

NUTS & VOLTS

M A G A Z I N E



\$3.50
VOL. 18 NO.3
MARCH 1996

Exploring Electronics And Technology For The Hobbyist And Professional

**CREATING
TROUBLESHOOTING
TREES: Your Key to Circuit
Understanding and Repair**

**SERVO-ANIMATED
SPECIAL FX!**

**CONTROL THE WORLD!
With a Speech Recognition
Interface System**

**INSIDE WIRE
MAINTENANCE: Part 3**

NEW!

STAMP APPLICATIONS
*New column puts the spotlight on
BASIC Stamp projects, hints and tips.*

POWER YOU CAN GET YOUR HANDS ON!

10-480 MHz Classic Generator

Hewlett Packard 608E

Signal Generator...\$239

The HP 608E provides high-quality, versatile performance with distinctive ease of operation. Offers an adjustable, calibrated output of 0.1 μ V to 1 V rms from 10 to 480 MHz. 0 to 95% AM, +CW or Pulse modulation. Basic accuracy of $\pm 0.5\%$. Includes a built-in crystal calibrator which provides frequency check points; jack provided for audio frequency output; crystal accuracy better than 0.01%.

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Quality



Comes With FREE HP-IB Cable

Hewlett Packard 2225A

HP-IB ThinkJet Printer.....\$149

Here is the popular HP ThinkJet Printer at a great price! This printer is a quiet, compact desktop printer that is very efficient (150 cps) while delivering crisp, easy-to-read text and graphics for letters, reports, and spreadsheets in either draft or quality mode. Well known throughout the industry so software support is never a problem. Print cartridges are disposable and easily replaced. Due to its size, features, quality, and dependability, the HP 2225A is an excellent choice. Utilizes the popular HP-IB interface.

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Most Bandwidth For Your Dollar... Only \$3.25/MHz

Hewlett Packard 1720A

275 MHz Oscilloscope...\$895

The 1720A is a high-performance oscilloscope with a 275 MHz bandwidth. Two vertical channels with deflection factors of 10 mV to 5 V/div. ($\pm 2\%$), in 9 steps. Trigger source from A, B, or composite. Main time base: 10 nS to 0.5 S/div. (basic accuracy of 2%), Delayed Time Base: 10 nS to 20 ms/div. Display Modes of A, B, ALT, CHOPPED, A+B. Other features include Hold-Off, Scale Illumination, X-Y Display, Auto Focus and Intensity features.

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2 FREE TPI P1001 Probes

Kikusui COS6100 Oscilloscope...\$695



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Ready for a 5 channel portable Oscilloscope? One with up to 12 traces? We have it in the Kikusui COS6100. This 100 MHz Oscilloscope has a 20 kV accelerating voltage for a very bright, clear display. The COS6100's front-panel is laid out logically so using it is quite simple.

Boasts features normally not found on similar scopes, making it very powerful! It will trigger from channel 1, 2, 3, or "ALT" and the patented "trigger lock" allows for stable, automatic triggering even on complex signals such as TV waveforms. Another unusual feature is the ability to display several lissajous patterns at once. For example, X-Y displays of channel 3 vs. channel 1, 2, 4, and 5 can be displayed simultaneously. This is an outstanding value on a powerful, easy-to-use Oscilloscope...order yours today and receive 2 FREE probes!

AC or Battery Operation

Hewlett Packard 204C

5 Hz-12 MHz Oscillator...\$249

The HP 204C is a small, lightweight capacitive-tuned oscillator. AC line or rechargeable battery operation makes this instrument ideal for both field and laboratory use. The HP 204C provides frequency from 5 Hz to 12 MHz in 6 overlapping ranges with a flatness of $\pm 0.5\%$ (from 100 Hz to 300 kHz). Delivers an output voltage of >2.5 V rms (10 mW or $+10$ dBm) into 600 Ω . Includes Sync Output >100 mV rms into <100 pF over entire range.

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HP-IB Communications To 1000 Meters!

Hewlett Packard 37203A

HP-IB Extender...\$149



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The 37203A HP-IB Extender overcomes the range limitations imposed by the cabling rules of the Interface Bus and provides high-speed (up to 50 k bytes/second), low-cost extension up to 1000 meters! 37203A's are used in pairs: each Extender serializes the normally parallel HP-IB information and transmits it to the other Extender where it is reconverted back to its original format. The transmission medium can be a single low-cost coaxial cable for both directions of transmission! Supports all HP-IB functions including pass control and parallel poll, electrical isolation plus error detection and correction protects HP-IB from transmission errors. Just think...up to 1000 meters between HP-IB instruments using coaxial cable, unbelievable!



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Lowest Cost LCR Bridge

ESI 815AF

Impedance Bridge...\$249

The 815AF Impedance Bridge is a portable, self-contained instrument providing accurate, reliable measurements. Designed to measure resistance to 12 M Ω , inductance to 1200 H, storage factor "Q" of inductors to 1000, capacitance to 1200 mF, and dissipation factor "D" of capacitors to 1.05. Internal generator makes measurements at 1 kHz and also has external generator capability for measurements at other than 1 kHz. Features include null meter, decade readout, zero check function, and protective cover.

With TV Sync Capabilities

Goldstar OS-9020A

20 MHz Oscilloscope...\$379

The Goldstar OS-9020A oscilloscope provides both high quality and performance with lower cost to fill the requirements of schools, industry, service shops and hobbyists. This 20 MHz oscilloscope is loaded with features such as automatic focus, variable hold-off, TV sync circuit, X-Y operation, and a 6-inch rectangular CRT with internal graticule. Basic specifications include a vertical deflection bandwidth of DC to 20 MHz, (7 MHz magnified), modes of operation are CH1, CH2, Add, Dual/Chop. Deflection factor of 5 mV/div to 5 V/div in 10 calibrated steps. Accuracy in normal operation is $\pm 3\%$. Time base of 0.2 μ S/div to 0.2 S/div in 19 calibrated steps. Trigger system modes of auto, norm, TV-V, TV-H with source of CH1, CH2, Line and External. The OS-9020A meets IEC-348 safety requirements. The OS-9020A is sold factory new and includes a 2 year warranty. For an economic choice with high quality the Goldstar OS-9020A can't be beat.

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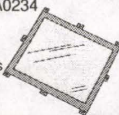
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since 1964!

...brings you a potpourri of high-tech goodies for the techno-tinkerer!
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Large-scale LCD

- From HP laptop computer (model unknown)
- Epson part number of ECM-A0234
- 7" x 9.25" display area
- 16 pin header on .1" centers
- Factory new in antistatic bags

HSC# 15016 **\$24.95**



Arcade Game Controls

- Heavy-duty switch-type joysticks, made by Wico
- New in box, 10A Microswitch contacts
- Mounting flange 3" x 3.5", stick with knob is 3.25" high
- Choice of red or black teardrop or red ball knobs

HSC# 15227 Red Teardrop HSC# 15228 Black Teardrop
HSC# 15230 Red Ball Knob **Your choice \$6.95**



- Heavy-duty "fire" buttons, made by Wico
- New, 10A Microswitch contacts
- Mounting flange 1.25" dia., mounts in 1.125" hole
- Nicely dished button, choose from several colors (Note: only a few blacks were available at press time)

HSC# 15218 Yellow, HSC# 15219 White
HSC# 15220 Blue, HSC# 15221 Green,
HSC# 15222 Red

Your Choice \$1.95 ea.

Modem Madness!

- Hyundai external 2400 & 1200 bps modems
- New in box with telco cable, manual, power adaptor
- CCITT V.21(V.22/V.22bis for 2400), MNP-5 compatible
- 5" x 1.25" x 8.5" compact size, software included

HSC# 15179 2400 bps External Modem **\$17.50**

HSC# 15238 1200 bps External Modem **\$9.95**

1200 bps internal modem card, new with software

HSC# 15239 1200 bps Internal Modem **\$4.95**

Tiny IDE Hard Drive

- 43 Megabyte, IDE Interface, 23 ms access time
- Toshiba MK1122FC 2.5" hard drive
- Overall Size 2.75" x 4" x .75"
- Looks like new, 90-day warranty
- Can be used with standard IDE and power cables by purchasing adapter card (HSC# 15202, \$4.95) and modifying to fit (we provide instructions)

HSC# 15203 **\$39.95**

Huge SCSI Hard Drive

- Fujitsu M2266S Full Height 5.25" Hard Drive
- 1.2 Gigabyte (1.08 GB Formatted)
- SCSI Interface (SCSI-II Capable)
- 14.5 ms avg. access time
- Great for File Server
- Looks like new, 90-day warranty

HSC# 15197 **\$399.00**



Handy Power Supplies

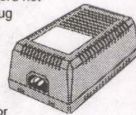
A) Switching power supply rated at 5VDC, 3A, Measures 2.75 x 3.25 x 5.25", IEC receptacle for universal (100 - 250VAC, 47 - 63 Hz) input, IEC cord not included, 6" Output cord with DIN plug
New in box. HSC#14996 **\$5.95**

B) Linear supply rated at 12VDC @ 1200 mA. Input is strapped for 240 VAC input, use as is with 110VAC for lower voltage output, or re-strap it for 110VAC use at 12VDC. Measures 2.5 x 4 x 6.5", IEC cord not included.
HSC# 14980 **\$5.95**

C) Standard 6" IEC power cord for use with above supplies, misc. colors & styles, used. HSC# 80119 **\$9.99**

D) Multi-output linear supply rated at 5VDC @ 600mA, +12VDC @ 250mA, -12VDC @ 250mA, 110VAC input, measures 2.5" x 3" x 4.75", generous 4" AC input cord, 5-pin DIN output cord, HSC# 15137 **\$14.95**

E) Same as "D" above, only 5VDC @ 500mA, +12VDC @ 1A
HSC# 15139 **\$9.95**



VGA to RGB Cable

- Ten foot cable
- High-density 15-pin D-sub (VGA type) connector at one end
- 5 BNC Connectors at the other end: Red, Green, Blue, Horizontal and Vertical synch.
- Perfect for those high-res CAD monitors

HSC# 14963 **\$14.95**

Disk Drive Case x 2!

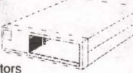
- Upright style case for 3.5" hard drives
- Includes power supply, fan
- 25-pin D-conn can be removed, enlarge hole for your connector
- 2.25" x 6.25" x 7.25" compact size
- Uses IEC power cord (not included)
- Power & drive activity LED's



- Low-profile case for 5.25" drives
- Perfect for CD-ROM drives
- 9.5" x 2.5" x 10.5" overall size
- 50-pin SCSI daisy-chain connectors
- Uses IEC power cord (not included)
- Internal audio cable, RCA jacks on back
- Features 40W power supply, fan, SCSI ID switch

HSC# 15170 Upright 3.5" Drive Case **\$39.95**

HSC# 15243 Low-Profile 5.25" Drive Case **\$39.95**



Network Cable Special

- Dual Workstation Installation Kit
- Two high-quality 10' RG-58 coax BNC cables
- Two BNC tee's
- Two BNC 50Ω terminators
- One BNC coupler
- Enough to cable two Thin-net workstations to the wall-plate distribution point

HSC# 14967 **\$9.95**

Rechargeable Battery

- 4 "D" Cell-size - 4.8VDC 3500 mAh/5hr NiCd
- Sturdy steel case with mounting ears, pin jacks
- Charge regulation circuitry, .5 A Fuse
- Case size 9" x 4.25" x 2.25" (batteries can be unplugged and removed if desired)
- Unused, 1992 date codes (still good)

HSC# 15067 **\$4.95**

Laser Diode

- Toshiba TOLD-9200
- 3 to 4 mW at only 75 - 100mA of current!
- 670nm wavelength (visible red)
- Brand new prime
- Uncollimated, needs current regulation
- Application sheet with suggested circuit supplied

HSC# 15163 **\$17.95**

CD-ROM Starter Kit!

- Sony CDU-535 internal CD-ROM Drive (uses caddies)
- Working drive pulled from multimedia systems
- Single-speed half-height drive, Sony 40-pin interface
- Front earphone/speaker jack, rear audio connection
- New controller card, cable included (no software, caddy)
- 90-day warranty

HSC# 15191 **\$49.95**



Back-up Tape Drive

- Colorado Memory Systems "Jumbo" model drive
- 120 Megabyte external tape-backup unit
- Requires software (we don't have it, sorry!)
- Interfaces like a floppy drive (37-pin connector on back)
- 6.75" x 2.5" x 10" case with power supply, no IEC cord
- 90-day warranty

HSC# 15171 **\$59.95**

Computer Parts Specials!

- Eight-bit VGA/EGA Video Display Card
- 256K VRAM, non-upgradeable, may be used
HSC# 15059 **\$19.95**
- IDE Hard/Floppy Controller, high quality Maxtor brand
- New 16-bit card in anti-static bag
HSC#15237 **\$4.95**
- Slim-line AT case, new, no power supply
- Three 3.5" drive bays, 90° slot expander, hardware
HSC# 15196 **\$14.95**

External Floppy Drive

- 5.25" half-height 360K floppy drive, beige face
- Sturdy beige enclosure with power supply
- IEC Power cord, 37-pin D cable included
- Case size 6" x 2.25" x 12.5" (great for mounting other external drives, i.e. CD-ROM, etc.)
- New in box, with manual
- 90-day warranty

HSC# 15138 **\$24.95**

Transaction Terminal

- Used VeriFone Tranz 240 terminals
- Vacuum-fluorescent alphanumeric 16-character readout
- 12-key keypad
- Z-80 proc.
- CMOS program EPROM
- Mag-stripe read-head (may have been disconnected)
- Communicates over an RS-485 line
- Needs 8.5 VAC adaptor
- Quantity discounts available



HSC# 14848 **\$19.95**

New! QRP Kit Specials

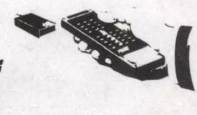
- Popular QRP ham transceiver kits by Oak Hills Research
- 1.5 Watt (Sprint) & 3 Watt (Explorer) models
- 30, 40 Meter bands avail. for Sprint, 20, 30, 40 for Explorer
- 100% complete kits with chassis, knobs, etc.
- All coils prewound for assembly ease
- QRP Wattmeter kit WM-1 available for \$79.95
- Sprint Transceiver Kit **\$89.95**
- Explorer Transceiver Kit **\$129.95**

Aerial Dogfight Game

- Lucasfilm's "Their Finest Hour -- The Battle of Britain"
- Historically accurate depiction of key WW II battle
- "Fly" a Spitfire, Stuka or one of six other fighter planes
- Realistic-looking cockpit instrument panel on screen
- Instruction book has 45 page history of the war with period photographs, campaign maps, profiles and quotes
- Turn on a "cockpit camera" to record your battle
- IBM/DOS/EGA/VGA, AdLib compatible.
- HSC#14694 **\$9.95**

Remote Control for your Computer!

- Infrared Remote operates your computer from 50 feet
- Perfect for sales presentations, training, demonstrations
- Serial Interface (IBM version) or ADB (Mac version)
- Handheld remote is 7" x 2.5" x .5"
- Included software provides screen pointer for emphasis
- Keystroke mapping table can be customized, saved
- Roam the room, make eye contact with your audience
- Like using a TV set remote control (easy to set-up, use)
- HSC# 15240 IBM Remote Keyboard **\$29.95**
- HSC# 15241 Mac Remote Keyboard **\$39.95**



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R10 AND R20 INTERCEPTORS

Selftuning near field receivers with signal strength indicators.

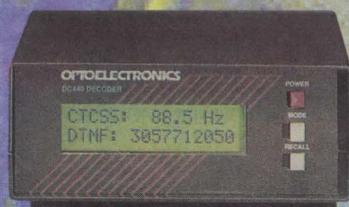
R10.....\$359.00

R20.....\$119.00



R10 Interceptor is the fastest way to pick up nearby two way radio transmission, no matter what the frequency is. The R10 is a totally unique instrument for two way communications test, security, surveillance, and recreational monitoring. Twin LED bargraph for signal strength and deviation are on the front panel. Audio output is suitable for tone decoding with the DC440. Earphone, antenna, internal NiCad batteries, and adapter are included.

R20 RF General purpose Signal Strength detector also can intercept AM signals for earphone monitoring. Its small size and low cost make the R20 useful for transmitter checking, RF room sweeping, and monitoring nearby AM transmissions. R20 comes with a 9V battery and a built-in antenna.



DC440 DECODER

Decodes DTMF, CTCSS, and DCS
CIV compatible, optional nicad.

DC440.....\$259.00

Opt/nicads.....\$39.00

DC440 Decoder works with any receiver, service monitor or the R10 Interceptor to decode Subaudible tones (CTCSS) and codes (DCS) and Touch-tone (DTMF) characters. The display is a two line alpha numeric LCD with back light. Push-button switches control all functions from the front panel. CI-V serial interface supports computer controlled scanning with ScanStar Commercial software. NiCad battery pack is optional.

SCOUT 40

New frequency recorder-records up to 400 frequencies with 250 hits on each frequency and much more.

SCOUT.....\$449.00



Scout is much more than a counter, it is a frequency recorder with a 400 frequency memory. Up to 250 repeat hits are also stored with each frequency. Perfect for discrete, in the pocket frequency collection, or drive by monitoring. Exclusive "Reaction Tune" feature tunes an OS456 or Icom receiver instantly for monitoring. PC software is included to download frequencies and an optional CD, Spectrum for the Scout, can look them up in the FCC database. Rapid Charge, High Capacity Batteries, back lit LCD display, serial interface, beeper and pager style vibrator are included.

OPTOSCAN 456

Computer controlled interface.
For use with the Radio Shack
Pro 2005/6 Series Scanners.

OS456.....\$299.00



OptoScan 456 is the fastest computer controlled scanning system and the only one with Tone (CTCSS) Codes (DCS) and touch tone (DTMF) decoding standard. When installed in the highly regarded Pro-2005/6 receiver the OS456 is also much less expensive than any other computer controlled scanning system. Installation is easy with simple hand tools and only two solder connections. Supported by all popular Scanning Software.

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N100-FM Broadcast Band Notch Filter.....\$99.00

CF802-Cellular Band Pass Filter/Amplifier.....\$149.00

BLP70-Low Pass Filter.....\$36.00

BHP70-High Pass Filter.....\$40.00

CX12-RS232/CIV Interface Converter.....\$89.00

TA100S-Telescoping Whip Ant. with BNC connector.....\$12.00

DB32-Dual band VHF/UHF miniature antenna.....\$29.00

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Send a SASE for a copy of our writer's guidelines.

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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We will not be able to replace missed issues of the magazine due to unreported address changes.

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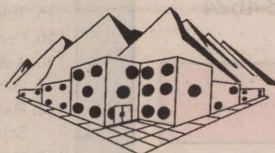
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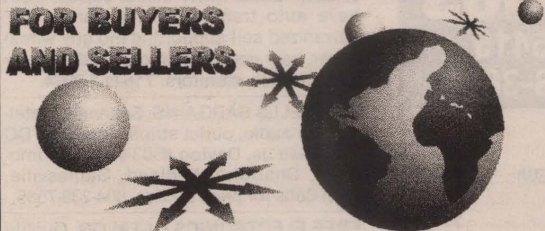
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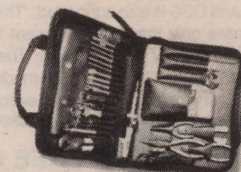
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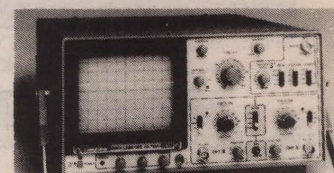
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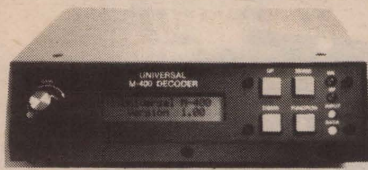
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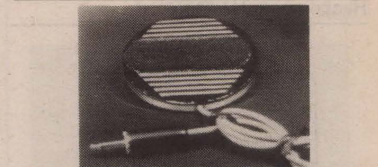
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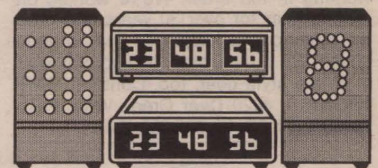
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Laser Light Travels Back in Time

Phase Conjugated Light (which we'll abbreviate PCL) and Phase Conjugate Mirror (PCM) are the terms applied to laser (and non-laser, less often) light whose optical properties have been altered in such a way so that the beam appears to have traveled backwards in time. Here we make a definition since time is a forward, one-way event, as far as human experience has thus far shown it on a macroscopic (large) scale. But, when considering the very small, such as with individual particles of atoms, or the light they emit in packets, called PHOTONS, common-day, macroscopic logic fails us frequently, and the time-forward distinction can fail as these particles commonly have no allegory in human thinking. Like, I can expect to get wrinkles when I'm older, but an atom has no such distinguishing features, regardless of its age, so in essence, it can be considered "timeless" and "eternal." [1]

It is necessary to detach yourself from everyday experience in order to grasp the real concepts. And the concepts are indeed proven real. It is possible, utilizing the proper experimental set-up, to remove most or all of the distortion that will occur during a laser beam's transit through any medium other than the clear vacuum of space, where, if long distances are considered (like the distance between planets) of course distortion will occur eventually. Practical considerations at the moment prevent us from trying phase conjugate methods in space, but there is no reason why they cannot be used eventually. It is not out of the realm of scientific possibility that if mankind ever establishes a colony in another planetary system surrounding another star, phase conjugated laser beams may be used for communication purposes, albeit limited by the speed of light.

The Russian Scientist's Experiment

The first time the PCL effect was noticed was in 1972 by Boris Ya. Zel'dovich and fellow colleagues at the P.N. Lebedev Physical Institute in Moscow. Figure 1 shows the components of the experiment. What Boris and other scientists did was to shine the bolt of light released from a ruby laser (a), profile of beam shown at (1), first through frosted glass (f), profile of beam shown at (2), and then into high-pressure methane gas inside a long glass tube (d). With a beam of such intensity, what was expected was a distorted scattering of light (2) and reflection backward from this compound under high pressure. What they did not expect was the laser beam, whose profile was distorted (again, 2) by the frosted glass, the optical components of the system, the intervening air, and the gas itself, was reflected back through the frosted glass, and appeared nearly undistorted! (3, at detector g). Something was happening to the laser beam; it was being time-reversed and the distortions corrected by the high-pressure methane. Refer again to the individual components in the sketch in Figure 1. The experimental set-up consisted of (a) the ruby laser, pumped optically by the helical Xenon flashlamp shown wrapped around it and its high-energy storage capacitor. (In reality, the flashlamp probably would have had more turns than shown to increase the necessary optical power to lase the rod. Also, the rods generally are quite small, averaging a few inches in length and 0.25 to 0.375 inches in diameter. Heat is one reason for this, as when pumped with a flashlamp, the rod absorbs lots of infrared energy which will usually prevent the rod from outputting laser light until it has cooled, a period of several minutes in free air.) Components (b) and (c) are fully reflective and partially reflective mirrors, respectively.

In the following article, we'll refer to regular or partially reflecting mirrors as such, and they represent common optical parts that are first-surface; mirrors whose coating appears facing the input light source rather than at the back of the mirror material — like the kind of mirror you look into every day while grooming yourself. Component (d) is the long methane-filled glass tube, and component (e) is speculative on my part, but probably would have to exist; it is a beamsplitter that sends the light information to component (g), the device that measured the quality of the phase conjugated beam. Probably there was a standard mirror behind the long methane tube, but that is not shown as that is also speculative. Precise details of the experimental set-up are sketchy, as are all details originating from the former Soviet Union during this time period. Reason being, as you shall see shortly, the phase conjugate property can lend itself to awesome advanced optical weaponry techniques . . .

Figure 2 shows how the laser beam is returned by a PCM to the light source regardless of the angle of incidence, within reason. Obviously, we are not going to get a perfect return at a one degree incident angle, but the return at most other angles is nearly perfect. Notice the small arrows. The solid ones are the incident beam, and the outlined ones depict the reflected

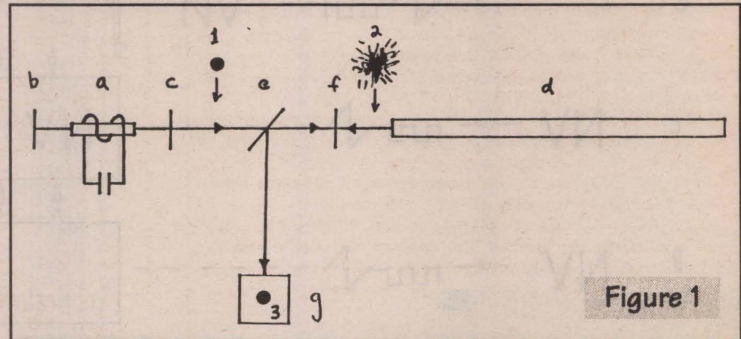


Figure 1

beam. Figure 2A shows what happens when the light beam is reflected from a regular mirror. Note the beam is expanded and reflected off the mirror at an angle. Figure 2B is quite different. That shows the laser beam not only being reflected back towards the source, but the angle of dispersion narrowing, as well, so what you have really is equal to spatially AND time-reversed light.

The PCM mirror can be made of different materials. One that I read about is liquid carbon disulfide, another solid crystals, still another gaseous material such as the methane or vaporized elements such as sodium at high temperature. In all cases, the materials exhibit the peculiar property of optical NON-LINEARITY; that is, the material does not respond to the inputted light in a fashion that is mathematically linear; more of a logarithmic function instead.

Figure 3 shows a very interesting property of PCL. Consider a coded signal that has arbitrarily the waveshape of that shown in Figure 3A. Here, we have a waveshape followed by a data message (NV), and that waveshape is the first to arrive at a regular mirror. Note that the reflected pattern at Figure 3B shows what we intuitively expect a mirror to do; reflect the pattern in the same manner as received — temporally speaking. So, the waveform comes in first, followed by "NV" and the waveform is reflected first, followed by "NV," but both are backwards, because of the temporal displacement. In the PCM system, however, the reflected waveform + data is dramatically different in the way that not only is the signal returned in the sequence that it arrived, but that there is no temporal displacement. The

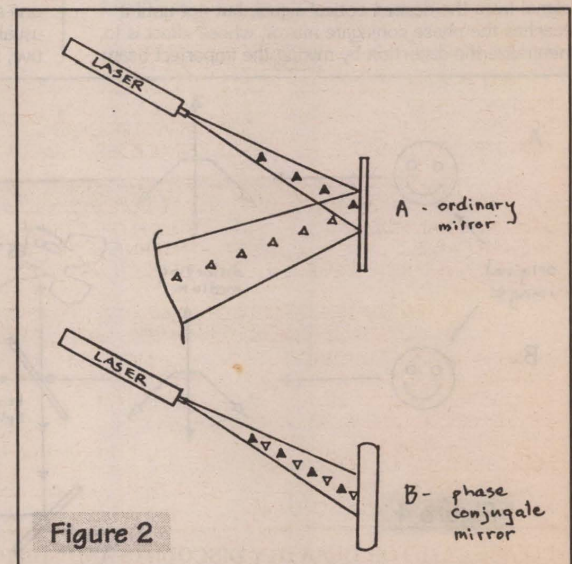


Figure 2

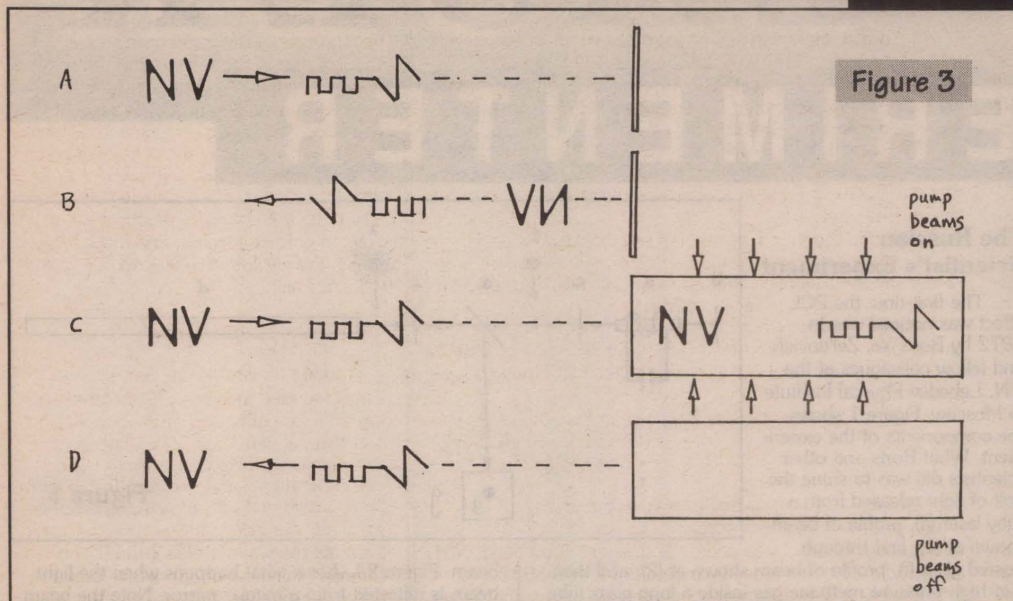


Figure 3

requirement is the PCM must be physically large enough to accommodate the input signal over its duration, while being energized by laser beams called "pump beams" as shown in Figure 3C. If the pump beams are turned off during the input to the phase conjugate medium, then you can't get the effect of time-reversed light out. So, the beams must be input as shown in Figure 3C, "examining" the input signal as shown in the same figure, and outputting the signal in the same temporal sequence as shown in Figure 3D. Notice the pump beams are turned off at this point, being no longer necessary, however, there are such accomplishments as continuous PCMs and amplifying cells which may return the data in a time-reversed fashion, as long as they are energized by the laser pump beams.

Fixing the Distortion of a Data Signal

Figure 4 shows the effect of a PCM on a signal distorted by a medium. That medium could be air, a fiber optic cable, water, or another distorting medium. We see the Smiley face image (A) being sent to the reception sensor(s), whatever they may comprise, through the distorting medium. Smiley arrives in sad shape, as we can see (gee, doesn't this sketch remind you of your mother-in-law, eh?). The PCM techniques can all but eliminate this problem. First, the beam is passed through a beam splitter, which mixes and separates the garbage signal from the desired optical signal, but not until it reaches the phase conjugate mirror, whose effect is to neutralize the distortion by mixing the imperfect beam

with a mirror image of its own imperfections. As a result, the Smiley face re-appears as a restored image at (B), after perhaps being modified in size by another optical component. In this case, a regular mirror steers the image at the experimental set-up to the detector, which can be a CCD camera, monitor, fluorescent card, or whatever piece of detection apparatus functions best with the laser frequency involved.

A Deadly Satellite Destroyer

Although we haven't heard publicly of PCL used as a weapon, it certainly can be applied as one. The PCL effect is not only useful as a temporal and distortion removing technique, but also can be used as a laser amplifier, for non-destructive or destructive purposes. Figure 5 shows an experimental set-up done at the University of Southern California. Here's how it works: Central to the technique is a barium titanate crystal, fashioned into a non-linear optical component. Remember that a laser is a resonator cavity like a microwave cavity? And that it has two mirrors to bounce the laser energy back and forth so it will amplify? This is similar to a regenerative receiver that keeps building up the received signal, amplifying it so that the sensitivity of the receiver is greatly increased. The exception being super-radiant lasers like nitrogen and atomic-pumped X-ray lasers require no mirrors since they operate in nanosecond time frames and only give one shot of output per shot of excitation pumping. But usually, laser mirrors have to be close to 100% reflective, the rear mirror being within a few tenths of a percent of perfect reflectance and the front usually about 95% to 99% to allow exit of the laser beam.

The U.S.C. researchers discovered that by using the BaTiO₃ crystal, it could be excited by pumping opposite sides with a strong

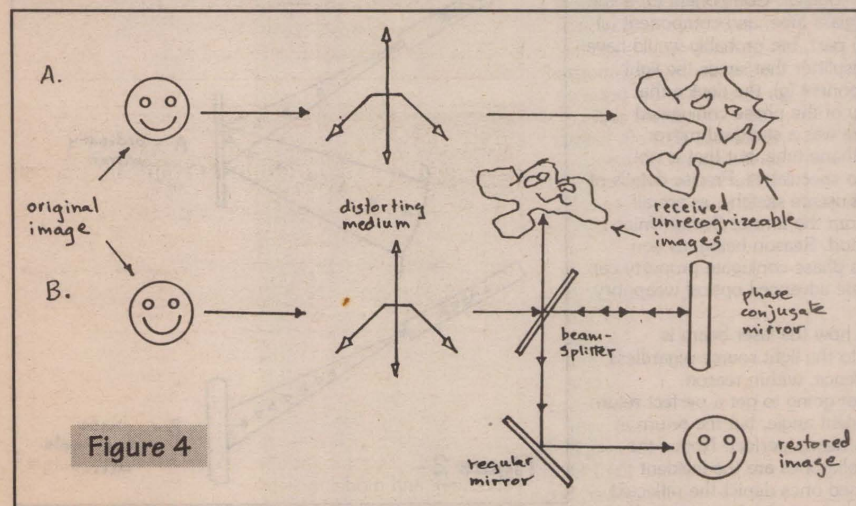


Figure 4

Laser Helpline: A Reader-To-Reader Interactive Forum

This is the second presentation of this forum; we'll continue to publish it each month as a free service to the readers of *The Laser Experimenter* who wish to get in touch with one another by whichever medium they mutually prefer. To place your "free ad" (no commercial products, please), send your abstract and communication protocol to: *The Laser Experimenter*, Laser Helpline, P.O. Box 74, Cornwall Bridge, CT 06754; we anticipate more interaction in the near future as more readers become aware of this unique service.

Anthony Charlton, the writer of this column, has experienced an interesting response to the article about Fiber Optic Gyroscopes, appearing in the Jan. '95 issue of this publication. What he would like very much to find out is non-proprietary (i.e., non-trade secret) information that could help foster the construction of an amateur F.O.G. device. Reasonable copying and time fees will be gladly reimbursed provided an estimate is given beforehand. Send your correspondence to The Laser Experimenter address given above.

Reader Phelps Jameson is searching for a way to measure the reflectivity of chlorophyll in different plants, using a laser of the proper wavelength. This is for hothouse-grown looseleaf lettuce his firm currently cultivates and other vegetables his company wants to try growing in the future. The purpose is to assess their biological health, which is directly related to chlorophyll production, among other factors. Hopefully, an accurate measurement sensor can be implemented, either by reflective or absorptive methods. This sensor should span across different visible wavelengths, and will serve to optimize the spectrum of the grow lights employed; e.g., changing or adding different lamps, filtering them, etc., to accelerate plant growth via real-time measurements and their results. Wavelengths of most interest center around 630 nm (orange-red) and 460 nm (blue). Readers interested in this idea are invited to contact Mr. Jameson c/o The Laser Helpline; he is willing to exchange his ideas at no charge through this information medium first, with a possibility of a future mutual consultant liaison.

laser beam. Of course, the beam has to be the proper wavelength and above the threshold level of power in order to induce amplification. The set-up shown in Figure 5 used an Argon laser as the pump, and such lasers of that time usually ran about one or more watts of output. The beam is steered through the center of the crystal using a regular mirror. Part of the beam travels onto the wedge shaped mirror, which reflects the beam back into the crystal. This second beam forms the required pump beam to induce amplification.

Now it gets interesting. Any shiny object placed in the vicinity of the now excited crystal will cause a laser beam to exit the crystal, and reflect off that shiny object! The kitchen spatula was chosen as a novel shiny object, and is essentially a mirror with low reflectivity and high distortion. But, as we have learned thus far, the PCL effect corrects the distortion both spatially and temporally. Should another shiny object be present, the beam would search it out also. Thus, one has to be careful working around such experiments, as the eye-glasses of the unlucky researcher show at the top of the figure may reflect enough light to have the laser track and beam directly into them, and as a result, his or her eye(s).

Footnotes:

(1) Here I am not considering the possible decay of the proton, or the transmutation of one unstable atomic particle into another according to statistical probability, which is well-defined and quantified.

(2) P.S.: I don't get a kickback from any companies I recommend.

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SOURCES

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

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it takes several minutes to find the satellite using an X-Y locator geometry; what is that compared to the expensive optics and telemetry equipment required otherwise? Once the satellite returned an adequate reflection, the phase conjugate laser would lock fully on, and the death blow delivered by pouring power into that laser at the shooter's leisure. The technology is there; let's hope if it comes to practical use we have the ordinance first, and more importantly, the wisdom to use it prudently and with restraint.

Organizational Bliss

Working on several different projects simultaneously involves a lot of effort looking into the public and one's own library and various periodicals. We experimenters can painlessly keep well-ordered track of our experiments and results using modern, inexpensive methods of storing and retrieving data, whether in physical or electronic form, all the while avoiding the "Bean-Counter" mind-set of oppressive organizational dogma. My problem has always been to keep the projects in progress carefully separated from one another, and the data accompanying them! So, several years ago, a company mailed me a catalog of office supplies at discount prices, and I thought you'd like to know about them {2}. Of course, there are lots of companies around who do the same thing, it's just the results were great with this outfit, and phoned-in orders are usually delivered the next day via UPS. Their name is Viking Office Products, and their phone number appears in the "Sources" section of this column.

Next month, we'll again touch briefly on organization, devising a generic plan for the electronics/science experimenter and have more on optical phase conjugation. It's also about time we wrapped up the project on Building a Helium-Neon Laser Power Supply, and I hope to get this all accomplished by the next installment. **NV**

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

CLOSING QUOTE:

"There is something fascinating about science. One gets such wholesale returns of conjecture out of such a trifling investment of fact." — Mark Twain from "Life On The Mississippi."

Anthony Charlton is an active electronics and science "do-it-yourself" project designer, does custom R & D, and writes technical articles. Previous work experiences include design of hardware & software for microprocessor-based process control systems and electronic design. His hobbies include lasers, gardening, target shooting, and model rocketry.

How does this relate to killing satellites? I read about such an idea from a source whose scientific credibility is unverifiable, but it makes sense to this author. Suppose you are on earth, and you want to liquidate an enemy's satellite. We know from the publicity in the media that it's possible to deliver enough energy from a mountaintop location (chosen because the air is thinner, and pollution less, both which interfere with a laser beam's energy delivery quotient) to destroy a satellite. In fact, I have a video tape that shows a Strategic Defense Initiative (SDI) infrared laser blasting a real, but un-war-

headed rocket booster of the type that carries nuclear warheads to kingdom come. Consider the steps needed to be taken if you want to destroy this satellite. What is required is first to find and identify it; that shouldn't be too much of a problem as there are many people who keep track of such objects in space, and you practically couldn't place a football up there without someone on the ground noticing it. If the satellite has any shininess above the level of illumination from the stars or moon, and if that reflectivity is great enough to overcome losses from the earth's atmosphere, one can then shine a

tracking laser onto the satellite until the PCL laser "finds" it, just like it "found" the spatula. Then, you could pour raw, destructive laser power into the non-linear phase-conjugate medium. That medium would become super-excited, and the energy would be delivered to the satellite until it was either vaporized or disabled to the point where the ground ordinance was shut off, having been deemed effective.

The fascinating aspect of all of this is that no tracking equipment is required to keep the destructive beam on the satellite for any length of time, despite its rapid orbit; once the phase conjugate laser has found it, that's the end of it. Using imagination, let's say one could locate the target satellite first using radar, then criss-cross the sky with the locator laser, and the PCL laser on standby power. So,

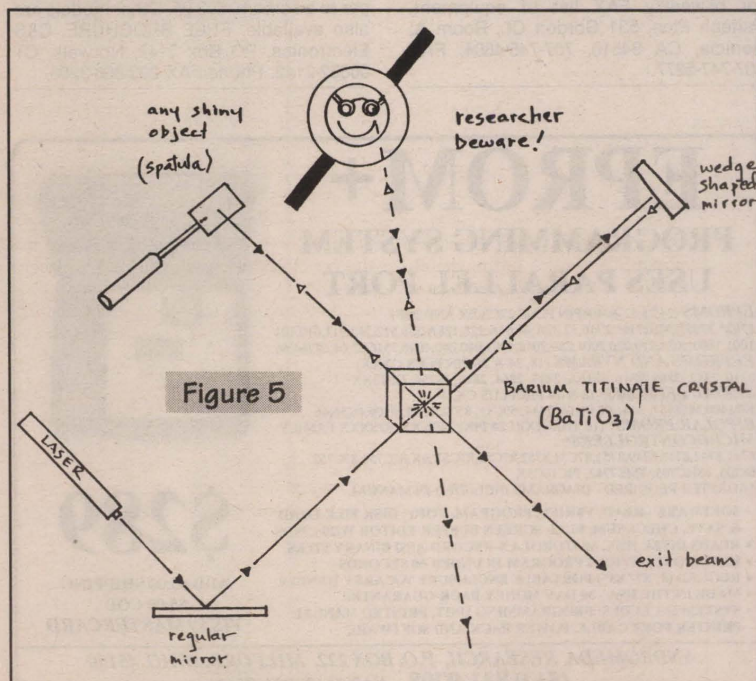


Figure 5

SURPLUS TEST EQUIPMENT

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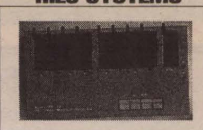
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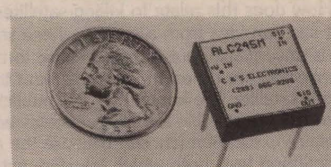
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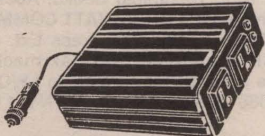
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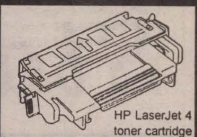
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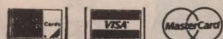
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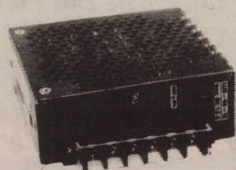
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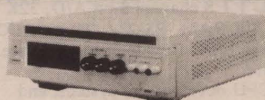
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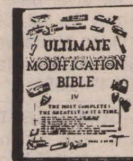
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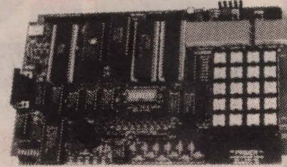
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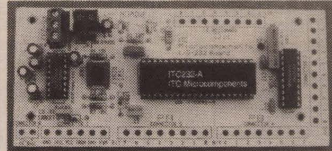
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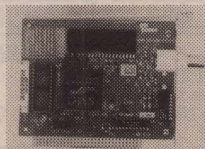
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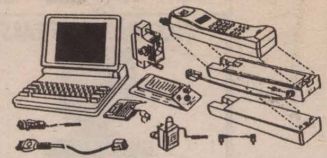
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Stamp Applications:

New Feature!
Puts the Spotlight on
BASIC Stamp Projects,
Hints, and Tips

by Scott Edwards

Welcome

to the first installment of Stamp Applications, a forum for users of BASIC Stamp single-board computers. Every month, we'll introduce new ideas in hardware and software for the Stamp, answer questions, and keep up with news about the Stamp and related products.

To kick things off, let's look at the newest member of the Stamp product line — the BS1-IC — also known as "Stamp on a SIP." SIP stands for single-inline package, and it describes the diminutive new Stamp's printed circuit board. The entire circuit plugs right into a 14-pin SIP socket. This makes it easier to breadboard with the Stamp, or incorporate it into your own circuit designs.

Figure 1 shows the layout and important dimensions of the BS1-IC. I elected to sketch the unit rather than photograph it because its small size makes it a real challenge to get a decent picture.

The BS1-IC has four advantages over the regular, full-sized Stamp. The first and most obvious is size. The BS1-IC is small enough to be treated as a component that can be integrated into ultra-small designs.

The second advantage is price. At \$29.00, the BS1-IC has everything the original \$39.00 Stamp had, except for the battery clips and prototyping area. If your power supply is something other than a 9V battery, you won't miss the clips.

And if you're not a fan of wire-wrapping (I detest it! Crocheting for engineers!), you'd probably never use the grid-of-holes proto area anyway. The BS1-IC plugs right into socket-type proto boards,

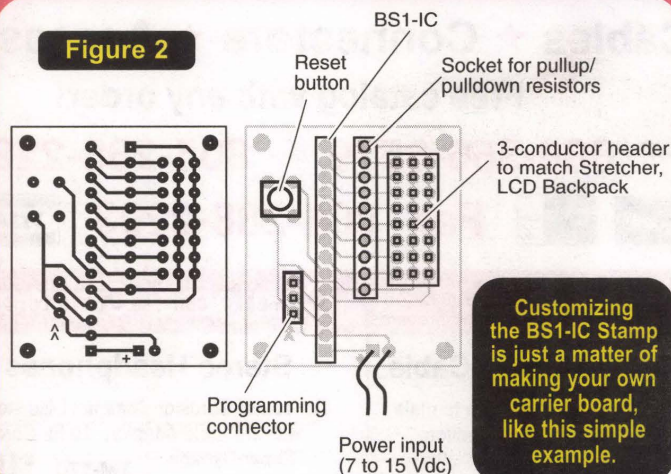
like the ones sold by Radio Shack and Jameco, allowing rapid circuit testing. If you want to add the clips and proto grid later, you can buy a "carrier board" for \$10.00 to turn the BS1-IC into a normal form-factor Stamp.

The third advantage over the original Stamp design is not very glamorous, but nonetheless important: The BS1-IC has a reset line that's accessible to your circuitry. You can add a button between reset and ground. This allows you to reset a runaway program to the beginning. You can also treat the reset connection as an output, using it to reset other logic in your circuit. This is a significant benefit for equipment that must reset and work in perfect synchronization.

The fourth, least tangible benefit of the component-style package is professional appearance. You can now integrate a factory-assembled and tested Stamp into a prototype or product without having a messy jumble of printed circuit boards

The new BS1-IC packs all the features of the original BASIC Stamp — plus a few new ones — onto an IC-sized circuit board.

Figure 2



under the hood. Put the BS1-IC right on the circuit board with your application-specific components.

In my first application for the BS1-IC, I wasn't too worried about looking good. I just wanted to reduce the jumble of jumper wires that was accumulating as I interfaced Stamps to different projects and test jigs around the shop. My Stamp Stretches and LCD Serial Backpacks both borrow power from the Stamp and use a standard connector layout: +5V, ground, serial data. I decided to make a bunch of three-wire jumpers with female header sockets at each end. I then designed my own carrier board with eight, three-conductor male headers — one for each input/output pin.

Figure 2 shows the resulting board layout. I present it not as a finished product, but as an example of how simply you can turn Parallax's newest Stamp into Scott's Stamp or Mary's Stamp or Acme Industries' Stamp.

That wraps up this month's installment of Stamp Applications. Future columns will dig into Stamp hardware and software issues, generally presenting at least one schematic and one program listing each month. Initially, I'll take the topics from Parallax's technical support folks and the online venues where the Stamp is discussed.

But I'd be grateful for your suggestions.

NV

Contact me at:

Scott Edwards Electronics
964 Cactus Wren Lane
Sierra Vista, AZ 85635

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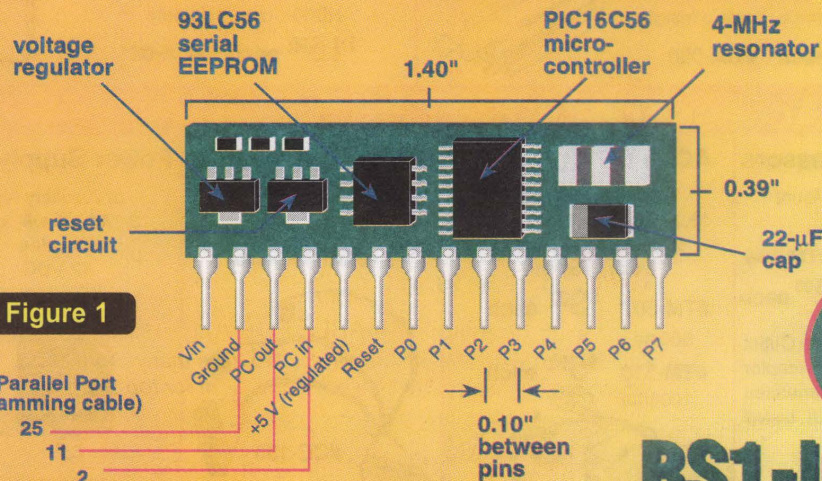


Figure 1

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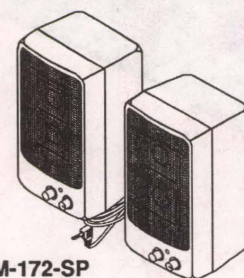


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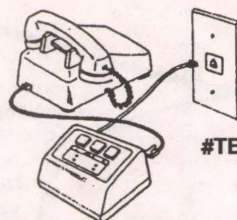
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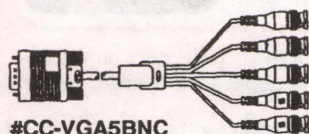
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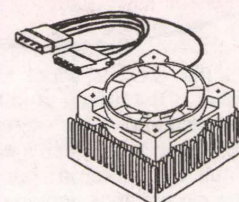
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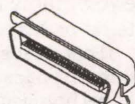
3 piece crimp type with gold pin
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#CN-548 75¢ each 100 up 60¢ each

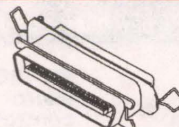
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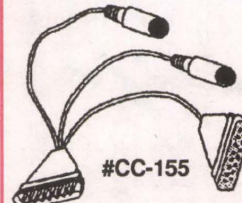
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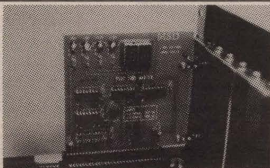
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Electric Car Conversion

Part 12

Conventional wisdom says the key to making electric cars successful in the mainstream is a better battery. This is only partly true. A battery with more capacity would give the car longer range, but it would only be practical if it was also compact and affordable.

by Shari Prange

The search for high-capacity compact batteries, lead by the U.S. Advanced Battery Consortium (USABC), focuses on "exotic" materials — sodium sulphur, silver zinc, etc. Unfortunately, the prices are also exotic.

There is also another battery study group and another approach. The U.S. Advanced Lead Acid Battery Consortium (USALABC) is looking at ways to improve the capacity of traditional lead acid batteries by using different plate and paste materials and designs. The kinds of capacity improvements made here are more evolutionary than revolutionary. However, they are also affordable for you and me.

Fast Charging

The USALABC is also looking at the interaction between the batteries and the charger. After all, the real limitation is not the range of the batteries, but the amount of time it takes to recharge them. If recharging time could be brought down to less than 15 minutes, electric cars would have effectively the same range as gas cars.

The problem with charging batteries quickly is that charging generates heat, and heat damages the batteries internally. The amount of heat generated is directly related to the amount of input current. If the amperage is too high, the battery will be damaged.

The USALABC is experimenting with different battery designs that will allow the battery to accept higher levels of current during charging without damage.

Pulsed Charging

They are also investigating different methods of charging. The most promising at the moment is pulsed charging. In this technique, current is fed into the battery in a series of tiny pulses, with brief pauses between them. This method causes less heat build-up.

A further refinement includes a tiny discharge between charge pulses. Although this seems counter-productive, this two-steps-forward-one-step-back technique makes the plate surface more receptive to the incoming charge.

The chargers of the future are likely to resemble the speed controllers we are using now, utilizing pulse width modulation to feed the batteries the maximum possible charge without damaging them.

The Last Amp is the Hardest

The amount of heat (and potential battery damage) is not a constant function of the charging current. It is also related to the state of charge of the battery. An "empty" battery can accept much more current than a nearly full one. Older, more primitive chargers didn't account for this. Toward the end of the charging cycle they would cause the batteries to literally boil, which greatly shortened their lifespan. Modern chargers sense the batteries' state of charge and taper their current

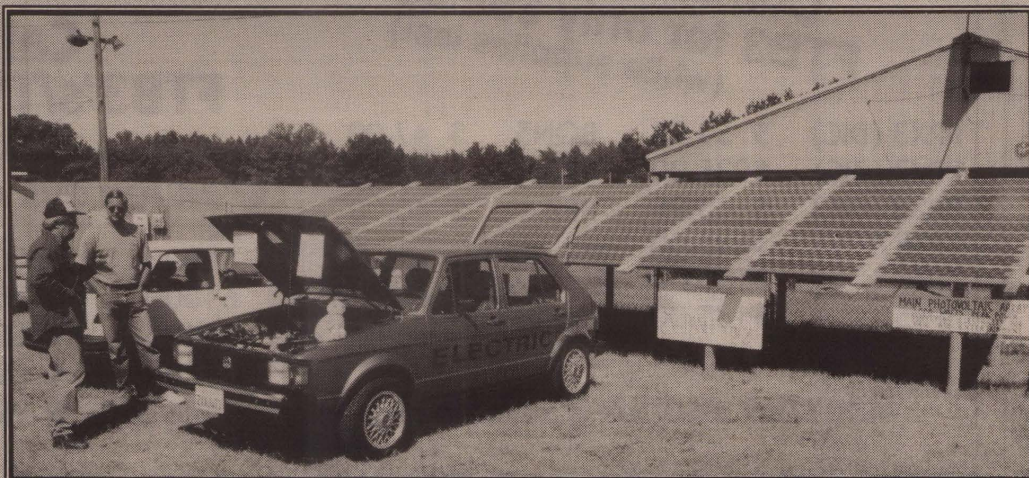
ed in quick charge situations. Current research indicates that quick charging can only bring batteries up 80% from "empty" to "full" without damage.

What this means in real life is that a quick charge would be a supplement to, not a replacement for, slow charging. Typically, you would slow charge your car regularly overnight at home, or possibly during the day at work. Most of the time, this would be all the charge you would need.

On those occasions when you needed to drive farther in a day than your slow charge permitted, you would pull into a charging station for a 10- or 15-minute charge that would bring you up most — but not all — of the way to a full charge. You might make two or three of these stops during a really busy driving day or a long trip. However, that night you would still plug into a slow charger to finally bring the batteries up to full and equalize them.

High Voltage

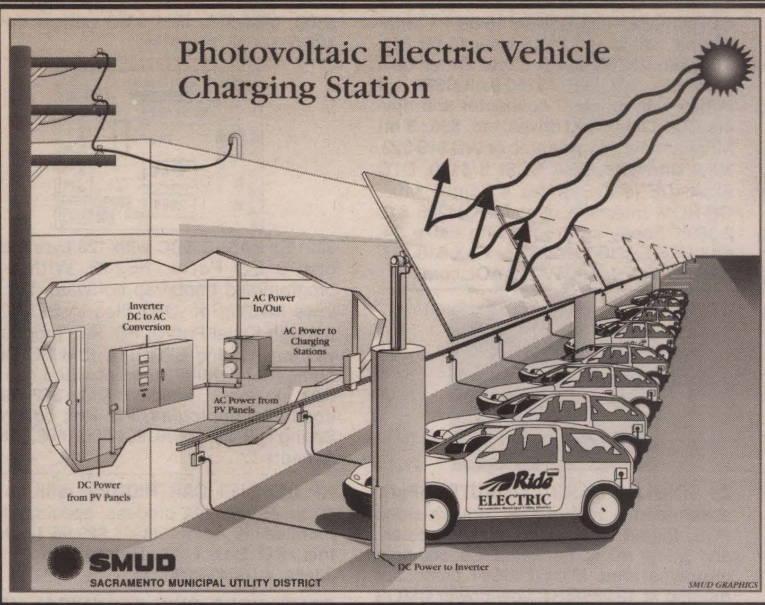
One problem with quick charging is that it requires high voltage — at least 440 volts. A typical, fairly modest, battery pack has about 22 KW/hrs. capacity. Even at the higher current levels allowed by pulse charging, it requires a lot of voltage to pump that many watt/hours into the batteries in a few minutes.



output accordingly.
This problem becomes exacerbat-

It takes a solar array about the size of a household roof to charge an electric passenger car.

Photovoltaic Electric Vehicle Charging Station



Used by permission of the Sacramento Municipal Utility District.

This does not thrill utility companies. They prefer electric cars to charge overnight, in their offpeak hours. The thought of hundreds of commuters going for a quick charge on their lunch break during peak electrical demand creates nightmare visions of mass brown-outs.

It is likely that charging stations will house large storage battery banks, which they will charge overnight and draw from during the day to minimize impact on the grid.

Quick pulsed charging is probably the most likely near term range extender for electric cars. The technology could be ready for commercialization in as little as five years.

Solar Power

It would be nice if we could simply cover the tops of our cars with solar cells and run on sunshine. Unfortunately, that is not an option. If solar cells were 100% efficient, it would require a 10 foot square array to power an average passenger car at cruising speeds. Actual cells are less than 15% efficient.

Some cells are more efficient than others. Unfortunately, the most efficient cells are also the

In the near future, electric vehicles will have reserved parking spaces with charging outlets.

ered with solar panels. Commuters drive their electric cars from home to the garage, then take the transit train into the city. While they are at work all day, the sun is beaming down on the garage roof and feeding electricity to the cars parked beneath it. Excess electricity is fed into the power grid. At night or on cloudy days, the cars can charge on power that was "banked" in the grid when the sun was shining.

Sacramento Municipal Utility District already has such a charging station for the many electric vehicles in its fleet. Charging stations like these for commuters, coupled with effective mass transit, could clean the air and reduce traffic congestion.

Powered Roadways

Another fascinating possibility is the powered roadway. This is an offshoot of inductive charging. The basic inductive charging system does

most expensive — and the most fragile.

All of this explains why solar race cars are the way they are: a tiny pod for a driver, a huge wing of solar cells, and a total vehicle weight of under 300 pounds.

But solar power does have a place in charging electric cars. The place is at the charging station. Imagine a parking garage for a city mass transit system. The roof of the garage is cov-

not require an actual physical connection for charging. The vehicle is simply nosed into a charging slot. A receiving plate on the vehicle comes into close proximity to a charging plate in front of or beneath the car. Electricity can flow between the two plates without actual contact.

Although this kind of charging is available in a few industrial applications, it is not available for passenger car conversions. However, it does present the tantalizing possibility of the inductive roadway.

In the inductive roadway, the charging plate is actually a grid running down the center of the road, just below the surface. You could put your hand down on the road without receiving any shock. However, a car passing over the road, if equipped with the proper receiving plate, could draw its power from the road as it drives.

A sample stretch of this type of roadway has been built and demonstrated successfully in southern California. Why don't we have them everywhere? First, there is the expense of

installing miles of charging grid beneath existing roads. There would have to be enough vehicles capable of using the system to justify it.

Second, there is the problem of how to bill users for the electricity. A computerized system that could recognize an ID signal for each car? Toll booths? General highway taxes? Powered roadways will most

likely first come into use for municipal vehicles such as busses. These vehicles are concentrated in downtown areas, and travel the same daily route, with known miles and hours of operation. They would benefit most heavily from such a system, and would be easy to bill. We already have electric busses using overhead trolley lines. This simply moves the lines under the pavement.

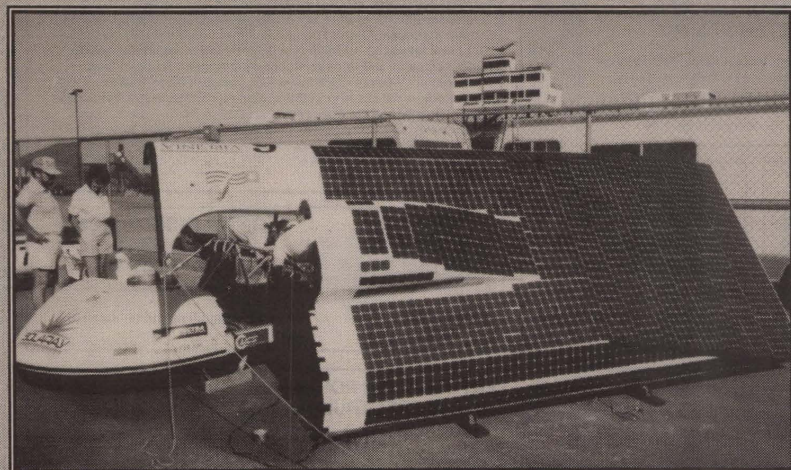
Eventually, private cars may be equipped to take advantage of powered roadways. You would probably still have a battery pack and charge your car at home. Your batteries would carry you from home to the downtown grid, where you would be able to run off the inductive charge.

A system of this sophistication, while lovely in concept, is a little further away in actual execution.

Just Do It

These are just a taste of the developments already in the works for electric cars. But if you want an electric car, don't wait for the "perfect" battery or charger. Build your car — and start enjoying it — now. As these improvements become available, you can upgrade, and your car will get better and better.

Development is driven by the marketplace. The more people there are driving electric cars, the more incentive there is for manufacturers to spend the time and money on development. You can wait for the technology to improve, or you can help make it happen. NV



Solar race cars consist of small driver pods and large arrays of solar cells.

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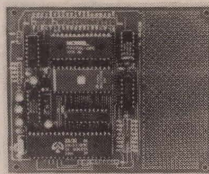
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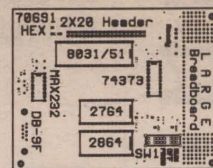
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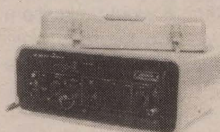
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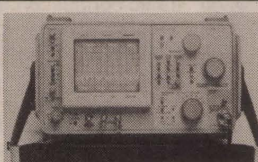
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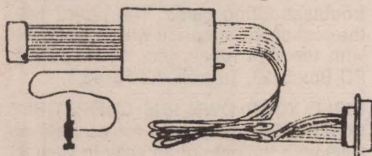
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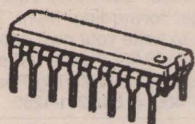
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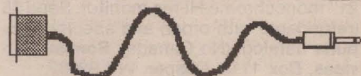
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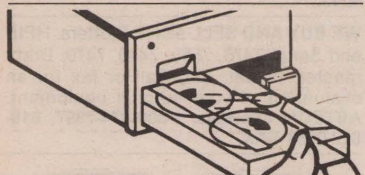
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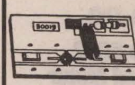
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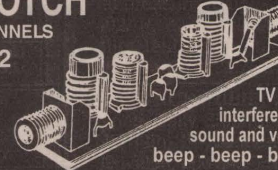
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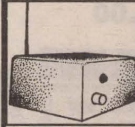
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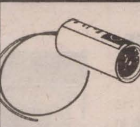
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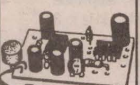
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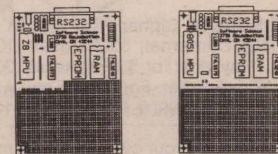
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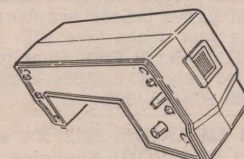


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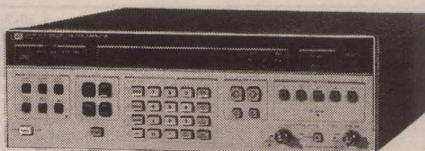
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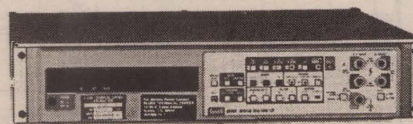
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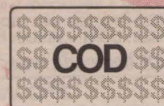


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Creating Troubleshooting Trees: Your Key to Circuit Understanding and Repair

by Ronald A. Reis

You're an electronics experimenter, you have been building projects from *Nuts & Volts Magazine* and various "project mags" for some time. Most of your projects work — many the first time you apply power. But even if you're a seasoned builder, you know that sooner or later you are going to be troubleshooting a project that just doesn't test out. That's when things can get tricky.

True, many project articles will give you general troubleshooting procedures to follow when your project won't squawk, light up, or put out the required voltages. But what's really needed is a detailed, project-specific troubleshooting plan, one designed to take you step-by-step through every possible contingency. You need a project troubleshooting tree.

How do you get such a tree? In most cases, you'll have to "grow" it yourself. Doing so has its advantages. By designing your own troubleshooting tree, you will get to know your project's theory of operation down to the last detail. Furthermore, in the process you'll be creating a blueprint that will hone your troubleshooting skills for all the electronic circuits to come.

In this article, we show you what a project troubleshooting tree is, explain why it is so useful, and discuss its basic elements. We then go through the creation of a troubleshooting tree for a power supply project. At this point you should be ready to give it a try yourself. But first, we'll give you some "cultivating" tips. Then we supply the schematic and discuss the theory of operation for a Three-Channel Color Organ

Project. Your challenge is to create its troubleshooting tree. We will print a "solution" elsewhere in the magazine.

Before You Plant the Seed

Before you plant the seed and start cultivating a troubleshooting tree for a just-completed project, you'll want to spend a moment in preliminary project inspection and check-out. A moment spent now will save much time in detailed troubleshooting later on.

During inspection, look for three things: correct component placement, correct wiring, and correct soldering.

The primary cause of project failure is incorrect component placement. Either the wrong component is inserted in a given location, or a polarized component is placed in the right location, but inserted in the wrong direction. Either condition could result in project malfunction or worse, total failure. Examine the circuit scrupulously; make sure all components are positioned correctly.

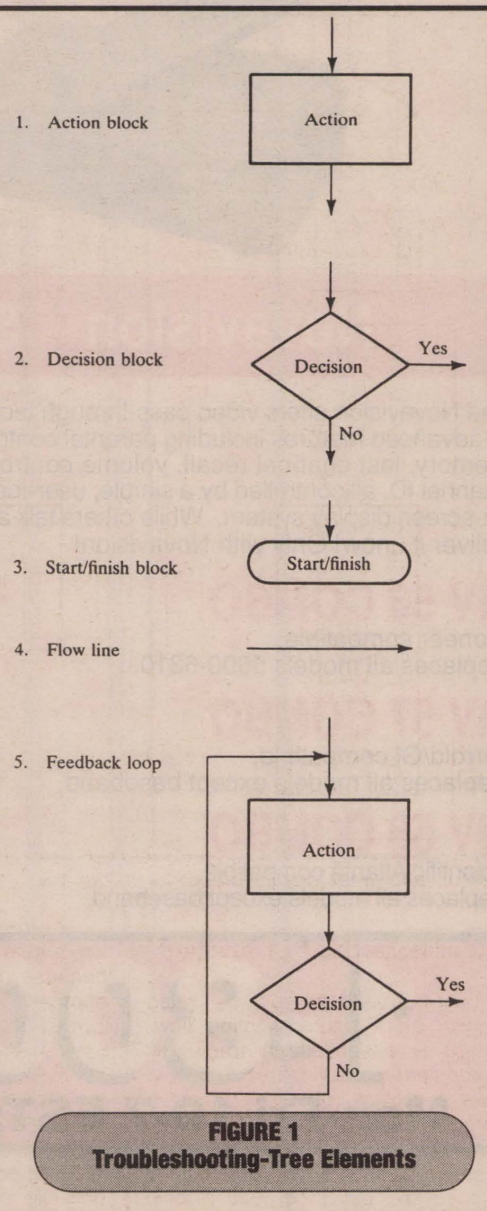
The second most prevalent cause of project failure is incorrect wiring: missing connections, wrong connections, and broken connections. The latter is a particularly annoying problem, showing up frequently in the form of hairline cracks in the copper traces of printed circuit boards. If you suspect a given trace, check it with a continuity tester or an ohmmeter.

