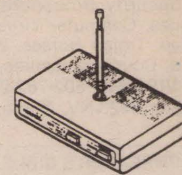
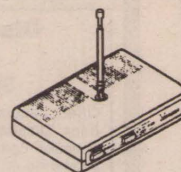
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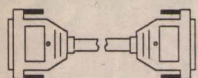
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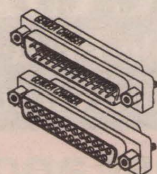
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#GC-25M-2	DB25	\$3.00
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#GC-37M-2	DB37	\$5.00
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#GC-25F-2	DB25	\$3.00
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Amphenol IDC

Male

#CN-681	50 pin SCSI	\$3.00
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#CN-680	50 pin SCSI	\$1.50
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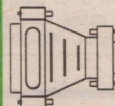
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"IBM" Compatible



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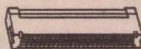
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#CA-930

\$4.00 each
20 @ \$3.80 ea.

IDC Card Edge Connector

34 pin Female



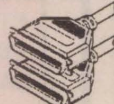
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Parallel Centronics Cable

36 Pin Male to male

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#CC-366	6 foot	\$4.00
#CC-MMC	10 foot	\$5.00



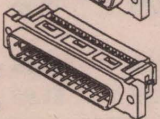
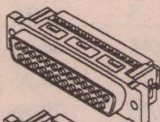
IDC Connector DB Type

Male

#CN-567	DB9	\$1.50
#CN-554	DB25	\$1.00 6-\$5.00
#CN-476	DB37	\$4.00

Female

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#CN-555	DB25	\$1.00 6-\$5.00
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3 piece crimp type with gold pin for RG-58 Ethernet



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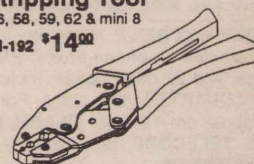
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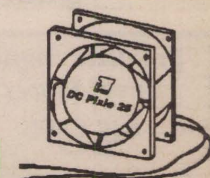
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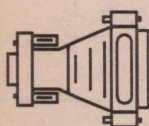
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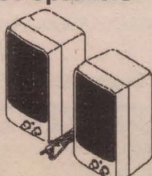
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900 MHz breakthrough!

New technology launches wireless speaker revolution...

Recoton develops breakthrough technology which transmits stereo sound through walls, ceilings and floors up to 150 feet.

By Charles Anton

If you had to name just one new product "the most innovative of the year," what would you choose? Well, at the recent *International Consumer Electronics Show*, critics gave Recoton's new wireless stereo speaker system the *Design and Engineering Award* for being the "most innovative and outstanding new product."

Recoton was able to introduce this whole new generation of powerful wireless speakers due to the advent of 900 MHz technology. This newly approved breakthrough enables Recoton's wireless speakers to rival the sound of expensive wired speakers.

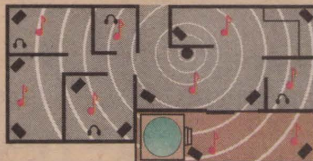
Recently approved technology. In June of 1989, the *Federal Communications Commission* allocated a band of radio frequencies stretching from 902 to 928 MHz for wireless, in-home product applications. Recoton, one of the world's leading wireless speaker manufacturers, took advantage of the FCC ruling by creating and introducing a new speaker system that utilizes the recently approved frequency band to transmit clearer, stronger stereo signals throughout your home.



150 foot range through walls!

Recoton gives you the freedom to listen to music wherever you want. Your music is no longer limited to the room your stereo is in. With the wireless headphones you can listen to your TV, stereo or CD player while you move freely between rooms, exercise or do other activities. And unlike infrared headphones, you don't have to be in a line-of-sight with the transmitter, giving you a full 150 foot range.

The headphones and speakers have their own built-in receiver, so no wires are needed between you and your stereo. One transmitter operates an unlimited number of speakers and headphones.



Recoton's transmitter sends music through walls to wireless speakers over a 75,000 square foot area.

Crisp sound throughout your home. Just imagine being able to listen to your stereo, TV, VCR or CD player in any room of your home without having to run miles of speaker wire. Plus, you'll never have to worry about range because the new 900 MHz technology allows

stereo signals to travel over distances of 150 feet or more through walls, ceilings and floors without losing sound quality.

One transmitter, unlimited receivers. The powerful transmitter plugs into a headphone, audio-out or tape-out jack on your stereo or TV component, transmitting music wirelessly to your speakers or headphones. The speakers plug into an outlet. The one transmitter can broadcast to an unlimited number of stereo speakers and headphones. And since each speaker contains its own built-in receiver/amplifier, there are no wires running from the stereo to the speakers.

Full dynamic range.

The speaker, mounted in a bookshelf-sized acoustically constructed cabinet, provides a two-way bass reflex design for individual bass boost control. Full dynamic range is achieved by the use of a 2" tweeter and 4" woofer. Plus, automatic digital lock-in



Breakthrough wireless speaker design blankets your home with music.

tuning guarantees optimum reception and eliminates drift. The new technology provides static-free, interference-free sound in virtually any environment. These speakers are also self-amplified; they can't be blown out no matter what your stereo's wattage.

Stereo or hi-fi, you decide. These speakers have the option of either stereo or hi-fi sound. You can use two speakers, one set on right channel and the other on left, for full stereo separation. Or, if you just want an extra speaker in another room, set it on mono and listen to both channels on one speaker. Mono combines both left and right channels for hi-fi sound. This option lets you put a pair of speakers in the den and get full stereo separation or put one speaker in the kitchen and get complete hi-fi sound.

Factory direct savings.

Our commitment to quality and factory direct pricing allows us to sell more wireless speakers than anyone! For this reason, you can get these speakers far below retail with our 90 day "Dare to Compare" money-back guarantee and full one year manufacturer's warranty. For a limited time, the Recoton transmitter is only \$69. It will operate an unlimited number of wireless speakers priced at \$89 and wireless headphones at \$59 each. Your order will be processed in 72



These wireless stereo headphones have a built-in receiver.

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Built-in receiver and amplifier:

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Don't take our word for it. Try it yourself.

We're so sure you'll love the new award-winning Recoton wireless speaker system that we offer you the **Dare to Compare Speaker Challenge**. Compare Recoton's rich sound quality to that of any \$200 wired speaker. If you're not completely convinced that these wireless speakers offer the same outstanding sound quality as wired speakers, simply return them within 90 days for a full "No Questions Asked" refund.

Recoton's Design and Engineering Award



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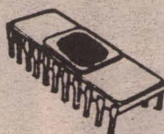
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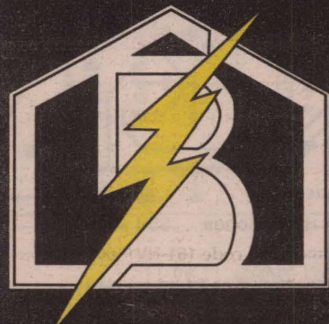
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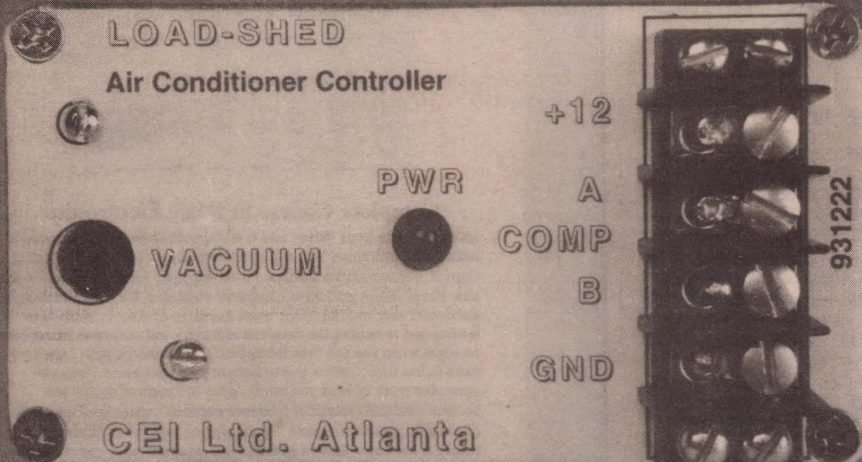


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THE LOAD-SHED

by Charles Ball

BUILD



Controller

Auto Air Conditioner

Introduction

Small cars are great for economy but most are marginally powered when fully loaded, and especially with the air conditioner running full tilt. This loss of reserve power is particularly noticeable in mountainous areas or when passing. We can poke up the mountains without much danger other than blood pressure. Passing is a different story; if we don't get around, we get hurt — or worse.

Here is a handy little gadget — the Load-Shed — that can be used to de-activate the air conditioning compressor briefly during periods of intense acceleration to give extra head room for the power train. The loss of air conditioning for a few seconds is not noticeable, since the fan continues to blow. In most cars the air conditioner compressor cycles periodically anyway as a means of controlling temperature.

The added power boost is noticeable, even on larger, higher powered cars. This extra boost is sometimes all you need to get around the "slo-poke" ahead safely.

The Load-Shed works by sensing manifold vacuum and therefore can be used only on gasoline powered, non-turbo charged cars.

Theory/Circuit Description

The Load-Shed works by monitoring the intake manifold vacuum via a vacuum/pressure switch, VS1. Refer to the schematic diagram, for the following discussion. In the normal operating state (engine on, air conditioner running), U1 is idle and the output (pin 3) is low. This ensures that Q2 is off and allows Q1 to be on through drive provided by R5. Q3 is turned on by the drive provided by Q1 through R7, and the compressor clutch is energized.

When the vacuum drops below 30% of normal, VS1 opens. The negative transition caused by VS1 opening and the R1 pull-down effect, causes a negative transition to U1's trigger input (pin 2) through C2. This causes U1's output to go high, turning on Q2, turning off Q1 and subsequently turning off Q3, which de-energizes the compressor. The compressor remains de-energized for the timing period of U1. Once the timing period has expired, the compressor is re-energized by the output of U1 again going low, turning off Q2 and allowing Q1 and Q3 to turn on. The timing period is determined by C3 and the combination of R8 and R9. R9 allows delay adjustment over the range of 2-10 seconds.

Capacitor C4 is used to prevent false triggering of U1. Resistor R2 provides a discharge path for C2 following a closure of VS1; R5 provides drive for Q1; R6 allows the output of U1 to swing its full range to ensure proper operation of the timer and R10 ensures that Q3 turns off when drive is removed. CR1 provides reverse polarity protection while CR2 uses a free-wheeling diode to suppress transients generated by the collapsing magnetic field of

the compressor coil. LED1 provides a visual indication of ignition power and R11 provides current limiting for the LED.

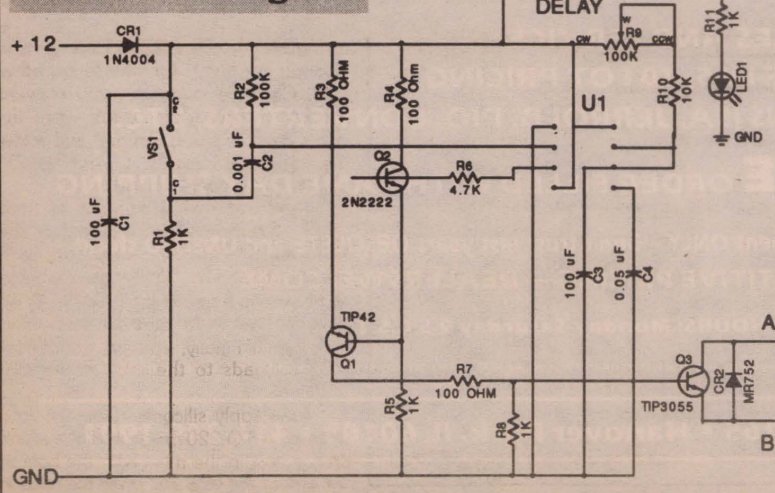
Construction

The Load-Shed is fabricated on a glass epoxy circuit board and housed in a two-piece zinc die cast enclosure. Wire-wrap breadboards are not recommended because of the vibration and temperature cycling prevalent in an automotive environment. The board can be fabricated from the layout or purchased from the source in the parts list.

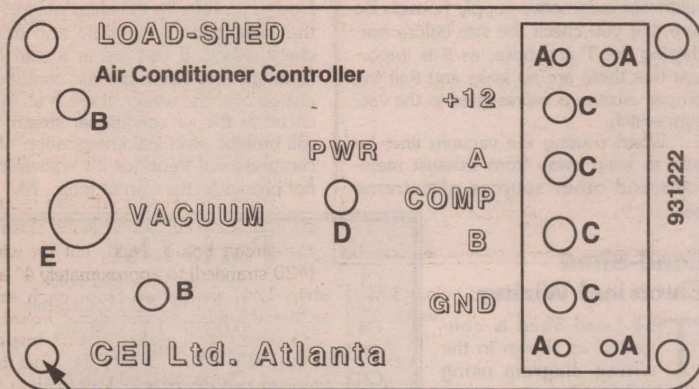
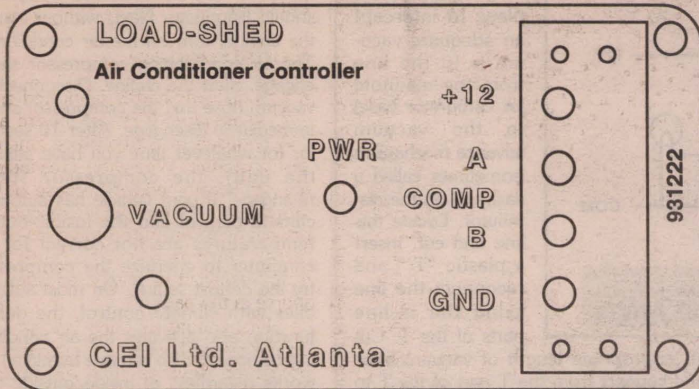
First mount all parts (except Q3) on the circuit board. Use caution with polarized devices such as diodes, capacitors, and semiconductors. Temperature is a big factor (<40 to >200°F) for any device operating under the hood of an automobile. Consequently, resistors, diodes, and capacitors should be spaced slightly above the board to allow for expansion and contraction during temperature cycles such that component leads will not be stressed and create premature failure.

After the components are mounted and soldered, cut all leads close to the circuit board. Next, cut six wires (#20 stranded) to approximately 4" and strip 1/4" insulation from each end. Solder the wires in the circuit board at VS1 (two wires, **polarity not important**), +12, A, B, and GND. You may want to use different colors of wire for the different signals to make final assembly easier. Note that Q1, although a power transistor, does not require heat sinking. Q3, on the other hand, is heat sunk to the case and insulated with a mica washer. Q3 should be installed after the case is prepared to ensure alignment with the hole in the case.

Schematic Diagram



BUILD THE LOAD-SHED



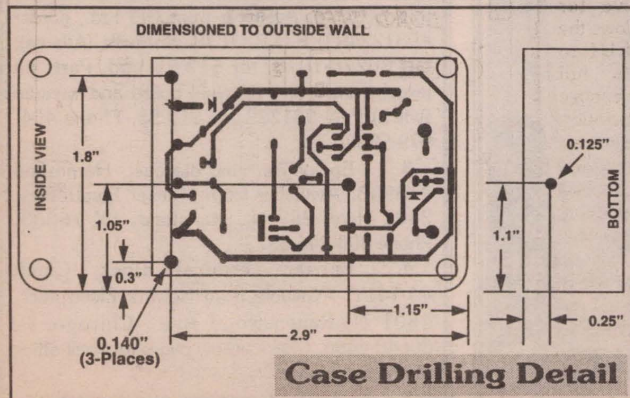
**Top - Front Panel Art
Bottom - Drilling Template**

Preparing the Case

An actual size front panel layout is provided. This layout can be copied or cut out of the magazine and used as a drilling template for the front cover of the case. Simply trim to size and temporarily attach with tape. Center punch all the holes, remove the template, and drill using the drill sizes as shown. Note that because of tight clearance, nuts cannot be used on the mount-

ing screws for TB1. Therefore, it will be necessary to drill the holes the size shown and tap with a #6-32 NC tap, available at hardware stores. After drilling and tapping, debur the holes by hand. This can be done by applying an oversized drill bit or countersink tool.

Drilling for the bottom and side of the case is also shown. Measure and mark carefully to ensure that the circuit board lines up properly. The end of the circuit board



Case Drilling Detail

with Q3 **must** be against the end of the case, since Q3 is heat sunk to the case. A circuit board or its layout may be used as a template when placed inside the case. Center punch, drill, and debur as above, paying special attention to the hole in the end of the case where Q3 mounts. The Q3 mounting surface **must** be completely smooth to allow correct seating of Q3 and the mica insulator. The three holes in the bottom of the case should be countersunk (from the bottom outside) after drilling to allow the use of flat head screws. You can use an oversized drill bit or a conventional countersink tool to perform this function.

Once the case is drilled, countersunk, and deburred, install three #6-32 x 1/2" flat head screws from the outside. Secure inside with #6 internal lock washers and #6-32 x 5/32" nuts. Tighten securely.

NOTE: Vibration is going to be a big factor during the life of this device. Therefore, good soldering and assembly techniques are essential. All hardware requires lock nuts or lock washers, unless the hardware is self-tapping. All wires should be stranded (19 strand, 20 AWG) to prevent breaking under vibration.

Line up the circuit board over the screws and seat on the nuts. Line up, measure, and prepare the leads of Q3 such that with the circuit board in place, Q3's mounting hole lines up with the one previously drilled in the case. Once the leads are properly prepared, install Q3 in the circuit board and solder. Temporarily put the case aside.

Test and Calibration

To properly bench test the Load-Shed, it is necessary to simulate actual operating currents at the Q3 level. This can be achieved by using the test circuit as shown.

Temporarily short the two leads coming from the printed circuit board holes marked VS1. Connect the circuit to a 12 VDC supply as shown. The bulb(s) should be selected to draw approximately 2 amps (typical compressor clutch current). You can parallel several bulbs as necessary to simulate the load while also giving a visual indication of functionality.

With 12 V applied, the bulbs should be illuminated. Now, disconnect the two

wires previously shorted. The bulbs should immediately extinguish. The bulbs will remain extinguished for the timing period set by R9. The time that you prefer the Load-Shed to keep the compressor de-energized can be set by adjusting R9 and repeating the above procedure, using a stop watch or second hand to establish time.

Final Assembly

Once the board is checked and the delay set, the solder side should be cleaned with an environmentally safe flux remover, as a build-up of solder flux becomes conductive in a humid environment and can alter timing and bias of electronic circuits. After cleaning, make sure the board is totally clean and dry. Coat with a plastic insulating spray to protect from corrosion and accidental short. The inside of the enclosure bottom should also be sprayed.

Front Panel Preparation

The front panel layout in the article can be used as the actual nameplate with proper preparation or can be used to fabricate an aluminum or plastic nameplate using some of the kits, procedures, and sources described in my previous N&V article [Nameplates, Overlays and other Interesting Tidbits](#) appearing in the June '92 issue and also the N&V article [VR12MX](#) appearing in the February '94 issue.

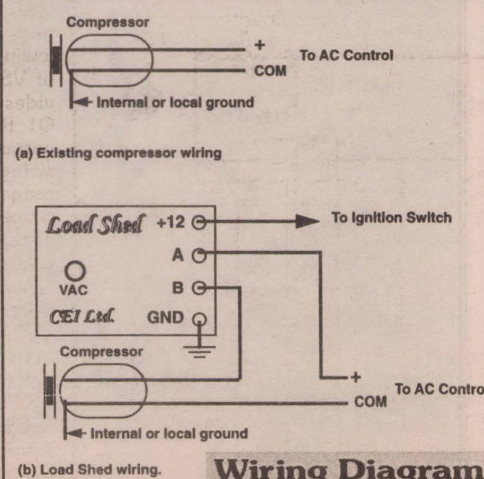
To use a photocopy of the nameplate, simply have it plastic laminated at a local office supply or service bureau such as Kinko's. Then trim to size and attach with carpet tape. Cut out the holes with a #2 Xacto blade and you are ready to go.

Mount the vacuum switch using two #4-40 x 1.00" screws, internal tooth lock washers, and nuts. The shorter port on the vacuum switch (marked vacuum) protrudes through the front cover. Next, mount TB1. Use four #6-32 x 0.625" screws and internal tooth lock washers. Finally, insert half of the LED mounting clip into the front side of the Load-Shed cover. Slide the T-1 3/4 LED into the rear of the clip. Slide the clip retainer over the LED leads and snap onto the part of the LED clip protruding through the panel to secure the LED in place.

Connect a 4" red wire to the positive lead of the LED (the longer lead is positive) near the base of the LED. You can solder or use #30 wire wrap wire. Connect another color wire to the other lead. Clip any excess lead to prevent shorting to other components when the cover is put in place. Connect and solder the respective leads to "L" and "GND" points on the printed circuit board.

Next cut four 1" pieces of heat shrink of sufficient size to slide over the terminals of TB1. Slide these over each wire going to TB1. Solder each wire to its respective terminal (+12, GND, A, B), slide the heat shrink over the connection and shrink. Finally, connect and solder the two leads to the vacuum switch, VS1.

Now apply silicone grease to both sides of a TO-220 mica insulator. Line up the hole in the mica with the hole in the end of the case and press the mica in



Wiring Diagram



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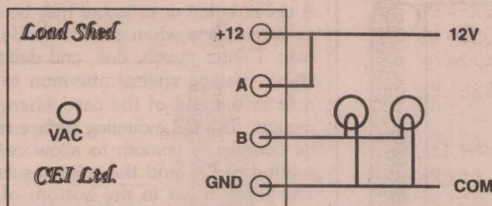
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BUILD THE LOAD-SHED



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place (the silicon grease will hold it in place). Align the circuit board over its mounting screws, lining up Q3's mounting hole with the mica and the case. Place a #4 insulating shoulder washer over a #4-40 x 0.5" screw and guide through the transistor mounting hole, mica, and case. Secure the screw on the outside of the case with an internal tooth lock washer and nut. Tighten. Then, using an ohmmeter, check that the tab of Q3 is insulated from the case.

The enclosure can be shielded from the elements by sealing around all the front panel components using silicon rubber and also applying a small bead of the silicone rubber around the lip of the front cover before attaching. Attach the front cover using the four screws provided with the enclosure.

Installation

Installation is pretty much where you can find space to mount the unit. Preferably away from high heat sources such as manifolds, radiators, and the like. A mounting bracket will have to be fabricated and attached to the Load-Shed housing. No provision has been made in this article to second guess what your physical installation scenario might be.

Once you have found a suitable location and mounted the Load-Shed, the vacuum connection needs to be

addressed. The best place to intercept an adequate vacuum is in the line from the manifold (or carburetor base) to the vacuum advance mechanism (sometimes called a dashpot) on the distributor. Locate this line and cut, insert a plastic "T," and reconnect the line using the in-line ports of the T. Cut an appropriate length of vacuum hose and connect from the T part of the T to the vacuum sensor on the Load-Shed. T connectors and vacuum hose are available from automotive supply houses. Be sure that you check the size before purchasing the T and hose, as it is important that there are no leaks and that the proper vacuum is represented to the vacuum switch.

When routing the vacuum line, be sure to keep away from exhaust manifolds and other sources of extreme heat.

Load-Shed Electrical Wiring

The Load-Shed is connected as shown in the wiring diagram using high quality splice connectors. The automobile shop manual should be consulted if you are unsure where to make the connection.

Final Check-out

There are several check-out scenarios. Use the one most convenient for you.

After connecting and verifying the integrity and polarity of the connections, turn on the

ignition. The LED on the Load-Shed should illuminate. Next, without starting the engine, turn on the air conditioning. The air conditioning compressor should engage. Start the engine. Disconnect the vacuum hose and the compressor should immediately disengage. After 10 seconds (or for whatever time you have adjusted the unit), the compressor should re-engage. If your vehicle has automatic climate control and the inside/outside temperatures are not correct for the computer to energize the compressor, try the defrost setting. On most automobiles with climate control, the defrost function also activates the air conditioning compressor (to remove humidity) and works regardless of inside/outside temperature.

If all does not work according to Hoyle... refer to the shop manual and the installation schematic and double check wiring. If you are in a cold environment and have lost air conditioner charge over the winter, there is an inhibit circuit in the air conditioner stream that will prohibit electrical energization of the compressor if freon (or it's equivalent) is not present in the Carnot loop. NV

Parts List

C1, 3	100 uF, 16 V Electrolytic
C2	0.001 uF, 100 V Ceramic
C4	0.05 uF, 100 V Mylar
CR1	Diode, 1N4004
CR2	Diode, MR750 (MR752)
LED	LED, T 1-3/4, RED
Q1	Transistor, TIP42
Q2	Transistor, 2N2222
Q3	Transistor, MJE3055
R1, 5, 8, 11	Resistor, 1K, 1/4 Watt, 5%
R2	Resistor, 100K, 1/4 Watt, 5%
R3, 7	Resistor, 100 ohm, 1/2 Watt, 5%
R6	Resistor, 4.7K, 1/4 Watt, 5%
R9	Trimpot, 100K Cermet
VS1	Vacuum Switch, World Magnetics #245031 ¹

Misc: Printed Circuit Board #931224R1², Enclosure, Hammond #1590B³; Terminal block, TB1, Cinch 6-141Y⁴; Screws, nuts, wire, solder, and splice connectors. See below for parts availability.