A third and very critical check requires you to inspect for poor solder connections. Cold-solder joints will prevent adequate contact between component leads and wires or PC board traces. Be sure all solder connections are shiny rather than dull gray. Resolder any that are not.

After you have completed these preliminary inspections, go ahead and turn your project on. If you suspect a malfunction, try using four of your five senses to check for the more obvious problems.

By using the senses of sight, hearing, smell, and touch, you can do a surprisingly thorough check-out of your project. With sight, you can see if a component has fractured or burned out. By listening, you can detect unusual sounds, such as crackling, high-pitched whines, and sizzling. With smell, you can sniff for leaky transformers or capacitors, burning coils, and searing plastic from "cooking" transistors and ICs. And with the sense of touch, you can feel components that are too hot or too cold. If you can't keep your finger on it, it's probably burned out; if it is stone-cold, chances are it's not drawing any power.

At this point, after you have completed your preliminary inspection and check-out, it's time to consult your project-specific troubleshooting tree. Let's see what such a tree is, why it is so



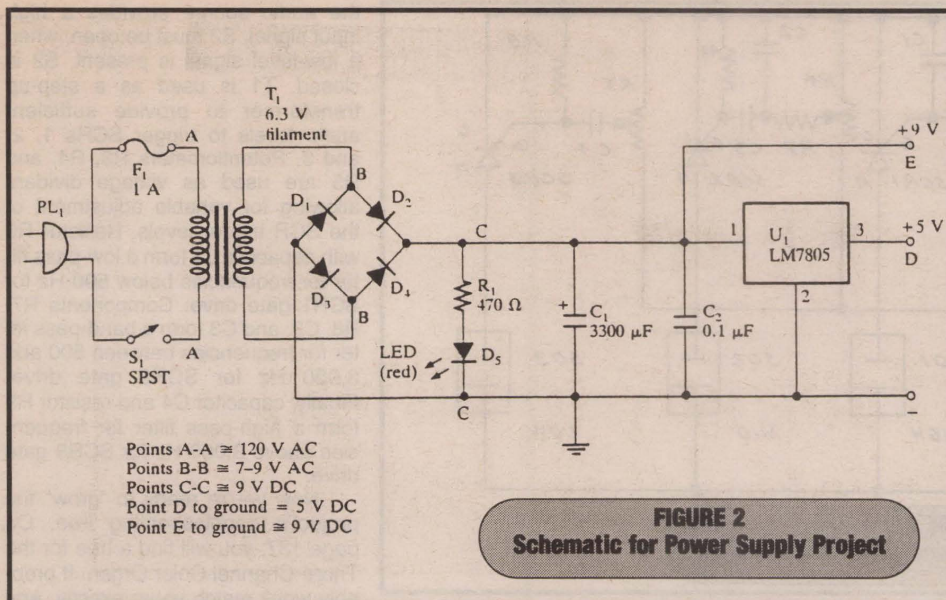
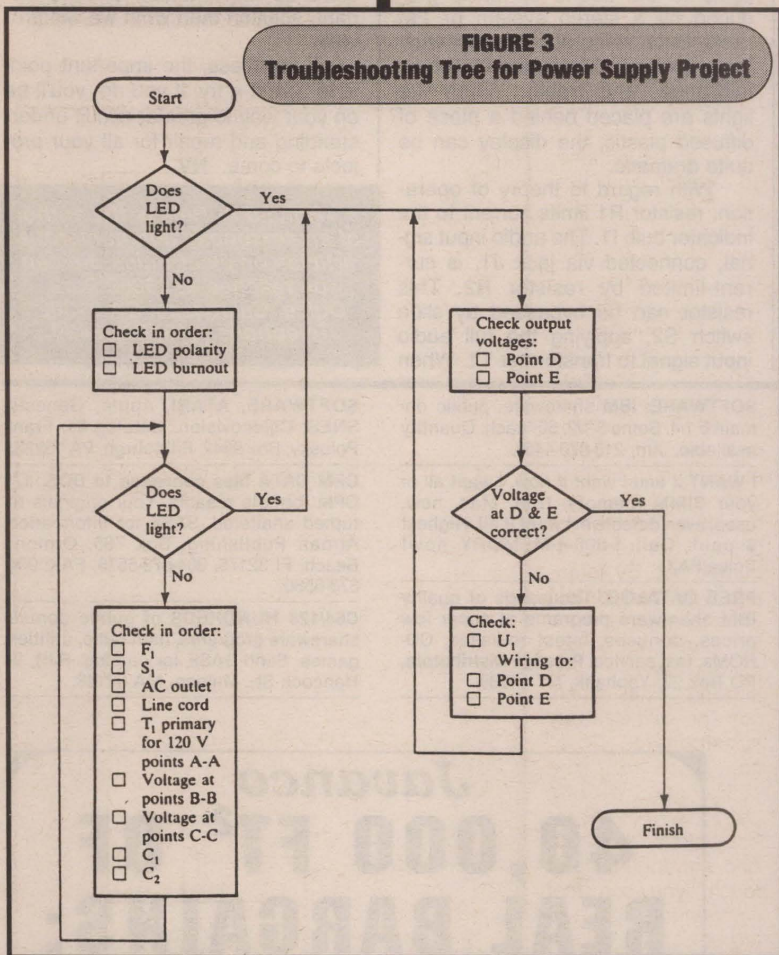


FIGURE 2
Schematic for Power Supply Project



useful, and what are its main elements.

Troubleshooting Tree Structure

A troubleshooting tree (also known as a troubleshooting flowchart) is essentially a traditional computer-type flowchart adapted to take a project builder step-by-step through every possible circuit problem. See Figure 3. When you have worked your way through the various procedures indicated, you should

wind up with a fully functioning project.

A troubleshooting tree is an invaluable troubleshooting tool because it represents a logical approach to finding the cause of circuit malfunctions. It is a process that says, in effect: "Do this, and if it does not correct the problem, do the next thing on the list. Keep proceeding until the problem is solved." Troubleshooting trees always have two properties. One, they present all possible problems that can occur.

Two, they present such problems, or faults, in a logical sequence. If your troubleshooting tree contains these two attributes, it is most likely drawn correctly and will function well as a troubleshooting aid.

The troubleshooting tree consists of the following five elements (Figure 1):

1. Action Block. Rectangular block in which is stated an action or actions to be taken. It has one input and one

output.

2. Decision Block. Diamond block in which a yes/no question is asked. It has one input and two outputs (yes or no).

3. Start/Finish Block. Elliptical block in which is placed the word "start" or "finish," as appropriate.

4. Flow Line. Line with an arrow indicating the direction to be taken between action and decision blocks.

5. Feedback Loops. Formed with a flow line from a decision block output (yes or no) to an action block input.

Let's apply these elements to the construction of a troubleshooting tree for a power supply project.

The Troubleshooting Tree Illustrated

As the complete schematic of Figure 2 shows, the power supply is designed to provide a fully regulated +5V and an unregulated +9 VDC. Line cord PL1 couples the 120 VAC from the wall socket, via fuse F1 and switch S1, to the primary of transformer T1. The transformer steps down the incoming voltage to approximately 9 VAC. Diodes D1-D4 produce full-wave rectification. LED D5, with its associated current-limiting resistor R1, gives a visual indication when the circuit is turned on. Capacitors C1 and C2 provide filtering and transient suppression, respectively. An LM7805 -5V regulator, U1, ensures a steady +5V at output D regardless of load conditions.

The troubleshooting tree for the power supply project is shown in Figure 3. Let's follow it from start to finish.

After preliminary inspection and check-out, we start and proceed to the first decision block of the troubleshooting tree. Here we are asked: Does the LED light? If the answer is yes, we proceed to another action block, as indicated. There we are told to check for correct output voltages at points D and E. We then

advance to a second decision block where we are asked: Are the output voltages at D and E correct? If the answer is yes, we head straight to the finish block — the project works. If the voltages are not correct, it is onto a new action block where we are instructed to check voltage regulator U1 and the wiring to points D and E. After each check, we loop back to the earlier action block, as indicated, and check for correct output voltages again. Eventually, we will get the proper voltages, break out of the loop, and proceed to the finish block.

If when we are first asked if the LED is lit, the answer is no, we proceed to a different action block, as indicated. Here we check for correct LED polarity and to see if the LED is burned out. Then it's forward to a new decision block that asks us again if the LED is lit. If it is, we proceed as delineated in the previous paragraph. If the LED is still not lighting, we advance to a final action block where we go through a series of component and voltage checks, in the order listed. After each check we loop back to the question: Does the LED light? Eventually the answer will be yes, and we proceed onto the section to the right, where we go through the previously discussed checks.

Cultivating Tips

Here are a half-dozen "cultivating," or design tips you will want to consider when developing your own project-specific troubleshooting tree:

One. Always start by determining exactly what your project is supposed to do. Keep in mind, that can often be more than one thing.

For example, our power supply project is actually supposed to do two things. One, it should turn on its LED indicator, and two, it should deliver +5V and +9VDC at points D and E, respectively.

Two. You should have at least as many decision blocks as you have things for the project to do. Looking at it another way, you will have a question for each function your project carries out. Again, examining the power supply project's troubleshooting tree we see two distinct decision blocks. (One of the three is actually repeated.) Thus two things to do, two questions to ask.

Three. Begin actual drawing with a branch or branches that lead as directly as possible to the finish, and thus a working project.

Four. Place a decision block immediately following the start elliptical block. Be optimistic, jump right off asking if the project works.

Five. One of the outputs of a decision block, usually the "no" out-

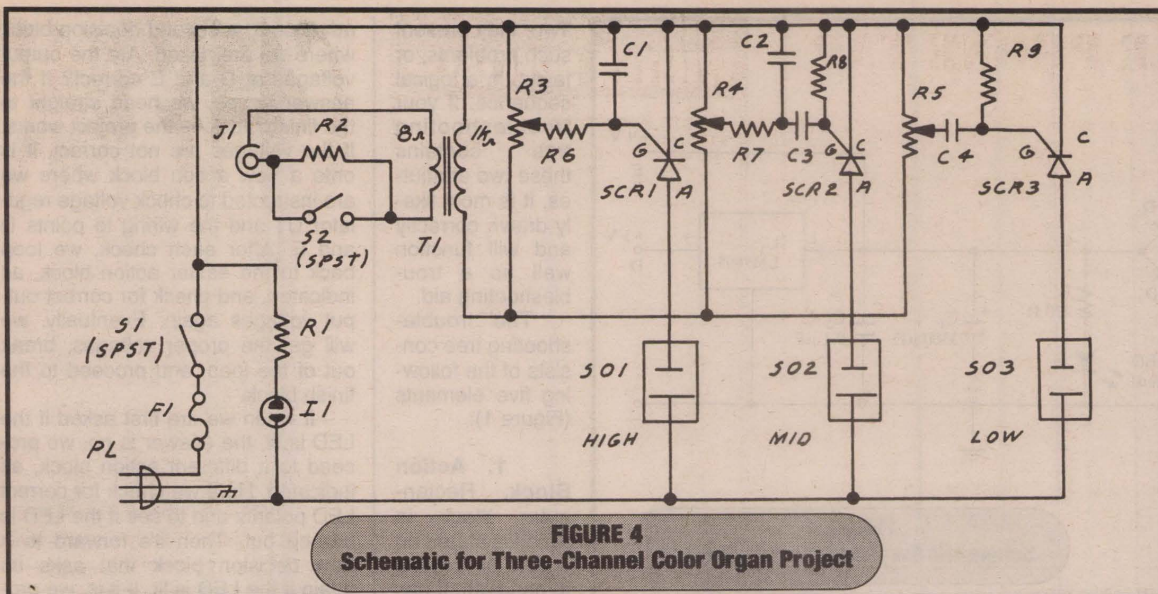


FIGURE 4
Schematic for Three-Channel Color Organ Project

put, often goes directly to an action block, where various procedures are taken to correct the problem.

Six. Keep in mind, creating a troubleshooting tree is often a matter of style. No two troubleshooting trees for the same project are likely to grow and branch in exactly the same way. The tree, like a computer program from which it derives its concept, can be tight, with as little detail as necessary, or open with every step and action delineated. Again, like a computer program, some trees are simply more elegant than others. That's okay. When you

design yours, just be sure the tree presents all possible faults and that they are shown in a logical sequence. Elegance will come with practice and experience.

Your Tree-Growing Challenge

Are you ready to try your hand at growing a project-specific troubleshooting tree? If so, simply pick a project and go for it. Or, we'll choose one for you. In Figure 4 we present the schematic of a moderately complex project — a Three-Channel Color Organ.

The color organ is a project that

flashes three strings of Christmas lights to the sound of music produced by a stereo system or FM radio. Each string of lights responds to a range of frequencies: bass, midrange, and treble. When the lights are placed behind a piece of diffused plastic, the display can be quite dramatic.

With regard to theory of operation, resistor R1 limits current to the indicator bulb I1. The audio input signal, connected via jack J1, is current-limited by resistor R2. This resistor can be bypassed by slide switch S2, applying the full audio input signal to transformer T1. When

the audio source provides a high input signal, S2 must be open; when a low-level signal is present, S2 is closed. T1 is used as a step-up transformer to provide sufficient audio levels to trigger SCRs 1, 2, and 3. Potentiometers R3, R4, and R5 are used as voltage dividers allowing for variable adjustment of the SCR trigger levels. Resistor R6 with capacitor C1 form a low-pass filter for frequencies below 500 Hz for SCR1 gate drive. Components R7, R8, C2, and C3 form a band-pass filter for frequencies between 500 and 3,000 Hz for SCR2 gate drive. Finally, capacitor C4 and resistor R9 form a high-pass filter for frequencies above 3,000 Hz for SCR3 gate drive.

Now you're ready to "grow" the project's troubleshooting tree. On page 137, you will find a tree for the Three-Channel Color Organ. It probably won't match yours exactly. And I have no doubt that some of you will come up with a better, or more elegant, solution than what we will provide.

Regardless, the important point is to give it a try. If you do, you'll be on your way to greater circuit understanding and repair for all your projects to come. **NV**

Ronald A. Reis is the author of six textbooks and numerous articles on electronics. He can be reached at 23052 Park Dulce, Calabasas, CA 91302. Telephone (818) 222-8439.

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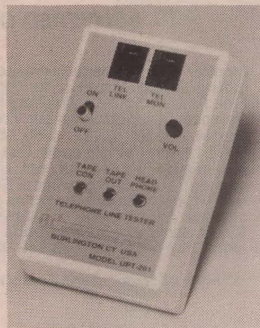
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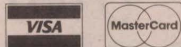
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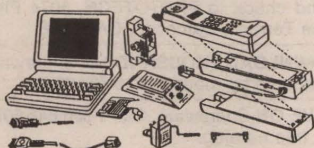
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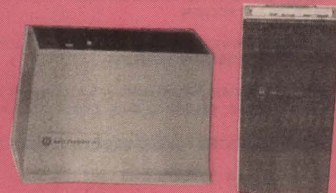
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Also: Panasonic TZ - PC 175 Series Converter w/volume. Topcases for Panasonic, SA and Jerrold (all models) also available. Call for pricing and availability.



Panasonic TZPC 145 **\$65**
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SA 8511 channel 3 **\$65**

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Capacitor	Cost	Capacitor	Cost
1uF - 50V	.06	3.3uF - 50	.06
100uF - 50V	.10	33uF - 35V	.06
100uF - 63V	.11	33uF 50V	.07
1000uF - 16V	.15	330uF - 50V	.14
1000uF - 50V	.30	330uF - 63V	.14
.22uF - 50V	.06	4.7uF - 50V	.07
22uF - 50 V	.06	47uF - 50V	.08
2200uF - 16V	.22	47uF - 63V	.08
600uF - 50V	.24	470uF - 50V	.19

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Pioneer T-20 **3.95**
SA T-20 **3.95**
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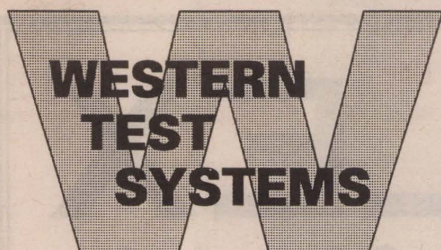
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TEK 5A18N 2 MHz Dual Trace Amplifier	\$125.00
TEK 5A19N 2 MHz Differential Amplifier	\$175.00
TEK 5B10N 2 MHz Time Base / Amplifier	\$100.00
TEK 7A13 100 MHz Differential Comparator Amp., LED display	\$400.00
TEK 7A18 75 MHz Dual Trace Amplifier	\$100.00
TEK 7A22 1 MHz High CMRR Differential Amplifier	\$400.00
TEK 7B53A 100 MHz Dual Time Base	\$200.00
TEK R7704 100 MHz Quad Trace	\$600.00
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TEK SC502 15 MHz Dual Trace Oscilloscope plug-in, TM500 series	\$375.00

ABOVE 100 MHz

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TEK 7904 500 MHz 4-slot frame	\$500.00
TEK 7904 500 MHz System, with 7A24, 7A26, 7B92A	\$1,100.00
TEK 7904 500 MHz System, with 7A24, 7A26, 7B80, 7B85	\$1,100.00
TEK 7A24 400 MHz Dual Trace Amplifier	\$450.00
TEK 7A26 200 MHz Dual Trace Amplifier	\$250.00
TEK 7A29 1 GHz Single Channel Amplifier	\$850.00
TEK 7B10 1 GHz Time Base	\$500.00
TEK 7B15 1 GHz Delaying Time Base	\$600.00
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TEK 7B85 400 MHz Delta Delaying Time Base	\$250.00
TEK 7B87 400 MHz Time Base, with pretrigger acquire clock (7B54)	\$250.00
TEK 7B92A 500 MHz Dual Time Base	\$450.00

STORAGE

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TEK SC503 10 MHz Dual Trace	\$700.00
Storage Oscilloscope, TM500 series	

DIGITAL

TEK 2201 20 MHz Analog & Digital Oscilloscope, 20 MS/s	\$1,300.00
TEK 468 100 MHz Analog / 10 MS/s Digital Oscilloscope	\$1,300.00
TEK 7D20/R7603 Programmable	\$1,300.00
Digitizer w/frame, 10 MHz 1-shot/70 MHz rep	

SAMPLING

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TEK 7S11 Sampling Unit	\$450.00
TEK 7S14 1 GHz Dual Channel Sampling Unit	\$700.00
TEK 7T11 Sampling Sweep Unit	\$950.00
TEK R7603 1 GHz Dual Trace Sampling system, w/7S14	\$750.00

CALIBRATION

TEK SG503 Levelled Sine Wave Generator, 0.25-250 MHz, TM500 series	\$850.00
TEK TG501 Time Mark Generator, 1nS-5S, TM500 series	\$750.00

WAVEFORM GENERATORS

FUNCTION

HP3310A 5 MHz Function Generator	\$325.00
HP3310B 5 MHz Function Generator, monocyte & burst operation	\$425.00
SYNTEST SI-102 TTL Clock	\$150.00
Synthesizer, 0.1 Hz-16 MHz, 6 decade resol.	
TEK DD501 Digital Delay & Burst Gen., for function & pulse gen's	\$375.00
TEK FG502 11 MHz Function Generator, TM500 series	\$325.00
TEK FG504 40 MHz Function Generator, TM500 series	\$875.00
TEK RG501 Ramp Generator, TM500 series	\$225.00
WAVETEK 132.2 MHz VCG / Noise Generator	\$600.00
WAVETEK 135.2 MHz Lin/Log	\$275.00
Sweep/Function Generator, tone burst	
WAVETEK 148.20 MHz Function Generator, AM/FM/PM modulation	\$700.00
WAVETEK 166.50 MHz Pulse/Function Generator	\$1,250.00

PULSE

HP214B 10 MHz Pulse Generator, 50 V/50 Ohms, auto duty cycle	\$2,250.00
HP8004A 10 MHz Pulse Generator, double pulse & offset	\$250.00
HP8005B 20 MHz Dual Output Pulse Generator	\$400.00
HP8012B 50 MHz Pulse Generator	\$600.00
HP8080A/81A/82A/83A 300 MHz Word Generator	\$900.00
HP8080A/91A/92A/93A 1 GHz Dual Channel Pulse Generator	\$1,650.00
HP8080A/91A/92A/93A 1 GHz Single Channel Pulse Generator	\$1,400.00
HP8080A/91A/93A 1 GHz Clock Generator	\$900.00
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PHILIPS PM5785B 125 MHz	\$1,100.00
Dual Output Pulse Gen., burst mode, 1 nS Tr	
TEK PG501 50 MHz Pulse Generator, TM500 series	\$300.00
TEK PG502 250 MHz Pulse Generator, Tr<1nS, TM500 series	\$700.00
TEK PG505 100 kHz Pulse Generator, 80V, TM500 series	\$275.00
WAVETEK 801 50 MHz Pulse Generator	\$550.00

PROGRAMMABLE

HP8165A Programmable Signal Source, 1 MHz-50 MHz	\$2,600.00
TEK AWG510 Arbitrary Waveform Generator, 50 MS/s, 12 bits	\$3,000.00
TEK AWG5105-opt.02 Arbitrary	\$4,250.00
Waveform Generator, dual channel option	

TEK PFG5505 Programmable 12 MHz Pulse/Function Generator	\$1,275.00
WAVETEK 278-opt.02 12 MHz Programmable	\$1,500.00
Synthesized Function Gen., GPIB	

VOLTAGE & CURRENT

VOLTMETERS

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KEITHLEY 181 6-1/2 digit Nanovoltmeter, 10 nV sensitivity, GPIB	\$1,500.00
SOLARTRON 7150 5-1/2 / 6-1/2 digit Multimeter, GPIB	\$550.00
TEK DM511-opt.02 4-1/2 Digit DMM, w/P6602 Temp. Probe, TM500 (NEW/BOXED)	\$395.00

CALIBRATION

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FLUKE 752A DC Reference Divider	\$2,500.00
VALHALLA 2703 AC Voltage Calibrator, 0-1200 VRMS, 10 Hz-100 kHz	\$2,200.00

VOLTAGE SOURCES

HP6114A Precision Dual Range Power Supply, 20 V 2 A / 40 V 1 A	\$875.00
HP6115A Precision Dual Range Power Supply, 50V 0.8A / 100V 0.4A	\$875.00

CURRENT METERS & SOURCES

HP428B DC Clip-on Milliammeter, 1 mA-10 A f.s.	\$350.00
HP6177C DC Current Source, to 50V, 500mA	\$600.00
HP6181C DC Current Source, to 100 V, 250 mA	\$675.00
HP6186C DC Current Source, to 300V, 100mA	\$750.00
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KEITHLEY 225 Current Source, 1 nA-99.9 mA, 10-100 V compliance	\$450.00
KEITHLEY 642 Electrometer	\$3,900.00
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TEK CT-5 High Current Transformer for P6021/A6302, to 1000A	\$650.00

IMPEDANCE & COMPONENT TEST

LCR

BALLANTINE 3205A 4 digit Micro-Ohmmeter	\$875.00
BOONTON 62AD 1 MHz Inductance Meter, 2-2000 uH	\$700.00
BOONTON 72BD 1 MHz Digital Capacitance Meter, 2-2000 pF	\$700.00
E.S.I. 296V 4-1/2 Digit LCR Bridge, 120 Hz & 1 kHz	\$850.00
GR 1666 DC Resistance Bridge, 1 micro-ohm - 100 kilohms	\$1,000.00
GR 1689-M RLC Digibridge	\$2,500.00
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HP4329A High Resistance Meter, 500K ohm-2x10E16 ohm, 10-1000V	\$1,350.00
HP4342A Q Meter, 22 kHz-70 MHz, Q=5-1000	\$2,250.00
MEGURO MQ-171 VHF Q Meter, 20-230 MHz, Q=10-500, freq. readout 100 Hz	\$1,100.00

STANDARDS

E.S.I. RS-9259-Decade Resistor, 0.01 ohm-1.2 Megohm	\$2,000.00
E.S.I. SR1010 Resistance Transfer Standards, 1 ohm-100 K/step	\$800.00
FLUKE 5450A Programmable Resistance Standard, 2 & 4 wire	\$2,750.00
GR 1409-SERIES Standard Mica Capacitors, 0.05% accuracy	\$150.00
GR 1432-N 5-Decade Resistor, to 11,111 ohms, 0.1 ohm res.	\$275.00
GR 1432-U 4-Decade Resistor, 0-111.1 ohms, 0.01 ohm resolution	\$175.00
GR 1433-X 6-Decade Resistor, to 111,111.0 ohms, 0.1 ohm res.	\$550.00
HP16470B Stable Inductors, set of 4	\$500.00
LEEDS & NORTHROP 4220-SERIES Milliohm Standards	\$650.00

CURVE TRACERS

TEK 577D1/177 Storage Curve Tracer, with standard test fixture	\$2,250.00
TEK 7C11N Curve Tracer, to 0.5W, 7000 series	\$500.00

TDR

TEK 1502-opt.04 Time Domain Reflectometer, 0-2,000 feet, chart recorder	\$2,250.00
TEK 1503-opt.04 Time Domain Reflectometer, 0-50,000 feet, chart recorder	\$2,000.00

POWER SUPPLIES

SINGLE OUTPUT

GLASSMAN PS/EG-05R05 5KV CV/CL Power Supply, to 6mA	\$500.00
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HP6038A Autoringing Power Supply, 0-60 V / 0-10 A / 240 W, HP1B	\$1,750.00
HP6206B Dual Range Power Supply, 30 V at 1 A / 60 V at 0.5 A	\$250.00
HP6207B 180 V at 200 mA CV/CC Power Supply	\$300.00
HP6259B-026 10V at 50A CV/CC Power Supply	\$500.00
HP6260B-027 10V at 100A CV/CC Power Supply	\$675.00
HP6261B-027 20 V at 50 A CV/CC Power Supply	\$675.00
HP6263B 20 V at 10 A CV/CC Power Supply	\$400.00

HP6264B-011 20 V at 20 A CV/CC	\$500.00
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HP6267B 40 V at 10 A CV/CC Power Supply	\$550.00
HP6268B 40 V at 30 A CV/CC Power Supply	\$850.00
HP6289A 40 V at 1.5 A CV/CC Power Supply	\$250.00
HP6296A 60V at 3A CV/CC Power Supply	\$400.00
HP6299A 100 V at 750 mA CV/CC Power Supply	\$250.00
HP6384A 4.0-5.5 V at 8 A CV/CL Power Supply	\$175.00
HP6438B 60V at 5A CV/CC Power Supply	\$375.00
KEPCO JOE-36-15M 36 V at 15 A CV/CC Power Supply	\$375.00

MULTIPLE OUTPUT

HP6253A Dual Output 20 V 3 A CV/CC Power Supply	\$500.00
HP6255A Dual Output 40 V 1.5 A CV/CC Power Supply	\$500.00

MISCELLANEOUS

ACME PS2L-1000 Programmable Load, to 75V / 150A / 1000 Watts	\$450.00
ELGAR 121B/401V AC Power Source, 0-135 V, 120 W, 45 Hz-10 kHz	\$650.00
HP59501A HP1B Isolated DAC/Power Supply Programmer	\$175.00
HP6827A Bipolar Power Supply/Amplifier, to 100 V, 500 mA	\$800.00
KEPCO BOP 36-5M Bipolar Op Amp/Power Supply, to 36 V, 5 A	\$550.00
KIKUSUIPLZ-72W Programmable Load, 4-110 V, 0-12 A, 70 W max.	\$200.00

TIME & FREQUENCY

UNIVERSAL COUNTERS

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HP5315A 100 MHz/100 nS Reciprocal Counter, high res. audio	\$550.00
HP5315A-001 100 MHz/100 nS Universal Counter, TCXO reference	\$650.00
HP5316A 100 MHz/100 nS Universal Counter, HP1B	\$750.00
HP5316A-003 100 MHz/100 nS Universal Counter, HP1B, 1.0 GHz C-chan.	\$1,000.00
HP5370B-001 100 MHz Univ. Time Int. Counter, 20 pS single shot, OCXO	\$2,250.00
HP51420A-010, 030VXI card 200 MHz/2 nS Univ. Counter, TCXO & 2.5 GHz C-ch	\$1,500.00
RACAL-DANA 1992-04E, 55 100 MHz/10 nS Univ. Counter, 1.3 GHz C-ch, OCXO, GPIB	\$950.00
TEK 7D15 225 MHz Universal Counter/Timer, 7000 series	\$275.00
TEK DC5004 Programmable 100 MHz/100nS Counter/Timer, TM5000 series	\$475.00
TEK DC5009-opt.01 Programmable 135 MHz Univ. Counter/Timer, TCXO, TM5000	\$750.00
TEK DC5010 350 MHz/3.125 nS Univ. Counter, TM5000 series	\$1,200.00
TEK DC503A 125 MHz Universal Counter/Timer, TM5000 series	\$500.00
TEK DC509 135 MHz High Resolution Universal Counter/Timer, TM500	\$700.00

FREQUENCY COUNTERS

EIP 545-opt.05, 08 18 GHz Frequency Counter, OCXO and GPIB	\$1,875.00
FLUKE 7220A-opt.111 1.3 GHz Communications Counter, TCXO option	\$650.00
HP5305B/5300B-001 1.3 GHz Counter Package w/TCXO ref., high res. audio	\$450.00
HP5340A-001, 006 18 GHz Frequency Counter, OCXO, +39 dBm limiter	\$1,900.00
HP5340A-001, 011 18 GHz Frequency Counter, OCXO reference, HP1B	\$1,900.00
HP5342A-01, 04, 05, 11 24 GHz Frequency Counter, OCXO, DAC, and HP1B	\$3,900.00
HP5345/5355/5356A-006 Pulsed/CW Frequency Counter, 0.4-18.0 GHz, 75 nS pulse	\$3,500.00
SYSTRON-DONNER 605-4B 24 GHz Frequency Counter	\$1,875.00
SYSTRON-DONNER 605-4B opt.05, 26.25 GHz Frequency Counter, GPIB	\$2,400.00
TEK 7D14 525 MHz Frequency Counter, 7000 series	\$175.00
TEK DC502 550 MHz Frequency Counter, TM500 series	\$400.00
TEK DC504 80 MHz Frequency Counter	\$125.00

STANDARDS

AUSTRON 1250A Crystal Frequency Standard, 0.1 / 1.0 / 5.0 MHz, AC/batt.	\$900.00
HP5087A-031 Distribution Amp., 0.1 / 1.0 / 5.0 MHz x 4 channels each	\$1,800.00

AUDIO & BASEBAND

SPECTRUM ANALYZERS

HP3580A-002 Spectrum Analyzer, 5 Hz-50 kHz, 1 Hz res., bal. input	\$1,850.00
HP3581A Wave Analyzer, 15 Hz-50 kHz	\$900.00
HP3586C Selective Level Meter, 50 Hz-32.5 MHz, 50 & 75 ohms	\$1,750.00
HP8556A LF Section, 20 Hz-300 kHz	\$500.00
TEK 7L5-opt.25/7603 Spectrum Analyzer, 20 Hz-5 MHz, w/tracking gen, display	\$2,250.00

DISTORTION ANALYZERS

HP334A Distortion Analyzer, 5 Hz-600 kHz, -60 dB, auto nulling	\$550.00
HP339A Distortion Analyzer, built-in low distortion osc.	\$2,400.00
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HP3400A RMS Voltmeter, 10 Hz-10 MHz	\$250.00
HP400FLAC Voltmeter, 100 uV-300 V f.s., 20 Hz-4 MHz	\$200.00

OSCILLATORS

FLUKE 6011A Synthesized Signal Gen., 10 Hz-11 MHz, 10 Hz res.	\$1,200.00
HP209A Sine/Square Wave Generator, 4 Hz-2 MHz, 5 VRMS max.	\$225.00
HP3335A Synthesizer/Level Generator, 200 Hz-80 MHz	\$3,250.00
HP4204A Synthesizer, 10 Hz-1 MHz, 1 mV-30 V/600 Ohms	\$350.00
HP652A Test Oscillator, 10 Hz-10 MHz	\$300.00
ROCKLAND 5100 Synthesizer, 1 mHz-1.999999999 MHz	\$400.00

FILTERS, MISCELLANEOUS

KROHN-HITE 3202 Dual High-Pass/Low-Pass Filter, 20 Hz-2 MHz, 24 dB/oct	\$600.00
KROHN-HITE 3342 Dual HP/LP Filter, 0.01 Hz-99.9 kHz, 48 dB/octave	\$1,100.00
KROHN-HITE 3343 Dual HP/LP Filter, 0.01 Hz-99.9 kHz, 48 dB/octave	\$950.00
P.A.R. 189 Filter/Amplifier, 0.1 Hz-110 kHz, variable Q & gain	\$400.00
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

HP11517A/18A/19A/20A Harmonic Mixer, 12.4-40.0 GHz, for 8555A, 8565A	\$700.00
HP11970U WR19 Harmonic Mixer, 40-60 GHz	\$1,400.00
HP5371A Modulation Domain Analyzer, 125 mHz-500 MHz	\$5,900.00
HP8406A Comb Generator, 1/10/100 MHz increments, to 5 GHz	\$450.00
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
HP8554B/8552B/141T Spectrum Analyzer, 100 kHz-1250 MHz, 100 Hz resolution	\$2,000.00
HP8555A RF Section, 0.01-18 GHz	\$950.00
HP8555A/8552B/141T Spectrum Analyzer System, 10 MHz-18 GHz, 100 Hz res.	\$2,250.00
HP8558B/181T Spectrum Analyzer, 0.1-1500 MHz, 1 kHz res., w/display	\$2,250.00
HP8559A/181T Spectrum Analyzer, 0.01-21 GHz, 1 kHz res., w/display	\$4,500.00
TEK 496P Spectrum Analyzer, 1 kHz-1.8 GHz, 30 Hz res., GPIB	\$5,500.00
TEK 7L18/7603 Spectrum Analyzer, 1.5-18.0 GHz, 30 Hz res., w/display	\$3,400.00
TEK TR503 Tracking Generator, 0.1-1800 MHz, for 492/4/5/6	\$1,750.00

NETWORK ANALYZERS

HP11665B Modulator, 0.15-18.0 GHz, for use with 8755/6/7	\$375.00
HP8407A/8412A/8601A Network Analyzer, 100 kHz-110 MHz, with sweep generator	\$1,250.00
HP85020A Directional Bridge, 0.01-4.3 GHz, N(f), for 8755/6/7	\$750.00
HP85021A Directional Bridge, 0.01-18.0 GHz, APC7, for 8755/6/7	\$1,200.00
HP85021C 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/11666A-02/181T Scalar Network An. w/dir. bridge, 10 MHz-18 GHz & frame	\$1,750.00
NARDA 7000A/7202/7206 Microwave Multimeter System: scalar analysis 0.1-18 GHz	\$1,950.00
WILTRON 5601 3x/7550 Scalar Network Analyzer, w/3 detectors, 0.01-18.5 GHz	\$2,000.00
WILTRON 5601 560-98K50 Scalar Network Analyzer, w/VSWR Autotester 0.01-40 GHz	\$2,950.00

SIGNAL GENERATORS

BOONTON 1020 Synthesized Signal Gen., 0.15-540 MHz, GPIB	\$1,850.00
BOONTON 102C Signal Generator, 0.45-520 MHz, AM, FM	\$850.00
COMSTON FS-2000-4 Synthesizer, 10 MHz-4 GHz, 1 uS speed, -140 dB noise	\$15,000.00
FLUKE 6060A/AN Synthesized Signal Gen., 10 kHz-520 MHz, 10 Hz res, GPIB	\$2,000.00
GIGATRONICS 875/86 Levelled Multiplier, 26.5-40.0 & 50.0-75.0 GHz outputs	\$8,000.00
HP85100V Frequency Mult., 10-15 GHz in / 50-75 GHz out >0 dBm	\$4,250.00
HP8614A Signal Generator, 0.8-2.4 GHz, AM, FM, Pulse	\$550.00
HP8654A Signal Generator, 10-520 MHz, metered AM/ unmetred FM	\$650.00
HP86601A RF Plug-In, 10 kHz-110 MHz, for 8660 series	\$650.00
HP8660C/86602B/86633B Synthesized Signal Generator, 1-1300 MHz, AM, FM, GPIB	\$2,750.00
HP8660C/86603A-002/34A Synthesized Sig. Gen., 1-2600 MHz, phase mod. to 10 MHz	\$4,500.00
HP8683B Signal Generator, 2.3-6.5 GHz, AM, WBFM, Pulse	\$5,000.00
HP8684B Signal Generator, 5.4-12.5 GHz, AM, WBFM, Pulse	\$5,000.00
ROHDE & SCHWARTZ SMK Signal Gen., 10 Hz-140 MHz, -130 dBc/20 kHz phase noise	\$1,750.00

WILTRON 6742A Synthesizer/Sweep Generator, 18.0-26.5 & 26.5-40.0 GHz	\$9,000.00
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SWEEP GENERATORS

EIP 928-opt.9201 Sweep Gen., 1.0-18.6 GHz, step atten., power sweep, GPIB	\$4,000.00
HP8601A Generator/Sweeper, 0.1-110 MHz, +20 dBm levelled	\$500.00
HP8620C Sweep Oscillator Frame	\$550.00
HP8620C-011 Sweep Oscillator Frame, GPIB programmable	\$675.00
HP86210A RF Plug-In, 3-350 MHz, +13 dBm levelled	\$450.00
HP86220A RF Plug-In, 10-1300 MHz, +10 dBm levelled	\$850.00
HP86222A RF Plug-In, 0.01-2.4 GHz, +13 dBm levelled	\$1,400.00
HP86222A-002 RF Plug-In, 10-2400 MHz, 70 dB step attenuator	\$1,750.00
HP86222B-002 RF Plug-In, 10-2400 MHz, crystal markers, 0-70 dB atten	\$1,950.00
HP86235A RF Plug-In, 1.7-4.3 GHz, +16 dBm unlevelled	\$600.00
HP86240A RF Plug-In, 2.0-8.4 GHz, +16 dBm unlevelled	\$950.00
HP86241A-001 RF Plug-In, 3.2-6.5 GHz, +8 dBm levelled	\$500.00
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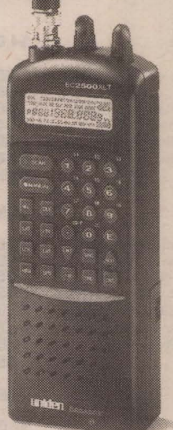
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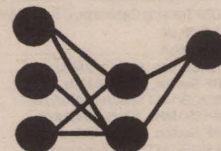
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OPEN CHANNEL

by
Harry Helms

Cheap, Legal RF for Fun and Profit

If you want to operate most radio transmitters in the United States, you need a station license (and often an operator's license) from the Federal Communications Commission. The FCC assigns call letters for licensed stations and has strict operating rules for them. If you feel like doing something not provided for in the rules, you've got a real problem!

However, there is one provision that allows anyone to set up their own radio station and do pretty much whatever they please — broadcast, conduct two-way communications, set up data links and telemetry, operate a beacon — in a variety of modes and with any call sign of their own choosing. You can operate on the AM and FM broadcasting bands, the upper end of the 30 to 50 MHz band tuned by scanners, and even the long-wave range as low as 160 KHz. It also offers a way for *Nuts & Volts* readers to turn their tinkering skills into cold, hard cash.

Sound too good to be true? Well, it is true — but there is a big catch.

Part 15 Is The Ticket

The section of the FCC rules that make unlicensed broadcasting possible is known as Part 15. The actual rules are scattered across FCC volumes, but Part 15 has become a convenient shorthand for all legal unlicensed radio operations other than CB.

The catch is the power levels permitted. The "standard" for Part 15 operation is a transmitter power of 100 milliwatts, or one-tenth of a watt. Technical standards since then have been tightened and refined (for example, allowable power now depends on field strength on FM rather than transmitter input power), but Part 15 operation is still "micropower." The maximum permitted transmitter power is one watt in the 160 to 190 KHz range, 100 milliwatts on the AM broadcast band, and only a fraction of a watt on the FM broadcast band and 49 MHz. Nor do you get much of a break when it comes to antennas. You are generally restricted to short single-element antennas (like telescoping "whip" types) with a length varying by frequency range. The combination of low transmitter power and short antennas means your usual range on the AM and FM bands is 200 feet or less on typical receivers.

So why bother? One good reason is that Part 15 range can be extended through certain tricks, such as favorable location of the transmitter, smart frequency selection, and improving receiving gear. Another is that Part 15 lets you experiment with a variety of weak-signal modes (like continuous wave) to extend range. Finally, I'm con-

vinced that Part 15 offers more entrepreneurially inclined radio hobbyists with some unique money making opportunities!

Frequency Ranges and Gear

One big surprise you get when you examine the regulations in Part

15 is that unlicensed "operation" is permitted on numerous frequency ranges, such as around 13.5 MHz. This is because the original intent of Part 15 was to legalize incidental radio emissions from scientific and medical devices. Today, Part 15 also covers things like radio energy emitted by television sets and personal computers. However, Part 15 regulations make intentional communications impractical on any frequencies other than 160 to 190 KHz, the AM broadcast band, the FM broadcast band, or the 49 MHz "free band." The 160 to 190 KHz has been discussed in an earlier "Open Channel" column; it's mainly a band for hardcore experimenters due to the high level of electrical noise and poor propagation on those frequencies.

The tightened technical specs for Part 15 have actually made communications tougher on the AM and FM broadcasting bands. While it's common to still see Part 15 transmitters for those bands called "100 milliwatt" units, the actual allowable transmitter powers are usually somewhat less on 49 MHz and the FM broadcast band under the new field strength standards; most legal Part 15 transmitters for those frequencies have input powers of 50 to 75 milliwatts. However, you have little to worry about as a user if your transmitter power is a little over the FCC's standards so long as you don't cause interference to a licensed station.

The stricter technical standards have had the unfortunate affect of taking away one of the favorite tricks of earlier Part 15 experimenters. One tighter specification actually limits the length of any connecting cable between your microphone and the Part 15 transmitter! This new requirement came about because several clever Part 15 experimenters in the 1960s and 1970s came up with the notion of mounting the transmitter unit separately atop a building or tower and linking it via a cable to a "control point" inside a home where the microphone, audio circuitry, and power supply would be located. The greater elevation of the remote transmitter unit would allow it to cover a greater area, especially on the FM broadcast band. One manufacturer, International Crystal, even came out with an entire line of Part 15 transceivers for AM, FM, CB, and even 160 to 190 KHz during the mid-1960s. Unfortunately, the popularity of Part 15 "walkie-talkies" on the CB channels resulted in the

FCC establishing the more restrictive Part 15 rules we are stuck with today.

Home construction of Part 15 transmitters was popular back in the 1960s and 1970s. However, most were crude "wireless microphones" not suitable for real broadcasting. Fortunately, there are a lot of Part 15 transmitter kits and finished units available from companies advertising here in *Nuts & Volts*. This new Part 15 equipment has a lot of advantages over the older stuff. For example, several FM band transmitters today are capable of broadcasting in stereo and have line level-compatible inputs suitable for use with microphones, tape decks, etc. A complete list of Part 15 resources is given in Table 1.

Part 15 gear for the 49 MHz is available from toy stores to electronics shops (those walkie-talkies for kids are prime examples!). While it's possible to build your own 49 MHz transmitter, it's usually much simpler to modify an existing 49 MHz walkie-talkie. Almost all of these units use narrow-band FM (no more than 5 KHz deviation), so you'll be forced to build your own if you want to use another form of modulation. Fortunately, low-power oscillator circuits for the 50 to 54 MHz ham band are fairly common and can be found in ham radio reference books and back issues of various ham radio magazines. These circuits are simple (usually involving one transistor) and permit use of modes such as AM, CW, and single-sideband (SSB).

Squeezing Out More Range

The limitations of transmitter power and antenna, plus the effective prohibition on using a remote transmitter, are serious impediments if you want to cover a wide area with your Part 15 signal. However, there are some ways around them and remarkable results can be achieved. For example, Rex Wilson of Kingman, AZ, operates a beacon transmitter on 1631 KHz. This beacon repeats the call letters "TI" continuously in Morse code using CW. The transmitter power is only 100 milliwatts and his antenna is a loaded vertical only 10 feet long. Despite this, his beacon is a regular most winter nights at my location near San Diego and Rex has received correct reception reports from Hawaii and Illinois! Similar beacons have been heard at distances of well over 1,000 miles.

What are the secrets of maximizing the range of Part 15 microwatts? One obvious one is elevation, even at AM band frequencies. Rex Wilson's Kingman location is on the high plains of northern Arizona at an elevation in excess of a mile. The higher you can get a Part 15 transmitter into the air, the greater your coverage area will be. Maybe you can't operate from a mountaintop location, but you will be amazed at the improved range you can get just by moving the transmitter from a ground level location to somewhere like the

The Low and Medium Frequency Scrapbook by Ken Cornell. The "bible" of Part 15 operation on longwave (160 to 190 KHz) and the AM broadcast band. Antennas, transmitters, test equipment — the whole enchilada! Available from radio book dealers or directly from the author at 225 Baltimore Ave., Point Pleasant Beach, NJ 08742.

Curry Communications, 737 North Fairview St., Burbank, CA 91505, offers a transmitter kit for the 160 to 190 KHz range.

LF Engineering, 17 Jeffery Road, East Haven, CT 06513, offers transmitter kits and accessories for the 160 to 190 KHz range.

Ramsey Electronics, 793 Canning Parkway, Victor, NY 14564, manufactures AM

and FM transmitter kits. Available directly or through many *Nuts & Volts* advertisers.

PAN-COM International, P.O. Box 130, Paradise, CA 95967, has several transmitter kits for AM, FM, and longwave, in addition to publications relating to Part 15.

The Lowdown Bulletin Board System, with sections devoted to part 15 experimentation, especially on AM and longwave. This 2400 baud system can be reached from 7:00 p.m. to 8:00 a.m. Eastern time on weekdays and 24 hours on weekends at (607) 672-0360.

Resources for Part 15 "Microcasting" Table 1

OPEN CHANNEL

second story of a house or top of a building.

A more subtle secret of successful Part 15 operators is the use of a good ground plane. Rex Wilson's antenna is mounted atop a mobile home. The mobile home has a metallic shell, and the roof forms an excellent ground plane for his antenna. Part 15 regulations prohibit the use of multi-element antennas or elaborate ground systems that are part of the antenna (like a vertical with several ground radial wires), but says nothing about installing the antenna above a "natural" ground plane like a metal roof. Thus, it's legal to locate your Part 15 transmitter on a metal table or even in the middle of a sheet of corrugated metal and you'll probably get a significant improvement in your coverage area.

Finally, there is one way around the limitation on the distance between the microphone (or other audio source) and Part 15 transmitter — locate your audio source at the transmitter itself and place the transmitter at the base of your antenna! Rex Wilson has his transmitter and its keying circuit outdoors in a weather-sealed housing next to his antenna. The transmitter is connected directly to his antenna, eliminating any loss in a transmission line.

Keep in mind that Part 15's antenna restrictions only apply to transmitters. You can use whatever you want for reception, and increasing your receiving capabilities is a great way to increase the coverage area of a Part 15 transmitter. (Those who manage to hear Rex Wilson's beacon at considerable distance all use high-performance receivers and antennas.) Most cordless phones today operate today around 46 and 49 MHz under standards similar to those for Part 15. If you have a scanner receiver with an outside antenna, you've no doubt

heard both handset and base units around those frequencies, often at a considerable distance. You can do the same thing on the AM and FM bands.

Applications of Part 15

So how can you put Part 15 to use for fun and profit?

Beacons and telemetry transmitters are one obvious application. Part 15 transmitters consume relatively little power, making battery or solar cell power supplies practical. Part 15 transmitters are small, light, and can be easily sealed to keep out moisture. Their small size means it is easy to transport them to a remote location (such as the top of a mountain or building) and install them. Getting an acceptable audio source can be a problem, though. If you can install your Part 15 transmitter on top of a building and there's a source of AC power, you could use a tape deck or other source of high quality audio. But if your transmitter is installed in the sticks, you'll need an audio source that also consumes little power. One solution used with beacon stations is an "identifier" circuit of the sort developed for ham radio repeater stations. These circuits use digital logic ICs to turn the transmitter on and off to form call letters in Morse code. This helps conserve battery life, since the transmitter is "on" and consuming power only during the period when the identifier circuit triggers it. Other circuits could be used to "trigger" the transmitter, such as a temperature, motion, or vibration sensor. The outputs of these "sensing" transmitters could be received on ordinary AM and FM radios, forming the heart of an inexpensive security or monitoring system. (Those "baby room" monitors are nothing more than Part 15 transmitters operating on 49 MHz, after all.)

And this brings us back to the "profit" part of this month's title. There are a lot of possible applications of

Part 15 technology, and some clever and entrepreneurial *Nuts & Volts* readers might be able to cash in on them.

One possible application is in real estate sales. Have you ever driven by a house for sale or new housing development and seen a sign giving a phone number to call for more information? You probably would like more information about the house before talking to an actual sales agent. Now imagine that the house had a sign out front telling you to tune to 91 MHz FM or 1610 on the AM dial for more information. You could tune your radio to that dial spot and hear a continuous tape loop describing the home and its features. In the same manner, Part 15 transmitters could provide motorists with information regarding yard and garage sales, special events, sales promotions at shopping centers or car dealerships, etc. (To be honest, there have been some efforts already to adapt Part 15 technology for these purposes, but usually the proposed systems are expensive.) A *Nuts & Volts* reader with a few Part 15 transmitters and tape decks with continuous loop cassettes could set up a nice little business producing custom messages and renting and installing the transmitters.

Are you more interested in being a disc jockey? I'm willing to bet that many special events attracting the public would be willing to "rent a radio station" for that event. You could provide some entertainment for the event along with special announcements relating to parking, lost kids, changes in schedule, etc. Mobile DJ services providing party music are popular, and I'll bet there is some angle for offering to broadcast the party to the neighborhood in addition to providing the music.

I've been wrong about a lot of stuff before, so don't take this as gospel. But I really have this notion that some enterprising souls could start a nice little business based upon Part 15 microtransmitters. I'm already working on a couple of ideas myself and I'll report on my efforts in a future issue of *Nuts & Volts*. **NV**

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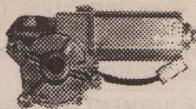
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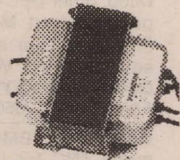


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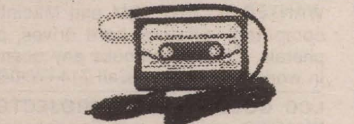
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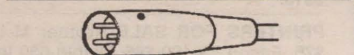
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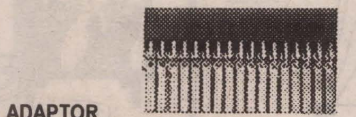
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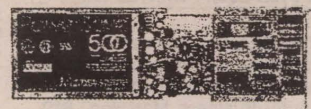
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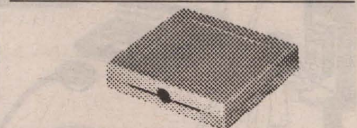
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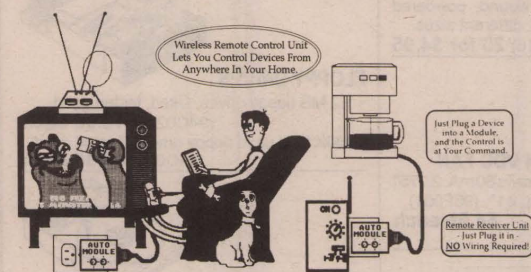
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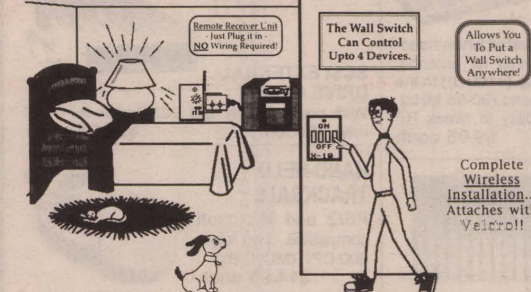
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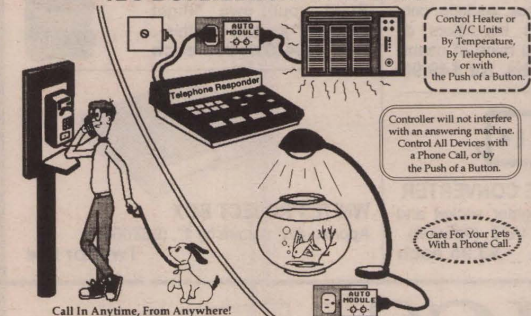
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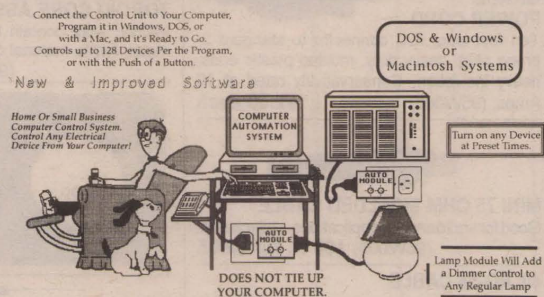
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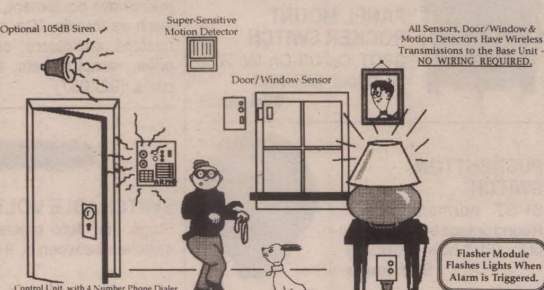
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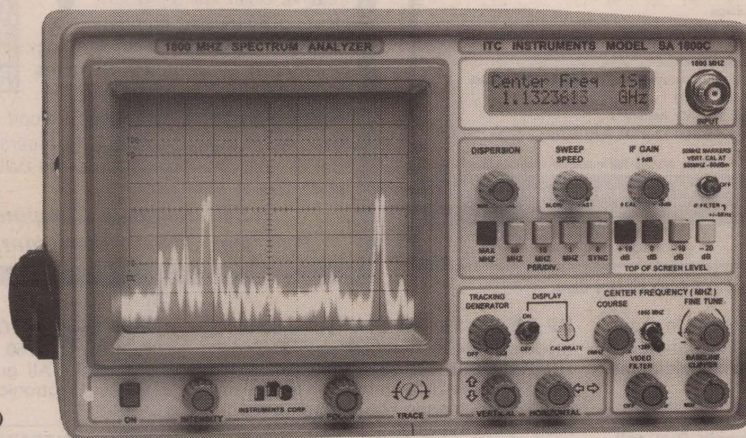
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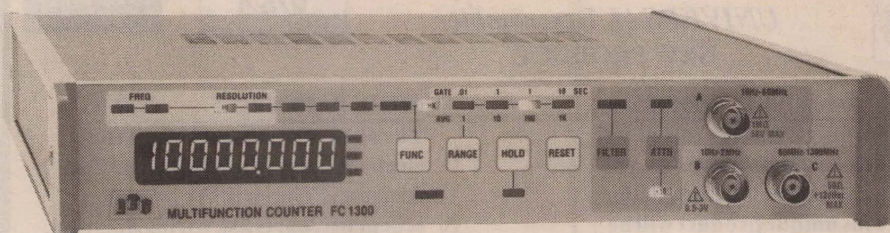
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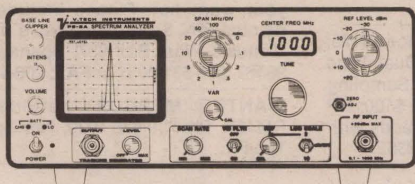
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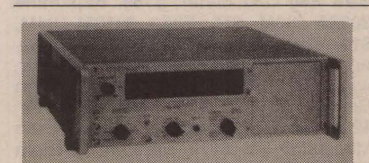


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MMMotion MMMemory II Records Every Move You Make, Automates Models, Puppets, and Displays

Some projects occupy a special place where electronics, art, and magic overlap. The Motion Memory II is one of those projects. Using the MM2 and a pair of model-airplane servos you can record and play back live-action animations over two minutes long. Imagine...

...creating spooky monsters that roll their evil eyes and bare their wicked teeth at Halloween.

...animating lively toy-making elves for a Christmas display.

...incorporating moving dinosaurs into your own home-video sequel to Jurassic Park.

...using servo-aimed mirrors to turn spotlights or eye-safe lasers into an electronically choreographed light show.

...putting life into museum exhibits, store displays, or trade-show booths with moving signs, graphs, and pointers.

The MM2 could be the start of your show-biz career. After all, the original Motion Memory was an immediate success in the entertainment industry. Despite its modest 20-second recording time, MM1 landed a role in Disneyland's Lion King parade, swiveling the ears of a giraffe. (I'm not making this up.) With its increased recording capacity of 2 minutes 16 seconds, MM2 might get more than a bit part.

The MM2 is easy to use. It translates the position of a PC-style joystick

into proportional signals that control two servos. If you press the joystick trigger, MM2 writes position data into its 16,384 bytes (16K) memory. Recording stops when you press the joystick thumb button, or the memory is filled.

On playback, MM2 retrieves data from memory and uses it to control the servos, ignoring the joystick. If it is set for one-shot mode, playback stops at the end of the sequence. In loop mode, the sequence plays continuously until the mode is changed or the power is turned off.

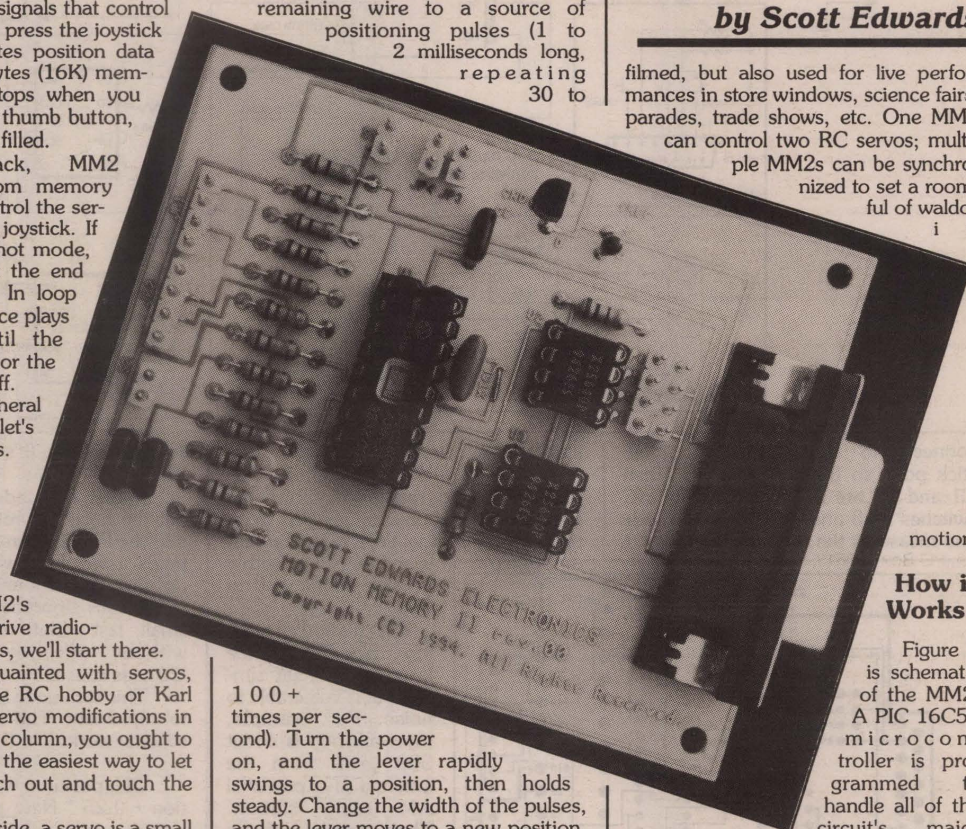
That's the general description. Now let's dig into the details.

Servos: Versatile Mechanical Positioners

Since MM2's purpose is to drive radio-control (RC) servos, we'll start there. If you aren't acquainted with servos, either through the RC hobby or Karl Lunt's inventive servo modifications in his N&V robotics column, you ought to be. They're about the easiest way to let your projects reach out and touch the real world.

From the outside, a servo is a small plastic box with three wires going in, and a mechanical lever or wheel coming out. Hook the red and black wires to +5 volts and ground. Connect the

remaining wire to a source of positioning pulses (1 to 2 milliseconds long, repeating 30 to



100+ times per second). Turn the power on, and the lever rapidly swings to a position, then holds steady. Change the width of the pulses, and the lever moves to a new position. Figure 1 depicts the relationship between pulse width and servo position.

RC models use servos to control steering, throttle, landing gear, and a host of accessories. These models range from tiny (under a foot) to gigantic (12-foot wingspans aren't uncommon). Servos are available in a similar range of sizes and capabilities.

The entertainment industry has adopted servos in a big way. Virtually any puppet (known in the trade as a "waldo") that you see on TV or in the movies is servo controlled by a skilled effects technician working a joystick. The reason is simple: servo control wiring is far easier to conceal from the camera than traditional puppet strings and sticks.

The MM2 takes this idea one step further: Why not record a performance so that it can be played back over and over? The recorded motions can not only be

by Scott Edwards

filmed, but also used for live performances in store windows, science fairs, parades, trade shows, etc. One MM2 can control two RC servos; multiple MM2s can be synchronized to set a roomful of waldos in

motion!

How it Works

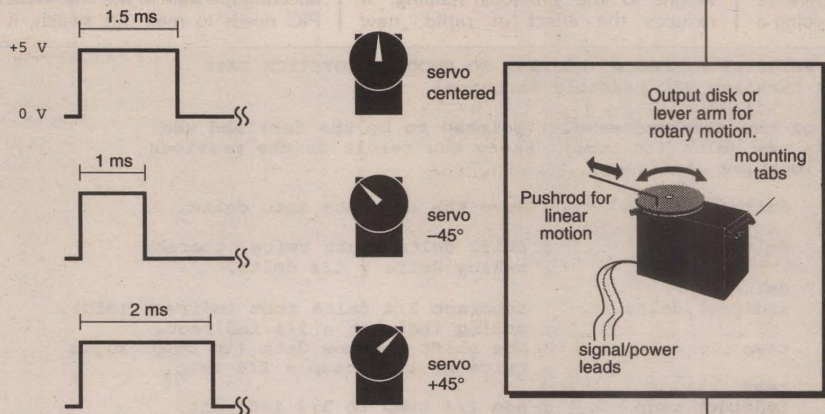
Figure 2 is schematic of the MM2. A PIC 16C54 microcontroller is programmed to handle all of the circuit's major functions. If you're

not familiar with PICs, check out the Dec. '94 issue of N&V or contact one of the sources in the parts list for more information. Basically, a PIC is a one-chip computer with limited memory (25 bytes in this case) and program storage (512 instructions). Once programmed, the PIC becomes an inexpensive custom IC.

Our PIC is programmed for three major jobs: reading PC joysticks, generating servo pulses, and managing 16K of memory. Let's start with the joystick input.

A PC-style joystick consists, at a minimum, of two pots and two push-buttons. The pots are linked to the stick so that one responds to left and right motions, the other to up and down. These pots, which have a resistance range of 0 to 140K, are wired to a common + terminal as shown in Figure 2. The buttons are wired to a common ground terminal.

Looking at the schematic, you'll see that the MM2 circuit connects the joystick pots across a pair of capacitors, C1 and C2. To read the pots' positions, the PIC first charges these caps by pulling pins RA0 and RA1 to ground. The other ends of the caps are



A train of positive pulses, repeated at a 30- to 100-Hz rate, controls servo position. Most servos have a range of 90 degrees, but "retract" servos travel 180 degrees or more.

Figure 1. Servos are versatile positioning devices for live-action animation.

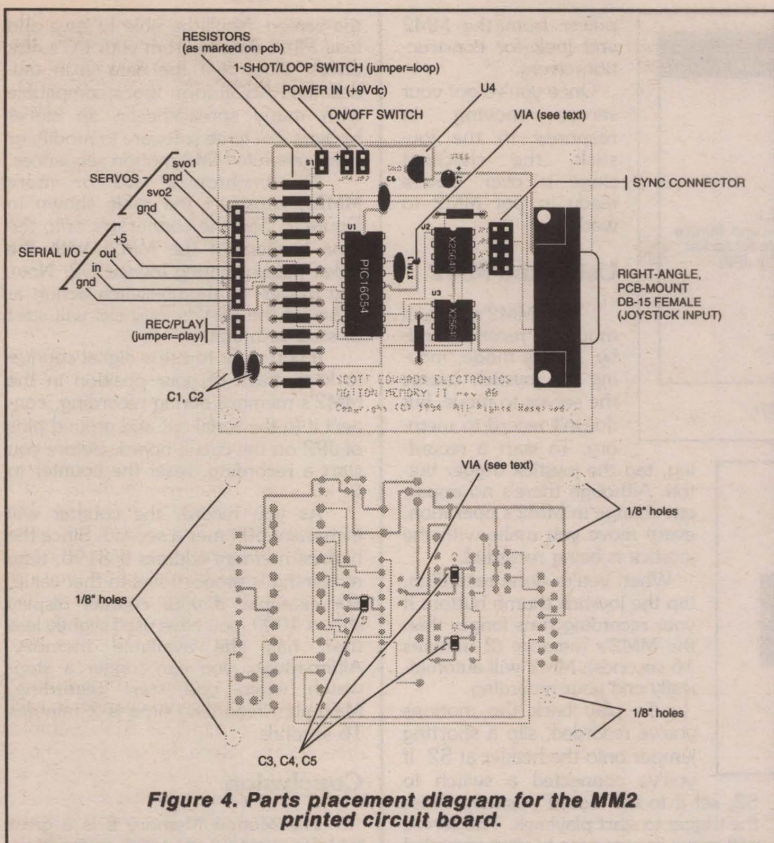


Figure 4. Parts placement diagram for the MM2 printed circuit board.

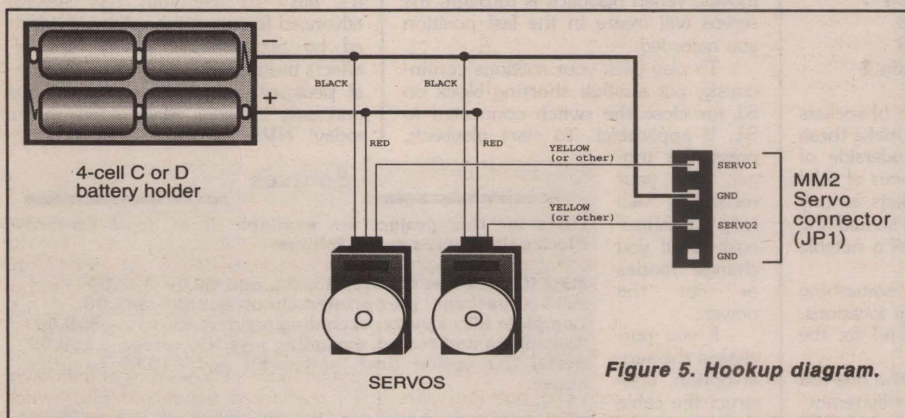


Figure 5. Hookup diagram.

Parts List

Semiconductors

U1 — PIC16C54 microcontroller programmed with MM2 firmware. See source.
 U2, U3 — Xicor X25640 8192-byte serial EEPROM. See source.
 U4 — 78L05 5-volt, 100-mA voltage regulator (Digi-Key AN78L05-ND)
 XTAL1 — 4 MHz ceramic resonator, Integrity Tech ZTS 4.00M. See source.

Resistors (all 1/4-watt or smaller)

R1, R2, R7, R8 — 220 ohms
 R3, R4, R9, R12 — 100,000 ohms
 R5, R6, R13, R14, R15 — 1,000 ohms
 R10 — 220,000 ohms
 R11 — 22,000 ohms

Capacitors

C1, C2, C6 — 0.022uF, 50 WVDC polyester capacitors (Digi-Key P4586-ND)
 C3, C4, C5 — 0.027uF, 50 WVDC surface-mount ceramic capacitor (Digi-Key PCC273BGCT-ND)
 C7 — 1uF 16 WVDC tantalum electrolytic capacitor

Miscellaneous

DB-15 female, PCB mount, short body (Jameco 77956); IC sockets (use machine-pin type if making your own PCB); header stakes on snappable strips; jumper blocks; 9V battery clip; servos [hobby shop or ACE RC (address below)]; PC-compatible joystick; switches (substitute for jumper blocks if desired); enclosure (if desired).

ables the EEPROM, and switches its pin RB4 to input. This method of doubling up inputs and outputs on a single pin is common in PIC designs.

The loop/one-shot switch is handled differently. It borrows the PIC's real-time clock/counter (RTCC) input. This input is normally used to detect edges — on or off transitions. However, it's possible to trick RTCC into seeing an edge where there's only a steady state. Just toggle the RTCC's control bit between positive-edge and negative-edge detection. This clocks the bit on the RTCC input into its internal counter register. Listing 2 is a program snippet that shows how it's done.

Other small details: The MM2 features serial input and output lines. The serial input is not used in the basic MM2; it's an extra-cost option. The option lets you connect the MM2 to a PC in order to read and write the EEPROM memory. This way you could store a library of motion recordings on disk and download them to the MM2 as needed.

Whether or not your MM2 has the serial option, the serial output has another function. It outputs 60 pulses per second when the MM2 is recording. This lets you connect a digital counter to the MM2 in order to keep track of your place in the MM2's memory. If you reset the counter to 0 before starting the recording, it will count to 8190 when the MM2 reaches the end of memory. Of course, the sweep second hand of your watch will do almost as well, but I couldn't resist adding this feature. On the circuit board, you'll notice that the serial connector includes a pin with regulated +5V to power homebrew or commercial counter circuits drawing up to 50 mA.

The MM2 also includes a sync connector, which allows you to connect several MM2s together so that all of them respond to any of the joystick trigger (start) and thumb (stop) buttons. This lets you start and stop MM2 recordings in perfect sync for more elaborate animations.

The sync connector also lets you use a variation on the old recording-studio trick that permits singers to sing harmony with themselves. The tape deck plays back a previous vocal on one channel, and records the new vocal on another. Similarly, you can link two MM2s via the sync connector. Set one for play and the other for record. When you press the trigger to begin the new recording, playback will also start up. You can use the playback motions as a point of reference for recording the new motions.

One other possible use for the sync connector is to activate other devices. Suppose you wanted to synchronize an electronic soundtrack with MM2 motions. You'd connect the sync to trigger the audio playback at the same time the motion sequence starts.

Building the MM2

The key to the MM2 is its double-sided printed circuit board, shown in Figure 3. You can make your own

board from the artwork in the figure, or purchase one ready-made from the source in the parts list. The ready-made board has plated-through holes, and the layout relies on these to connect the top and bottom sides of the board. If you construct your own PCB, you'll have to solder components on both the top and bottom of the board. There is also a via — a top-to-bottom-layer jumper — that you must install. Insert a piece of hookup wire into the via hole and solder it on both sides of the board.

You'll have to do the same thing for some of the DB-15 pins, since these aren't accessible for top-layer soldering once the connector is in place. So before you install the connector, pass thin pieces of bare wire (such as stripped #30 wire-wrapping wire) through the connector holes. Solder them on the top side, being careful not to plug the holes. When you install the connector and solder the bottom side, the proper connections will be made.

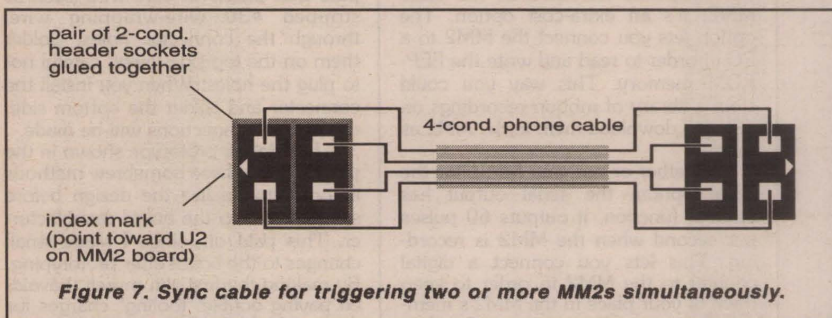
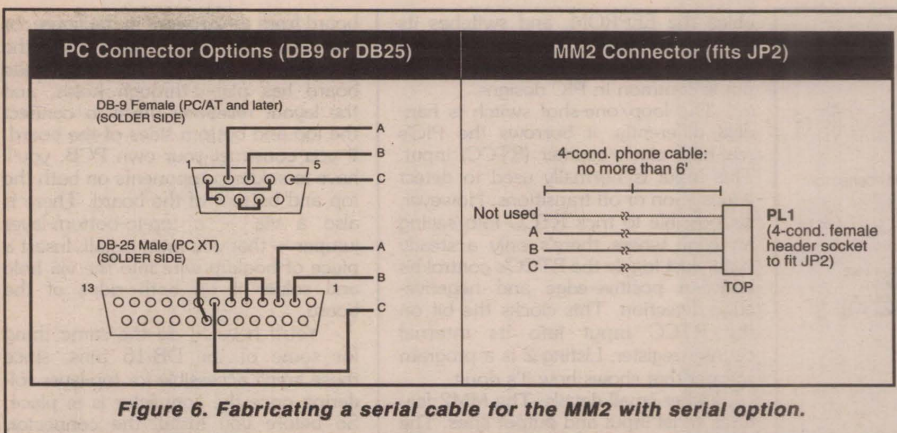
I made the prototype shown in the photos using these homebrew methods in order to finalize the design before submitting it to the board manufacturer. This paid off, since I made small changes to the board after prototyping. By making the first run myself, I avoided paying double "tooling" charges for the board, which would have added about \$200.00 to my costs.

The resulting ready-made board is easy to construct, thanks to a novel layout by Scary Design Studios (see parts list for contact information). Components are grouped for convenient installation, and the part numbers are etched into copper on the board. Figure 4 shows the parts placement. Use sockets for U1, U2, and U3. If you're making your own PCB, use machine-pin sockets, since these have metal turrets that allow you to solder them on the top side of the board. If you're using the ready-made board, you may use any kind of sockets you like.

Note that capacitors C3, C4, and C5 are surface-mount types and go on the underside of the board. If you've never done surface mount before, here's your chance. You'll be pleasantly surprised at how easy it is. Just follow these steps:

- Tin one of the two pads with a light coating of solder.
- Pick up the component with tweezers in one hand, and your soldering iron in the other. Heat the tinned pad with the soldering iron, then press one end of the component into the melted solder. Make sure that the other end of the component lines up with the other pad. Remove the soldering iron. Hold the component in place for an additional second or two.
- Now put down the tweezers and pick up some solder. Solder the unsoldered end of the component. If necessary, apply a little more solder to the other end. You're done.

As your board nears completion, you have a decision to make: box or no box. You can either mount the MM2 in an enclosure, or leave it au naturel. Either way, I suggest that you use header stakes on the board at JP1 through JP4 and S1/S2. In a boxed version, you can attach female header sockets to switches, servo output connectors, and the battery clip. When it comes time to install the board, just plug



everything together and secure the board in place.

For a box-less version, the header stakes themselves can serve as switches. Slip jumpers (also known as shunts or shorting blocks) over the posts for ON; remove them for OFF. Since most of the action happens at the joysticks, this isn't as cumbersome as it sounds.

When you finish soldering the board, leave U1, U2, and U3 out of their sockets for final checkout.

Checkout and Use

To check out your completed MM2, you will need a 9V battery, PC-compatible joystick, and one or more servos with appropriate battery pack. The servos must always work off a separate power supply from the MM2. The MM2's power supply is too puny to run the servos' motors, and separating the power supplies reduces the chance that motor noise will interfere with the MM2's operation.

Make sure that U1 through U3 are out of their sockets. Connect the 9V battery to the board and short the pins of the ON/OFF header together. Don't connect the joystick yet. Get your voltmeter and check the following points

for 5 VDC (plus or minus 0.5 VDC):

Black Probe	Red Probe
U1, pin 5	U1, pin 14
U2, pin 4	U2, pin 8
U3, pin 4	U3, pin 8
DB-15, pin 4	DB-15, pin 1

Depending on the type of sockets you used, you may have to make these measurements from the underside of the board, or insert thin pieces of solid hook-up wire into the sockets as tiny probes. For the DB-15, you should find that a bent paper-clip makes a suitable probe extension.

If your probing shows something other than 5 VDC at these locations, re-inspect your soldering and fix the problem before continuing.

Once you're sure that the five-volt supply works, turn off power by removing the jumper from the ON/OFF header. Install U1 through U3 in their sockets. Plug the joystick into the DB-15 connector. Connect servos to the unit as shown in Figure 5. Connect power to the servos and install the ON/OFF jumper. Leave the other jumpers off for now.

Now grab the joystick and move it around. The servos should move in response. If they don't, disconnect

power from the MM2 and look for construction errors.

Once you've got your servos moving in response to the joystick, the checkout stage is over. You're ready to put MM2 to work.

Using the MM2

The MM2's default mode is record/stand-by. In this mode, moving the joystick causes the servos to move, but doesn't record to memory. To start a recording,

every move you make with the joystick is being recorded. When you're done recording, tap the joystick thumb button. If your recording runs longer than the MM2's memory (2 minutes 16 seconds), MM2 will automatically end your recording.

To play back the motions you've recorded, slip a shorting jumper onto the header at S2. If you've connected a switch to

S2, set it to the closed position. Press the trigger to start playback. The servos will move in response to your recorded moves. When playback is through, the servos will freeze in the last position you recorded.

To play back your motions continuously, put another shorting block on S1 (or close the switch connected to S1, if applicable). To start playback, press the trigger. Now your recording will loop continuously until you change modes or cut the power.

If you purchased the serial option, construct the cable shown in Figure 6. Connect the cable between the MM2 and your PC's serial port. Fire up the serial-option software and follow the instructions on

the screen. You'll be able to save and load MM2 data to/from your PC's disk drives. Note that the data is in tab-delimited ASCII form that's compatible with many spreadsheets, so clever hackers can write software to modify or even generate MM2 motion sequences.

To synchronize two or more MM2s, construct the cable shown in Figure 7. Slip the connectors onto the sync headers of the MM2s with the index mark pointing toward U2. Now, any trigger- or thumb-switch action at either of the MM2's joysticks will start or stop both units.

If you want to use a digital counter to keep track of your position in the MM2's memory during recording, connect it to the serial-out and ground pins of JP2 on the circuit board. Before you start a recording, reset the counter to 0.

As you record, the counter will increment 60 times a second. Since the highest memory address is 8190, time remaining is proportional to that value. For example, if your counter display shows 4000, you have used slightly less than half the available memory. Alternatively, you can trigger a stop-watch when you start recording. Maximum recording time is 2 minutes 16 seconds.

Conclusion

The Motion Memory II is a great tool for creating electronic animation. It's easy to use, but has several advanced features and options suggested by professionals in the special-effects business. Despite its professional pedigree, the MM2 is inexpensive and easy to build. Make some magic today! **NV**

Sources

Parts for this project are available from Scott Edwards Electronics. Prices are as follows:

MM2 IC package: U1, U2, U3, U4, and CR1 — \$29.00
MM2 IC package, plus printed circuit board — \$45.00
Complete kit of parts, excluding joystick, servos — \$59.00
Assembled and tested, excluding joystick, servos — \$99.00
Serial I/O option (incl. software): add \$10.00 to prices above.

Prices include Priority Mail shipping to the U.S. Scott Edwards Electronics accepts Visa and MasterCard, as well as personal checks, money orders, and institutional POs (subject to credit approval). COD orders incur a \$7.00 surcharge. Order from:

Scott Edwards Electronics
964 Cactus Wren Lane
Sierra Vista, AZ 85635
Phone 602-459-4802
Fax 602-459-0623

Scott will answer questions regarding this project via E-Mail: Internet — 72037.2612@compuserve.com; CompuServe — 72037,2612. Although the source code for this project is not available, Scott can provide component routines (Xicor EEPROM driver, serial I/O, pot reading) through his Source Book and AppKit products. Interested in computer control of servos? Scott sells a kit for the Serial Servo Controller, which can command eight servos (expandable to 256 servos) from a single computer serial port. Contact him for more information.

Scary Design Studios engineered the easy-to-build printed circuit board for the MM2. They have the skills, experience, and high-end CAD software to handle any project. Give designer Mike Tripoli a call at 412-795-3822 for information or an estimate.

Digi-Key, 701 Brooks Avenue South, P.O. Box 677, Thief River Falls, MN 56701-0677; phone 1-800-344-4539.
Jameco Electronic Components, 1355 Shoreway Road, Belmont, CA 94002-4100; phone 1-800-831-4242.
ACE R/C, 116 W. 19th Street, P.O. Box 511, Higginsville, MO 64037; phone 1-800-322-7121 or 1-816-584-6303.

LISTING 2. METHOD FOR USING RTCC TO SAMPLE A STEADY-STATE INPUT (written in Parallax PIC assembly language)

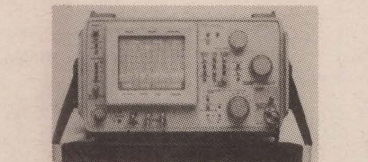
```
; Normally, the clock-counter input (RTCC) will only register an edge
; (change in state) on its input. However, it can be tricked into
; seeing a steady state by toggling the option register between
; rising-edge trigger and falling-edge trigger, as shown in this
; fragment. The object is to copy the bit state on RTCC to a bit
; flag called "loop_one" which controls the loop/one-shot function
; of the MM2.

clr RTCC ; Clear the counter.
mov option,#11101000b ; Set option for rising trigger (bit4=0).
mov option,#11111000b ; Set option for falling trigger (bit4=1).
test RTCC ; Test RTCC for zero.
snz ; If RTCC<>0, then skip the instruction
clrb loop_one ; that would write a 0 to loop_one.
sz ; If RTCC=0, then skip the instruction
setb loop_one ; that would write a 1 to loopone.
; The net result is that if RTCC=0, loopone = 0 and if RTCC = 1, then
; loop_one = 1.
```


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TEKTRONIX 492 portable solid-state spectrum analyzer \$8,650, option 1, 2, 3, \$8,350, option 1,2. Davilyn, 1-800-235-6222.

CURVE TRACER, Tektronix 576 \$1,250. **Gould 4040** digital storage oscilloscope, \$250. **Tektronix 453** 50MHz portable, \$150. **HP 1600A** logic analyzer w/pods, \$95. **Tektronix 545A/CA** \$75. 519, 567, 575A, P6032, plug-ins, CRTs, parts. Call for detailed list, evenings or weekends please. 602-938-4033 or 602-978-3026.

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74LS91	74LS399	75	LM121	1.55	UN2966	1.10
74LS92	74LS399	75	LM121	1.55	UN2967	1.10
74LS93	74LS399	75	LM121	1.55	UN2968	1.10
74LS94	74LS399	75	LM121	1.55	UN2969	1.10
74LS95	74LS399	75	LM121	1.55	UN2970	1.10
74LS96	74LS399	75	LM121	1.55	UN2971	1.10
74LS97	74LS399	75	LM121	1.55	UN2972	1.10
74LS98	74LS399	75	LM121	1.55	UN2973	1.10
74LS99	74LS399	75	LM121	1.55	UN2974	1.10
74LS100	74LS399	75	LM121	1.55	UN2975	1.10
74LS101	74LS399	75	LM121	1.55	UN2976	1.10
74LS102	74LS399	75	LM121	1.55	UN2977	1.10
74LS103	74LS399	75	LM121	1.55	UN2978	1.10
74LS104	74LS399	75	LM121	1.55	UN2979	1.10
74LS105	74LS399	75	LM121	1.55	UN2980	1.10
74LS106	74LS399	75	LM121	1.55	UN2981	1.10
74LS107	74LS399	75	LM121	1.55	UN2982	1.10
74LS108	74LS399	75	LM121	1.55	UN2983	1.10
74LS109	74LS399	75	LM121	1.55	UN2984	1.10
74LS110	74LS399	75	LM121	1.55	UN2985	1.10
74LS111	74LS399	75	LM121	1.55	UN2986	1.10
74LS112	74LS399	75	LM121	1.55	UN2987	1.10
74LS113	74LS399	75	LM121	1.55	UN2988	1.10
74LS114	74LS399	75	LM121	1.55	UN2989	1.10
74LS115	74LS399	75	LM121	1.55	UN2990	1.10
74LS116	74LS399	75	LM121	1.55	UN2991	1.10
74LS117	74LS399	75	LM121	1.55	UN2992	1.10
74LS118	74LS399	75	LM121	1.55	UN2993	1.10
74LS119	74LS399	75	LM121	1.55	UN2994	1.10
74LS120	74LS399	75	LM121	1.55	UN2995	1.10
74LS121	74LS399	75	LM121	1.55	UN2996	1.10
74LS122	74LS399	75	LM121	1.55	UN2997	1.10
74LS123	74LS399	75	LM121	1.55	UN2998	1.10
74LS124	74LS399	75	LM121	1.55	UN2999	1.10
74LS125	74LS399	75	LM121	1.55	UN3000	1.10
74LS126	74LS399	75	LM121	1.55	UN3001	1.10
74LS127	74LS399	75	LM121	1.55	UN3002	1.10
74LS128	74LS399	75	LM121	1.55	UN3003	1.10
74LS129	74LS399	75	LM121	1.55	UN3004	1.10
74LS130	74LS399	75	LM121	1.55	UN3005	1.10
74LS131	74LS399	75	LM121	1.55	UN3006	1.10
74LS132	74LS399	75	LM121	1.55	UN3007	1.10
74LS133	74LS399	75	LM121	1.55	UN3008	1.10
74LS134	74LS399	75	LM121	1.55	UN3009	1.10
74LS135	74LS399	75	LM121	1.55	UN3010	1.10
74LS136	74LS399	75	LM121	1.55	UN3011	1.10
74LS137	74LS399	75	LM121	1.55	UN3012	1.10
74LS138	74LS399	75	LM121	1.55	UN3013	1.10
74LS139	74LS399	75	LM121	1.55	UN3014	1.10
74LS140	74LS399	75	LM121	1.55	UN3015	1.10
74LS141	74LS399	75	LM121	1.55	UN3016	1.10
74LS142	74LS399	75	LM121	1.55	UN3017	1.10
74LS143	74LS399	75	LM121	1.55	UN3018	1.10
74LS144	74LS399	75	LM121	1.55	UN3019	1.10
74LS145	74LS399	75	LM121	1.55	UN3020	1.10
74LS146	74LS399	75	LM121	1.55	UN3021	1.10
74LS147	74LS399	75	LM121	1.55	UN3022	1.10
74LS148	74LS399	75	LM121	1.55	UN3023	1.10
74LS149	74LS399	75	LM121	1.55	UN3024	1.10
74LS150	74LS399	75	LM121	1.55	UN3025	1.10
74LS151	74LS399	75	LM121	1.55	UN3026	1.10
74LS152	74LS399	75	LM121	1.55	UN3027	1.10
74LS153	74LS399	75	LM121	1.55	UN3028	1.10
74LS154	74LS399	75	LM121	1.55	UN3029	1.10
74LS155	74LS399	75	LM121	1.55	UN3030	1.10
74LS156	74LS399	75	LM121	1.55	UN3031	1.10
74LS157	74LS399	75	LM121	1.55	UN3032	1.10
74LS158	74LS399	75	LM121	1.55	UN3033	1.10
74LS159	74LS399	75	LM121	1.55	UN3034	1.10
74LS160	74LS399	75	LM121	1.55	UN3035	1.10
74LS161	74LS399	75	LM121	1.55	UN3036	1.10
74LS162	74LS399	75	LM121	1.55	UN3037	1.10
74LS163	74LS399	75	LM121	1.55	UN3038	1.10
74LS164	74LS399	75	LM121	1.55	UN3039	1.10
74LS165	74LS399	75	LM121	1.55	UN3040	1.10
74LS166	74LS399	75	LM121	1.55	UN3041	1.10
74LS167	74LS399	75	LM121	1.55	UN3042	1.10
74LS168	74LS399	75	LM121	1.55	UN3043	1.10
74LS169	74LS399	75	LM121	1.55	UN3044	1.10
74LS170	74LS399	75	LM121	1.55	UN3045	1.10
74LS171	74LS399	75	LM121	1.55	UN3046	1.10
74LS172	74LS399	75	LM121	1.55	UN3047	1.10
74LS173	74LS399	75	LM121	1.55	UN3048	1.10
74LS174	74LS399	75	LM121	1.55	UN3049	1.10
74LS175	74LS399	75	LM121	1.55	UN3050	1.10
74LS176	74LS399	75	LM121	1.55	UN3051	1.10
74LS177	74LS399	75	LM121	1.55	UN3052	1.10
74LS178	74LS399					

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- Favorite Channel Memory
- Wireless Remote Control
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Add on Descrambler for Jerrold Systems

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SA - 3	\$59	\$55	\$49
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HP SPECTRUM analyzer sale. 1KHz-110MHz, HP 141T-8552B-8553B system with manuals checked working with a 30 day guarantee. \$1,400! 1-800-435-1516 Tech-Systems.

BUY, SELL, late model test equipment, all makes. Buy parts for HP, Tek and Fluke. Jim, JCS, Ph: 800-44-TESLA, FAX: 510-475-0442.

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HP SPECTRUM analyzers. 10MHz-18GHz (with mixers 40GHz). HP 141T-8552B-8555A system with manuals and 30 day guarantee. \$1,950. Tech-Systems, 1-800-435-1516.

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HP 3457A "current catalog" DMM 3-1/2-7-1/2 digits, \$2,100, options available. Call 1-800-435-1516 Tech Systems.

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HP 141T, 8552A, Spectrum analyzer system. 10MHz to 18GHz. \$1,650. 30 day warranty. Reliable service. Bob Morgan Test Equipment Sales. Ph/FAX 717-842-1534.

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Hear exciting air-craft communications—pick up planes up to 100 miles away! Receives 110-136

MHz AM air band, smooth varactor tuning superhet with AGC, ceramic filter, adjustable squelch, excellent sensitivity and lots of speaker volume. Runs on 9V battery. Great for air shows or just hanging around the airport! New 30-page manual details pilot talk, too. Add case set for "pro" look.

AR-1 kit.....\$29.95 Matching case set, CAR.....\$14.95

FM RECEIVERS & TRANSMITTER

Keep an ear on the local repeater, police, weather or just tune around. These sensitive superhet receivers are fun to build and use. Tunes any 5 MHz portion of the band and have smooth varactor tuning with AFC, dual conversion, ceramic filtering, squelch and plenty of speaker volume. Complete manual details how the rigs work and applications. 2M FM Transmitter has 5W RF out, crystal control (146.52 included), pre-specs and data/mike inputs. Add our case sets for a nice finish.

FM Receiver kit Specify band: FR-146 (2M), FR-6 (6M), FR-10 (10M), FR-220 (220MHz).....\$34.95
CFR Matching case set.....\$14.95
FT-146 Two Meter FM transmitter kit.....\$99.95

MICRO-MIKE

World's smallest FM wireless mike. Smaller than a sugar cube including battery and mike. Two sets of SMT parts supplied in case you are clumsy! Terrific audio pick-up (pin drop at 5 ft) and transmit range of 300 ft.

We include the battery (watch style), electret mike and even a tuning tool! Be a James Bond and learn SMT too! FM-5 Micro mike kit.....\$19.95

FM WIRELESS MIKES

Pick the unit that's right for you. All units transmit a stable signal in the 88-108 MHz FM band up to 300' except for High power FM-4 and PB-1 Phone bug that go up to 1/2 mile.

FM-1 Basic Kit.....\$5.95
FM-2, as above.....\$5.95
but with added mike pre amp.....\$7.95
FM-4, long range with very sensitive audio pickup.....\$14.95
PB-1, Phone bug needs no battery, hooks to phone line.....\$14.95
MC-1, Micro size sensitive mike cartridge for FM-1,2,4.....\$2.95

SURROUND-SOUND/REVERB

Add concert hall realism to your stereo, TV or even 2-way radio! Easily synthesize a stereo effect from mono sources or richly enhance regular music. Add a big-volume reverb to your radio voice that others will envy! Our reverb/surround sound kit uses a Bucknet Brigade IC Device for reliable solid-state performance. Adjustable reverb, delay and mix controls to customize your sound. Easily connected to radios, stereos, CB's and TV's. Plenty of audio input to drive a small speaker for stand-alone operation too. Experience the fun and realism that surround sound provides - without spending hundreds! Add our case set for a neat, pro look.

RV-1 Surround Sound/Reverb kit.....\$59.95 CRV Matching case set.....\$14.95
RV-1WT Assembled RV-1 and case.....\$99.95

TOUCH-TONE REMOTE CONTROL

Control virtually anything by Touch-Tone remote control. The URC-1 has 16 switched outputs, 4 adjustable voltage outputs (20 mv steps 0 to 5 VDC), two 10K digital pots (for volume, squelch, etc.) and 3 timers adjustable from 10 ms to 40 hours! Two level passwork control allows secure control and multi-level access. Six digit LED display shows currently entered codes and a crystal controlled touch-tone decoder provides reliable operation. There's nothing else like this unit, be in complete control of remote radios, thermostats, hi-fi's, homes or even factories with the URC-1. Add our matching case set for a handsome finish.

URC-1 Remote control kit.....\$129.95 CURC Matching case set.....\$14.95
URC-1WT Fully assembled URC-1 and case.....\$189.95

FM SUBCARRIER DECODER

Tap into the world of commercial-free music and data that is carried over many standard FM broadcast radio stations. Decoder hooks to the demodulator of FM radio and tunes the 50-100 KHz SCA subcarrier band. Many radios have a demod output, but if your radio doesn't, it's easy to locate, or use our FR-1 FM receiver kit which is a complete FM radio with a demod jack built-in. These "hidden" subcarriers carry lots of neat programming - from stock quotes to news to music, from rock to easy listening - all commercial free. Hear what you've been missing with the SCA-1.

SCA-1 Decoder kit.....\$27.95 CSCA Matching case set.....\$14.95
FR-1 FM receiver kit.....\$24.95 CFR Matching case for FR-1.....\$14.95

L-C METER

Measure inductors from 10 uH-10mH and capacitors from 2 pF-2uF with high accuracy by connecting the LC-1 to any digital multimeter. Two pushbutton ranges for high resolution readings and we even give you calibration components to assure proper accuracy of your kit! Active filters and switching supplies require critical values, no one should be without an accurate LC meter. For a pro look, add our matching case set.

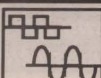
LC-1 LC meter kit.....\$34.95 CLC case set.....\$14.95

MOTOR CONTROLLER

Control the speed and direction of any motor. Use our SMD-1 for those nice steppers you see surplus, and our MSC-1 for DC motors. The stepper driver features variable speed, half step rotation, direction and power down mode, can drive most any stepper motor. Our DC driver features pulse width modulation control allowing full motor torque even at low speeds and can drive motors up to 50 VDC @ 10 Amps! Add our case set for a professional assembly.

SMD-1 Stepper kit.....\$24.95 MSC-1 DC motor kit.....\$24.95
CMSD SMD-1 case.....\$14.95 CMSC MSC-1 case.....\$14.95

SYNTHESIZED AUDIO GENERATOR



DDS (Direct Digital Synthesis) technology brings you a terrific audio generator at a fantastic price! Generates from 0.01 Hz to 50 KHz with five digit LED display of frequency. Sine and square wave output adjustable 0-5

volt p-p. Frequency selected by direct keyboard entry and with handy continuous tune tuning knob. Crystal controlled accuracy of 10 ppm and two memories for rapid frequency changes. Retire that jury-rigged old generator and treat yourself to the pleasure of using a new state-of-the-art SG-550!

SG-550 Kit.....\$199.95 SG-550WT assembled.....\$269.95

SHORTWAVE RECEIVER

Fantastic receiver that captures the world with just a 12" antenna! Can receive any 2 MHz portion from 4-11 MHz. True superhet, has smooth varactor tuning, AGC, RF gain control, plenty of speaker volume and runs on a 9V battery. Fascinating Scout, school or club project, provides hours of fun for even the most serious DXer. For the car, consider our shortwave converter. Two switchable bands (in 3-22 MHz range), each 1 MHz wide—tunable on your car radio dial. Add some interest to your drive home!

Shortwave receiver kit, SR1.....\$29.95

Shortwave converter kit, SC1.....\$27.95

Matching case set for SR1, CSR.....\$14.95

Matching case set for SCI, CSC.....\$14.95

AM TRANSMITTER

High quality, true AM broadcast band transmitter is designed exactly like the big commercial rigs. Power of 100 mW, legal range of up to 1/4 mile. Accepts line level inputs from tape and CD players and mike mixers, tunable 550-1750 KHz. Complete manual explains circuitry, help with FCC regs and even antenna ideas. Be your own Rush Limbaugh or Rick Dees with the AM-1! Add our case set for a true station look.

AM-1 Transmitter kit.....\$24.95

CAM Matching case set.....\$14.95

SCANNER CONVERTER

Tune in on the 800-950 MHz action using your existing scanner. Frequencies are converted with crystal referenced stability to the 400-550 MHz range. Instructions are even included on building high performance 900 MHz antennas. Well designed circuit features extensive filtering and convenient on-off/bypass switch. Easy one hour assembly or available fully assembled. Add our matching case set for a professional look.

SCN-1 Scanner converter kit.....\$49.95

SCN Matching case set.....\$14.95

SCN-1WT Assembled SCN-1 and case.....\$89.95

STEREO FM TRANSMITTER

Run your own Stereo FM radio station! Transmits a stable signal in the 88-108 MHz FM broadcast band up to 1 mile. Detailed manual provides helpful info on FCC regs, antenna ideas and range to expect. Latest design features adjustable line level inputs, pre-emphasis and crystal controlled subcarrier. Connects to any CD or tape player, mike mixer or radio. Includes free tuning tool for a pro look add our matching case set with on-board whip antenna.

FM-10A Stereo transmitter kit.....\$34.95

CFM Case, whip ant set.....\$14.95



DR. NI-CAD CONDITIONER/FAST CHARGER

Quit spending big bucks for replacement battery packs, rejuvenate and condition your batteries for peak capacity. Advanced circuitry has optimized discharge before charge to eliminate memory effect and to condition batteries that have been poorly cared for in the past. Quick charge rapidly brings battery to full charge in less than an hour—just 15 minutes for some types! And "top-off" charge mode squeezes every last bit of energy into each cell for the absolute most capacity. Switch-mode regulator controls constant current charge while being monitored by a negative delta-V system that cuts off the last charge at the exact point of full charge—batteries are charged, not cooked! Charges NiCads or NiMH packs from 2 to 10 cells (easily expanded) and current capacities up to 10 Amp-hours. Runs on 12 to 15 VDC. Quit cooking your batteries, buying new packs, waiting hours for recharge, get a Dr. Ni-Cad today! Available in money saving kit form or wired and tested with case at a special price. Kit builders: add our matching case set for a snazzy finish.

DN-1 Dr. Ni-Cad conditioner/fast charger kit.....\$49.95

CDN Matching case set.....\$14.95

DN-1WT Fully assembled Dr. Ni-Cad with case.....\$89.95

SPEED RADAR

New low-cost microwave Doppler radar kit "locks" cars, planes, boats, horses, bikes or any large moving object. Operates at 2.6 GHz with up to 1/4 mile range. LED digital readout displays speed in miles per hour, kilometers per hour or feet per second! Earphone output allows for listening to actual Doppler shift. Uses two 1-lb coffee cans for antenna (not included) and runs on 12 VDC. Easy to build—all microwave circuitry is PC stripline. ABS plastic case with speed graphics for a professional look. A very useful and full-on fun kit.

SG-7 Complete kit.....\$99.95

STEREO PEAK HOLD BARGRAPH

Finally a dual LED bargraph with a peak hold display! Bargraph displays are neat and eye catching but their speed is their downfall - they just can't capture the peaks. Our kit is like two units in one, a fast display to show the signal and a long persistence display to capture peaks, similar units go for hundreds of bucks! We offer 3 models: Linear for general use, Semi-Log for audio VU meters, and Log for power displays. Dual - for stereo! - 10 segment multi-colored LED display for snazzy, eye grabbing display and easily set ranges for virtually any signals, from voltmeters to audio VU meters to audio power amps to SWR meters. Complete instructions for easy hook-up to most any device. Add our matching case set for a sharp looking unit.

PH-14 Dual Linear bargraph kit.....\$39.95 PH-15 Dual Log bargraph kit.....\$39.95

PH-16 Dual Semi-Log bargraph kit.....\$39.95 CPH Matching case set.....\$14.95

SPEECH SCRAMBLER

Descramble most scramble systems heard on your scanner radio or set up your own scrambled communication system over the phone or radio. Latest 3rd generation IC is used for fantastic audio quality - equivalent to over 30 op-amps and mixers! Crystal controlled for crystal clear sound with a built-in 2 watt audio amp for direct radio hook-up. For scramble systems, each user has a unit for full duplex operation. Communicate in privacy with the SS-70. Add our case set for a fine professional finish.

SS-70 Scrambler/descrambler kit.....\$39.95

CSD Matching case set.....\$14.95

SS-70WT Assembled.....\$79.95

SS-70 and case set.....\$79.95

CS-1 Crystal set kit.....\$19.95

TOUCH-TONE DECODER

Grab Touch-Tone numbers right off the air, phone or tape. A simple hook-up to any radio speaker or phone line is all that is required to instantly decipher touch-tone phone numbers or codes. A 256 digit memory stores decoded numbers and keeps its memory even in the event of power loss. An 8 digit LED display allows you to scroll through the memory bank to examine numbers. To make it easy to pick out number groups or codes, a "dash" is inserted between sets of digits that were decoded more than 2 seconds apart. A "central-office" quality crystal controlled decoder is used allowing rapid and reliable detection of numbers at up to 20 digits per second! For a professionally finished look, add our matching case set. Start cracking those secret codes tomorrow with the Tone Grabber!

TG-1 Tone Grabber kit.....\$99.95 CTG Matching case set.....\$14.95

TG-1WT Fully assembled TG-1 and case.....\$149.95

DIGITAL VOICE RECORDER

Chatterbox digital voice storage unit will record your message of up to 20 seconds. Time is split up into four 5 second blocks which can be played separately or cascaded for longer messages. An LED display shows message location and current mode for easy operation. Nifty built-in interfaces allow simple connection to transmitters for automatic keying when the PTT is initially closed or after it is released. You can even loop your rig's mike through the Chatterbox. For contest or fun use, the CB-1 can drive an external speaker. Includes a built-in electret mike. For that finishing touch, add our matching case set.

CB-1 Voice recorder kit.....\$59.95 CCB Matching case set.....\$14.95

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EIP MICROWAVE PULSE COUNTER Model 451, Band A 300 to 950MHz, Band B 925 to 18GHz. \$1,195. ISA, PO Box 6955, Laguna Niguel, CA 92607. 714-495-5566, FAX 714-495-4742.

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TEST EQUIPMENT FOR AUDIO, BROADCAST, VIDEO: Tek A6302 & AM 503 current probe & amplifier, DC to 50MHz, \$890; **PG 508** 50MHz pulse generator (variable rise, fall times), \$325; **Tek DM 502A** auto-ranging multimeter, \$215; **HP 3455A** 6-1/2 digit multimeter, \$550; **Tek AA 501** distortion analyzer, \$1,295; **Tek DA 4084** distortion analyzer (like AA 5001), \$1,295; **HP 334A** distortion analyzer (older color), \$275; **HP 334A** distortion analyzer, \$375; **Tek 466** 100MHz portable storage oscilloscope, \$845; **Tek 485** 350MHz portable oscilloscope, \$795; **Tek 7633** 100MHz storage mainframe, \$475; **Tek 7A22** super high-sensitivity differential amplifier, \$395; **Tek 7854** 400MHz oscilloscope mainframe: digital storage, waveform processing, GPIB, \$975; **Tek 7D20** digital storage plug-in: cursor measurements, min/max enveloping, signal averaging, \$825. Excellent condition, with warranty. **Pepper Systems**, 214-353-0257.

HP651A TEST Oscillator. 10Hz to 10 MHz. 600, 75 ohm outputs. \$125. Logimetrics 921 CW, AM generator. 50KHz to 80MHz \$175. Narda 7000A microwave multimeter system, 10MHz to 18GHz, with manual \$950. Bob Morgan Test Equipment Sales. Ph/FAX 717-842-1534.

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WANTED PRECISION Oscillator/clocks by Tracor, Sulzer, Arbitor, TRAK, True-time, etc. Anything precision with an analog or digital display is of interest. Call Bill Scolnik, 1-800-634-7036.

WANTED: LATE MODEL TEST EQUIPMENT (Tektronix, HP, Fluke). Especially: Tek SG 505/2, Tek S-6, Tek 2465A/B. Also, test equipment service manuals needed. **Pepper Systems**: 214-353-0257; 214-902-9511 Fax.

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 <p>20 MHz Oscilloscope with Delay Sweep PS-205 \$429.95 Dual Trace, Component test, 6" CRT, X-Y Operation, TV Sync, Z-Modulation, CH2 Output, Graticule Illum, 2 probes each has x1, x10 switch. Best price with delay sweep. PS-200 20 MHz DUAL TRACE \$339.95 PS-400 40 MHz DUAL TRACE \$494.95 PS-405 40 MHz DELAY SWEEP \$569.95 PS-605 60 MHz DELAY SWEEP \$769.95 Scope Probe: 60MHz x1, x10 \$13, 100MHz x1, x10 \$22</p>		 <p>20 MHz Digital Storage Oscilloscope DS-203 \$729.95 Switchable between digital and analog modes 2 K word per channel storage Sampling rate: 10 M sample/sec 8 bit vertical resolution (25 Level/div) Expanded Timebase 10ms/div - 0.5 s/div Refresh, Roll, Save all, Save CH2, Pre-Trig Plotter Control 250MHz x1, x10 \$29, 250MHz x100 \$39</p>	
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 <p>FUNCTION GENERATOR FG-2100A \$169.95 0.2 Hz - 2 MHz in 7 ranges Sine, square, triangle, pulse and ramp Output: 5mV-20Vp-p 1% distortion, DC offset ± 10V VCF: 0-10V control frequency to 1000.1</p>		 <p>FUNCTION GEN./COUNTER FG-2102AD \$229.95 Generates signal same as FG-2100A Frequency counter 4 digits Feature TTL and CMOS output</p>	
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Don Lancaster's

RESOURCE BIN

number thirty-eight

Exploring high frequency resources.

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 Mountain Standard Time.

A portion of my PSRT RoundTable on *GENie* has also been set aside for you *Nuts & Volts* readers. This is the place you go for instant tech answers. Among the many files in our library, you will find complete reprints for all the *Resource Bin* columns.

I did manage to wrangle one super special sign-up deal for you *Resource Bin* readers. Ten free hours and new Internet access features. See the trailer blurb for details.

High Frequency Resources

At one time "high frequency" meant amateur radio. Possibly with a little citizen's band stuff thrown in. These days, though, you're more likely to be interested in TVRO dishes, wireless mice and modems, speed and sports radars, cable tv or weather satellites, ATV television, cellular phones, video re-broadcasters, GPS navigation, SETI, radio astronomy, scanners, wireless microphones, LAN networks, remote controls, or spread spectrum.

As you raise the frequency of any electronic circuit, your needed tools and techniques will change. Circuit strays first become really critical and then impossible. At high freq, you'll go to *distributed* and *transmission line* design techniques. Lumped coils and caps get replaced by cavities, helical resonators, or striplines.

Special transistors and ICs may be required. In tiny packages.

Your signals often get too small and too fast to view directly. Noise gets crucial. These days,

analog flat-out won't hack it anymore. Practically all new high frequency designs are going totally digital. Or nearly so.

At some point "black magic" sets in. System design becomes more of an art than a science. And you either do or do not have a "feel" for that art.

Firstoff, we'll leave the *status quo* right where it is. Your best beginning point still remains the ...

Radio Amateur's Handbook

Newly re-issued in its 72nd reincarnation, this must-have gem is now known as the *ARRL Handbook for Radio Amateurs*. Here you'll find lots of hands-on and readable coverage for high frequency basics.

NEXT MONTH: Don looks at the perils and pitfalls of auto electronics.

Fair Radio Sales

My long time favorite source for surplus high frequency stuff is *Fair Radio Sales*. Still at the same old stall after all these years. Their free flyers list genuine bargains in older military surplus. Which can be a great place to get started. They've also got older test gear. Cheap, but heavy.

Another possibility is *Radio Research Instruments*. These folks are way more expensive than Fair Radio. They also have the snide habit of not publishing prices with their catalogs. But this is where you'd go for an entire military surplus radar system or a working 50-foot microwave dish mount.

Mini-Circuits Labs

Most microwave stuff tends to be outrageously overpriced. Owing to its gold-plated military heritage. But one major exception

is *Mini-Circuits Labs*. Who offers broadband and low-noise dollar "MAR" amplifiers.

One competitor is *California Eastern Laboratories*. Hot new HF products are those miniature ceramic resonators and filters. *Trans-Tech* is one source.

Heathkit

No, they didn't drop *completely* off the map. They're just a much smaller and leaner company than they used to be. Heath's main focus these days is industrial education. They still have bunches of HF self-study courses.

Ham, Comm, and Cable Mags

We covered these in depth earlier, so I won't repeat myself here. Other than to note in passing that these are all highly useful resources.

Detailed ham radio pub reviews in NUTS17.PS on *GENie* PSRT. For cable insider mags, NUTS29.PS. And for cellular, mobile, and general comm secret stuff, HACK64.PS. These are also available in my *Resource Bin* and *Hardware Hacker* reprints. As per my nearby *Synergetics* ad.

But I will mention three unique mags: *ATV Quarterly* and *ATV Today* on amateur television. And *Weather Sat Ink* for weather reception info.

Industry Trade Journals

My favorite mid-frequency pub is that free *RF Design*. Their Dec. '94 issue describes a mind-boggling TRF receiver breakthrough. One that completely blows away super-regens and single conversion superhets. Not to mention extending the useful range of *unlicensed* aps past 1,000 feet.

By far your finest microwave trade journal is *Microwaves and RF*. Lots of solid technical articles. They also do a *Microwaves Product Extra* tabloid. And a second shopper is *MPD*, short for *Microwave Product Digest*.

The *Microwave Journal* is oldest of old line microwave publications. At one time, they also had outstanding technical articles.

I keep getting these strange phone calls from people pretending to be in their editorial department. Asking me that I do not send them any more subscribers or advertisers. Apparently we are beneath their dignity.

Or else their publisher is the victim of a cruel hoax.

There is also a *Defense Electronics* trade journal.

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RESOURCE BIN

HIGH FREQUENCY RESOURCES

Addison-Wesley Jacob Way Reading MA 01867 (617) 944-3700	Fair Radio Sales PO Box 1105 Lima OH 45802 (419) 227-6573	Maxim 120 San Gargiel Drive Sunnyvale, CA 94086 (800) 998-8800	Navtech Bookstore 2775 S Quincy St #610 Arlington VA 22206 (800) NAV-0885	Siemens Components 2191 Laurelwood Rd Santa Clara CA 95054 (408) 980-4500
Amat Radio Astronomers 247 N Linden St Massapequa NY 11758 (516) 798-8459	GENie 401 N Washington St Rockville MD 20850 (800) 638-9636	McGraw-Hill Bookstore 1226 Sixth Ave New York NY 10020 (212) 512-4100	Philips/Signetics PO Box 3409 Sunnyvale CA 94088 (800) 234-7381	Sony Semiconductor 10833 Valley View St Cypress CA 90630 (714) 220-9100
ARRL Handbook 225 Main St Newington CT 06111 (203) 666-1541	GPS World 859 Willamette St Eugene OR 97440 (503) 343-1200	Microwave Journal 685 Canton St Norwood MA 02062 (617) 769-9750	Plessey Box 660017 Scotts Valley CA 95067 (800) 927-2772	Spread Spectrum Scene PO Box 2199 El Granada CA 94018 (800) 524-9285 (415) 726-6849
ATV Quarterly 1545 Lee St Des Plaines IL 60018 (708) 803-8994	Harris Semiconductor Box 883 Melbourne FL 32902 (407) 724-7000	Microwave Prod Digest 34 Evergreen Place Tenafly NJ 07670 (201) 568-5835	Qualcomm 6455 Lusk Blvd San Diego CA 92121 (619) 587-1121	Synergetics Box 809 Thatcher AZ 85552 (602) 428-4073
ATV Today 1492 Highway 30 Clarence IA 52216 (319) 452-3377	Heathkit PO Box 1288 Benton Harbor MI 49022 (616) 982-3200	Microwaves & RF 611 Rt #46 West Hasbrouck Ht NJ 07604 (201) 393-6286	Radio Observer 5805 Deland Ave Ft Pierce FL 34951 (407) 464-2118	Trans-Tech 5520 Adamstown Road Adamstown MD 21701 (301) 695-9400
California Eastern Labs 4590 Patrick Henry Dr Santa Clara CA 95054 (408) 988-3500	Hewlett-Packard Journal 3200 Hillview Ave Palo Alto CA 94304 (415) 857-1501	Mini-Circuits PO Box 350166 Brooklyn NY 11235 (718) 934-4500	Radio Research Insts 584 N Main St Waterbury CT 06704 (203) 753-5840	Trimble Navigation 585 N Mary Ave Sunnyvale CA 94086 (800) TRI-MBLE
Defense Electronics 5000 S Syracuse Way S650 Englewood CO 80111 (303) 220-0600	Institute of Navigation 1800 Diagonal Rd #480 Alexandria VA 22314 (703) 683-7101	Motorola 5005 E McDowell Rd Phoenix AZ 85008 (800) 521-6274	RF Design 6800 S Syracuse Wy #650 Englewood CO 80111 (303) 220-0600	Weather Sat Ink 4821 Jessie Dr Apex NC 27502 (910) 362-5822 FAX
DKD Instruments 1406 Parkhurst Simi Valley CA 93065 (805) 581-5771	Int Journal Ir/mm Waves 233 Spring St New York, NY 10013 (212) 620-8000	MX-Com Inc 4800 Bethania Station Rd Winston-Salem NC 27105 (800) 638-5577	Rockwell GPS PO Box 568842 Dallas TX 75356 (214) 996-5863	Wireless Design & Dev 301 Gibraltar Dr Morris Plains NJ 07950 (201) 292-5100

Desperately searching for a mission.

An obscure resource that often has good high frequency stuff in it is the free *Hewlett Packard Journal*. For some strange reason, though, it does seem to target only HP products.

Wireless Design & Development is an exciting new trade journal. Free.

Data Books and Such

The best way to build up your high frequency info library is to read the trade journals. Then use their bingo cards to pick up data books, ap notes, and freebie samples.

There's scads of this stuff out there. Let's look into several useful starting points: *RF Device Data* from *Motorola*. *Radio Communication System ICs* from *Sony*. *Satellite, Cable & TV IC Handbook* offered by *Plessey*. *RF and Microwave Transistors & Diodes* from *Siemens*. The *Mixed Signal ICs* from *MX-Com*. The *RF Wireless Comm* from *Philips*.

Spread Spectrum Comm

The concept of *spread spectrum* first started as military anti-jamming. But these days, your commercial aps are revolutionizing all of high frequency comm. Instead of assigning specific high power carriers to stations, each one is given a unique and broad-

band noise-like code. One that intentionally smears over a lot of bandwidth.

Since each receiver only responds to one unique code, many stations can transmit interference free.

Some of these applications may use *direct synthesis* spread spectrum where the entire band is used at once. Others use *frequency hopping*.

Yet another major benefit of spread spectrum comm is that much of it is license free. Since the transmit energy is broadband, very little interfering peak energy is present.

Let's see. The definitive text on this is Marvin Simon's *Spread Spectrum Communications Handbook*. Published by *McGraw Hill*. A 1,200 page tome which gives a thorough (but at times difficult) coverage.

For those really complex details of commercial applications, try instead *CDMA: Principles of Spread Spectrum Communication*, from Andrew Viterbi. Who developed most forms of reliable digital comm in use today.

Published by *Addison-Wesley*.

Switching to a lighter and a more readable resource, check into Randy Robert's *Spread Spectrum Scene*.

Spread spectrum comm has long gone beyond the construction project stage. One older GPS build-it-yourself project was sold

by Dan Doberman's *DKD Instruments*. But full commercial chipsets are the only way to go.

Suitable sources include *Rockwell*, *Harris*, *Qualcomm*, and *Maxim*.

GPS

One of the most developed spread spectrum uses is the GPS navigation system. Short for *Global Positioning Satellites*. A family of 24 roving birds, some of which are now overhead.

They broadcast uniquely coded, but quite low level signals at frequencies in the 1200 and 1600 MHz range. The signals are way too weak to pick up on an ordinary radio receiver, but a specialized GPS receiver easily picks them up by using a small antenna. At least in most outdoor locations which have a patch of visible sky.

When you process the signals from three or more satellites, your current latitude, longitude, and elevation can be found. Velocity, too.

How accurate? Well that depends. The military reserves their option of fouling up the works for no apparent reason. By way of their wonderful "selective availability" option. With selective availability off, your typical accuracy is 100 feet or so. But more like 500 when activated.

Naturally, workarounds to selective availability got hacked long ago. By going to a *differential*

system, you can easily pick up accuracy in the twenty foot range. And down to five feet at extra hassle. The differential system works by having one fixed and one movable station. By comparing where the fixed station says it is to where it really is, you correct errors.

Since the corrections are useful over many tens of miles, commercial FM stations are newly transmitting GPS corrections on a sub-carrier.

By going to fancy systems and long term measurements, GPS accuracy to better than one inch is possible.

There's also a technically superior Russky system known as GLONASS. Often used for European coverage.

A real cute example of what all of them French veterinarians call a "four paw" sure came down recently. One expensive and high profile full color ad of a GPS receiver sitting on a topo map. Proudly proclaiming its extreme accuracies. While it displayed a *four hundred mile error*! Naturally, their photo studio was nowhere near the location on the topo map.

Do beware of ancient GPS receiver technology now being dumped to the distressed yuppie surplus houses. Our helpline lore reports the original *Sony PIXIS* is especially disappointing. The latest receivers are *much* better and actually lower cost than any of their deeply discounted ancestors. Insist on five simultaneous channels.

The leading trade journal here is *GPS World*. Who also occasionally do publish a *GPS World Product Showcase* tabloid shopper, as well. One leading receiver manufacturer is *Trimble*, who offer several fine GPS tutorials. The best GPS technical papers come down from the *Institute of Navigation*. One good resource for related books and such is the *Navtech Bookstore*.

Smith Charts

Serious high frequency designers have to know and use Smith Charts. If you don't know what one is, you have no business trying to design anything above 100 MHz.

If you do know about these, we've got lots of roll-your-own Smith charts available as SMITHCHT.PS.

Really Far Out

One high frequency opportunity is still going begging. What I call the *mystery band* lies

RESOURCE BIN

between 300 GHz and 10 THz. *Submillimeter wavelengths or quasi-optical frequencies.* This area covers 9.7 TeraHertz. That's enough for 1,600,000 HDTV signals. But it is almost totally unused.

Except possibly for the occasional radio astronomer or two.

This spectrum is unregulated! Until recently, there's been no good amplifiers or oscillators for this band, but that's about to change.

The final open spectrum frontier is likely to turn into a stampede.

Your finest scientific journal here seems to be the *International Journal of Infrared and Submillimeter Waves*. Two related resources here are the *Society of Amateur Radio Astronomers* and the *Radio Observer* newsletter.

More info on hacking the mystery band appears in HACK84.PS.

This Month's Contest

For our contest this month, just tell me about any unusual high frequency resource. Or any related opportunity.

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. **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 (520) 428-4073, besides offering all of his own books, reprints, and all of his consulting services. He also has a free catalog full of his resource secrets waiting for you. Your best calling times are 8-5 on weekdays, Mountain Standard Time.

Don is now the sysop of GENIE PSRT, where a special Resource Bin topic has been reserved for Nuts & Volts readers. For modem access: (800) 638-8369. When prompted, enter JOINGENIE. When asked for a keyword, enter DMD524.

You can also reach Don at Synergetics, Box 809, Thatcher, AZ 85552. Or send any messages to his Internet address of SYNERGETICS@GENIE.GEIS.COM

#80 TEST EQUIPMENT cont.

NORTH ATLANTIC 321A Wideband Phase Angle Voltmeter; 5310 Electronic Synchro/resolver simulator, GPIB/BCD. 619-439-1345.

TEST EQUIPMENT, ETC: HP 7580B 8-pen drafting plotter, sizes A-D, \$1,475; **Fluke 540B** thermal transfer standard, \$1,500; **Tek 1105** portable battery-operated inverter, for 465, 475, etc. scopes, and TM 500 series mainframes, \$195; **HP 59401A** bus system analyzer for GPIB, \$675; **Tek 390AD** dual-channel waveform digitizer, \$600; **HP 214B** high-power pulse generator, \$1,750; **HP 3575A** gain-phase meter (dual display), \$700; **HP 6002A** autoranging 200 watt power supply, \$750; **HP 6227B** 0-25V 0-2.0A dual tracking lab power supply, \$475; **HP 6443B** 0-120V 0-2.5A power supply, \$450. **Kikusui PLZ 300W** electronic load, \$600; **HP 8405A** vector voltmeter, \$395; **HP 8015A** 50MHz pulse generator, \$425; **GR 1689** LCR meter, \$2,400; **BMI 4800** and **Dranetz 606**, 626 printing power line disturbance monitors. Call, excellent condition! All with warranty. **Pepper Systems**, 214-353-0257.

WANTED AUSTRON Satellite Receiver; **TRAK SYSTEMS** GPS Station Clock; **EL-DORADO** Model 784 Time Meter. Call Bill Scolnik, 1-800-634-7036.

METERS: HP 3455A 6-1/2 digit multimeter, \$550; **Tek DM 501A** 4-1/2 digit multimeter, \$250; **Tek DM 502A** auto-ranging multimeter, \$215. **Pepper Systems**, 214-353-0257.

TEK P6006 X10 Scope Probe with accessories \$15. **Boonton 82AD** Modulation Meter \$850. **Fluke 730A** DC Transfer Standard \$550. **Sorenson SRL20-12** DC Power Supply \$245. **Bob Morgan** Test Equipment Sales. Ph/FAX 717-842-1534.

SIGNAL GENERATORS: HEWLETT PACKARD 8614A, 800-2400MHz or HEWLETT PACKARD 8616A, 1800-4500MHz \$195. **ISA**, PO Box 6955, Laguna Niguel, CA 92607. 714-495-5566, FAX 714-495-4742.

RF EQUIPMENT: HP 5342A 18GHz microwave counter, \$1,900; **HP 5342A/1** 18GHz microwave counter (oven time base), \$2,200; **Tek 4921/2,3** spectrum analyzer, 50KHz through 21GHz, 100Hz resolution bandwidth, digital storage, internal pre-selector, CRT readout, calibrated, \$8,000; **Tek TR 503.1** to 1800MHz tracking generator, calibrated, \$1,400; **Tek SW 503/1** 400MHz sweep generator, \$325; **HP 3403C/3,6** true RMS digital voltmeter (DC - 100MHz, autoranging, remote control, dB display), \$375; **HP 8660C/005**, 100 synthesized signal generator mainframe, \$1,700; **HP 86222B**.01 to 2.4GHz sweep oscillator plug-in, \$1,600; **HP 8505A** RF network analyzer - .5 to 1300MHz, 100 dB dynamic range, with phase-lock option 005 and HP 8501A storage normalizer. Bright CRT, \$3,700. Excellent condition, with warranty. **Pepper Systems**, 214-353-0257.

TERTRONIX 491 Spectrum analyzer, 10MHz-12.4GHz. \$600. **HP 5340A** microwave counter, 10Hz-18GHz \$1,000. **Fluke 8502A**, 6.5 digit multimeter, opt. 1, 2, 3, 4, 5, \$600. **HP 8553B** spectrum analyzer plug-in, \$250. **HP 1741A**, 100MHz, dual trace storage scope, \$350. Call for list of others. **Don Phelps**, WA6IPQ. 909-279-7347.

141T SPECTRUM analyzer plug-ins: HP 8553B 110MHz R/F \$250; HP 8552B I/F \$395; **HP8406A** Comb Generator for calibrating 141T system, brand new \$350; 141T cable clones: tracking generator, preselector \$95; **HP8505/8754**, etc. network analyzer cables \$135. Others. Call Wade, 309-523-3262.

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TEK 1410/SPG3/TSG2/TSG3 NTSC TV signal generator, like new \$950. **Tek 146** NTSC signal generator \$500. **Wavetek 1062** RF signal generator, new, \$475. **HP 355D/01** attenuator, new, \$75. **Wavetek 1084** microwave signal generator \$400. **Marconi TF2300A** modulation meter \$250. **Naptech**, 707-928-1961.

EIP 351D 0-18 GHz counters \$1,295 ea. 1-800-435-1516.

DIGITAL C,L METERS. 4 and 4 1/2 digits, several models to choose from, 30 day money back/3 year repair warranty. Large LED display, small, rugged aluminum box. Test frequency 10MHz/1MHz down to 1KHz. Accuracy: $\pm 0.2\%$. Resolution: 0.0001pF/0.001pF & 0.0001 μ H/0.001 μ H. Test signal: sinewave 0.1V/1V analog output, many more features. Best performance/price ratio, available today with prices starting at \$360. **DIGITAL PHASE METERS.** 3Hz to 30MHz, 0.01° accuracy, 1/2 LED display. Features: auto gain/attenuation, no adjustments, accept any wave forms, same mechanical features and warranty terms. Price \$670. All equipment is manufactured in the USA by **TBE ELECTRONICS**, PO Box 42, Candor, NY 13743. Ph: 607-659-3030.

CARVER: TWO column press; up to 25 metric tons of pressure. Contains 2.95" x 10" steel heating and chilling platens with individual Fenwal controls. \$2,000. **ISE**, Ph: 210-350-5555, FAX: 210-350-5574.

LOGIC ANALYZER 64 bit TTL analyzer Max sample rate 40MHz. 32K trace buffer. Powerful 64 bit comparator circuit for triggering or compare store. Four trigger levels. Works off PC printer port. Data displayed on PC or laptop screen. Compact, portable measures 7 1/4" x 11" x 1 1/2". \$950. For information contact: **Data Trace, Inc.**, 404-394-5918, FAX: 404-394-0199.

FOR SALE: Dolch Logic analyzer model PALAS 40C50 with 6 Logic probes. Paid \$12,000, will sacrifice for \$5,000 or best offer. Call Nova, 516-582-2250 or FAX 516-582-2267.

WANTED AUSTRON 2090A Synchronous filter, **AUSTRON 2110A/B** disciplined standard. Call Bill Scolnik, 1-800-634-7036 or FAX 1-800-788-5005.

ELECTRONIC EQUIPMENT, surplus, misc. electronic and scientific equipment. For list contact T-Minus-7, 45845 Warm Springs Blvd. #F, Fremont, CA 94539. 510-651-9477, FAX 510-651-3657.

NETWORK ANALYZER HP 8660A/86601A/8707A, used vacuum tubes, Trygon P/S W5C40-30-0V, Fluke 415B KVP/S. E-Mail N1176R@aol.com, Mountain Surplus, PO Box 1366, Cedar Crest, NM 87008. 505-281-6450, FAX 505-281-7477.

TEKTRONIX 528A waveform monitor with service manual \$1,000 or best offer. 904-763-5540.

WESTERN REGION

MARCH 4

CA - SANTEE — Ham Radio, Computer & Electronics Swap Meet. **SPONSOR:** ARC of El Cajon. **LOCATION:** Santee Drive-In, 10990 N. Woodside. **HOURS:** 6:30am-7. **ADMISSION:** 50¢. **TALK-IN:** 146.520. **FEATURES:** C - E - F - R - H. **DEALER INFO:** \$6 vehicle. **CONTACT:** Pat, WA6MHZ, ARCEC, Box 50, El Cajon CA 92020. 619-561-0052.

MARCH 4-5

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

MARCH 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+ (PL 94.8) fr west, 145.350- (PL 100) fr east. **FEATURES:** E - H - FP - F/R. **DEALER INFO:** Setup after 7am only. \$15 space fee. Covered spaces avail. If rain. **CONTACT:** Noel Anklam KC6QZK, 510-447-3857 eves. or 510-783-2803 message days.

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

MARCH 11

AZ - SCOTTSDALE — ARRL Hamfest. **SPONSOR:** FARE and ARCA. **CONTACT:** Clifford Hauser, KD6XH, 8741 N. Hollybrook Ave., Tucson, AZ 85741. 602-744-9095.

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.*

MARCH 11-12

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

MARCH 12

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

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

MARCH 18

CA - ANAHEIM — Computer Show & Sale. **LOCATION:** Anaheim Stadium. **HOURS:** 10am-4pm. **ADMISSION:** \$4, 12 & under free. **FEATURES:** C - DP. **CONTACT:** Robert Austin Corp., 1209 Howard Ave., Suite 200, Burlingame, CA 94010.

CA - SANTEE — Ham Radio, Computer & Electronics Swap Meet. **SPONSOR:** ARC of El Cajon. **LOCATION:** Santee Drive-In, 10990 N. Woodside. **HOURS:** 6:30am-7. **ADMISSION:** 50¢. **TALK-IN:** 146.520. **FEATURES:** C - E - F - R - H. **DEALER INFO:** \$6 vehicle. **CONTACT:** Pat, WA6MHZ, ARCEC, Box 50, El Cajon CA 92020. 619-561-0052.

MARCH 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.*

MARCH 19

AZ - PHOENIX — Computer & Electronic Swap Meet. **SPONSOR:** Electronic Materials & Computers. **HOURS:** 8am-3pm. **ADMISSION:** Free. **FEATURES:** FP. **DEALER INFO:** Vendor spaces \$15. **CONTACT:** 3102 W Thomas Rd. #902, Phoenix AZ 85017. 602-272-3200.

OR - MILTON FREEWATER — 49th Annual W7DP Swapfest. **SPONSOR:** Walla Walla Valley ARC.

Events CALENDAR

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.

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**

LOCATION: Milton Freewater Community Center. **HOURS:** 8am-3pm. **ADMISSION:** Free with sign-in. **TALK-IN:** 147.280. **FEATURES:** DP - F/R. **DEALER INFO:** Swap tables; radio gear & related equipment only. **CONTACT:** David L. Pence, KB7WRT, 810 E. Sumach St., Walla Walla WA 99362-1348. 509-525-2529.

MARCH 25

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

MARCH 25-26

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.*

MARCH 26

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

MARCH 27-28-29-30-31

CA - SANTA CLARA — PCI Bus Industry Conference & Exposition. **SPONSOR:** Annabooks & EDN. **LOCATION:** Santa Clara Westin Hotel & Convention Center. **FEATURES:** C - S. **CONTACT:** Chip Stockton, PCI '95 Conference Mgr., c/o Annabooks, POB 271078, San Diego CA 92128-2417. 619-673-0870, 619-673-1432 FAX, CompuServe 73204.3405.

APRIL 1

CA - HANFORD — Hams & Hackers Swapmeet. **SPONSOR:** The Kings ARC. **LOCATION:** Hanford Fraternal Hall, 10th Ave. at Florida. **HOURS:** 8am-7. **ADMISSION:** Free. **TALK-IN:** 145.11, 147.33 (PL 100). **FEATURES:** C - DP - E - F/R - H. **DEALER INFO:** Tables \$5. **CONTACT:** Doug, KG6BGQ, 209-582-0949 or 209-584-5414.