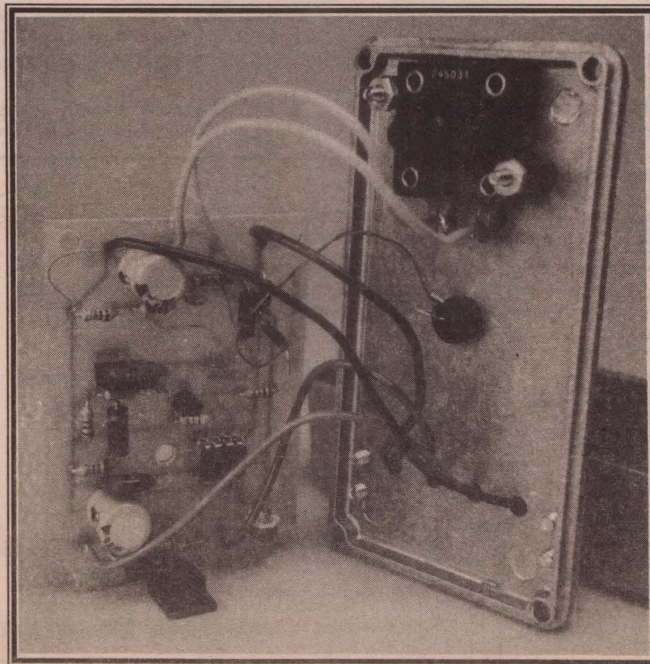
Parts Availability:

1. Vacuum switch, Mfg. by World Magnetics, P/N 245031. Available from American Science and Surplus, (Order #23055) 360 S. Howard Street, Skokie, IL 60076 for \$7.50 plus shpg. Phone 708-982-0870.

2. Printed Circuit Board, Mfg. by CEI Ltd., P/N 931224. Available from CEI Ltd., (Order #931224R1) P.O.B. 1078, Snellville (Atlanta), GA 30278-1078, for \$12.95 ppd. Parts kit (except enclosure, terminal board and vacuum switch) P/N 931222 for \$19.95. Phone 404-979-5900.

3. Enclosure, zinc die cast, Hammond #1590B. Available from Mouser Electronics, 2401 Hwy. 287 N., Mansfield, TX 76063. Phone 800-346-6873

4. Barrier Terminal Block, Cinch #4-141Y. Available from Newark Electronics, 4801 N. Ravenswood Ave., Chicago, IL 60640-4496. Check yellow pages for local office phone number.



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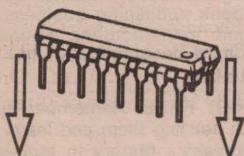
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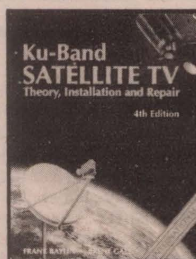
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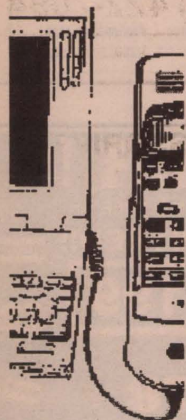
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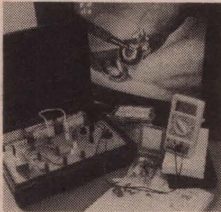
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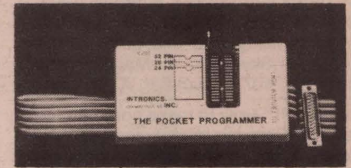
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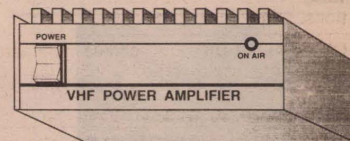
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Model #106510-00.....\$24.95 Ea.

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Used for holding computer configuration.
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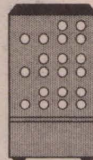
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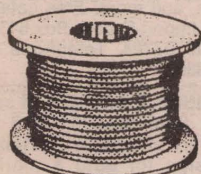
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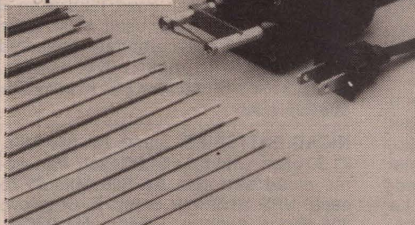
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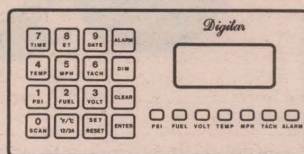
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Nuts & Volts Magazine/April 1994 103

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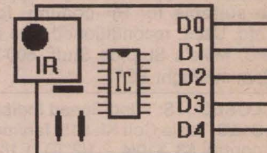
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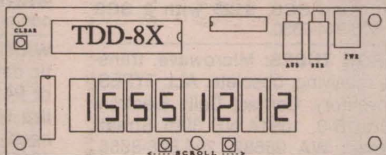
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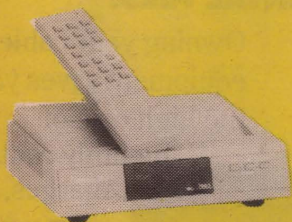
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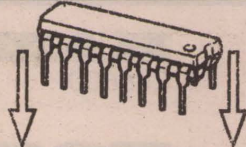
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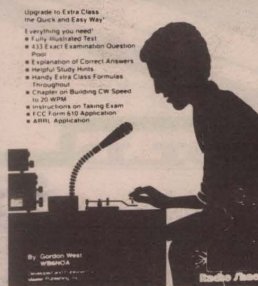
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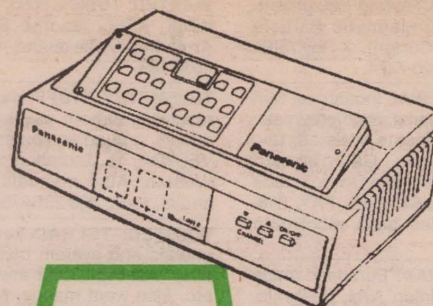
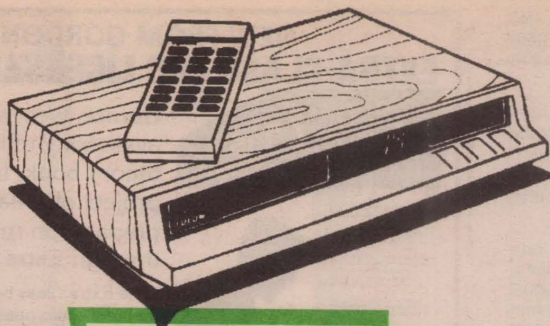
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RESOURCE BIN

number twenty-seven

Electronic servicing opportunities.

Our usual reminder here that the *Resource Bin* is now a two-way column. You can get tech help, consultant referrals and off-the-wall networking on nearly any electronic, *tinaja* questing, personal publishing, money machine, or computer topic by calling me at (602) 428-4073 weekdays 8-5 MST. I've got a free pair of insider secret resources brochures waiting for you when you call or write.

A portion of my PSRT RoundTable on *GENie* has also been set aside for you *Nuts & Volts* readers. This is the place to go for instant tech answers. Among the many files in our library, you will find complete reprints and preprints for all of my *Resource Bin* columns. I've just added a new "fast access" feature for you. Have your modem dial (800) 638-8369, followed by HHH. Then `XTX99005,SCRIPT`.

By the way, be sure to enter your HHH *immediately* after your modem software reports a connection. This is how *GENie* recognizes your baud rate. If you get gibberish on the screen, you were too slow with your HHH.

A free *GENie* brochure if you voice call (800) 638-9636.

A reminder that all of the previous *Resource Bin* columns are offered both online and as bound volumes. I have also just done a major update to my free *insider secrets* catalog. Give me a helpline call or see my *Synergetics* ad for more details.

I have gotten a lot of requests lately for info on where to go to get info for doing your own electronic servicing and repair. Sadly, the opportunities for home based repair setups have gotten rather ugly over the years. And aren't likely to improve any.

Starting up your own home repair service for, say, computer monitors, simply is not realistic these days. And most consumer electronics warranties apply *only* to properly authorized and trained dealer networks.

Very simply, it used to be cheaper to fix things than replace them. No more. Repairs were vastly simpler. Less skill was needed to

understand what was coming down. Firms were far more open with their tech manuals and their replacement parts. And, of course, most service problems these days are software related.

On the other hand, most electronic gear is infinitely more reliable today. It just doesn't break in the first place. Unless it gets hit with lightning.

Yet there are bucks to be made in a scant few specific areas. VCR repairs, microwave ovens, and laser printers seem to be your best ongoing bets.

Some First Principles

Before we look at some places to go for electronic service help, let's check into some seldom-discussed ideas that I've found useful to handle most any servicing problem...

Make sure the problem is real — Be sure that the actual difficulty and what you think the problem is are the same. An intermittent cannot be fixed until you can make it

NEXT MONTH: Don looks at several insider secrets for electronic breadboarding.

appear on command.

Look before you leap — More often than not, a careful visual inspection and a long talk with the owner will pinpoint the problem. When you jump right in, you'll miss the obvious every time.

Use the right tools — These days a decent oscilloscope can be had for as little as \$50.00. It is totally *unthinkable* to ever try any electronic repair without one.

Find the cause, not the symptom — Most electronic systems fail for a reason. Fuses blow because of circuit faults. Resistors burn up because of way too much current. Power stages can fail because of overload, tuning, or a lack of drive. Replacing obviously "bad" parts with new ones will only burn up the

new parts.

Cause the patient no harm — On any larger, older, or antique electronics (especially anything that has not been turned on for years), do not *ever* apply power until passive resistance checks clear the way!

Supplies. Then signals. Then loads — If you are dealing with any modern piece of electronic gear whose power supplies are self protecting, check first to find line power or source current present. Then test for correct voltages in appropriate places. Next, look for proper signals at suitable points in the circuit. Finally make sure loads are reasonable and well behaved. Along the way, touch, feel, and smell.

Think twice, measure once — There's no point in measuring anything that ain't broke. Think out what you are going to do ahead of time. Try to zero in on the *one* test that tells you the most.

Divide and conquer — If you find out where the problem is *not*, you can divide the remaining places to look in half. Repeating this several times will isolate the problem. For instance, on a radio, touch the volume control with your finger (after making sure you have a cold chassis, of course!). If you produce hum, your audio and supply power is okay, and you've got an RF, IF, or antenna problem.

On any mechanical engine problem, determine both fuel and spark. Ask what nutrient is missing.

On a computer interface problem, use the simplest possible tests done at your lowest possible software levels first. There is no way an applications package will work if the comm wires are crossed. Or if the baud rate or stop bits are wrong. Printer handshaking doesn't usually get to be a problem till after a page or so. So, no printing at all is a more fundamental problem than a delayed handshake.

Substitute and simplify — These are your two most powerful weapons. If you can compare a good unit against a bad one, always do so. But *never* put any potentially bad parts back into the good unit. The plague can spread.

Make the problem worse — If all else fails, find the simplest possible setup in which *only* the problem exists. Get rid of all extra side effects, of all fancy software, all possible places to hide. Eliminate everything extraneous.

MSM and Electronic Servicing

There are very few magazines that target electronic service work. I have only been able to find two so far.

One of these is *Electronic*

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Servicing, which is big on consumer electronic repairs, especially TV sets and VCRs. Their ads include some major supply sources for repair parts and exchange modules. They also supply a *ProFact* center-fold each month, and often include useful directories.

MSM is also called the *Magazine of Service Management*. This one is more aimed at computer peripheral repairs, especially larger dot matrix printers and hard disks.

There's a few electronic technician associations which do offer member newsletters and similar services. Not being much of a joiner, I've personally found these outfits to be of very little use. It is also unclear to me just what real benefits they offer. As with most other fields, "certification" programs simply do not work.

Still, you might like to check into the *ETA Technician Association News* and the *ISCET Update*. Or the *Servicer Newsletter* from the *United Servicers Association*. Or the *NESDA*, short for the *National Electronic Service Dealers Association*.

Your traditional source for service info has been *SAMS PhotoFacts*, who are now only the faintest shadow of their former selves. They do offer an excellent directory. Full collections of older Photofact sets often are offered here in *Nuts and Volts*.

More obscure service and schematic info is sometimes offered by *Bomarc Services*.

ECG and NTE

The two leading sources for repair and replacement semiconductors are *ECG* and *NTE*. These folks both have low cost reference manuals available. So does *Radio Shack*,

who also offers an extensive parts locator service and a few cross reference directories.

Info on who makes what in the way of semiconductors is available by way of the pricey *EEM Master*.

A number of companies specialize in foreign transistors, with the real biggie being *MCM Electronics*. Three outfits having lots of VCR parts and support are *MAT Electronics*, *Premium Parts*, and *Parts Express*.

One specialized VCR tool source is *Tentel*. A source of television repair modules is *PTS Electronics*.

Several IC distributors specialize in stocking ancient or otherwise obsolete parts. Two of the leading firms here appear to be *Rochester Electronics* and *Sunset Silicon*.

For really old radio parts, there's an entire separate world of electronic collectibles. We looked at lots of these last fall. Two useful starting points here are *Antique Radio Classified* and *Antique Electronic Supply*.

Laser Printers

Desktop publishing laser printers, especially those speaking PostScript, are one of the few areas where there are genuine opportunities for smaller scale custom services. Besides repairs, there's toner cartridge reloading, hard drum refitting, upgrades, and used machine sales.

Most leading printer manufacturers (especially Apple Computer) are real snotty when it comes to providing any service or repair info. Fortunately, most of the major laser printers use identical mechanical engines. Which means that the info from one supplier is largely good for another.

Hewlett Packard Manuals offer some outstanding repair manuals. These may also be quickly and conveniently used on Apple, QMS, and other Canon engine based systems. Sadly, all the prices are rather steep at \$120.00 or so each. But the first use will usually pay for the manual many times over.

Some laser printer repair schools are outright scams, and a few others have really bad reputations. But one that I have found a major exception is *Don Thompson*, who offers top quality training seminars, videos, parts, and module exchanges.

Your first test for any school is to ask for a list of satisfied customers in your area. If they do not immediately comply, run away from them.

The center of the laser printer repair industry is *Recharger* magazine. This one has hundreds of ads for supplies, training, and related materials, plus tech and service info.

One good source for special laser printer cables and most interconnects is *Redmond Cable*.

Copier repairs are generally a bad scene, owing to previous ugly vibes within a sick industry. But there is a *Copier & Imaging Technology* mag.

We also have a lot more info on laser printing opportunities up on my *GENie* PSRT. You can start out with our *TONERTRX*.PS file.

Microwave Ovens

Microwave ovens are yet another consumer electronics item that's fairly easy to fix. Besides the maggie itself, you've got a power supply, a timer, and some safety interlocks.

Sources of replacement mag-

netrons are once again *MCM Electronics* and *MAT Electronics*. Typical costs are in the \$36.00 range or so.

Electronic Organs

I'm amazed that any interest at all remains in electronic organs, since a modern synth gives you a thousand times the instrument for far less than one tenth the cost. At any rate, most electronic organ chips are no longer manufactured.

One possible source for original electronic organ top octave generators and keyers is *Fistella Microelectronics*. They specialize in stocking what few devices remain, along with modular workarounds.

Arcade Video Games

There is a lively market in older arcade video games. Their electronics are rather crude and simple, and most of the service problems relate to plain old abuse. The usual complaint is a big lack of interest in anyone putting quarters in them anymore.

You'll find two major trade journals here, namely *Play Meter* and *RePlay* magazines. There's also supposedly a techie pub known as the *STAR Tech Journal*. But I was unable to get further info on this one by press time. So this one is only a maybe.

One source of video game repair info is *Randy Fromm*, who has books, videos, hands-on training schools, repair parts, restoration services, and exchange modules.

Some really good stuff.

Tech info on older electromagnetic pinball machines is surprisingly easy to get. One superb source is *Steve Campbell's Pinball Pages*. Much more on pinball resources in general in my file *HACK75.PS* which I have recently uploaded to my *GENie* PSRT.

Auto Computers

Useful information on automobile computers is extremely hard to come by. First because much of it is treated as insider trade secrets. And secondly, because there are severe EPA penalties for modifying any car computer in any way. Ferinstance, if you modify a car computer such that it dramatically reduces your pollution and increases your mileage, you have committed a felony. The feds will lock you in jail and throw away the key.

Some info on car computers does appear here in *Nuts & Volts* ads. You can also try to use the *SAE Library* for background info. I've also found *Pact Services* to be a useful resource here. You might also check the ads in the performance mags.

RESOURCE BIN

A Service Yarn or Two

The all time classic TV service story involved a technician dealing with a problem customer. What he finally did was adjust the TV set to a slow vertical roll, then told the customer to pick the picture they wanted.

My own toughest electronic service job ever? It involved an intermittent mid air short circuit, and boy, was it ever hard to find.

This one was on a fire alarm system for a small Arizona town. Known as a *Gamewell Fire Alarm Telegraph*. What you basically had was a single wire about 36 miles or so long that wound up one alley and down another to the little red boxes on each street corner. Inside of each box was an incredibly sophisticated spring mechanism the size of your fist.

When tripped, a box would spell out its location by a cam breaking the line circuit in a certain pattern. As I recall, 2-3-1 was the station itself, and other codes led to specific areas in the town. What you have here, of course, is a local area network.

Amazingly, this 1880's technology (yeah — the EIGHTEEN eighties!) was smart enough to avoid all its packet collisions by making sure the line was not in use before sending its own code! Obviously, two pulled boxes would generate garbage without packet collision avoidance.

The box was also smart enough to test the line's signal quality! If the fire ever burned through the alarm line, an alternate circuit through ground was selected by way of a balanced relay. There were self-test provisions and a method at each box to short out part of the system for debugging.

You want a baud rate? You got it. One baud! That was the rate the box number got spelled out, repeating five times and then quitting. Back at the station, a relay at the top of the wet cell battery supply tripped a honker made from three Santa Fe diesel air horns. A separate relay at the bottom of the battery supply tripped a paper tape printout device.

And therein lay the problem. The tape device was something of a great grandfather to a teletype punch. The theory was that you could read this tape if you were late responding to the fire station.

The symptom was obvious enough: Very late on certain very rare dark and windy nights, there would be all sorts of tape punched out on the floor. And the punched numbers simply didn't make sense at all. In fact, most of the time, there was a total rip down

the middle of the tape, rather than being any identifiable numbers.

Now the tape wasn't used all that much, but *any* reliability problem in a fire alarm system is bad news. Their documentation for the system was largely missing or illegible and had gone through several upgrades over the years. The original thought was that there was some loose connection somewhere in the decades old system.

And would I please find it?

The problem with blaming an open circuit is that the honker would also have tripped. That would have been easy to find and would have promptly gotten everyone's attention. Whether they liked it or not. Thus, you never knew when the problem was going to appear. You just had to wait till the middle of a dark and windy night and then go down to the firehall and hope to catch the culprit in action.

Which got old in a hurry. Finally, on one exceptionally windy night, I did manage to catch our gnome in action. I watched the tape spitting out on the floor, ran out across our town, shorted out half of the alarm system, and came back. The tape stopped. I repeated the process three times just to be sure. Now, instead of having 36 miles of problem, I had narrowed it down to a mere 18.

Naturally, the wind died down by then, preventing further tests.

At least we had now proven that the problem was real and not some sort of a bizarre hoax.

Yeah, I thought of some kind of recording time domain reflectometry setup. And of putting a transmitter on the tape punch to let me know when the problem was coming down. But this was a low budget and low time operation. And I still wasn't sure exactly what we had.

This excruciating process of wait for the wind, short-unshort-short-unshort went on for months. The only bright spot was that the symptoms were gradually getting worse. At long last, I narrowed the problem down to two boxes one block apart. The wire went out one box, twenty feet straight up in the air, around the block, and finally twenty feet straight back down to the other box. Mid-air short or no, the problem *had* to be in this wire!

The next morning, I hopped on my bicycle and inspected every inch of the offending wire.

Nothing. Again. Nada.

But wait! Near the alarm wire but not in contact with it was a residential house drop that consisted of three twisted power wires and a *grounded* (!) supporting guy wire. What was happen-

ing was that the power poles would flex enough in very high winds to cause the guy wire to saw its way through the alarm wire insulation.

Causing an intermittent mid-air dead short!

In retrospect, it probably would've been faster and simpler to physically inspect the entire 36 miles an inch at a time. When we did this after the fact, we found three more problem areas. But there was no guaranteeing that it was a wire problem in the first place. And, as with any service hassle, you usually don't know what you really have until after you fully solve the problem once and for all.

But this one certainly was a good example of how divide-and-conquer can be a useful service technique. And how most forgone conclusions (a mid-air "ground" can't happen) can lead you to ongoing grief.

I also never picked up on the fact that the cause *had* to be some high frequency event, when compared to the intended baud rate.

This Month's Contest

As usual, I suspect I have missed several important electronic servicing resources. So, just tell me about any other resources. Or share an unusual servicing story with us.

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.

More on resources for electronic servicing appears in our collected *Resource Bin* reprints. Available in book form per my nearby *Synergetics* ad, or on line from *GENIE PSRT*.

Let's hear from you. **NV**

Microcomputer pioneer and guru Don Lancaster is the author of 32 books and countless tech articles. Don maintains his no-charge tech helpline found at (602) 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 fast modem access, use (800) 638-8369 and enter HHH. When prompted, enter XTX99005,SCRIPT.

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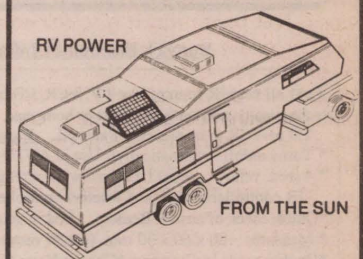
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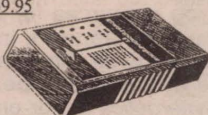
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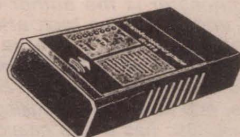
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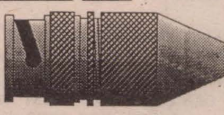
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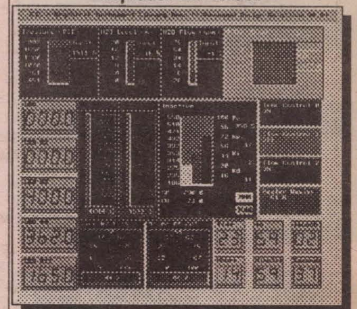
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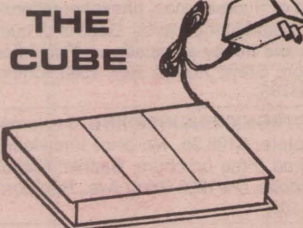
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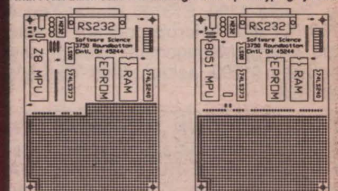
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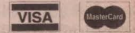


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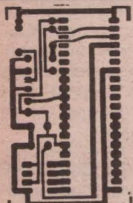
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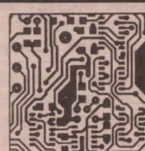
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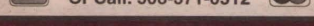
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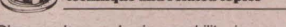
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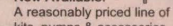


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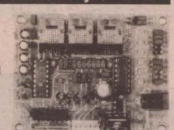
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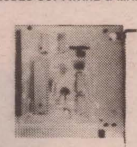
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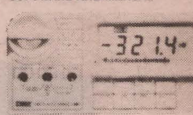
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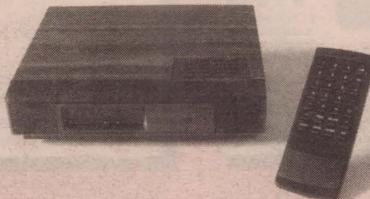
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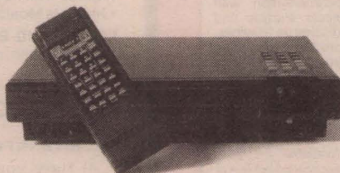
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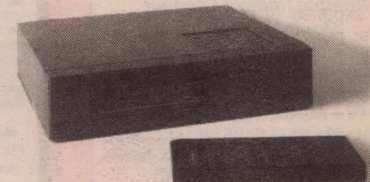
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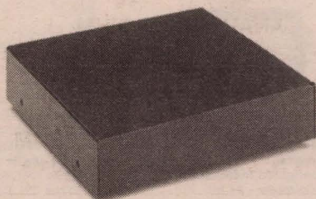
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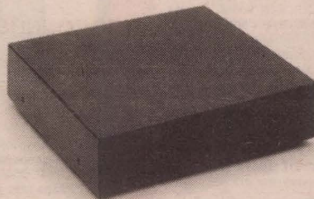
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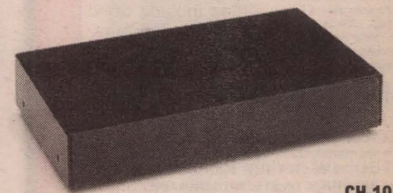
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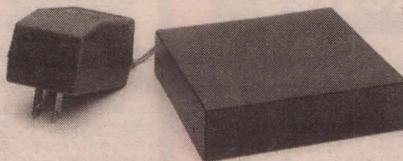
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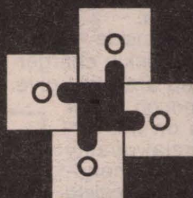
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Corner of Geneva & Santos, Daly City

 April 17, 1994
ARCO ARENA
One Sports Parkway, Sacramento

April 23, 1994
SANTA CLARA COUNTY FAIRGROUNDS
344 Tully Rd., San Jose

May 1, 1994
SAN MATEO EXPO CENTER
2495 S. Delaware, San Mateo

Southern Calif

April 17, 1994
GLENDALE CIVIC AUDITORIUM
1401 N. Verdugo Rd., Glendale

April 23, 1994
ANAHEIM STADIUM
2000 State College Blvd., Anaheim

May 21, 1994
ANAHEIM STADIUM
2000 State College Blvd., Anaheim

May 28, 1994
GLENDALE CIVIC AUDITORIUM
1401 N. Verdugo Rd., Glendale

May 29, 1994
INDUSTRY HILLS SHERATON
1 Industry Hills Parkway, City of Industry

June 12, 1994
PICKWICK CENTER
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June 18, 1994
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FEEDING

VHF AND UHF

Mobile and base station VHF, UHF, dual-band, and tri-band vertical antennas are pre-matched by the manufacturer for a smooth transfer of RF energy from your coax to the actual radiating antenna element. Most mobile and base antennas for VHF and UHF operation feature impedance matching networks within the antenna, or in the base, to offer a 50 ohm match to your 50 ohm coax.

If you decide to home brew your own VHF or UHF antenna systems, the local ham radio store carries antenna handbooks that describe various methods of matching the base impedance. For a ground plane, bend the quarter wavelength radials down at about a 45-degree angle to achieve a 50 ohm match. Straight out, the match is more like 30 ohms. Straight down, such as a quarter wavelength vertical mounted atop a fence post, the impedance might look more like 100 ohms. And anytime you have a mismatch, SWR goes up, radiated power goes down, and your mobile and handheld begins to heat up more rapidly on transmit.

Other methods of loading mobile and base vertical antennas are DC shunt-fed loading coils, matching stubs, and tuned coax harnesses.

But most hams today simply go out and buy the pre-tuned mobile antennas that offer significant gain, dual- and tri-band operation, and a variety of mounts that can hook onto almost any crevice of a vehicle without marring the paint. For base station use, many radio amateurs use white fiberglass tubes that easily affix to your home's vent pipe, and

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inside these white fiberglass tubes are copper elements arranged as a collinear radiator, and properly phased and matched with internal coax harnesses for a perfect 50 ohm operation.

During the recent Los Angeles earthquake, emergency communicators who hooked up their tiny handhelds to outside antennas always enjoyed crystal-clear communications through distant repeaters and area emergency operation centers. Emergency communicators attempting to work only off of their handheld's rubber antenna inside the evacuation center were quick to learn that an outside antenna with suitable coax was an absolute MUST.

MATCHING H.F.

There were plenty of opportunities for emergency communicators at the L.A. quake area to come up on high frequency ham to get messages into and out of the disaster area. Some would work out of their mobile vehicles outside of the evacuation center, and this was a great way to go. Little outside noise, no one spilling coffee on your rig, no power supply problems, and the front seat of your vehicle

where you could lay back and get a few winks between traffic handling.

But some shelters required bringing the H.F. equipment inside, and hooking to some sort of H.F. whip outside. If you could run coax between your mobile H.F. whip and your inside transceiver, you are all set. Just make sure no one trips

over the coax. But many shelters were not readily accessible by radio communicator vehicles, so this meant setting up your H.F. station inside with the whip mounted on something outside.

No problem inside — a 12-volt battery with a trickle charger in a well-ventilated area will give you more than enough power to keep you on the air. The commercial quality Bob Heil, K9EID, headsets with noise-canceling microphone are perfect for this type of operation. He has plugs that will fit Kenwood, Yaesu, and ICOM transceivers — plus special plugs for any other type of transceiver. (For more info, contact Heil Sound, Marissa, Illinois; 618-295-3000.)

RG8X or RG8U, or better yet, RG213 coax is fine for a 75-foot run out of the shelter, and to the remote-mounted mobile whip. For under 50 feet, you could even get by (barely) with inexpensive RG58AU coax, too.

So where are you going to put the whip? For a 50 ohm match, your quarter wavelength whip antenna needs a minimum of a quarter wavelength of metallic ground directly below it. At one shelter, the ham mounted the whip to a ridiculous-looking pair of CB radio vice grips/antenna mount, and clamped onto a horizontal metal rail in the bleachers above him. This ham had the most outstanding worldwide signal there was because of all the metal directly below the whip. Who cares what the mount looks like, right?

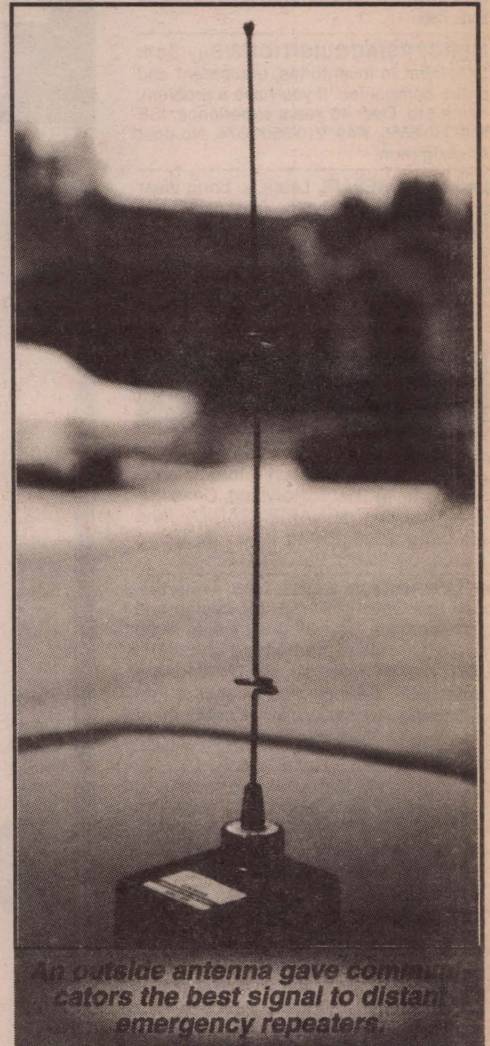
"I measured my match with an AEA SWR recorder with LCD readout, and it was a perfect 1:1 on my operating frequency after I adjusted the tip whip one inch in," comments Red Cross communicator Cindy Hughs, KC6OPI. "I could communicate as easily to New York as I could to Australia off of the Outbacker antenna I had set up over the railing," adds Hughs.

At another shelter, the high frequency antenna was a 5-band trap vertical, mounted to a Radio Shack mast driven seven feet into the softball field outside of the evacuation center. The SWR wouldn't dip below 2.5:1, and the on-the-air performance was terrible.

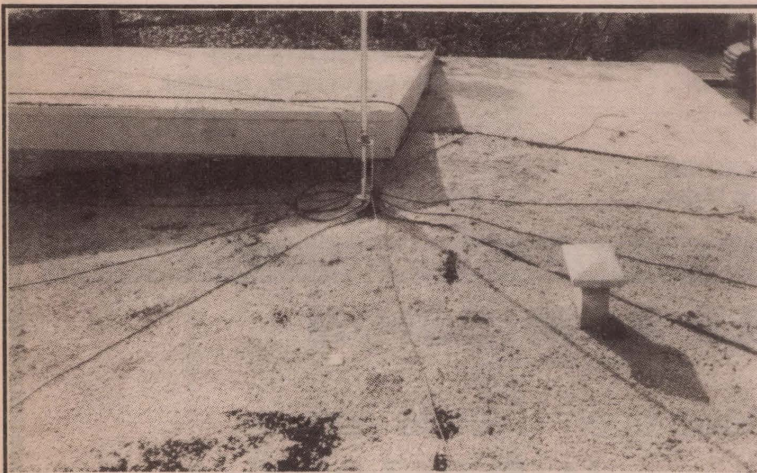
Over 1,000 amateur radio operators staffed over 36 evacuation shelters with amateur radio communications for over three weeks continuously after the 4:31 a.m. L.A. earthquake in January. This was one of the largest and longest emergency radio callouts in the history of Southern California, and licensed amateur radio operators, plus licensed GMRS radio operators, plus REACT members and CB Channel 9 radio operators deserve credit for a job well done.

"You couldn't ask more for a perfect ground than this," comments the local ham radio operator, showing us his blisters from pounding in the Radio Shack mast into the hard clay. "The problem must be somewhere within one of the antenna traps."

Wrong — the problem is a



An outside antenna gave communicators the best signal to distant emergency repeaters.



Temporary ground radials laid out on a shelter roof worked well.

ground system with relatively low conductivity because of the high ohmic resistance of dry clay. Remember that radiation resistance — the ability to get a loud signal out — is an index of the amount of applied power that is consumed as useful radiation, rather than simply lost as heat in the earth or in the conductor. The efficiency of the antenna can be found by dividing the radiation resistance by the total feedpoint impedance of a resonant vertical antenna. Mounting any H.F. whip over dry ground will lead to a loss in efficiency, and also poses hazards for anyone that might touch

the antenna as you are on the air transmitting.

We took this 5-band vertical off of the ground mount, walked it over to a nearby chainlink fence, attached it to the vertical post on the fence as best we could, and the high frequency transceiver jumped to life. SWR dropped down to 1.1:1, and signals began to pour in.

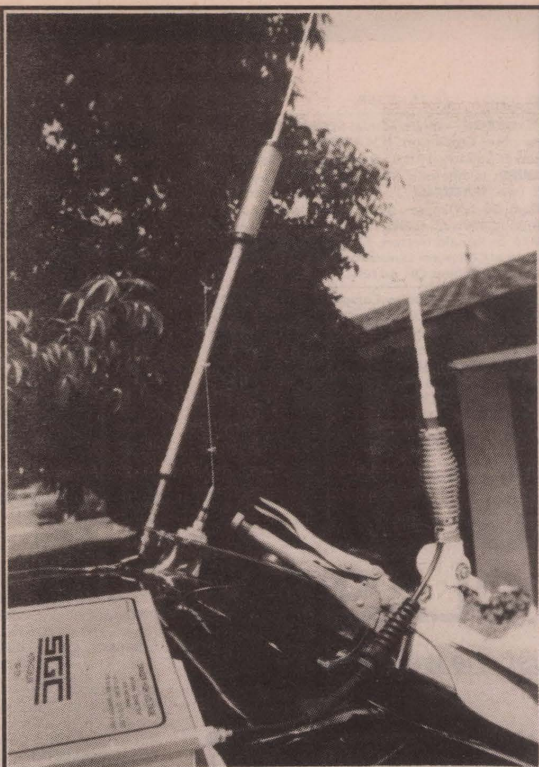
One more example of good grounding techniques for an H.F. whip occurred out in the San Fernando Valley when radio operator Carol Rubin, KA6KPS, needed to pull in high frequency weather FAX imagery for a local command post anticipating the problems of an incoming storm.

"They placed us in a National Guard tent in the middle of a football field, and there was absolutely nothing metal that I could find as a counterpoise to my lightweight H.F. Ham Stick antenna," recalls Rubin. "But the National Guard had plenty of extra speaker wire for their P.A. systems, so I had them cut me up four lengths of wire each 16'6" long, a quarter wavelength to the 20-meter band we needed to operate on for ham transceive and weather facsimile reception," adds Rubin.

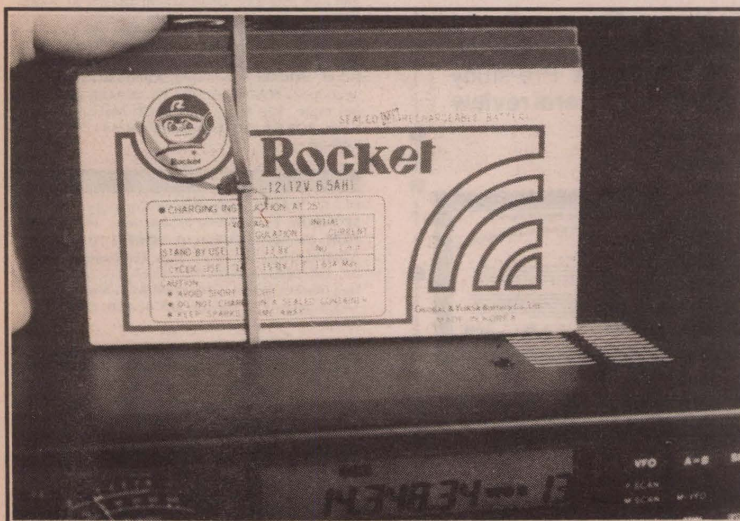
The H.F. whip was mounted on one of the wooden tent poles, and the four quarter wavelength wires attached to the base, and fanned out and down at a 45-degree angle. Instant success. On weather facsimile, noise levels instantly dropped when the radials were connected,

and on transceive SWR was well below 2:1. Although the quarter wavelength radials did not have the conductivity or square foot surface area that the metal bars on a bleacher have, the H.F. antenna feedpoint was close enough to allow the transceiver to operate at full power output by another General class ham.

And after the disaster was over, the most functional type of H.F. mount was that ugly pair of vice grips with an L-bracket that contained a SO-239 for the coax, an insulator, and a 3x24 stud and female adapter for the H.F. whip. As ridiculous as this mount may seem, it could clamp onto any metal almost instantly, and you are on the air with a perfectly matched feedpoint. NV



Vice grip antenna mount (lower right) allowed for a temporary, quick attachment to a ground plane.



The sealed rechargeable battery was put to good use during the earthquake.

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Events

CALENDAR

Enterprises, 812-333-4484.

LA - BATON ROUGE — Greater Baton Rouge Computer Exposition. **LOCATION:** Sheraton Baton Rouge Hotel, 4728 Constitution Ave. **HOURS:** 11am-7pm. **ADMISSION:** \$5, under 12 free. **FEATURES:** AC - C - E - FP - S. **DEALER INFO:** Tables \$50. Setup 7am-10am. **CONTACT:** John M. Lockhart, 15538 Springwood Ave., Baton Rouge LA 70817. 504-751-3338, FAX 504-755-3351. 24 hour show info: 504-296-7575.

MI - PORT HURON — Computer Trade Show. **LOCATION:** Mc Morran Place, 701 Mc Morran Blvd. downtown. **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

APRIL 23

MI - WESTLAND — Great Lakes Computer Expo & Sale. **SPONSOR:** Progressive Computer Productions. **LOCATION:** Wayne-Ford Civic League, 1645 Wayne Rd. 1 blk S of Ford Rd. **HOURS:** 10am-4pm. **ADMISSION:** Adults \$4, Seniors/Students \$3, under 12 free w/adult. **FEATURES:** C - DP - FP - F/R - S. **DEALER INFO:** 8' \$30 ea, 12' \$40 ea. **CONTACT:** Progressive Computer Productions, 23814 Michigan Ave., Ste 237, Dearborn MI 48124. 313-425-9276.

OH - NORTH CANTON — Computer Show. **SPONSOR:** Mercury Productions. **LOCATION:** Sheraton Hotel. **HOURS:** 10am-4pm. **ADMISSION:** \$4, \$3 w/coupon. **FEATURES:** DP - FP. **DEALER INFO:** \$40 per table, \$99 for 3. **CONTACT:** Mercury Productions, POB 39130, Cleveland OH 44139. 216-248-0021.

APRIL 23-24

CO - DENVER — 6th Annual Show & Swap Meet. **SPONSOR:** Colorado Radio Collectors. **LOCATION:** National Western Complex, one mile E of I-25 on I-70. **HOURS:** Sat: 9am-6pm, Sun: 10am-3pm. **CONTACT:** Dick Hagman, 303-794-6674.

TX - ABILENE — Hamfest/ARRL West Texas Section Convention. **SPONSOR:** Key City ARC. **FEATURES:**

Continued from page 47

CB - DP - F/R. **CONTACT:** 915-672-8889.

APRIL 24

MI - GRAND RAPIDS — Computer Trade Show. **LOCATION:** Kentwood Club, 3684 28th St. SW. Across from Eastbrook Mall. **HOURS:** 10am-4pm. **ADMISSION:** Adults \$4; Seniors & Students \$3; under 12 free w/adult. **FEATURES:** C - DP. **CONTACT:** Computers & You, 313-283-1754.

OH - LIMA — Lima Computer Festival. **SPONSOR:** Support Services. **LOCATION:** Veterans Memorial Civic & Convention Center, 7 Town Square. **HOURS:** 10am-4pm. **ADMISSION:** \$4, seniors/students \$3, under 12 free. **FEATURES:** C - DP - F/R. **DEALER INFO:** Setup: 7:30am-9:45am. 8' tables draped and covered: 1-4 \$35 ea., 5+ \$30 ea. **CONTACT:** Support Services, POB 1350, Taylor MI 48180. 313-295-2237.

OH - YOUNGSTOWN — Computer Show. **SPONSOR:** Mercury Productions. **LOCATION:** Holiday Inn. **HOURS:** 10am-4pm. **ADMISSION:** \$4, \$3 w/coupon. **FEATURES:** DP - FP. **DEALER INFO:** \$40 per table, \$99 for 3. **CONTACT:** Mercury Productions, POB 39130, Cleveland OH 44139. 216-248-0021.

APRIL 29

OH - DAYTON — 1994 Annual Banquet. **SPONSOR:** Southwest Ohio Chapter of Quarter Century Wireless Assn. **LOCATION:** Alex's Continental Restaurant. **HOURS:** C.O.D. bar at 7. Banquet at 7:30. **ADMISSION:** \$15 ea. Reservations required. QCWA membership not required. **CONTACT:** Make checks payable to Robert L. Dingle, Treas. Chapter 9 & mail to: 1117 Big Hill Rd., Kettering, OH 45429-1201.

APRIL 29-30-MAY 1

OH - DAYTON — Dayton Hamvention. **SPONSOR:** Dayton Amateur Radio Assn. Inc. **LOCATION:** Dayton Hara Arena & Exhibition Center. **ADMISSION:** \$11 adv., \$14 door (valid all 3 days). **FEATURES:** B - C - CB - DP - EX - FM - F/R. **DEALER INFO:** Flea Market info: 513-276-6932. \$30/I

EVENTS CALENDAR

space, \$60/2 adjacent, \$150/3 adjacent. Electricity add \$40 space. **CONTACT:** Hamvention, Box 964, Dayton OH 45401-0964. 513-276-6930. Lodging info: 513-223-2612 (no reservations by phone).

MAY I

IA - BURLINGTON — Burlington Hamfest '94. **SPONSOR:** Valley Emergency Communications Assn. **LOCATION:** Burlington Drive-In Theater, Agency St. off US 61 & US 34. **HOURS:** 7:30am-3pm. **ADMISSION:** \$4, under 12 free w/adult. **TALK-IN:** 146.790 (146.190 Input) WOLAC/R & 146.520 simplex. **FEATURES:** C - E - FP - F/R - H. **CONTACT:** Chuck Gysl, N2DUP, Burlington Hamfest, POB 911, Burlington IA 52601-0911 or call 319-752-3000 voice/fax.

IN - INDIANAPOLIS — Computer Show. **SPONSOR:**

National Computer Fairs. **LOCATION:** Holiday Inn East, 6990 E. 21st St. **HOURS:** 10am-3pm. **ADMISSION:** \$3. **FEATURES:** C - CB. **DEALER INFO:** Setup 8am-10am. Tables: 1-4/\$25 ea., 5+/\$20 ea. Reservations paid one week prior to event get \$5 per table discount. **CONTACT:** National Computer Fairs, POB 501403, Indianapolis IN 46250. 317-843-9201.

MI - FLINT — Computer Trade Show. **LOCATION:** Holiday Inn, 5353 Gateway Centre, I-475 or US-23 exit Hill Rd. **HOURS:** 10am-4pm. **ADMISSION:** Adults \$4; Seniors & Students \$3; Under 12 free w/adult. **FEATURES:** C - DP. **CONTACT:** Computers & You, 313-283-1754.

MN - BEMIDJI — Hamfest. **SPONSOR:** Paul Bunyan ARC. **HOURS:** 8am-2pm. **TALK-IN:** 146.13/73. **FEATURES:** CB - EX - FM - F/R. **CONTACT:** Steve Hake, Hamfest Chairman, 4331 Pincherry Rd., Bemidji

MN 56601. 218-751-9558.

OH - AKRON — Micro Mania! **SPONSOR:** National Computer Exposition. **LOCATION:** Akron Hilton/Quaker Square, 135 S. Broadway (downtown). **HOURS:** 10am-4pm. **ADMISSION:** \$5 w/ad, under 12 free. **FEATURES:** FP. **DEALER INFO:** Setup 8am-10am. 80-100 tables. Sellouts are common, early booking advised. **CONTACT:** Joe Bowen, 216-442-1776 or Ronald Nelson, FAX: 216-292-7746. National Computer Exposition, 30799 Pinetree Rd. #230, Cleveland OH 44124.

OH - FINDLAY — Findlay Computer Festival. **SPONSOR:** Computer Support Services. **LOCATION:** Hancock Arena, 3430 N Main St. **HOURS:** 10am-4pm. **ADMISSION:** \$4 seniors, \$3 students, under 12 free. **FEATURES:** DP - F/R. **DEALER INFO:** 8' tables draped & covered. 1-4 tables \$35 ea., 5+ tables \$30 ea. **CONTACT:** Computer Support Services,

POB 1350, Taylor MI 48180. 313-295-2237.

MAY 7

OK - ENID — Tall Gator Swap Meet. **LOCATION:** Meadowlake Park on South US 81 Hwy. **HOURS:** 8am-5pm. **ADMISSION:** Free. **TALK-IN:** 147.375 + 600. **FEATURES:** FP - F/R. **DEALER INFO:** Limited table space available by request only. **CONTACT:** Fred, N5QJX, 405-242-3551; Tom, N5LWT, 405-233-8473; Dick, N5HEL, 405-233-9869.

WI - MANITOWOC — Hamfest & Computer Swapfest. **SPONSOR:** Mancorad Radio Club. **LOCATION:** Manitowoc County Expo Center, Intersection of Hwys 42-151 & I-43 on Co. Hwy. R. **HOURS:** 8am-7. **ADMISSION:** \$2 adv., \$3 door. **TALK-IN:** 146.01/61. **FEATURES:** EX - FM - F/R. **DEALER INFO:** 8' tables \$3, w/electric outlet \$8. Fri. night set-up until 10:00 or early Sat. morning. **CONTACT:** SASE to: Mancorad RC, POB 204, Manitowoc WI 54221-0204 or call Red 414-684-9097 days or Ron 414-793-4733 evenings.

MAY 8

OH - ATHENS — 15th Annual Hamfest. **SPONSOR:** Athens County ARA. **LOCATION:** City Recreation Center. Take East St. exit on either US Route 33 or US Route 50. **HOURS:** 8am-3pm. **ADMISSION:** \$4. YL's & spouses of male hams free. **TALK-IN:** 146.15-600. **FEATURES:** DP - FM - F/R. **DEALER INFO:** John Biddle, WDBJLM, 80 Wonder Hills Dr., Athens OH 45701. 614-594-8901 after 6 pm. **CONTACT:** Carl J. Denbow, K8JXG, 63 Morris Ave., Athens OH 45701-1939.

OH - MEDINA — Medina County Hamfest '94. **SPONSOR:** Medina 2 Meter Group, Inc. **LOCATION:** Medina County Community Center, 735 Lafayette Rd. **ADMISSION:** \$4 door, \$3 adv. **FEATURES:** C - E - FM - H. **DEALER INFO:** Tables \$6. 10' flea market space \$4. **CONTACT:** Send SASE to: Medina Hamfest Committee, POB 452, Medina OH 44258. 216-725-4492 10am-5pm.

MAY 14

IN - HIGHLAND — Computer Possibilities Unlimited. **SPONSOR:** Bee Software. **LOCATION:** Lincoln Center, 2450 Lincoln. **HOURS:** 10am-3pm. **ADMISSION:** \$5, under 12 free. **FEATURES:** AC - C - DP - FP - F/R - S. **CONTACT:** Info/Discount tickets: 219-931-3761.

MI - CADILLAC — Swap & Eyeball QSO. **SPONSOR:** Wexauke ARC. **LOCATION:** Cadillac Middle School. **ADMISSION:** \$4. **TALK-IN:** 146.98 repeater. **DEALER INFO:** Tables \$6. **CONTACT:** Wexauke ARC, POB 163, Cadillac MI 49601 or call Dan, KEBKU, 616-775-0998.

MI - FLINT — Computer Show. **SPONSOR:** TechNet Super Shows. **LOCATION:** I.M.A. Sports Arena, 3501 Lapeer Rd., I-69 take Exit 139. **HOURS:** 9am-6pm. **ADMISSION:** \$5. **FEATURES:** AC - C - CB - DP - E - F - F/R. **DEALER INFO:** 8' covered & skirted tables: 1-3 \$75, 4+ \$65. Setup 6am. **CONTACT:** TechNet Super Shows, Kathleen Svrcek, POB 8213, Flint MI 48501. 810-767-3372.

MI - WESTLAND — Great Lakes Computer Expo & Sale. **SPONSOR:** Progressive Computer Productions. **LOCATION:** Wayne-Ford Civic League, 1645 Wayne Rd, 1 blk S of Ford Rd. **HOURS:** 10am-4pm. **ADMISSION:** Adults \$4, Seniors/Students \$3, under 12 free w/adult. **FEATURES:** C - DP - FP - F/R - S. **DEALER INFO:** 8' \$30 ea, 12' \$40 ea. **CONTACT:** Progressive Computer Productions, 23814 Michigan Ave., Ste 237, Dearborn MI 48124. 313-425-9276.

OH - NORTH CANTON — Computer Show. **SPONSOR:** Mercury Productions. **LOCATION:** Sheraton Hotel. **HOURS:** 10am-4pm. **ADMISSION:** \$4, \$3 w/coupon. **FEATURES:** DP - FP. **DEALER INFO:** \$40 per table, \$99 for 3. **CONTACT:** Mercury Productions, POB 39130, Cleveland OH 44139. 216-248-0021.