CA - SANTEE — Ham Radio, Computer & Electronics Swap Meet. **SPONSOR:** ARC of El Cajon. **LOCATION:** Santee Drive-In, 10990 N. Woodside. **HOURS:** 6:30am-7. **ADMISSION:** 50¢. **TALK-IN:** 146.520. **FEATURES:** C - E - F - R - H. **DEALER INFO:** \$6 vehicle. **CONTACT:** Pat, WA6MHZ, ARCEC, Box 50, El Cajon CA 92020. 619-561-0052.

WA - SPOKANE — Hamfest & Computer Show. **SPONSOR:** Inland Northwest Hamfest Association. **LOCATION:** Spokane Interstate Fairgrounds. **HOURS:** 9am-5pm. **ADMISSION:** \$6 adv., \$7 door, 12 & under free. **FEATURES:** CB - EX - S. **DEALER INFO:** Swap tables \$13. Dealer tables \$13 + dealer & one person free. Set-up Fri. March 31st 9am-6pm. **CONTACT:** Warren Kelsey, S. 1405 Crestline, Spokane WA 99203.

APRIL 1-2

WA - SPOKANE — ARRL Hamfest. **SPONSOR:** Inland Northwest Hamfest Assoc. **CONTACT:** Warren Kelsey, KJ7BB, 1405 S. Crestline, Spokane WA 99203. 509-534-8443.

APRIL 2

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+ (PL 94.8) fr west, 145.350- (PL 100) fr east. **FEATURES:** E - H - FP - F/R. **DEALER INFO:** Setup after 7am only. \$10 space fee. Covered spaces avail. If rain. **CONTACT:** Noel Anklam KC6QZK, 510-447-3857 eves. or 510-783-2803 message days.

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

APRIL 8

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

APRIL 9

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

APRIL 15

CA - ANAHEIM — Computer Show & Sale. **LOCATION:** Anaheim Stadium. **HOURS:** 10am-4pm. **ADMISSION:** \$4, 12 & under free. **FEATURES:** C - DP. **CONTACT:** Robert Austin Corp., 1209 Howard Ave., Suite 200, Burlingame, CA 94010.

CA - SAN DIEGO — MarketPro Computer Show &

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

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:** ARC of El Cajon. **LOCATION:** Santee Drive-In, 10990 N. Woodside. **HOURS:** 6:30am-7. **ADMISSION:** 50¢. **TALK-IN:** 146.520. **FEATURES:** C - E - F - R - H. **DEALER INFO:** \$6 vehicle. **CONTACT:** Pat, WA6MHZ, ARCEC, Box 50, El Cajon CA 92020. 619-561-0052.

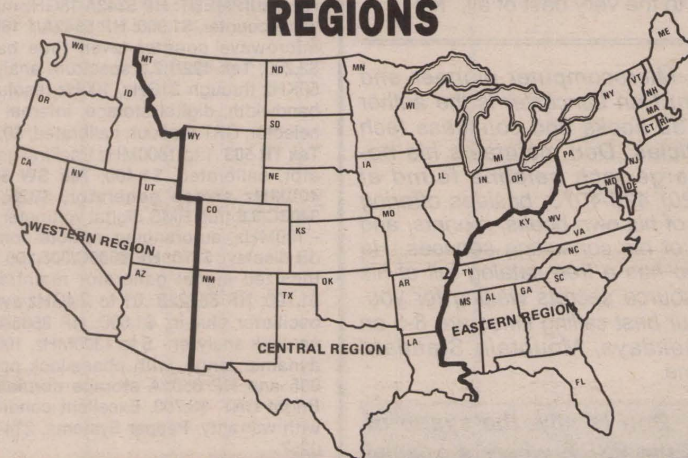
APRIL 19-20-21

NV - LAS VEGAS — Electronic Distribution Show & Conference. **SPONSOR:** Electronic Industries Assoc., Electronics Representatives Assoc., National Electronic Dist. Assoc. **LOCATION:** Las Vegas Hilton. **HOURS:** Wed/Thu: 9am-5pm; Fri: 9am-3pm. **ADMISSION:** Closed Door to Camp Followers. Admittance only to exhibiting manufacturers (except newcomers evaluating EDS for future participation). **FEATURES:** AC - CB - E - S. **CONTACT:** Show Manager - Gretchen Oie, 312-648-1140.

APRIL 22-23

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

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
- RV-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

CMA Computer Shows - 804-272-1570

KGP Computer Shows - 908-297-2526

MarketPro Computer Shows:

West (CA) - 415-388-8893

East (MD, OH, PA, VA) - 301-365-9696

N.E. (CT, MA, NJ, NY, RI) - 201-265-1075

NARISAM Computer Shows - 404-663-0983
800-436-6707

Northern Computer Shows - 508-744-8440

Events CALENDAR

FEATURES: C. **CONTACT:** MarketPro Computer Shows.*

APRIL 29

CA - SONOMA — Hamfest. **SPONSOR:** Sonoma Veterans of the Moon ARC. **LOCATION:** Sonoma Veterans Memorial Bldg., 126 First St. East. **HOURS:** 8am-4pm. **ADMISSION:** Free. **TALK-IN:** 145.35, 148.85, & 147.48 Simplex. **FEATURES:** E - EX - F - F/R. **CONTACT:** Darrel Jones WD6BOR, 707-996-4494.

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

APRIL 29-30

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.*

APRIL 30

CA - SACRAMENTO — Ham Radio/Computer Swap Meet. **SPONSOR:** CSUS Student ARC. **LOCATION:** California State Univ. at Sacramento, US 50 & Howe Ave. **HOURS:** 7am-12pm. **ADMISSION:** Free. **TALK-IN:** 145.230 (dup PL 162.2). **FEATURES:** F - F/R. **DEALER INFO:** Sellers \$10. **CONTACT:** Gary Webbenhurst, KC6URB, 916-381-6602 evenings.

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

MAY 6

CA - SANTEE — Ham Radio, Computer & Electronics Swap Meet. **SPONSOR:** ARC of El Cajon. **LOCATION:** Santee Drive-In, 10990 N. Woodside. **HOURS:** 6:30am-7:30pm. **ADMISSION:** 50¢. **TALK-IN:** 146.520. **FEATURES:** C - E - F - F/R - H. **DEALER INFO:** \$6/vehicle. **CONTACT:** Pat, WA6MHZ, ARCEC, Box 50, El Cajon CA 92020. 619-561-0052.

MAY 7

CA - LIVERMORE — East Bay Area Amateur Radio/Electronics/Computer Swap Meet. **SPONSOR:** Livermore Amateur Radio Klub (LARK). **LOCATION:** Las Positas College, N of I-580 at Airway Blvd. exit. **HOURS:** 7am-12noon, rain or shine. **ADMISSION:** Free. **TALK-IN:** 147.045 + (PL 94.8) from west, 145.350 (PL 100) from east. **FEATURES:** E - H - F - F/R. **DEALER INFO:** Setup after 7am only. \$10 space fee. Covered spaces avail. if rain. **CONTACT:** Noel Ankam KC6QZK, 510-447-3857 eves or 510-783-2803 message days.

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

MAY 13-14

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

MAY 14

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

MAY 20

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

CA - SANTEE — Ham Radio, Computer & Electronics Swap Meet. **SPONSOR:** ARC of El Cajon. **LOCATION:** Santee Drive-In, 10990 N. Woodside. **HOURS:** 6:30am-7:30pm. **ADMISSION:** 50¢. **TALK-IN:** 146.520. **FEATURES:** C - E - F - F/R - H. **DEALER INFO:** \$6/vehicle. **CONTACT:** Pat, WA6MHZ, ARCEC, Box 50, El Cajon CA 92020. 619-561-0052.

MAY 20-21

WA - YAKIMA — ARRL Hamfest. **SPONSOR:** Yakima ARC. **CONTACT:** Mark Tharp, KB7HDX, POB 2222, Yakima WA 98907. 509-965-3379.

MAY 21

AZ - PHOENIX — Computer & Electronic Swap Meet. **SPONSOR:** Electronic Materials & Computers. **HOURS:** 8am-3pm. **ADMISSION:** Free. **FEATURES:** FP. **DEALER INFO:** Vendor spaces \$15. **CONTACT:** 3102 W. Thomas Rd. #902, Phoenix

AZ 85017. 602-272-3200.

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

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

CENTRAL REGION

MARCH 4

IA - CEDAR RAPIDS — 12th Annual Eastern Iowa Computer Fair. **SPONSOR:** Commo-Hawk Computer Users Group. **LOCATION:** Teamsters Union Hall, 5000 J St. SW. **HOURS:** 8am-6pm. **ADMISSION:** \$2 donation. **CONTACT:** Leland Hosford at 319-393-4631 (voice, evening), 319-393-4852 (FAX), leland@ins.infonet.net (Internet).

MI - WATERFORD — Computer Trade Show. **LOCATION:** NOCC CAI Building, 5640 Williams Lake Rd., Exit 89 off I-75, go W 3.5 mi. to Walton Blvd., turn right. **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.

OK - ELK CITY — Hamfest. **SPONSOR:** W. Central OK ARC. **LOCATION:** Civic Center, Exit 41 off I-40. **HOURS:** 9am-5pm. **ADMISSION:** \$5 adv., \$8 door. **TALK-IN:** 146.16/76. **CONTACT:** WCOARC, POB 2023, Elk City OK 73648. 405-472-3442 days or 405-473-2572 eves.

MARCH 5

MI - SOUTHGATE — Computer Trade Show. **LOCATION:** Southgate Civic Center, 14700 Dix-Toledo Rd., bet. Northline & Eureka. **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.

MARCH 7-8-9

TX - DALLAS — Computer Telephony Conference & Expo. **LOCATION:** Dallas Convention Center. **ADMISSION:** \$795. **CONTACT:** Computer Telephony, 12 W. 21st St., New York, NY 10010. 212-691-8215, FAX 212-691-1191. E-Mail = Harry Newton @ MCI Mail 101-5032.

MARCH 10

MO - ST. LOUIS — 35th Annual Ham Radio Auction. **SPONSOR:** Jefferson Barracks Amateur Radio Club. **LOCATION:** Concordia Turners Hall, 6432 Gravois Ave. **HOURS:** 7:30pm-7:45pm. **ADMISSION:** Free. **TALK-IN:** 146.34/94, 144.61/145.21. **FEATURES:** F/R. **CONTACT:** Carl H. Hohenberger, WB0BZP, 5266 Parker Ave., St. Louis MO 63139-1340. 314-351-7084.

MARCH 10-11-12

LA - LAFAYETTE — Hamfest. **SPONSOR:** Acadiana ARA. **LOCATION:** Holiday Inn Hollidrome, E. Service Rd. off I-49. **HOURS:** Fri. 5pm-7pm, Sat. 8am-4pm, Sun. 8am-12pm. **ADMISSION:** \$3 adv., \$5 door. **TALK-IN:** 147.63/03, 146.22/82, 144.73/145.33, 147.81/21. **FEATURES:** EX - F. **CONTACT:** Carolyn Oubre, 601 Sugar Mill Rd., New Iberia LA 70560. 318-364-2857.

MARCH 11

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.*

ND - FARGO — Amateur Radio & Computer Fair. **SPONSOR:** Red River Radio Amateurs. **LOCATION:** West Fargo Fair Ground. **HOURS:** 8am-3pm. **ADMISSION:** \$6, 12 and under free. **TALK-IN:** 146.76 WILLO. **FEATURES:** C - H - S. **CONTACT:** ARCEC '95, POB 3215, Fargo ND 58108-3215.

OH - AKRON/MOGADOR — Computer Mania! **SPONSOR:** National Computer Exposition. **LOCATION:** St. Nicholas Social Hall, 755 S. Cleve. Ave., US 224 & Rt. 532 & 3 mi. S1-76 Ex. 29. **HOURS:** 10am-4pm. **ADMISSION:** \$1 off w/ad, under 12 free. **FEATURES:** FP. **DEALER INFO:** Setup 8am-9:45am. Sellouts are common, early booking advised. **CONTACT:** Joe Bowen, 216-442-1776 or Ronald Nelson, FAX: 216-292-7746. National Expo's, Inc., 30799 Pinetree Rd. #230, Cleveland OH 44124.

MARCH 12

IN - INDIANAPOLIS — Indiana Hamfest & Comput-

er Show. **SPONSOR:** Morgan County Repeater Assn. **LOCATION:** Indiana State fairgrounds, Pavilion bldg. **HOURS:** 8am-7. **ADMISSION:** \$7. **TALK-IN:** 147.06. **FEATURES:** C - FM. **DEALER INFO:** 8' table \$15. Setup 3/11 3pm-9pm, 3/12 6am-8am. **CONTACT:** Deanne Martin, N9TEJ, 39 Lake Shore Dr. #14, Martinsville IN 46151. 317-342-4307.

MI - LANSING — Computer Trade Show. **LOCATION:** Holiday Inn South Convention Center, 6820 South Cedar St., Exit #104 off of I-96. **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.

OH - CIRCLEVILLE — Hamfest. **SPONSOR:** Teays ARC. **LOCATION:** Pickaway County Fairgrounds, 4-H Bldg., St. Rt. 22. **HOURS:** 8am-7. **ADMISSION:** \$4 adv., \$5 door. **TALK-IN:** 147.180 +. **FEATURES:** C - DP - FM - F/R - H. **DEALER INFO:** Tables: \$5 adv., \$6 door. **CONTACT:** Dan Grant, WBUCF, 22150 Smith-Hulse Rd., Circleville OH 43113. 614-477-3026.

OH - CLEVELAND — Computer Mania! **SPONSOR:** National Computer Exposition. **LOCATION:** Clarion Hotel, Eastlake, 35000 Curtis Blvd. at Rt. 2 & Rt. 91. **HOURS:** 10am-4pm. **ADMISSION:** \$1 off w/ad, under 12 free. **FEATURES:** FP. **DEALER INFO:** Setup 8am-9:45am. Sellouts are common, early booking advised. **CONTACT:** Joe Bowen, 216-442-1776 or Ronald Nelson, FAX: 216-292-7746. National Expo's, Inc., 30799 Pinetree Rd. #230, Cleveland OH 44124.

OH - CONNEAUT — 9th Annual Hamfest & Computerfest. **SPONSOR:** Conneaut Amateur Radio Club. **LOCATION:** Conneaut Human Resource Center, 327 Mill St. **HOURS:** 8am-3pm. **ADMISSION:** \$4 adv., \$5 door. **TALK-IN:** 147.39. **FEATURES:** C - EX - F/R. **DEALER INFO:** Tables \$8, Setup 6am. **CONTACT:** Clarence Baugher, WB8AS, 109 Daniels Ave., Conneaut, OH 44030-2315. 216-593-3038.

MARCH 18

KS - COLBY — Hamfest. **SPONSOR:** Trojan ARC. **LOCATION:** Colby National Guard Armory on K-25. **HOURS:** 8am-2pm. **ADMISSION:** \$2. **TALK-IN:** 146.82. **FEATURES:** EX - F - F/R. **DEALER INFO:** Tables \$5. **CONTACT:** TARC, POB DX, Colby, KS 67701-0983.

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.

MI - MARSHALL — 34th Annual Michigan Crossroads Hamfest. **SPONSOR:** S. Michigan ARS & Marshall High Photo Electronics Club. **LOCATION:** Marshall High School. **HOURS:** 8:00am-3:00pm. **ADMISSION:** \$3 adv., \$4 door. **TALK-IN:** 146.66 or 146.52. **FEATURES:** C - F - F/R. **DEALER INFO:** Tables \$1 per ft., min. 4 ft., plus admission set up 6:00am. **CONTACT:** Wes Chaney N8BDM, 616-979-3433 or SMARS, POB 934, Battle Creek, MI 49016.

MARCH 18-19

TX - MIDLAND — St. Patrick's Day Swapfest. **SPONSOR:** Midland Amateur Radio Club. **LOCATION:** Midland County Exhibit Bldg. **HOURS:** Sat. 9am-5pm, Sun. 8am-2:30pm. **ADMISSION:** \$7 adv., \$8 door. **FEATURES:** DP - FM. **DEALER INFO:** Tables: 1-2 \$10 ea., 3+ \$15 ea. **CONTACT:** Midland Amateur Radio Club, POB 4401, Midland TX 79704.

MARCH 19

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 - F - F/R - All indoors. **CONTACT:** 24-hour Hotline 708-974-3123.

IL - STERLING — 35th Annual Hamfest. **SPONSOR:** Sterling Rock Falls Amateur Radio Society. **LOCATION:** Sterling High School Field House, 1608 4th Ave. **HOURS:** 7:30am-7. **ADMISSION:** \$3 adv., \$4 door. **TALK-IN:** 146.25/146.85 W9MEP Repeater. **FEATURES:** C - E - FM - F - F/R - H - RV - S. **DEALER INFO:** Tables \$5, w/electricity \$6. Set up Sat. 6pm-9pm, Sun 6:30am. **CONTACT:** Lloyd Sherman, KB9APW, POB 521 Sterling IL 61081-0521. 815-336-2434.

MI - ANN ARBOR — Great Lakes Computer Expo & Sale. **SPONSOR:** Progressive Computer Productions. **LOCATION:** Holiday Inn, US-23 & Plymouth Rd. **HOURS:** 10am-4pm. **ADMISSION:** Adults \$4, Seniors/Students \$3, under 12 free w/adult. **FEATURES:** C - DP - F - F/R - S. **DEALER INFO:** 8' \$35 ea. 12' \$40 ea. **CONTACT:** Progressive Computer Productions, 23814 Michigan Ave., Ste 237, Dearborn MI 48124. 313-425-9276.

MI - MADISON HEIGHTS — Computer Trade Show. **LOCATION:** 876 Horace Brown Dr., 1 blk. E of I-75.

3 blks. S of 13 Mile Road. **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.

OH - COLUMBUS — Columbus Computer Fair. **LOCATION:** Comfort Inn North, off I-71 on Granville-Dublin. **CONTACT:** Ben Yanto, AGI Computer Fairs.*

OH - MAUMEE — Hamfest/Computer Fair. **SPONSOR:** Toledo Mobile Radio Assoc. **HOURS:** 8:00am-3:00pm. **ADMISSION:** \$4 adv., \$5 door. **DEALER INFO:** Tables before March 1; \$15 & \$20. After March 1; all tables \$25. **CONTACT:** Bob Mann N8UPT, 8035 Lewis Ave., Temperance, MI 48182.

WI - JEFFERSON — Hamfest. **SPONSOR:** Tri County Amateur Radio Club. **LOCATION:** Jefferson County Fairgrounds. **HOURS:** 8am-7. **ADMISSION:** \$4. **DEALER INFO:** 6' tables \$5. Set up 7am. **CONTACT:** W9MQB, 213 Frederick St., Ft. Atkinson WI 53538. 414-563-6381 eves.

MARCH 25

IN - MICHIGAN CITY — Hamfest & Computer Flea market. **SPONSOR:** Michigan City Amateur Radio Club. **LOCATION:** Rogers High School, 8466 Pahs Rd. **HOURS:** 8am-2pm. **ADMISSION:** \$4. **TALK-IN:** 146.37/97 (131.8 Hz PI). **FEATURES:** CB - FM - H. **DEALER INFO:** 6' tables \$6, elec. hook-ups \$2. Early set up for vendors. **CONTACT:** Ron Stahovik, N9TPC, 213 So. Dickson St., Michigan City IN 46360. 219-872-6594.

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 - F/R - S. **DEALER INFO:** 8' \$35 ea. 12' \$40 ea. **CONTACT:** Progressive Computer Productions, 23814 Michigan Ave., Ste 237, Dearborn MI 48124. 313-425-9276.

TX - TEXARKANA — ARRL Hamfest. **SPONSOR:** Four States ARC. **CONTACT:** Tom Comstock, N5TC, 1700 Dominik, College Station TX 77840. 409-693-1181.

MARCH 26

IL - GRAYS LAKE — 16th Annual Lamarsfest '95. **SPONSOR:** Libertyville & Mundelein ARS. **LOCATION:** Lake County Fairgrounds, Rts. IL-120 & US-45. **HOURS:** 8am-2pm. **ADMISSION:** \$4 adv. w/SAFE, \$5 door. **TALK-IN:** 147.945/345, 146.52. **FEATURES:** C - CB - E - F - F/R - H. **DEALER INFO:** Commercial tables \$25, wall tables \$15, swapfest table \$10. Setup 6am. **CONTACT:** Lamarsfest '95, 650 Green Bay Rd., Lake Bluff IL 60044. Frank Avellone, W9GLO, 708-234-4124 before 10pm.

IL - PALATINE — Computer Central. **LOCATION:** Harper College. **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.

KY - LOUISVILLE — Computer Fair South. **SPONSOR:** MEKA Enterprises, Inc. **LOCATION:** Executive West Hotel, I-65 & 264 Freedom Way at the Fairgrounds. **HOURS:** 10am-3pm. **CONTACT:** William Ibarra, MEKA Enterprises, 2656 E. 2nd St., Bloomington IN 47401. 812-333-4484, FAX: 812-333-4650.

MI - ANN ARBOR — Colossal Computer Sale. **SPONSOR:** Jewish Community Center. **LOCATION:** Washtenaw Community College's Morris Lawrence Bldg. **HOURS:** 9:30am-4pm. **ADMISSION:** \$4. **FEATURES:** C - F/R. **DEALER INFO:** Tables \$30. **CONTACT:** Merle Goldman, 313-971-0990.

MI - DEARBORN — Computer Trade Show. **LOCATION:** Dearborn Civic Center, 15801 Michigan Ave., corner of Greenfield. **HOURS:** 10am-4pm. **ADMISSION:** Adults \$4; Seniors & students w/ID \$3; under 12 free w/adult. **FEATURES:** C - DP. **CONTACT:** Computers & You, 313-283-1754.

MI - FLINT — Five Star Productions Computer 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-4pm. **ADMISSION:** \$4, \$3 w/this ad. **FEATURES:** AC - C - CB - DP - F - F/R. **CONTACT:** Five Star Productions, 2436 Nerredia St., Flint MI 48532. 810-768-6058 (pager), 810-230-0988 (after 4pm).

MARCH 31-APRIL 1

AR - LITTLE ROCK — Little Rock Hamfest & ARRL State Convention. **LOCATION:** Little Rock Expo Center. **HOURS:** Fri. 4pm-9pm, Sat. 8am-5pm. **FEATURES:** AC - CB - F - FM - T. **CONTACT:** Jim Blackmon, KB5IFV, 1008 Pine St., Arkadelphia AR 71923-4919. 501-246-6734 or 501-246-7833.

Continued on page 140

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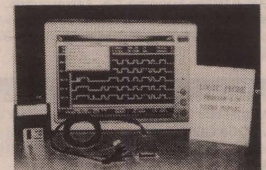
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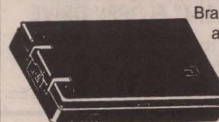
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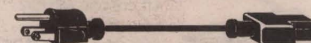


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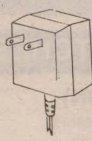
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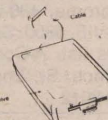
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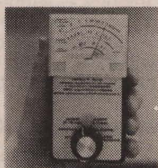
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Nuts & Volts Magazine/March 1995

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Control The World With A Speech Recognition Interface

by
Anthony
Charlton

upon recognition. The active LED will blink off when the next output is activated. This method of lighting just one LED at a time is used to conserve power, lest a power failure occur, and the system will have to shift to a back-up battery (9 or 12 V) for the outage duration.

Low-power CMOS circuitry is used in the SRI, the exception being one TTL IC, which consumes a nominal 40 mA

Consider: A computer that recognizes your voice. Science fiction? Not anymore. One construction article already appeared in this magazine about how to build a Speech Recognition Circuit.

This article will combine the circuits of the previous article and this one to give you a fully functional device that can turn peripheral cir-

cuitry on and off by voice command alone. The system responds to words you have trained into it.

Hereafter, we will refer to the original recognition/training part of the electronic assembly as the (S)peech (R)ecognition (S)ystem or SRS, and the Interface Circuit described in this article as SRI, for (S)peech (R)ecognition (I)nterface.

It is important to reiterate this article presents an add-on to the original SRS construction article, increasing its usefulness greatly.

Locating the Original SRS Construction Article

The first article, entitled "Build This Speech Recognition Circuit" by John Iovine, appears in the Apr. '94 issue of *Nuts & Volts* from pages 22 through 24. It will be necessary to refer to that article if you want to build the SRS/SRI. Back issues are available from *Nuts & Volts* for \$5.00 each; just send your request with payment to their address and a note about which issue you want.

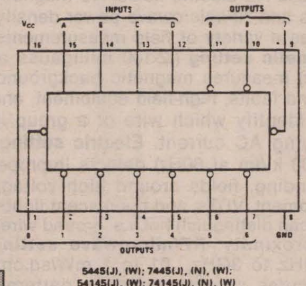
The original SRS had only a numerical LED output. We will add on a decoding system to enable 10 discrete out-

puts, then take you through the circuitry required to interface relays and solid-state control devices for 120 VAC; those devices are called TRIACs. You can then con-

trol a variety of appliances using these options. We'll also show how flip-flops can be added to the output to enable toggling of up to 10 different external appliances, while setting each or all to remain on indefinitely by your spoken command.

The original SRI prototype developed by us allowed only one peripheral device to be turned on at any time, so you will have to add some simple circuitry if you desire to have more than one appliance turned on or off at a time. For convenience, 10 status LEDs correspond to the decoded outputs, and each one will light when that output is activated during either training or

Connection Diagram



1

in the prototype. The CMOS buffer circuitry, consisting of 74C14 Hex Schmitt Triggers, is capable of driving many more loads than its TTL counterpart, and thus is used. CMOS circuitry,

TRUTH TABLE

NO.	INPUTS				OUTPUTS									
	D	C	B	A	0	1	2	3	4	5	6	7	8	9
0	L	L	L	L	L	H	H	H	H	H	H	H	H	H
1	L	L	L	H	L	H	H	H	H	H	H	H	H	H
2	L	L	H	L	L	H	H	H	H	H	H	H	H	H
3	L	L	H	H	L	H	H	H	H	H	H	H	H	H
4	L	H	L	L	L	H	H	H	H	H	H	H	H	H
5	L	H	L	H	L	H	H	H	H	H	H	H	H	H
6	L	H	H	L	L	H	H	H	H	H	H	H	H	H
7	L	H	H	H	L	H	H	H	H	H	H	H	H	H
8	H	L	L	L	L	H	H	H	H	H	H	H	L	H
9	H	L	L	H	L	H	H	H	H	H	H	H	L	H
INVALID	H	L	H	L	L	H	H	H	H	H	H	H	H	H
	H	H	L	L	L	H	H	H	H	H	H	H	H	H
	H	H	L	H	L	H	H	H	H	H	H	H	H	H
	H	H	H	L	L	H	H	H	H	H	H	H	H	H
	H	H	H	H	L	H	H	H	H	H	H	H	H	H

H = High Level (On), L = Low Level (Off)

2

in this case, requires a pull-up resistor on each input when interfaced with TTL circuitry, and that is provided in the design.

We Fix Some Minor Data from the SRS Article

During the complex procedure of writing and processing a magazine article, it is likely a few errorrrrrs (heh, heh) or omissions will creep in with any project. Such as it is with the original SRS

Word Training Pattern

Four iterations of each word are used, as this significantly improves the percentage of recognition. The words cannot be trained redundantly in sequence, as the interface won't respond correctly if that is done. So, one cannot iterate "fish" several times and expect the SRS to access the correct location in its memory, and the SRI decode it properly at the interface. "Fish," by the way, toggles our tropical fish tank's lights. It would look a little strange to guests if one was saying "fish, Fish, Fish! FISH!!!" while looking at the tank and nothing was happening, so proper training is helpful, as you can see. So, a special training pattern must be followed, even if you don't want to use all 10 outputs. You can use any words you like to be recognized.

I chose the following 10 words, each monosyllabic as per the requirements for best performance. Words one through five are essentially test words, and the correct number should appear on the LED of the display when they're spoken. The interface should also turn on the correct LED and whatever driver circuit you've chosen for that corresponding LED. You can replace one through five, or leave them in, but it is suggested to try them initially to test the SRI and your training diction. Here's the prototype's word list, numerical locations, and training pattern; note one is a whistle tone:

Sequence Word

#1 one #2 two #3 three
#4 four #5 five #6 fish
#7 light #8 a pure whistle tone
#9 thank #10 mind

Train as follows, note the sequence is repeated four times:

Location/Word	Location/Word	Location/Word
#01 one	#11 one	#21 one
#31 one	#02 two	#12 two
#22 two	#32 two	#03 three
#13 three	#23 three	#33 three
#04 four	#14 four	#24 four
#34 four	#05 five	#15 five
#25 five	#35 five	#06 fish
#16 fish	#26 fish	#36 fish
#07 light	#17 light	#27 light
#37 light	#08 a whistle	#18 a whistle
#28 a whistle	#38 a whistle	#09 thank
#19 thank	#29 thank	#39 thank
#10 mind	#20 mind	#30 mind
#40 mind		

Take your time, and speak each word slowly, clearly, in a natural voice. But not too slow, or you may be in a different mood when you want the circuit to perform and it won't consistently if you are in a hurry and trained it while perfectly relaxed.

The SRI can also detect speech characterizations. These are a little tricky, since it takes a great deal of practice to utter a word like say "Bond; James Bond," and have it come out each time sounding like Sean Connery or the way you personally imitate his speech.

Anyway, it's no harm, doesn't cost anything, and such experiments are a lot of fun!

article. I have taken the liberty of renumbering part of the pertinent schematics and re-doing the Parts List so that it corrects any loose ends and clarifies the project. The same always applies to my article(s) too; I have willingly accepted constructive criticisms from the readers of same in the interest of writing better articles. We'll point out any of the "fixes" for you as we go along, either in text, or on drawings, and please be sure and note the differences when you construct the project so that it will go together without confusion and work with the new, add-on interface circuit without a glitch.

To make construction easier, we have re-published the corrected SRS's Schematic, a foil-side PC Board Pattern (the original was component side), rebuilt the Parts List adding additional Sources, and created a Parts Placement Diagram, also depicting the foil side. This should make your understanding more solid. We have included all the information, instructions, and tips you will need to build the add-on SRI circuit and to improve upon the voice-recognition performance of the SRS.

Let the Application Engineer Beware!

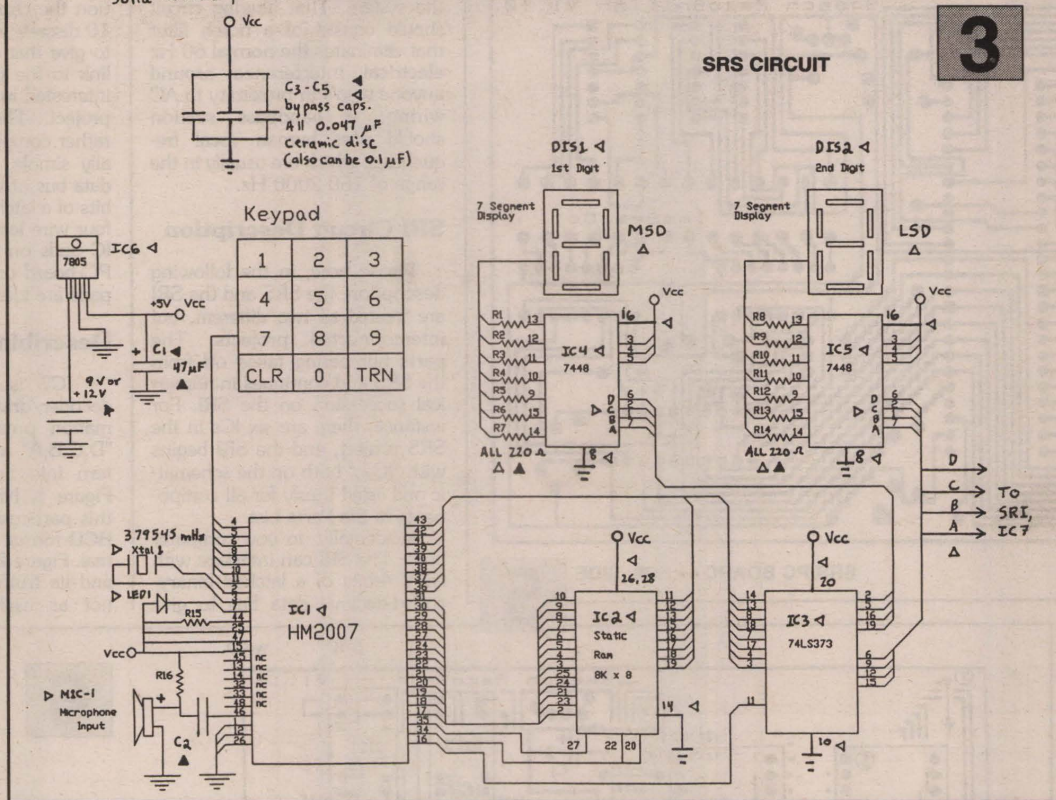
It MUST be noted, BEFORE we begin describing the circuits, this project ABSOLUTELY, POSITIVELY SHOULD NEVER BE CONNECTED TO AN APPLIANCE THAT COULD THREATEN YOUR SAFETY MIGHT IT FAIL TO RESPOND TO YOUR VOICE! Such applications in this category are many, but voice-operated wheelchairs, medical equipment, and cooking appliances immediately come to mind as dumb things to assign this system to control. Why? Well, an experimenter-level, inexpensive system is simply not yet error-proof enough at this time in the evolution of speech-recognition technology to trust it with tasks that require consistent reliability. Let us enjoy it for what it is, despite its limitations. There are many wonderful applications of the circuit that you can find which DON'T involve any dependency-related risk.

Also, each interface will be activated during training. Turn off all connected appliances at their power switches during training, or they will sequence on as you train.

Speech Recognition in the Real World

You can train this intelligent system to react to your voice or other persons. This circuit should be a real boon to the physically challenged or to someone recovering from a health problem that impairs his or her locomotion. You can turn your TV, VCR, stereo, radio, lamps, fishtank lights, outside, and garage lights, and so forth, on and off using

Solid arrows point to error correction, hollow ones to schematic additions



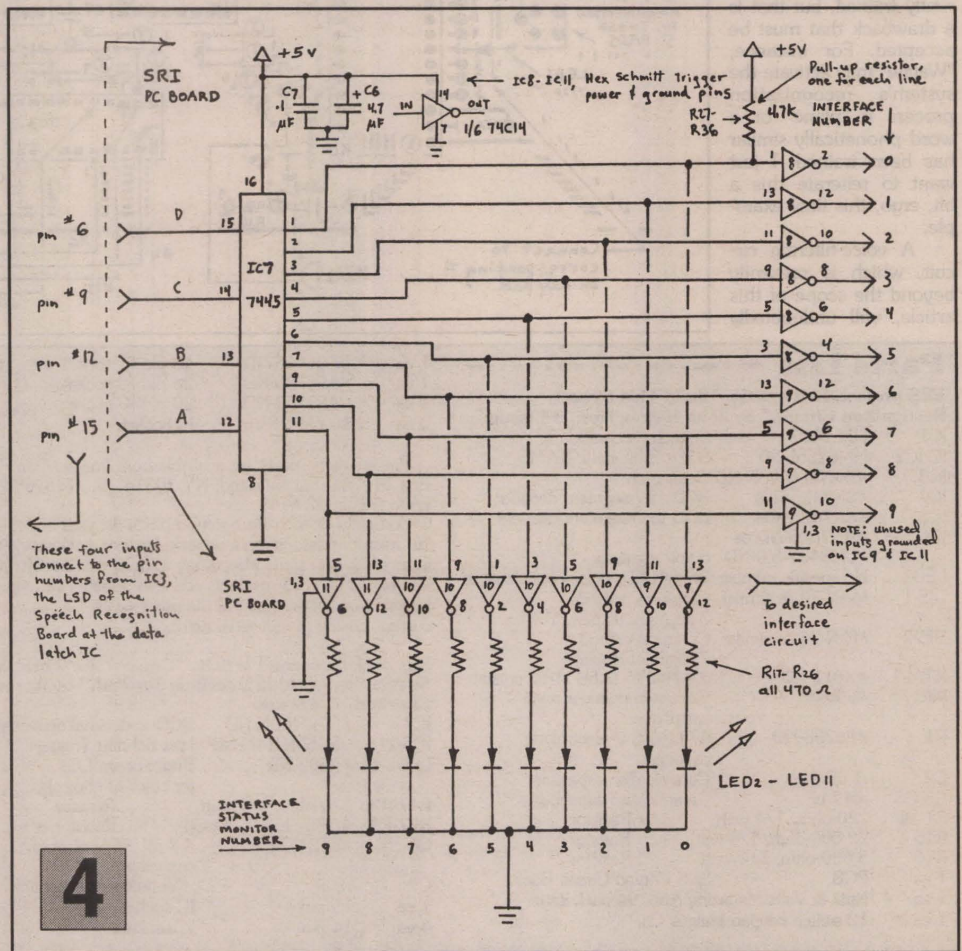
your voice, or educate the system to respond to another person's voice, as well. Up to 10 different words may be used to control, as mentioned, 10 different appliances.

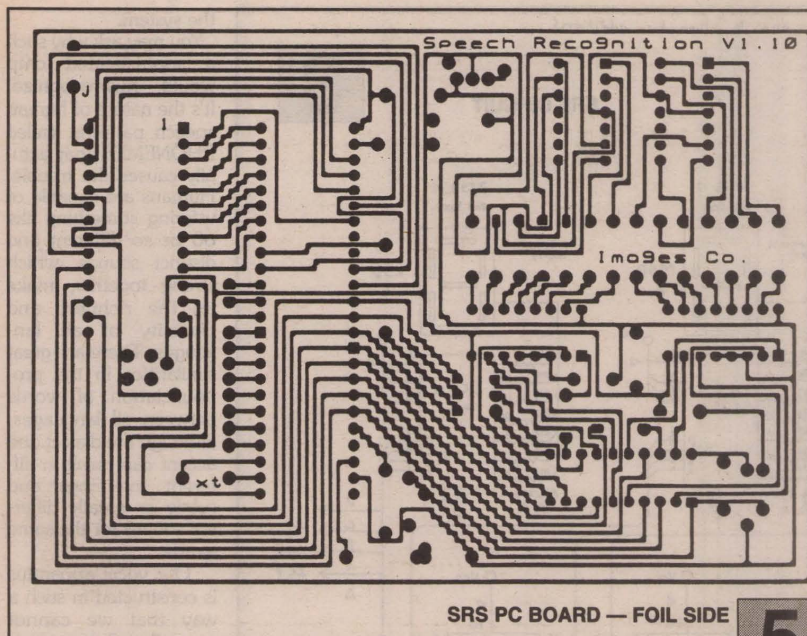
The heart of the SRS is the HM-2007 integrated circuit — a very extraordinary accomplishment of integrated circuit technology by itself. This dedicated IC has the ability to input voice, store the pattern in memory, and output the recognized word on its data bus. The outputted word is equal to the sequence in which it was input. After a word is trained, it is stored in external memory; in this case, an 8K by 8 bit low-power static RAM. It is important to remember that the word that was trained mustn't conflict phonetically with any other trained word. Let's take an example.

Say you trained the Japanese word "kami" which means paper, I think (just starting to learn some simple Japanese). If you spoke the word "Connie" the SRS would probably respond to that as "kami" because they are phonetically similar. Note: the first few letters or

similar sounds in the spoken word are what the SRS, in its constant attention to decipher, would react to. Similarly, the Japanese word "kai," pronounced quite like the English "hi" or "high," may also result in false recognition if either or both these words were also trained to

imitate perfectly the sonorous voice of a cello, or boom of a bass drum, or chop-chop whirl of a helicopter blade. We can imitate, but the quality of reproduction breaks down if you analyze the audio spectrum of human vs. non-human sound sources in detail. The HM-2007





SRS PC BOARD — FOIL SIDE

5

will recognize phonemes in any language, provided they are spoken at the same speed and pitch. And cross-recognize those phonemes to a degree. Despite this linguistic catch, the chip still performs remarkably well. I find it has about a 75% ability to recognize a trained word on the first utterance. Admittedly, the chip will often try and assign a recognition to a word that is not currently trained, but that is a drawback that must be accepted. For instance, "Wayne" may activate the system's recognition process if "plane" or a word phonetically similar has been trained; I just want to reiterate this a bit, ergo, this final example.

A voice-filtering circuit, which is presently beyond the scope of this article, will undoubtedly

serve to increase the reliability of the system. That filtering circuit should consist of a notch filter that eliminates the normal 60 Hz electrical interference around anyone who's in proximity to AC wiring. A bandpass section should pass human vocal frequencies, which are usually in the range of 150-2000 Hz.

SRI Circuit Description

Please note, in the following description, the SRS and the SRI are treated as two different, but interconnected projects. The parts numbering takes off from the SRS and continues in numerical succession on the SRI. For instance, there are six ICs in the SRS project, and the SRI begins with "IC7," both on the schematic and listed thusly for all components in the Parts List.

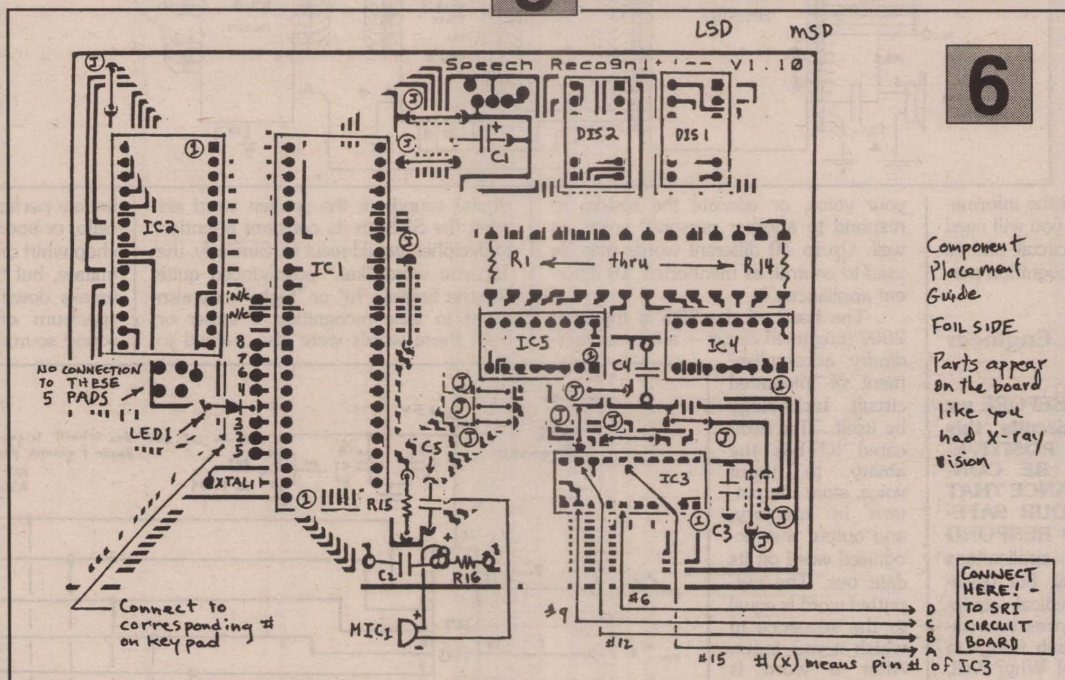
Incidentally, to you computer buffs: The SRI can interface with ANY 4-bits of a latched binary-coded-decimal data bus to give

ANY project with this type of connection the capability for controlling up to 10 discrete external devices. We wanted to give that capability without forcing a link to the prior SRS project for those interested in this particular construction project. The SRI circuit, despite its rather complex appearance, is functionally simple. It attaches to the latched data bus of the SRS circuit (or any four-bits of a latched TTL-level data bus) with four wire leads, carefully soldered to the IC pads on the solder side of the SRS PC board or to another project. Those pads are identified in Figure 6

Describing the SRI Circuit

IC7 is a 7445 BCD-to-Decimal decoder/driver chip. It takes the information present at its inputs, labeled "D,C,B,A" and converts this logic pattern into an output that appears in Figure 1. Note that the active logic of this particular chip equals Logic "0," in BCD format for (B)inary (C)oded (D)ecimal. Figure 2 shows the pinout of the IC and its truth table. Logic 0 signals are not as useful to turn on peripheral devices as Logic 1 active. Besides, it's mentally confusing to some to have a zero turn ON a device. So, we use three 74C14 Schmitt Trigger ICs in order to invert the Logic 0 signal to a more understandable Logic 1 and to increase the drive power of IC7, so it may both drive the interface status monitor LEDs and drive the interfaces themselves. The Schmitt Trigger is an inexpensive IC, and is has very good digital noise immunity, while also providing adequate drive current for any reasonable load. Since the Schmitt Triggers are CMOS technology, the loading on IC7 is almost negligible.

IC8 and part of IC9 serve to drive whatever interface circuitry you



6

Component Placement Guide

Foil Side

Parts appear on the board like you had X-ray vision

CONNECT HERE! - TO SRI CIRCUIT BOARD

Parts List

SRS project, first article, "Build This Speech Recognition Circuit," by John Iovine, Apr. '94 issue:

IC1	HM 2007	Speech recognition
IC2	HM6265L-90	8 K x 8 bit static RAM
IC3	#DM74LS373N-ND	Octal latch
IC4	#SN74LS48N	BCD to 7-segment decoder
IC5	#SN74LS48N	BCD to 7-segment decoder
IC6	#AN7805-ND or #LM340T-5.0-ND	5 volt regulator
LED1	No specific number	Bright LED, color of preference
DIS-1	MAN-74 or similar	Common cathode 7-segment display
DIS-2	MAN-74 or similar	Common cathode 7-segment display
XTAL1	#X011-ND	3 579 545 (3.58 MHz) crystal
MIC-1	#P9949	Electret condenser mike cartridge
C1	#P6238-ND	47 uF, 25 V electrolytic capacitor
C2	.1 uF	Ceramic disc capacitor
C3-C5	.047 uF	Ceramic disc capacitor
R1-14	220-ohm, 1/4 watt	Resistor
R15	22,000-ohm, 1/4 watt	Resistor
R16	5,600-ohm, 1/4 watt	Resistor
1 ea	PCB	SRS Printed Circuit Board
1 ea	Nuts & Volts Magazine Apr. '94 back issue	
1 ea	12 switch keypad	Images Co.

1 ea	#A95486-ND	48 pin IC socket
1 ea	#A95286-ND	28 pin IC socket
1 ea	#A95203-ND	20 pin IC socket
2 ea	16 pin	IC socket

The following parts are available from Images Co., P.O. Box 140742, Staten Island, NY 10314; ph: (718) 698-8305, FAX: (718) 982-6145

Complete Speech Recognition (SRS) Kit (less SRI interface kit, microphone, microphone jack, battery, enclosure, Apr. '94 issue of Nuts & Volts Magazine): \$75.00 plus \$5.00 shipping and handling. NYS residents add appropriate sales tax. Images also carries most of the other parts. Call or write for current pricing of individual items.

SRI project, second article, "Control the World with a Speech Recognition Interface System!," by Anthony Charlton, this issue.

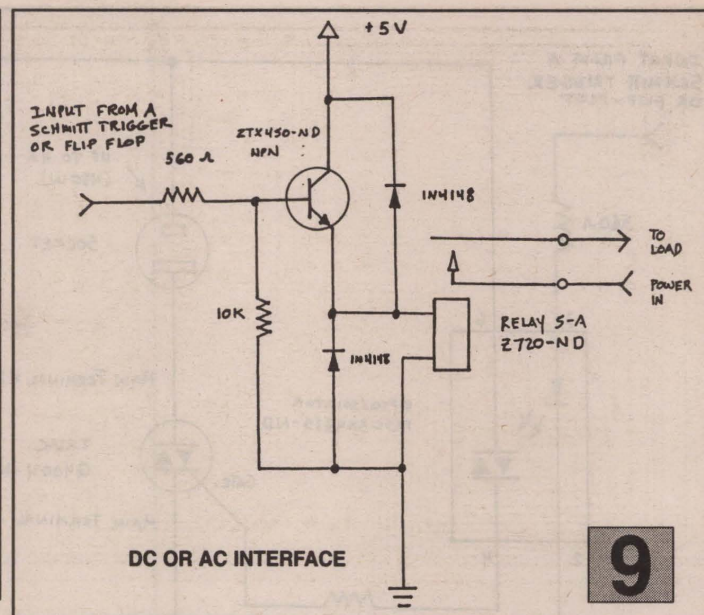
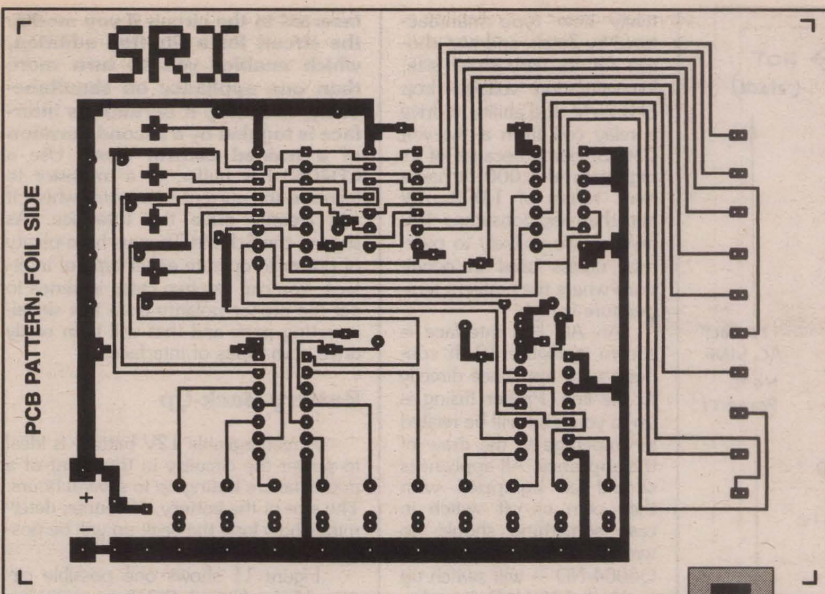
IC7	#DM7445N-ND	BCD-to-decimal decoder/driver
IC8-11	#MM74C14N-ND	Hex Schmitt Trigger
LED2-11	#P302-ND	Bright green LED (or color of choice)
R17-R26	470-ohm, 1/4 watt	Resistor
R27-R36	4,700-ohm, 1/4 watt	Resistor
C6	#P6247-ND	4.7 uF, 35 V electrolytic capacitor
C7	.1 uF	Ceramic disc capacitor
1 ea	16 pin	IC socket
4 ea	14 pin	IC socket

Peripheral Driver Interfaces Parts List

DC / AC Interface (1 for each Interface):		
1 ea	#ZTX450-ND	Zetex NPN transistor
1 ea	#Z720-ND	5-amp miniature SPDT relay
1 ea	#1N4148CT-ND	High speed switching diode
1 ea	560-ohm, 1/4 watt	Resistor
1 ea	10,000-ohm, 1/4 watt	Resistor
AC Line Interface (1 for each Interface):		
1 ea	#MOC3042IS-ND	Zero-crossing triac optocoupler
1 ea	#Q4004-ND	4-A, 400-V triac
1 ea	#P-101KW-2BK-ND	10,000-ohm, 2-W resistor
1 ea	560-ohm, 1/4 watt	Resistor
1 ea	Socket	For 120 VAC load
1 ea	A9306-ND	6-pin optoisolator socket
Battery Back-Up System:		
1 ea	12V Battery	Rechargeable to suit
1 ea	RJL	Trickle charge resistor to suit
1 ea	#1N5819CT-ND	1-A, 40 PIV Schottky rectifier

The parts prefixed with the pound (#) sign are also available from Digi-Key Corp., 701 Brooks Road South, P.O. Box 677, Thief River Falls, MN 56701-0677; PH: (800) 344-4539, FAX: (218) 681-3380. Prefixed numbers are Digi-Key's actual stock number; be sure and mention the exact number to avoid confusion. Digi-Key has a \$25.00 minimum order & free catalog.

Back issues of Nuts & Volts can be obtained by sending \$5.00 to: 430 Princland Court, Corona CA, 91719.



may care to add. Since this IF circuitry could be any number of kinds of devices, the PCB pattern for them has not been provided here in this article, although some tested and proven circuit designs have been drawn.

A series resistor of 470 ohms limits both the current to each status LED, and reduces the power consumption of the SRI. It is desirable to reduce the power consumption to as low a value as possible, since the battery back-up circuit, to be presented shortly, is used in case the power fails. We want to be able to preserve the trained memory of the volatile RAM for at least a few hours, so as not to have to go about the somewhat tedious process of re-training the SRS in the event of a short-duration power failure. Should your application demand it, it is highly suggested you modify the circuit to use a non-volatile RAM; EPROM, ROM, or EEPROM are suggested. Such modifications are currently beyond the scope of this article. However, I would like to hear of any suggestions you have about how to accomplish this if you write me at the P.O. Box mentioned at the end of this article. Constructive criticisms are welcomed, as well.

Building the SRI

The schematics for the two projects appears in consecutive order in Figures 3 and 4. Note Figure 3 where the SRI connects to the SRS at IC3. The circuit continues off the figure

to Figure 4, which shows the input at IC7. Note the decoded outputs are labelled "interface number 0-9" and the interface status monitor LEDs labelled similarly. Note the Interface Number INCREASES numerically, while the status monitor LEDs

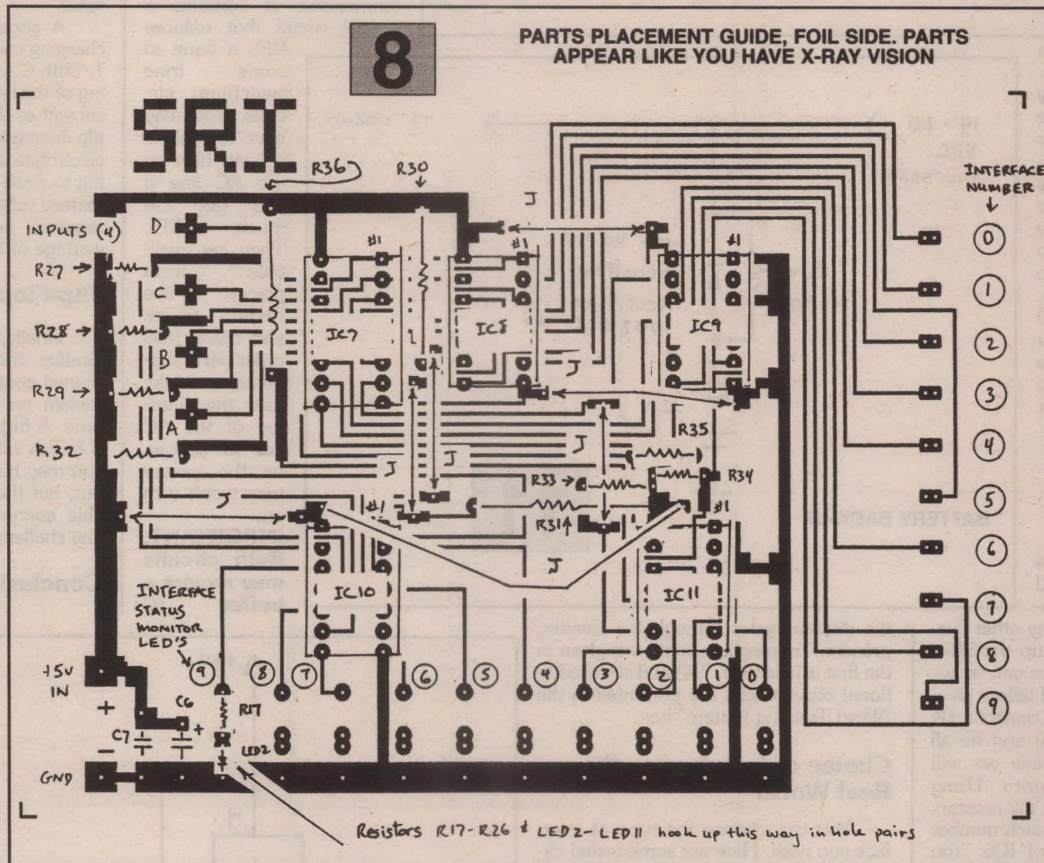
in the Guide were whited out to reduce clutter. By placing a copy of the PCB pattern next to the Guide, you can easily decode where to solder the components and IC sockets in. Be absolutely certain to use IC sockets with both pro-

found the traces to be rather closely spaced and had to use a small soldering iron tip, a 20 watt iron, and fine 0.025" diameter wire for it to go together easily. There are only a few non-polarized components in this joint project. Be sure and get pin 1 of each IC and polarity of the components correct. On the SRS board, the ICs are not placed so pin 1 faces in the same direction; with the SRI, they all face in the same direction.

PC Board Observations

Both boards can be "piggybacked" for a more compact arrangement. The actual size template of the SRI measures 3-3/8" x 4-3/8" and 3.5" x 5.0" if you follow the space occupied by the other brackets. You can easily make the board 3.5" by 5.0" to match the SRS board, realizing some free area along the edges. The SRI board is not yet available from a supplier like the SRS board is, so you'll have to make your own PC board. The author will gladly provide you with a 2X blow-up of the pattern for free, which you can take to a copy shop and have reduced by 50% to actual size to make your own board from. Either photo-

graphic or iron-on techniques may be used, depending upon which you prefer. The 2X pattern is easier to work with, as it comes out sharper when reduced than the magazine can depict in print at life-size. Iron-on techniques allow you to copy to a specially treated film, iron that to bare copper PCB material with a household iron, and etch without further processing. It is an easy technique. An iron-on technique PC material supplier is listed in a box in this article. Regardless of the method you prefer, there are a few pointers that should be followed to



appear to DECREASE numerically. However, if you count both in a clockwise direction, they both increase, and this was chosen as a more efficient way to display the status for my application, and the PCB layout reflects this.

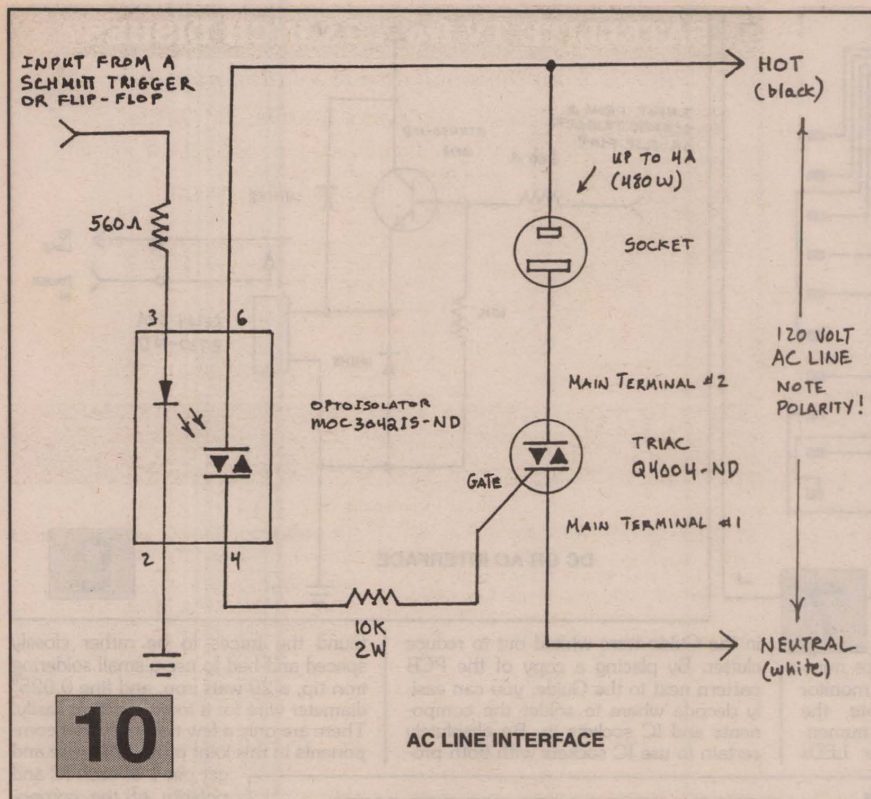
The PCB pattern for the SRS appears in Figure 5. The Parts Placement Guide is given in Figure 6. Once drawn, this complex PC board appeared so "busy" it was hard to follow where to put the parts, so the majority of the traces

jects, particularly the SRS, as it has expensive, static-sensitive CMOS integrated circuits.

The PCB pattern for the SRI appears in Figure 7. Note the four cross-shaped pads that denote where the inputs from the SRI are to go. The interfaces and the interface status monitor LEDs appear in similar positions as on the schematic.

Figure 8 shows the Parts Placement Guide for the SRI. The positions of each component are clearly marked. Careful soldering techniques will help here; I

Iron-on PC Board technique film and material supplier:
DynaArt Designs
3535 Stillmeadow Lane
Lancaster, CA 93536-6624
Phone (805) 943-4746
FAX (805) 943-3776



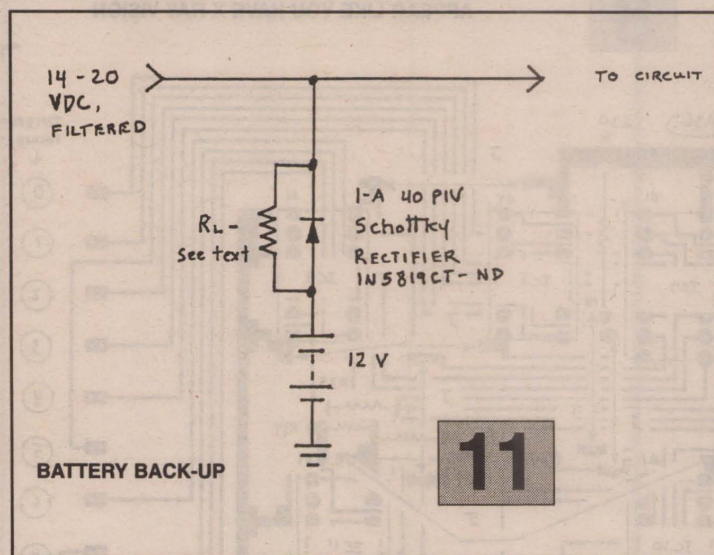
insure good results when you mount the components.

Before soldering in any parts, carefully review the etched PCB pattern for shorts, opens, and anomalies of the traces that may ruin the performance of the circuit. Since the traces are rather thin, you may have to use a continuity tester to examine any suspect traces. A simple battery and LED plus a series-limiting resistor in the LED circuit makes a very inexpensive way to check the integrity of your PC board.

Testing the Speech Recognition Interface

The testing procedure involves connecting the SRI board first to the power supply of the SRS board, or any other five-volt supply. Don't connect up the SRI's inputs to the SRS's data bus yet, as we want to make sure all is well before placing that circuit at any risk. Connect a 1K resistor to each input (D-A) and tie all the resistors to ground. Now we will check the decoding integrity. Using Figure 2 as a guide, connect the resistors to V+ and ground to make each number 0-9 appear at the input of IC6. You should read a high at the output of the corresponding interfacing Schmitt Trigger, and get the corresponding LED to light up. After all are verified as operating correctly (remember that with an input of "00" the "0" LED will light up—that is sort of confusing, as it's the first LED. Label the project with each number if it confuses you), hook up the SRS board in accordance with the schematics and parts placement guides.

When you train the circuit, if you press "99" and then "Clear," which clears all the memory, the LED's will strobe down themselves a few times, as



the display cycles through the clearing process. Training information is given in the first article (Apr. '94) and some additional observations are presented in the "Word Training Pattern" box.

Choice of Interface to the Real World

You can choose the type of interface you wish. Here are some tested circuits. A DC or AC controlling relay interface is shown in Figure 9. It will switch up to 5 A at 30 VDC or 250 VAC. The relay chosen is a good bargain (\$1.79) and has a five-volt coil so it can be driven from the +5 volt power supply of this project. Note the two protection diodes. These are ultrafast switching diodes that shunt the switching transients generated by the magnetic field in the relay coil when the relay switches state. Without them, the transistor would be destroyed the first time the relay switched. The NPN transistor is a rela-

tively new type manufactured by Zetex, and was chosen for its very small size, low-saturation voltage drop of 0.25 V, and ability to drive a relay coil from a five-volt CMOS source because of its high gain of 1,000. It has a max. rating of 1,000 mW and the relay consumes 400 mW, so it's unlikely to overheat unless used in conditions where the ambient temperature is high.

An AC line interface is shown in Figure 10. It connects your appliance directly to the line. Proper fusing is up to you, and will be related in amperage to the draw of the appliance. All appliances should be equipped with their own on/off switch in case something should go wrong. The triac shown—a Q4004-ND—will switch up to 4A @ 120 VAC. It probably will need a heatsink at this wattage, depending upon the type of load attached. A zero-crossing triac optocoupler isolated the circuit from the SRS/SRI, and substitutions are not recommended. It contains a special circuit that reduces

RFI, a bane to some triac switching circuits. You may have to include a hash filter in the AC line if you get too much RFI. They are available from places like Radio Shack and many mail order parts suppliers. Make sure the phasing of the AC line is proper, or the power triac won't turn on.

IMPORTANT: Both circuits may require a buffer IC

inserted in the circuit if you modify the circuit for a flip-flop addition, which enables you to turn more than one appliance on simultaneously, and keep it on until its interface is toggled by a second iteration of a trained control word. Use a CD4050 hex buffer, or a transistor to increase the current to a point where it will cleanly drive the interface. As shown, the Schmitt Triggers have plenty of power to operate either type of interface. You can use two gates in series to get the proper polarity from this signal-inverting part, and that will then easily drive both types of interfaces.

Battery Back-Up

A rechargeable 12V battery is ideal to power the circuitry in the event of a power failure lasting up to several hours. The size of the battery, of course, determines how long the back-up will be possible.

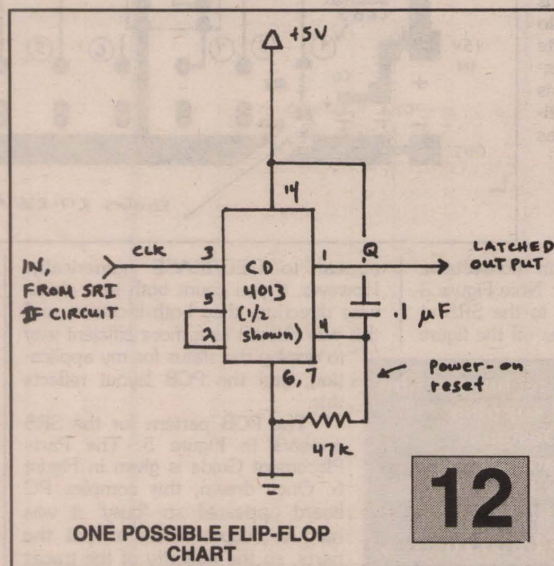
Figure 11 shows one possible circuit. Here, filtered DC from a power supply keeps the battery charged through a trickle resistor R(L). That resistor should be chosen in accordance with the manufacturer's specs so that the battery can remain charged, but not overcharged, on a standby basis. Consult the manufacturer's specs for the proper value.