MAY 14-15

IN - FT. WAYNE — Ft. Wayne Computer Fair. **SPONSOR:** Trade Show Productions, Inc. **LOCATION:** Memorial Coliseum. **HOURS:** 10am-5pm. **ADMISSION:** \$5 for both days. **FEATURES:** C - CB - DP - FM. **DEALER INFO:** Professional booths \$200, Flea Market spaces \$30. **CONTACT:** Mark Hanslip, 143 Schloss Ln., Dayton OH 45418. 513-263-3378.

MAY 15

IL - ORLAND PARK — The Orland Park Computer Show. **LOCATION:** Orland Park Civic Center, 147th St & LaGrange Rd (Rt. 45). **HOURS:** 9:30am - 3:00pm. **ADMISSION:** Adults \$5 - \$1 off with copy of this ad, 8-12 yrs \$2, under 8 free. **FEATURES:** AC - C - CB - DP - FP - F/R - All indoors. **CONTACT:** 24-hour Hotline 708-974-3123.

IL - PEOTONE — Hamfest '94. **SPONSOR:** Kankakee Area Radio Society. **LOCATION:** Will County Fairgrounds, I-57 to Peotone Exit 327 East. **HOURS:** 8am-7. **ADMISSION:** \$4 adv., \$5 door, under 12 free. **TALK-IN:** 146.94. **FEATURES:** C - DP - E - FM - F/R - H. **DEALER INFO:** Setup Sat. 6pm-8pm, Sun.

FRIDAY 6-10 PM, SATURDAY 9-5, SUNDAY 9-6 PM

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The Federal Communications Commission, for the first time in amateur radio history, allows applicants to obtain an amateur radio license in the United States without passing a Morse Code test. No-code Technician class operators gain all privileges from 30 MHz up! This includes worldwide SSB on 6m, repeater privileges on popular 2 meters, the 222 MHz band, the 440 MHz band, the 900 MHz band, the 1200 MHz band, plus much more.

SATURDAY EVENING WORKSHOP. Learn how to build your own 2-meter antenna system, and learn how to install radios in a boat or car. **MARINERS** - learn all about grounding, and how to obtain XE2 Mexican privileges when cruising south. (Workshop is optional-6:00 p.m. to 9:00 p.m.)

The new no-code Technician class license exams are based on the Novice Element 2, and Technician Element 3A written materials, covered in the exclusive Gordon West Novice and Technician class textbook. Examinations are multiple choice - exactly from the book. Pre-study now for an easy pass of both elements in class Sunday PM. **General code class, General review theory, conducted same weekend at same facility. Tell your ham friends!**

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Please fill out one registration form per person. Make your check payable to
RADIO SCHOOL, INC. 2414 College Drive, Costa Mesa, CA 92626 (714) 549-5000 DAYS • (714) 434-0666 24 HRS.

EVENTS CALENDAR

6am. Indoor tables \$5 ea. **CONTACT:** SASE to: Willis Bowser, 1210 N. Riverside Dr., Mommence IL 60954. 815-472-2079.

IN - SOUTH BEND — Camera/Computer Swap Meet. **LOCATION:** Century Center, downtown. **HOURS:** 10am-3pm. **ADMISSION:** \$4, under 12 free. **DEALER INFO:** 8' tables \$40 ea. **CONTACT:** Roger L. Smith, 8863 E. Black Point Rd., Syracuse IN 46567. 219-856-3863 voice/fax.

MI - HOLLY — 4th Annual Hamfest/Computerfest. **SPONSOR:** Fenton Area ARA & Ben Sherman Middle School ARC. **LOCATION:** Ben Sherman Middle School, 20 miles S of Flint between I-75 & US-23. **HOURS:** 8am-2pm. **ADMISSION:** \$4 adults, \$1 students, 12 & under free. **TALK-IN:** 146.780 -600, 442.250 +5MHz. **FEATURES:** DP - F/R - T. **DEALER INFO:** 8' table \$8, tailgating space \$4 before May 9, after May 9 tables \$10, tailgating \$6. **CONTACT:** FAARA Hamfest, POB 46, Fenton MI 48430 or call John Carlo, 313-629-0094 (home), 313-634-8398 (school).

OH - COLUMBUS — Columbus Computer Festival. **SPONSOR:** Computer Support Services. **LOCATION:** Aladdin Temple, 3850 Stelzer Rd. **HOURS:** 10am-4pm. **ADMISSION:** \$4, seniors/students \$3, under 12 free. **FEATURES:** DP - F/R. **DEALER INFO:** 8' tables draped & covered. 1-4 tables \$35 ea., 5+ tables \$30 ea. **CONTACT:** Computer Support Services, POB 1350, Taylor MI 48180. 313-295-2237.

OH - HOLLAND — The North-West Ohio Tri-County Hamfest. **SPONSOR:** Henry Co. ARC, Defiance Co. ARC, Fulton Co. ARC. **LOCATION:** Fulton Co. Fairgrounds, St. Rte. 108 at Exit 3, Ohio Turnpike. **HOURS:** 8am-4pm. **ADMISSION:** \$3 adv., \$4 door, under 12 free. **TALK-IN:** 147.195+. **FEATURES:** DP - EX - FM. **DEALER INFO:** Inside tables \$10 ea. w/1 vendor pass per table. Outside flea market spaces \$3 ea. Overnight camping spots \$10 after 5pm Sat. **CONTACT:** SASE to: 126 Muntz St., Holland OH 43527. 419-264-7775. VEC Testing contact: Tom Hay before May 8th, 419-542-6192.

OH - YOUNGSTOWN — Computer Show. **SPONSOR:** Mercury Productions. **LOCATION:** Holiday Inn Metroplex. **HOURS:** 10am-4pm. **ADMISSION:** \$4, \$3 w/coupon. **FEATURES:** DP - FP. **DEALER INFO:** \$40 per table, \$99 for 3. **CONTACT:** Mercury Productions, POB 39130, Cleveland OH 44139. 216-248-0021.

MAY 20-21

MIN - MINNEAPOLIS — Radio Daze '94. **SPONSOR:** Northland Antique Radio Club & AWA. **CONTACT:** NARC, POB 18362, Minneapolis MN 55418 or Don Hauff, 612-374-9739.

MAY 21

CO - COLORADO SPRINGS — Ham Radio Swapfest. **SPONSOR:** Pikes Peak Radio Amateur Assn. **LOCATION:** Liberty High School, 8720 Scarborough Dr., off Research Pkwy. N Colorado Springs. **HOURS:** 8am-3pm. **ADMISSION:** \$3, under 15 free. **TALK-IN:** 146.97, 146.52. **FEATURES:** C - DP - E - EX - F/R - H. **DEALER INFO:** \$10 first table, \$8 ea. additional. **CONTACT:** John Kramer, NOVBM, 1765 Kimberly Pl., Colorado Springs CO 80915. 719-550-1489 or Harvey Hunter, WA3ELB, 719-597-8964.

IL - GODFREY — Hamfest '94. **SPONSOR:** Lewis & Clark Radio Club. **LOCATION:** Lewis & Clark Community College, approx. 25 miles N of downtown St. Louis on US Rte. 67 just N of Alton, IL. **HOURS:** 8am-7. **ADMISSION:** 6 for \$5 adv., \$1 door. **TALK-IN:** 145.230 repeater. **FEATURES:** CB - DP - EX - FM - FP - F/R. **DEALER INFO:** Tables \$10 ea., no charge for flea market. **CONTACT:** Lewis & Clark Radio Club, Inc., POB 553, Godfrey IL 62035. 618-466-1909.

IN - INDIANAPOLIS — Indianapolis Computer Fair. **LOCATION:** Quality Inn East, 3525 N Shadeland, near Pendleton Pike. **HOURS:** 10am-3pm. **ADMISSION:** \$5, under 12 free. **FEATURES:** C - DP. **CONTACT:** Ben Yanto, AGI Computer Fairs.*

MO - KANSAS CITY — PHD KC Midwest Amateur Radio Convention. **LOCATION:** KC Market Center, Northwest of US I-435 & Front St. **HOURS:** 8:30am-5pm. **ADMISSION:** \$5 before May 8, \$7 after. Under 12 free. **TALK-IN:** 146.34/94. **FEATURES:** CB - DP - F - FP - F/R - RV - S. **DEALER INFO:** 8' x 30' tables \$10. **CONTACT:** PHD, POB 11, Liberty, MO 64068-0011.

MAY 21-22

LA - BATON ROUGE — Hamfest '94. **SPONSOR:** Baton Rouge ARC. **LOCATION:** The Great Hall, Bellemont Hotel, 7370 Airline Hwy. (US 61). **HOURS:** Sat: 8am-4pm, Sun: 8am-1pm. **ADMISSION:** \$3 adv., \$4 door. **FEATURES:** B - DP - F - FM - FP. **CONTACT:** Herb Ramey, KB5AQ, 504-346-0000 days, 504-654-6087 evenings or write: BRARC, 4079 Florida Blvd., Baton Rouge LA 70806.

MAY 22

IL - DECATUR — Decatur Area Hamfest. **SPONSOR:** Cenosis ARC. **LOCATION:** Richland Community Col-

lege, corner of Reas Bridge Rd. & Brush College Rd. **HOURS:** 8am-2pm. **ADMISSION:** \$4, 16 & under free. **TALK-IN:** 146.13/73. **FEATURES:** EX - FM - F/R. **DEALER INFO:** Outdoor flea market set-up \$1, no tables furnished. **CONTACT:** Decatur Area Hamfest, Spencer A. Carter, N9LVW, POB 4595, Decatur IL 62525. 217-692-2460 evenings

IL - GLEN ELLYN — Computer Central. **LOCATION:** College of DuPage, Physical Education Bldg. Main Arena, 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.

IN - CLARKSVILLE — Computer Show Extravaganza. **LOCATION:** Holiday Inn, I-65 take Exit #1 from

Kentucky or Indiana. **HOURS:** 9:30am-3pm. **FEATURES:** C. **DEALER INFO:** 1-2 tables \$40 ea., 3+ \$35 ea. **CONTACT:** Computer Show Extravaganza, POB 1462, Columbus IN 47202. 812-376-3264, FAX: 812-375-0057.

IN - KOKOMO — Indianapolis Computer Fair. **LOCATION:** Ramada Inn. **HOURS:** 10am-3pm. **ADMISSION:** \$5, under 12 free. **FEATURES:** C - DP. **CONTACT:** Ben Yanto, AGI Computer Fairs.*

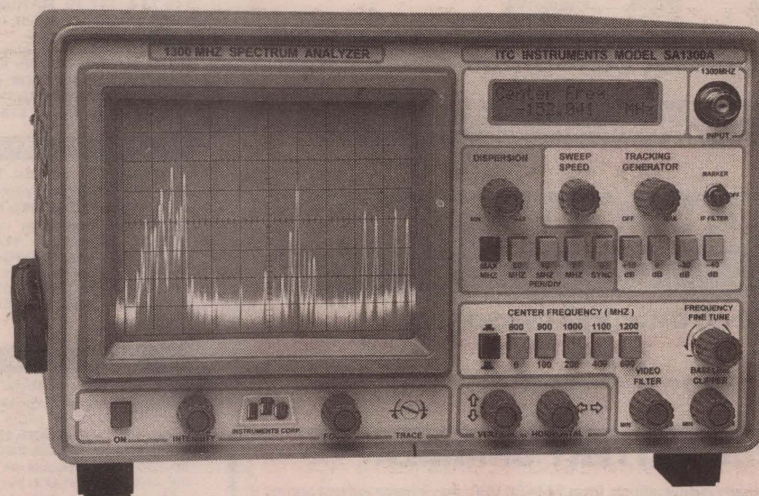
MI - SOUTHFIELD — Michigan Computer Festival. **SPONSOR:** Computer Support Services. **LOCATION:** Southfield Pavilion, 26000 Evergreen Rd. **HOURS:** 10am-4pm. **ADMISSION:** \$4 seniors, \$3 students, under 12 free. **FEATURES:** CB - DP - F/R - S. **DEALER INFO:** Setup 7:30am-9:45am. 8' tables draped & covered. 1-4 tables \$50 ea., 5+ tables

\$40 ea. **CONTACT:** Computer Support Services, POB 1350, Taylor MI 48180. 313-295-2237.

OH - CANFIELD — Hamfest & Computer/Electronics Flea Market. **SPONSOR:** 20/9 Radio Club, Inc. **LOCATION:** Canfield Fairgrounds, Rt. 46. **ADMISSION:** \$3 adv., \$4 door, under 16 free w/adult. **TALK-IN:** 147.315+, 443.225+, 224.160. **FEATURES:** DP - FM - FP - F/R. **DEALER INFO:** Inside 8' tables \$8, admission not included. Outdoor flea market space free w/admission. **CONTACT:** Don Stoddard, 42 S. Whitney Ave., Youngstown OH 44509 216-793-7072 or Dave Mellott, 2895 Penny Ln., Austintown OH 44515. 216-793-0816.

OH - CLEVELAND — Micro Mania! **SPONSOR:** National Computer Exposition. **LOCATION:** Holiday Inn/Strongsville, 15471 Royalton Rd., I-71

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Events CALENDAR

Exit 231A. HOURS: 10am-4pm. ADMISSION: \$5 w/ad, under 12 free. FEATURES: FP. DEALER INFO: Setup 8am-10am. 80-100 tables. Sellouts are common, early booking advised. CONTACT: Joe Bowen, 216-442-1776 or Ronald Nelson, FAX: 216-292-7746. National Computer Exposition, 30799 Pinetree Rd. #230, Cleveland OH 44124.

MAY 27-28-29

OH - CLEVELAND — Super Flea Market. SPONSOR: Mercury Productions. LOCATION: I-X Center. HOURS: 10am-4pm. ADMISSION: \$1. FEATURES: DP - FM - F/R - S. DEALER INFO: 1 table \$130, 2 + \$99 ea. Setup 8am. Estimated attendance 30,000. CONTACT: Mercury Productions, POB 39130, Cleveland OH 44139. 216-248-0021.

MAY 28

IN - MERRILLVILLE — Computer Possibilities Unlimited. SPONSOR: Bee Software. LOCATION: Michelangelo Hall, 6220 Broadway. HOURS: 10am-3pm. ADMISSION: \$5, under 12 free. FEATURES: AC - C - DP - FP - F/R - S. CONTACT: Info/Discount tickets: 219-931-3761.

LA - SPRINGHILL — North Louisiana/South Arkansas Hamfest. SPONSOR: Springhill & Arkla ARCS. LOCATION: Springhill Civic Center. TALK-IN: 146.73 & 147.39. FEATURES: CB - F - FM. CONTACT: David Smith, KF5BF, POB 812, Springhill LA 71075. 318-539-3226.

MO - COLUMBIA — 19th Annual Hamfest & Computer Expo. SPONSOR: Central Missouri Radio Assn. CONTACT: W. "Mac" McKenzie, Jr. K4CHS, 314-882-7413 days & 314-442-7619 evenings.

MAY 29

IL - CHICAGO — Hamfest. SPONSOR: Chicago ARC. LOCATION: DeVry Institute of Technology, 3300 N Campbell. HOURS: 8am-3pm. ADMISSION: \$3 adv., \$4 door, under 12 free. TALK-IN: 147.255 +, 444.825 +. FEATURES: CB - DP - EX - FM - FP - F/R. DEALER INFO: Indoor table space \$1/foot, outdoor flea market space free. Setup 6am. CONTACT: CARC, 5631 W Irving Park Rd., Chicago IL 60634. 312-666-1606 or 312-545-3622.

JUNE 4

OH - CLEVELAND — Micro Mania! SPONSOR: National Computer Exposition. LOCATION: Marriott Hotel, 4277 W. 150th St. at I-71. HOURS: 10am-4pm. ADMISSION: \$5 w/ad, under 12 free. FEATURES: FP. DEALER INFO: Setup 8am-10am. 80-100 tables. Sellouts are common, early booking advised. CONTACT: Joe Bowen, 216-442-1776 or Ronald Nelson, FAX: 216-292-7746. National Computer Exposition, 30799 Pinetree Rd. #230, Cleveland OH 44124.

JUNE 5

IL - PRINCETON — Princeton Hamfest & Computer Show. SPONSOR: Starved Rock Radio Club. LOCATION: Bureau County Fairgrounds. ADMISSION: \$4 before June 1, \$5 afterwards. TALK-IN: 146.355/955. FEATURES: DP - FM - FP. DEALER INFO: Outside flea market free. Electricity available. 8' tables \$10 ea. CONTACT: Bruce Burton, KU9A, 1153 Union St., Marseilles IL 61341. 815-795-2201.

IN - INDIANAPOLIS — Computer Show. SPONSOR: National Computer Fairs. LOCATION: Holiday Inn East, 6990 E. 21st St. HOURS: 10am-3pm. ADMISSION: \$3. FEATURES: C - CB. DEALER INFO: Setup 8am-10am. Tables: 1-4/\$25 ea., 5+/\$20 ea. Reservations paid one week prior to event get \$5 per table discount. CONTACT: National Computer Fairs, POB 501403, Indianapolis IN 46250. 317-843-9201.

KS - SALINA — Hamfest. SPONSOR: Central Kansas ARC. LOCATION: 4-H Building, Kenwood Park. HOURS: 8am-3pm. ADMISSION: \$4. TALK-IN: 147.03/63. FEATURES: CB - DP - E - F - FM - FP - F/R - H. CONTACT: Larry White, KB0BH, 336 Sunset Dr., Salina KS 67401. 913-827-3737.

OH - CLEVELAND — Micro Mania! SPONSOR: National Computer Exposition. LOCATION: Holiday Inn/Hudson, 240 Hines Hill Rd., at I-80 Ohio Tpk (N Exit 12). HOURS: 10am-4pm. ADMISSION: \$5 w/ad, under 12 free. FEATURES: FP. DEALER INFO: Setup 8am-10am. 80-100 tables. Sellouts are common, early booking advised. CONTACT: Joe Bowen, 216-442-1776 or Ronald Nelson, FAX: 216-292-7746. National Computer Exposition, 30799 Pinetree Rd. #230, Cleveland OH 44124.

OH - PARMA — Cleveland Computer Festival. SPONSOR: Support Services. LOCATION: UAW 1005 Hall, 5615 Chevrolet Blvd. (Stump Rd.). HOURS: 10am-4pm. ADMISSION: \$4, seniors/students \$3, under 12 free. FEATURES: C - DP - F/R. DEALER INFO: 8' tables: 1-4 \$35, 5 or more \$30 ea. Setup 7:30am-9:45am. CONTACT: Support Services, POB 1350, Taylor MI 48180. 313-295-2237.

JUNE 9-10-11

AR - LITTLE ROCK — ARCA National Convention.

SPONSOR: Arkansas Antique Radio Club. LOCATION: North Little Rock Riverfront Hilton, intersection of I-30 & I-40. FEATURES: B - FM - S. CONTACT: ARCA '94, c/o Tom Burgess, POB 191117, Little Rock AR 72219-1117. 501-565-1750 after 5 & on weekends.

JUNE 10-11-12

TX - ARLINGTON — Ham-Com '94/ARRL National Convention. CONTACT: John Fleet, WA5OHG, Box 25028, Dallas, TX 75225.

JUNE 11

CO - LOVELAND — Superfest XVI. SPONSOR: Northern Colorado ARC. LOCATION: Larimer County Fairgrounds, 700 S. Railroad. HOURS: 8am-3pm. ADMISSION: \$3. FEATURES: C - CB - DP - E - EX - FP - F/R - H. DEALER INFO: Tables \$8. CONTACT: Orlin Jenkins, KOQJ, 303-353-7097 for tables; Musser Moore, 303-221-3698 for general info.

JUNE 12

IL - ORLAND PARK — The Orland Park Computer Show. LOCATION: Orland Park Civic Center, 147th St & LaGrange Rd (Rt. 45). HOURS: 9:30am - 3pm. ADMISSION: Adults \$5 - \$1 off with copy of this ad, 8-12 yrs \$2, under 8 free. FEATURES: A - C - CB - DP - FP - F/R - All indoors. CONTACT: 24-hour Hotline 708-974-3123.

IL - WILLOW SPRINGS — 37th Annual Hamfest. SPONSOR: Six Meter Club of Chicago, Inc. LOCATION: Santa Fe Park, 91st & Wolf Rd. HOURS: 6am-7. ADMISSION: \$4 adv., \$5 door. TALK-IN: 146.52, 146.37/97. FEATURES: DP - FP - F/R. CONTACT: Joseph Gutwien, WA9RJL, 7109 Blackburn Ave., Downers Grove IL 60516. 708-963-4922.

OH - AKRON — 27th Annual Hamfest, Picnic & Flea Market. SPONSOR: Goodyear Amateur Radio Club. LOCATION: Goodyear Wingfoot Lake Park, on State Rte. 43 between I-76 & Hartsville OH. HOURS: 8am-4pm. ADMISSION: \$4 adv., \$5 gate. Free admission for immediate family, spouse & children. TALK-IN: 146.385/985. FEATURES: DP - EX - FM. DEALER INFO: Flea market free w/admission ticket. Inside tables \$6. CONTACT: Send SASE to: David Hyde, WB8FX, 1821 Cromwell Dr. #B, Akron OH 44313-5546 or call 216-796-5685.

OH - TOLEDO — Toledo Computer Festival. SPONSOR: Computer Support Services. LOCATION: Masonic Great Hall, 4645 Heatherdowns. HOURS: 10am-4pm. ADMISSION: \$4 seniors, \$3 students, under 12 free. FEATURES: DP - F/R. DEALER INFO: 8' tables draped & covered \$40. Maximum 5 tables per dealer. Setup 7:30am-9:45am. CONTACT: Computer Support Services, POB 1350, Taylor MI 48180. 313-295-2237.

JUNE 18

IN - INDIANAPOLIS — Indianapolis Computer Fair. LOCATION: Quality Inn East, 3525 N Shadeland, near Pendleton Pike. HOURS: 10am-3pm. ADMISSION: \$4, under 12 free. FEATURES: C - DP. DEALER INFO: No charge for User Group setups. CONTACT: Ben Yanto, AGI Computer Fairs.*

IN - INDIANAPOLIS — Indianapolis Computer Fair. LOCATION: Quality Inn East, 3525 N Shadeland, near Pendleton Pike. HOURS: 10am-3pm. ADMISSION: \$5, under 12 free. FEATURES: C - DP. CONTACT: Ben Yanto, AGI Computer Fairs.*

MI - GRAND RAPIDS — 14th Annual Hamfest. SPONSOR: Independent Repeater Assn. LOCATION: Wyoming National Guard Armory, 44th St., 1/2 mi. W of the 131 x-way. HOURS: 8am-2pm. ADMISSION: \$4 before June 11, \$5 after, under 12 free. TALK-IN: 147.160. FEATURES: DP - EX. DEALER INFO: \$5 per table, setup 6am. CONTACT: Tom or Kathy Werkema, 562 92nd St. SE, Byron Center MI 49315. 616-698-6627.

JUNE 19

OH - YOUNGSTOWN — Computer Show. SPONSOR: Mercury Productions. LOCATION: Holiday Inn Metroplex. HOURS: 10am-4pm. ADMISSION: \$4, \$3 w/coupon. FEATURES: DP - FP. DEALER INFO: \$40 per table, \$99 for 3. CONTACT: Mercury Productions, POB 39130, Cleveland OH 44139. 216-248-0021.

JUNE 25

IN - HIGHLAND — Computer Possibilities Unlimited. SPONSOR: Bee Software. LOCATION: Lincoln Center, 2450 Lincoln. HOURS: 10am-3pm. ADMISSION: \$5, under 12 free. FEATURES: AC - C - DP - FP - F/R - S. CONTACT: Info/Discount tickets: 219-931-3761.

MI - WESTLAND — Great Lakes Computer Expo & Sale. SPONSOR: Progressive Computer Productions. LOCATION: Wayne-Ford Civic League, 1645 Wayne Rd, 1 blk S of Ford Rd. HOURS: 10am-4pm. ADMISSION: Adults \$4, Seniors/Students \$3, under 12 free w/adult. FEATURES: C - DP - F/R - S. DEALER INFO: 8' \$30 ea, 12' \$40 ea. CONTACT: Progressive Computer Productions, 23814 Michi-

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Events

CALENDAR

gan Ave., Ste 237, Dearborn MI 48124. 313-425-9276.

JUNE 26

IL - GLEN ELLYN — Computer Central. **LOCATION:** College of DuPage, Physical Education Bldg. Main Arena, 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 - ANN ARBOR — Colossal Computer Sale. **SPONSOR:** Jewish Community Center of Washtenaw County. **LOCATION:** Washtenaw Community College, Job Skills and Campus Events Bldg. East Huron River Dr. **HOURS:** 9:30am-4pm. **ADMISSION:** \$3. **FEATURES:** C (new & used) - F/R - Tax deductible donations of used equipment welcome. **DEALER INFO:** Tables \$30. **CONTACT:** Judi Lindemann, 313-971-0990.

MI - FLINT — Computer Trade Show. **SPONSOR:** 5 Star Productions. **LOCATION:** Flint Holiday Inn, Gateway Centre, US-23 at Hill Rd. Exit 2 miles S of I-69. **HOURS:** 10am-5pm. **ADMISSION:** \$4, \$3 w/this ad. **FEATURES:** AC - C - CB - DP - FP - F/R. **CONTACT:** Five Star Productions, 810-768-6058 (pager).

EASTERN REGION

APRIL 2

CT - WATERFORD — Ham Radio Auction. **SPONSOR:** Southeast Connecticut Radio Amateur Mobile Society. **LOCATION:** Senior Citizens Center, Waterford Municipal Complex (Rt. 85, S of Exit 77 of I-95 or N of Exit 82 of I-95). **HOURS:** 10am-7. **ADMISSION:** Free. **TALK-IN:** 146.07/.67 repeater. **FEATURES:** F/R. **DEALER INFO:** Setup 9am. **CONTACT:** KA1BB, 203-739-8016.