A good rule of thumb for standby charging current for lead-acid batteries is 1/50th C, where C is the amp/hour rating of the battery. Decrease the charging current as the voltage of the power supply increases to avoid boiling off the electrolyte. Choose your resistor according to peak DC input voltage minus the battery voltage divided by the amperage required, and overbuild as far as the wattage of this component.

Flip-Flop Circuit

Finally, Figure 12 shows a typical flip-flop circuit. It will turn on when a trained control word is first uttered, and remain on until it is uttered a second time. A further utterance will turn it on; a fourth off, and so forth. Remember, you may have to add a buffer at its output, but these ICs are cheap and available everywhere, so that shouldn't be any challenge.

Conclusion



We hope you have enjoyed this article about speech recognition techniques and interfacing. This relatively new technology will likely result in bringing about fascinating new worlds of appliance and process control that are directed by human voice command.

The author can be contacted by writing him at: P.O. Box 74, Cornwall Bridge, CT 06754, either for comment or to obtain a free 2X PCB pattern of the SRI board. Your FAX number, which will be kept confidential, will greatly speed replies. NV

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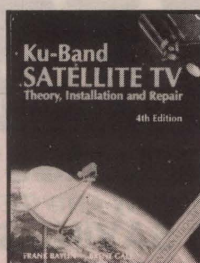
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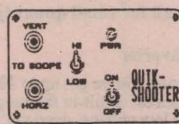
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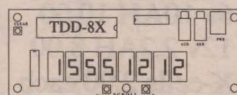


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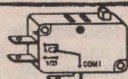
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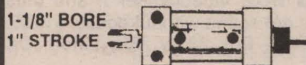
PRICES SLASHED!!!

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accepted



CROUZET # F83161.6
12AMP 250VAC
.187" QUICK CONN. TERM
PHENOLIC PLUNGER ACT-
UATOR. SPDT
SALE PRICE ... 90¢

AIR CYLINDER



1-1/8" BORE
1" STROKE
Shelfer
Ports 1/8 NPT
Retractor length 7-5/8"
Rod 5/16", 5/16-24 thread, with clevis
Force exerted approx 1.15 of air pressure
Nose end bore block mount
Back end has shock absorber 5/16-18 stud

- Double acting
- Wt. 2 lb

\$6.95
10 for \$60.00

DECORATOR AUTOMATIC WALL SWITCH LITRONIC US - ULTRALIGHT

THIS DECORATOR STYLE AUTOMATIC WALL SWITCH, IS AN ATTRACTIVE LIGHT SWITCH REPLACEMENT THAT INSTALLS IN PLACE OF EXISTING WALL SWITCH TO TURN LIGHTING ON WHEN A PERSON ENTERS A ROOM OR OFFICE AND OFF WHEN THE SPACE IS VACATED.

VOLTAGE: 120 OR 277VAC 50/60HZ
MIN. LOAD: 80WATT 120V, 160WATT 277V
MAX. LOAD: 1000W 120V, 1500W 277V
SENSOR TYPE: low power ultrasonic 25khz crystal
SENSOR COVERAGE: 250 sq. Ft. With 180° detection field
ADJUSTMENTS: sensitivity and time out (5 to 25 minutes)
MIN.-MAX. red led lights when movement is sensed.
SWITCHING CAPACITY: 800 watts, ballast loads, single or double switches.

COLOR: WHITE

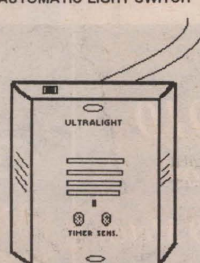
SIZE 5"SQ X 1 3/8" THICK

OFF/AUTO SWITCH: turns lights off manually when necessary, or leaves lights in automatic control mode

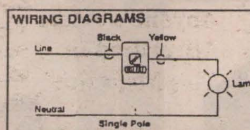
ENERGY SAVINGS FROM 30 TO 60% SINCE LIGHTING WILL NO LONGER REMAIN ON ONCE ROOM IS VACANT.

BRIGAR SALE PRICE \$12.95 EA.
..... 5 FOR \$60.00

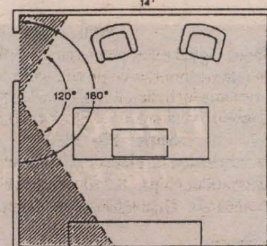
AUTOMATIC LIGHT SWITCH



TURNES LIGHTS ON & OFF AUTOMATICALLY



Typical Application 196 sq. ft.



Shaded area requires slight body movement; unshaded area requires only hand or arm movement

DOCUMENTATION & SCHEMATIC INCLUDED

THIS UNIT CAN ALSO BE USED TO MAKE A BURGLAR ALARM SYSTEM.
KIT INCLUDES: 1 SENSOR UNIT, 1 POWER CORD AND 4 ALARM BUZZERS. (MIN. OF 75 WATT LIGHT BULB NEEDED-NOT SUPPLIED)
KIT #HG700 \$18.95 EA.

hp HEWLETT PACKARD
GREEN RECTANGULAR LED
PART# HLMF-S500 DIFFUSED
SIZE: 5MM X 2MM 200,000 PCS. IN STOCK
SALE PRICE 100 @ .10EA. 1000 @ .05 EA.

OMRON
PC MOUNT OR AS PLUG IN
GENERAL PURPOSE RELAY
OMRON MY4-02 4PDT
CONTACT: 5A 240VAC
5A 28VDC
COIL: 24VDC
UL & CSA - CLEAR POLY. COVER
SIZE: 1 1/2" X 1 1/16" X 3/4" STANDARD
ICE CUBE RELAY. BRAND NEW
FACTORY BOXED.
1 TO 49 PCS. \$2.25 EA.
50 PCS. & UP \$1.95 EA.

Variable Transformers

GENERAL ELECTRIC
VOLT-PAC



VARIABLE TRANSFORMER
GENERAL ELECTRIC VOLT-PAC
USED FOR INDUSTRIAL & LAB APPLICATIONS TO CONTROL VOLTAGE, CURRENT, POWER HEAT, SPEED, LIGHT & ELECTROMECHANICAL FORCE
* DIAL INDICATOR KNOB NOT INCLUDED
VOLT-PAC MODEL # 9T92A
INPUT VOLTAGE: 120VAC 60HZ
ISOLATED OUTPUT: 0 - 60VAC,
ISOLATED PRIMARY, CONSTANT
CURRENT LOAD: 5 AMP
2 UNITS PUT IN SERIES WILL GIVE
0-120VAC OUTPUT. SIZE: 4 3/8" DIA.
4" HIGH. WEIGHT 6 LB.
BRIGAR SPECIAL \$19.50

COMPUTER PRODUCTS MODEL # EM951S 5-9W DC/DC CONVERTERS LOW-COST UNREGULATED

PC-Mountable Excellent Isolation
PI Input Filter High Efficiency

COMPUTER PRODUCTS
MODEL # EM951S
5-9W DC/DC CONVERTERS
■ PI INPUT FILTER
■ 500V ISOLATION
■ SHORT CIRCUIT PROTECTED
■ HIGH EFFICIENCY - 75%
■ NON-CONDUCTIVE PLASTIC ENCLOSURE
2" X 2" X 0.4" PACKAGE
OUTPUT VOLTAGE ±12V/ ±375MA
INPUT VOLTAGE: 5VDC
REGULATION LINE: 1.2% LOAD 8%
REFLECTED RIPPLE: 75ma P-P
5 PIN PC MOUNTABLE
BRAND NEW FACTORY BOXED.
PRICE 9.95 EA.



WABER #WH7NSA
MULTI-PURPOSE ELECTRONICS
PROTECTOR WITH SURGE ALERT.
* 7 OUTLET STRIP WITH 4' CORD
* AUDIBLE ALARM - SOUND IF SURGE
PROTECTION IS NOT FUNCTIONING
* MASTER POWER SWITCH
* PUSH TO RESET 15AMP BREAKER
* HIGH IMPACT THERMOPLASTIC CASE
* UL APPROVED LIST PRICE \$29.95
SALE PRICE
BRIGAR SALE PRICE \$7.95



PRICE \$1.19 EA.
10 FOR \$10.00 100 FOR \$90.00

TELEDYNE
SOLID STATE RELAYS
PART# 615-8500
Control Volts: 3-32vdc
Rated: 10A @ 250VAC
50/60Hz - Opto isolated
Connection: screw or quick
connects. (Removed from un-
used equipment)
SALE PRICE \$8.95

WIDEC TORIN #TA450DC
MODEL #A31256-16
12VDC .42 AMP 3 BLADE.
METAL HOUSED-PLASTIC IMPELLER
4 11/16" SQ. X 1 1/2" THICK. 12" WIRE
LEADS. WEIGHT 1 LB. 100 CFM
BRAND NEW FACTORY BOXED.
SPECIAL SALE PRICE \$7.95



ANSWERING MACHINE CODE-A-PHONE 1750

FEATURES:
* ONE TOUCH PLAYBACK
* AUTO OUT GOING MESSAGE CHECK
* BUILT IN CASSETTE
* VOICE-ACTIVATED RECORDING
* FAST FORWARD, PAUSE, & REWIND
* RING DELAY (1, 2, 3, 4)
* LED MESSAGE DISPLAY
* VARIABLE OUT GOING MESSAGE
* NO CALL DISCONNECT
* 90 MIN CONVO COMMERCIAL QUALITY
ORIGINAL COST \$179.00
BRIGAR SALE PRICE \$7.95

ANALOG METER MOVEMENT
50 MICRO AMP D.C. FULL SCALE
LARGE 4.5" DIAMETER - MIL. SPEC.
PANEL METER 3.5" DIA. VIEWING AREA.
ZERO ADJUSTMENT KNOB. WHITE FACE.
SCALES: IN GREEN, BLACK, AND BLUE
LETTERS. THREE AC AND THREE DC
VOLT SCALES. 0 - 2.5, 5 AND 10. ONE
RESISTANCE SCALE FROM 0 TO INFINITY.
INCLUDES RUBBER GASKET, MOUNTING
HARDWARE. 1 1/4" BEHIND PANEL DEPTH
BRAND NEW FACTORY BOXED.

ANALOG PANEL METERS
MULTIMETERS
PHASTRON # 40-013857

PRICE
..... \$4.95 EA.



SWITCHING POWER SUPPLY
Fully Enclosed-Fan cooled-Multiple Output
Part # 130569SXD INPUT 115Vac
Output 1: +5 Vdc 10Amp
Output 2: +12Vdc 1 Amp
Output 3: -5 Vdc 0.1Amp
Output 4: logical signal +3.25Vdc
Common: 2.5 volt with 1000 ohm
Fan Cooled, EMI Filtered & on-off switch
Size: 12"L x 3 1/2"W x 2" deep - 3 1/4 LB
BRAND NEW FACTORY BOXED.
SALE PRICE \$9.95

Irradiated Polyolefin Shrinkable Tubing

SHRINKAGE RATIO 2:1 (50% Shrinkage)

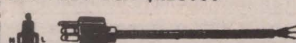


SHRINK TUBE FP301
MFG: 3M (POLYOLEFIN)
GREY 3/4" 200 ft. per reel
sale price \$49.95/reel

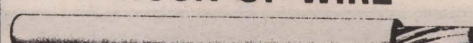
Electronic Cords

3-CONDUCTOR ELECTRONIC SUPPLY CORDS
* UL Listed, CSA Certified

ELECTRONIC CORDS - POWER CORDS
3 COND. 18AWG TYPE SGT 8' GREY
AC LINE CORD. COND. COLORS: BLK,
WHT, GREEN .312 O.D. MOLDED
VINYL GROUNDING PLUG
PRICE \$1.49 EA.
100 PCS. FOR \$125.00



HOOK-UP WIRE



18 AWG BLUE - 16/30 TIN - 125°C 600V
CSA TYPE CL1251 - AWM STYLE 3321 - MFG: AIW CO.
10,000 FT PER REEL - PRICE \$ 200.00

18AWG TAN - 16/30 UNTINNED - 125°C 600V
MFG: AIW CORP. .109 O.D.
10,000 FT. PER REEL - PRICE \$ 200.00

#90 SATELLITE EQUIPMENT cont.

VIDEOCYIPHER RS module, with Video-Pal, all receipts, ID information & operating instructions, fully legal, \$295. With Channel Master enclosure, add \$25. 914-223-3351.

OAK SATELLITE DECODER MODULE, \$299. Watch Disney, Discovery, ABC, BBC, CBN, CBS, NBC, PPV, Sports, Weather, Cooking, Home Improvements & Soaps. Send SASE. **Stand-Alone B-MAC's, & Oak Decoders Available. TRI-ANGLE PRODUCT DISTRIBUTORS USA,** 5750 Lakeshore Dr., Holland, MI 49424. USA. 616-399-6390 M-F 9am to 2pm, EST.

WANTED; DRAKE Model PRC 2400 programmable remote control; accessory that was available with Drake ESR 2400 Satellite receiver, any condition, prefer working unit. Call Mike 8-5 Central time at 334-263-6034.

AVCOM PSA-37D portable spectrum analyzer, new condition, \$1,950. 1-800-788-6078.

VCII MODULES, many Virgin, also VCII chassis (5) with remotes. LNAs (many). Dual Feedhorns (Chaparral). Seavy feed. Prosat motor controllers (10). STS LNB (930-1430). Janeil and Anderson BDC. Tracker II motor controller. Make offers. 410-974-4150.

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15 CCOR cable TV trunking amplifiers, w/fail safe, new, \$200 ea. 818-352-6619.

VIDEOCYIPHER II, modules, products and repairs. Auto update software, codes and components. For repairs call 201-728-3217 10am-6pm EST. 1614-0 Union Valley Rd., W. Milford, NJ 07480. Also buying VC IIs and BMAC decoders.

SOUND WITH & WITHOUT CODES. If you have an old Videocypher II descrambler board we will show you which channels sound is available on without codes and how to receive them. We will also explain to you in detail how to receive sound on channels that require codes, how to obtain codes for free and which software works the best in your Videocypher II. To receive our complete information package please send \$14.95 US funds in the form of cash, cheque, money order or Visa/MasterCard number and expiration date and a self addressed envelope to Evolution Electronics, 701 Tossland Rd. E., Suite 378, Whitby, Ontario, Canada L1N 9K3. Very prompt service.

VIDEOCYIPHER II descrambling manual. Schematics, video and audio. Explains DES, EPROM, CloneMaster, Pay-per-view (HBO, Cinemax, Showtime, Adult, etc.) \$16.95, \$2 postage. Schematics for Videocypher Plus \$20. Schematics for Videocypher 032, \$15. Collection of Software to copy and alter EPROM codes, \$25. VCII Plus EPROM, binary and source code, \$30. **CABLETRONICS, BOX 30502N, Bethesda, MD 20824.**

LEARN HOW videocypher II and plus owners get sound without codes. \$19.95. Nassirian. Box 382-V, Rio Linda, CA 95673.

TOP OF THE LINE SATELLITE EQUIPMENT AT DISCOUNT PRICES. Complete Houston Tracker Systems with (module, IRD, dish, and electronics) \$1,059 and up. Electronics pkg. \$169, 10" Pareclipse dish (UPS) \$499. Shipping additional. Many top brand IRDs and Satellite Equipment available. Computers 486 systems complete starting at \$879. EVCO can now offer long distance calling for 14 cents a minute anytime anyway. 800 Numbers \$10 a month. Call or send SASE for catalog. 1-800-335-7511, 410-335-7511 EVCO 3316 Choptank Ave., Baltimore, MD 21220-4328.

RECEIVE SOUND VIRTUALLY FREE on many premium VCII plus channels such as HBO/CINEMAX if you have a VCII plus descrambler board. This is totally legal and one of the industries best kept secrets. Please send \$19.95 US funds in the form of cash, cheque, money order or Visa/MasterCard number and expiration date and a self addressed envelope to Evolution Electronics, 701 Rossland Rd. E., Suite 378, Whitby, Ontario, Canada L1N 9K3. You will be sent a complete information package containing detailed instructions. Very prompt service.

WANTED: LARGE SATELLITE ANTENNAS, 7-20 meter, commercial grade only. Also transmitters for uplink, HPAs, exciters, etc. Prefer Scientific Atlanta, Andrews, Vertex, RSI, etc. Will remove. PTL Cable Service, Inc. Phone 407-747-3647, FAX 407-575-4635.

SATELLITE EQUIPMENT: Fully programmable stereo C/KU receivers with remote control, 25 degree C-Band LNAs 36VDC motors, RF modulators, and complete satellite systems. Call 714-548-5521.

SYNC-A-LINK UNIVERSAL VIDEO SYNC GENERATOR is an educational and troubleshooting tool for those persons seeking technical support for evaluating different types of video difficulties. It will restore all horizontal & vertical sync lines from standard or distorted analogue video-type formats. It requires pretuned baseband video, and comes complete with operations manual & 90-day warranty. Total package case with power pack completely assembled, aligned, tested. \$150. Voice orders and information 918-479-6451 or write to Sync-A-Link Communications, PO Box 4, Locust Grove, OK 74352.

Emperor TS-5010

The Royalty of Radios

10 Meter

\$219.⁹⁹ C.O.D.

#E00-00001



148 GTL

Mobile Citizens Band Radio

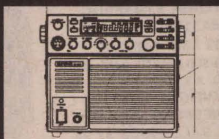
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Pre-programmed Scanning Radio with Highway Patrol Warning Alert

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25 Watt Capability



#R10-10004

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RANGER RCI 2970

100 Watt - 10 Meter Mobile



#R10-10010

C.O.D. \$349.⁹⁹

Antron A-99 A65-00002 \$ 39.⁹⁹

Wilson 1000 Magnet Mt. W30-05004 \$ 59.⁹⁹

K40 Antenna A20-05002 \$ 39.⁹⁹

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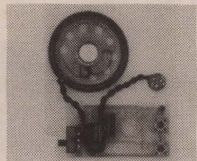
DESCRAMBLERS, SATELLITE receiver systems, components. **BELOW WHOLE-SALE!** Direct from foreign manufacturers. Any quantity. Many offer free samples. Complete step-by-step guide, address, tips, etc. \$12 postpaid. SMI, Box 5500-A, Lakeland, FL 33807.

REPAIRS, SOFTWARE, etc. for satellite equipment. No TX sales. Buying 010, 018, 019 VCI's. K. Perry, PO Box 816, Leander, TX 78646-0816. Phone: 512-259-4770.

AUDIO — VIDEO — LASERS

START YOUR OWN TECHNICAL VENTURE! Don Lancaster's newly updated **INCREDIBLE SECRET MONEY MACHINE II** tells how. We now have autographed copies of the Guru's underground classic for \$18.50. Synergetics Press, Box 809-K, Thatcher, AZ 85552. 602-428-4073. VISA/MC.

WANTED: AMPEX professional audio tape recorders and accessories. Al Ross, 8022 27th NE, Seattle, WA 98115. 206-525-4624.



ETVM-2000 20 SECOND RECORD AND PLAY NATURAL SOUND SYSTEM. The ETVM-2000 offers and easy, simple and low cost solution for natural voice record and playback on a miniature 1.0" x 2.4" PC board. Using state of the art **CHIP-ON-BOARD** technology (which provides unbeatable sound quality), the ETVM-2000 is ready to integrate into custom prototypes or production runs of thousands. The module has 20 seconds of record time, a superb **microphone**, high quality **speaker**, 4 AA **battery case** and an **LED recording indicator**. Extra through holes for push to record, play, LED indicator locations and a motion sensor are available. **PRICE:** \$25 (Quantities of 2-25), \$15 (Quantities of 1000) Visa or MasterCard accepted, Ohio orders add 6.25%. EDTM Inc. Ask for Jeff or Mark. 419-389-0354. **DISTRIBUTORS WELCOME.**

FREE! THE ETC CATALOG of manuals for Amateur, Audio, and Test Equipment. AG Tannenbaum, PO Box 110, East Rockaway, NY 11518. 516-887-0057, FAX 516-599-6523.

VCR WANTED: Mitsubishi HS700UR, HS710UR, or Akai VP55U in good condition. Jim, 310-815-9090.

ALTEC SHURE sound equipment all types. SARA-COMM, 25 Gladwish Rd., Delmar, NY 12054. 518-439-9531.

SONY EVS900 H8mm VCR. Like new w/accys & op. manual. Cable-ready. L&S Cable editing. Digital stereo sound. \$1,000 or best offer. 813-787-3856 or 813-781-0948 after 6pm.

MACBETH DENSITOMETERS RD 919 complete in fine working order \$225. TD-904 Transmission densitometer \$355. INTERNATIONAL LIGHT, 1L 1500 RADIOMETER with 4 optical light sources, in new condition, \$205 complete. ARVIN/ECHO WR 231 Airborne Video Recorder excellent condition complete \$125. Psitech Plus, 707-745-4804, FAX 707-747-5277.

FIBER-OPTIC FM system capable of multi services, video, audio and data. Acoustic-Optic modulators adapted to fibers. Send SASE envelope for info on these brand named products to EO Techniques, 16 Slusser Ave., New Hartford, NY 13413-2117.

NIGHT VISION kits and brand name VS and foreign units. My complete kits include all necessary components to make your own night vision scope, saving you big bucks! US Military Image Intensifiers, IR tubes, foreign and more. Call or write: NE Night Vision Supply, PO Box 1088, Sturbridge, MA 01566, or 508-347-7238.

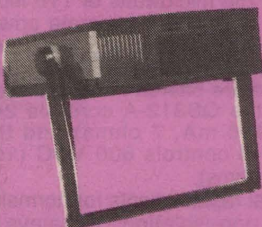
LASER RANGEFINDER measures distances up to 1800 meter: 10cm accuracy @ 1Hz update rate, 5mW laser diode, battery operated w/microcontroller. \$2,000. Plans \$20. 20MHz preamplifier/detector \$160. Send \$1 ea. for data sheets. Laser Sensor Technology, 3873 Easy Circle, Marietta, GA 30066. 404-928-2867.

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R&D #633 PACTEC CASE w/stand Only \$14.95

ZERO VOLTAGE TURN ON ZERO CURRENT TURN OFF SOLID STATE RELAYS



10 Amp 120/140VAC 5VDC/TTL Control Input R&D #441 \$8.50
25 Amp 120/280VAC 3-32 VDC Control Voltage R&D #693 \$12.50

AVANTEK GPD-464
Thin Film Cascadable Amplifier Module
5 - 400 MHz +17dBm out
R&D #98 GPD-464 \$4.95



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Linemaster T-51 Series
With 6 foot 18-2 SVT Cord & Skid-Proof Base Pad
NORMALLY OPEN 7 AMP 1/6HP 125-250 VAC
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50 uH 20 AMPS DC TOROID
Audio Noise Filtering
64 turns #13AWG 0.01 Ohms.
R & D #965 \$3.50 or 10 @ \$3.00 each

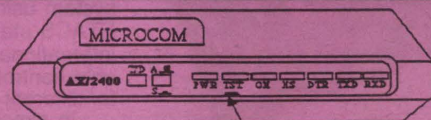


Multi-Conductor Cable SALE

NUMBER OF CONDUCTORS

	AWG	DESCRIPTION	PRICE/100'	FULL REEL	P/N
1	#22	20,000 VOLT BLACK TEST LEAD	\$9.00/C	\$75/K	A190
1	#12	40,000 Volt FLEXIBLE Black Silicone	\$15.50'	\$25/K	A189
2	#30	SILVER-PLATED BRAID SHIELD	\$9/C		A058
2	#18	SAE Type SXL 600V 105 C Cross-Linked	\$7.50/C	5K'@.05	A214
2	#14	SXL 600V 105C X-L UV-Tolerant	\$15/C	3K'@.10	A213
2	#12	SHIELDED Twisted Pair Audio 600V - PE	\$45/C	1K'@.15	A196
2	#10	SXL 600V 105C X-L Black PVC Jacket	\$25/C	2K'@.18	A212
3	#16	SHIELDED Stranded 600V 60C	\$20/C	1K'@.15	A012
4	#20	SHIELDED Solid	\$20/C	500'@.15	A024
4	#26	Stranded	\$12/C	2.5K'@.09	A146
7	#18	SAE Type SXL 600V 105C X-L/PVC-JKT	\$22/C	1.5K'@.18	A210
8	#16	NEOPRENE RUBBER INSULATION	\$125/C		A007
9	#14	600V 80C UL2463 UL VW-1 ALPHA#1279	\$45/C	500'@.39	A013
10	5 PAIR	#18 300V 80C UL2464 BELDEN#9159	\$100/C	500'@.88	A037
12	6 PAIR	#24 Stranded SHIELDED LOW-CAP	\$22/C	1K'@.17	A022
15	#22	Stranded	\$40/C	1K'@.251	A069
16	8 PAIR	#24 Stranded SHIELDED CL2	\$29/C	1K'@.191	A006
18	9 PAIR	#16 INDIVIDUALLY SHIELDED	\$99/C	500'@.88	A133
20	10 PAIR	#22 SHIELDED	\$65/C	250'@.45	A060
30	15 PAIR	#22 INDIV-SHIELD BELDEN#8776	\$195/C	1K'@1.50	A092
50	25 PAIR	#24 Solid PLENUM / TEFLON	\$125/C	1K'@1.10	A056

QUANTITIES ARE LIMITED !

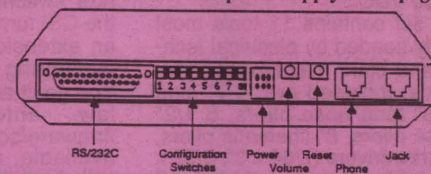


The front panel contains seven indicator lights and two push button switches.

MICROCOM AX/2400C ERROR-CORRECTING MODEM

300/1200/2400 BPS STAND ALONE
BELL 212A & 103 and CCITT V.22 bis
With data compression for higher thrupt.
AUTO DIAL, AUTO ANSWER, MANUAL DIAL & ANSWER
R&D #97 NEW MODEM with power supply & 170 page book.

\$69.00



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BRAND NEW • INTELLIGENT DISPLAY

LSI HD44780 & HD44100 Chips/Full ASCII character set
Interfaces to 4 & 8 bit mpu's / 5 VDC, 2 ma, 3.85" x 1.75" x .25"
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5 PIN MS CONNECTORS • NEW, by ITT/Cannon • Matched Pair
Right angle Female Plug with Cable Clamp: MS3108A-14S-5S
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NEW PRODUCT EDITOR,
430 PRINCELAND CT., CORONA, CA 91719

News

INSULATED TOOLS



Jensen Tools, Inc., now offers a set of insulated tools that are engineered for safety when working around live electrical wires and charged equipment. Each tool has been individually tested at 10,000 volts and certified safe at 1000 VAC/1500 VDC.

The set contains 11 tools most frequently needed by electrical technicians and plant maintenance professionals. Included are: a 7" side cutter, 8" long nose pliers, 6 1/2" long nose pliers, 8" linemans pliers, and 7 screwdrivers (7/64 x 3", 5/32 x 4", 7/32 x 5", 1/4 x 6" slotted; 0 x 2 1/4", 1 x 3", and 2 x 4" Phillips).

These are made of chrome vanadium steel. Each one has an insulated sheath that is permanently affixed to the tool for reliable protection against accidental electrical shock. The set comes in a zipper kit with velcro strips to hold each tool in place. Altogether it makes a handy package that anyone working with electrical systems and equipment could use.

The Insulated Tool Set (Part #194B675) is priced at \$225.00.

For information or to order contact:

JENSEN TOOLS INC.
7815 S. 46TH ST., DEPT. NV
PHOENIX, AZ 85044
602-968-6231 1-800-426-1194

RFM OPTION FOR CSI

Electronic Countermeasures, Inc., now has an optional Radio Frequency Module (RFM) for use with the Cellular Surveillance Interface (CSI).

The RFM receives cellular frequencies only in the forward control channel mode (AMPS-only) and eliminates the need for a cellular capable scanner/receiver.

The CSI decodes the digital data transmitted on cellular control channels. It interprets the data as

cellular commands, displays it on your PC screen, and changes the frequency on your radio or the optional AMPS-only RFM. The CSI will work on cellular systems in North America, Europe, the Middle East, Southeast Asia, Hong Kong, etc. Anywhere there is a cellular system using the AMPS, TACS, or ETACS standards; including those international systems that use variable control channel starting points for different countries.

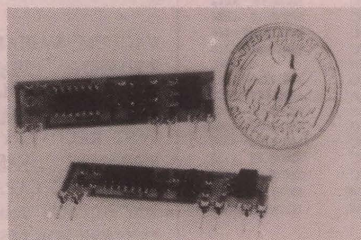
In simple terms, the CSI reads the control channel data in a cell and tunes your radio, or optional RFM, to the specified voice channel when a cellular call is placed or received in that cell. This allows you to monitor the call for voice quality, etc. When the call switches to a new voice channel, your radio or RFM now switches, as well. In essence, the CSI turns your radio or RFM into an extension of the phone you're monitoring. No more partial calls. You get it all. Multi-cell software and law enforcement EZ-Track firmware/software options are now available, as are complete PC or cell phone based systems.

The CSI is a small, high-tech, low-cost test instrument for cellular/electronic shops or commercial businesses requiring cellular monitoring capability. It has additional application as a fixed or mobile surveillance unit for law enforcement, government, or other investigative agencies. Customers must order on their letterhead. Other security products for both surveillance and defensive purposes are available.

For further information, contact:

ELECTRONIC COUNTERMEASURES, INC.
65-31 AVE. SOUTH WEST, DEPT. NV
CALGARY, ALBERTA, CANADA T2S 2Y7
403-233-0644 FAX: 403-233-8849

HIGH VOLTAGE SOLID-STATE NC SWITCHES



A new series of solid-state normally-closed 3-terminal switches

that require low input current and provide good small-signal performance, as well as high voltage capability is available from QBAR Tech Inc.

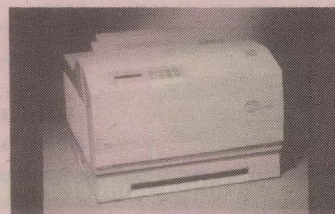
QB312 Series normally-closed switches are high voltage small to medium signal switches that only require 150 microwatts of TTL input and do not need a separate power supply lead. Permitting simplified control wiring, these solid-state switches are offered in two SIP versions: the QB312-A controls 240 VDC (190 mA, 7 ohms) and the QB312-B controls 600 VDC (100 mA, 40 ohms).

Ideal replacements for normally-closed non-isolating DC relays in small-signal applications requiring high voltage blocking, QB312 Series normally-closed switches measure 0.5"H x 1.5"L. Applications include discharging off-line power supply filter capacitors, activating warning displays, and fail-safe switching for telecommunications devices.

For more information, contact:

QBAR TECH, INC.
812 PROCTOR AVE., DEPT. NV
OGDENSBURG, NY 13669
315-393-3793 FAX: 315-393-9017

TYPHOON 8 NETWORK PRINTER



Dataproducts Corporation announces the Typhoon 8, an RISC-based eight page-per-minute network laser printer with 1200 DPI resolution, full bleed 11" by 17" imaging, Adobe PostScript Level 2, PCL5+ and 7475A emulations, 36 MB memory, and a PostScript fax/modem option for camera-ready document faxing.

The Typhoon 8, the fourth member of the Typhoon laser family introduced by Dataproducts, offers camera-ready tabloid-size output for presentations, reports and electronic publishing. Rated at 20,000 pages per month, the Typhoon 8 provides lithographic quality output using 1200 x 1200 DPI print resolution. DpTek's TrueRes™ technology is incorporated to improve curves and

smooth jagged edges. The printer also uses Dataproduct's new 7-micron toner system which further enhances print quality by providing cleaner edges, better graphics, and reduced toner scatter.

The Typhoon 8's optional PostScript and CCITT Group 3 fax/modem can send and receive documents in camera-ready high-resolution. Documents faxed to the Typhoon 8 from any PostScript-equipped fax/modem will be printed at 1200 DPI, regardless of the PostScript resolution of the originating system. Instead of the loss of resolution normally associated with faxing, the faxed documents can now be improved.

The Typhoon 8 supports all standard paper sizes up to A3 (11" x 17") and oversize-B for full-bleed 11" by 17" images.

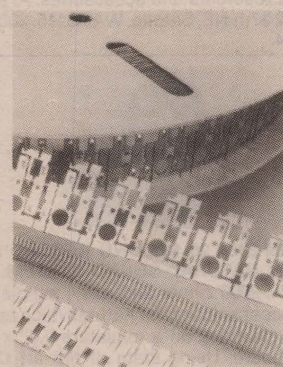
The printer's standard memory of 36 megabytes can be expanded to 68 megabytes. Optional 2MB or 4MB flash RAMs are available for storing fonts and forms. Standard paper handling includes one adjustable 250-sheet input tray for standard paper sizes up to 11" by 17", a multimedia feeder for oversize-B sheets and heavier bond paper (up to 32 lb.), and a 250-sheet correct-order output tray. Optional cassette/deck units can be installed in the Typhoon 8 to provide additional paper input capacity.

The Typhoon 8 printer is available in three base models: a 600 DPI, 4 MB version for \$3,199.00, a 600 DPI, 4 MB version with Ethernet for \$3,699.00 and a 1200 DPI, 36 MB version for \$5,199.00.

For further details, contact:

DATAPRODUCTS
6219 DE SOTO AVE., DEPT. NV
WOODLAND HILLS, CA 91367
800-980-0374 FAX: 703-648-9433

ELECTRONIC CONNECTOR COMPONENTS



Custom engineered thin gauge metal stampings that can be supplied on reels for automated assembly equipment used in manufacturing connectors, terminals, and spring contacts are available from A.J. Knott Tool & Mfg. Corporation.

Electronic components supplied on reels from A.J. Knott are made in sizes from 0.003" to 0.060" thick with tolerances to ±.0005" on holes, depending upon thickness, and ±.003" on form dimensions. Typical components include rolled connectors, terminals with in-line tapping,

New Product News

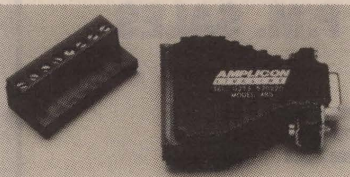
male blade connectors and spring contacts.

Manufactured using progressive die metal stamping, electronic components supplied on reels can be fabricated from low expansion alloys, copper-based alloys, and clad or selectively plated metals. Featuring CpK of 2.0 or greater quality, they can be produced in 250,000 to 20 million piece-per-year quantities.

For more information, contact:

A.J. KNOTT TOOL & MFG., CORP.
179 FORTUNE BLVD.
P.O. BOX 368, DEPT. NV
MILFORD, MA 01757
508-473-1234 FAX: 508-473-0824

RS-232 TO RS-485 CONVERTER FOR 9-PIN COM PORTS



ICS DataCom now has a new plug-in unit for converting RS-232 signals to RS-422 or RS-485 compatible signals. The new Model 485F9 converter is available with a female connector for direct connection to the 9-pin PC COM ports. The converter handles data rates over 115.2 Kbaud and extension distances greater than 1,200 meters. When used in pairs or with other RS-422 or RS-485 devices, the converter provides greater noise immunity and longer distances between serial devices than would be possible with standard RS-232 signals.

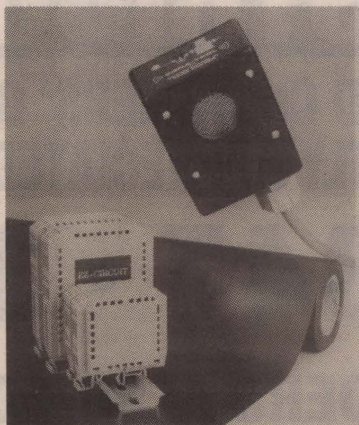
The new Model 485F9 converter eliminates the need to use a 9-pin to 25-pin adapter when converting RS-232 signals from 9-pin COM ports to RS-422 or RS-485 type signals. This is a growing problem since 9-pin COM ports are used as the second COM port on all desktop computers and as the standard COM port connector on most portable computers.

The Model 485F9 converter is configured as a DCE device to match the PC COM ports which are DTE devices. The unit uses 100 mA of +5 to +12 VDC power which is furnished by an external module. All serial and power connections are made by removeable screw terminals. The unit complies with the new European Electromagnetic Compatibility directive, 89/336/EEC. The Model 485F9 converters are \$99.00 each. A companion 9-volt power supply module is included with each unit.

To obtain details, contact:

ICS DATACOM
473 LOS COCHES ST., DEPT NV
MILPITAS, CA 95035-5422
408-263-5500 FAX: 408-263-5896

CONSTANT LINE SPEED CALCULATOR



A constant line speed calculator that eliminates loops and stops the winder/unwinder in the event of a web break has been introduced by Waddington Electronics, Inc.

The EZ Circuit Constant Line Speed Calculator features a sonic sensor that measures roll diameter with .01" resolution and .01 second response times, and a series of analog function modules. Capable of regulating both speed and tension without loops, it can operate at line speeds from 0 to 3,000 FPM or better, and instantly stops the winder/unwinder in the event of a web break.

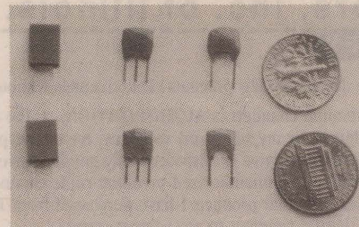
Eliminating diameter calculators, the EZ Circuit Constant Line Speed Calculator includes a DIN rail mountable summing module, load cell amplifier, frequency-to-voltage converter, and an analog divider. Easy to calibrate by screw adjustment, this simple analog system saves panel space and is ideal for small OEM applications where costly digital equipment may not be required.

The EZ Circuit Constant Line Speed Calculator is priced from \$597.00 (list), depending upon the number of modules included. Literature and pricing are available upon request.

For more information, contact:

WADDINGTON ELECTRONICS, INC.
25 WEBB ST., DEPT. NV
CRANSTON, RI 02920
401-781-3904 FAX: 401-781-1650

CERAMIC RESONATOR



Ceramic Resonators with built-in capacitors have become desir-

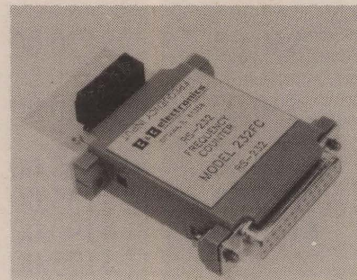
able clocks for low-cost embedded micro-controllers. Latest ceramic resonators offer quite adequate frequency accuracy of ± 0.003 fosc ($\pm 0.3\%$ frequency tolerance). Ceramic resonators are particularly suitable for low-power battery application, as low as 1.85 VCC. Physically similar to epoxy dipped ceramic capacitors, ceramic resonators are easy for auto-insertion, flow solder, and washable board assembly.

Integrity Technology Corporation's ZTS Ceramic Resonator series with built-in capacitors are well suited for popular microcontroller clocks, such as 8051/48/31, PIC16/17, 68HC05/08/11, Z8, COP8, MSM65, and many others. ZTS ceramic resonators have a frequency range from 2 to 12 MHz. Standard built-in capacitor is 30 pF for CMOS oscillating circuit. Fast start up rise time is less than 100 μ sec depending VCC. Operating temperature range is from -20°C to +80°C. Volume price of ZTS frequency is 18 cents each in 10K lot. Production lead time is five to seven weeks.

For other information, contact:

INTEGRITY TECHNOLOGY CORP.
1400 COLEMAN AVE., STE. E15,
DEPT. NV
SANTA CLARA, CA 95050-4358
408-262-8640 FAX: 408-262-1680

FREQUENCY & TIMING MEASUREMENTS THROUGH RS-232 PORT



B & B Electronics Manufacturing Company has available its new RS-232 Frequency Counter, Model 232FC (\$69.95). Powered from the RS-232 port handshake lines, the 232FC allows you to make frequency measurements of TTL level signals. If the handshake lines are not available, a 12 VDC external supply can be used to power the converter.

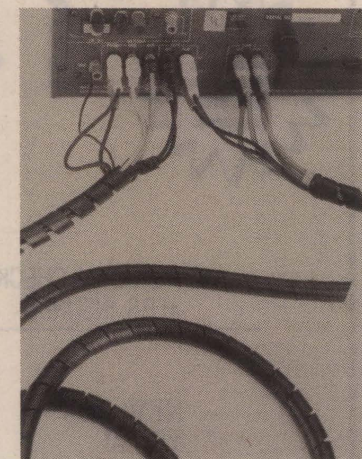
The 232FC makes frequency measurements from 5 Hz to 2 MHz, and duty cycle measurements from 5 Hz to 50 KHz. Simple commands will allow you to make measurements with your own program. The 232FC is shipped with software that logs and plots frequency and duty cycle information, as well as display histograms. Sample code in BASIC, Pascal, and C that demonstrates the 232FC commands is provided. In all, the 232FC gives you an affordable way to complement and

enhance your data acquisition capabilities.

For more information about the RS-232 Frequency Counter and to receive B & B Electronics' free catalog of (I) Serial Communication Interface and Control Equipment (I) contact:

B & B ELECTRONICS MANUFACTURING CO.
707 DAYTON ROAD,
P.O. BOX 1040, DEPT. NV
OTTAWA, IL 61350
815-434-0846 FAX: 815-434-7094
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Heli-Tube spirally cut cable wrap sells for \$3.95 (retail) in 1/2" OD size and comes in a 10 ft. poly-bag with a header card. Private labeling and bulk packaging are available. For more information, contact:

M.M. NEWMAN CORPORATION
24 TIOGA WAY, P.O. BOX 615,
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This article will describe how you can build a simple water-detecting alarm for use in your home or business. Very few parts are needed if you wish to build it from scratch, or you can purchase the two most essential parts separately and just add a battery and sensor wire. If you aren't into constructing your own unit, you can buy one professionally assembled and packaged.

by Fred Blechman

Build a Water-Detecting

Alarm

Water is the most abundant of all chemical compounds. It is both an essential ingredient of all living organisms and a major component of the environment in which they live. Its three natural states: water (liquid), and ice or snow (solid) cover about 75% of the earth's surface, and water vapor (gas) is an important major constituent of the atmosphere.

But, just as too much of a good thing can be bad, too much water, or water in the wrong places, can also cause big problems. People drown in water. Floods from

overlooked by alarm manufacturers! Since you can build a simple water-detecting alarm for less than \$10.00, you can make a bunch of them and spot them wherever there might be a need.

Building a Simple Water-Detecting Alarm

Figure 1 shows the schematic of a simple water-detecting alarm circuit, and the Parts List specifies the parts. There are many circuits that could be used for this

has no positive voltage on its anode, so it is inactive. The second IC section has a HI output, directly connected to the inputs of the two parallel-connected IC sections, so they have a LO output and the buzzer is silent.

Now assume the bare wire leads or the comb-like sensor grid have water across them. Unless the water is totally pure (distilled), it conducts electrons. The input of the first IC section is pulled LO, essentially to ground (negative battery terminal), so its output is HI. Therefore, the

next IC section, with a HI input, has a LO output which, in turn, means the output of the parallel-connected sections are HI. The piezo buzzer blares out.

However, since the flashing LED anode is now positive, it starts conducting and the LED goes on, thus lowering the voltage below the threshold of the following IC section, so its output goes HI, the parallel sections' outputs goes LO, and the buzzer stops!

Internal circuitry in the flashing LED causes the LED to start and stop conducting about twice a second, resulting in the buzzer sounding whenever the LED is off. This twice-a-second pulsating buzzer is much more noticeable than a continuous buzzer, and uses less power.

Some of the items in the Parts List require more discussion. The integrated circuit is specified as a CD4011, but this is sometimes just referred to as a 4011. The 100K resistor is a nominal value for average alarm sensitivity. The higher the value of this resistor, the more sensitive the alarm is to moisture across the sensor conductors. The lower the value of this resistor, the greater the moisture required to activate the alarm. For example, using 22K for the resistor value, you'll need to virtually immerse the sensor in water to get the alarm to sound.

The continuous

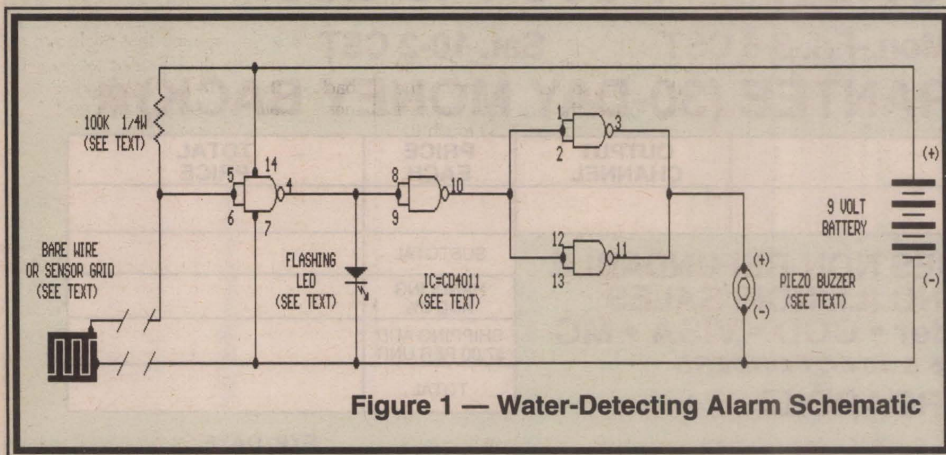


Figure 1 — Water-Detecting Alarm Schematic

bad weather, or earthquakes causing the collapse of dams, cause enormous damage every year all over the world. And in your home or business, a corroded water heater, a burst washing machine hose or a leaking roof can ruin floors, carpets, and furniture.

Well, you may not be able to stop a flood or an earthquake, but it's easy enough to place a water-detecting alarm wherever you want to know that water is where it shouldn't be!

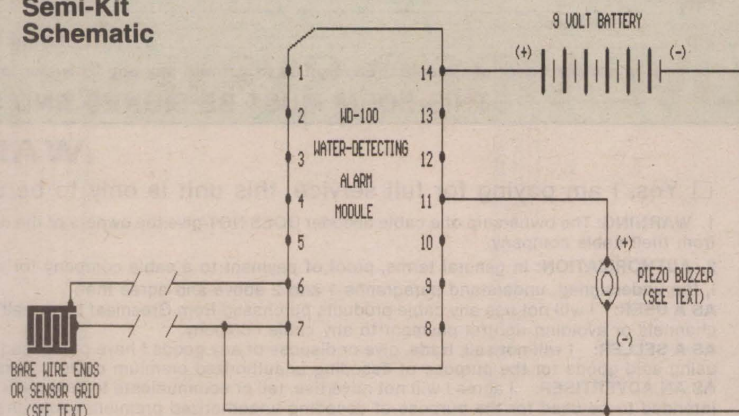
Surprisingly, I was unable to find a "water alarm" in any of several electronic and industrial catalogs I checked — not even Radio Shack! When you consider that swimming pools and spas can overflow when being topped off each week, that drains and cellars can flood when a sump pump quits, that sewers backup, that water heaters regularly corrode and leak, that laundry and dishwashing hoses can burst, or that any water pipe just about anywhere can leak, it's amazing that water detectors are not spotted all over your home or business — yet they seem to be

purpose, but this simple design has some special features. For one thing, it is powered by a standard 9-volt radio-type battery that will last virtually shelf life if the alarm is not activated frequently, since the alarm only draws power when it is activated. No switch is needed. The sound output warbles to attract attention. The water-sensor can be as crude as a piece of speaker wire with stripped ends up to 1,000 feet away. You can connect several sensors in parallel to monitor a number of places simultaneously. And testing can be done with just a wet finger!

Describing how the water-detecting alarm works is more difficult than building it or using it. The heart of the circuit is a CD4011 Quad NAND IC (integrated circuit). This has four NAND (not-AND) gates, all contained within a single inexpensive 14-pin DIP (dual-inline pins) package. Radio Shack charges \$.99 for this IC, but it is generally available from electronic parts houses for \$.35 or less.

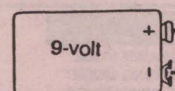
When both inputs of a NAND gate

Figure 2 Semi-Kit Schematic

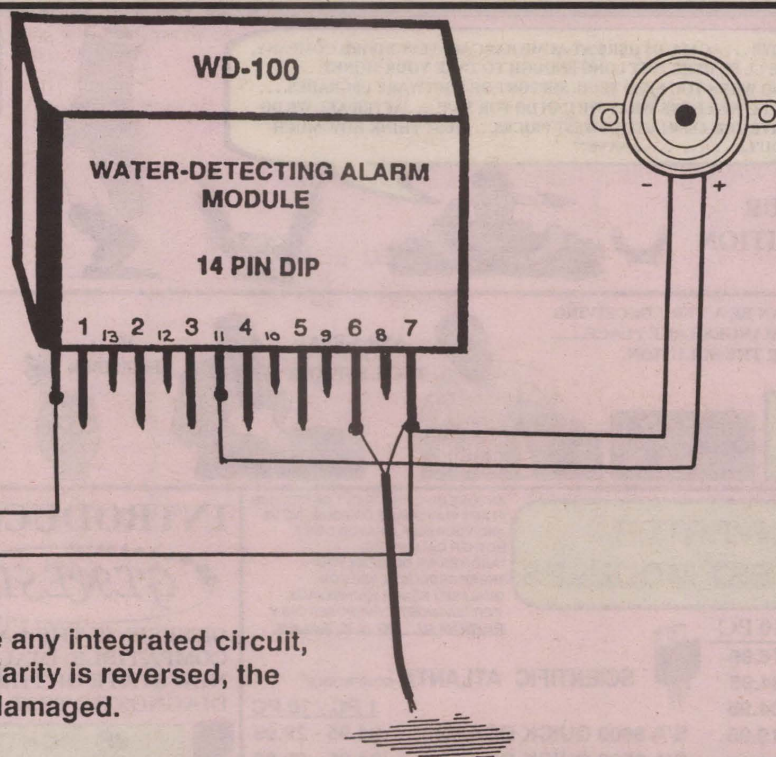


**Figure 3
Pictorial
Assembly**

Pins 1, 2, 3, 4, 5, 8, 9, 10, 12, 13 NC



CAUTION! Like any integrated circuit, if the battery polarity is reversed, the module will be damaged.



gates are housed in a single 14-pin chip. Using just about any mounting board (see page 121 of the Radio Shack 1995 Catalog for many choices), just insert the IC and wire the pins as shown in Figure 1, with external leads going to the battery,

sensor, and buzzer.

The "sensor grid" is constructed of a number of wires closely spaced, but not touching each other, joined together to form two conductors. The advantage of the sensor grid is that it can be made large

enough to cover an area of any size.

If all you need is a small spot to detect water, just use a length of speaker wire (up to 1,000 feet) with the ends stripped about 1/8" to expose the bare wire.

Whichever sensor you use, whenever sufficient moisture bridges the conductors at any point, the circuit is completed to the IC and the alarm sounds. Therefore, the easiest way to test the unit is to connect the battery, wet your finger, and touch the sensor or both bare wires to trigger the alarm. To stop the alarm, dry the sensor, remove your finger from the bare wires, or disconnect the battery.

An Easier Way

Ah, but for those of you who don't have well-stocked junkboxes of electronic parts, and don't wish to hunt down and assemble the required parts, there is an easier way: a semi-kit available from CED (4209 Evergreen Lane, Annandale, VA 22003; phone 703-354-2545). This semi-kit consists of a WD-100 Water-Detecting Alarm Module (\$12.95) and a WD-77 110dB 9VDC piezo continuous buzzer (\$6.95). You can get both or either item,

with a shipping and handling charge of \$2.00 per order, and 4.5% sales tax for shipments within Virginia.

The WD-100 Module is a cleverly packaged combination of a CD4011 IC, the resistor, and the flashing LED, all pre-wired, and packaged in a tiny .4"W, .65"L, .5"H 14-pin potted module.

Figure 2 shows a schematic of the simple external wiring to the battery, sensor, and buzzer. For those of you unfamiliar with schematics, Figure 3 is a pictorial showing the same thing. All you do is connect the four items as shown and test it with your finger as described earlier. It's up to you how you package the module, buzzer, and battery.

The Easiest Way

There is an even easier way — buy the assembled WD-60 water detecting alarm from CED (address and phone listed previously) for \$21.95 plus \$3.00 shipping and handling per order, adding 4.5% sales tax if shipped to a Virginia address.

The assembled unit comes in a hinged 2.5"W, 3.3"L, .9" thick white plastic box with double-stick tape backing. Inside the box is a compartment and connector for the 9-volt battery, the WD-100 Module, and the WD-77 Piezo Buzzer. Coming out the rear of the box is a two-wire cable about six-feet long terminating in a small plastic box with a .8" square printed circuit sensor grid on one face.

All you do is plug in the battery (not supplied), and place the sensor face down on the area you want monitored. Place the alarm box on anything that might not get wet, or use the double-sided tape on the back of the alarm box to mount it on a nearby wall. How simple can it get?

Summary

There are many ways to skin a cat — and many types of alarms. The water-detecting alarm circuit shown in Figure 1 provides a device not generally available, it uses few parts, and it has many features. You can build it from parts you may already have or can get, you can buy a pre-assembled module and buzzer, or you can buy a ready-to-use assembled unit. Installation and testing could hardly be any simpler.

When you give it some thought, there are many places you can use this alarm to alert you to a problem you might otherwise overlook until it became serious. Forewarned is forearmed. **NV**

Build It PARTS LIST

Note: R/S=Radio Shack Catalog Number

- CD4011 integrated circuit (see text) (R/S 276-2411 — \$.99)
- 100K 1/4-watt resistor (see text) (R/S 272-1347 — 5/\$.49)
- 9-volt rectangular battery (R/S 23-583 — \$.99)
- 9-volt battery snap connector (R/S 270-325 — 5/\$1.39)
- Piezo Buzzer (continuous— see text) (R/S 273-065 — \$2.49)
- Piezo Buzzer (pulsating — see text) (R/S 273-066 — \$4.29)
- Flashing LED (see text) (R/S 276-036 — \$1.29)
- Miscellaneous: Speaker wire, solder.

Easy-Way Parts List
(Available from CED. See text)
WD-100 Water-Detecting Alarm Module
WD-77 Piezo Buzzer

Easiest-Way
(Available from CED. See text)
WD-60 Assembled Water-Detecting Alarm

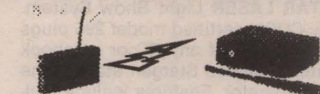
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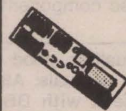
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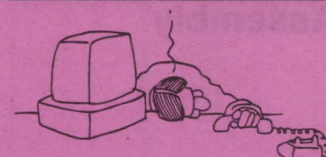


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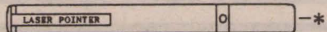


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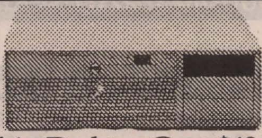


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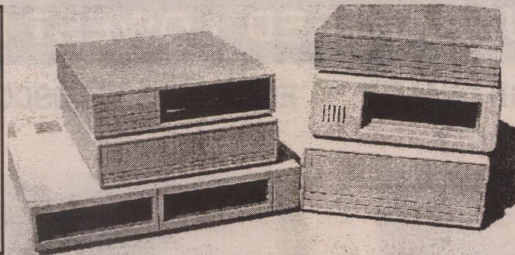
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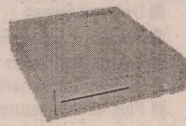
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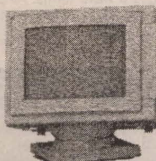
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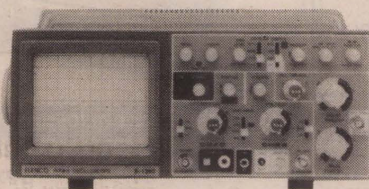


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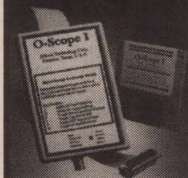
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Nuts & Volts Magazine/March 1995

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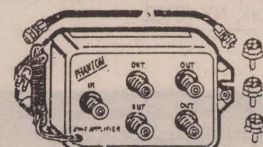
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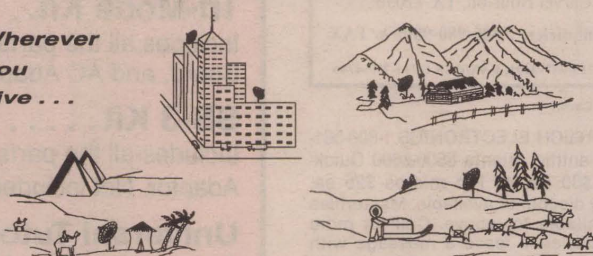
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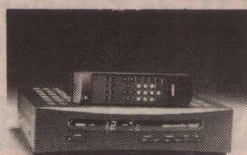
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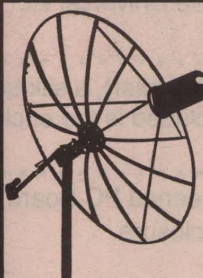
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In the past two issues, we have learned methods for clearing a telephone line of impairments such as noise, static, xtalk, and radio frequency interference. This month, we will examine EMI (electro-magnetic interference) and PI (power line interference/hum).

In review, the local telephone company (telco) delivers service to a "point of demarcation" (demarc) located on the side or rear of your home. Modern demarc devices called NIDs (network interface devices) are equipped with an RJ11-type jack/plug combination that provides a quick way to determine if a problem is in the telco network or your CPE (customer provided equipment).

EMI can be described as a buzzing or grinding sound that varies in intensity. Almost any device that contains electronic components will be vulnerable to EMI. Older telephone instruments contained mostly passive components, with just a few non-linear elements. However, newer designs include operational amplifiers and electronic filters that improve the volume level of both normal and interfering signals.

EMI nearly always coincides with the use of an electrical appliance or device in your home/business. EMI is caused by electrostatic and electromagnetic fields induced or radiated from a variety of items such as vacuum cleaners, computers, word processors, lamp ballasts, light dimmers, electric motors and controls, neon lamp power supplies, power tools, electronic air cleaners, and similar devices used around the home. All the items listed above can and do cause varying levels of EMI.

Our previous discussions of noise highlighted the need to document times/dates of trouble occurrences. This is true for EMI, also. Sources of EMI are easily determined because they are usually within your own home/business. Troubleshooting begins with a common

turn off the offending appliance while using the phone. However, this is not very practical, and reminds me of the man who went to the doctor complaining, "It only hurts when I do this," at which point the doctor replies, "Well, don't do that!" Scheduling time for corrective action will eliminate the need for emergency repairs.

When cordless phones first became popular, users often complained of noises caused by EMI. Newer models are improved and allow several channels to be selected for clear reception. However, since cordless phones are two-way radio systems, clarity can be influenced by installation methods. Locating the base unit close to high intensity EMI/RFI items such as computer monitors and television sets will cause noisy reception. Proximity to fluorescent lights and desk-top power

supplies will also diminish signal quality. The answer for reducing EMI on cordless phones is to move the base unit to several locations in the home, searching for the area of least conflict (electrically). Also, make note of areas where the receiver unit becomes noisy.

Corded phones are also susceptible to EMI from nearby electronics. Modern instruments are designed with various amplifier and signalling circuits. These designs often accept high levels of EMI. When testing the unit for EMI, wrap the base, cord, and handset in aluminum foil and place a normal call. During the conversation, remove the foil and determine if the noise level changes. If the foil clears the noise, the instrument is picking up the interference from free air reception. However, if the noise level does not

EMI. This will help determine if the noise signal is carried by the IWs.

EMI problems that are traced to the IW are caused by poor design of the installation. IWs are not shielded from EMI, and should not be installed within 16 inches of the noise sources listed above. In most cases, maintain a minimum of 24 inches of separation. However, 16 inches will suffice for enclosed runs where the electrical wiring is fastened to the

by d.b. levels

Inside Wire Maintenance Part 3

opposite wall stud. When installing with less than 24 inch separation, add several twists to the entire IW for the length of the exposure. Do not allow IWs to lay across the top of fluorescent light fixtures. This is a common problem for offices with drop/suspended ceilings.

If working in an industrial setting, do not locate the IW near electrical conduits serving heavy machinery. Avoid the temptation to fasten wiring along conduit runs. Thin-wall conduit does not offer the EMI shielding effect offered by threaded conduits. However, even small amounts of EMI leakage along the IW can reduce the signal-to-noise ratio to levels that produce audible interference. While this can be a nuisance for voice conversation, it can lead to errors in modem data transmission/reception.

Shielded wiring can reduce or eliminate the effect of EMI on voice/data communications. This can be an expensive solution, so inspection of existing wiring can save money. Also, shield quality varies widely. Select a cable that has layered shield, such as aluminum wrap covered in basket-weave/braided wiring. Inexpensive shielded cable has a loose weave shield conductor that is very "leaky" to electrical signals. Re-routing IWs from noise sources will clear many EMI troubles. If shielded wiring is employed, be sure it is a type intended for telephone service and is of the "twisted pair" design we learned about last month. Ground the shield at both ends of the cable, using an approved ground as directed by the National Electric Code (and

local codes). The use of special wiring types should be approved by local codes and must conform to any fire/safety regulations. Consult your electrical supplier for details. As a rule, grounding the shield at a single end will reduce interference from noise signals. However, for long runs of cabling, this also creates a safety hazard as illustrated in Figure A. As with any circuit, the point of highest current is also the point of lowest voltage. Conversely, the point of lowest current is the point of highest voltage. For short (<200') cable runs, the result is minimal. However, for lengths of over 200', induced currents can present a harmful concern to the safety of the worker. This is especially true for cables that are extended to other facilities such as those found in a campus arrangement.

Our first consideration is for the safety of users and technicians. Noise is a secondary factor that must be dealt with in a manner that does not create a more serious problem.

EMI troubleshooting methods closely compare to those outlined for RFI, and should begin with a removal of all CPE at the NID. Connecting a test phone or "butt-in" (discussed in the Jan. '95 issue), place a test call or revert on the line. "Reverting" is a process for calling your own line and may be accomplished by simply dialing your own directory number (DN). After receiving a busy signal or recorded announcement, hang up the phone. The line will ring back and you may answer as if a normal call was received. You may get another recorded announcement, but the

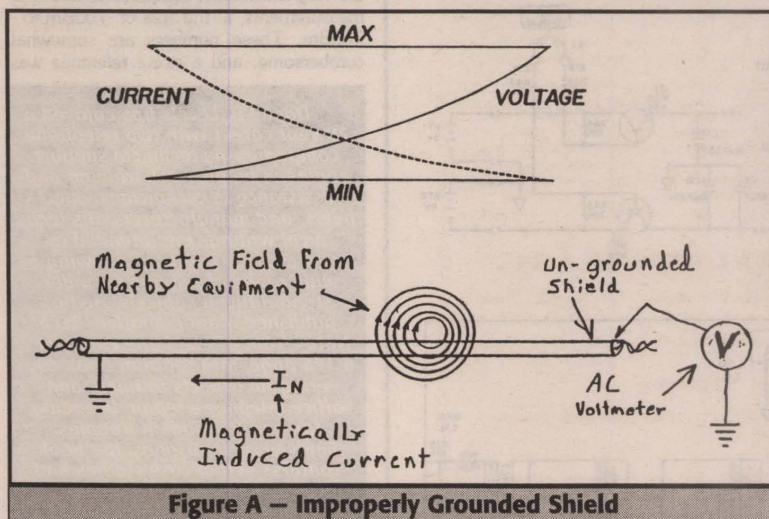


Figure A - Improperly Grounded Shield

sense review of appliances in use during times of interference.

Once the offending unit has been identified, we can diagnose the reason for the interference. The obvious answer is to

decrease, the EMI is being delivered to the phone via the IW and cords, or another instrument is allowing the interference. As we learned with RFI, remove all CPE from the line while conducting initial tests for



Figure 1 — T136BGMZ Standard Model(L) / Weatherproof Model(R)

line will become quiet. Some telephone switching systems require special codes to revert a line. If dialing your own number does not result in a reverted call, consult your telephone directory for instructions.

Once you have established a quiet line termination, connect each IW one at a time, while listening for the interfering signal. You will determine that a single IW is exposed to the noise source, and is back-feeding the signal to other IWs.

Again, re-routing the IW is the best way to eliminate interference. Causes and cures for EMI are very similar to remedies for RFI. Think of EMI as low frequency RFI. Be sure to thoroughly test any telephone instrument that uses internal/external AC power. Leaky (magnetic fields) transformers or faulty filtering capacitors can cause EMI internally to the unit. Keep telephone line cords separated from power cords and don't fasten or tape telephone cords to power extension cords. Do not allow cords to become a tangled mess — keep them neat and separate.

Most end users test for noise by listening carefully while calling another line (or reverting). While the human ear can be a good troubleshooting tool, it's difficult to produce quantifiable results by just listening for noise. Like any other signal, noise can be detected and measured as an electrical quantity. However, since noise can have infinite bandwidth, special rules must be followed to produce accurate results.

Telephone signal and noise levels are specified in terms of power. Therefore, voltage measurements must be calibrated to read the RMS value. When measuring single frequency signals, an average responding meter can be calibrated to read the RMS value of a sine wave, and will produce satisfactory results. However, noise signals may contain multiple frequencies and a variety of waveforms. We need a compromise between peak and average response for accurate signal measurements. The quasi-RMS detector retains the simplicity of common rectifying circuits, and has a response which closely approxi-

mates true RMS for white noise and most likely occurring waveforms. These signals should be measured in real-time, during an actual call.

Telco technicians conduct noise measurements during installation and routine maintenance procedures. For many years, noise measuring sets were large, bulky units that were not considered portable. In the early 1970s Wilcom Instruments began producing a line of portable, battery-powered test sets. The T136b model became the standard test instrument for thousands of telco installer/repairman. (See Figure 1.) This unit offered multiple test functions and was a compact design. Through the 1970s, the unit received several revisions for increased current measurements, impedance modifications, and added functions. Throughout the 1980s (and since), the T136BGMZ has replaced all previous models as the preferred unit. We will examine how this test set satisfies all the requirements for conducting basic noise tests on the local loop, including IWs and CPE.

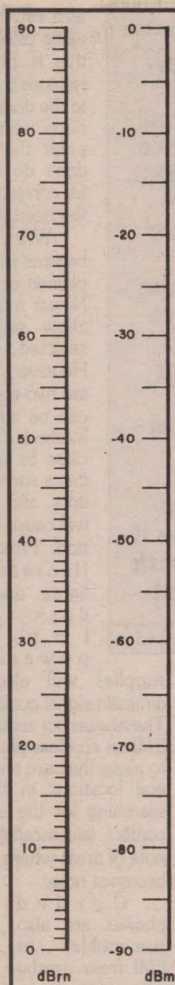


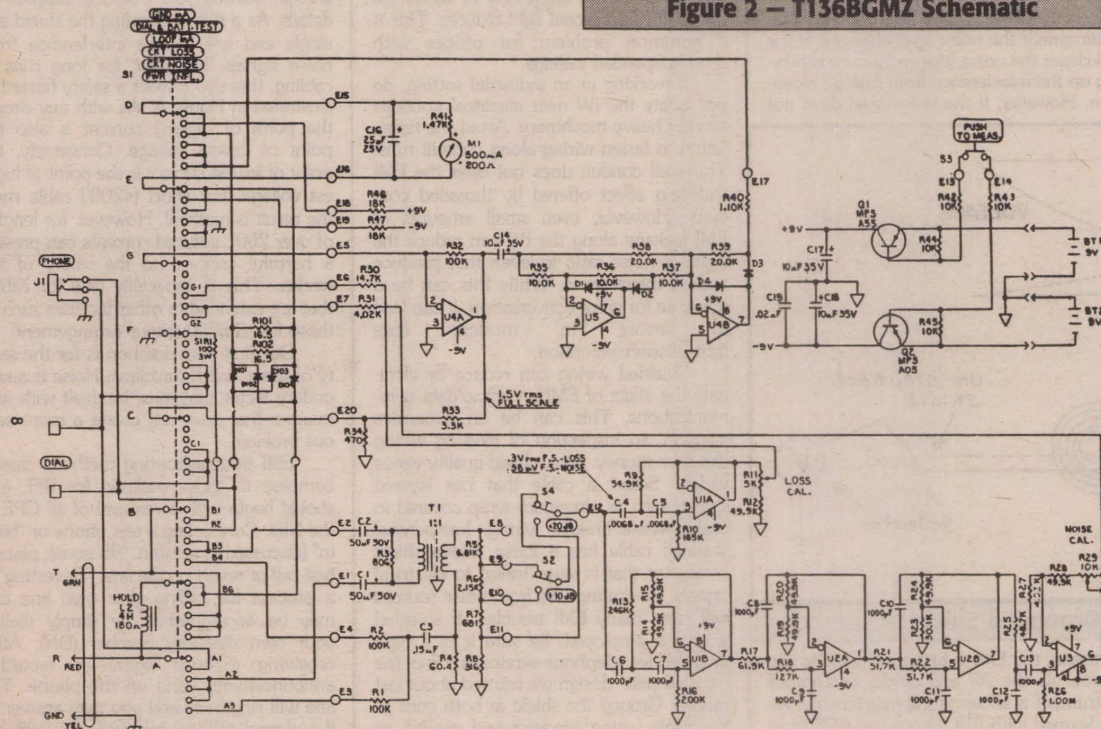
Figure 3
Noise
Reference
Conversion
Chart

The T136BGMZ is a small, compact, portable unit that can perform a variety of test functions from the NID or other locations. Test leads provide for connections to tip, ring, and ground conductors. Tip and ring are the two telephone line conductors serving your location. Our previous discussion on twisted pair cables (and IWs) noted that these two conductors are twisted together to form a mated pair, and can be jacketed with other pairs. Therefore, a three pair IW will contain three tip conductors, and three ring conductors. Test measurements must be conducted by accessing the tip and ring conductors for each line. Connecting across the tip of a given line, and the ring a second line will produce inaccurate readings. Note the dial access posts on the front of the T136. This offers a connecting point for a "butt-in" linesman test set or test phone. Once connected, a test number can be dialed (such as reverting on line), and the T136 will "hold" up the line during testing sequences.

As we continue our discussion of noise measurements, let's examine the actual circuitry that allows real-time testing. Figure 2 is a schematic of the T136BGMZ and illustrates contacts for six-function switch settings. The set is designed to measure current and tone signal losses, as well as metallic and common mode noise. We will explore the noise measuring circuits now and discuss other test functions in our next article.

For review, noise signals are expressed in terms of power. communications channels are tested for signal power delivered to the customer by transmitting a test tone at the input, while measuring signal power at the circuit output. In telecommunications, the circuit input is the telco serving the CO (central office) or remote. The output is the NID, located at the customer location. Without knowing the Input power, the output reading is useless. For example, a reading of -5dB does not indicate a loss or gain of signal, since the input could be higher or lower than -5dB. Therefore, a standard was adopted by imposing 1mW (milli-Watt) of power across an impedance of 600 ohms. This level is called 0dBm. All test signals are transmitted (unless otherwise stated) at a level of 0dBm. Therefore, an output reading of -5dB is expressed as -5dBm, indicating a signal power loss of 5dB. Noise readings are very small when compared to test tone measurements, in the area of -70dBm to -90dBm. These numbers are somewhat cumbersome, and a noise reference was

Figure 2 — T136BGMZ Schematic



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established at -90dBm. Therefore, -90dBm is 0dBm, where m denotes dB at reference noise level. (See Figure 3.) Conversely, +90dBm equals 0dBm, and +20dBm equals -70dBm, etc. Most noise signals on a telephone line measure between 0dBm and +30dBm. There is no need to measure levels below 0dBm, so there will be no -dBm measurements, such as -3dBm, etc. Since all noise measurements are expressed as positive numbers, we will drop the + symbol from the reading, as it is always implied.

The human ear is sensitive to a wide range of frequencies, generally 20Hz-20KHz. While younger listeners can easily detect signals above 16KHz, those of increased maturity may be unable to hear above 10-12KHz. The frequency response of the ear is not flat, and can be expressed as a curve when testing the annoyance (or interfering) effect of various frequencies (as compared to 1,000Hz) during a voice telephone call. In other words, when listening to a variety of low and high frequency tones, at what amplitude level do they

1,000Hz. The average person hears best when the received signal is near 1,000Hz, and noise is maximum when the frequency of the noise is near 1,000Hz. At a frequency of 200Hz, a signal of a given power is 25dB less disturbing than a 1,000Hz signal of the same amplitude. This characteristic response is also duplicated as a filter in every telephone instrument. Since we desire to measure noise signals that interfere with voice communications, we must conduct measurements with a test set which approximates the C message filter. The T136 contains a C message filter for noise measurements. Therefore, our noise measurements are actually expressed in dBmc, meaning decibels above reference noise, C message weighting (filtering).

The previous information is intended to be a primer that will allow meaningful interpretation of noise measurements. Noise measuring sets are available from a number of manufacturers and belong to a class of instruments called TIMS (transmission impairment measuring sets). While most TIMS can be purchased for \$2,000-

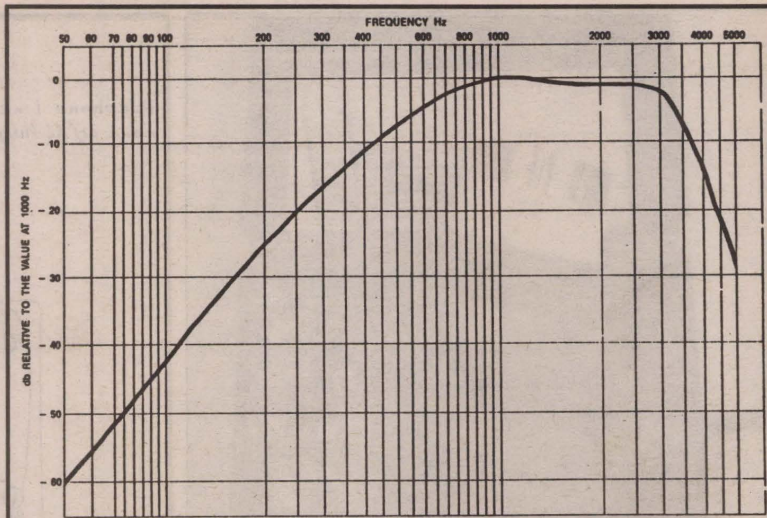


Figure 4 - C Message Response Curve

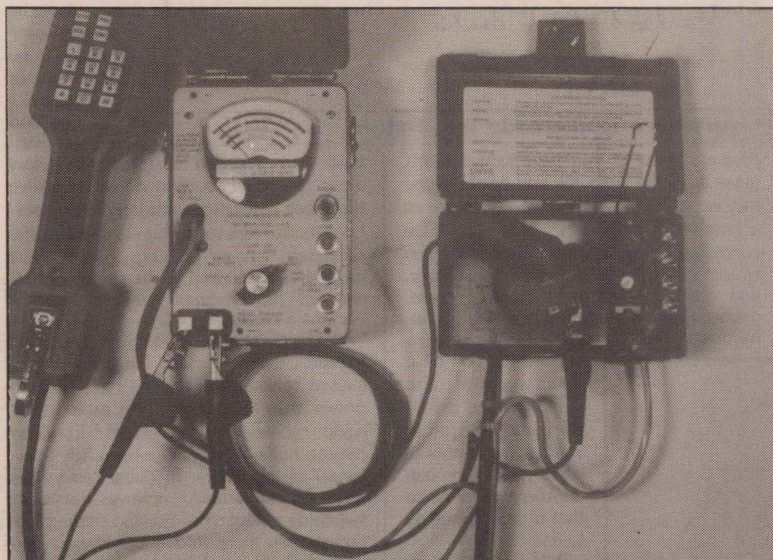


Figure 5A - Noise Reading with CPE Removed

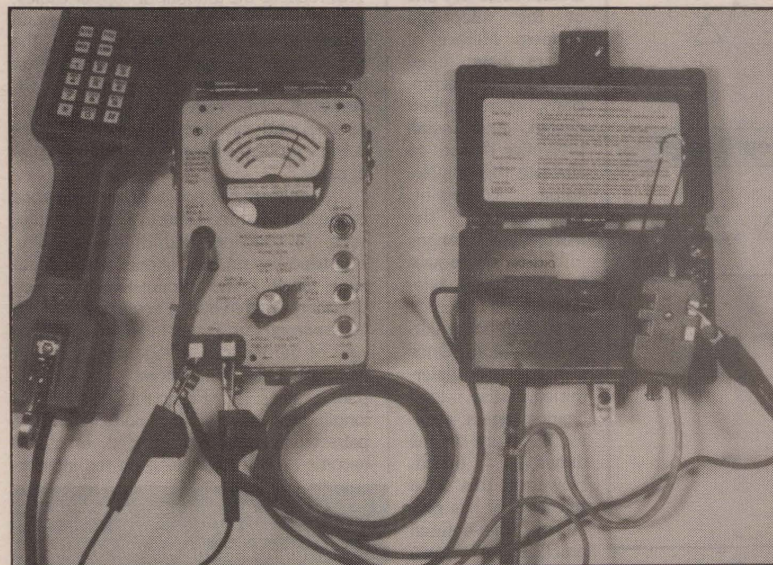


Figure 5B - Noise Reading with CPE Connected

become as annoying as a given level of 1,000Hz tone? The quantified average response to this hypothesis was presented as the industry standard "C message" response curve. (See Figure 4.) Notice that the curve assigns a 0dB reference to

\$2,500, the T136 was designed for mass market (technicians) prices of around \$250-\$350. These units are still available from Plantronics/Wilcom with excellent factory support/service. Jan-Tech Communications - 5577 S.E. Hwy 31,

Arcadia, FL 33821; phone 1-800-922-1959 - is your best source for used/surplus T136s (or other telco test equipment). Normal used price is \$150.00, but the manager is offering a 15% discount for *Nuts & Volts* subscribers (includes warranty). If you are serious about IW maintenance, you can't live without one.

Let's continue our discussion by conducting sample noise tests on a working telephone line. Accessing the NID, disconnect all CPE by removing the RJ plug. Place a Harris-Dracon 10210-000 test fixture into the jack. (See Figure 5A.) This test fixture is similar to the unit pictured in the Jan. '95 installment of this series, only this model contains its own RJ jack for "pass through" monitoring. With the test fixture installed and all CPE disconnected, connect the T136 meter by placing yellow lead to ground, green lead to test fixture tab "G," and red lead to test fixture tab "R." Connect a "butt-in" or test phone to the "dial" access posts on the front of the T136. If your test phone is not equipped with alligator clips, construct a test fixture by connecting two RJ11 jacks back-to-back, as shown in Figure 6.

Rotate the T136 Function switch to "dial & batt test," and revert on line. Once the line rings back and has been answered (by you), move the function switch to the "CKT noise" position and depress "push to meas" button. Observe the meter reading on the second scale from bottom, labeled "CKT Noise." Continue to depress meas. button for several minutes, looking for noise "spikes" or variations in the reading. If the noise reading is above 30dBm with all CPE removed, contact telco repair.

If readings are 0dBm-20dBm, connect CPE by plugging CPE feed RJ plug into the end of the test fixture. (See Figure 5B.) Readings may now be obtained with all CPE connected to line. In our example, Figure 5A indicates a noise reading of 10dBmc with CPE removed. When CPE is connected, reading jumps to 31 dBmc, indicating trouble in wiring, jacks, or instruments. The "push to meas" button has been internally shorted for these photographs. Continue to observe readings, again looking for spikes or swinging measurements. If noise increases with CPE connected, begin removing CPE units one at a time, while observing the noise meter. Once defective/improperly installed IWs or instruments have been removed from the line, reconnect all other CPE while observing measurements. This test will help locate any EMI caused by CPE wiring or instruments.

Continue noise investigation by restoring NID, moving the T136 to all jack locations in your home/business. Conduct noise measurements at all jack locations with CPE connected and disconnected, looking for changes in meter readings. Do not lift the receiver on any telephone during the measurement, because the normal voice signal will look like noise to the T136. If you desire to verify this, lift a receiver during test, using care not to "peg" the needle on the T136. Remember that the T136 is very sensitive to all signals while set to "CKT Noise" position. Also, be sure the line is reverted before switching the function knob from "dial" to "CKT noise" position. This test method will also locate IWs with series faults, as described in the January article. Now let's consider how the T136 actually measures noise signals. (See Figure 2.) While connected to the telephone line, and function switch is set to "dial & batt test," notice that the dial posts are across tip and ring. In any position other than "dial" or "current" measurement settings, a 180ohm coil is bridged across the line, which maintains a "hold" current without affecting the signal measurements. Circuit noise is the noise actually heard by the user and is measured across the line (differential mode). Therefore, the measurement is not referenced to ground.

The noise signal is coupled to transformer T1 through two 50 micro-Farad capacitors, shunted by a resistance of 806ohms. Notice the secondary winding is connected to ground with an effective

Future installments of this series include a lesson on the use of fiber optics in communications. To provide a better understanding of these tutorials, it will be helpful for you to acquire a 50/100 power microscope (or magnifying glass) and a section of fiber. The author has purchased sample lengths of optical fiber and prepared them for viewing. To receive a 12-inch, single mode/125 micron prepared optical fiber, send \$1.00 and (business size) self-addressed, stamped envelope to: db levels, P.O. Box 1125, Tallavest, FL 34270-1125.

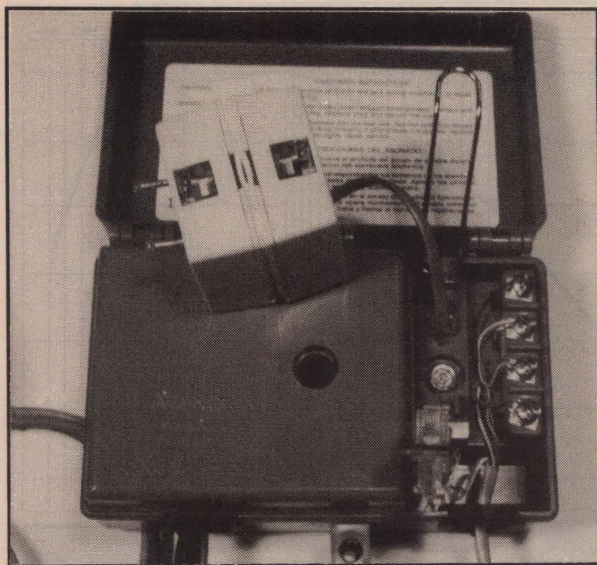


Figure 6A — Homemade Test Adapter

bridge resistance of 10Kohms. The parallel combination of 806 and 10Kohms equates to an input impedance of 735ohms. The telco uses two types of line to serve your location. One has an impedance of 900ohms, the other 600ohms. The input impedance of 735ohms allows the T136 to measure signals on either type of line without significant error. Following the unity turns ratio input transformer is a divider chain which allows for "+10dB," "+20dB" range extension. Normal signal flow is picked off at terminal E9 and connected to C6 via terminal E12. Integrated amplifier U1B is a two-pole, high-pass filter, fol-

lowed by two two-pole, low-pass sections (U2A & U2B). Finally, U3 is a passive response shaping amp with adjustable output for calibrating the circuit. These four sections perform C message weighting to noise signals, and are passed onto amplifier U4A. The 1,000Hz gain of the C message section and amplifier U4A is pre-set for a gain of 4000. This signal is passed to

the quasi-RMS detector section of U4A, U5, and U4B. U5 is a precision diode, delivering current to the inverting input of U4B through R38 and R39. This current is proportional to the instantaneous absolute value of the voltage at C14. The current is amplified by U4B and delivered across the movement and ground via R40, R41.

If C16 were omitted, the meter would be average responding. If placed at the cathode of D3, voltage would rise to follow peaks, discharging more slowly through

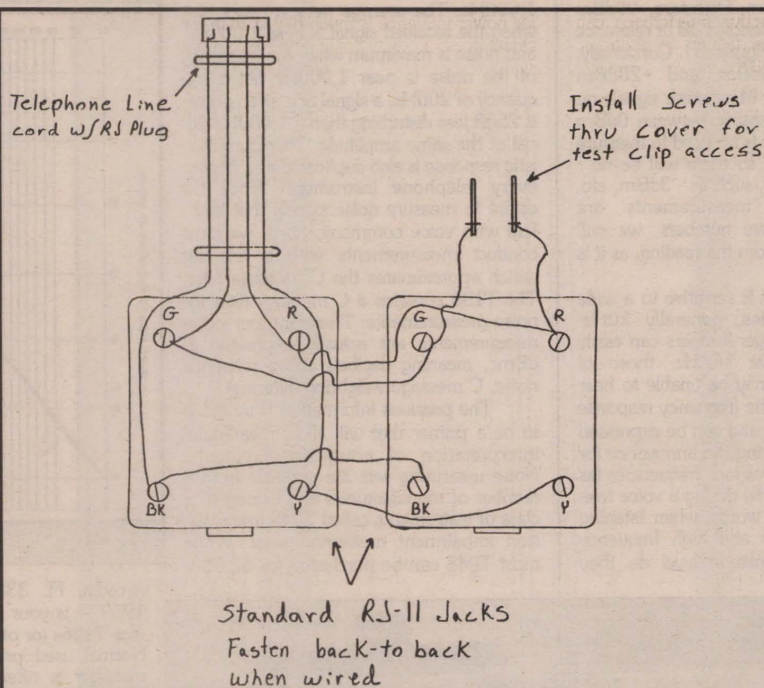


Figure 6B — Homemade Test Fixture

devices. Some of you have judged that I never fault the telco for any troubles you may experience. On the contrary, there are a number of noise types that cannot be controlled by the end user. Telcos employ special crews for noise mitigation efforts, and conduct joint noise reduction programs with area power companies. So far, we have only examined noise problems

over which you have direct control and responsibility. Before we move onto other subjects in telephony, we must review another type of noise that is very annoying to end users.

PI (power line interference) has been around since day one of the telephone business. Millions of dollars have been spent to train technicians, correct plant design, and install protective devices to alleviate this troublesome complaint. Complicating the matter are changes in loads on power lines, causing telephones to become noisy only under certain conditions. Once a fix has been determined, the load changes again, sending you back to the drawing board. However, this is a science that has produced well-defined practices for investi-

gations. The following information will help you learn how CPE can be the cause, but not the source of PI.

The telco CO is usually located in the approximate geographical center of a majority of the customers it serves. This was especially true in the 1950s-1970s, however, urban sprawl has caused residential sub-divisions to pop up miles from the

serving CO. Prior to the 1980s, telcos merely extended large cables to these areas, with capability for serving up to 3,000 customers.

However, installing large cables was not always practical, and "pair gain" systems became the preferred method for serving these areas. Pair gain allows a concentration of customer lines to be served by fewer cable pairs. Prior to pair gain devices, lines were conditioned by adding lumped inductances (called "load coils"). The load

coils were installed at measured points along the cable route to offset capacitive reactance associated with long cable runs. Load coils reduced usable bandwidth and restricted service offerings. Cable runs were usually installed in the same right-of-way as power lines, where exposure became a catalyst for PI.

Throughout the 1980s and this decade, a new design has reduced PI caused by exposure to long runs beneath power lines. Telcos routinely extend fiber optic cables to sub-divisions, installing remote units to serve hundreds (or thousands) of customers. In many cases, this arrangement actually removes racks of switching equipment from the serving CO and installs them into a building, underground vault, or above ground enclosure located at or near the new sub-division. This reduces the amount of copper cables, and allows customers improved service and access to advanced features. With the reduced runs of copper comes a reduction in noise complaints caused by PI. However, some areas still experience interference, and the fiber-fed remote will not correct problems caused by the "last mile" of cable.

The degree of power line interference is affected by three factors: 1) power influence; 2) coupling; and 3) susceptibility. The telco has no control over power influence, which is the amount and frequency of energy emitted by the power system into the environment. Power influence is a measure of the induced voltage appearing on nearby metallic conductors, such as telephone cables. (See Figure 8.) This causes a longitudinal current flow along the cable pairs which must be canceled, or it will become audible (depending on the interfer-

Figure 7A — Long Loop Design

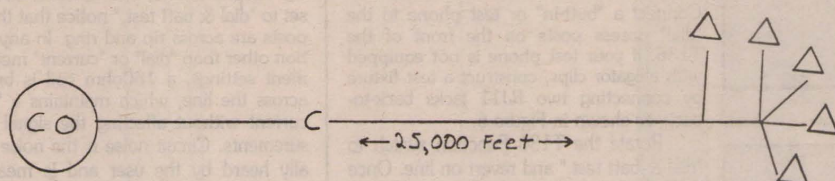
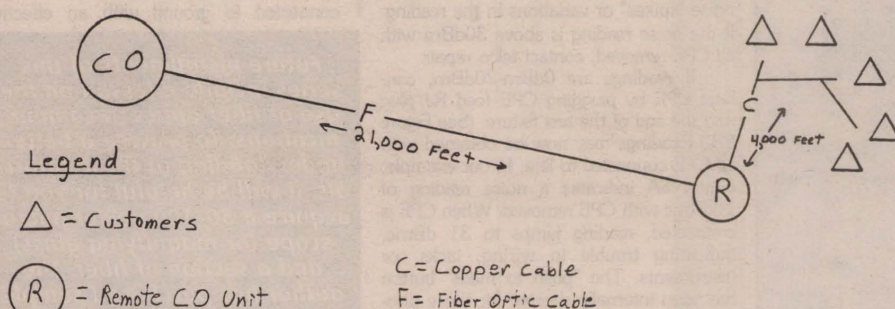


Figure 7B — Short Loop Design



Legend

△ = Customers

(R) = Remote CO Unit

C = Copper Cable
F = Fiber Optic Cable

lowed by two two-pole, low-pass sections (U2A & U2B). Finally, U3 is a passive response shaping amp with adjustable output for calibrating the circuit. These four sections perform C message weighting to noise signals, and are passed onto amplifier U4A. The 1,000Hz gain of the C message section and amplifier U4A is pre-set for a gain of 4000. This signal is passed to

R40, R41. For this reason, the ratio of R40, R41 was carefully chosen by the designer to provide the best response for a wide variety of waveforms.

Over the last three months, we have discussed troubleshooting methods and corrective measures to eliminate noise caused by problems within the scope of your CPE wiring, jacks, instruments, and

Have a telephone problem that can't be solved?

If you are in the middle of a bad experience, drop us a note at Nuts & Volts. Daniel Levels will analyze your trouble, offering suggestions for test procedures and corrective action.

Send your questions to Nuts & Volts, Dept. db, 430 Princeland Court, Corona, CA 91719. Questions will be answered in the next available issue.

ing frequency). Inductive interference can also cause mechanical failures in electronic equipment, such as PBXs, modems, and key systems. Balance of power line phase currents has a profound effect on this problem. When phase currents are balanced, little current flows in the neutral. However, heavy loading on any phase conductor causes significant current to flow in the neutral, and also through the earth. This is called ground return current. When phases are unbalanced, the magnetic field about the phase conductor is also out of balance with other magnetic phase fields. The uncanceled field cuts across the telephone cable, inducing a current as the field expands and collapses. In a perfectly balanced cable, there would be no adverse effect, however, there are no perfect realities.

Coupling can be affected by bonding and shielding practices of the telco, and most low-frequency induction problems can be corrected by a thorough investigation and test plan for shield effectiveness. One open cable sheath bond can cause inductive noise in an entire cable. In some cases a single open shield connection has caused an entire remote system to become noisy. The telco has direct control over per-

for power influence is much higher than for circuit noise. Longitudinal currents are more significant in terms of power than those of transverse mode orientation. Typical readings are from 65dBmrc-75dBmrc, rather than the 5dBmrc-10dBmrc of circuit noise. Remember, circuit noise measurements represent noise caused by longitudinal currents that are not canceled or attenuated by proper circuit balance, while PI readings directly quantify the entire longitudinal currents.

PI measurements are acquired in the same manner as described for CKT noise. After completing the CKT noise reading, rotate the T136 function knob to the "PWR INF" setting and depress "push to meas" button. Record readings for both measurements, comparing results with tests with/without CPE connected.

The telephone circuit (line) balance can be determined by subtracting the CKT noise reading from the power influence reading. For example, a PI reading of 65dBmrc and CKT noise measurement of 5dBmrc yields a balance of (65-5)=60dB. The target for balance is 60dB or above. A balance of 50-60dB is good, 40-50dB is fair, and anything less than 40dB is poor. The higher the balance, the higher amount

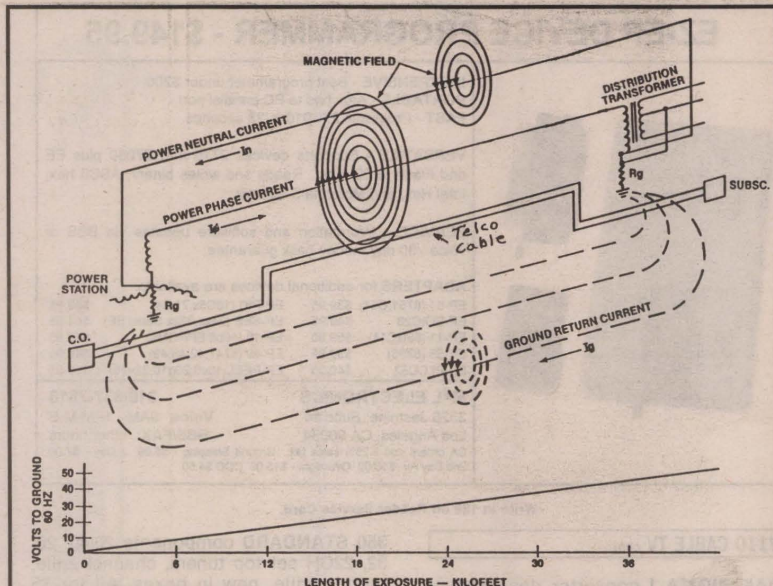


Figure 8 — Magnetic Induced Currents

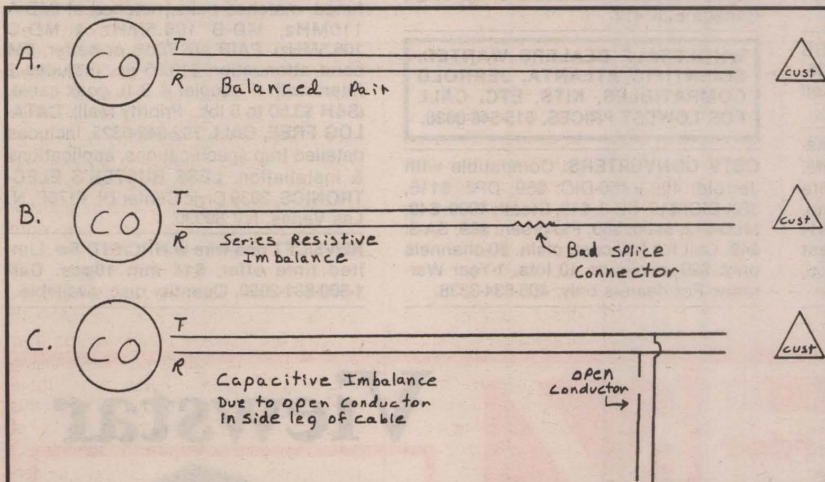


Figure 9 — Balanced vs. Unbalanced Cable Pairs

formance of shielding/bonding and grounding issues.

Susceptibility is the measure of how well balanced a circuit is before becoming adversely affected by an induced longitudinal current. A longitudinal current is a current that flows along a cable pair with respect to ground (common mode). Common mode signals can be measured with the T136. If the pair is well balanced, the currents cancel and no noise is heard. However, if the pair is unbalanced (even a little), noise will become audible and can be effectively measured and quantified. (See Figure 9.) This metallic (transverse mode) signal is the measurement we described as "CKT noise." Therefore, both signal types can be measured with the T136 test meter.

The circuit design for PI measurement is the same as with CKT noise with a major difference in the input section. (See Figure 2.) For PI testing, the tip and ring conductors are each in series with a 100Kohm resistance, shunted together and fed through capacitor C3 to the secondary side of T1. The signal is imposed across 60.4ohms and ground, which is coupled with the 50Kohm (effective 100K/2) to form a voltage divider.

As the signal passes through the secondary winding, the primary acts as a 735ohm termination. From this point, the signal follows the same convention as with CKT noise measurements. Notice the scale

of inductive currents can be tolerated without interference.

Unbalanced equipment provides a path to ground for longitudinal currents. Early models of answering machines had ring detectors triggering to ground, creating a slight unbalance condition. Remember that a path to ground invites current flow into your equipment, which may not be designed to handle the power.

Telcos can maintain balance by reducing bridged taps (multiple appearances of a pair in different cable sheaths) and repairing series and shunt faults in other conductors. Well balanced cables can withstand higher amounts of PI and even make up for poor shielding. However, all parameters must be dealt with effectively.

Another method for determining the degree of balance is to measure the AC signal voltage with a VOM. While this is not a very accurate method for noise investigations, it will give you a clue about the severity of the problem. Remove all CPE at the NID, connecting one lead of a VOM to ground. Measuring for AC Volts, set the multiplier at a high setting, stepping down to reasonable range after connection. This will keep from pegging the needle.

Using the Harris-Dracon test plug (or equivalent), touch the free meter lead to the tip side of the line. (See Figure 10.) Record the voltage measurement, repeating the procedure for the tip side of the line. Next,

measure across tip and ring for any metallic voltage. Be sure the VOM is in "AV volts" mode. Most VOMs pass a meter lead through a blocking capacitor in AC mode, removing any DC component from the measurement. Remember there is nearly 50VDC on the ring conductor, so be sure your meter removes this DC component from the reading.

Most lines will measure just a few millivolts of common mode voltage with little or no metallic signal. Lines with moderate PI will measure several volts to ground, and will not see much metallic if well balanced. Severe PI will provide readings of 15-35 volts to ground, yet measure little metallic voltage if the line is well balanced.

However, if unbalanced, several volts may be measurable across tip and ring, resulting in power line hum. Certain circuit elements, such as PBX and key system line cards, will often fail to operate with more than 10 volts AC (to ground) present on the line.

The previous discussion should convince you to maintain balance in your CPE. Since CPE is considered part of the circuit, balance can be affected by equipment connected to the line. For this reason, T136 readings for CKT noise and PI should be conducted with CPE both removed and connected.

In some instances, readings will be acceptable with CPE removed, but degrade severely when CPE is reconnected. This can be especially true for home-brew projects that do not consider the effect of balance.

If the telco cannot reduce or eliminate common mode voltages from your line, contact SNC Manufacturing Co., Inc. (101 Waukau Ave., Oshkosh, WI 54901; 414-231-7370) for information on their 30L & 70L series noise chokes. These are tuned, RF sealed dual chokes and can be installed at the NID to improve balance at power line frequencies. They are very effective at creating a high series impedance for noise signals, while causing no effect on performance of normal telephone line signalling/functionality.

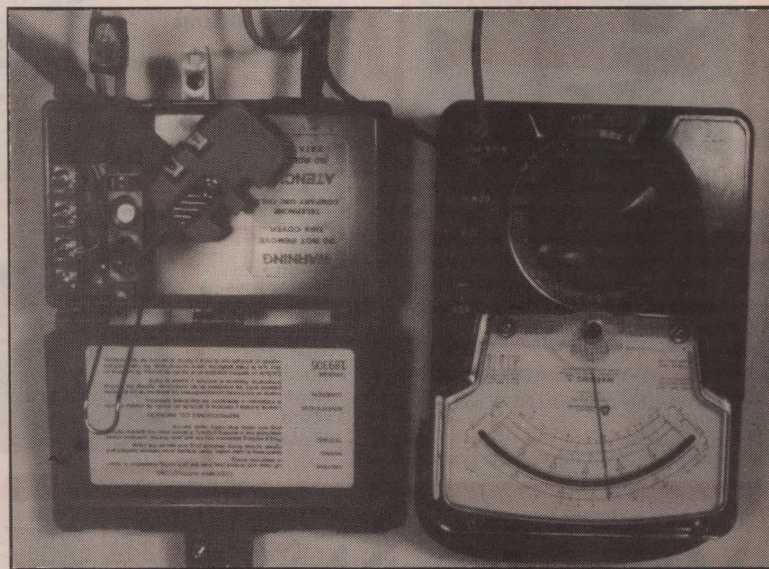


Figure 10 — Measuring Severe PI with 630 Tripplett

Again, while most PI troubles can be corrected by the telco, you are responsible for maintaining a balanced termination and may be the cause, but not the source of PI.

Next month, we will look at the remaining functions of the T136 for measurement of insertion loss and operating currents. NV

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#110 CABLE TV cont.

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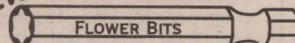
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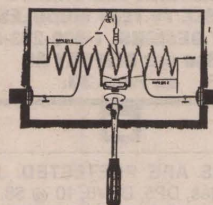
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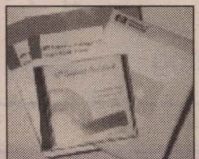
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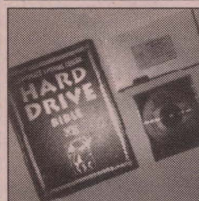
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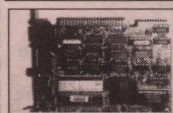
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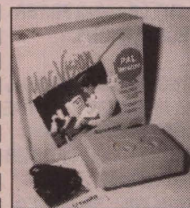
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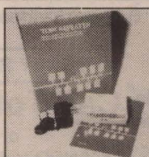
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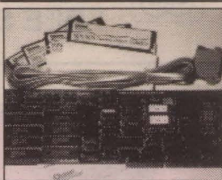
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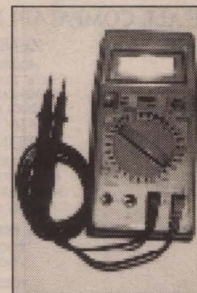
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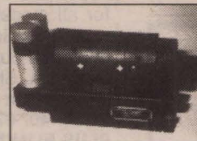
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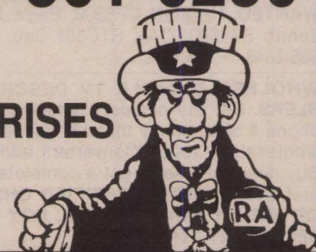
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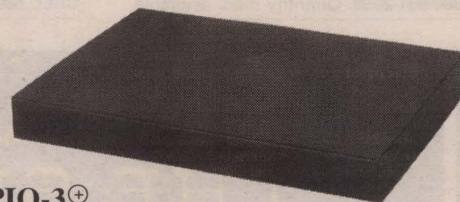
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AMATEUR ROBOTICS

I was talking about simple vision systems with my friend, Marvin Green. Regular readers of this column will remember Marvin as the designer of the Bot-Board, a single-chip 68hc11 circuit board that I mention often in these pages.

I had mentioned my trip to MIT last year, to cover the 6.270 Robot Design competition. While at MIT, I toured various labs and at one point ended up in the Artificial Intelligence library.

There, I saw an impressive demo of an autonomous robot equipped with a stereo video vision system. The robot stood about three feet tall, with a cylindrical base and a tall, slender body topped with a pair of miniature video cameras.

This baby could move! It raced around the carpeted library floor, at speeds faster than I could comfortably walk. It dodged tables, people, books, furniture, and even changes of flooring. And the only sensor it used was the vision system.

The robot was not tethered or restricted physically; it was free to roam wherever it wanted. But the control software specifically caused the robot to avoid elements its vision system tagged as obstacles.

One definition of an obstacle was a dark horizontal line in the cameras' fields of view. The library carpet was bordered by dark rubber molding, which the robot saw as something to avoid. It would tear across the floor, see the dark strip of molding, then veer off in another direction.

After explaining all of this to Marvin, I then began wondering aloud if there was a simple way

The first article covers the biological components of a frog's vision system. Filo describes the method frogs use to detect and track fast-moving prey, such as flies. Briefly, frogs determine the speed and angle of an object that crosses their field of view using a net convexity detector. They also use a sustained contrast detector to sense background light levels.

The net convexity detector is actually a group of two types of receptors on the eye's retina. The vast majority of receptors are low-sensitivity types, that provide a small voltage when triggered by the presence of a visual image.

The second kind of receptor provides a significantly higher voltage in response to a visual stimulus. These high-sensitivity receptors are relatively few in number, and are scattered across the retina. Note, however, that the high-sensitivity receptors never occur at the outer edge or in the center of the retina. Instead, they appear at various off-center sites.

This placement, coupled with the types of signals each receptor delivers, enables the frog's brain to deduce the speed and direction of travel of any small object in its field of view.

The sustained contrast detector works more

like a charge-coupled device (CCD) camera. This detector contains a matrix of receptors that monitor the general light level of the image seen by the frog. Each receptor provides a signal if its portion of the image is above a certain threshold of brightness. The frog's brain transforms this matrix of information into edges of optical contrast.

I'll not go into greater detail on the frog's eye's operation, but instead refer you to the *Byte* article and to the bibliography in that article.

Of more interest to me is the second article. Filo gives details of his ingenious designs of two robotic eyes, patterned after the frog's eye. He created a sustained contrast detector by arranging 20 phototransistors in a 4x5 matrix. Light, directed onto the matrix by a suitable lens, is converted into discrete 1s and 0s by simple electronics. The computer samples the resulting data and calculates a crude image in software.

The net convexity detector also consists of a 4x5 matrix of phototransistors, placed in the focal plane of a lens. Again, each phototransistor converts detected light into an electronic signal which is then sampled by the computer.

Here, however, the computer ignores the output of a phototransistor unless the device signals a sudden change in light. This means that the computer does not process cells seeing a constant light

level, whether that light is bright or dim.

When a cell registers a sudden change in light level, the computer generally accepts this change as a 1. The only exception is the single phototransistor designated as the high-sensitivity receptor. The computer translates its signal as a higher value, say, 2.

This arrangement means that any object crossing the robot's eye will generate a string of 1s with perhaps a 2 thrown in. The placement of the high-sensitivity receptor lets the software quickly determine the exact angle at which an object crosses the lens's field of view.

Filo's articles go into considerable depth on how his software translates the signals created by these two eyes into useful data for his robot system. He provides detailed drawings and explanations that you can easily adapt to your own use.

I hope you get a chance to read through Filo's articles. Besides the intriguing descriptions of the frog's eye, he used some very clever engineering to overcome the low level of technology available 15 years ago.

Remember when . . .

It's hard to believe how little was available to robotics experimenters in the late 1970s and early 1980s. Today, we often take for granted our 486 or Pentium processors, with their attendant half-gig hard drives and 32 Mb of on-board RAM. The computer hobby was considerably different back then.

The pages of these articles included advertisements for circuit boards for adding memory, in the form of static RAM, to an S-100 system. Assembled and tested boards containing 32K (yes, kilobytes) went for \$649 each, but serious experimenters could save \$50 by soldering a kit together.

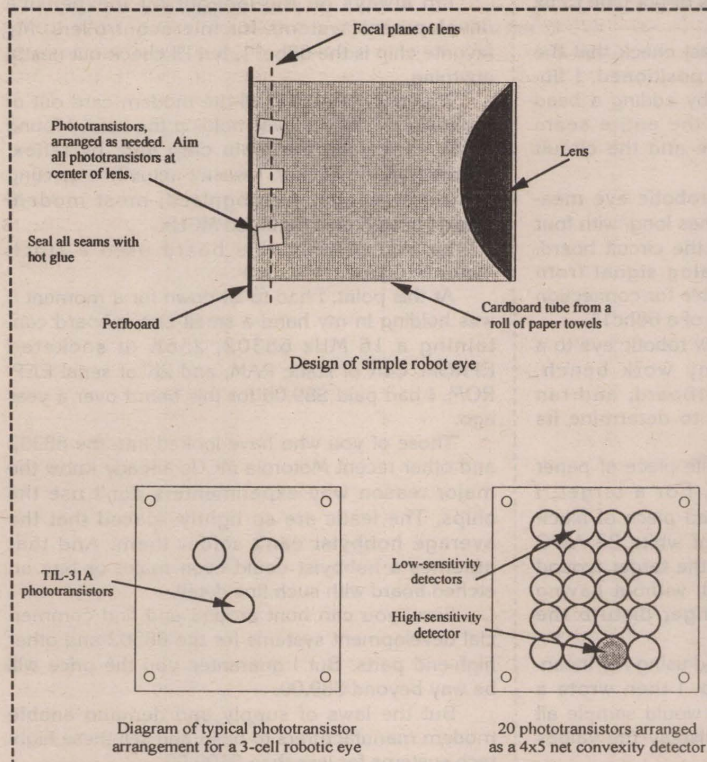
And robot builders didn't have 68hc11 BotBoards laying around, ready to drop into a frame and go. Filo's robot project consisted of a homemade mechanical hand, wired to and controlled by an 8008 microcomputer. Anyone out there remember the 8008?

Your own eye

I spent an evening putting together an eye of my own. Refer to the accompanying diagram of a simple robot eye.

This eye, or light sensor, consists of a plastic lens fitted to a heavy cardboard tube. At the focal plane of the lens, I mounted one-half of a Radio Shack experimenter board (276-148) containing three phototransistors and associated resistors. I then added a cable for hooking the electronics to a small 68hc11 system.

I bought the phototransistors and lens from Electronic Goldmine. The lens (G3068) sells for \$2.00 for a pair, and measures 1.5" in diameter, with a focal length of about 1.5". I scavenged three phototransistors from a surplus assembly, also offered by EG (G911). This assembly contains four TIL-31A photodetectors and four TI-305 IR LEDs, plus connectors, wire, and a red LED; cost is \$1.00 per assembly.



to build similar abilities into a small, servo-based robot such as Huey. Marvin replied that he had saved an old *Byte* magazine article that described exactly that.

Two days later, I received in the mail a folder containing some pages Marvin had trimmed out of the February and March 1979 (!) issues of *Byte*. The articles, entitled *Designing a Robot from Nature*, were written by Andrew Filo.

The TIL-31A photodetectors make ideal components for a robotic eye. They are housed in a small metal can that mounts vertically on a board, so the light-sensitive element faces away from the board. These detectors include their own high-quality lens built into the case, they are sensitive, and cost very little.

I only used three photodetectors in my robot eye, as I was building an eye for a specific purpose. You can certainly add more detectors if you like; the techniques I used will work in general.

I began by cutting a piece of cardboard tube from an empty roll of paper towels. This tube is about 1/4" larger in diameter than the lens, but it is easy to get and cheap.

I cut the tube to a length of two inches, using an Exacto™ knife. I then slit the tube lengthwise, using a single straight cut.

Next, I put one edge of the cut inside of the second edge, so I could roll the tube slightly smaller. I fitted the lens into one end of the tube, rolled the tube tightly against the lens, then temporarily taped the tube in place.

As shown in the diagram, I positioned the lens with the convex (outward bulging) side to the inside of the tube. I also took care to place the lens as close to the end of the tube as possible, making sure it was set perpendicular to the length of the tube.

When I had the lens properly positioned, I held it in place with three small dots of hot glue, applied at the joint formed by the lens and the tube wall.

After that glue cooled, I then added a bead of glue to the seam formed by the overlapping edges where I had earlier cut the tube. When that glue cooled, I then removed the temporary tape and sealed that section of the seam with hot glue, as well.

robotic eye.

After choosing the site for each phototransistor, I soldered them in place. I took care to mount the detectors about 1/8th inch above the circuit board. This small gap is critical because it allows the following sensor alignment.

Once soldered in place, I then carefully pushed each phototransistor slightly off-center, aiming it at the center of the lens. You can make this step easier if you place each phototransistor on the board so its leads are properly aligned for bending in the desired direction.

I then completed the wiring of the sensor board, adding the resistors and cabling. My sensor board needs five connections to the host computer; +5VDC, ground, and three analog signals. I terminated the cable with a female 5-pin MTA-style connector.

While placing the remaining components, I always checked to make sure nothing interfered with the planned placement of the lens tube. The lens tube will mount directly to the circuit board, in exactly one location, so I checked often to make sure I wasn't putting a part in a wrong place.

After soldering all the components, I positioned the lens tube onto the circuit board. While holding it in place, I visually checked alignment. When I was satisfied that I had the lens where I wanted it, I used three small dabs of hot glue to fix the lens tube in place.

After making one last check that the lens was properly positioned, I finished construction by adding a bead of hot glue along the entire seam formed by the tube and the circuit board.

The completed robotic eye measures about two inches long, with four mounting holes on the circuit board. It provides an analog signal from each detector, suitable for connection to the analog inputs of a 68hc11.

I mounted my new robotic eye to a small stand on my work bench, hooked it to a BotBoard, and ran some experiments to determine its field of view.

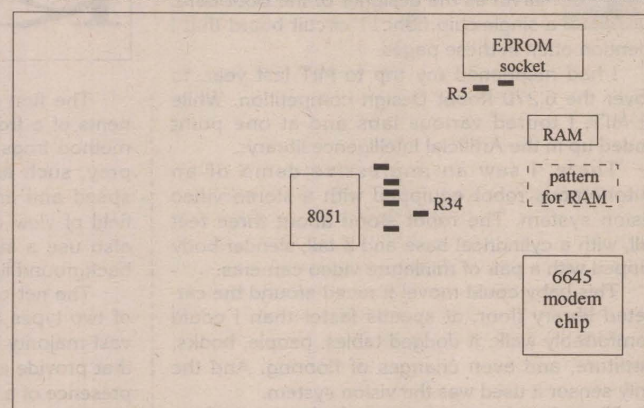
I used a solid white piece of paper as a background. For a target, I attached a dime-sized piece of black paper to a length of white 22 AWG wire. I could move the target around on the background, without having shadows or my finger disturb the readings.

I lit the background using my incandescent desk lamp. I then wrote a small program that would sample all three signals and display the values read on my laptop's screen.

I placed the eye about six inches from the background, started the program, and began moving the target around, noting the changes in the displayed readings.

Despite the target's size, only one detector ever saw it at any one time. The readings from a detector changed by about \$40, or 64 decimal, between light and dark. This wide range of values will ease the job of writing the final line-following software.

I have included a diagram showing how you could use this same technique to create a 4x5 cell net convexity detector. Remember that this design uses 20 identical photodetectors. The single detector marked as high-sensitivity is actually no more sensitive than its companions; the software you



Layout of Practical Peripherals
14.4 Kbaud external modem board

write simply gives this detector's output more value.

And remember that you might need to alter the base of the lens-holding tube slightly to accommodate the larger array of sensors.

Cheap development systems

I'm always on the lookout for inexpensive development systems for microcontrollers. My favorite chip is the 68hc11, but I'll check out nearly anything.

Recently, I had to pull the modem card out of my main PC. While I was holding the card, I found a QA sticker on the main chip and, by reflex, scraped off the sticker. I wasn't actually expecting to find a number I recognized; most modem boards use house-numbered MCUs.

Lo and behold, this board used a stock Motorola 68302.

At this point, I had to sit down for a moment. I was holding in my hand a small circuit board containing a 16 MHz 68302, 256K of socketed EPROM, 64K of static RAM, and 2K of serial EPROM. I had paid \$89.00 for this board over a year ago.

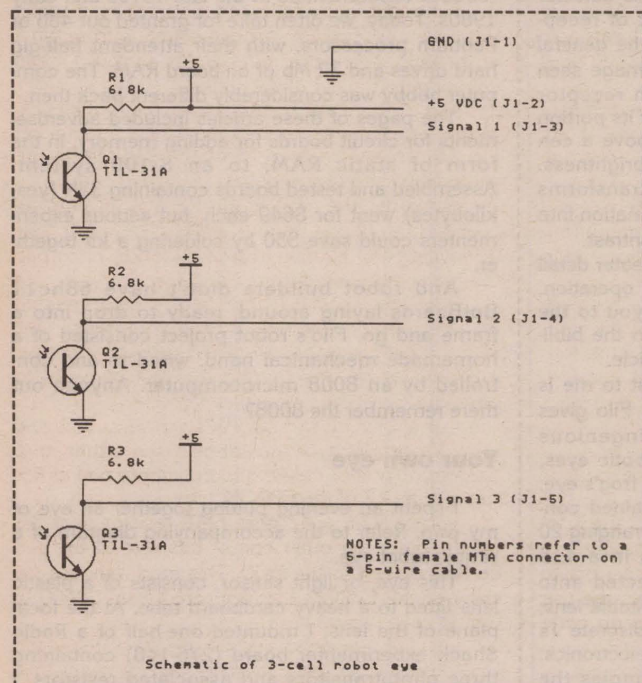
Those of you who have looked into the 68302 and other recent Motorola MCUs already know the major reason why experimenters don't use the chips. The leads are so tightly spaced that the average hobbyist can't solder them. And that assumes a hobbyist could even make or buy an etched board with such fine detail.

Sure, you can hunt around and find commercial development systems for the 68302 and other high-end parts. But I guarantee you the price will be way beyond \$89.00.

But the laws of supply and demand enable modem manufacturers to build and sell these high-tech systems for less than \$100.00.

I got on the phone to the modem's maker, Practical Peripherals, and talked to their technical service desk. What follows is the result of several conversations and some independent digging of my own.

Practical Peripherals sells two classes of modem, each in two different forms. The regular class modem contains an 80c31 variation, with 32K of socketed EPROM and 32K of static RAM. The processor runs at over 22 MHz, and is a house-



I now had a small lens and holder, ready for the addition of my robotic eye electronics.

The accompanying schematic shows the eye's electronics are quite simple. The simplicity arises because all of the A/D conversion and sampling occurs in the robot's 68hc11 microcontroller.

I started by choosing the arrangement of phototransistors I wanted. I used a triangle design because I was building an eye that my robot could use for following a dark line on a white surface. Refer to the accompanying diagram of a three-cell

numbered Siemens part.

The Pro class modem contains a 68302, which is a CMOS version of the 68000 with three on-chip high-speed serial ports, four controllable chip selects, 32 bi-directional I/O lines, and other goodies. This modem carries 256K of socketed EPROM (in two chips) and 64K of static RAM.

Practical Peripherals sells both classes of modem in either internal or external format. The latter is by far the more interesting to robotics hobbyists, as it includes an on-board serial port, eight LEDs, and a small wall-wart power supply.

The circuit boards in either class of external modem measure about 6-3/4" x 4-1/2" and make extensive use of surface mount technology (SMT).

Note that the above refers to the Practical Peripherals 14.4 Kbaud modems. I haven't had a chance to explore the newer, 28.8 Kbaud units yet. Besides, the price of the slower modems is dropping fast; as of this writing, mail-order prices for the Pro class 14.4 Kbaud external modems is \$129.00. Check the pages of *Computer Shopper* for suitable suppliers.

Other modem makers will likely use different chips, so if you want to try other MCUs, look around. I know that the older Supra internal modems used a Rockwell MCU with two socketed EPROMs on-board, which could point to a 16-bit 6502 variant. And some of the newer AT&T modems sport DSPs; anyone want to try hacking robot code with a DSP?

I have already turned a regular class Practical Peripherals external modem into a nice little 8051 development system. I started by heading down to the local Computer City and picking up a new modem for \$99.00.

I opened the case, took the modem board out, and spent some time looking over the electronics. I noticed a 62256 SMT 32K static RAM chip already soldered in place, with space next to it for a second chip. This leads me to suspect you could add an extra 32K of RAM by simply soldering in another chip.

But I was headed in another direction. I wanted to know where the ROM and RAM appeared in the 8031's I/O map. And the only way to learn that was to look inside the EPROM.

I want to stress something here. I have absolutely no intention of ever again using this board as a modem. I couldn't care less how Practical Peripheral's code works, how they designed their code, or how their code could be altered to change the modem's performance.

All I care about is locating the various I/O resources in the MCU's address map.

So I pulled the EPROM out of its socket, put it in the socket of my EPROM programmer, and downloaded its contents to my PC as an Intel HEX file.

Next, I needed an 8031 disassembler. I also realized that, eventually, I'd need a good 8051 assembler. Where better to look for such tools than the Internet?

A little bit of prowling through the comp.robotics Frequently Asked Questions (FAQ) file turned up pointers to several valuable FTP sites.

ftp.intel.com contains several tools and files supplied by Intel. There is lots of stuff for high-end MCUs, but not too much for the 8051. Still, it's an interesting site, and worth a look.

The two winners were bode.ee.ualberta.ca and ftp.pppl.gov. I picked up some very strong tools from both of them, but I don't have notes on exactly what software came from which system. I encourage you to try both of them.

Note also that bode.ee.ualberta.ca carries copies of nearly everything on the Motorola FREEWARE BBS.

From these two sites, I grabbed a very nice assembler from MetaLink. ASM51 appears to be a complete MCS-51 assembler, and its supports include files, macros, and segmentation. It is very fast, with good error descriptions, and templates for several different processors beyond the 8051.

I also picked up the DIS8051 disassembler from DataSync. This is an excellent disassembler, capable of translating a .HEX file into legal-looking 8051 assembler source. I say "looking," because I never actually tried to assemble the disassembled source. But the output is certainly good enough to skim through and understand.

I turned DIS8051 loose on the .HEX file from the Practical Peripherals EPROM, and took a look at the output source file. I used the information gleaned from my examination to start writing an 8051 monitor of my own.

Actually, I went back to the Internet and grabbed a copy of MON31-11.ASM from one of the above FTP sites. This file is the source code for a simple, but useable 8051 ROM monitor.

Using this source as a starting point, I began rewriting large sections and adding the features I wanted to see in my new monitor.

The result, which I call MON31-20.ASM, for version 2.0, serves my purposes well. I can now use it to explore other parts of the Practical Peripherals modem's electronics.

The next mods to make to the modem electronics involved rearranging the locations of the I/O resources. I needed to do this to make the board more useful for robotics.

As purchased, the EPROM resides in code space from \$0 to \$7fff, with a second image from \$8000 to \$ffff. The 32K static RAM runs from \$0 to \$7fff in data space.

This arrangement is nearly useless for robotics. The only memory in code space is the EPROM. This means that you have to burn your program into EPROM, try it, change it, burn it again, etc.

I need to change this layout somewhat. I want the EPROM to appear only from \$0 to \$7fff in code space. I also want the static RAM to reside at addresses \$8000 to \$ffff in BOTH data and code space.

This last feature is most important. If the RAM exists in both spaces, I can use the monitor to download data into data space RAM, then jump to an address in code space RAM. This lets me use the RAM as a ROM emulator, speeding up code development.

This conversion is actually quite easy, but be warned that you will need to do some careful work. The mods involve unsoldering one or two SMT pins and devices, and must be done with care.

You will need a fine-point soldering iron with a very clean tip, and some fine solder. You will also need a magnifying glass, fine-tipped tools such as tweezers and a screwdriver, and some means of removing excess solder, such as a solder pump.

The following instructions deal with board type A1033600. You can find the board type on a small barcode sticker on the solder-side of the board.

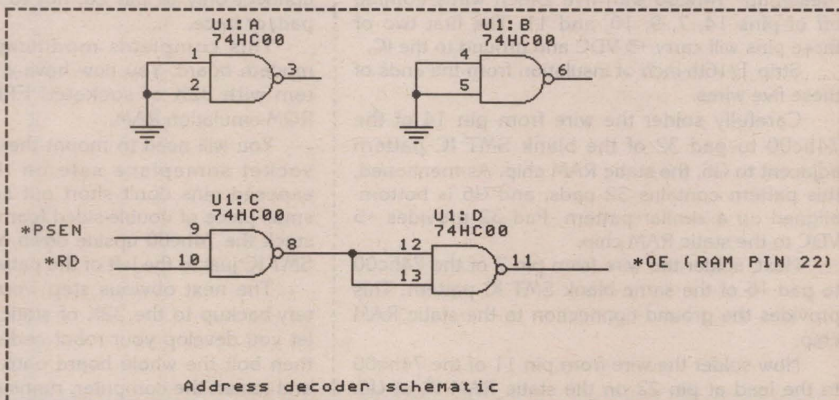
In fact, Practical Peripherals even puts a bar-

code sticker, complete with the board number, on the outside of all of their boxed modems. This lets you verify that you are buying the above board without even opening the box.

If you already have a Practical Peripherals modem, but it doesn't have this board type, read through the instructions anyway. You should be able to locate comparable junctions for your board.

Making the mods

My board contains a Siemens MCU, house-number SAB-C501-L20N; this is a square SMT chip in the center of the board. I spot-checked a few



pins of this IC and verified that it seems to match the pinout of an Intel 8051 in a PLCC 44-pin package.

This board also contains a 32-pin socket with a 28-pin EPROM plugged into it. The ROM socket sits in the upper-right corner of the board.

Note that in the following paragraphs, if I refer to pins on the EPROM, I mean counting from pin 1 of the chip. If I refer to pins on the socket, I mean counting from pin 1 of the socket.

The EPROM, a 27c256, is installed in the socket "bottom-aligned," so chip pin 14 fits into socket pin 16. Therefore, pin 15 of the EPROM is the same as pin 17 of the socket.

Similarly, the SMT static RAM IC is bottom-aligned in a 32-pad pattern at U6. Here, I will refer to device pins, numbered from 1 to 28, or to pattern pads, numbered from 1 to 32.

Begin by locating R5, an SMT resistor marked 470 (47 ohms), mounted on the component side of the board, near pin 15 of the EPROM. Remove this resistor by unsoldering it. Take care not to damage any of the tiny adjacent traces.

Cut a 2" length of 30 AWG wirewrap wire and strip 1/16th-inch of insulation from either end. Solder one end of this wire to the empty pad at R5, nearest pin 17 of the EPROM.

Locate R34, a 47 ohm SMT resistor near the MCU. Solder the other end of this wire to the pad on R34 closest to the MCU. This mod removes the copy of the EPROM that appeared from \$8000 to \$ffff in code space.

Carefully unsolder and lift pin 20 of the static RAM chip at U6. Be extremely careful doing this. You only need to lift the pin enough to clear the solder pad below it. Use a magnifying glass and a clean soldering iron, and take your time.

If you bend the pin up too far making this mod, DO NOT try to bend the pin back down nearer to the board. Doing so will surely fatigue and break the lead,

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ruining your board. Instead, flow a small amount of solder onto the pin so the solder acts to strengthen the lead.

When you are done, inspect your work to ensure that no filaments of solder short the pin to any of the adjacent pins or pads.

Now perform the same operation on pin 22 of this chip.

Wire up a socketed 74hc00 per the accompanying address decode schematic. Do not make any of the connections to the board yet; simply wire from pin to pin on the socket, using 30 AWG wirewrap wire and a solder-tail socket.

When finished, you should have a socketed "dead-bug" 74hc00 with five 2-inch wires coming off of pins 14, 7, 9, 10, and 11. The first two of these pins will carry +5 VDC and ground to the IC.

Strip 1/16th-inch of insulation from the ends of these five wires.

Carefully solder the wire from pin 14 of the 74hc00 to pad 32 of the blank SMT IC pattern adjacent to U6, the static RAM chip. As mentioned, this pattern contains 32 pads, and U6 is bottom-aligned on a similar pattern. Pad 32 provides +5 VDC to the static RAM chip.

Next, solder the wire from pin 7 of the 74hc00 to pad 16 of the same blank SMT IC pattern. This provides the ground connection to the static RAM chip.

Now solder the wire from pin 11 of the 74hc00 to the lead at pin 22 on the static RAM IC at U6. Note that you are soldering this wire to the chip's lead, NOT to the pad of the U6 pattern!

Make this connection by laying the wire along the lead, then heating the connection. DO NOT try to wrap the wire around the lead! This wire provides the *OE signal for the static RAM chip.

Solder the wire from pin 10 of the 74hc00 to pad 24 of the blank pattern at U12. This pad would

correspond to pin 22 of a static RAM chip, if it were soldered onto the pattern bottom-aligned. This pad provides the *RD signal from the MCI.

Solder the wire from pin 9 of the 74hc00 to the empty pad next to the legend C14, near pin 14 of the static RAM at U6. This pad provides the *PSEN signal from the MCI.

Finally, prepare a 2-inch length of wirewrap wire, trimming 1/16th-inch of insulation from either end. Solder one end of this wire to pad 22 of the blank pattern at U12. This would be pin 20 if a static RAM chip were soldered into place.

Solder the other end of this wire to the lifted pin 20 of the static RAM chip at U6. Take care to connect only to pin 20, not to any adjacent pin, pad, or trace.

This completes modification of the 8051 modem board. You now have a development system with 32K of socketed EPROM and 32K of ROM-emulation RAM.

You will need to mount the 74hc00 IC and its socket someplace safe on the board, so its exposed pins don't short out something. I cut a small piece of double-sided foam tape to size, then stuck the 74hc00 upside down on top of the small SMT IC just to the left of the pattern for U12.

The next obvious step would be adding battery-backup to the 32K of static RAM. This would let you develop your robot code on your desktop, then bolt the whole board onto your robot frame and restart the computer, running your code out of RAM.

I haven't installed such a battery-backup scheme yet, but I'll keep you posted.

The modified Practical Peripherals 8051 board seems ideally suited for robot hacking. Many of the 8051 signals have an SMT 47 ohm resistor soldered in series. I'm sure Practical Peripherals did this so they could add or subtract features by sim-

ply adding or removing resistors.

But this works to our advantage as well. Now you can easily isolate port pins and solder wires to the fat SMT pads, if necessary.

This board contains a number of interesting chips. The Rockwell 6645 chip drives the modem circuitry, which is fairly useless for robotics. But it might have additional features that a robot builder can exploit.

Of more interest to me is the ATMEL 24c16 2K serial EEPROM chip, located at U2, just to the left of the EPROM socket. Be sure to contact ATMEL and ask for a copy of the data sheets for this chip. It uses a stream of pulses to store and retrieve bytes of data from EEPROM, and could make a great place to stash power-up features, a small bootstrap, or other data.

I also noticed two Motorola 74hc595 8-bit serial-in, parallel-out converters. These are bizarre chips to have laying around inside a modem. I have a feeling Practical Peripherals used them as a poor-man's 8-bit output port, since running the 8051 in expanded mode uses up nearly all of its I/O lines.

Now you will need some software. My monitor isn't quite finished as of this writing, though it certainly will be done by the time you read this. I will make arrangements for storing this on an FTP site somewhere so you can retrieve it.

Those of you more adventurous can use the MON31-11.ASM source file as a starting point for your own efforts. Or you can roll your own monitor or robot code, using C, BAS051, or other language.

Note that you can find the source for BASIC52, a BASIC interpreter for the 8052 chip, at the Intel FTP site. With suitable modification on your part, this might prove a welcome addition to your development system. After all, you do have 32K of EPROM to fill up. **NV**

#115 TELEPHONE — FAX cont.