KY - HENDERSON — Spring Antique Radio Show & Swap Meet. **SPONSOR:** Mid-South Antique Radio Collectors. **LOCATION:** Days Inn, 2044 US 41 North. **HOURS:** 8am-3pm. **FEATURES:** F/R. **CONTACT:** Ron Ramirez, 502-667-5440.

MD - GAITHERSBURG — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Montgomery County Fairgrounds. **ADMISSION:** \$6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-530-2355.

VA - CHESAPEAKE — CARS Springfest Amateur Radio/Computer Show. **LOCATION:** Virginia Beach Pavillion. **HOURS:** 8am-3pm. **TALK-IN:** 146.97. **FEATURES:** C - EX - FM. **DEALER INFO:** Preston P. Ipock, N4SHI, 1026 Calloway Ave., Chesapeake VA 23324. 804-543-4610. **CONTACT:** Flea Market: Robert M. Holt, N4SFH, 2539 Roundtree Cir., Chesapeake VA 23323. 804-487-1896.

VA - RICHMOND — HAV Productions Computer Show & Sale. **LOCATION:** Showplace Annex, Mechanicsville Pike. **HOURS:** 10am-4pm. **ADMISSION:** \$6, under 12 free. **FEATURES:** C - FP. **DEALER INFO:** 8' tables \$75. **CONTACT:** HAV Productions, 1-800-859-4HAV.

APRIL 9

AL - ALBERTVILLE — 3rd Annual Marshall County Hamfest. **SPONSOR:** Marshall County ARC. **LOCATION:** Albertville Recreation Center. **HOURS:** 8am-

3pm. **ADMISSION:** \$2, under 12 free. **TALK-IN:** 147.06+ alternate 145.11. **FEATURES:** DP - EX - FM - FP - F/R - T. **CONTACT:** Marshall County ARC, c/o Hal Cofield KK4OT, 110 Beason Ln., Albertville AL 35950. 205-878-1017.

MD - BALTIMORE — Intertech Group Computer Show. **LOCATION:** Fifth Regiment Armory. **HOURS:** 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEATURES:** C. **CONTACT:** The Intertech Group.*

MD - NEW CARROLLTON — CMA Computer Show. **LOCATION:** Sheraton Hotel Exhibition Center. Exit 20 off I-95 Capt. Blitway. **HOURS:** 9:30am-3pm. **ADMISSION:** \$7, under 12 free. **FEATURES:** C. **DEALER INFO:** Table-Spaces all \$75 (6'). 250+ tables. **CONTACT:** CMA Shows, 804-272-1570.

APRIL 9-10

FL - GAINESVILLE — Poorman's Hamfest & Computer Show. **SPONSOR:** Gainesville ARS. **LOCATION:** Alachua County Fairgrounds, SR-24 & SR-222 at the airport. **ADMISSION:** \$4, tailgate \$6, tables \$7. Good both days. **TALK-IN:** 146.82. **FEATURES:** FP - F/R - T. **CONTACT:** Bill Wells K4RDP, POB 1397, High Springs FL 32643. 904-454-3105.

NJ - CHERRY HILL — PC Dealer Showcase. **SPONSOR:** StarWare. **LOCATION:** Cherry Hill Mall. **HOURS:** Sat. 10am-9:30pm, Sun. Noon-5pm. **ADMISSION:** Free. **FEATURES:** AC - FP - F/R. **DEALER INFO:** Tables \$95 ea. **CONTACT:** StarWare.*

APRIL 10

DE - NEW CASTLE — Hamfest '94. **SPONSOR:** Penn-Del Amateur Radio Club. **LOCATION:** Nurtemple, 198 S DuPont Hwy. **HOURS:** 8am-2pm. **ADMISSION:** \$5, XYL & kids free. **TALK-IN:** 147.225 +, 224.220. **FEATURES:** C - DP - E - EX - F/R - H - T. **DEALER INFO:** Indoor tables \$10 w/electricity, \$8 w/o electricity. Tailgating \$6. **CONTACT:** Send SASE to: POB 1964, Boothwyn PA 19061 or call 302-798-7270.

MA - FRAMINGHAM — Spring Flea Market. **SPONSOR:** Framingham ARA. **LOCATION:** Framingham High School, A St., 1.3 mi. N of Rts. 9 & 126 junction. **ADMISSION:** \$5 for early buyers (9am), \$2 for 10am buyers. **TALK-IN:** 147.15. **FEATURES:** C - DP - E - EX - FM - FP - F/R - H - T. **DEALER INFO:** Setup 8am, 6' table \$10 adv., \$14 door, includes 1 free admission. Limited tailgate space \$10. **CONTACT:** Tables: Barry, WN1N, 508-877-4947. Exams: Dick, WA1KUG, 508-877-0563.

ME - PORTLAND — Computer Shows & Sales. **SPONSOR:** Northern Computer Shows. **LOCATION:** Verrillo's Conv. Ctr., I-95 (Maine Turnpike) Exit 8. **HOURS:** 10am-3:30pm. **ADMISSION:** \$7, under 14 free w/adult. **FEATURES:** C. **DEALER INFO:** Setup 8am. **CONTACT:** Northern Computer Shows.*

NJ - TRENTON — HAMCOMP '94. **SPONSOR:** Delaware Valley Radio Assn. **LOCATION:** Trenton State College, Route 31, Ewing Township, 1 mi. S of Exit 4 of I-95 & Rt. 31. **HOURS:** 8am-1pm. **ADMISSION:** \$5. **TALK-IN:** 146.07-.67. **FEATURES:** FM - FP - F/R - T. **DEALER INFO:** 8' table indoors \$20, outdoor tailgate spaces \$12. Setup 6am. **CONTACT:** HAMCOMP '94, POB 7024, West Trenton NJ 08628. 609-882-2240.

NY - LONG ISLAND — Ham Radio & Electronics Auction. **SPONSOR:** Radio Central ARC. **LOCATION:** Suffolk Community College, LI Expwy. to Exit 62 N 1.5 miles. **HOURS:** Doors open 8:30am, auction begins at 10am. **ADMISSION:** \$3 buyers & sellers. **TALK-IN:** 145.15/4Z & 449.525/2A. **FEATURES:** FP - F/R. **DEALER INFO:** Sellers pay up 2% of sale price. Auctioneer: Frank K2PWG. **CONTACT:** John Mark, KB2QQ, 516-689-6343 or Emil Tillona,

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VA - RICHMOND — Intertech Group Computer Show. **LOCATION:** VA State Fairgrounds. **HOURS:** 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEATURES:** C. **CONTACT:** The Intertech Group.*

APRIL 16

MA - WOBURN — Computer Blowout. **SPONSOR:** Show Promotions, Inc. **LOCATION:** Northeast Trade Center, Exit 35 off Rte. 95. **HOURS:** 10am-4pm. **DEALER INFO:** Setup 7am-9am. **CONTACT:** Show Promotions, Inc., 405 Waltham St. #333, Lexington MA 02173. 617-863-9540, FAX: 617-863-2046.

MS - NATCHEZ — Old Natchez ARC Hamfest. **LOCATION:** Natchez Convention Center. **FEATURES:** EX. **CONTACT:** K5SVC, 601-442-0973 or N5YZC, POB 604, Natchez MS 39121.

NH - MERRIMACK — Computer Shows & Sales. **SPONSOR:** Northern Computer Shows. **LOCATION:** Merrimack Ramada Inn, Everett Turnpike (Rt. 3) Exit 11. **HOURS:** 10am-3:30pm. **ADMISSION:** \$7, under 14 free w/adult. **FEATURES:** C. **DEALER INFO:** Setup 8am. **CONTACT:** Northern Computer Shows.*

TN - CLINTON — Oak Ridge Hamfest '94. **SPONSOR:** Oak Ridge ARC. **LOCATION:** National Guard Armory. **HOURS:** 8am-5pm. **ADMISSION:** \$5. **TALK-IN:** 146.88, 146.97, 147.255. **FEATURES:** DP - EX - FM - F/R - T. **DEALER INFO:** 8' table \$8, outside tailgating \$5 per setup. There is no admission charge to dealers. **CONTACT:** Gene Muncy, KB4UUM, Rt. 5 Pine Cir., Clinton TN 37716. 615-435-1588.

VA - GOOCHLAND — S.M.A.R.T. Swapfest. **SPONSOR:** Six Meter Amateur Radio Team of VA. **LOCATION:** Goochland County Fairgrounds, Rt. 522 & 632. **HOURS:** 8am-3pm. **ADMISSION:** \$5, \$4 adv., under 12 free. Free tailgating w/admission. **TALK-IN:** 52.525, 146.52, 147.27 +, 444.800 +. **FEATURES:** C - CB - DP - E - EX - FM - F/R - H - T. **DEALER INFO:** Inside tables \$5. Setup 6am. **CONTACT:** Buddy Travis, KA4NNN, 703-894-0406.

VA - HAMPTON — HAV Productions Computer Show & Sale. **LOCATION:** Hampton University Convocation Center. **HOURS:** 10am-4pm. **ADMISSION:** \$6, under 12 free. **FEATURES:** C - FP. **DEALER INFO:** 8' tables \$75. **CONTACT:** HAV Productions, 1-800-859-4HAV.

APRIL 16-17

MD - BALTIMORE — PC Dealer Showcase. **SPONSOR:** StarWare. **LOCATION:** Whitmarsh Mall. **HOURS:** Sat. 10am-9:30pm, Sun. Noon-5pm. **ADMISSION:** Free. **FEATURES:** AC - FP - F/R. **DEALER INFO:** Tables \$95 ea. **CONTACT:** StarWare.*

NJ - WEST WINDSOR — 19th Annual Trenton Computer Festival. **LOCATION:** Mercer County Community College. **HOURS:** Sat. 10am-6pm, Sun. 10am-4pm. **ADMISSION:** Two-day ticket \$8. Two-day ticket senior citizens & students, \$5. Sunday only \$5. **FEATURES:** B - C - CB - FM - F/R. **DEALER INFO:** \$450 regular indoor booth, \$550 corner booth, \$225 second-floor minibooth. Outdoor flea market: \$35 for first spot, \$65 each additional spot. All vendor spaces indoor and out, require advance registration & payment. **CONTACT:** Trenton Computer Festival, 54 Concordia Center, Suite 161, Cranbury NJ 08512. 609-655-4999, 609-655-4898.

APRIL 17

MA - CAMBRIDGE — Tailgate Electronics, Computer & Amateur Radio Flea Market. **SPONSOR:** MIT Radio Society and The Harvard Wireless Club. **LOCATION:** Albany & Main Sts. **HOURS:** 9am-2pm. **ADMISSION:** \$2. **TALK-IN:** 146.52, 449.725/444.725 - pl 2A - W1XMR. **FEATURES:** FP. **DEALER INFO:** Tailgate room for 400 sellers, \$10 per space at gate, \$8 adv. Includes 1 admission. Setup 7am. For info call 617-253-3776. Mail advance reservations before the 5th. **CONTACT:** WIGSL, POB 82 MIT BR., Cambridge MA 02139.

NC - RALEIGH — RARSfest '94. **SPONSOR:** Raleigh Amateur Radio Society. **LOCATION:** Jim Graham Building, NC State Fairgrounds. **HOURS:** 8am-4pm. **ADMISSION:** \$5 adv., \$6 door. **TALK-IN:** 146.04/64, 146.28/88. **FEATURES:** CB - DP - EX - FM - F/R - RV-H. **DEALER INFO:** 1-4 8' tables w/2 chairs \$10 ea., 5+ tables \$9 ea. 120V AC power \$10. Rollin Ransom, NF4P, 919-269-4406. **CONTACT:** Rollin Ransom, NF4P, 1421 Parks Village Rd., Zebulon NC 27597. Exam: Vince Yakamavich, AA4MY, 919-847-8512.

RI - CRANSTON — Computer Shows & Sales. **SPONSOR:** Northern Computer Shows. **LOCATION:** National Guard Armory, Rt. 2 (Exit 14, Rt. 37 West Off I-95 take Oaklawn Exit to Rt. 2 S). **HOURS:** 10am-3:30pm. **ADMISSION:** \$7, under 14 free w/adult. **FEATURES:** C. **DEALER INFO:** Setup 8am. **CONTACT:** Northern Computer Shows.*

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Events CALENDAR

APRIL 23

FL - PALM BEACH GARDENS — Narisaam Computer Show. **SPONSOR:** NARISAAM, Inc. **LOCATION:** Palm Beach Gardens, 4000 RCA Blvd. **HOURS:** 10am-4pm. **ADMISSION:** \$5, \$4 w/ad, under 12 free. **FEATURES:** AC - C - FP. **CONTACT:** NARISAAM.*

MD - BALTIMORE — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Martin's West. **ADMISSION:** \$6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-530-2355.

NY - SUFFERN — Intertech Group Computer Show. **LOCATION:** Rockland Community College. **HOURS:** 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEATURES:** C. **CONTACT:** The Intertech Group.*

VA - WILLIAMSBURG — Intertech Group Computer Show. **LOCATION:** The College of William & Mary. **HOURS:** 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEATURES:** C. **CONTACT:** The Intertech Group.*

APRIL 23-24

GA - MARIETTA — Atlanta Area Computer Show. **LOCATION:** Cobb County Civic Center, 548 S. Marietta Pkwy. I-75 exit 112, Hwy 120 W. **HOURS:** Sat: 9am-5pm, Sun: 10am-4pm. **ADMISSION:** \$5 both days, \$4 Sun only. **FEATURES:** AC - C - DP - FP - F/R - RV-S. **DEALER INFO:** 8-ft tables \$35 for both days. **CONTACT:** POB 295, Riverdale GA 30274. 404-907-6225.

PA - NORTH WALES — PC Dealer Showcase. **SPONSOR:** StarWare. **LOCATION:** Montgomery Mall. **HOURS:** Sat: 10am-9:30pm, Sun: Noon-5pm.

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ADMISSION: Free. **FEATURES:** AC - FP - F/R. **DEALER INFO:** Tables \$95 ea. **CONTACT:** StarWare.*

APRIL 24

FL - FORT LAUDERDALE — Narisaam Computer Show. **SPONSOR:** NARISAAM, Inc. **LOCATION:** Holiday Inn West, 5100 N State Rd 7. **HOURS:** 10am-4pm. **ADMISSION:** \$5, \$4 w/ad, under 12 free. **FEATURES:** AC - C - FP. **CONTACT:** NARISAAM.*

MA - WOBURN — Intertech Group Computer Show. **LOCATION:** North East Trade Center. **HOURS:** 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEATURES:** C. **CONTACT:** The Intertech Group.*

VA - FAIRFAX — Intertech Group Computer Show. **LOCATION:** The Patriot Center. **HOURS:** 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEATURES:** C. **CONTACT:** The Intertech Group.*

VA - TYSONS CORNER — CMA Computer Show. **LOCATION:** Westpark Hotel, Leesburg Pike (DC Capital Beltway). **HOURS:** 9:30am-3pm. **ADMISSION:** \$5, under 12 free. **FEATURES:** C. **DEALER INFO:** 6-ft table \$60, 7:30am setup. **CONTACT:** CMA Shows, 804-272-1570.

APRIL 30

AL - SYLACAUGA — Talladega Radio Amateur Club Hamfest. **LOCATION:** Craig Smith Community Center. **FEATURES:** EX. **CONTACT:** Jim, KD4BHH, 205-245-7825.

MA - WORCESTER — Intertech Group Computer Show. **LOCATION:** The Centrum. **HOURS:** 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEATURES:** C. **CONTACT:** The Intertech Group.*

MD - GAITHERSBURG — Intertech Group Computer Show. **LOCATION:** Montgomery Co. Fairgrounds. **HOURS:** 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEATURES:** C. **CONTACT:** The Intertech Group.*

APRIL 30-MAY 1

SC - GREENVILLE — Greenville Hamfest & Computer Flea Market. **SPONSOR:** Blue Ridge Amateur Radio Society, Inc. **LOCATION:** Anderson County Fairgrounds, E of Anderson, SC on Hwy. 29 Business. **HOURS:** Sat: 8am-5pm, Sun: 8am-3pm. **ADMISSION:** \$4 adv., \$5 door, under 12 free. **TALK-IN:** 146.01, 146.61, 146.22, 146.82. **FEATURES:** DP - EX - FM - RV-H - T. **CONTACT:** BRARS, Inc., POB 6751, Greenville SC 29606. 803-297-1617.

MAY 1

DE - NEWARK — Intertech Group Computer Show. **LOCATION:** Carpenter Center, Univ. of Delaware. **HOURS:** 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEATURES:** C. **CONTACT:** The Intertech Group.*

MA - TAUNTON — Computer Shows & Sales. **SPONSOR:** Northern Computer Shows. **LOCATION:** Taunton Holiday Inn. Exit 9 off I-495, between Rt. 24 & I-95. **HOURS:** 10am-3:30pm. **ADMISSION:** \$7, under 14 free w/adult. **FEATURES:** C. **DEALER INFO:** Setup 8am. **CONTACT:** Northern Computer Shows.*

NH - MANCHESTER — Intertech Group Computer Show. **LOCATION:** The Center of NH — Holiday Inn. **HOURS:** 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEATURES:** C. **CONTACT:** The Intertech Group.*

NY - YONKERS — Giant Electronic Fleamarket. **SPONSOR:** Metro 70cm Network. **LOCATION:** Lincoln High School, Kneeland Ave. **HOURS:** 9am-3pm rain or shine. **ADMISSION:** \$5, under 12 free. **TALK-IN:** 440.425R PL156.7. **FEATURES:** DP - FP - F/R. **DEALER INFO:** \$18 1st table, \$13 ea. additional in adv. All tables \$25 at door. **CONTACT:** Otto Supliski WB2SLQ, 914-969-1053.

MAY 7

MD - GRASONVILLE — Hamfest & Computer Flea Market. **SPONSOR:** Kent Island ARC. **LOCATION:** VFW, VFW Rd. on N side of US 50/US 301. **HOURS:** 8am-2. **ADMISSION:** \$4. **TALK-IN:** 146.940. **FEATURES:** DP - F/R - T. **DEALER INFO:** Flea market tables & tailgating free. **CONTACT:** Glenn, WN3G, 410-643-1125 or Tom, K3ORC, 410-643-4675.

MD - NEW CARROLLTON — CMA Computer Show. **LOCATION:** Sheraton Hotel Exhibition Center. Exit 20 off I-95 Cap. Beltway. **HOURS:** 9:30am-3pm. **ADMISSION:** \$7, under 12 free. **FEATURES:** C. **DEALER INFO:** Table-Spaces all \$75 (6'). 250+ tables. **CONTACT:** CMA Shows, 804-272-1570.

NY - OWEGO — Southern Tier Hamfest. **SPONSOR:** Southern Tier ARC. **LOCATION:** Marvin Park Fairgrounds, Rte. 17C & Exit 64. **HOURS:** 8am-4pm. **ADMISSION:** \$3 adv., \$4 door, Tailgate \$2 extra. **TALK-IN:** 146.16/76, 146.52/52. **FEATURES:** B - CB - EX - F - FM - F/R - S - T. **DEALER INFO:** Tables \$15. Banquet (includes general admission) \$20 per person in advance. **CONTACT:** STARC, POB 7082, Endicott NY 13761-7082.

MAY 8

GA - NORCROSS — Narisaam Computer Show. **SPONSOR:** NARISAAM, Inc. **LOCATION:** Northeast

Events CALENDAR

Atlanta Hilton, 5993 Peachtree Industrial Blvd.
HOURS: 10am-4pm. **ADMISSION:** \$5, \$4 w/this ad, under 12 free. **FEATURES:** AC - C - FP. **CONTACT:** NARISAAM.*

MAY 14

MD - TIMONIUM — Intertech Group Computer Show. **LOCATION:** MD State Fairgrounds. **HOURS:** 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEATURES:** C. **CONTACT:** The Intertech Group.*

NH - NASHUA — Computer Shows & Sales. **SPONSOR:** Northern Computer Shows. **LOCATION:** Resurrection Center. 1.5 miles W of Rt. 3 (Exit 6) Rt. 130. **HOURS:** 10am-3:30pm. **ADMISSION:** \$7, under 14 free w/adult. **FEATURES:** C. **DEALER INFO:** Setup 8am. **CONTACT:** Northern Computer Shows.*

NY - SUFFERN — Intertech Group Computer Show. **LOCATION:** Rockland Community College. **HOURS:** 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEATURES:** C. **CONTACT:** The Intertech Group.*

MAY 15

MA - CAMBRIDGE — Tailgate Electronics, Computer & Amateur Radio Flea Market. **SPONSOR:** MIT Radio Society and The Harvard Wireless Club. **LOCATION:** Albany & Main Sts. **HOURS:** 9am-2pm. **ADMISSION:** \$2. **TALK-IN:** 146.52, 449.725/444.725 - pl 2A - W1XMR. **FEATURES:** FP. **DEALER INFO:** Tailgate room for 400 sellers. \$10 per space at gate, \$8 adv. Includes 1 admission. Setup 7am. For info call 617-253-3776. Mail advance reservations before the 5th. **CONTACT:** WIGSL, POB 82 MIT BR., Cambridge MA 02139.

MA - SPRINGFIELD — Intertech Group Computer Show. **LOCATION:** Eastern States Expo. **HOURS:** 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEATURES:** C. **CONTACT:** The Intertech Group.*

PA - VALLEY FORGE — Intertech Group Computer Show. **LOCATION:** Valley Forge Convention Center. **HOURS:** 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEATURES:** C. **CONTACT:** The Intertech Group.*

VA - ANNANDALE — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** NOVA. **ADMISSION:** \$6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-530-2355.

WV - WHEELING — 17th Annual Wheeling Hamfest/Computer Show. **SPONSOR:** The Triple States Radio Amateur Club. **LOCATION:** White Palace, Wheeling Park. **HOURS:** 8am-3pm. **ADMISSION:** \$2 adv., \$3 door. Women free, 17 & under free. **TALK-IN:** 146.910, 146.715. **FEATURES:** DP - FM - FP - F/R - RV-S. **CONTACT:** The Triple States Radio Amateur Club, Box 240, RR#1, Adena OH 43901. Phone/FAX 614-546-3930.

MAY 20-21-22

NY - ROCHESTER — 60th Annual Rochester Hamfest & Computer Show/Atlantic Division/NY State ARRL Convention. **SPONSOR:** Rochester ARA. **LOCATION:** Monroe County Fairgrounds, Rte. 15A & Calkins Rd. **ADMISSION:** \$6 adv., \$8 door. Send request to: Irv Goodman, AF2K, 515 Drumm Rd., Webster, NY 14580. **FEATURES:** B - C - CB - FM - T. **DEALER INFO:** Tailgate spot \$5. **CONTACT:** Rochester Hamfest, 300 White Spruce Blvd., Rochester NY 14623. 716-424-7184.

MAY 21

KY - PADUCAH — Hamfest. **SPONSOR:** Paducah ARA. **LOCATION:** Noble Park Civic Center, Hwy 45 & 60. **HOURS:** 8am-2pm. **TALK-IN:** 147.06/147.66. **FEATURES:** EX - F/R. **DEALER INFO:** Setup 6:30 am. **CONTACT:** David Fraser, KQ4IU, 5715 Blandville Rd., Paducah KY 42001. 502-554-7999 or Paul Smith, N4FFO, 229 Nickello Hts., Paducah KY 42001. 502-898-6834.

MA - WORCESTER — Intertech Group Computer Show. **LOCATION:** The Centrum. **HOURS:** 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEATURES:** C. **CONTACT:** The Intertech Group.*

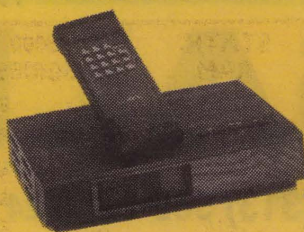
NJ - PHILLIPSBURG — Cherryville Hamfest. **SPONSOR:** Cherryville Repeater Assn. II, Inc. **LOCATION:** Warren County Farmers Fairgrounds. Exit 3 off Interstate 78. **HOURS:** 8am-2pm. **ADMISSION:** \$6. **TALK-IN:** 147.375 +, 146.820. **FEATURES:** C - DP - EX - F - F/R - H - T. **DEALER INFO:** Setup 6am. Indoor spaces \$15, tailgating \$10/space. **CONTACT:** Keith Burt, KF5FK, 908-788-4080. VE Exams: Marty Grozinski, NS2K, 908-806-6944.

PA - EPHRATA — Lancaster County Hamfest & Computers. **SPONSOR:** The Ephrata Area Repeater Society, Inc. **LOCATION:** Ephrata Senior High School, 803 Oak Blvd. **HOURS:** 8am-7. **ADMISSION:** \$4, children free. **TALK-IN:** 145.450, 444.650. **FEATURES:** EX - F/R - T. **DEALER INFO:** Inside B' tables \$6, 2 spaces tailgating \$3, electricity \$1. **CONTACT:** Ephrata Area Repeater Society, Inc., 906 Clearview Ave., Ephrata PA 17544. 717-366-2514 after 6pm.

RI - FORESTDALE — Spring Auction & Flea Market.