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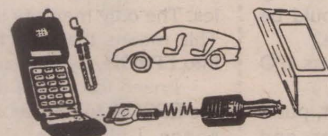
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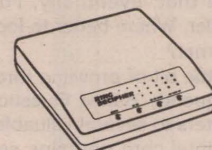


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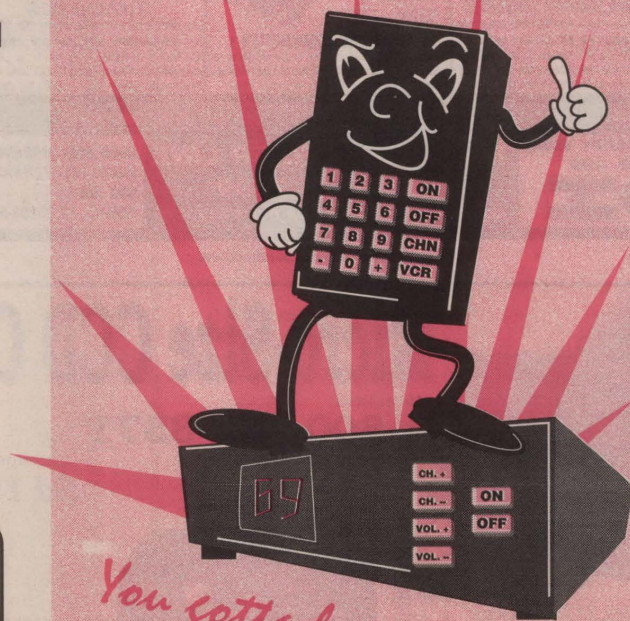
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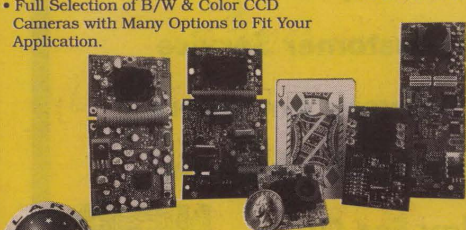
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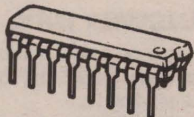
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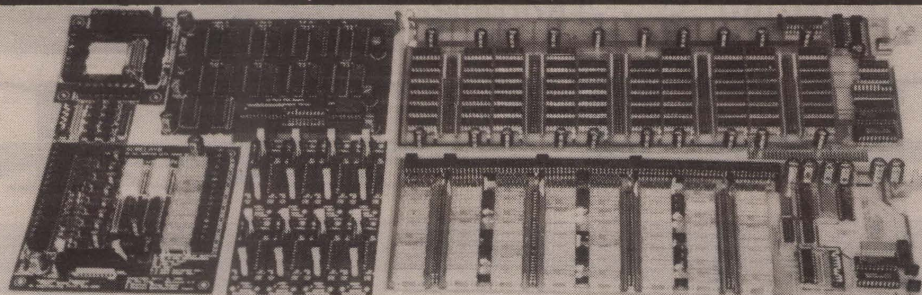
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- 16 Byte wide ports. 8 In + 8 Out. 1/2 card size.
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- Cards can share same space via extended I/O.
- Machine pin sockets make field repairs a snap.
- Silk screened, solder masked, & gold plated.
- See SCREWTERM, TERMACK, SCRELAY8

SCRELAY64

64 Channel Relay Board

- 64 SPST 10VA 100 VDC 70 VAC 0.5 AMP relays.
- Use to drive solenoids, valves, relays, contactors.
- 16 Relays per 64 line gold plated header.
- 2 pins per relay line reduces resistance
- Independent A & B lines on all relays
- High density board reduces computer slots used.
- Sensitive relays minimize power consumption.
- Only 1.0 milliseconds to turn on/off relays.
- Long life relays (10,000,000 operations).
- Cards can share same space via extended I/O.
- Power on reset leaves relays open on power up.
- Uses 16 Byte wide ports. 8 Input + 8 Output.
- Full length PC AT form factor card for 8 bit slot.
- Input ports can read back state of any relay.
- Gold plated 64 line headers support 16 relays ea.
- Silk screened, solder masked, & gold plated.
- Includes manual and software.

SCPROBE

240 Channel Stimulus/Response

- Ideal to test cables, wire harnesses, PCBs
- Use for ATE, testing switch matrices & boxes.
- 240 Output paired with 240 Input channels.
- Use to stimulate any line
- Then monitoring all other lines for responses.
- Set port 0 to stimulate any 1 of 240 channels
- Set port 1 to monitor selected channel.
- Read port 0 to determine response.
- Then scan 1 to 240 channels for response.
- Multiple boards may be used in system.
- Open collector outputs with 5.1K pullups.
- Every output paired with an input channel
- Uses only 4 ports in PC I/O space.
- Full size fuse protected PC/AT form factor card.
- Gold plated 50 line headers. 48 signal+power/gnd.
- Machine pin sockets make field repairs a snap.
- Silk screened, solder masked, & gold plated.

SCREWTERM

16 Channel Screw Terminal Board

- Directly interfaces to any port on SCPIO16.
- Supports 8 Input + 8 Output channels.
- LED Bargraph Displays monitor inputs & outputs.
- Screw terminals for all I/O, control & power lines.
- Termination resistors increase noise immunity.
- Fuse protected power lines.
- Screw terminal blocks socketed for quick release.
- Minimize your setup time.
- Reduce maintenance and repair costs.
- Saves many hours of building & wire wrapping.
- Shrouded Gold plated header with ejectors.
- Boards are Solder Masked & Silk Screened.
- I/O, Pwr, Gnd, Cntrl identified with legends.
- 3"x3" board with mounting holes & hardware.

TERMACK

128 Channel Termination Board

- Directly interfaces to SCPIO16
- Supports full set of 8 SCPIO16 cables.
- Supports 128 channels. 64 Input / 64 Output.
- 2 solder pads for ea. signal, control, & power line
- Provides simple interface to Solid State Relays.
- Easy interface to many other devices.
- Simple interface to wide range of sensors.
- Saves many hours of building & wire wrapping.
- Shrouded Gold plated headers with ejectors.
- Boards are Solder Masked & Silk Screened.
- I/O, Pwr, Gnd, Cntrl identified with legends.
- Large solder pads with plated through holes.
- Wide dual signal traces increase reliability.
- Plenty of well spaced mounting holes.

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Commercial	24.0 / 24.0 ma	189.00
Industrial	48.0 / 48.0 ma	229.00

SCPIO16 Accessories

Cable set	Eight 4' cables	32.00
SCRELAY8	8 optos + 8 rlys	129.00
TERMACK	8 hrs / 128 chnls	35.00
SCREWTERM	1 hdr / 16 chnls	29.00

SCRELAY64

64 Relays	495.00
32 Relays	295.00
16 Relays	195.00

Cable set	Four 4' cables	59.00
SCPROBE	240 Channels	489.00
	192 Channels	429.00
	144 Channels	369.00
	96 Channels	299.00
	48 Channels	199.00

Cable set	Five 4' cables	59.00
SCMIDI16	128 Channels	295.00

Cable set	Eight 4' cables	32.00
IOTESTER	Leds/Switches	29.95

Shipping & Handling	10.00
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Quantity Discounts Available	
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SCRELAY8

8 Optoisolators + 8 Relays

- Drive solenoids, valves, relays, & contactors.
- Monitor external events & power sources.
- Directly interface to any port on SCPIO16 board.
- 1500 V optically isolated inputs.
- SPST 10VA 100VDC 70VAC 0.5Amp relays.
- Sensitive relays minimize power consumption.
- LED Bargraphs display input & output status.
- Opto inputs monitor AC/DC 0..32 volt lines.
- Independent A & B lines on all relays
- Power on reset leaves relays open on power up.
- Fuse protected power lines.
- Supports use of optional external power supply.
- I/O, Pwr, Gnd, Cntrl identified with legends.
- 5"x5" board with mounting holes & hardware.

MIDI

SCMIDI16

MIDI

128 Line MIDI Digital I/O Board

- Control real world devices from MIDI systems.
- Turn 64 digital devices on/off as music plays.
- Accept commands from up to 64 digital inputs.
- FREE I/O Tester board when you buy SCMIDI16
- Accepts MIDI commands from MIDI controllers
- Programmable MIDI Channel number 1...16
- On board computer converts notes to Outputs
- On board computer converts inputs to Notes
- MIDI IN/OUT/THRU on 5 pin DIN connectors.
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- Uses same cables as SCPIO16
- Drives SCREWTERM, TERMACK, SCRELAY8
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TECH FORUM

This is a READER TO READER Column. All questions AND answers will be provided by *Nuts & Volts* readers and are intended to promote the exchange of ideas and provide assistance for solving problems of a technical nature. All questions submitted are subject to editing and will be published on a space available basis if deemed suitable to the publisher. All answers are submitted by readers and *NO GUARANTEES WHATSOEVER* are made by the publisher. The implementation of any answer printed in this column may require varying degrees of technical experience and should only be attempted by qualified individuals. Always use common sense and good judgement!

QUESTIONS

I have a Radio Shack Baby Room Monitor, Model 43-202 that I use to keep an ear on my radio room. Could I slide the base and receiver unit frequency(ies) either way (up or down) so that it will not be on any frequencies listed in Scanner Guides?

3951 J.H. Pompano, FL

HELP! HELP! HELP! I've got two dozen — 3-1/2" diskettes that are full of data entered by a Smith-Corona PWP-14 word processor; now I can't access the information. Can anyone convert them to ASCII or DOS language? The system that Smith-Corona used with this older machine is not compatible with ASCII or DOS.

3952 Lee L. Lipsky Garden Grove, CA

Does anyone know how to attach a WANG LPS-8/LIS-8 laser printer with a supposedly serial DB-25 interface to a PC serial port?

3953 Steven Huizenga Brown Deer, WI

I am looking for a telephone call screening device. On an incoming call it will ask the caller to enter an access code or remain on the line. If the correct code is entered a ring signal will be sent to peripheral one (phone). If the incorrect or no code is entered, peripheral two (answering machine) will ring. If peripheral one is not answered then output will switch to peripheral two. If anybody knows of such a device, or plans for constructing one, please let me know.

3954 Wesley Newswanger Ephrata, PA

Hello. I have seen and heard many video converters. Has anyone ever heard of a RGB to NTSC video converter?

3955 Marcel Gonzalez Miami, FL

I'm working on a Tandy 1000SX computer. It has memory chips marked MT4067-15 which is an 18 pin DIP and MT1259-12 which is a 16 pin DIP. Can someone give me pin-out and cross reference number for these? I know that MT4264-15 = 4164-15 and is DRAM. But, what are the two I listed above?

3956 Robert Ritchey Vandalia, IL

I would like to take a CD juke box, for example, the Fisher 24 CD player, and not only play music, but interface it to my computer. IBM, MAC, or both.

I would also like to take a TV and put four screens in one. For example, watch four TV programs at once and be able to adjust the sizes of the other windows. (This would be great on large screens.)

3957 John Lyons, Jr. Harrisonburg, VA

I would like to have a circuit that would be able to "Tach" R/C Type DC motors and other small hobby motors. These motors are capable of 60,000 to 80,000 RPMs.

If it is mechanical, there should be minimal loading. Same if the pick-up device is optical or ?

I'd like to use a DVM as a readout device and have the accuracy of the 100 RPMs. Input voltage on these motors could range from 0 to +12 VDC.

3958 Lou Shultz San Jose, CA

I recently obtained a monitor that I would like to hook-up (cable) to my 486/SVGA. It is Model VR290DA, 19", manufacturer: Digital Equipment Co. It has three BNC connectors RGB. Any suggestions?

3959 Bill Brinkerhoff Savannah, GA

I have a Drake TR33C which is an old crystal controlled two-meter amateur transceiver. I would like a schematic diagram of a simple synthesizer circuit that I could use to expand my frequency coverage to include the entire two-meter band.

39510 Donald Nappo Stanton, NJ

I need crystals for a Bearcat Base station scanner. But the price of the crystals exceeds what I would like to spend. \$5.00 a piece. Is there and device I can use to modernize this unit without the use of crystals and stay in the same economy class. It must be easy to install and have a range of 42.44-155.790, etc. for Rhode Island reception. Also, I see no scanner crystals for sale in the classifieds.

39511 Paul Recupero Portsmouth, RI

I have a Heathkit solid-state scope, model 10D-203-3 that has suddenly developed a ripple on the trace that is about one cm. in amplitude even with the input shorted. It is in the horizontal channel also. With the sweep set to external and the external input shorted the trace is a solid circle a little over one cm. in diameter. I substituted power supply capacitors and rectifiers, but there was no change. I disconnected the wires from the deflection amps at the CRT socket and shorted both

pairs of pins together and ended up with a trace a little over one cm. in amplitude, but the horizontal was almost a thin line. I bonded the circuit boards together with braid and connected the braid to the chassis, but the problem still persists. The scope is about 20 years old. Could it be the CRT? I could use some help.

39512 Richard L Gagnon Westfield, MA

I use an old Atlas 180 Amateur Radio rig that runs about 100W on 160-20 meters. I need an antenna switch. To save money, I'd like to build one. Is there any problem with using a 10 or 20 amp toggle switch, rather than the more expensive ceramic switches?

39513 David M. Colburn NH

Does anyone have hardware and software description for the remote control option on a JVC compact VHS palmcorder? The remote control is a serial device of some kind. I would like to interface it to my PC.

39514 Vinnie Saladino Commack, NY

I have a Tandy CM-8 Color monitor model 26-3215 that I would like to connect to a 9 pin CGA adapter. If anyone knows the pin connections on these monitors so I can replace the connector with a DB9, I would appreciate them contacting me.

39515 Mike Young Newville, AL

TV coverage of the US Congress includes sessions in both Houses and some committee hearings.

Would someone describe the sound systems being used? PA speakers are not obvious to the TV viewer although I'm sure they are there somewhere. Sound feedback seems to be well controlled.

39516 Bill Stewart Memphis, TN

Could someone tell me how to convert an American VCR to work in Europe?

39517 Syracuse, NY

Does anyone know how to modify a Super Galaxy mobile radio to include all or most of the 10-meter ham band? It only goes to 28.320 as of now.

39518 Bobby Calloway KC5JSN DeBerry, TX

I have an evaluation board that was manufactured by Harris Semiconductor Corporation. It is meant to demonstrate the RTX2001A

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.

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.

microprocessor and it has an on-board Forth Language. I have found it invaluable as a debugging tool for digital systems. Does anyone know where to get more of these modules?

39519 Gus Calabrese Denver, CO

I've got a Sanyo STK-437 Monolithic 2 channel power amp. Sanyo isn't any help, the data sheet and application notes are out of print. Could someone please help with; a basic stereo configuration, a bridge circuit, and suggestions for data

TECH FORUM

books, or project books dealing with this amp module.

39520 **Les Oliver**
Elverta, CA

Is there an easy way (or is there a way) to check a voltage regulator chip, such as 7805, etc.? I have a rather large handful of pulls, some from my own past projects. I need a method to verify, and if possible how well any of these work.

39521 **Michael Keller**
Lancaster, PA

A 2,000 volt power supply (10 amps), constantly blows a fuse. All the capacitors, transformers, and coils have been checked. They are okay. What could be the possible cause?

39522 **Richard D. Bennett**
Jamaica, NY

Over the past year my home has experienced various electronic disturbances. I have very little knowledge of electronics, but through a year of my own research, I have found I'm possibly being attacked by electromagnetic waves.

Lower AM on my handheld radio is all jammed. On a certain spot, I can push my television remote, and infra red tones (depending on button and function) are heard. When moving the radio dial, our televisions, no matter what station, pick up interference visually while tuning.

I've tried the FCC and they won't investigate, saying it's too much time and expense. I barely make over minimum wage, and cannot afford a specialist.

A compass in my living room spins around and around.

39523 **Donald Noble**
Riverside, CA

Seeking answer: Pre-recorded VHS video tape output brightness to stable video signal.

Most of the pre-recorded video

tapes on the market have added unwanted signal to keep people from copying. These tapes play on most low price NTSC composite video output TV signals.

Apparently, they seem to add a very low frequency AC to make video brightness slowly change from bright to dark.

We have a NTSC/PAL multi-format video player which converts NTSC RF composite to RGB component video signals. Our display is a VGA digital monitor.

We have not been able to view most pre-recorded VHS tapes. Can anyone help to stabilize our brightness problem?

39524 **Jerry Young**
Santa Clara, CA

I want to build a circuit that produces audible frequency of 700 Hz, and a second circuit that generates 1600 Hz. Generators will be three capacitors, 1 one transistor, three resistors or some such. Is there a chip that will generate CCITT numerical DTMF from 700 Hz to 1700 Hz?

39525 **Charles Dearing, Jr.**
Oakdale, LA

I need a temperature sensing circuit that will monitor the temperature of a room, send the information to an (IBM) computer, and then retrieve it from a remote location, via modem.

39526 **Joseph Chiaravalloti**
Woodlyn, PA

ANSWERS

ANSWER #29516 - FEB 1995

If you are stuck on using an SCR crowbar circuit, you may want to try using a Harris integrated circuit designed just for that purpose. It's an 8-pin DIP, part #ICL7665, available from Digi-Key (1-800-344-4539) for only \$3.00. It makes it easy to fire the SCR at a precise set voltage, and can

even give you an under-voltage warning also. I won't include a circuit here because Digi-Key can usually send you an application sheet with your order.

If you're open to other suggestions, you may want to try using a simple "Transorb." These are essentially, extremely fast-acting, high-surge current zener diodes that are universally used for surge and voltage spike protection. Devices marked 1.5KE15 and 1.5KE18 would be my suggestion. They are rated at 15 and 18 volts, respectively, and available from most electronic supply houses including Digi-Key, even Radio Shack may have some. The 1.5 in the part number means 1500 watts pulse power dissipation, and these guys will take up to 200 amps surge current. Advantage is simplicity and price - around a dollar. Disadvantage is they are not a precise as the Harris device.

When installed in parallel with the output of your power supply, the transorb will have a very high resistance if the voltage remains below the rated voltage. But if the voltage rises, the transorb will "short out" and blow the fuse, which is just what a crowbar does.

Robert Baust
Loganville, GA

ANSWER TO #29513 - FEB 1995

I am not clear on whether you must use thumb-wheel switches. A PIC microprocessor (or and equivalent such as an 8051, 68HC05, etc.) can be used. You will probably have to use steering diodes (32 of them) to allow you to read all 32 bits into the PIC and the retransmit them. Of course, then you have to write some code to make this work.

If you can use something other than thumb-wheels, I recommend looking at an HP48G calculator. You can buy one for less than \$100.00 at larger computer outlets. (I bought mine at ElecTek.) The HP48G is easy to program, it has serial output and if you

need parallel output, it is relatively easy to convert serial to parallel using a UART chip. This approach provides you with a numeric keypad and a cool display.

You might also want to look at New Micros Inc. (NMI). They have a low-cost (about \$49.00) module which has a microprocessor and the Forth Language built on board. In my opinion, this would be easier to program than a raw PIC.

The Basic Stamp from Parallax is an alternative to the New Micros approach. With their module you program in Basic. The 32 diode array is probably still necessary for the Basic Stamp or the NMI approach.

You might also want to check out a company that makes a cool integrated circuit for supporting front panels. Keypads, LEDs, and LCDs are supported. Their name is IQ Systems, Inc. In addition, I have a PIC based design that accepts serial commands and inputs/outputs serial data. I will send you the design info if you are interested.

New Micros, Inc., Gary Harden
1601 Chalk Hill Rd., Dallas, TX 75212,
214-339-2204, FAX 214-339-1585

IQ Systems, Inc. 20 Church Hill
Road, Newton, CT 06470, 203-270-8667, FAX 203-270-9064

Parallax, Inc. Desimone Lane
#69A, Citrus Heights, CA 95621,
916-624-8333, FAX 916-624-8003

WFT 4555 E. 16th Ave., Denver, CO
80222, 303-321-1119, FAX: 303-329-6904, Applelink: WFT Internet:
WFTCO#083aol.com

ANSWER TO #2958 - FEB 1995

The Micom should be useable on amateur HF. The Motorola Manual would be the ultimate authority.

My cross reference for the Motorola Micom Super Console indicates that the part number for this manual is 68-02929G85-0.

Manuals are available from Motorola, and you can contact them at (708) 538-0021. This is the Motorola Parts Identification phone number. Give them the model of your radio and they should be able to tell you availability and cost of a manual.

Ellis Electronics
Pikeville, NC

ANSWER TO #2956 - FEB 1995

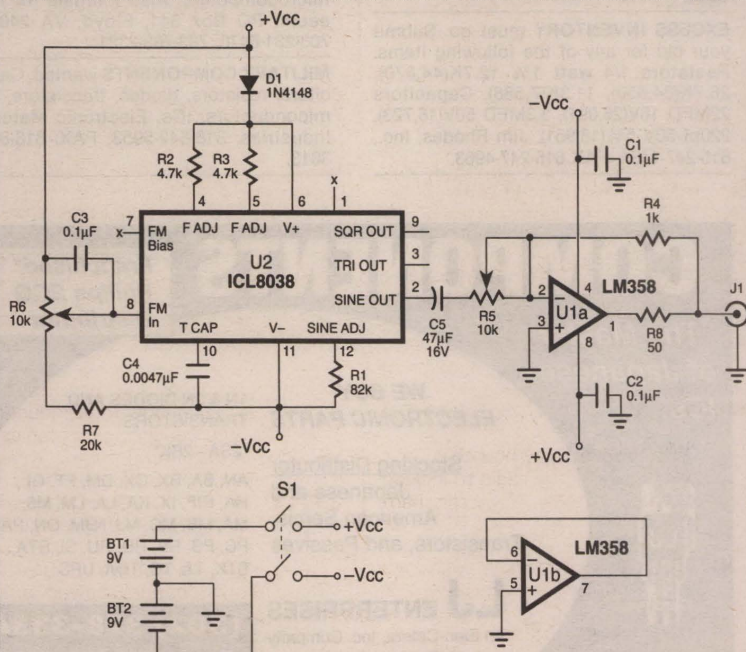
There are several types of these devices. The two most common are RF and magnetic. The RF type uses a tiny chip tuned to a frequency. The receiver bars emit electrostatic fields that charge the chip as it gets close to the field. When the capacitance is great enough, the chip discharges at that stores assigned frequency. Most of the tag is an antenna for the discharge.

When the receiver gets a signal, the alarm goes off. These are the tags that are removed in the store. The magnetic kind are the same principle, responding to a magnetic Hall Effect frequency. The pad that desensitizes the tag is just similar to a bulk eraser for tapes. Really high tech stores read each tag frequency and allows that number to pass through.

By the way, the alarm not only sounds, but the doors lock with mag-

Continued on page 135

Nuts & Volts Magazine/March 1995 **103**



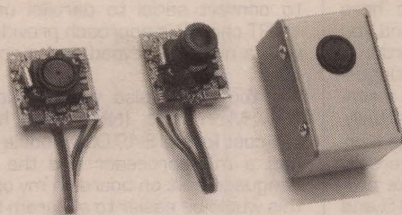
ANSWER TO #29517 - FEB 1995

A very compact audio signal generator can be constructed using a precision waveform generator IC (ICL8038) made by Harris Semiconductor. This IC is unique in that it will generate three waveforms; sine, triangle, and squarewaves. The frequency output is adjustable between .01Hz and 300KHz and the sinewave output distortion is less than 1%. The schematic diagram illustrates the application of the ICL8038 IC to construct a battery powered mini-audio signal generator which will provide 500Hz to 1.5KHz frequency range with adjustable amplitude output.

The output frequency of the generator is set by the combination of R2, R3, and C4. The output of the generator IC is AC coupled to op-amp U1 through C5. U1 buffers the output of U2 and provides amplitude output adjustment in conjunction with R5. Frequency control is accomplished through the adjustment of R6. Bipolar bias for the circuitry is supplied by two nine-volt batteries.

Kevin Goodwin
Oceanside, CA

MINIATURE BLACK & WHITE VIDEO CAMERA MODULES & CASES



ASC-307SM \$ 125
(Standard Lens)

ASC-307SMP \$ 145
(Pinhole Lens)

1-1/4" Square

.4 LUX Sensitivity

8 - 14 VDC

CASE-1
2-1/4" x 1-1/2" x 1-3/8"

Pinhole Lens Standard Lens Case-1

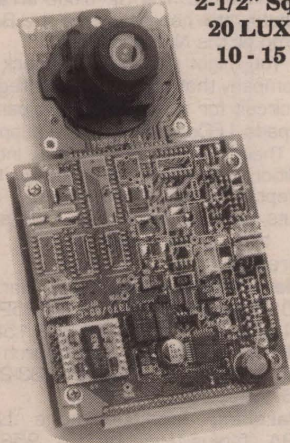
CASE-1 \$ 20

PAN-1C COLOR CAMERA \$ 275

2-1/2" Square

20 LUX Sens.

10 - 15 VDC



PORTABLE (PWT-1)

**WIRELESS
VIDEO/AUDIO
TRANSMITTER**

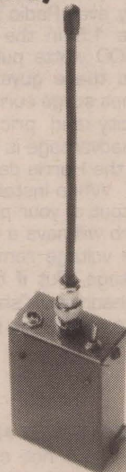
Up to 300'
Range

Operates on
Rechargeable
9 Volt Battery

Standard Video
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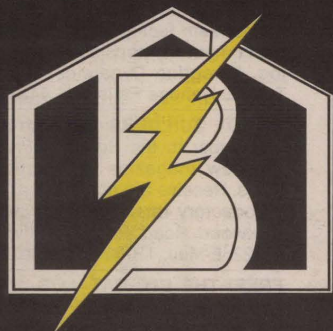
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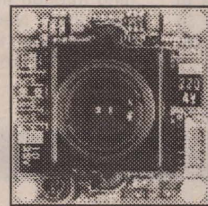


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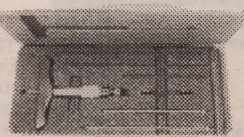
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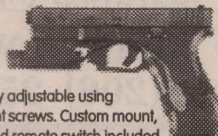
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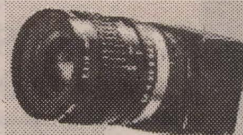
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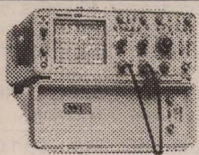
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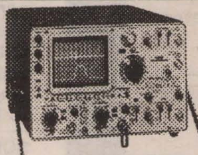
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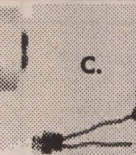
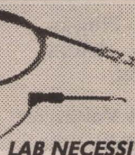
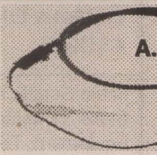
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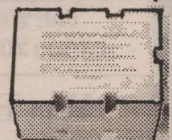
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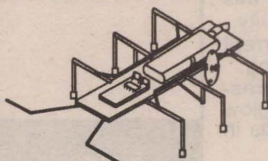


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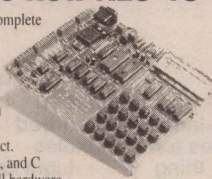
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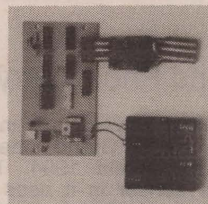
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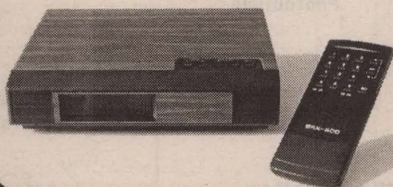


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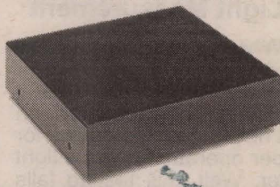
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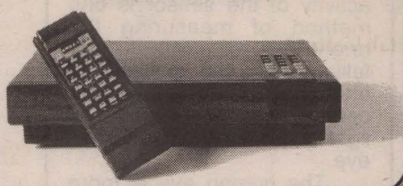
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THE SOLDERLESS BREADBOX

by Donald Wilcher

Light and Photometry: Part I

I've been developing an auto head-lamp sensor for the '96 Grand Cherokee vehicles for Chrysler since mid 1994. The unique thing about this sensor is it uses a semiconductor component instead of the traditional photoresistor/CdS cell.

The difference between the two components is the photodiode is linear in operation compared to its sister CdS cell. This characteristic makes it more sensitive under low levels of light intensity.

Another interesting feature about photodiodes is that they act as current sources when functioning in a photoconductive mode of operation.

In this month's column, we will investigate what light is, in terms of its physical properties and how to measure the intensity of the light. In addition to understanding the physics of light, an experimental investigation of light detection circuits will be presented, as well.

Next month's column will focus on measurement circuits and how to calibrate them for reading accurate values of light intensity. So let's begin our exploration of light by examining what it is and how it is produced.

What is Light?

Basically, light is a form of energy that travels from one place to another in the form of waves. The waves are in the form of vibrations caused by excited atoms. The excited atoms

that produce light, however, are emitted from matter and are absorbed by matter in separate bundles.

Light can be produced by any of the following methods:

- 1) By heating something until it becomes so hot that it gives off light. We say an object is incandescent when it is glowing hot.
- 2) By a chemical action such as combustion. The burning of a match or a candle are examples of this combustion/light producing activity.
- 3) By passing an electric current through a gas, as in neon-lighting.
- 4) By the process called fluorescence — certain substances glow when hit by strong radiations, as in fluorescent-lighting.

Whatever the method used, the basic source of light lies in a disturbance of electrons.

Light becomes visible only from objects as seen by our eyes. If the object itself produces the light (as does a piece of white-hot metal or a lighted lamp), it is said to be luminous or glowing. Light from some other source may strike an object and bounce from it to our eyes. We then say the object is illuminated. We see most things because they are illuminated by light from some other source.

Now that we understand the make-up of light and how we're able to see it, let's discuss how to measure its intensity using photometry.

Photometry — Science of Light Measurement

While developing the auto head-lamp sensor for Chrysler, one area that I needed to be educated on was how to test the device for proper operation using a light meter. Well, this testing falls under the category of Photometry.

Photometry simply deals with the science of measurement of visible light intensity. The use of the light meter to calibrate the light sensing activity of the sensor is one method of measuring the brightness of natural light falling upon the device, but photometry is especially concerned with the intensity of light as it relates to the human eye.

The human eye is more sensitive to light in the yellow-green part of the spectrum than it is to the other wavelengths. Most people can see electromagnetic radiation between about 380 and 770 nanometers in wavelength (a nanometer is about 10⁻⁹ meters) or about 3800 to

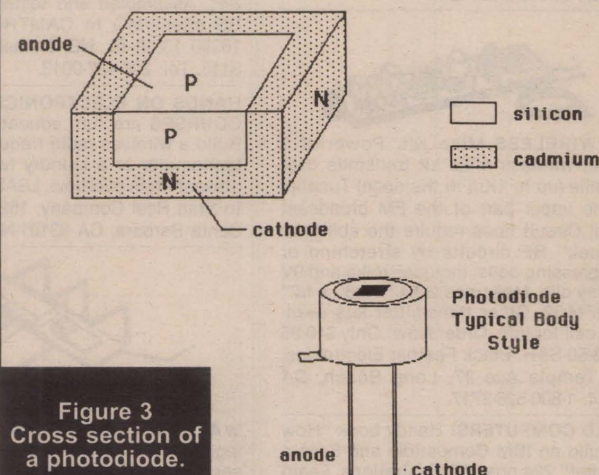


Figure 3
Cross section of a photodiode.

7700 Angstroms (an Angstrom unit corresponds to 0.1 nanometer or 10⁻¹⁰ meters).

The longer wavelengths appear as a progressively deepening red; the shorter wavelengths as fading violet. Some people can see at wavelengths shorter than 390 nanometers or longer than 750 nanometers. The human eye response curve is approximately shown in

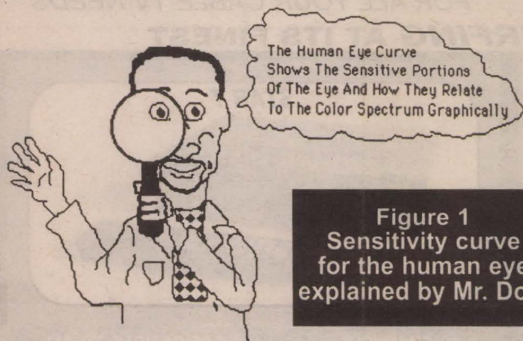


Figure 1
Sensitivity curve for the human eye explained by Mr. Don.

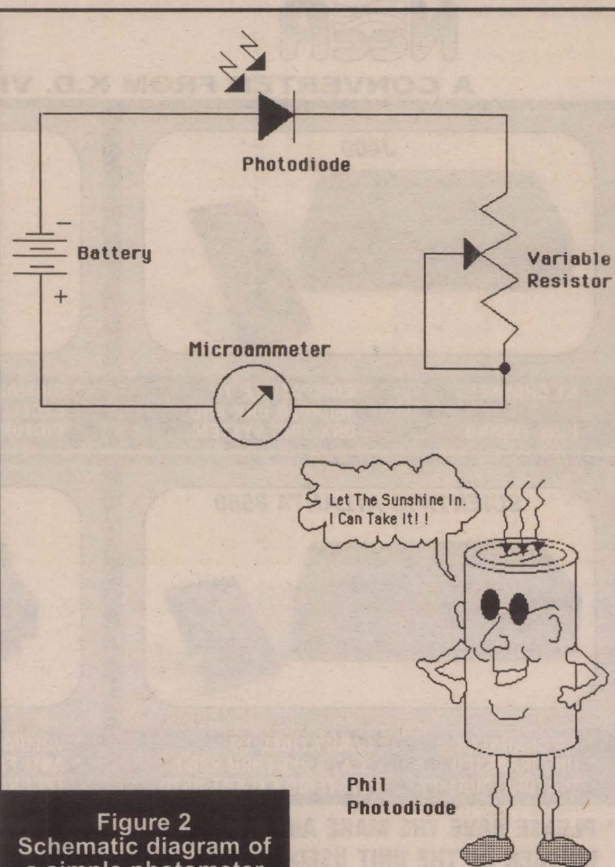


Figure 2
Schematic diagram of a simple photometer

THE SOLDERLESS BREADBOX

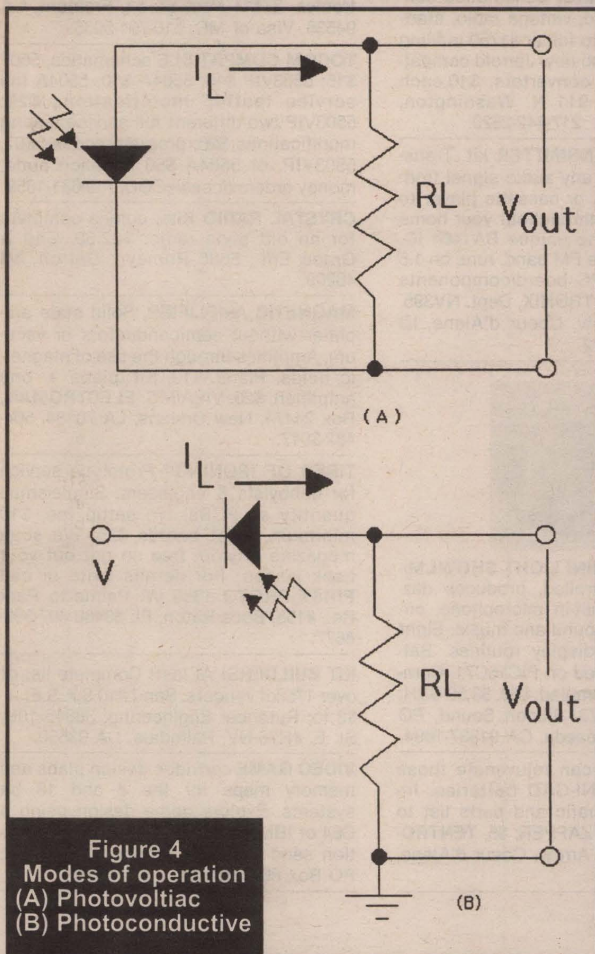


Figure 1.

Different photoconductive materials exhibit different sensitivity versus wavelength responses. In photometry, it is advantageous to use photoconductive substances with response closely resembling that of the human eye. A typical light measuring instrument consists of a photocell, a source of voltage, perhaps a variable resistance, and a milliammeter or microammeter, all connected in series. Figure 2 shows the schematic diagram of a simple photometer.

The meter's scale should be calibrated before the instrument is used. The photometer is an optical instrument used for measuring the intensity of a light source, such as a light bulb. The human eye is not capable of directly comparing two light sources, but it can compare the brightness of two similar surfaces. If the color of the two surfaces is the same, the eye can detect quite small differences in brightness.

Photoelectric devices measure the intensity of light. They are capable of accurate comparisons of light sources. Once calibrated, photoelectric photometers can determine the intensity of an unknown source. But how do we detect the presence of light in order to measure its intensity? To detect light intensity we can use a photodiode as the sensing component.

What is a Photodiode?

A photodiode is a silicon solid-state detector that consists of a shallow diffused P-N junction with connections provided to the outside world. The cross section of a typical photodiode is shown in Figure 3.

When the top surface is illuminated, photons of light penetrate into the silicon to a depth determined by the photon energy and are absorbed by the silicon generating electron-hole pairs.

The electron-hole pairs are free to diffuse throughout the bulk of the photodiode until they recombine. The average time before recombination is the minority carrier lifetime.

At the P-N junction is a region of strong electric field called the depletion region. It is formed by the voltage potential that exists at the P-N junction. Those light-generated carriers that diffuse into contact with this field are swept across the junction.

If an external connection is made to both sides of the junction, a photo-induced current will flow as long as light falls upon the photodiode.

In addition to the photocurrent, a voltage is produced across the diode. In effect, the photodiode functions exactly like a solar cell by generating a current and voltage when exposed to light. In order to generate a voltage or current signal from the photodiode, it must be configured in either one of two modes of operation: photovoltaic and photoconductive.

Modes of Operation — Photovoltaic/Photoconductive

A photodiode can be operated in either the photovoltaic or photoconductive mode. When forward biased, the photodiode is being operated in the photovoltaic mode. When illuminated, the diode will generate a photocurrent which will divide between the internal shunt resistance of the junction and any external load resistance. That part of the photocurrent that flows through the external load resistance will provide a small output voltage across this resistor.

When a reverse bias is applied, the photodiode is being operated in the photoconductive mode. In this mode, the photodiode functions as a current source. Figure 4 illustrates the wiring configurations for both modes of operation. The choice of operating modes hinges on the trade-off between the required speed of response and the maximum noise that can be tolerated in the actual application.

Now we've reached the part of our adventure where all of this information needs to be applied. The paragraphs to follow will illustrate the operation of the photodiode by means of experimental investigation. So, let's get our hands dirty with two detection circuits that will create the skeleton for next month's column.

Photodetection Circuits

In Figure 5, two photo-sensing circuits for detecting light intensity are shown. They are easy to construct and very sensitive to any light source. Photodiodes are obtainable from any of the electronic distributors that advertise in *Nuts & Volts*.

The detector in Figure

5A operates whereby light falling upon the surface of the photodiode, no current is generated in the series network. This condition will produce an output of zero voltage. Upon detecting no light, the photodiode will establish a level of current in the network circuit which will generate an output voltage equal to +5V. The light intensity levels will influence the output voltages produced by the detector circuit.

The circuit in Figure 5B operates in the opposite fashion where no light on the circuit produces no output voltage. With light on the sensor, an output voltage will exist. Basically, the operations of the two detector circuits are that of inverting and non-inverting sensing circuits.

As mentioned earlier in the discussion, these circuits are very sensitive. The lamp on my bench had to be turned off because it would interfere with operation of the circuits and their output voltages. Therefore, I had to use a pen light as my light source for evaluating the circuits.

Further Thoughts and Experimentation

Well, I hope that you found the photodiode to be an interesting component. The function of this device is no different than the semiconductor Si(Silicon) diode, with the exception of depending on light for establishing a current flow in the circuit. The two detection circuits presented are just the tip of the iceberg for measuring light intensity.

Next month, we will continue the discussion and primarily focus on the construction and operation of some useful photometer devices. Continue to explore on your own some of the practical uses that can be applied to the two detection circuits. For example: an optical switch or isolator.

If time permits, drop me a line at the Solderless Breadbox in care of *Nuts & Volts* about your investigations. I will present some of these ideas in future columns. Enuf said, see ya next month in the Breadbox!!! NV

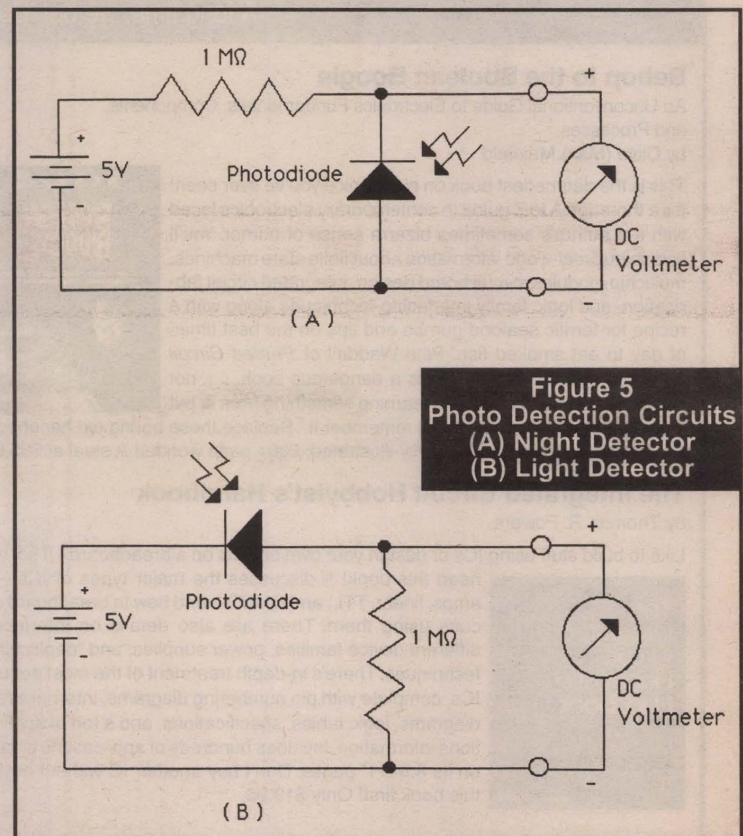


Figure 5
Photo Detection Circuits
(A) Night Detector
(B) Light Detector

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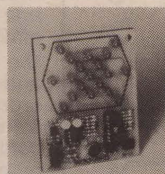
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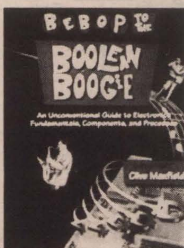
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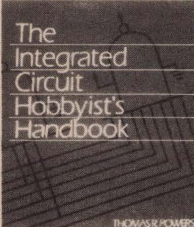
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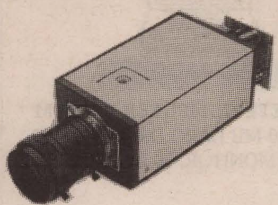
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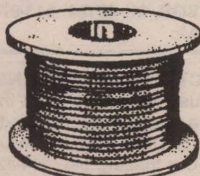
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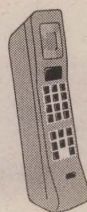
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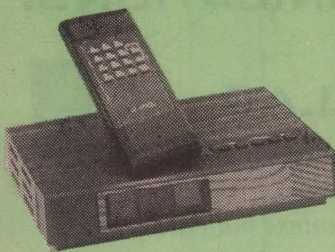
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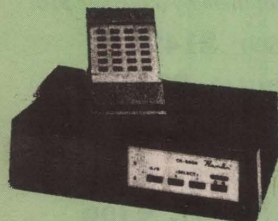


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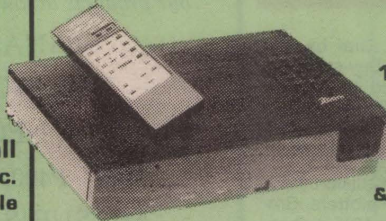
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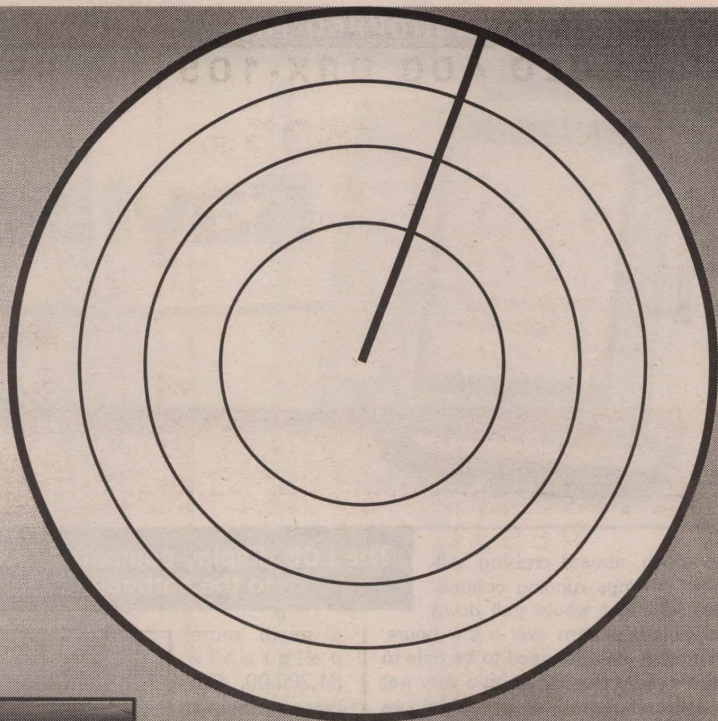
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MARINE RADARS GO LCD



Two Raytheon PATHFINDER@/ST Radars aboard the Trump Princess provide superior target detection to navigate this one-of-a-kind megayacht.

by
Gordon West

radars were 20 miles in range for pleasure boats, and up to 100 miles in range for the military. Because radar waves travel line of sight and don't bend much beyond the horizon under normal atmospheric conditions, no more than 100 miles would do anyone any good when trying to detect other ships on their radar set.

About 10 years ago, manufacturers introduced raster scan radar displays

which are the same as a television-type display. Black-and-white or color, your position was in the center, and you would see targets in range and bearing all around you. Raster scan displays also allowed computerized automatic tracking (ARPA) to be introduced so you could sound alarms if the radar detects an incoming vessel on a collision course. You could also create guard zones in specific sectors, variable range alarms, Loran and GPS interface, moving target indicators, and a host of other icons that you could put onto the screen for better boating safety.

But many mariners needed a good basic radar with little current consumption. Since the CRT required high voltage, the display had to be kept absolutely dry, and the typical 16-mile CRT radar would draw 5 amps at 12 volts DC. While 5 amps doesn't sound

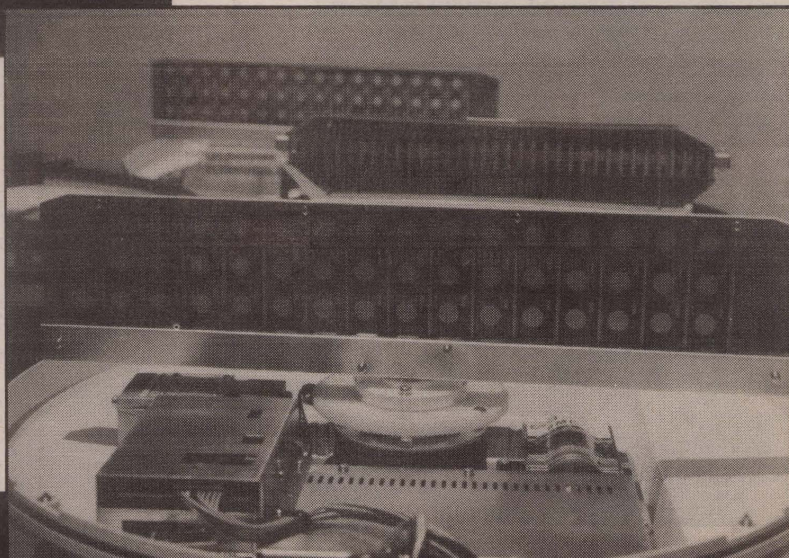
Marine radars are constantly being improved for boaters to see in the dark and travel in the fog, plus shore stations to watch harbor traffic on the big tube.

The very early marine radar was an oscilloscope presentation of pulse transmit and return echo receive, displayed as a time delay on the CRT. Antennas were fixed forward, so boats would only see what was ahead of them as a primary return echo. Radar range is determined by the velocity of radiowaves in a normal atmosphere, with a radar wave propagating one nautical mile in 6.18 microseconds. If a target was five miles away, it would take a total of 61.7 microseconds for the radar pulse to travel out from the antenna unit, strike

the target, and return as an echo. It would travel five miles out in 30.9 microseconds, and the echo would take an additional 30.9 microseconds to return. The older "A scope" would show this as a primary "blip" and the secondary echo "blip" so many microseconds to the right on the oscilloscope.

The big advancement was the planned position indicator, allowing radar targets to be viewed in distance and bearing from your ship in the center of the phosphorous tube. Phosphorous had a slow decay on the face of the tube, and made for an excellent display. Early marine

New phased array printed circuit board antenna units.





The LCD display compared favorably in resolution to the cathode ray tube display.

like much, aboard cruising sailboats, 5 amps running continuously at night would pull down the battery system over a few hours. There was also the need to be able to put the radar display up on a very wet bridge, and high voltage and moisture don't mix.

Enter the liquid crystal display. The LCD marine radar displays had some extremely strong points over older cathode ray tube displays:

- Minuscule current consumption at 12 volts DC
- Waterproof enclosure
- Direct sunlight viewing
- Backlit for night-time viewing
- Lighter, thinner, and easier to install

Along with LCD radars came an improvement in lightweight marine radar antennas — instead of using a parabola as a reflector to the microwave energy, radar manufacturers developed a printed circuit board (PCB) phased array which fed the radar energy from the magnetron directly to a flat PCB to radiate the radar energy out, and to receive the return echoes.

All of this brought the price of marine radar down from \$3,500.00 to

a much more palatable \$1,200.00. But there are only a few manufacturers who have developed an LCD small boat marine radar:

Furuno, Model 1621 radar (415-873-9393)
Raytheon RL-9 LCD radar (603-647-7530)
Autohelm ST-LCD radar (603-881-5838)

Each set offers a 7" diagonal liquid crystal display screen with amazing clarity. The screens are black and white — color LCD which is found

in high-priced computers has not been perfected for the small boat marine radar, nor is color that necessary for small marine radar displays. Black-and-white LCD supertwist displays provide the best daylight and night-time viewing.

All three radars offer 16-mile maximum target detection, with close-in range scales all the way down to one-quarter mile. The Furuno Model 1621 LCD radar was originally sold as an eight-mile maximum set, but when Raytheon and Autohelm

radome antenna units that also incorporate the powerful magnetron transmitter. The relatively short antennas offer a six-degree horizontal beam width which allows relatively good target discrimination out to three miles. Targets beyond three miles away that are close together will appear as one big blob because of the small length of the antenna arms.

Marine radars operate on the FCC assigned marine radar band 9300-9500 MHz "X-band." X-band emissions are microwave, and are considered dangerous when the operator is standing within a foot of the rotating radar arm. Radar antenna units should never be positioned on power boats on the brow of the flying bridge. This puts the radar energy directly into everyone standing on the flying bridge, and this is not considered safe by the American National Standards Institute (ANSI). Radar arches and radar masts that have been prefabricated are available

from most marine stores to keep the radar energy well above everyone's head.

During recent sea trials of the Furuno, Raytheon, and Autohelm LCD small boat radars, we were able to detect close-in targets as near as 64 feet. Anything closer than that exceeded the capabilities of the radar's short pulse length and fastest pulse repetition rate, and simply merged into the center dot on the screen. But targets more than 70 feet away were clearly visible on the LCD screen.

And what kind of targets can you see on a marine radar out on the bay? Dingys, docks, and other boats show up as major "blips" on the screen. They don't show up as the silhouette of a sailboat, but they do show up as a major



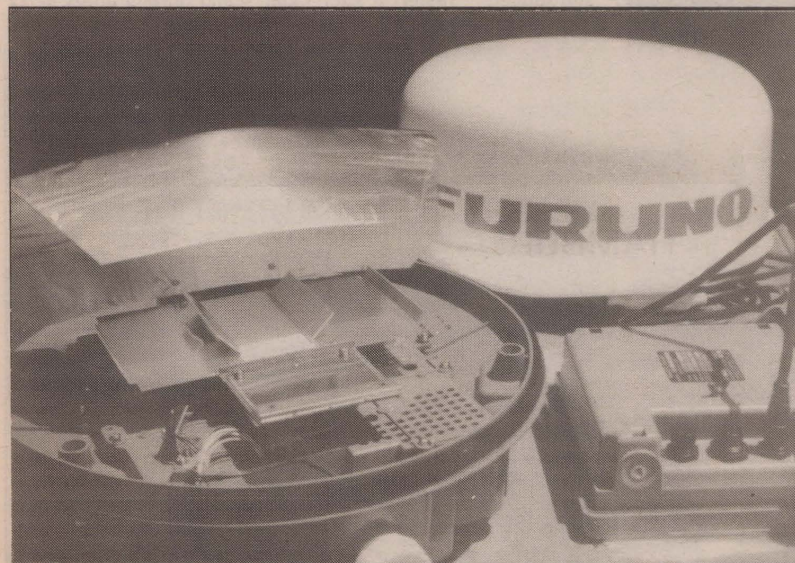
Large marine radars still use a glass cathode ray tube.

came out with their new 16-mile radars, Furuno came up with a simple chip mod to double their Model 1621 radar range.

"Most mariners find that eight miles is more than enough for using their radars aboard small boats," comments Ken Englert, owner and president of Maritime Communications in Marina Del Rey, CA. "The Furuno range-extension chip sets and installation are available for a couple hundred bucks, but quite frankly, most mariners have not taken advantage of the chip set updates," adds Englert.

These small LCD radars offer a peak pulse power output of 1,500 watts from their small 16" white

The small LCD Furuno radar uses a parabola as the active antenna.



target indication. Some call them blobs; some call them targets; some call them blips — but there's no mistaking that there is something out there that you want to avoid when coming in at night or in the fog.

We were surprised to see the small boat marine radars detect seagulls sitting on the water up to one-half mile away. You could easily see pelicans flying low over the water go across your bow or stern. In extremely calm harbors, you could even see the telltale sign of crab pot markers when you approached within one-quarter mile. These are about the size of a one gallon bleach bottle that is sometimes filled with air and used as a marker. Even these plastic bottles can return radar energy as an echo.

But things that radar will not see

would be floating planks, logs, underwater obstructions, or small targets missed on the screen when severe wave return echoes occur in choppy seas. Rough swells can easily return unwanted radar echoes, and some radars can be switched into the "short time control" (STC) to help minimize ocean-wave return.

Marine radars have been specifically identified as "okay to install yourself" by the Federal Communications Commission without the commercial general radiotelephone license necessary. However, mariners doing their own installation are not permitted to make any adjustments to the transmitter magnetron or oscillator circuitry. If someone asks you to install their marine radar, plan to spend a day hooking up well-marked wire terminals, with most of the time devoted to the physical mounting of the antenna and indicator unit, and only about one hour required with a screwdriver. It's an easy hook-up.

Many mariners will install their own marine radars, but toss the instruction manual overboard as soon as they begin to see targets show up on the screen. Each marine radar needs to be "fine tuned" which is also permitted under the rules to be done by a non-licensed operator. Fine-tuning is compensating the receiver delay circuitry to insure that flat breakwaters indeed look straight as opposed to convex or concave on the readout. Timing errors are attributed to extension or shortening of the antenna lead-in cable as it comes from the factory. Proper adjustment of the center dot will also minimize how big this dot is, and maximize how close in you can detect a target on marine radar.

A ship station license is required for marine radar. You fill out FCC Form 506, check off the box that says you already have a marine VHF transceiver onboard (which all mariners should have), and check the "R" box showing radar at X-band frequencies. This is accomplished on FCC Form 506A, updated August 1993, with a \$45.00 fee for modifying a present marine station license. If there is no station license onboard, the fee is \$115.00 for a 10-year permit. There is no operator permit required to run a marine radar. However, mariners employing you as an electronics genius to help work on their radar will need you to officially sign off any technical work that you do on the inside, and this requires the general radiotelephone operators license (GROL) with the specific marine radar endorsement. **NV**

If you're interested in marine electronics and marine radar, and if you have a background in electronics, you can study on your own to pass the commercial GROL test with a \$25.00 study package (plus \$3.00 P&H) covering the Gordon West book on Elements 1 and 3, and a study book for Element 8, marine radar. Gordon West Radio School, 2414 College Drive, Costa Mesa, CA 92626. Checks only.

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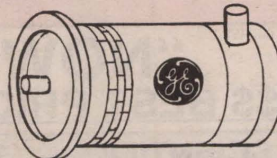
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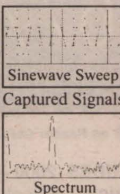
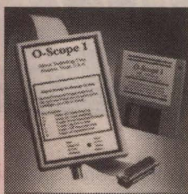
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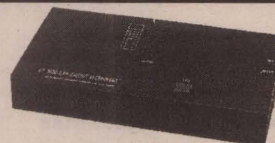
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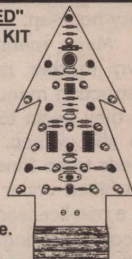
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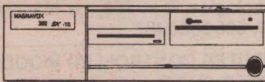
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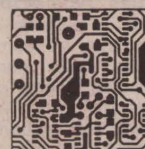
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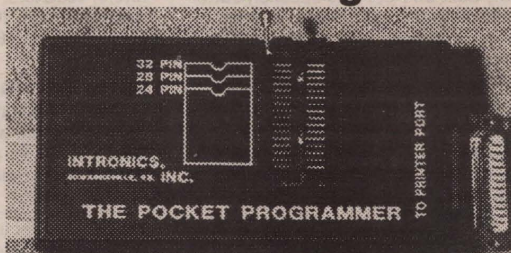
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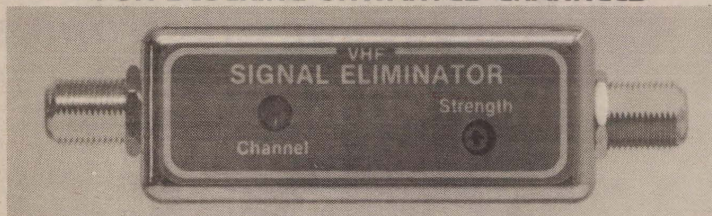
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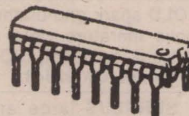
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by Richard Schroeder

Mr. S Solves The Mystery Hum Case

Once upon a time, in a far away land, there lived a wise old man. This old man had spent many years designing and building fine audio amplifiers. His name was — well, let's call him Mr. S.

Through his many years, he had accumulated a vast amount of knowledge and wisdom, and his fame spread far and wide. People would come from miles around for help and advice with their amplifier problems, even paying him handsomely for a few of his handwritten notes and diagrams.

This made Mr. S feel very good. It made him feel as though he was the last word — king of the amplifier designers.

One day, as he was basking in his numerous successes, he was contacted by a Mr. M. Now Mr. M was also a man who had spent years and years designing and manufacturing amplifiers and other audio equipment, much of it being used in recording studios.

Here was a man who could truly analyze live and reproduced sound in a critical way. It seemed that his ears and brain had built-in oscilloscopes, meters, and distortion analyzers. In short, he had golden ears.

Mr. M, after a short introduction in which he praised Mr. S regarding his knowledge of amplifier design, proceeded with a request. It seemed that Mr. M wanted Mr. S to design and prototype a super fine amplifier, one that would be used as a playback monitor amplifier in a large prestigious recording studio.

One needs to understand that recording engineers and others involved in analyzing reproduced sound, also have golden ears. They can detect the slightest hum or noise that would detract from the desired sound. In view of this, Mr. M made it clear that his new amplifier must exhibit ultra quiet performance, especially when the program material was at a low level, or even non-existent.

These and other critical specifications were discussed. The conversation ended with Mr. M agreeing to pay a handsome reward to Mr. S if he could deliver the specified product. At that point, the two parted.

With full confidence that he could design this super quiet amplifier, Mr. S quickly got started on his assignment.

Within minutes of their parting, Mr. S, with paper and pencil in hand, drew up a circuit diagram. He was so excited that he skipped supper, working far into the night.

When he awoke, having fallen asleep at his desk, he looked at the circuit diagram and marveled at his creation. He could almost hear pure undistorted noise free golden tones emitting from the paper. Within a few days, he began gathering the various components needed for the project, and a few weeks later he had completed a prototype of the super

fine amplifier.

There he stood, admiring his handiwork. In his mind, it was a thing of beauty. Its bright shiny power transistors contrasted nicely against the black background of the heatsinks. The printed circuit boards bristled

with colorful capacitors and resistors. The wiring was neatly bundled and routed here and there with graceful bends and turns.

Now came the moment of truth! Mr. S carefully connected his expensive speakers and CD player to the amplifier and then turned on the power switch. The light from his 100 watt bulb dimmed momentarily and suddenly his shop was filled with the thunderous sounds of **ALSO SPRACH ZARATHUSTRA**.

The sound was tight, continuous, spacial, resonant, well defined, sound stage, non-compressed, and a dozen more of those adjectives that the guys and gals in high-end audio use to describe high fidelity sound reproduction.

Mr. S was very happy, but his joy was short lived, for when the music level decreased to a whisper he heard something that struck terror into his heart — the dreaded 60 Hz HUM! "Impossible" he said, "My design is perfect — my components are perfect — my wiring scheme and techniques are perfect." Mister S was devastated.

You see, Mr. S had employed time-honored principles in designing and wiring the power supply and the ground return lines from the various circuit function blocks that must find their way back to the supply. Mr. S was well aware that a poorly thought out and executed ground return scheme can be the very cause of hum and noise in an amplifier.

Let's diverge from our story for a moment, to better understand ground return schemes and their importance. At this point, you will find it helpful to look at the diagram Mr. S kindly provided for us. It shows a typical ground return scheme, properly done. Be sure to read the special notes in

regard to the diagram.

Good power supply and ground return wiring dictates that 1) The heavy AC currents that flow in the filter capacitors, rectifier diodes, and transformer be confined to a very small well-defined area or point. This

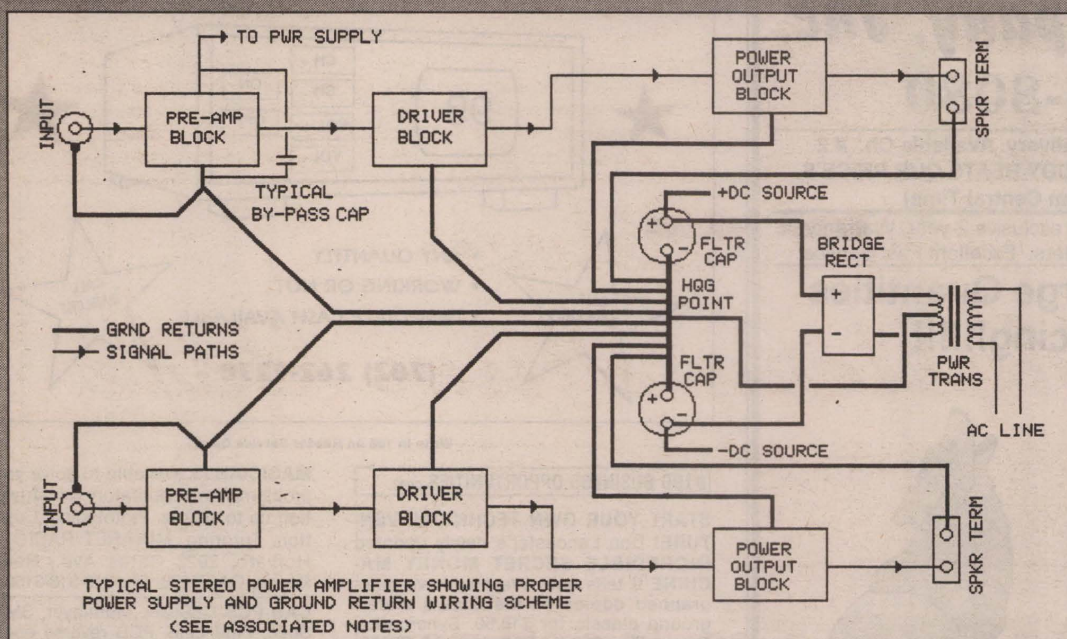
is also true regarding the heavy currents that flow in the speaker circuit. 2) This point must be located near the power supply components, especially the large filter capacitors. 3) The low side or common ground parts of each block of circuitry must find a direct path back to this special point.

This special point can properly be called the "ground return point," "high quality ground point," "star ground point," or other similar expressions. Mr. S has always preferred "high quality ground point" and abbreviates it simply HQG. This then will be the expression used herein.

Keep in mind that this HQG ground point may or may not connect to the metal chassis and/or earth ground. In regard to earth ground (via the green colored third wire of the power cord), it seems that most manufacturers connect it to the chassis whether or not the HQG point connects there. Some manufacturers, by means of a removable link, give the user the options of connecting or disconnecting the HQG point to the metal chassis which is usually connected to earth ground.

Again it needs to be stressed that the low side or common ground parts of each circuit building block must be insulated from each other and insulated from the metal chassis. Each block then has its own conductor that finds its way back to the HQG ground point. This, in turn, dictates that the low side of all input and output connectors be insulated from the chassis. In regard to this last statement, however, note the following.

Some engineers while following the above described HQG scheme choose not to insulate input or output connectors from the metal chassis. They cite the theory that any one part of a circuit can be connected to ground with no ill effects. This is quite valid, and perhaps that is why one can find high-quality audio equipment with various configurations of input and output connector grounding. It seems that if a good HQG scheme is used, these engineering preferences are unimportant because



1) Input and/or output connectors may be connected to the chassis (see text).

2) Though not shown, power connections from the output (high signal current) blocks must connect very close to the filter capacitors. Power from the capacitors to the other blocks can use the "daisy chain" method.

3) The low side of any active type voltage regulators must also connect directly to the HQG point.

4) Some variations may be permissible. Example: The common ground points of the both pre-amp blocks and/or both driver blocks could be connected together and returned to the HQG point with a single heavy conductor. This might be the case when a PCB is used.

the chassis is merely serving as a shield, not a power or signal conductor.

In summary then, the whole idea behind this ground return scheme is to keep troublesome AC currents or signal currents from flowing in the chassis or any of the common ground circuitry where these currents would otherwise get amplified and ultimately be audible.

Back to our story. After staring at the speaker and listening to the offensive noise for a long time, Mr. S in his infinite wisdom determined that the hum would not go away unless he took some decisive action.

So Mr. S set the amplifier up onto his test bench and connected to it his vast array of sophisticated test gear (actually an old Heathkit scope). As he had always done, he connected the low side of the oscilloscope probe to the HQG ground point of the amplifier. This is generally accepted as proper troubleshooting technique.

Probing the amplifier output

point at the high side speaker terminal, Mr. S expected to see the waveform that represented the offending hum. To his amazement, it was not present.

"Impossible" he said, "I heard it with my own golden ears."

Thinking it might be an intermittent problem, he again connected the speakers, and again heard the hum loud and clear. Back to the bench — no hum. This went on for several frustrating cycles until almost by accident the oscilloscope probe touched the low side speaker terminal. To the amazement of Mr. S, there on the oscilloscope screen was the elusive 60 Hz waveform. "Impossible," he again said. Keep in mind that this terminal was directly wired to the HQG point with an eight-inch length of #14 gauge wire. It went nowhere else.

Mr. S was baffled. One part of his brain asked the other part of his brain this question: How can one end of this wire have 200 millivolts of

noise on it, and the other end have none? He examined the wire closely, looking for something like a short circuit to the chassis or to some component, but found nothing. He did notice, however, that the wire was routed very close — almost under the power transformer. Then it hit him like a bolt out of the blue. He realized that the magnetic core of the transformer was inducing the noise into the wire, and inserting it between the HQG point and the insulated low side speaker terminal. This then explained why the output point of the amplifier was "clean," and yet the speaker was receiving the noise.