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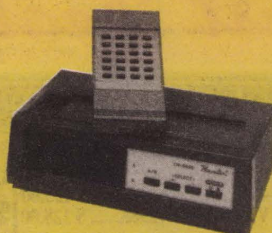


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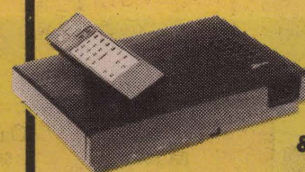
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SPONSOR: Rhode Island Amateur FM Repeater Service, Inc. **LOCATION:** VFW Post 6342, Main St. **HOURS:** Flea Market: 8am. Auction: 11am. **TALK-IN:** 146.76. **FEATURES:** FM - F/R. **DEALER INFO:** Flea Market spaces \$5. **CONTACT:** Rick Fairweather, K1KYI, 106 Chaplin St., Pawtucket RI 02861. 401-725-7507 between 7 & 8pm

VA - ROANOKE — Roanoke Mayfest '94. **SPONSOR:** Roanoke Valley ARC. **LOCATION:** Roanoke Civic Center. **HOURS:** 9am-4pm. **ADMISSION:** \$5 adv., \$6 door. **TALK-IN:** 146.985 (-600), 442.50+. **FEATURES:** CB - DP - EX - FM - T. **DEALER INFO:** Commercial space, 1' 8" table & 2 chairs \$20. Inside flea market tables 1' 8" table & 1 chair \$10. Tailgating \$5. Electricity \$15. **CONTACT:** R.V.A.R.C., POB 2002, Roanoke VA 24009. 703-343-6794, FAX: 703-342-1250.

WV - FLATWOODS — Central WV Swapfest. **SPONSOR:** Pioneer Amateur Radio Assn. **LOCATION:** Braxton County High School, Exit 67 off I-79. **HOURS:** 8am-7. **TALK-IN:** 145.29-, 146.61-. **CONTACT:** Ed Messinger, N8OYY, 304-462-5312 or Vic Moyers, N8MJQ, 304-462-7885 or write: PARA/ Swapfest, POB 301, Glenville WV 26351.

MAY 21-22

GA - HARTWELL — 16th Annual Lake Hartwell Hamfest. **SPONSOR:** Toccoa, Anderson & Hartwell ARCS. **LOCATION:** Sadlers Creek State Park. **HOURS:** 9am-7. **ADMISSION:** Free. **TALK-IN:** 146.790-. **FEATURES:** DP - EX - FM - RV-H. **CONTACT:** Blant Addison, WA4NRU, Rte. 1 Box 42, Toccoa GA 30577 or Joe Brown, K4CLQ, POB 1525, Anderson SC 29622.

GA - NORCROSS — Atlanta Area Computer Show. **LOCATION:** North Atlanta Trade Center, 1700 Jeurgens Ct. I-85 N to exit #38 (Indian Trail) & right to Oakbrook Parkway, turn right to Jeurgens Ct. **HOURS:** Sat: 9am-5pm. Sun: 10am-4pm. **ADMISSION:** \$5 both days; \$4 Sun. only. **FEATURES:** AC - C - DP - FP. **DEALER INFO:** Setup Sat. 6am-9am. 8' table \$45 + \$6.00 business license. **CONTACT:** POB 295, Riverdale GA 30274. 404-907-6225.

MD - BALTIMORE — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Martin's West. **ADMISSION:** \$6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-530-2355.

MD - HAGERSTOWN — Great Hagerstown Hamfest. **SPONSOR:** Antietam Radio Assn. **LOCATION:** Hagerstown Jr. College Athletic & Recreation Center. **HOURS:** 8am-3:30pm. **ADMISSION:** \$5, under 12 free. **TALK-IN:** 146.34/146.94. **FEATURES:** DP - EX - FM - T. **DEALER INFO:** Setup 6am. Tailgate spaces \$5 ea. **CONTACT:** Antietam Radio Assn., POB 52, Hagerstown MD 21741.

NJ - PISCATAWAY — Musician's Warehouse Sale & Electronics Flea Market. **LOCATION:** North Stelton Firehouse Hall, 70 Haines Ave. (off Stelton Rd.). **HOURS:** 10am-4pm. **CONTACT:** Tri-State Music Fairs, 908-359-0124.

NY - PLAINEDGE — Long Island Hamfest/Computer Show. **SPONSOR:** Great South Bay Radio Club & Suffolk County Radio Club, Inc. **LOCATION:** Plainedge High School, Rte. 107 S of the Southern State Pkwy. **HOURS:** 9am-4pm. **ADMISSION:** \$7, additional personnel \$6. **TALK-IN:** 146.685, 223.86. **FEATURES:** C - EX - F - FM - F/R - T. **DEALER INFO:** 2.5'x8' tables \$25, bring your own table-space \$20. Setup 7:15am. **CONTACT:** Andy Feldman, WB2FXN, 516-928-3868 7pm-10pm or Walt Wenzel, KA2RGI, 516-957-5726.

RI - PROVIDENCE — Intertech Group Computer Show. **LOCATION:** RI Convention Center. **HOURS:** 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEATURES:** C. **CONTACT:** The Intertech Group.*

VA - TYSONS CORNER — CMA Computer Show. **LOCATION:** Westpark Hotel, Leesburg Pike (DC Capital Beltway). **HOURS:** 9:30am-3pm. **ADMISSION:** \$5, under 12 free. **FEATURES:** C. **DEALER INFO:** 6-ft table \$60. 7:30am setup. **CONTACT:** CMA Shows, 804-272-1570.

MAY 28

MA - WOBURN — Intertech Group Computer Show. **LOCATION:** North East Trade Center. **HOURS:** 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEATURES:** C. **CONTACT:** The Intertech Group.*

MD - GAITHERSBURG — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Montgomery County Fairgrounds. **ADMISSION:** \$6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-530-2355.

VA - FAIRFAX — Intertech Group Computer Show. **LOCATION:** The Patriot Center. **HOURS:** 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEATURES:** C. **CONTACT:** The Intertech Group.*

MAY 29

CT - NEW HAVEN — Intertech Group Computer Show. **LOCATION:** New Haven Coliseum. **HOURS:** 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEATURES:** C. **CONTACT:** The Intertech Group.*

MD - GAITHERSBURG — Computer Show. **SPONSOR:** Ryan Shows. **LOCATION:** Gaithersburg Hilton Hotel, I-270 Exit 11 East. **HOURS:** 9:30am-3pm. **ADMISSION:** \$6, under 12 free. **DEALER INFO:** 6' tables \$60, includes electricity. Setup 7:30am. **CONTACT:** Ryan Shows, 804-323-9755.

NC - GASTONIA — 2nd Annual Memorial Weekend Hamfest. **SPONSOR:** Gastonia Area ARC. **LOCATION:** Gastonia Area ARC. **HOURS:** 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEATURES:** C. **CONTACT:** The Intertech Group.*

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Events CALENDAR

FL - KARYAE PARK — Linwood Rd. **HOURS:** 8am-4pm. **ADMISSION:** \$4 adv., \$5 door, 12 & under free, includes 1 tailgate space. **TALK-IN:** 146.805-600, 444.150 +. **FEATURES:** CB - DP - F/R - RV-S. **DEALER INFO:** Commercial dealer info: Mike Jackson, N4AYO, 704-922-3593 evenings. **CONTACT:** Hamfest info: Bill Shogran, WB4TSW, 704-735-1218. Preregistration info: Joe Picard, N4IXC, 704-735-1218.

VA - WILLIAMSBURG — Intertech Group Computer Show. **LOCATION:** The College of William & Mary. **HOURS:** 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEATURES:** C. **CONTACT:** The Intertech Group.*

JUNE 4

MA - SPRINGFIELD — Intertech Group Computer Show. **LOCATION:** Eastern States Expo. **HOURS:** 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEATURES:** C. **CONTACT:** The Intertech Group.*

NC - DURHAM — Intertech Group Computer Show. **LOCATION:** Durham Civic Center. **HOURS:** 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEATURES:** C. **CONTACT:** The Intertech Group.*

NC - WILMINGTON — Seafest. **SPONSOR:** Azalea Coast Amateur Radio Club. **LOCATION:** Trask Coliseum on the UNC - Wilmington Campus, 601 S. College Rd. **HOURS:** 9am-3pm. **ADMISSION:** \$4 adv., \$5 door. **TALK-IN:** 147.180 +. **FEATURES:** AC - CB - DP - EX - FM - F/R. **DEALER INFO:** Tables \$6, chairs \$1, 120 volts AC \$5. **CONTACT:** ACARC, POB 4044, Wilmington NC 28406. 919-675-6180 days, 919-799-4195 nights.

NJ - TEANECK — Hamfest. **SPONSOR:** Bergen Amateur Radio Assn. **LOCATION:** Fairleigh Dickinson University, Rte. 4 River Road Exit. **HOURS:** 8am-2pm. **ADMISSION:** \$2, XYLs & Harmonics free. **TALK-IN:** 146.1979, 146/52. **DEALER INFO:** Spaces \$10, spaces with power \$20. Preregistration required for spaces with power. **CONTACT:** Jim Joyce, K2Z0, 201-664-6725. No phone calls after 10 pm.

TN - KNOXVILLE — Hamfest. **SPONSOR:** Radio Amateur Club of Knoxville. **LOCATION:** Tennessee Valley Fairgrounds, Chilhowee Park. **HOURS:** 8am-4pm. **ADMISSION:** \$5. **TALK-IN:** 147.30 +, 224.50 +. **FEATURES:** DP - EX - FM - F/R - T. **DEALER INFO:** Indoor table \$10, outdoor tailgating \$3. Setup Fri. after 6pm, Sat. 6am. Reservations: Angela Crigger, N4RPR, 2707 Pine Hill Dr., Knoxville TN 37938. 615-694-9071. **CONTACT:** Ross A. Ramsey, KC4YDR, 790 N Cedar Bluff Rd., Knoxville TN 37923. 615-690-1520.

VA - ANNANDALE — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** NOVA. **ADMISSION:** \$6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-530-2355.

JUNE 5

NC - CHARLOTTE — Intertech Group Computer Show. **LOCATION:** Charlotte International Trade Center. **HOURS:** 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEATURES:** C. **CONTACT:** The Intertech Group.*

NY - SUFFERN — Intertech Group Computer Show. **LOCATION:** Rockland Community College. **HOURS:** 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEATURES:** C. **CONTACT:** The Intertech Group.*

JUNE 11

CT - NORWICH — Ham Radio Auction. **SPONSOR:** Radio Amateur Society of Norwich. **LOCATION:** Bozrah Moose Lodge, Fitchville Rd. **HOURS:** 10am-7. **ADMISSION:** Free. **TALK-IN:** 146.730-. **FEATURES:** FP. **DEALER INFO:** Setup 9am. Bring

your gear to sell (10% commission to RASON). **CONTACT:** 203-376-2216 Rick KDILC or 203-859-2041 Tony N1MQS

FL - FORT LAUDERDALE — Narisaam Computer Show. **SPONSOR:** NARISAAM, Inc. **LOCATION:** Holiday Inn West, 5100 N State Rd 7. **HOURS:** 10am-4pm. **ADMISSION:** \$5, \$4 w/ad, under 12 free. **FEATURES:** AC - C - FP. **CONTACT:** NARISAAM.*

MD - NEW CARROLLTON — CMA Computer Show. **LOCATION:** Sheraton Hotel Exhibition Center, Exit 20 off I-95 Capt. Bitway. **HOURS:** 9:30am-3pm. **ADMISSION:** \$7, under 12 free. **FEATURES:** C. **DEALER INFO:** Table-Spaces all \$75 (6'). 250 + tables. **CONTACT:** CMA Shows, 804-272-1570.

NC - WINSTON-SALEM — Hamfest/Computer & Electronics Fair. **SPONSOR:** Forsyth Amateur Radio Club, Inc. **LOCATION:** Dixie Classic Fairgrounds. **HOURS:** 9am-5pm. **ADMISSION:** \$6 adv., \$7 door. **TALK-IN:** 146.04/64. **FEATURES:** AC - C - CB - DP - EX - FM - F/R - H - RV-H - S - T. **DEALER INFO:** Indoor flea market tables \$10, outside tailgating \$3 per vehicle, covered outside space \$10. Info: Don Edwards WB4KQ, 910-723-7388. **CONTACT:** Forsyth Amateur Radio Club, Inc., POB 11361, Winston-Salem NC 27116. 910-723-7788 (24 hrs.).

NH - MANCHESTER — Intertech Group Computer Show. **LOCATION:** The Center of NH — Holiday Inn. **HOURS:** 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEATURES:** C. **CONTACT:** The Intertech Group.*

VA - NORFOLK — Intertech Group Computer Show. **LOCATION:** Scope Convention Center. **HOURS:** 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEATURES:** C. **CONTACT:** The Intertech Group.*

JUNE 12

FL - WEST PALM BEACH — Narisaam Computer Show. **SPONSOR:** NARISAAM, Inc. **LOCATION:** Palm Beach Airport Hilton, 150 Australian Ave. **HOURS:** 10am-4pm. **ADMISSION:** \$5, \$4 w/ad, under 12 free. **FEATURES:** AC - C - FP. **CONTACT:** NARISAAM.*

KY - ERLANGER — Ham-O-Rama '94. **SPONSOR:** Northern Kentucky ARC. **LOCATION:** Erlanger Lions Park, I-75 to Exit 184-B (Rt. 236 East). Two miles to Dixie Hwy. (US Rts. 25 & 42). Turn R and go S one mile to Sunset Ave. R on Sunset to end of street. **HOURS:** 8am-7. **ADMISSION:** \$4 adv., \$5 door, under 13 free. **TALK-IN:** 147.255 +, 147.375 +. **FEATURES:** DP - F - FM - F/R. **DEALER INFO:** Indoor tables \$15, flea market space \$2 ea. Setup 6am. **CONTACT:** KC4FET c/o NKARC, POB 1062, Covington KY 41012. 606-341-1213.

MA - WORCESTER — Intertech Group Computer Show. **LOCATION:** The Centrum. **HOURS:** 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEATURES:** C. **CONTACT:** The Intertech Group.*

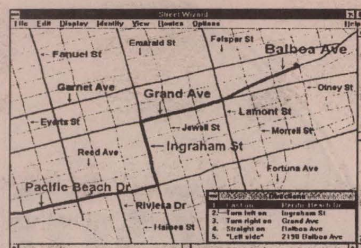
NY - DARIEN — Lancaster New York Hamfest. **SPONSOR:** Lancaster ARC. **LOCATION:** Darien Center Fire Co., Rte. 77 at Rte. 20. **ADMISSION:** \$4 until May 22, \$5 after. **TALK-IN:** 147.255 +, 600, 146.550 Simplex. **CONTACT:** WA2CJJ Nick, 5645 Genesee St., Lancaster NY 14086. 716-681-6410 or NZGDU Luke, 1105 Ransom Rd., Lancaster NY 14086. 716-683-8880.

PA - PLEASANT HILL — Pleasant Hill Computer & Hamfest. **SPONSOR:** Hanover Area Hamming Assn. & Pleasant Hill Fire Co. **LOCATION:** Pleasant Hill Fire Co., carnival grounds, 5 miles S of Hanover. **HOURS:** 8am-7. **ADMISSION:** \$5, under 12 free. **TALK-IN:** MD 145.41-, PA 146.895-. **FEATURES:** EX - F/R - T. **DEALER INFO:** Indoor tables \$10 ea., tailgating \$1 plus admission. Setup 6am. **CONTACT:** Ralph Stoffel, N3KZS, 5219 Hanover Pike, Manchester MD 21102. 410-239-4918. VE testing info: Bill, N2J3, 359-7090 or Pat, WW3U, 632-4237.

PA - WINFIELD — Hamfest. **SPONSOR:** SVARC &

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Milton ARC. LOCATION: Winfield Fireman's Grounds, 60 miles N of Harrisburg on US Route 15. **HOURS:** 8am-4pm. **ADMISSION:** \$4. **TALK-IN:** 145.18/78, 146.82/22. **FEATURES:** FM - FP - F/R - T. **DEALER INFO:** Outside table/tailgate space at \$1 per 6 feet. **CONTACT:** SVARC, Inc., Box 73, Hummels Wharf PA 17831. 717-473-7050. Packet WY3M@NR3U.PA.

VA - RICHMOND — Intertech Group Computer Show. **LOCATION:** VA State Fairgrounds. **HOURS:** 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEATURES:** C. **CONTACT:** The Intertech Group.*

JUNE 18

DE - NEWARK — Intertech Group Computer Show. **LOCATION:** Carpenter Center, Univ. of Delaware. **HOURS:** 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEATURES:** C. **CONTACT:** The Intertech Group.*

MD - GAITHERSBURG — Computer Show. **SPONSOR:** Ryan Shows. **LOCATION:** Gaithersburg Hilton

Hilton, I-270 Exit 11 East. HOURS: 9:30am-3pm. **ADMISSION:** \$6, under 12 free. **DEALER INFO:** 6' tables \$60, includes electricity. Setup 7:30am. **CONTACT:** Ryan Shows, 804-323-9755.

TN - NASHVILLE — Hamfest/State ARRL Convention. **SPONSOR:** Nashville Amateur Radio Club. **LOCATION:** Tennessee State Fairgrounds. **HOURS:** 7am-5pm. **ADMISSION:** \$5. **TALK-IN:** 145.47. **FEATURES:** DP - FM. **DEALER INFO:** Tables with 2 chairs \$10 ea., flea market space \$10. **CONTACT:** Murray Jones, K4ANH, 615-824-7216; Willie Porter, KB4BL, 615-385-4893. Write: Hamfest Nashville, 29 The Arcade, Nashville TN 37219. 615-256-6994.

JUNE 19

MA - CAMBRIDGE — Tailgate Electronics, Computer & Amateur Radio Flea Market. **SPONSOR:** MIT Radio Society and The Harvard Wireless Club.

Continued on page 131

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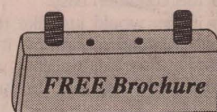
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A

few years ago, I was involved in the installation of a large sound system with multiple speakers. When the time came to test the system, we applied power along with a test signal and almost instantly learned a new expression — "smoke test." You see, one of our big expensive power amplifiers just went up in smoke. Being brilliant engineers and technicians, we immediately checked the main speaker feed line with an ohmmeter and found that it measured only a few ohms. From our vast knowledge and experience, we concluded that we did not really know what the line should measure, in view of the great number of speakers involved, and our use of a 70 volt type feed system.

As it turned out, the problem was caused by a distant shorted line, and our ohmmeter test did not give us the information we needed to correct the problem quickly. The experience taught us the value of always using an impedance meter rather than an ordinary ohmmeter to check speaker lines.

Maybe you are not involved in testing large speaker systems but enjoy designing and building speaker enclosures. You will find the impedance meter described herein very useful in checking the actual impedance of your speaker, because often the 8 ohm rating of a speaker goes sky high at some frequencies in certain enclosures. As you probably know, this condition causes distortion and poor output. The multi-frequency aspect of our impedance meter makes testing for this condition easy.

Even if you would just like to learn more about impedance and how it affects current flow and power transfer, you will benefit from this instrument. In this case,

you will find the suggested impedance experiment (listed at the end of this article) very educational.

Our impedance meter also has several bonus features that will make it a valuable addition to your test equipment. For example, it can produce sinewave signals at eight discrete frequencies which can be used in a variety of testing and experimenting applications.

Another feature is that it actually produces a low level sound in the speakers under test, which in itself can be very handy, especially in troubleshooting appli-

cations. In addition, the instrument can be used to test transformers for shorted turns, turns ratio, and poor low frequency response. Protection is provided for the meter when it is driven past its full-scale mark, which does occur in the absence of test terminal loads.

What is impedance? Simply stated, impedance is AC resistance. It can rightly be called "opposition to alternating currents." Its opposition to alternating currents can be likened to the way pure resistance opposes direct current. Its unit of measurement is OHMS, and its symbol is Z.

Impedance in a device or circuit is the result of one or more reactances, such as inductive reactance or capacitive reactance, but it also considers any DC resistance present. In a given device, the reactive components might be in series or parallel, and the same can be said for the DC resistance. Because of these reactances, an impedance figure will change with frequency. It is interesting to note that although DC resistance is not considered reactive, it is often referred to as impedance. For example, we might say that an amplifier has an input impedance of 10,000 ohms, even though it is almost pure DC resistance.

A loud-speaker is a perfect demonstrator of what impedance is all about, because it exhibits inductance, capacitance, and DC resistance. At any one frequency, the AC source, which is usually the power amplifier, sees the combination of these reactances.

Impedance analysis of a speaker is especially difficult because the movement of the cone changes the effective inductance and capacitance of its voice coil. Add to this the speaker's coupling to the environment which is different at various frequencies, along with the fact that it functions as a motor and at times a generator, and you can see why a plain ohmmeter will not indicate what the poor amplifier is looking at.

If you were to measure the impedance of a typical 8 ohm speaker with an ordinary ohmmeter, the figure might be something like 5 ohms. This is because you had measured only the DC resistance of the voice coil wire. For the most part, it is the inductance of the voice coil that makes its impedance 8 ohms, rather than 5 ohms, and as shown above no 8 ohm speaker will measure 8 ohms at all frequencies.

Another area of a sound system that often requires the use of an impedance meter rather than an ohmmeter is where a 70 volt transmission line system is used. This is often called a "constant voltage" system.

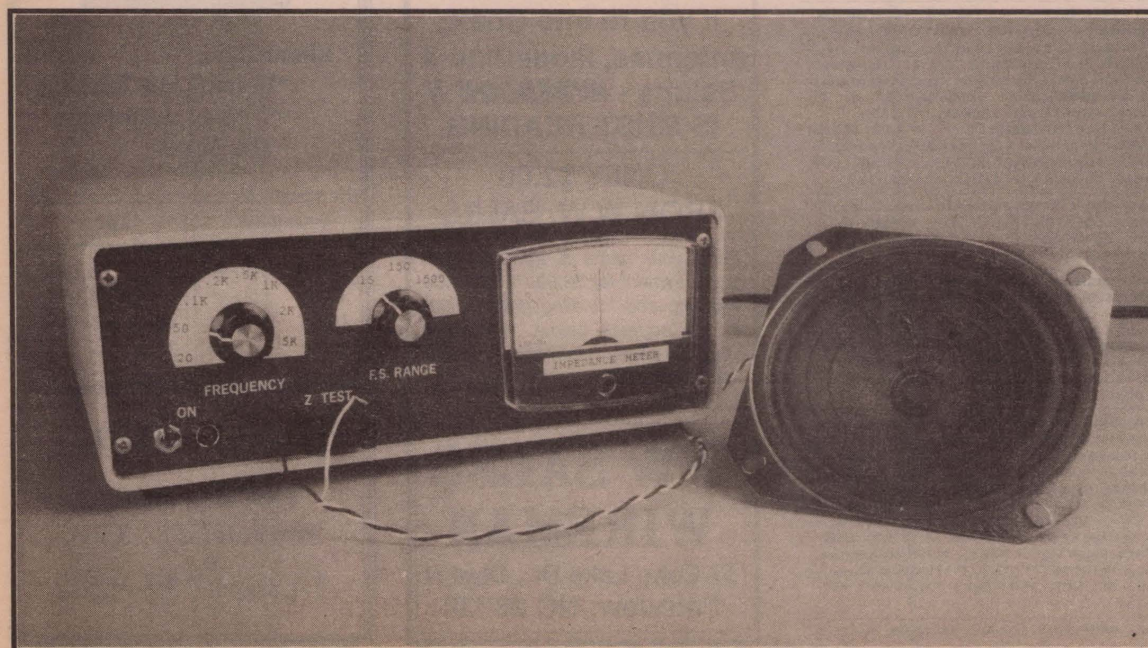
Here the amplifier drives a single pair of wires with levels up to 70 volts, and a transformer at each speaker steps the voltage back down to a normal voice coil level. Often times, 15 or 20 speakers will be connected in parallel across this transmission line. Serious problems occur (obviously) if the transformers get miswired or have shorted turns, and often they occur when the transformers have very poor low frequency response due to low inductance.

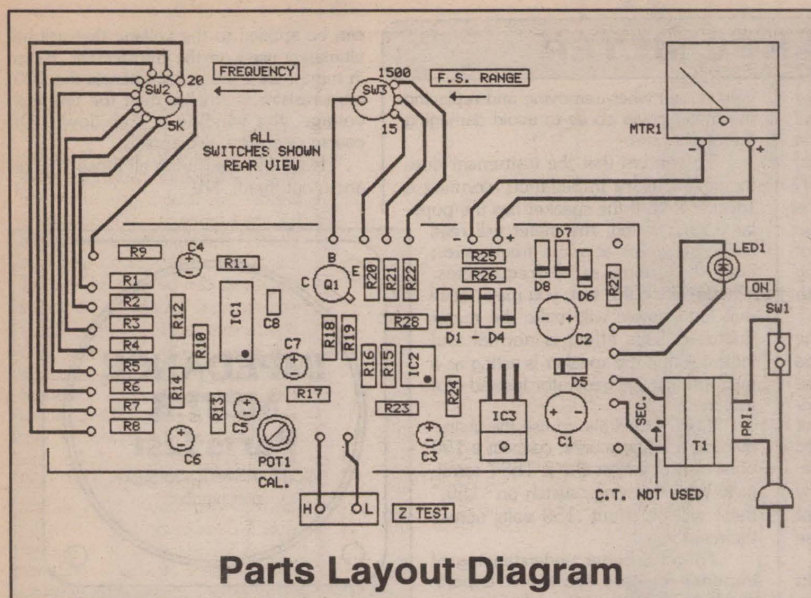
Any way you look at it, when first testing or when troubleshooting this kind of a system, only an impedance meter will do the job.

It would be nice if impedance was the same at all frequencies, but it isn't. Here is where our impedance meter shines. It can check impedance at eight different frequencies — from 20 Hz to 5 KHz. Its impedance range is 15 ohms to 1500 ohms in three decade related ranges using a "0-15" meter scale. It should be noted that the three decade related ranges correspond to the full-scale point on the meter,

Build an IMPEDANCE METER

by Richard Schroeder





Parts Layout Diagram

hence the F.S. RANGE label on the switch.

THE CIRCUIT — HOW IT WORKS

Please refer to the block diagram. As you can see, there are four basic parts to the measurement system — five, if you consider the output terminals.

The system operates as follows: The SINEWAVE GENERATOR works into the VOLTAGE TO CONSTANT CURRENT CONVERTER to produce a constant AC current through the ground referenced load. This current can be set to any one of three decade related values by means of the range switch.

Constant current means that the current is not dependent on the load resistance or impedance. This fact implies that only the voltage will change if the ohmic value of the load changes, and the voltage will always be proportional to the ohmic value. As an example, if an 8 ohm speaker develops X voltage, a 16 ohm speaker will develop 2X.

The AC voltage that is thus developed across the load is passed on to the PEAK-TO-PEAK DETECTOR. This circuit amplifies and rectifies the voltage to a level sufficient to drive the METER (DC).

We have then a system that will measure the combined total of the reactive components as well as the DC resistance.

The multi-frequency aspect of this system is especially helpful in determining which of the reactive components is the largest contributor to the total impedance. For example, if the impedance figure goes down with an increase of frequency, the load is mostly capacitive. If the figure goes up with an increase of frequency, the load is mostly inductive. If the figures do not follow a strict pattern, there is probably a complexity of reactances present.

Now for a circuit description in a little more detail. Please refer to the schematic diagram. Locate IC1. This is really a multi-purpose function generator that, in our case, has been configured as a sine wave generator by means of all those little capacitors and resistors that surround it. This chip produces frequencies that are dependent on the current that flows out of its pin #7 to ground. The eight different value resistors that get selected (one at a time) by reason of switch SW2, produce the different currents that, in turn, produce the different frequencies.

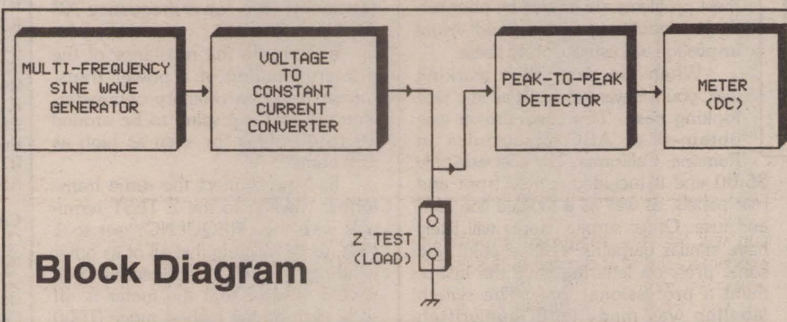
The accuracy of these frequencies is around $\pm 10\%$ which is adequate for the instrument's intended use. If you would like greater accuracy, try a 1% or 2.5% type capacitor in the C7 position, and 1% type resistors. Distortion in the sine wave

tor, the current, in turn, is constant.

The power transistor at the output of the op-amp provides the extra current required to drive the rather low impedance loads. The transistor is configured as an emitter follower that finds itself inside the negative feedback loop of the op-amp. This arrangement cancels the non-linearities of the transistor and assures that there is current gain (or capability) without voltage gain.

As mentioned before, the AC voltage that gets developed across the load gets passed on to the peak-to-peak detector. This circuit is made up of IC2B, four diodes, and a few resistors. It first amplifies and then rectifies both halves of the sine wave signal to produce pulsating DC voltage which, in turn, drives the DC meter movement. Note that the diodes are configured as a fullwave bridge, and that they are placed in the negative feedback loop of the op-amp. This arrangement cancels out the normal non-linearity of the diodes, resulting in accurate meter readings even at the lower end of its scale.

The usual high value capacitor used in filtering the pulsating DC voltage is pur-



Block Diagram

signal is around one or two percent which is adequate.

The sine wave output found at pin #2 feeds a trim potentiometer (POT1) which, in turn, feeds one input of the constant current circuit. This trim pot is the calibration control for all the ranges.

Though it might not at first be obvious, the voltage to constant current converter is basically an op-amp configured as a two input differential amplifier with unity gain. The four resistors responsible for this configuration are R15-R18, all 270K ohms. One of the inputs is at the wiper of the trim potentiometer, and the other input is the point that finds its way to the Z TEST terminal.

This circuit is interesting in that it adds any voltage that gets developed across the load terminals (Z TEST), to the existing sine wave voltage at the top end of the selected range resistor. This makes the voltage across the resistor constant, and because all current in the load flows through the resis-

posely missing because it is not needed. In our case, we simply let the inertia of the meter mechanism do the filtering.

The power supply is somewhat different from the usual design found in op-amp circuitry. Though there are four diodes, three are connected in series to produce a negative voltage, and one is

connected so as to produce a positive voltage. The one diode is configured as a halfwave rectifier, and along with its capacitor produces about 17 volts positive, which in turn feeds voltage regulator IC3. The regulator, in turn, produces a stable 12 volts that powers most of the circuitry. The three diodes collectively are also configured as a halfwave rectifier to produce about 15 volts negative (unregulated). The series arrangement of the diodes serves to drop or lose a few volts so as to better satisfy the needs of the op-amps.

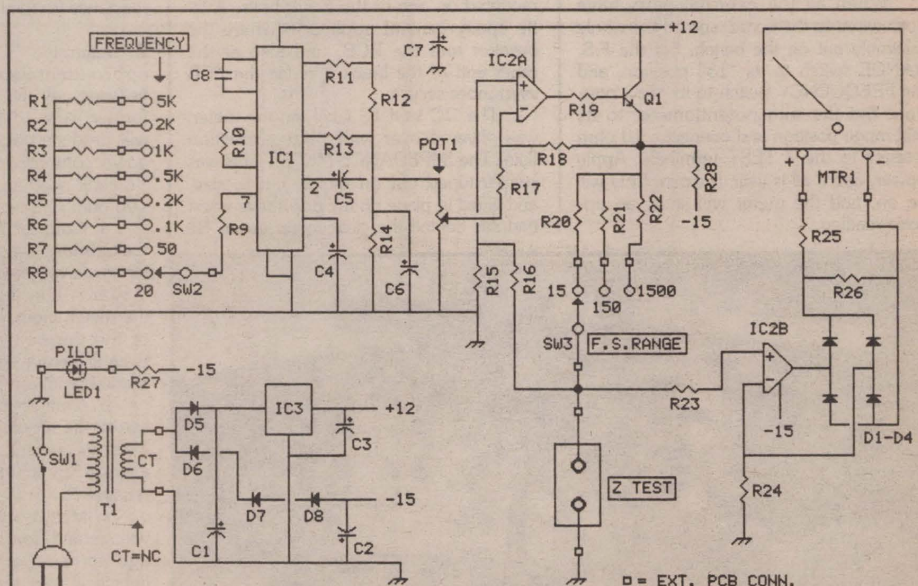
CONSTRUCTION

You will probably want to start with the building of the circuit board. Refer to the parts layout diagram and install the components as shown. If you are using the perf-board method of construction, it is suggested that you still follow the same general layout. Keep in mind that the diagram shows the component view, not the copper trace view. If you will be making your own printed circuit board (PCB) from the pattern shown in this article, remember that the pattern must be placed in such a way that the final product will show the "ZM" lettering in a readable direction when looking at the copper side of the board.

When installing the components on the PCB, pay close attention to any polarity markings on the components such as the \pm markings on electrolytic capacitors, and the color bands on the diodes. Then, of course, make the orientation agree with the diagram. Use good quality solder and be careful to assure good connections while avoiding solder bridges between traces. When the components have been installed and checked, you are ready for the testing and adjusting procedure.

TESTING AND ADJUSTING

For this operation I recommend that you cut, strip, and tin all the wires needed to connect the external components to the board. These will include the transformer, meter, rotary switches, LED, and terminals. Concerning the Radio Shack



Schematic Diagram

IMPEDANCE METER

Adjust the trim potentiometer for a meter reading of "10," which will calibrate all the ranges. To confirm proper operation on the other ranges, use a 100 ohm resistor on the "150" range, and a 1000 ohm resistor on the "1500" range. The meter should read "10" in all three cases. Other areas of the meter scale can be checked using resistors of different values, along with the appropriate range settings.

With a resistor in place, with the meter reading correctly, rotate the FREQUENCY switch to its other positions and observe the meter. The reading should remain constant. If the unit passes these tests, it can be assumed that the sinewave distortion and frequency characteristics are reasonably close to specifications. You may want to confirm this sometime with the use of an oscilloscope.

If you experience any trouble in getting the instrument to work properly, carefully check for proper parts placement and also the external wiring for proper point to point placement. The layout and schematic diagrams, along with a meter and perhaps an oscilloscope, should help in locating and correcting any problems. Actually, most problems are caused by poor solder connections, and a good visual inspection will usually locate these.

When the circuitry is working well, you will want to put it all in a nice looking case. The case shown was obtained at ABC Electronics in Pomona, California. The cost was only \$5.00 and it included usable front and rear panels, as well as a molded line cord and fuse. Other surplus stores will likely have similar bargains. A little paint and some press-on lettering gave the instrument a professional look. The switch labeling was made with typewritten numerals and white paper, cut and pasted in place. The pictures should help you in positioning the panel mounted components.

The case design was such that it was not practical to mount the PCB on the case floor. Rather, the PCB was secured to the inside of the front panel by means of a hand-formed metal bracket that mounted on one of the meter bolts. A little epoxy cement applied to where the bracket met the PCB, and also at the other end of the bracket, made the PCB even more secure.

The DC VOLTS label (on the meter) was covered over with white correction fluid. The IMPEDANCE METER label was simply typed out on paper, cut to size, and glued in place on the decorative insert that sits behind the clear meter cover. Be

very careful when removing and replacing the meter cover so as to avoid damaging the mechanism.

To confirm that the instrument does in fact measure impedance, connect a speaker to it. If the speaker has the popular 8 ohm rating, the meter will read around 8 ohms at some frequencies, but not 8 ohms at all frequencies. When making this test, you may notice that loud noises will make the meter fluctuate. This effect is normal and indicates that the speaker is acting as a microphone — a generator instead of a motor.

If you would like to use the instrument as a signal source, connect a 150 ohm resistor across the Z TEST terminals. With the range switch on "150," there will be about .150 volts across the resistor.

To get a better understanding of impedance, here are a few experiments you may want to perform:

1. Prove that inductance of sufficient quantity looks like an open circuit (very high resistance) to a mid-frequency AC source. Also prove in the same experiment that the same inductance begins to look like a short circuit (very low resistance) to a lower frequency AC source.

- a. Measure the resistance of the primary winding of a power transformer using an ordinary ohmmeter. You will find the value to be around 10 to 40 ohms, or even as high as 100 ohms.

- b. Now connect the same transformer winding to the Z TEST terminals with the FREQUENCY set to 1 KHz, while assuring that all of its other windings are left unconnected. You should observe that the meter is off scale even on the highest range (1500 ohms). While this does not prove that its impedance is infinite, it shows that it is greater than 1500 ohms — quite different from the ohmmeter reading.

- c. Now measure the impedance at the lower frequencies and observe that the ohmic figure goes down. This is due to the fact that though the inductance of the device did not change, the reactance (to the lower frequency) did.

2. Determine the turns ratio (which is approximately the voltage ratio) between any two windings of a transformer. Also, determine if a winding will produce voltage step-up or step-down compared to another winding. You will need an AC voltmeter and a 100 ohm resistor for this experiment.

- a. Connect a winding, preferably the primary winding, to the Z TEST terminals with the FREQUENCY set to 1 KHz. As in the above experiment, the meter should read off-scale on any of the three range switch positions. Even if there is some on-scale reading, proceed with the experiment.

- b. Connect the 100 ohm resistor across the winding of interest and find a range switch setting that gives a good up-scale (but not off-scale) reading.

- c. Measure the Z TEST terminal voltage and note it. Measure the voltage across the winding of interest (which is also the 100 ohm resistor) and note it also. Now divide the smaller of the two figures into the larger figure and you will have a ratio figure that

can be applied to the voltage that will be ultimately used on the transformer. Keep in mind that if the voltage across the 100 ohm resistor is smaller than the terminal voltage, the winding is step-down. Of course vice-versa also applies.

Have fun measuring all those impedances out there! **NV**

IMPEDANCE METER Parts List

NOTE: RS# = Radio Shack part number

RESISTORS (all 1/2 watt, 5% tolerance, carbon, unless otherwise noted)

R19,R24: 100 ohm
R20: 100 ohm, 1% tolerance
R10: 220 ohm
R9,R12,R14,R23,R27,R28: 1K ohm
R25: 4.7K ohm
R22: 10K ohm, 1% tolerance
R1,R26: 18K ohm
R11,R13: 22K ohm
R2: 47K ohm
R3: 91K ohm
R4: 180K ohm
R15,R16,R17,R18: 270K ohm, 1% tolerance
R5: 470K ohm
R6: 910K ohm
R7: 1.8M ohm
R8: 4.7M ohm

CAPACITORS

C1,C2: 1000 microfarad, 25 or 35 volt, electrolytic, radial leads, RS# 272-1032
C3,C4,C5,C6,C7: 10 microfarad, 25 or 35 volt, electrolytic, radial leads, RS# 272-1025
C8: .01 microfarad, 50 or 100 volt, mylar, 10% tolerance, RS# 272-1065

POTENTIOMETER

POT1: 4.7K ohm or 5K ohm, trim type, RS# 271-281

INTEGRATED CIRCUITS

IC1: XR2206 (suffix/prefix letters not important)
IC2: LF353N or TLO82, dual bi-FET op-amp
IC3: 7812 voltage regulator, positive 12 volts, RS# 276-1771

DIODES

D1,D2,D3,D4: 1N4148, signal type
D5,D6,D7,D8: 4002, power type, note: last digit 3-8 OK

SWITCHES

S1: S.P.S.T., miniature toggle, RS# 275-634
S2: 12 position rotary (only 8 positions used), RS# 275-1385
S3: 12 position rotary (only 3 positions used), RS# 275-1385

LED

LED1: panel mounted style, RS# 276-068

METER

MTR1: .001 amp (full-scale), DC movement, 0-15 volt scale, RS# 270-1754

TRANSISTOR

Q1: 2N3053, NPN, medium power, RS# 276-2030

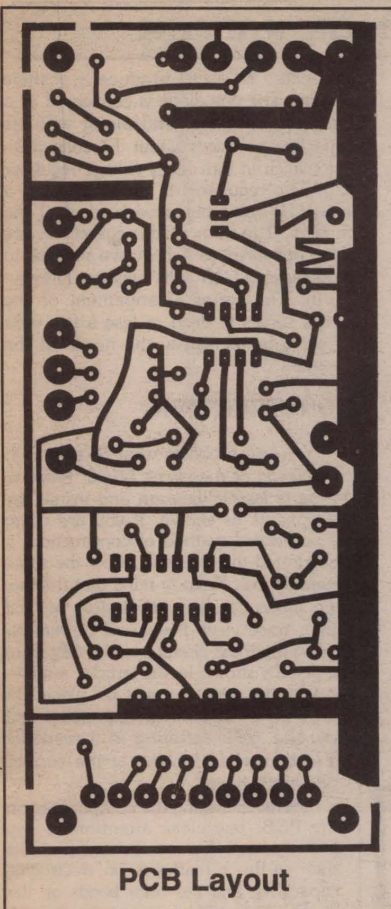
TRANSFORMER

T1: 12.6 volt @ .45 amps, RS# 273-1365, (center tap not used)

MISCELLANEOUS

Case, line cord, PCB, press-on lettering, etc.

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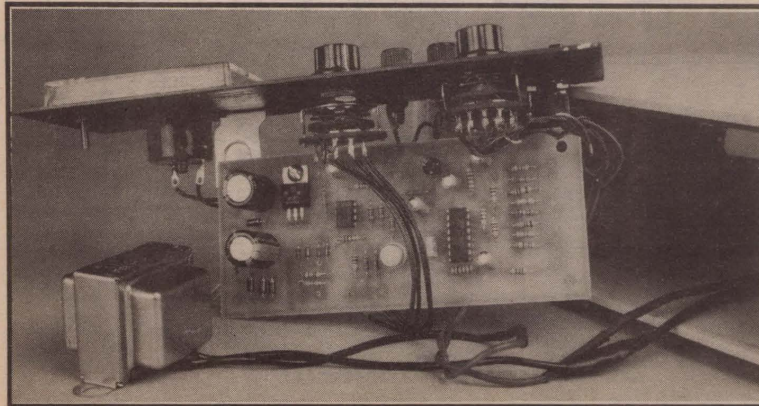


PCB Layout

meter, do not use the auxiliary resistor that comes supplied with it when purchased. Simply make direct connections from the meter terminals to the PCB, while paying attention to the polarity markings.

If you connect all the components using flexible wire, cut to lengths of around five inches, you will find that these for the most part can be left in place when the whole assembly is finally installed in its enclosure or case. Also, you may find it better to simply solder the wires directly to the pads on the copper side of the PCB rather than poking them through the holes from the top side.

When all the external parts have been wired to the board, spread the whole assembly out on the bench. Set the F.S. RANGE switch to its "15" position, and the FREQUENCY switch to its "1K" position. Set the trim potentiometer to its mid-range position and connect a 10 ohm resistor to the Z TEST terminals. Apply power, and if all is well, the pilot LED will be on, and the meter will show an up-scale reading.



Continued from page 127

LOCATION: Albany & Main Sts. **HOURS:** 9am-2pm.
ADMISSION: \$2. **TALK-IN:** 146.52, 449.725/
 444.725 - pl 2A - W1XMR. **FEATURES:** FP. **DEALER**
INFO: Tailgate room for 400 sellers. \$10 per space
 at gate, \$8 adv. Includes 1 admission. Setup 7am.
 For info call 617-253-3776. Mail advance reserva-
 tions before the 5th. **CONTACT:** WIGSL, POB 82
 MIT BR., Cambridge MA 02139.

MD - GREENBELT — Computer Show & Sale.
SPONSOR: MarketPro. **LOCATION:** Martin's Cros-
 swinds. **ADMISSION:** \$6. **FEATURES:** C - FP. **CON-**
TACT: MarketPro, POB 41044, Bethesda MD
 20814. 301-530-2355.

PA - VALLEY FORGE — Intertech Group Computer
 Show. **LOCATION:** Valley Forge Convention Center.
HOURS: 10am-4pm. **ADMISSION:** \$7, under 10
 free. **FEATURES:** C. **CONTACT:** The Intertech
 Group.*

JUNE 25

MA - WOBURN — Intertech Group Computer Show.
LOCATION: North East Trade Center. **HOURS:**
 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEA-**
TURES: C. **CONTACT:** The Intertech Group.*

VA - FAIRFAX — Intertech Group Computer Show.
LOCATION: The Patriot Center. **HOURS:** 10am-
 4pm. **ADMISSION:** \$7, under 10 free. **FEATURES:** C.
CONTACT: The Intertech Group.*

VA - TYSONS CORNER — CMA Computer Show.
LOCATION: Westpark Hotel, Leesburg Pike (DC
 Capital Beltway). **HOURS:** 9:30am-3pm. **AD-**
MISSION: \$5, under 12 free. **FEATURES:** C. **DEALER**
INFO: 6-ft table \$60. 7:30am setup. **CONTACT:**
 CMA Shows, 804-272-1570.

JUNE 26

MD - TIMONIUM — Intertech Group Computer
 Show. **LOCATION:** MD State Fairgrounds. **HOURS:**
 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEA-**
TURES: C. **CONTACT:** The Intertech Group.*

RI - PROVIDENCE — Intertech Group Computer
 Show. **LOCATION:** RI Convention Center. **HOURS:**
 10am-4pm. **ADMISSION:** \$7, under 10 free. **FEA-**
TURES: C. **CONTACT:** The Intertech Group.*

MONTH AT A GLANCE

APRIL 1994

APRIL 2

CA - San Mateo - California Computer Show & Sale*
 CA - San Rafael - MarketPro Computer Shows*
 CA - Santee - Santee Swap Meet
 CO - Longmont - Longmont ARC LARCFEST
 CT - Waterford - SE Conn RAMS Ham Radio Auction
 IN - Columbus - Columbus ARC Hamfest
 IN - Indianapolis - AGI Computer Fairs*
 IN - Indianapolis - National Computer Fairs Computer Show
 KY - Henderson - Spring Antique Radio Show & Swap Meet
 MD - Gaithersburg - MarketPro Computer Show & Sale
 VA - Chesapeake - CARS Amateur Radio/Computer Show
 VA - Richmond - HAV Productions Computer Show & Sale

APRIL 3

CA - Livermore - Livermore ARC Swap Meet
 OH - Dayton - AGI Computer Fairs*

APRIL 8-9

AR - North Little Rock - Arkansas State Convention

APRIL 9

AL - Albertville - Marshall County ARC Hamfest
 CA - Los Altos Hills - Foothill College Flea Market
 CA - Oakland - California Computer Show & Sale*
 CA - Oceanside - Oceanside Swap Meet
 IN - Highland - Computer Possibilities Unlimited
 MD - Baltimore - The Intertech Group Computer Shows*
 MD - New Carrollton - CMA Computer Shows
 MI - Livonia - Computers & You Computer Show
 MN - Fergus Falls - Lake Region Amateur Radio Hamfest
 MN - Rochester - Rochester ARC Hamfest/Computer Show
 MO - Branson - Skaggs ARC Hamfest
 OH - Cleveland - National Computer Expo Micro Mania
 OK - Lawton - Lawton Ft. Sill ARC Hamfest

APRIL 9-10

FL - Gainesville - Gainesville ARS Hamfest/Computer Show
 NJ - Cherry Hill - Starware Computer Show*

APRIL 10

CA - Pleasanton - California Computer Show & Sale*
 CA - Santa Rosa - MarketPro Computer Shows*
 CA - Ventura - MarketPro Computer Shows*
 DE - New Castle - Penn-Del ARC Hamfest
 IL - Orland Park - The Orland Park Computer Show
 IL - Winthrop Harbor - Lake County Computer Show & Sale
 MA - Framingham - Framingham ARS Spring Flea Market
 ME - Portland - Northern Computer Shows*
 MI - Madison Heights - Computers & You Computer Show
 NJ - Trenton - Delaware Valley Radio Assn. HAMCOMP '94
 NY - Long Island - Radio Central ARC Electronics Auction
 OH - Cleveland - National Computer Expo Micro Mania
 VA - Richmond - The Intertech Group Computer Shows*
 WI - Madison - Madison Area Repeater Assn. Hamfest

APRIL 15-16-17

CA - Visalia - International DX Convention

APRIL 16

CA - Northridge - California Computer Show & Sale
 CA - Santee - Santee Swap Meet
 IN - Evansville - National Computer Fairs Computer Show
 IN - Merrillville - Computer Possibilities Unlimited
 MA - Woburn - Show Promotions, Inc. Computer Blowout
 MO - Joplin - Joplin ARC Hamfest
 MS - Natchez - Old Natchez ARC Hamfest
 NH - Merrimack - Northern Computer Shows*
 TN - Clinton - Oak Ridge ARC Hamfest

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VA - Goochland - Six Meter Amateur Radio Team Swapfest
 VA - Hampton - HAV Productions Computer Show & Sale

APRIL 16-17

CA - Daly City - California Computer Show & Sale*
 CA - San Diego - MarketPro Computer Shows*
 MD - Baltimore - Starware Computer Show*
 NJ - West Windsor - 19th Annual Trenton Computer Festival

APRIL 17

CA - Glendale - California Computer Show & Sale*
 CA - Sacramento - California Computer Show & Sale*
 IL - Glen Ellyn - Computer Central
 IL - Rockford - Rockford ARA Hamfest/Computerfest
 IL - Sullivan - Moultrie ARK Hamfest
 IN - Columbus - Meka Enterprises Computer Fair
 LA - Baton Rouge - Greater Baton Rouge Computer Expo
 MA - Cambridge - MIT RS & Harvard Wireless Hamfest
 MI - Port Huron - Computers & You Computer Show
 NC - Raleigh - Raleigh ARS RARSfest '94
 RI - Cranston - Northern Computer Shows*

APRIL 23

CA - Anaheim - California Computer Show & Sale*
 CA - San Jose - California Computer Show & Sale*
 FL - Palm Beach Gardens - Narisaam Computer Shows*
 MD - Baltimore - MarketPro Computer Show & Sale
 MI - Westland - Great Lakes Computer Expo
 NY - Suffern - The Intertech Group Computer Shows*
 OH - North Canton - Mercury Productions Computer Show
 VA - Williamsburg - The Intertech Group Computer Shows*

APRIL 23-24

CA - Sacramento - MarketPro Computer Shows*
 CO - Denver - Colorado Radio Collectors Show/Swap Meet
 GA - Marietta - Atlanta Area Computershows
 PA - North Wales - Starware Computer Show*
 TX - Abilene - Key City ARC Hmst/ARRL W Texas Sec Conv

APRIL 24

CA - Oxnard - MarketPro Computer Shows*
 FL - Ft. Lauderdale - Narisaam Computer Shows*
 MA - Woburn - The Intertech Group Computer Shows*
 MI - Grand Rapids - Computers & You Computer Show
 OH - Lima - Lima Computer Festival
 OH - Youngstown - Mercury Productions Computer Show
 VA - Fairfax - The Intertech Group Computer Shows*
 VA - Tysons Corner - CMA Computer Shows

APRIL 29

OH - Dayton - Southwest Ohio Chapter QCWA Banquet

APRIL 29-30-MAY 1

OH - Dayton - Dayton Hamvention

APRIL 30

AL - Sylacauga - Talladega Radio Amateur Club Hamfest
 CA - Sonoma - Valley of the Moon ARC Hamfest
 MA - Worcester - The Intertech Group Computer Shows*
 MD - Gaithersburg - The Intertech Group Computer Shows*

APRIL 30-MAY 1

CA - Del Mar - MarketPro Computer Shows*
 CA - Vallejo - MarketPro Computer Shows*
 SC - Greenville - Blue Ridge ARS Hamfest

MAY 1994

MAY 1

CA - Livermore - Livermore ARC Swap Meet
 CA - Riverside - Riverside Computer Show
 CA - San Mateo - California Computer Show & Sale*
 DE - Newark - The Intertech Group Computer Shows*
 IA - Burlington - Valley Emergency Comm. Assn. Hamfest
 IN - Indianapolis - National Computer Fairs Computer Show
 MA - Taunton - Northern Computer Shows*
 MI - Flint - Computers & You Computer Show
 MN - Bemidji - Paul Bunyan ARC Hamfest
 NH - Manchester - The Intertech Group Computer Shows*
 NY - Yonkers - Metro 70cm Network Electronic Flea Market

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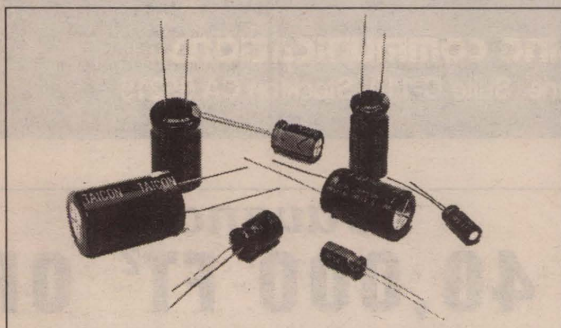
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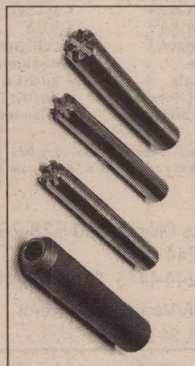


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100uF - 63V	.16	33uF 50V	.13
1000uF - 16V	.22	330uF - 50V	.31
1000uF - 50V	.61	330uF - 63V	.34
.22uF - 50V	.11	4.7uF - 50V	.13
22uF - 50 V	.11	47uF - 63V	.24
2200uF - 16V	.48	470uF - 50V	.43
		600uF - 50V	.43

Security Bits



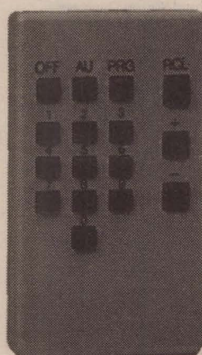
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Continued from page 134

you. After signing up and logging on, type PATENT or M1268.

Denton Bramwell
St. Joseph, MI

ANSWER TO #39420 - MAR. 1994

I am not aware of the specific details of the unit that he has. I have a watch analyzer that I do have a schematic for the sensor head. The watch to be tested is laid on a sensor probe. The probe in the sensor head uses capacitive coupling feeding a number of cascade high gain op-amps with interstage crystal filters. The sensor could be considered a TRF receiver with very narrow bandwidth at 32 KHz. The sensor head is connected to the analyzer via a cable. The analyzer uses a 10 MHz quartz crystal as a reference to compare the watch oscillator frequency against. The reference oscillator is a very good grade assembly with an oven for temperature stabilization. The analyzer has a digital display for output.

I don't know if my analyzer is the same make or model that Mr. Richmond has. I can share what I have on the sensor head. The analyzer that I have is for sale. Mr. Richmond may contact me as listed below.

Warren L. Wilson
701 E. Thrift Avenue
Kingsland, GA 31458-8213

ANSWER TO #39419 - MAR. 1994

Analyzing and generating TV and VCR remote signals with a 386SX requires an I/O board, some simple circuitry for infra-red (IR) sensing and transmitting, and software.

An I/O board called The Experimenter is available from a company called Fascinating Electronics for about \$150.00 and is suited for your problem. This is an intelligent board with a microcontroller and EPROM program capable of counting pulses and measuring widths on four input channels and generating pulse trains of particular widths on eight output channels. The use of a microcontroller allows operation with simple commands in quick BASIC through a serial port and eliminates the need for machine language programming and timing calculations, greatly reducing the software design effort.

A plastic IR filter window and an IR photo-transistor with a pull-up resistor will be needed to detect the signal from the remote and drive an input channel. Circuits can be built on a grid of unused pads supplied on the I/O board. One of the output channels will need to be connected through a resistor to drive an IR emitting diode (about 20mA) to generate the IR signals. (Radio Shack sells an IR emitter/detector pair.)

The pulses from a remote can be analyzed and transmitted by using simple counting and timing commands in the quick BASIC program which is supplied with the I/O board. Storing and recalling the codes can be done with your own BASIC program.

Determining unknown codes may be difficult since some remotes use over a dozen pulses for various widths, and the train is sometimes sent more than once.

Although a learning remote is also capable of imitating functions, the advantage of using a computer is the unlimited number of codes which can be stored and recalled.

Fascinating Electronics

P.O. Box 126
Beaverton, OR 97075
Tel: (800) 683-KITS

Paul Szozdowski
Euclid, OH

ANSWER TO #39410 - MAR. 1994

You have several choices to provide telephone service for your church. Which is best depends on your needs, budget, and projected calling pattern. Your options are:

Conventional telephone: This is probably the simplest solution, unless your telephone company wants some enormous sum to run a line out to your church. You may consider setting the church up on a party line with pastor's phone to reduce the connect charges.

Radio telephone: This option is popular in rural areas. It may be called something like "Rural Telephone Service," or whatever, but it is basically a radio telephone that works and looks like a conventional telephone. Operation costs are higher than wired phones, but installation is usually much cheaper.

Cellular telephone: This may not be as expensive as you think. The telephone may be offered free with some service options. Reconditioned phones are available for less than \$100.00 from several suppliers. If you expect to make few calls, you can get service for as little as \$9.95 a month. Another option that may be of interest is "unlimited weekend calling" which some companies offer for about \$15.00 over regular service. If you expect most of the use of the phone to be on Sundays, this could be an attractive option. There may be other benefits to using a cellular phone — such as being able to reach the pastor in an emergency when he is away from his telephone.

Extending existing service: This would be done using commercial, amateur or Citizens Band radio equipment and a device called a "phone patch." Commercial radios would require licensing, but you may be able to lease them from a Specialized Mobile Radio ("SMR") provider in your area, which may also be able to provide a telephone termination as well. This service isn't much harder to use than a cellular phone and can be much cheaper in rural areas. The radios look and operate much like a cellular telephone. I don't recommend using amateur or CB phone patches. The former requires strict licensing of the operators and a considerable investment in equipment unless your pastor is already a ham. I don't believe unattended phone patch service is permitted on CB, and in any case, it would be subject to interference on this heavily used band.

Cordless telephones: Sounds crazy, but if you've got a good line of sight between the parsonage and the church, one of the new 900 MHz spread spectrum cordless phones (e.g., Tropez) might be able to make the jump if you set up some high gain directional antennas on appropriate masts. If you've got an electronics buff in the congregation it might make an interesting project. Be sure and check applicable FCC regulations to make sure you aren't in violation of any Part 15 restrictions on external antennas on unlicensed devices if you want to try this.

George R. Scott
Alexandria, VA

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NUTS & VOLTS MAGAZINE
430 Princeland Court
Corona, CA 91719

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.

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Ads received BY our closing date (the 10th of the month) will run the following month. EX: Ads received by May 10th will run in June. Ads postmarked through May 10th but received after the closing date will be placed in the next available issue. No cancellations or changes after the 10th.

The **first two words** of your ad will be set in **BOLD CAPS** at **no charge**. 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.

You may fax in ad copy or changes to Nuts & Volts before the closing date (the 10th) at 909-371-3052 using a MasterCard or Visa. Be sure to include the credit card expiration date, the name that appears on the card and a daytime phone number. Ads faxed in without credit card information will not be printed until payment is received in full. For verification of faxed-in ads, call 909-371-8497.

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Subtotal	No. of Issues
Total	

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[illegible]

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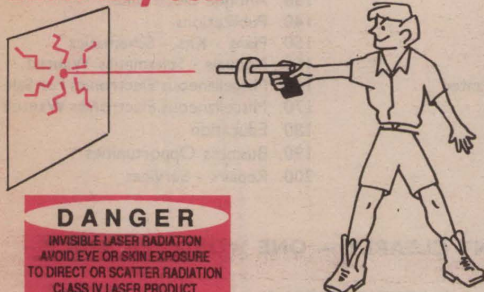
Electronic and Scientific Products

Mystery Levitating Device!

Remember War of the World? Objects float in air and move to the touch. Defies gravity, amazing gift, conversation piece, magic trick or great science project.

ANT1K Easy to Assemble Kit / Plans \$19.50

Laser Ray Gun



Advanced project produces a burst of light energy capable of burning holes in most materials. Hand-held device uses rechargeable batteries. 500 joules of flash energy excite either a neodymium glass, yag or other suitable 3" laser rod. This is a dangerous CLASS IV project (individual parts/assemblies available).

LAGUN1 Plans \$20.00
LAGUN1K Kit / Plans Price on Request

Extended Play Telephone Recording System



READY TO USE! Automatically controls and records on our X-4 extended play recorder, taping both sides of a telephone conversation. Intended for order entry verification. Check your local laws as some states may require an alerting beeper.

TAP20X Ready to Use System \$129.50



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Neat little device allows you to make hand and shock balls, shock wands and electrify objects, charge capacitors. Great payback for those wise guys who have wronged you!

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Pocket-sized wand produces 100,000 watts of power for personal defense, field and lab use, etc.

BLS3 Plans \$10.00
BLS3K Kit / Plans \$69.50

Homing / Tracking Transmitter

Beeper device, 3 mile range.

HOD1 Plans \$10.00 HOD1K Kit / Plans \$49.50

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Highly sensitive stethoscope mike.

STETH1 Plans \$8.00 STETH1K Kit/Plans \$44.50



NEW!

Telephone Line Grabber / Room Monitor

ALL NEW! The Ultimate in Home or Office Security & Safety! Simple to Use! Call your home or office phone, push a secret tone on your telephone keypad to access either: A. On premises sounds and voices; or B. Existing telephone conversation with break in capability for emergency messages. CAUTION: Before assembly or use, check legalities with your state Attorney General's office as you may require "beepers" or other 3rd party alerts.

TELEGRAB1 Plans Only \$10.00
TELEGRAB1K Kit / Plans \$99.50

Ultrasonic Blaster

Laboratory source of acoustical shock waves. Blow holes in metal, produce "cold" steam, atomize liquids. Many cleaning uses for PC boards, jewelry, coins, small parts, etc.

ULB1 Plans \$10.00 ULB1K Kit/Plans \$69.50

100,000V Intimidator / Shock Wand Module

Build an electrical device that is affective up to 20 feet. May be enclosed for handheld, portable field or laboratory applications.

ITM2KM Easy-to-Assemble Electronics Kit \$49.50
ITM2 Plans only, credit-able to kit \$10.00

Ion Ray Gun

Projects charged ions that induce shocks in people and objects without any connection! Great science project as well as a high tech party prank. IOG3 Plans \$8.00

IOG3 Kit/Plans \$69.50

Invisible Pain Field Generator

Shirt pocket size electronic device produces time variant complex shock waves of intense directional acoustic energy, capable of warding off aggressive animals, etc.

IPG7 Plans \$8.00 IPG7K Kit/Plans \$49.50
IPG70 Assembled \$74.50

SUPER GIANT

Smoke Assortment

Special Introductory Offer! WOW! Over 500 Items! This is the LARGEST Smoke Assortment we have! Each super giant assortment contains at least 500 pieces - enough to last you a long time. And the best thing is the SPECIAL price - less than 12 cents per item. Guaranteed value at least 50% more than you pay! SMOKE 25 \$59.50



TV & FM Joker / Jammer

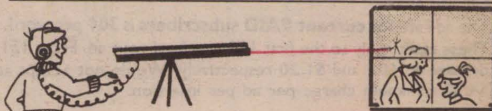
Shirt pocket device allows you to totally control and remotely disrupt TV or radio reception. Great gag to play on family or friends. Discretion required.

EJK1KM Easy to Assemble Electronic Kit \$24.50

Visible Beam Laser

High brightness red HeNe laser visible for miles. Produce your own light show! Projects a visible beam of red light clearly visible in most circumstances. Can be used to intimidate by projection of a red dot on target subject. Also may be used to "listen in" using our laser window bounce method #LLIS1 below. Easy to build module makes A working visible laser!

LAS1KM Kit w/1mw Laser Tube, Class II \$69.50
LAS3KM Kit w/2.5mw Laser Tube, Class IIIa \$99.50



"Laser Bounce" Listener System

Allows you to hear sounds from an area via a lite beam reflected from a window or other similar objects. System uses our ready-to-use LATR1 Laser Terminator gun site as the transmitter. The receiver section is supplied as an easy-to-build kit, including our cushioned HS10 headsets. LLIST2 Plans \$20.00

LLIST1K Kit of Both Transmitter and Receiver \$199.50
LLIST20 Assemble with Laser Gun Site \$299.50

3mw Visible Red Pocket Laser

Utilizes our touch power control!
VRL3KMX Kit/Plans \$74.50

Pocket Sized Night Viewer

Uses Low Level Starlight to See in the Dark!

- Low Cost • Ultra-Hi Lite Amplification!
- Auto Brightness Control
- Limited Amount Available
- Made in USA • Night surveillance • Animal studies, etc.

Can be used to fly an airplane or drive a car! PKV7 Plans \$15.00

PKV7K Easy to Assemble Kit \$1,295.00
PKV70 Ready to Use \$1,595.00

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Subminiature! Crystal clear, ultra sensitive pickup transmits voices and sounds to FM radio. Excellent for security, monitoring of children or invalids. Become the neighborhood disk jockey, or go "under cover" using our sunglasses FM radio (see catalog). FMV1 Plans \$7.00
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SUGL10 Sunglasses with built in FM Radio \$29.50

Telephone Transmitter - 3 Mi

Automatically transmits both sides of a telephone conversation to an FM radio. • Tunable Frequency • Undetectable on Phone • Easy to Build and Use • Up to 3 Mile Range • Only transmits during phone use. VWPM7 Plans \$7.00
VWPM7K Kit/Plans \$39.50

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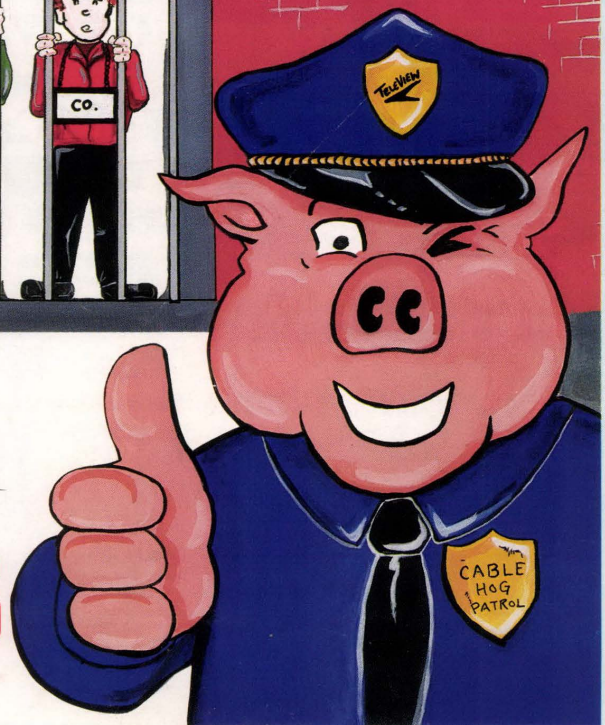
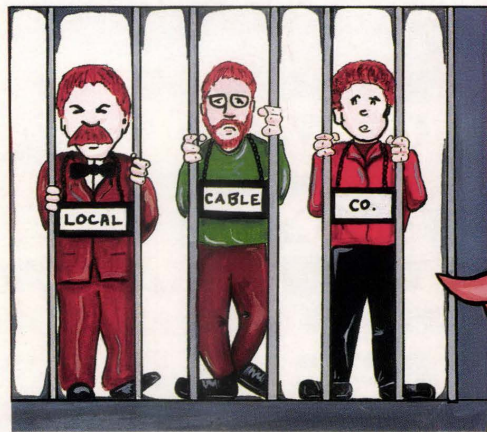
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Bearcat 8500 XLT

500 Channel Scanner

With 800 MHz!

\$375

Without a doubt, this is the premier scanner on the market today. It features coverage from 25 MHz to 1.3 GHz* in 500 channels. 20 banks store these channels and your 20 most important channels can be designated as priority channels. The exclusive dot matrix-alpha numeric illuminated display allows you to program in the name of the station (Dallas Police for example) on the screen for easy identification of each channel. The great features of the 890 XLT are also included such as a VFO knob, turbo scan, selectable scan delay, reception counter and step select. If you want the best, get an 8500 XLT today! * Cellular Blocked, Not Continuous

AOR

AR1000XLT

1000 Channel

Continuous

Coverage Receiver

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Continuous coverage of 5 to 1300 MHz (no gaps). Features include: lock-out search and scan, cigarette lighter plug cord, belt clip, case, flex antenna, and earplug. Covers AM and W/FM. VFO knob or keypad. 6.7" x 1.4" x 2.6", 10 oz.



Fluke 51

Digital

Thermometer

\$89

Uses any standard K or J thermocouple probe. Accuracy of $\pm (0.1\% \text{ of reading} + 0.7^\circ \text{C or } 1.3^\circ \text{F})$ for K-type; $\pm (0.1\% \text{ of reading} + 0.8^\circ \text{C or } 1.4^\circ \text{F})$ for J-type.



Hewlett Packard

141T/8552B/8553B

Spectrum Analyzer

\$2495

The HP 141T based spectrum analyzer features absolute calibration of frequency and amplitude, high resolution and sensitivity, wide dynamic range, and simple to interpret display output. The 141T mainframe features an easy to read 8 x 10 cm variable persistence CRT with a writing rate from 0.2 sec to 15 sec. Maximum storage time is over 2 hours at reduced brightness. The 8552B/8553B IF and RF sections feature a tuning range from 1 kHz to 110 MHz with 18 calibrated scan widths from 20 Hz/div to 10 MHz/div in 1, 2, 5 sequence. Amplitude range is from -140 to 0 dBm. Bandwidths are adjustable from 10 Hz to 300 kHz.



Universal 1001S

100 MHz X1/X10 Oscilloscope Probe

\$245

Factory new passive probe offering X1 and X10 attenuation ranges plus adjustable compensation, all at a fantastic price! Bandwidth: 100 MHz (X10), 6 MHz (X1). Rise time: 3.5 ns (X10), 50 ns (X1). Input Impedance: 10 M Ω (X10), 1 M Ω (X1). Input Capacitance: ~ 15 pF (adjustable from 15 to 35 pF) (X10), 100 pF (X1). Includes all probe accessories and data sheet.

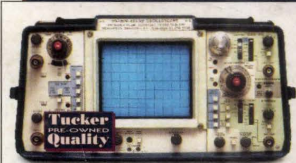
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X1, X10 PROBES! MANUAL! TUCKER QUALITY!

This is the first time we have been able to offer such a quality scope, with its excellent bandwidth for this super-low price. You must act now - quantity is limited! Tektronix built these instruments rugged, with ease of serviceability in mind. They were built to work in such extreme temperatures from Tulsa, Greenland to Mojave, California. They tested it to work at 15,000 feet, and subjected it to 30g's shock, why they even dropped tested it from eight inches on each corner and face, a total of 14 drops. That's why we think you will get years of carefree service from it. This instrument would be just as at home in a Fortune 500 company's test lab or an individual's Ham Shack. Since it draws only 60 watts of power, with a small 12 volt inverter, you can work on your boats' radios and radar, your cars' 2-way radios, and if you have an airplane you can probably figure a way to work on your instruments and radios.

SPECIFICATIONS:

- Vertical Section:
 - Bandwidth: DC to 100 MHz with or without probe
 - Bandwidth limit mode: bandwidth limited to 20 MHz
 - Rise time: 3.5 ns or less
 - Deflection Ranges: 5 mV/div. to 5 V/div. in 10 ranges (1-2-5 sequence)
 - Max. Input Voltage: ± 250 VDC peak AC at 50 Hz
 - Display Modes: CH 1, CH 2, (normal or inverted), Alternate, Chopped (250 Hz rate), Added, X-Y

Horizontal Section:

- Time Base A: 0.5 S/div. to 0.05 μ S/div. in 22 steps (1-2-5 sequence). X10 magnifier extends fastest sweep rate to 5 ns/div.
- Time Base B: 50 mS/div. to 0.05 μ S/div. in 19 steps (1-2-5 sequence). X10 magnifier extends fastest sweep rate to 5 ns/div.
- Mixed Sweep Accuracy: A portion: $\pm 4\%$; B portion: $\pm 2\%$
- Horizontal Display Modes: A, A intensified by B, B delayed by A, mixed

Sweep Section:

- Calibrated Delay Time: Continuous from 0.1 μ S to a least 5 S after the start of the delaying A sweep
- Differential Time Measurement Accuracy: For measurements of two or more major dial Divs.: $\pm 15\%$ C to $\pm 35\%$ C, 1% $\pm 0.1\%$ of full scale

Power Requirements: 100 V to 132 V or 200 V to 264 V RMS. 48 Hz to 440 Hz. Maximum power consumption of 60 W at 115 V, 60 Hz. Weight: 27 lbs. Size: 13.6" W x 7.0" H x 24.4" D



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TV SYNC

Tektronix 2213

Portable Oscilloscope

\$650

Light weight (13.5 lb.) dual-trace, 60 MHz oscilloscope that features a bright, sharply defined trace on an 80 x 100 mm CRT. Its vertical system provides calibrated deflection factors from 2 mV/div to 10 V/div. Trigger circuits enable stable triggering over the full bandwidth of the vertical system. The horizontal system provides calibrated sweep speeds from 0.5 sec/div to 50 ns/div along with a delayed-sweep feature. A X10 magnifier extends the maximum sweep speed to 5 ns/division.

Government Paid \$11,450

Ballantine 9648M

Portable Universal

Counter

\$299



Portable, solid-state, general purpose Universal Counter. Frequency range: 0.1 Hz to 550 MHz; period range: 10⁻⁵ to 10⁻¹ s. Frequency of a burst signal may be measured as easily as that of a CW signal. Loaded with features including autoranging, 9-digit, high intensity LED display, and eleven measurement modes which ensures the ability to measure just about all parameters of time. A, B, and C inputs provide versatility. Sensitivity on C input (sine wave) is as follows: 30 mV rms (30 to 100 MHz), 15 mV rms (100 to 450 MHz), and 25 mV rms (450 to 500 MHz). Built rugged to meet military specifications, this counter is enclosed in a combination case lid that provides water and explosion proofing as well as shielding from EMI.



HP 8405A

Vector Voltmeter

\$995

The HP 8405A Vector Voltmeter measures voltage vectors described by both magnitude and phase. This capability makes the 8405A a unique instrument for about any design and test application in the frequency range of 1 to 1000 MHz. Measurement capabilities include insertion loss and group delay of pass-band filters and other transmission devices, gain and phase margin of amplifiers, complex impedance of mixers, antennas, etc. Two channels allows for ratio measurements and phase difference between the two channels. Gain or loss in excess of 90 dB and phase measurements with 0.1° resolution over a 360° phase range are possible. Comes standard with BNC adapters only. Other accessories available, call for more information.

HP 3334A

Distortion

Analyzer

\$695



The HP 3334A Distortion Analyzer is a versatile analyzer, widely used in both lab and production areas. Measures total distortion down to 0.1% full scale at any frequency between 5 Hz and 800 kHz; harmonics are indicated up to 3 MHz. This instrument will also measure noise as low as 50 μ V and measures voltage from 300 μ V to 300 V full scale. Features also include automatic nulling mode and high-pass filter. 3 dB point at 400 Hz with 18 dB per octave roll off; 60 Hz rejection: 40 dB. Call for more information!



1040 MHz

Tucker Quality

Boonton 102F

FM/AM Signal Generator

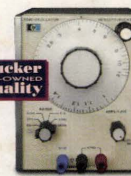
\$3495

This generator covers the frequency range from 450 kHz to 1040 MHz with an output of -130 dBm to +13 dBm. Features include low distortion, wide bandwidth FM, wide FM deviation on all RF bands. Low phase shift AM optimized for VOR tests. Low sideband noise and residual FM. External counter capability to 150 MHz. 10 Hz RF resolution for narrow-band receiver testing. Externally replaceable RF fuse for reverse power protection.

HP 204C

Oscillator

\$249



The HP 204C is a small, lightweight capacitive-tuned oscillator. Interchangeable power packs, line, rechargeable batteries or mercury batteries make this instrument ideal for both field and laboratory use. Frequency range from 5 Hz to 1.2 MHz in 6 overlapping ranges. Flatness of $\pm 0.5\%$ (from 100 Hz to 300 kHz). Output Voltage ≥ 2.5 V rms (10 mW or ± 10 dBm). Output Impedance $\geq 50 \Omega$. Sync Output ≥ 100 mV rms into $\leq 100 \Omega$ over entire range.



HP 3200B

VHF Oscillator

\$695

Provides 10 to 500 MHz in six bands. Frequency accuracy is within $\pm 2\%$ after half-hour warm-up. Power level across a 50 Ω external load is greater than 200 mW (10 to 130 MHz); greater than 150 mW (130 to 260 MHz); greater than 25 mW (260 to 500 MHz).

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