To make a long story short, Mr. S simply re-routed the wire and the noise vanished into thin air. The mystery had been solved!

Mr. S began making excuses for what amounted to a wiring error. He felt that if he had used a better transformer — one that would not have radiated so much magnetic field — the problem would not have

occurred. You and I know that it was still a dumb way to route the wire.

Be that as it may, Mr. S was quite happy that he had corrected the problem, but felt badly that it had taken him so long to find the source of it. After all, how could the "king of the amplifier designers" get so stumped and frustrated over a simple hum problem? After thinking about it for a long time, Mr. S conceded that he was not as great an engineer as he had imagined. He realized that a person, no matter how knowledgeable, can always learn something new and beneficial.

About this time the phone rang. Mr. M was inquiring about his new super amplifier. Mr. S said it was ready and could be picked up right away. Mr. M picked it up, evaluated it, and was very pleased with its performance. He then paid Mr. S a handsome reward for his work, and they both lived happily ever after.

*** HAVE A HUM FREE DAY
*** NV

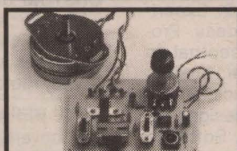
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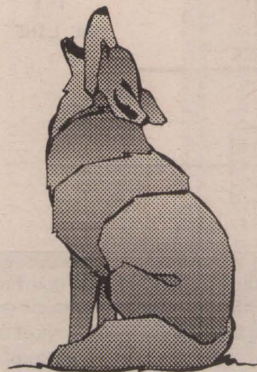
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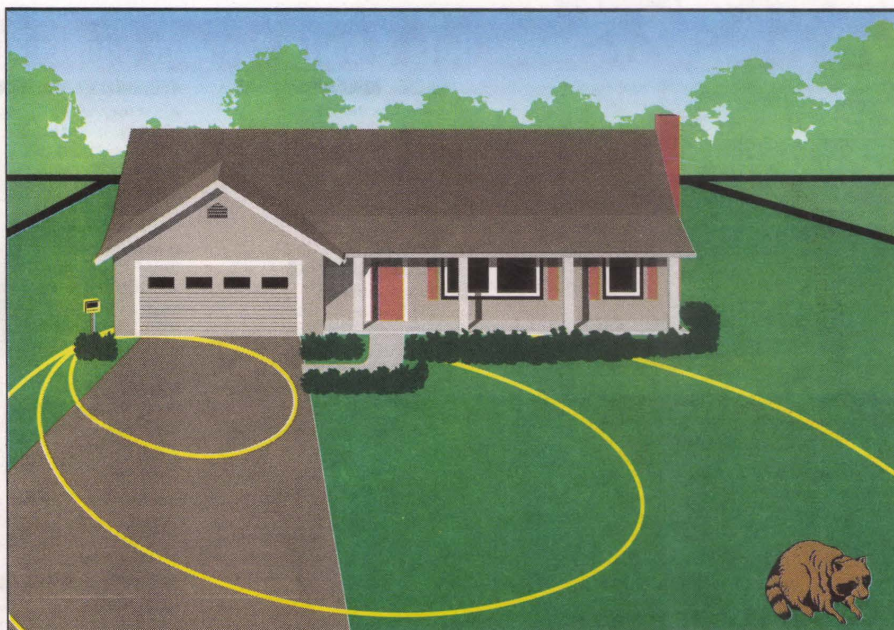
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by Charles Anton

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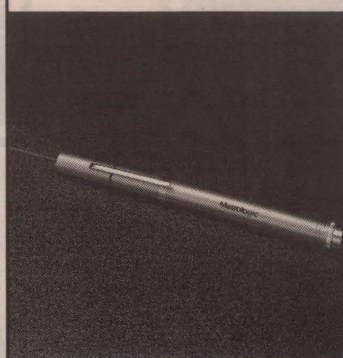
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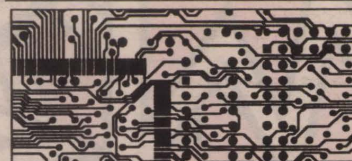
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TECH FORUM

Continued from page 103

netic locks that require 1,300 pounds of pressure to open them, preventing the perpetrator from running out of the store.

Walter A. Smith
San Francisco, CA

ANSWER TO #29519 - FEB 1995

To convert the printer, you will need to purchase a serial to parallel converter, about \$25.00, and a line analyzer, about \$10.00. Put the line analyzer on the printer and perform the self-test. Find out which are TX, DTR, CTS, and ground. Make a cable and on the converter, set the dip switches to set, the serial side to 7, one and even. You will have to experiment with the baud rates. Another option is just to plug the printer into a COM port of your computer and program your printer output to that COM port you are using. You don't HAVE to use LPT-1.

Walter A. Smith
San Francisco, CA

ANSWER TO #2951 - FEB 1995

No Paul, you cannot get your CD player to record. Players use a low-power laser diode and triple beam splitter to track and read information on the disk. Newer writeable CDs, the CD/R machines use a combination of technology to track and read (low power) and burn (high power) the digital data onto a writeable media. This has many requirements and many pitfalls, the least of which is that the

entire DC must be formatted on a computer prior to writing. Be it music or data, all 760+ megabytes must be assembled on a hard disk or equivalent or larger size and tested. Any flaw in the headers or markers will cause the entire disk to be unusable, a waste of a \$23.00 media, not to mention a great quantity of frustration.

However, hope is on the horizon! A company in California, Pinnacle Micro, has announced a CD/R that does not need to be "imaged." It will do audio and computer (ISO 9660) CDs, and it looks like a tape recorder to the attached machine. The cost is about \$1,900.00 plus those pesky \$23.00 disks.

Looks like you'll be saving those pennies.

Henry Hamarman
Lansdale, PA

ANS. TO #129410 - DEC 1994

Most tape drives that take DC300 tapes are called quarter inch drives (QIC), because the magnetic tape in the cartridge is a quarter of an inch wide. The interface for these drives are usually QIC or SCSI. Both interfaces are 50 contacts/pins at the drive. QIC usually uses card edge connectors while SCSI uses IDC headers. Most drives are manufactured by WANGTEK, ARCHIVE, CALIPER, CIPHER, and ALLOY to name a few. Some of the older drives that use DC300 tapes and work off of your floppy connector only work in PC/XTs or slow ATs, these usually have 34 contacts on the tape drive just like their

smaller cousins that use DC2000 or DC2120 mini cartridges.

Interface cards are still available for QIC interface drives. These are very fine drives for back-ups of any drive on a DOS machine including backing up A and B (all of your floppies) onto tape. I can also access my CD-ROM on E:\>, as of now I have not tried backing up my CD-ROM. You also need back-up software and there are three I recommend: **1)** SYTOS PLUS ver 1.42. **2)** SYTOS PLUS ver 1.42 and finally, last but not least. **3)** SYTOS PLUS ver 1.42.

The hardware interface (controller card) is usually QIC24 (from the card to the drive). The software interface is usually QIC36 or QIC02 for drives (DC300/DC600 carts) up to 60 megs, 120 with data compression. The QIC36 or QIC02 cards tend to be proprietary, except for ARCHIVE's. The QIC 36 cards have the WANGTEK name on them and are a full-length card. I have payed as little as five bucks for a card or drive. So, even if your drive is proprietary you are on the right track. Go to swap meets/used computer stores. These are good sources for used tape drives.

Bill Jackson
Kensington, MD

ANSWER TO #29521 - FEB 1995

Because the new DSS TV service converts all analog signals to digital before uplinking to the satellite, getting a bigger dish to increase signal strength will do nothing for you in

respect to noise reduction. You will notice if you gradually move your 18" dish on and off the satellite, your picture will either be there, or totally disappear without any degradation in the picture or sound quality in the process.

This is one of the benefits of digital vs. analog. Although at present, analog has the ability to give you better picture quality due to the infinite number of video levels and the wide bandwidth gives you the highest resolution, analog signals are susceptible to picture degradation from terrestrial interference, bad weather, and dish alignment problems. Digital offers and extremely clean, low noise picture regardless of signal strength, provided the service is being uplinked cleanly, and can fit into a much narrower bandwidth due to the art of compressing that data.

Today's compression techniques allows us to place up to six channels on one transponder that normally accommodates a single broadcast quality analog channel.

Kevin T Kaas
Hudson, WI

ANSWER TO #2952 - FEB 1995

The Epson 510 printer has a multitude of options set by control switches. Without looking at the user's manual, it would appear that you have two distinct problems.

The first is that the "page break" is set. This may be called "skip over perforations in your printer. This makes the printer, not the software, skip the end of page and start a new page with-

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ANSWER TO #1952 - JAN 95

The problem with Commodore 64 compatible printers is that these devices use the Commodore synchronous serial interface to communicate with the C64. An IBM PC compatible printer port is a parallel interface, however, it is possible to use this parallel port to emulate the C64 serial interface by constructing a special cable and writing a little bit of software.

The cable is used to connect the PC DB25 pin parallel printer port to the 6 pin DIN serial port on the C64 compatible printer. The parts needed are one DB25 male connector (Radio Shack #276-1429), one 6 pin DIN plug (RS #274-020), and some six conductor cable (RS #278-874 or equivalent). Note that the cable length should be kept to less than six feet. The wiring connections and signal descriptions for this cable are given as follows:

Commodore 64 DIN plug pin:	Parallel printer DB25 connector pin:
1 (SRQ IN)	2 (DATA0)
2 (GND)	20 (GND)
3 (SER ATN)	3 (DATA1)
4 (SER CLK)	4 (DATA2)
5 (SER DAT)	5 (DATA3)
6 (RST)	6 (DATA4)

The software uses the PC parallel port to emulate a C64 serial port. The example program, C64.C (Listing 1), is written in Borland's Turbo C. It reads input and sends each character to the printer. It can be used as a filter in an MS-DOS command line pipe. For example, DOS commands such as: dir | c64 would print a directory listing, or type a file | c64 would print the contents of a file.

I have also written an MS-DOS device driver which can be used to allow any PC application to print to a C64 compatible printer, and it supports multiple printers connected to a single PC parallel port. The listing for this software is too lengthy to print, however, I will make this software and assembled cables available to N&V readers for a nominal charge; just write me for details. With these C64 compatible printers often selling for less than \$25.00 at garage sales and flea markets, it's easy to add a couple of additional "scratch" printers to any PC system.

Listing 1:

```
#include <stdio.h>
#include <ctype.h>
#include <dos.h>

#define PORTADR 0x378 // LPT1=0x378, LPT2 = 0x278
#define PRINTADR 0x04 // C64 compatible printer address
#define SRQ 0x01 // C64 SRQ IN signal
#define ATN 0x02 // C64 ATN signal
#define CLK 0x04 // C64 CLK signal
#define DAT 0x08 // C64 DAT signal
#define RST 0x10 // C64 RST signal

// function prototypes
void initc64(void);
void putc64(unsigned char);
void puts64(char *);
void putbyte(unsigned char, unsigned char);

// function main() loops to read input characters and send them to the printer
void main(void)
{
    char buff[128], *ptr;

    initc64();
    while(fgets(buff, 80, stdin))
    {
        for(ptr = buff; *ptr; ptr; putc64(*ptr++));
    }
}
```

out printing on the perforation. Turn it off. Also be sure that the page length set is equivalent to the paper length. In english, this means that for an 11 inch page, at 6 lines per inch, you should have the page set for 66 lines! Be sure to check that — if your printer is set to skip, and the page is set for 66, you'll have a conflict since the top and bottom 1/2 inch are cut off leaving a 60 line page. (Common problem also with Okidata OL400 laser printer.)

As far as that annoying "hunt" for the first ten lines again, a common problem. Set your printer for uni-directional printing, not bi-directional. Bi will make your printer "home" while the buffer is filling — even if the computer is telling it to print in one direction. You may also have to check your interface speed (I know you don't want to hear

this). If your new computer is high speed 486DX or a P5, the parallel port may be high speed. Your Epson is not. Set the port in your computer CMOS to slow speed. Also check your printer cable. It should be less than 12 feet and employ all the control lines, as well as all the data lines. If in doubt, buy a new good (not cheap) one.

Henry Hamarman
Lansdale, PA

ANSWER #2953 - FEB 1995

The typical 110 volt AC multisocket strip uses a neon bulb built into the switch to let you know when the strip is "on." To understand why the neon lamp may flicker, you must understand why it lights in the first place.

Basically, a neon glow lamp is a glass envelope from which air has

```
// function initc64() initializes the driver and the C64 compatible printer
void initc64(void)
{
```

```
    // set initial port output value to all bits high
    outportb(PORTADR, RST | SRQ | ATN | CLK | DAT);
```

```
    // initialize printer: RST=0, then RST=1
    outportb(PORTADR, SRQ | ATN | CLK | DAT);
    delay(250);
    outportb(PORTADR, RST | SRQ | ATN | CLK | DAT);
    delay(2250);
```

```
    // Set printer to listener: ATN and CLK low, printer will ACK with DAT low
    outportb(PORTADR, RST | SRQ | DAT);
    while(!(inportb(PORTADR) & DAT));
```

```
    // Send printer address (currently set for address 4)
    putbyte(0x20 | PRINTADR, 0);
```

```
    // Send printer mode
    putbyte(0x67, 0);
}
```

```
// function putc64() sends a byte of data (byteval) to the C64 compatible printer
void putc64(unsigned char byteval)
{
```

```
    // Check for upper/lower case conversion
    if (isalpha(byteval))
    {
        byteval = (isupper(byteval)) ? tolower(byteval) : toupper(byteval);
    }
    // Send character
    putbyte(byteval, ATN);
}
```

```
// function putbyte clocks the actual byte to the C64 compatible printer bit by bit
void putbyte(unsigned char byteval, unsigned char mode)
{
```

```
    register int bitloop;
```

```
    // Set CLK high, printer will ACK with DAT high
    outportb(PORTADR, RST | SRQ | CLK | DAT | mode);
    while(!(inportb(PORTADR) & DAT));
```

```
    // Loop to output bits of data
    delay(1);
    for (bitloop=0; bitloop<8; bitloop++)
```

```
    {
        outportb(PORTADR, RST | SRQ | ((byteval & 1) ? DAT : 0) | mode);
        delay(1);
        outportb(PORTADR, RST | SRQ | CLK | ((byteval & 1) ? DAT : 0) | mode);
        delay(1);
        byteval >>= 1;
    }
}
```

```
    // Set CLK low and DAT high for end of byte, printer will ACK with DAT low
    outportb(PORTADR, RST | SRQ | DAT | mode);
    while(!(inportb(PORTADR) & DAT));
}
```

John Keyerleber

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been removed and replaced by neon gas. When the voltage on the electrodes is zero, a few electrons and positive ions are drifting around inside the lamp. They come from the neon gas which is partly ionized by energy absorbed by outside light, cosmic rays, or a radioactive substance put in the lamp to produce partial ionization, so that it will operate in a dark environment.

When the voltage between the electrodes is increased, the positive ions and the electrons are attracted to the positive and negative electrodes, respectively. A small current flow begins. As the voltage is increased, the electrons are accelerated with such force that they collide with other neon atoms, liberating additional electrons, which in turn, further

increase activity. At some threshold voltage (called "firing" or "breakdown" voltage) an avalanche effect causes huge numbers of electrons and ions to form, current suddenly soars, and the ionized neon gas around the negative electrode glows.

Once fired, the lamp will continue to glow until the voltage falls below and "extinguishing" voltage. In a DC circuit, only one electrode glows; in a 60 Hertz AC circuit, both electrodes appear to glow, since they change polarity 60 times per second.

Since these lamps can conduct high current, they will literally explode unless a series resistor — typically 150,000 ohms with an NE-2 glow lamp — is used. Different neon lamps have different firing and extinguishing voltages and safe current capacities.

Glow-lamp power strips typically have the neon bulb and resistor built into a switch with a red translucent rocker knob. External light lowers the firing voltage; darkness increases the firing voltage. Also, as the lamp ages, its firing voltage increases, sometimes only allowing the bulb to glow on peak voltage readings, so it flickers. With the flood of cheap, imported power strips, it is not uncommon for them to use marginal lamps (without the radioactive additive) that flicker in dark places as they age.

Fred Blechman
West Hills, CA

ANSWER TO #2957 - FEB 1995

Dave left out a few details of his requirements, like what is the supply power source and how accurate and regulated the 100 VDC needs to be, but from the mention of a 555 I'll assume that he wants to operate it from a low-voltage (battery). As to regulation, I'll have to make some assumptions.

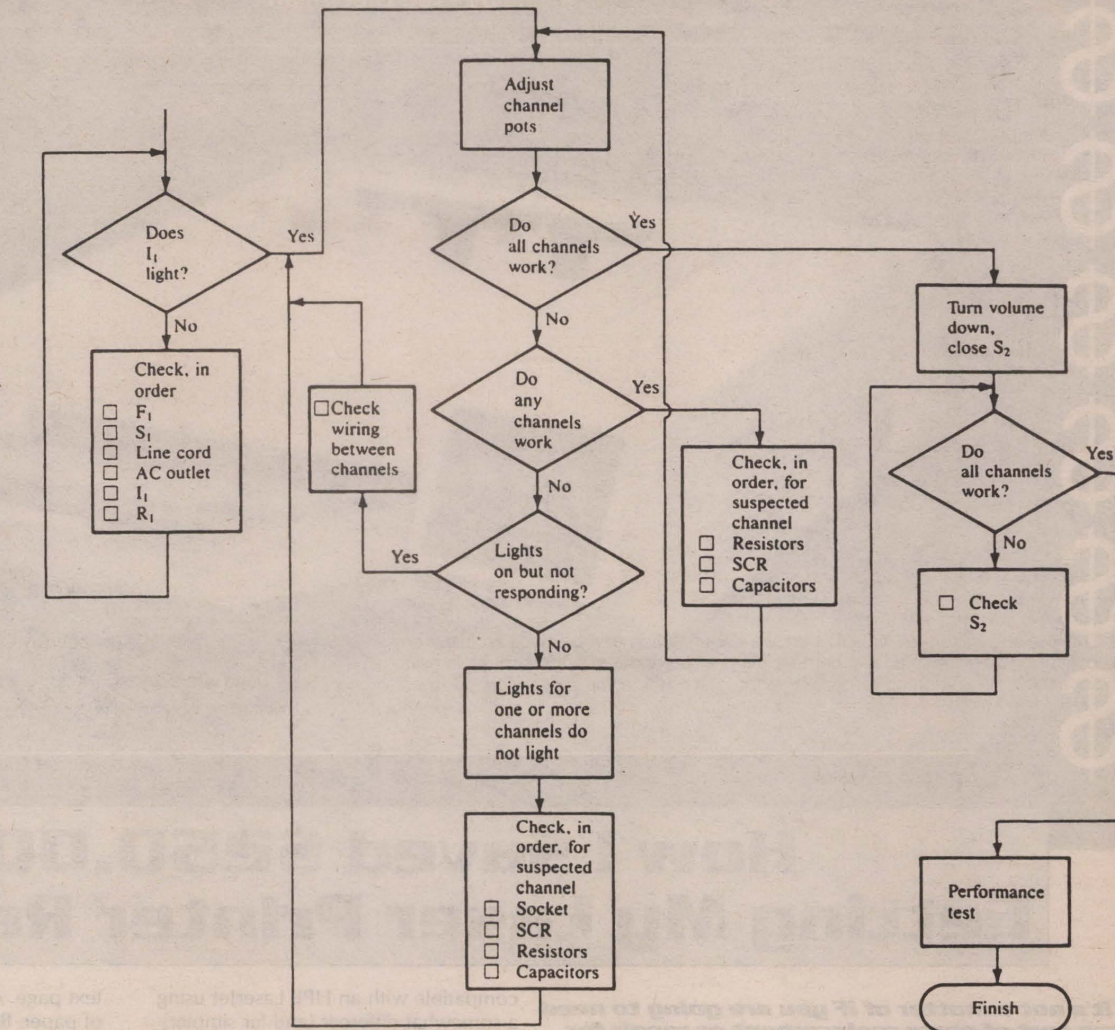
Firstly, 100 volts at 30 mA. is 3 watts. On a home brew project you'd be lucky to get 50% efficiency, meaning the 555 would have to switch 6 watts, or .5 amps at 12 volts or 1 amp at 6 volts to generate the power you need. This is a little more than the average 555 can handle. You may be better off trying some other options.

My first suggestion, assuming that the output does not have to be well regulated, would be to try to modify an existing device readily available from electronics suppliers. Sources like All Electronics, Electronic Goldmine, Marlin P. Jones, etc., have several items that may work well. Some examples:

1) Power converter for Vacuum Fluorescent Displays — these converters typically convert 3 to 12 volts DC to 60 to 100 volts AC to drive the displays. They put out AC, but some diodes and filter capacitors could fix that. (I'll assume that if you know about using the 555 you can figure out how to rectify AC.) These converters are small and cheap, usually less than \$5.00.

2) Zenon flash tube circuits — as used for camera electronic flashes or fire alarm strobe lights. Again they take low voltage DC (3-24 volts), but the output is more like 200-300 volts DC. You could lower the output with a voltage divider or perhaps by operating the circuit from lower than normal voltage. These are cheap too, I've seen camera flash units for \$3.49 (Marlin Jones 407-848-8236).

3) Fluorescent lantern drivers — these convert battery power to drive 6 watt fluorescent tubes in camping lights. Electronic Goldmine has a kit for \$23.00, but you could buy a cheap "Multifunction Fluorescent Emergency Light" (like for a car) at Wal-Mart or K-Mart for less than \$10.00. These guys will have a small circuit board inside that will put out around 100-120 volts AC to operate the fluorescent tube. Again, a little diode and capacitor work will get you going. If you need good regulation, I would suggest using a linear technology device, part number LT1072. This is a switch-mode regulator that is very easy to



Troubleshooting Tree for Three-Channel Color Organ (Solution for Page 32 Challenge)

use. It comes as a 5-pin TO-220 package that can be configured with a few external parts to make a wide assortment of voltage converters. It's available from Digi-Key (1-800-344-4539) for \$4.00. If you ask for the application sheet you will find it has a circuit design to generate 100 VDC at 75 mA.

Robert Baust
Loganville, GA

ANSWER TO #29511 - FEB 1995

There are some types of Single Station detectors (as they're called in the business), that have provisions for cascade wiring, where one detector can activate the sounders in the rest of the units, but you probably do not have that type. They are not that common and are usually 120 VAC powered, anyway. But I do have a few suggestions on how to connect your battery powered smoke detectors to the fire alarm loop of your control panel. Here are a few ways it might be done:

1) If the smoke detector has an "escape light" or mechanical buzzer-type sounder, you can probably connect a low-current relay in parallel with

the light or sounder, and then connect the relay contacts to your NO alarm loop. Radio Shack used to have a six-volt relay that only required 12 milliamps to operate, which would work fine. This will not work if the detector has a piezo-type sounder, as these are driven by AC not DC. Another problem is that you will get a false alarm when the battery goes low and the sounder chirps.

2) If a piezo sounder is used, try connecting a PNP power transistor in series with the positive battery lead. Most general purpose TO-3 types will handle this job. Connect the emitter to the battery positive and the base to the smoke detector. The small non-alarm operating current will not be enough to bias the transistor on, but when the detector trips and draws a couple hundred milliamps, the transistor will turn on and positive voltage will be present at the collector lead to trip a relay. This will have the same false alarm problem as option 1.

3) If the smoke detector has an LED indicator, use an opto-coupler (such as MCT-2), wired in series with the LED. Hook the input of the opto

(pins 1 and 2) in series with the LED. If the LED stops blinking, try reversing the connection. Connect the emitter-collector output (pins 4 and 5) to the alarm loop, making sure the emitter (pin 4) is on the negative side of the circuit. Typical fire alarm circuits have a delay of about half a second built in, so the normal flashing of the LED should not trip the alarm, but when the LED lights steady (alarm condition) it should activate your fire system. This hook-up has the advantage that it will not false alarm when the battery goes low.

Robert Baust
Loganville, GA

ANSWER TO #29523 - FEB 1995

Vibrating pagers "buzz" by spinning up a motor with an eccentric weight on its shaft. The easiest way to add this feature to your own project is to salvage the vibrator from a junked pager. You can accomplish the same trick by attaching any kind of off-center weight to a small DC motor, but the resulting package won't be as small as one made by a pager manufacturer.

Bob Scott

by Fred Blechman



How I Saved \$250.00 Getting My Laser Printer Repaired

It's not a matter of IF you are going to need some sort of parts replacement or repair for your laser printer — it's a matter of WHEN. Sooner or later you'll need a new toner cartridge, or a new photoconductor drum, or both. In most cases, for most laser printers, the toner and drum come in the same replacement assembly. However, it is very common for a separate drum assembly and the toner cartridge to be used instead of a combined unit.

In any case, many different problems can occur in these complex printers, and repairs can be expensive if you simply have major assemblies replaced. Most authorized repair dealers will be happy to provide this service. However, there are alternatives of which you may not be aware. Read on . . .

"You need a new drum assembly. That's \$289.00 plus postage and sales tax."

"What!" I exclaimed. "Are you sure? Is that what's wrong with my printer?"

"Yes," replied the local authorized dealer. "No doubt about it. Get a new drum assembly — you can install it yourself — and your problem will disappear."

Hmmmm. I thought about it. I don't give in that easy. The dealer was actually correct, but he didn't tell me the whole story. What follows is the rest of the story, and how I saved over \$250.00 getting my laser printer repaired.

To begin with, let me point out that my particular printer is not technically a laser printer, since it does not use a laser beam. My OKIDATA OL400 is actually an "LED Page Printer" that uses 2400 tiny LEDs (light-emitting diodes) in a single line eight-inches across (300 per inch) instead of a laser beam. However, for all intents and purposes, it is

compatible with an HP/II LaserJet using a somewhat different (and far simpler) printing technology.

The OL400 uses toner and an organic photoconductor coating (OPC) drum, like all laser printers, but with a slight difference. The toner is in a separate cartridge that drops into a drum assembly. This is becoming a common arrangement, used by some Panasonic, Brother, and other laser printers — perhaps yours.

The drum assembly has the required mechanism and gears to turn the drum and feed the toner, a wiper blade to clean the drum, and a reservoir for used toner. The drum assembly (\$289.00) is supposed to be good for 12,000 to

15,000 copies, while the toner cartridge (about \$30.00) is good for about 2,500 copies. So it should take about five toner cartridges before you might need a new drum assembly.

Well, I was recently only on my third toner cartridge when a blotched area about 3" wide and about 1" high started printing near the top of each FIRST page in a run, and ONLY the first page. The blotch consisted of many closely-spaced vertical lines.

All subsequent pages were normal, unless the drum stopped in between. The drum would automatically stop turning, going into an energy-saving "sleep mode," whenever there was no new information going into the printer memory for over a minute. Then, when the next page was to be printed, and the drum started again, the first page out would have the blotch.

For text runs, I'd simply force a false "blank" page (on which the blotch printed) before the first

text page. Annoying, but not disabling, and a waste of paper. But when I tried to do a graphic dump, the drum went into sleep mode waiting for the page-memory to be completed before the drum would start to turn — and the blotch ruined the graphic print! That I could not live with, so I called the local Okidata Service Center and that's when I was told I needed a new drum assembly for \$289.00 plus shipping and tax.

But it didn't make sense to me. If the OPC drum itself — the most expensive part of the drum assembly — was bad, why were all sheets BEYOND the first sheet printing perfectly?

I checked with some trade magazines (see sidebars) and found the OPC drum alone (not the whole drum assembly) was being sold for \$69.00. This sounded to me like the drum alone could be replaced, if necessary. Hmmmm.

I pulled the drum assembly from my OL400 (it just lifts out after pressing a couple of pushbuttons) and looked it over. It looks similar to photocopy and laser cartridges that have both the drum and toner in one assembly. Having used recycled photocopy machine toner cartridges for years (and also having written articles about the process), I knew just from looking at it that this OL400 drum assembly could be disassembled and parts replaced. I also knew it would be foolhardy for me to try to do it myself, since special screws are used, and who knows how many parts (gears, springs, etc.) there are inside? But I also knew that opening toner cartridges — and replacing toner — and sometimes OPC drums — was a large and growing industry supported by at least two magazines (see sidebars).

I called Renee and Larry at Laser Cartridge Services in Northridge, CA (818-349-8243) since they had always provided me with good service for recycled toner cartridges for my Canon photocopy

machines. They took these kind of things apart as a regular part of their business. Also, they now offer laser printer cleaning, maintenance, and repair. Renee explained that they did not service Okidata OL400s, had never been asked, and saw it as too small a market for their operation.

My next step was going to be to contact those selling replacement drums, reasoning that they must also provide a drum replacement service. However, before I got to look any further, I happened to mention my dilemma to Mel Marcus, a computer-guru friend who had been using laser printers for years. I told him I hated to spend about \$300.00 for a whole new drum assembly when it seemed that perhaps only the drum itself could be replaced (if that was the problem) at a much lower cost.

He told me he recently had a "fuser assembly" problem with his Hewlett Packard laser printer and he found, using the local phone book yellow pages, a Woodland Hills, CA laser printer repair source: Laser Printer Basics (800-748-5632 or 818-346-1064). He said Jack C. Kern, the owner, fixed his machine quickly and inexpensively, even picking up and delivering the printer. Mel suggested I give him a call.

So I did. Jack, a former Hughes engineer, recently enlarged his cartridge recycling business to include laser printer repair. He told me that from what I described (and I also faxed him a copy of a bad page), he thought the only thing wrong was a wiper blade in the drum assembly. He said if I brought him my drum cartridge he would disassemble it and replace the wiper blade for only \$35.00! Furthermore, if that wasn't the problem, and an OPC drum was actually needed, it would cost \$125.00 (and the \$35.00 to replace the wiper blade would be applied to the \$125.00 total).

How could I say no? The bottom line: He replaced the wiper blade overnight for \$35.00, the drum assembly was dropped into the OL400, and it has worked perfectly ever since — with probably 7,000 more copies before I need a new OPC drum!

Finding Local Repairs

The moral of the story is that manufacturers want to sell complete assemblies, but you might find local individual entrepreneurs that have learned how to replace failed parts at a great saving. Since getting my drum assembly repaired, I've found another local (Chatsworth, CA) source for toner, drums, and repairs: Steven Burrow, CARTRICHARGE, at 818-888-0006. He offers a complete recycled Okidata OL400 drum assembly for only \$89.95 — almost \$200.00 less than a new one!

Repairing laser printers has become a new specialized business. Look under "Computer Repairs" in the yellow pages of the phone book for someone that advertises "laser printer repairs." See the sidebars about two magazines that could lead you to parts and repair facilities for your particular printer.

Or call Renee, Jack, or Steven. They offer toner, drum cartridges, and off-site repairs for most laser printers by mail-order anywhere in the USA. You could save yourself a bundle! **NV**

RECHARGER MAGAZINE (3340 Sunrise Ave., Suite 101, Las Vegas, NV 89101. Phone: 702-438-5557, Fax: 702-438-4025) is an independent publication serving the cartridge recycling industry and its associated suppliers. (Recycling is sometimes called "remanufacturing" or "recharging"). It offers technical information on recycling various laser printer and copier cartridges, laser printer maintenance and repair, ink-jet refilling, and ribbon recycling.

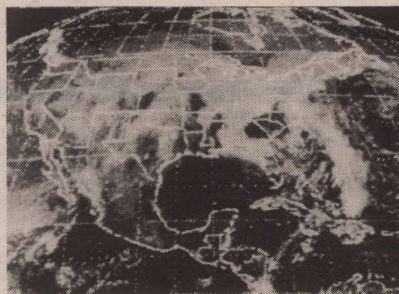
This magazine is published monthly (\$45.00 per year for a subscription; call them for single issue price) and typically runs 130 glossy pages. Although basically aimed at recyclers, it offers a free referral service to help end users locate a cartridge recycler in their area. The ads in the magazine provide sources and information on toners, OPC drums, and other supplies used by recyclers. Contacting these sources should lead you to those who will provide the repairs you need.

Flash Magazine — The Premier Journal of Desktop Publishing (Black Lightning Publishing, Inc., Riddle Pond Road, West Topsham, VT 05086. Phone: 802-439-6462, Fax: 802-439-6463) is one of the most interesting and readable "technical" publications I've seen. Its small 5.25" x 8.5" pamphlet-sized 98-page format is printed on glossy paper and has lots of color photos and artwork. It is published bimonthly (six issues a year) for \$15.00 a year prepaid, or \$23.70 a year if billed. A sample issue is \$6.00 postpaid.

Aimed at the individual, rather than recyclers, *Flash Magazine* tells you how to get the most from your printer with information useful to the average or expert laser printer user. How-to articles cover the range from maintenance and repair to printing techniques, common publishing projects, and imaginative, creative ways to make the best use of your laser printer. You'll find long in-depth articles peppered with helpful hints and tips from small innovative companies and self-publishing authors — all sprinkled with a good bit of humor and Yankee ingenuity.

Although the primary focus of this magazine is on desktop publishing and iron-on transfer toners and supplies, each issue has several advertisers that offer laser printer recycled products and repairs.

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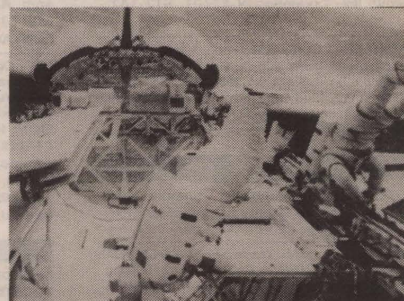


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Nuts & Volts Magazine/March 1995

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APRIL 1

CO - LONGMONT — LARCFEST. **SPONSOR:** Longmont ARC. **LOCATION:** Boulder County Fairgrounds, Hover & Nelson Rds. **HOURS:** 8am-3pm. **ADMISSION:** \$4. **TALK-IN:** 147.27/146.52. **FEATURES:** CB - EX - F/R - F/R - H. **DEALER INFO:** Tables \$8 + admission. **CONTACT:** Send SASE: Randy Stevens, NONMD, 5280 Cypress Dr., Boulder CO 80303. 303-499-1106.

IN - COLUMBUS — Hamfest. **SPONSOR:** Columbus ARC. **LOCATION:** Bartholomew County 4-H Fairground, Family Arts Bldg., State Road 11. **HOURS:** 8am-2pm. **ADMISSION:** \$3.50 adv., \$4 door. **TALK-IN:** 146.790/146.190. **DEALER INFO:** Tables: 8' \$6, 6' \$4.50. Set-up: Fri. 6pm-10pm, Sat. 6am. **CONTACT:** Marion Winterberg, WD9HTN, 11941 W. Sawmill Rd., Columbus IN 47201. 812-342-4670.

MI - JACKSON — Computer Trade Show. **LOCATION:** Jackson Catholic Middle School, 915 Cooper St., approx. 1 mi. S of I-94. **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.

APRIL 2

IN - NOBLESVILLE — Noblesville Computer Fair. **LOCATION:** Hamilton County Fairgrounds, off SR37. **CONTACT:** Ben Yanto, AGI Computer Fairs.*

MI - FLINT — Computer Trade Show. **LOCATION:** Holiday Inn, 5353 Gateway Center, exit at Hill Rd. from US-23 or I-475. **HOURS:** 10am-4pm. **ADMISSION:** Adults \$4; Seniors & students w/ID \$3; under 12 free w/adult. **FEATURES:** C - DP. **CONTACT:** Computers & You, 313-283-1754.

MI - NOVI — Great Lakes Computer Expo & Sale. **SPONSOR:** Progressive Computer Productions. **LOCATION:** Sheraton-Oaks Hotel, I-96 & Novi Rd., across from Twelve Oaks Shopping Center. **HOURS:** 10am-4pm. **ADMISSION:** Adults \$4, Seniors/Students \$3, under 12 free w/adult. **FEATURES:** C - DP - F/R - S. **DEALER INFO:** 8' \$35 ea. 12' \$40 ea. **CONTACT:** Progressive Computer Productions, 23814 Michigan Ave., Ste 237, Dearborn MI 48124. 313-425-9276.

OH - CLEVELAND — Compvter Mania! **SPONSOR:** National Computer Exposition. **LOCATION:** Holiday Inn/Strongsville, 15471 Royalton Rd. & Rt. 82 at I-71 Exit 231A. **HOURS:** 10am-4pm. **ADMISSION:** \$1 off w/adult, under 12 free. **FEATURES:** FP. **DEALER INFO:** Setup 8am-10am. Sellouts are common, early booking advised. **CONTACT:** Joe Bowen, 216-442-1776 or Ronald Nelson, FAX: 216-292-7746. National Expo's, Inc., 30799 Pinetree Rd. #230, Cleveland OH 44124.

WI - MADISON — 23rd Annual Madison Swapfest. **SPONSOR:** Madison Area Repeater Assoc. **LOCATION:** Dane County Exposition Center Forum Bldg. **HOURS:** 8am. **ADMISSION:** \$4 adv., \$5 door. **TALK-IN:** 147.75/15. **FEATURES:** C - CB - E - FM - F/R. **DEALER INFO:** Tables: \$10 + admission. Adv. only. **CONTACT:** MARA, POB 8890, Madison WI 53708-8890.

APRIL 7-8

OK - LAWTON — Lawton - Ft. Sill ARC Hamfest. **SPONSOR:** Lawton - Ft. Sill ARC. **LOCATION:** Great Plains Coliseum. **HOURS:** Fri. 6:30pm-9pm; Sat. 8am-5pm. **ADMISSION:** \$4 adv., \$5 door. **TALK-IN:** 146.91. **FEATURES:** C - CB - DP - E - EX - F - FM - F/R - H - S. **DEALER INFO:** Tables: \$8 adv, \$10 door. **CONTACT:** Bob Morford, 405-355-6120.

APRIL 8

MN - FERGUS FALLS — 8th Annual ARRL Affiliated Hamfest. **SPONSOR:** Lake Region ARC. **LOCATION:** Ottertail County Fairgrounds, Hockey Arena, Hwy. 59 S. **HOURS:** 8am-3pm. **TALK-IN:** 146.040/146.640. **FEATURES:** EX - F/R. **CONTACT:** Wm. Morgan, Rt. 6 Box 43, Fergus Falls MN 56537.

MO - JOPLIN — JARC Hamfest '95. **SPONSOR:** Joplin ARC. **LOCATION:** John Q. Hammons Convention Center, 3615 Rangeline. **HOURS:** 8am-3pm. **ADMISSION:** \$6, under 12 free. **TALK-IN:** 147.214. **FEATURES:** DP - EX. **DEALER INFO:** Tables \$7.50. Setup 6:30am-8am Northside. **CONTACT:** JARC, POB 2983, Joplin MO 64803. 417-782-5848 evenings, or 417-673-8371 Andy Gabbert, KA0TUD.

OK - LAWTON — 49th Annual Hamfest. **SPONSOR:** Lawton Ft. Sill ARC. **LOCATION:** Comanche County Fairgrounds. **HOURS:** 8am-5pm. **ADMISSION:** \$4 adv., \$5 door. **TALK-IN:** 146.91/31. **FEATURES:** DP - EX - F. **DEALER INFO:** Tables: \$8 adv., \$10 door. **CONTACT:** Bob Morford, KA5YED, 1415 NW 33rd St., Lawton OK 73505. 405-355-6120.

WI - GREEN BAY — Swapfest. **SPONSOR:** Ashwallben High School Tech Club & Brown County ARES. **LOCATION:** Ashwallben High School, 2391 South Ridge Rd. **HOURS:** 8am-12pm. **ADMISSION:** \$3 adv., \$4 door. **TALK-IN:** 147.075 +. **FEATURES:** C - EX - FM - F/R - H. **DEALER INFO:** Tables: Adv. 4' \$4, Door 4' \$5. Setup Fri. 7-10pm. **CONTACT:** Chad Stiles, N9PAY, 2171 Barbary Ln., 140 March 1995/Nuts & Volts Magazine

Green Bay WI 54304. 414-494-2936. Lisa Kolbusz, N9VJL, 520A Columbia Ave., Green Bay WI 54303. 414-497-1807.

APRIL 9

IL - ROCKFORD — Electronics Expo & Hamfest '95. **SPONSOR:** Rockford ARC. **LOCATION:** Rockford Metro Centre, 300 Elm Street. **HOURS:** 8:00am-1:30pm. **ADMISSION:** \$5. **FEATURES:** C - CB - DP - E - EX - FM - F/R - H. **DEALER INFO:** Tables \$10 & \$12.50, set up 5:00am only. **CONTACT:** RARA, POB 8465, Rockford, IL 61126 or Wayne & Fay Hansen, 815-397-6027.

MI - TROY — Computer Trade Show. **LOCATION:** American Polish Cultural Center, 2975 E. Maple Rd., (15 mi.), corner of Dequindre. **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.

OH - CLEVELAND — Compvter Mania! **SPONSOR:** National Computer Exposition. **LOCATION:** Holiday Inn/Hudson, 240 Hines Hill Rd., at I-80 Ohio Tpk. Exit 12, 1/2 N. **HOURS:** 10am-4pm. **ADMISSION:** \$1 off w/adult, under 12 free. **FEATURES:** FP. **DEALER INFO:** Setup 8am-9:45am. Sellouts are common, early booking advised. **CONTACT:** Joe Bowen, 216-442-1776 or Ronald Nelson, FAX: 216-292-7746. National Expo's, Inc., 30799 Pinetree Rd. #230, Cleveland OH 44124.

APRIL 15

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

MI - GRAND RAPIDS — Computer Trade Show. **LOCATION:** Holiday Inn Crown Plaza, 5700 28th St. SE, E of I-96 Exit #43. **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.

OH - TOLEDO — Compvter Mania! **SPONSOR:** National Computer Exposition. **LOCATION:** Ramada Inn/Southwyck, 2340 S. Reynolds Rd., Ohio Tpk. 80/90 Exit 4 N. **HOURS:** 10am-4pm. **ADMISSION:** \$1 off w/adult, under 12 free. **FEATURES:** FP. **DEALER INFO:** Setup 8am-9:45am. Sellouts are common, early booking advised. **CONTACT:** Joe Bowen, 216-442-1776 or Ronald Nelson, FAX: 216-292-7746. National Expo's, Inc., 30799 Pinetree Rd. #230, Cleveland OH 44124.

APRIL 22

IL - KANKAKEE — Computer Expo. **SPONSOR:** Kankakee River Valley Computer Users Group. **LOCATION:** Kankakee County Fairgrounds. **HOURS:** 9am-2pm. **ADMISSION:** \$4, 10 & under free. **FEATURES:** C - CB - E - FM - F/R. **CONTACT:** KRVCUG 815-935-1605.

MI - BRIGHTON — Computer Trade Show. **LOCATION:** Brighton High School, 7878 Brighton Rd., take Exit 145 off of I-96 S to Main St., turn right & go to 7th St., turn left at school. **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.

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' \$35 ea. 12' \$40 ea. **CONTACT:** Progressive Computer Productions, 23814 Michigan Ave., Ste 237, Dearborn MI 48124. 313-425-9276.

APRIL 23

IL - ARTHUR — 33rd Annual Hamfest. **SPONSOR:** Moultrie ARK. **LOCATION:** Moultrie/Douglas Fairgrounds. **ADMISSION:** \$4, 14 & under free. **TALK-IN:** 449.275/444.275 146.055/146.655. **FEATURES:** EX - FM. **DEALER INFO:** Inside tables \$8, outside flea market setup free, indoor setup Sat. 12pm-4pm, Sun. 6am-8am. **CONTACT:** M.A.R.K., POB 91, Lovington IL 61937. Or Ralph Zancha, WC9V, 217-873-5287.

IL - GLEN ELLYN — Computer Central. **LOCATION:** College of DuPage, Park Blvd. & College Rd. **HOURS:** 9:30am-3pm. **ADMISSION:** Adults \$6, 8-12 \$2, under 8 free. \$1 off reg. adult admission w/this ad. **FEATURES:** AC - C - FP. **CONTACT:** Computer Central, Jay B. Robinson, 708-940-7547.

IL - SULLIVAN — ARRL Hamfest. **SPONSOR:** Moultrie ARK. **CONTACT:** Ralph Zancha, WC9V, POB 91, Lovington IL 61937. 217-543-2178.

KY - LOUISVILLE — Computer Fair South. **SPONSOR:** MEKA Enterprises, Inc. **LOCATION:** Executive West Hotel, I-65 & 264 Freedom Way at the Fairgrounds. **HOURS:** 10am-3pm. **CONTACT:** William Ibarra, MEKA Enterprises, 2656 E. 2nd St., Bloomington IN 47401. 812-333-4484, FAX: 812-

333-4650.

MI - SOUTHGATE — Computer Trade Show. **LOCATION:** Southgate Civic Center, 14700 Dix-Toledo Rd., bet. Northline & Eureka. **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.

OH - PERRYSBURG — CDE Computer Expo. **LOCATION:** Perrysburg Holiday Inn, Interstate 75 @ State Rte 20. **HOURS:** 10am-4pm. **DEALER INFO:** 8 ft. tables \$35, set up 8:30am-10:00am. **CONTACT:** CDE Computer Products, 635 Flanders Ave., Bowling Green, OH 43402-1520, or Dave 419-352-9316.

APRIL 28

OH - DAYTON — Annual Banquet. **SPONSOR:** Southwest Ohio Chapter of the Quarter Century Wireless Assoc. **LOCATION:** Alex's Continental Restaurant. **HOURS:** COB Bar @ 7pm; Banquet @ 7:30pm. **ADMISSION:** \$15. Reservation deadline is April 26. **CONTACT:** Mail checks payable to: Robert L. Dingle, Treas. Chapter 9; 1117 Big Hill Rd., Kettering, OH 45429-1201.

APRIL 28-29-30

OH - DAYTON — 44th Annual Dayton Hamvention. **SPONSOR:** Dayton Amateur Radio Association. **LOCATION:** Hara Arena. **ADMISSION:** \$12 adv., \$15 door, good all 3 days. **FEATURES:** B - C - DP - E - EX - F - FM - H. **DEALER INFO:** Flea Market: 3 spaces max. (Must purchase admission ticket.) \$35/space, \$70/2, \$160/3. Electricity \$40 per space. Covered tent: \$230 ea. Exhibit info: 513-276-6931, FAX 513-324-2159. Flea Market info: 513-276-6932. **CONTACT:** General info: 513-276-6930.

APRIL 30

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 - F/R - F/R - All indoors. **CONTACT:** 24-hour Hotline 708-974-3123.

MI - ANN ARBOR — Great Lakes Computer Expo & Sale. **SPONSOR:** Progressive Computer Productions. **LOCATION:** Holiday Inn, US-23 & Plymouth Rd. **HOURS:** 10am-4pm. **ADMISSION:** Adults \$4, Seniors/Students \$3, under 12 free w/adult. **FEATURES:** C - DP - F/R - S. **DEALER INFO:** 8' \$35 ea. 12' \$40 ea. **CONTACT:** Progressive Computer Productions, 23814 Michigan Ave., Ste 237, Dearborn MI 48124. 313-425-9276.

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 Road. **HOURS:** 10am-4pm. **ADMISSION:** Adults \$4; Seniors & students w/ID \$3; under 12 free w/adult. **FEATURES:** C - DP. **CONTACT:** Computers & You, 313-283-1754.

MAY 6

AR - RUSSELLVILLE — ARRL Hamfest. **SPONSOR:** Arkansas River Valley AR Foundation. **CONTACT:** Jerry Wilkinson, WB4ICV, 544 Richland Circle, Russellville AR 72801. 501-968-7257.

TX - AMARILLO — ARRL Hamfest. **SPONSOR:** Panhandle ARC. **CONTACT:** Guy Pigg, WZSC, POB 3842, Amarillo TX 79116-3842. 806-372-8462.

MAY 6-7

TX - ABILENE — ARRL West Texas Section Convention & Hamfest. **SPONSOR:** Key City ARC. **LOCATION:** Abilene Civic Center. **HOURS:** Sat. 8am-5pm; Sun. 9am-2pm. **ADMISSION:** \$7 adv., \$8 door. **TALK-IN:** 146.160/760. **FEATURES:** EX - FP. **DEALER INFO:** Tables \$5; set-up, Fri. 5/5 4pm-9pm, Sat. 5/6 6am. **CONTACT:** Peg Richard KA4UPA, 1442 Lakeside Dr., Abilene, TX 79602. 915-672-8889.

MAY 7

IN - INDIANAPOLIS — Indianapolis Computer Fair. **LOCATION:** Celebrations. **CONTACT:** Ben Yanto, AGI Computer Fairs.*

MN - BEMIDJI — Hamfest. **SPONSOR:** Paul Bunyon ARC. **LOCATION:** Bemidji Eagles Club. **HOURS:** 8:00am-3:30pm. **TALK-IN:** 146.13/73. **FEATURES:** CB - DP - EX - FM. **CONTACT:** Dave Peterson NOQHL, 218-751-2314; George Welte NW0BU, 218-751-2931; to register for testing, Gurnee Bridgeman W9NT.

MAY 12-13

NE - SOUTH SIOUX CITY — Ham Convention. **SPONSOR:** Iowa State Convention & Hamboree #17. **CONTACT:** Dick Pitner, WOFOZ, 2931 Pierce St., Sioux City IA 51104. 712-258-1520.

MAY 13

WI - MANITOWOC — Lakeshore Hamfest, Electronics & Computer Swapfest. **SPONSOR:** Mancord

Radio Club. **LOCATION:** Manitowoc County Expo. **HOURS:** 8am-7. **ADMISSION:** \$2 adv., \$3 door. **TALK-IN:** 146.61- or 147.03 +. **FEATURES:** DP - EX - F/R. **DEALER INFO:** Tables, \$4 ea., electric outlets, \$5 ea., set up Fri. night until 10pm or early Sat. morning. **CONTACT:** Glen 414-684-7096 or Red 414-684-9097.

MAY 15

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

MAY 20

IN - INDIANAPOLIS — Indianapolis Computer Fair. **LOCATION:** Quality Inn East, 35th & Shadeland Ave. **CONTACT:** Ben Yanto, AGI Computer Fairs.*

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' \$35 ea. 12' \$40 ea. **CONTACT:** Progressive Computer Productions, 23814 Michigan Ave., Ste 237, Dearborn MI 48124. 313-425-9276.

MO - KANSAS CITY — Missouri State Convention. **SPONSOR:** Missouri State Convention. **CONTACT:** Chuck Miller, WAOKUH, 7000 NE 120th St., Kansas City MO 64166. 816-781-7313.

TX - ARLINGTON — Calculator & Antique Instrument Collector Convention. **SPONSOR:** International Assoc. of Calculator Collectors. **LOCATION:** Arlington Convention Center, 10 minutes from Dallas/Ft. Worth Airport. **HOURS:** 10am-4pm. **ADMISSION:** Free. **DEALER INFO:** 8 ft. tables \$20. **CONTACT:** Skip Solberg 817-467-0368, 717 Salisbury, Arlington, TX 76014.

MAY 20-21

NM - RUIDOSO — ARRL Hamfest. **SPONSOR:** Sierra Blanca ARC. **CONTACT:** Gunnar Carlson, AE4W, POB 4067, Ruidoso NM 88345. 505-525-2159.

OH - CINCINNATI — Cincinnati Computer Fair. **LOCATION:** Cincinnati Gardens. **HOURS:** Sat. 10am-5pm, Sun. 10am-3pm. **ADMISSION:** \$5. Good both days. **DEALER INFO:** 10 x 10 professional space w/backdrop & electricity 2' draped tables w/chair \$200. 8 x 6 Flea market space w/8' table \$30. Elec. \$5. **CONTACT:** 513-263-3378

MAY 21

IA - BURLINGTON — Valley Emergency Communications Assn. **CONTACT:** Chuck Gysl, N2DUP, POB 911, Burlington IA 52601-0911. 319-752-3000.

IL - GLEN ELLYN — Computer Central. **LOCATION:** College of DuPage, Park Blvd. & College Rd. **HOURS:** 9:30am-3pm. **ADMISSION:** Adults \$6, 8-12 \$2, under 8 free. \$1 off reg. adult admission w/this ad. **FEATURES:** AC - C - FP. **CONTACT:** Computer Central, Jay B. Robinson, 708-940-7547.

IL - PEOTONE — ARRL Hamfest. **SPONSOR:** Kankakee Area Radio Society. **CONTACT:** Willis Bowser, K9IFO, 1210 N. Riverside Dr., Momence IL 60954-3452. 815-472-2079.

IN - WABASH — ARRL Hamfest. **SPONSOR:** Wabash County ARC. **CONTACT:** Larry Manning, N9AFI, 5199 E. State Rd. #218, LaFontaine IN 46940. 317-981-4735.

MAY 26-27-28

OK - TULSA — Oklahoma State Convention. **SPONSOR:** Oklahoma State Convention. **CONTACT:** Merlin Griffin, WB5OSM, 11671 E. 80th St. N #BB, Owasso OK 74055. 918-272-3081.

MAY 27-28

WY - CASPER — ARRL Hamfest. **SPONSOR:** Casper ARC. **CONTACT:** Steve Speir, N7JJO, 3511 Swanton Ave., Casper WY 82609. 307-265-5675.

MAY 28

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 - F/R - F/R - All indoors. **CONTACT:** 24-hour Hotline 708-974-3123.

EASTERN REGION

MARCH 4

AL - TUSCALOOSA — Hamfest. **SPONSOR:** Black

CALENDAR

Warrior Swapfest. **CONTACT:** Kelly Bruce WD4DAT, POB 032171, Tuscaloosa AL 35403. 205-339-7882.

NJ - ABSECON — "Springfest '95" Hamfest. **SPONSOR:** Shore Points ARC. **LOCATION:** Holy Spirit High School, on Rte 9 (about 3/4 mi. S of Rte 30). **HOURS:** 9am-7. **ADMISSION:** \$5, non-ham XYLs and children free. **TALK-IN:** 146.385/.985 repeater. **FEATURES:** EX - FM - F/P - H - T. **DEALER INFO:** Indoor tables: \$7/8", reservations accepted, setup 7am. Outdoor tailgating, weather permitting: \$5/painted parking space. First come, first served, no reservations accepted. **CONTACT:** SPARC, POB 142, Absecon NJ 08201.

MARCH 4-5

MA - WALTHAM — MarketPro Computer Show & Sale. **LOCATION:** Hillcrest, 220 Bear Hill Rd. **HOURS:** 9:30am-4pm. **ADMISSION:** \$6, under 12 free. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

MARCH 5

MA - NORTHAMPTON — 11th Annual MTARA Amateur Radio Flea Market. **SPONSOR:** Mt. Tom Amateur Repeater Assn. **LOCATION:** Smith Vocational School, Rte 9. **HOURS:** 9am-7. **ADMISSION:** \$3, under 12 free. **FEATURES:** DP - F/R - T. **DEALER INFO:** Vendor setup 8am. Tables \$12 adv, \$15 door, includes 1 admission. Tailgating \$5 per parking space, weather permitting, does not include admission. Vendor reservations: Jim, K1MEA, 413-527-3199 eves before 2200 EST. **CONTACT:** Mt. Tom Amateur Repeater Assn, Inc., 316 Main St., Easthampton MA 01027.

MA - TAUNTON — Computer Shows & Sales. **SPONSOR:** Northern Computer Shows. **LOCATION:** Taunton Holiday Inn, Exit 9 off I-495, between Rte. 24 & I-95. **HOURS:** 10am-3:30pm. **ADMISSION:** \$7, under 14 free w/adult. **FEATURES:** C. **DEALER INFO:** Setup 8am. **CONTACT:** Northern Computer Shows.*

MARCH 11

FL - LAKE WORTH — Free Flea. **SPONSOR:** West Palm Beach ARC. **LOCATION:** John Prince Park at Mouth Circle. **HOURS:** 8am-2pm. **ADMISSION:** Free. **TALK-IN:** 147.135 + 600 or 146.670 - 600. **FEATURES:** FM - F/R - T. **CONTACT:** Marvin, KD2CK @ KB4VOL. 407-683-2930.

NJ - PARSIPPANY — MarketPro Computer Show & Sale. **LOCATION:** Parsippany Hilton. **HOURS:** 9:30am-4pm. **ADMISSION:** \$6, under 12 free. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

VA - ANNANDALE — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** NOVA. **HOURS:** 9:30am-4:30pm. **ADMISSION:** \$6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-530-2355.

MARCH 11-12

NC - CHARLOTTE — 1995 Charlotte Hamfest & Computerfair. **SPONSOR:** Mecklenburg Amateur Radio Society. **LOCATION:** Charlotte Merchandise Mart, Liberty Hall. **HOURS:** Sat: 9am-5pm, Sun: 9am-2pm. **TALK-IN:** 144.69/145.29. **FEATURES:** C - CB - DP - F - S. **DEALER INFO:** Ken Boyd, WA0QNZ, Charlotte Hamfest, POB 221136, Charlotte NC 28222-1136. 704-377-8873.

NJ - PENNSAUKEN — Computer Show. **LOCATION:** South Jersey Expo Center, off NJ Tpke. Exit #4 on rt. 73. **HOURS:** 9:30am-4:30pm. **FEATURES:** C. **DEALER INFO:** 500+ tables. **CONTACT:** KGP Computer Show.*

PA - WILLOW GROVE — PC Dealer Showcase. **SPONSOR:** StarWare. **LOCATION:** Willow Grove Park Mall, Rt. 611 & 63. **HOURS:** Sat: 10am-9:30pm, Sun: Noon-6pm. **ADMISSION:** Free. **FEATURES:** C - FP. **DEALER INFO:** Tables \$95 ea. per day. **CONTACT:** StarWare, 610-584-8770.

MARCH 12

CT - BRISTOL — Annual Hamfest Fleamarket. **SPONSOR:** Insurance City Repeater Club, Inc. **LOCATION:** Bristol Eastern High School, King St. (Rte 229). **HOURS:** 9am-1pm, snow date March 19th. **ADMISSION:** \$4. **TALK-IN:** 146.88, 224.80. **DEALER INFO:** Tables \$10 ea. For table reservations, send SASE to: Al Gerke, N1JWF, 63 N Washington St., Apt 2, Plainville, CT 06062-1921 or call 203-747-1925. Amateur Radio Exams at 10am. Send SASE to ICRP, POB 165, Pleasant Valley, CT 06063. Pre-registration only.

MD - FREDERICK — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Frederick Fairgrounds. **HOURS:** 9:30am-4:30pm. **ADMISSION:** \$6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-530-2355.

NH - PORTSMOUTH — Computer Shows & Sales. **SPONSOR:** Northern Computer Shows. **LOCATION:** Frank Jones Center, Exit 5 off I-95 to Rt. 1 Bypass South. **HOURS:** 10am-3:30pm. **ADMISSION:** \$7, under 14 free w/adult. **FEATURES:** C. **DEALER INFO:**

Setup 8am. **CONTACT:** Northern Computer Shows.*

NY - STONY BROOK — MarketPro Computer Show & Sale. **LOCATION:** Stony Brook University. **HOURS:** 9:30am-4pm. **ADMISSION:** \$6, under 12 free. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

PA - YORK — 8th Annual York Springfest. **LOCATION:** York fairgrounds, The Old Main Bldg. **HOURS:** 8am. **ADMISSION:** \$5, 12 and under free. **TALK-IN:** 146.97(-). **FEATURES:** DP - F/R - T. **DEALER INFO:** 6am vendor & tailgate setup. Tables \$19 & \$25 (add \$10 for electricity). Tailgating \$5 per space. **CONTACT:** 717-843-7864, leave msg. Write: York Springfest, POB 526, Red Lion, PA 17356.

MARCH 18

NH - SALEM — Computer Shows & Sales. **SPONSOR:** Northern Computer Shows. **LOCATION:** Rockingham Park, I-93 Exit 1. **HOURS:** 10am-3:30pm. **ADMISSION:** \$7, under 14 free w/adult. **FEATURES:** C. **DEALER INFO:** Setup 8am. **CONTACT:** Northern Computer Shows.*

OH - DAYTON — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Dayton Fairgrounds. **HOURS:** 9:30am-4:30pm. **ADMISSION:** \$6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-530-2355.

VA - ANNANDALE — CMA Computer Show. **LOCATION:** NOVA. **HOURS:** 9:30am-3:30pm. **ADMISSION:** \$6. **FEATURES:** C - S. **DEALER INFO:** \$60/table, 7am-9am setup. **CONTACT:** CMA Shows, POB 13813 Richmond VA 23225. 804-272-1570.

MARCH 18-19

FL - FORT WALTON BEACH — 25th Annual Hamfest/Swapfest. **SPONSOR:** Playground ARC. **LOCATION:** Ft. Walton Beach Fairgrounds. **HOURS:** Sat: 8am-5pm, Sun: 8am-3pm. **FEATURES:** FM. **DEALER INFO:** For tables, call Bud, K8YNU, 904-243-5404, 9am-5pm CDT; or Scott, KE4BFT, 904-244-3182, 5pm-9pm CDT. **CONTACT:** For RV space only, call Roberta 904-862-0211. Address all inquiries to GAR, POB 873, Ft. Walton Bch. FL 32549.

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:** 8' table \$45 + \$6.00 business license. **CONTACT:** POB 295, Riverdale GA 30274. 404-907-6225.

MD - ANNAPOLIS — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Anne Arundel Comm. College. **HOURS:** 9:30am-4:30pm. **ADMISSION:** \$6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-530-2355.

NJ - WAYNE — Computer Show. **LOCATION:** William Paterson College, near I-80, Rt. 23 & Rt. 46. **HOURS:** 9:30am-4:30pm. **FEATURES:** C. **DEALER INFO:** 500+ tables. **CONTACT:** KGP Computer Show.*

PA - EASTON — PC Dealer Showcase. **SPONSOR:** StarWare. **LOCATION:** Palmer Park Mall, Rt. 22 to Rt. 248N. **HOURS:** Sat: 10am-9:30pm, Sun: Noon-5pm. **ADMISSION:** Free. **FEATURES:** C - FP. **DEALER INFO:** Tables \$95 ea. per day. **CONTACT:** StarWare, 610-584-8770.

MARCH 19

MD - NEW CARROLLTON — CMA Computer Show. **LOCATION:** Ramada Hotel. **HOURS:** 9:30am-3:30pm. **ADMISSION:** \$6. **FEATURES:** C - S. **DEALER INFO:** \$60/table, 7am-9am setup. **CONTACT:** CMA Shows, POB 13813 Richmond VA 23225. 804-272-1570.

NH - NASHUA — Computer Shows & Sales. **SPONSOR:** Northern Computer Shows. **LOCATION:** Sheraton Tara. **HOURS:** 10am-3:30pm. **ADMISSION:** \$7, under 14 free w/adult. **FEATURES:** C. **DEALER INFO:** Setup 8am. **CONTACT:** Northern Computer Shows.*

NY - YONKERS — WECAST '95. **SPONSOR:** Westchester Emergency Communications Assoc. **LOCATION:** Yonkers Raceway. **HOURS:** 9am-2pm. **ADMISSION:** \$6, under 14 free w/adult. **TALK-IN:** 147.060. **FEATURES:** C - CB - DP - E - EX - F - FP - F/R - H - T. **DEALER INFO:** Indoor tables: \$20 + 2 free admissions w/first table. Outdoor tailgating: \$10 w/1 free admission. Reservations required. 914-962-9666. **CONTACT:** Tom (WB2NHC) and Jeanne (N2NQY) Raffaelli, 544 Manhattan Ave., Thornwood NY 10594.

OH - COLUMBUS — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Columbus Exposition Ctr. **HOURS:** 9:30am-4:30pm. **ADMISSION:** \$6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-530-2355.

MARCH 25

FL - FORT LAUDERDALE — Narisaam Computer

Show. **SPONSOR:** Narisaam, Inc. **LOCATION:** Holiday Inn West, 5100 N State Rd. 7. **HOURS:** 9:30am-3:30pm. **ADMISSION:** \$5, \$4 w/ad, under 12 free. **FEATURES:** AC - C - FP. **CONTACT:** Narisaam.*

MA - WILMINGTON — Computer Show. **LOCATION:** Shriner's, N of Boston at I-93 Exit #39. **HOURS:** 9:30am-4:30pm. **FEATURES:** C. **DEALER INFO:** 500+ tables. **CONTACT:** KGP Computer Show.*

NY - RYE — MarketPro Computer Show & Sale. **LOCATION:** Rye Hilton. **HOURS:** 9:30am-4pm. **ADMISSION:** \$6, under 12 free. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

MARCH 25-26

MD - BALTIMORE — PC Dealer Showcase. **SPONSOR:** StarWare. **LOCATION:** White Marsh Mall, I-95 to Exit 67B. **HOURS:** Sat: 10am-9:30pm, Sun: 11am-6pm. **ADMISSION:** Free. **FEATURES:** C - FP. **DEALER INFO:** Tables \$95 ea. per day. **CONTACT:** StarWare, 1-800-523-0702.

MD - TIMONIUM — Hamfest & Computerfest. **SPONSOR:** Baltimore Amateur Radio Club. **LOCATION:** Timonium Fairgrounds. **HOURS:** 8am-4pm both days. **ADMISSION:** \$5 one day, \$8 weekend (adv. only). **FEATURES:** B - C - CB - E - EX - FM - F/R - H - T. **DEALER INFO:** Call for intro. **CONTACT:** Donald Baker, N2MCG, Commercial Sales, POB 95, Timonium MD 21094-0094. 410-426-3378 or 1-800-426-3378.

PA - PITTSBURGH — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Lawrence Convention Center. **HOURS:** 9:30am-4:30pm. **ADMISSION:** \$6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-530-2355.

MARCH 26

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.*

NC - KINSTON — Fifth Annual Down East Hamfest. **LOCATION:** Lenior County Fairgrounds, Hwy 11 South, follow signs from US Hwy 70 East. **HOURS:** 8am-3pm. **ADMISSION:** Adv. \$4 ea. or 3 for \$10; Door \$5 ea. or 3 for \$12. **TALK-IN:** 146.085/146.685. **FEATURES:** DP - EX - FM - F/R - T. **DEALER INFO:** Tables \$9 ea., First come, first served basis. **CONTACT:** Down East Hamfest, Inc., POB 1778, Kinston, NC 28503. 919-524-5724.

NY - HEMPSTEAD — Computer Show. **LOCATION:** Hofstra University Field House, Meadowbrook Parkway Exit M-4, Hempstead Tpke. 1 mi. on right past Coliseum. **HOURS:** 9:30am-4:30pm. **FEATURES:** C. **DEALER INFO:** 500+ tables. **CONTACT:** KGP Computer Show.*

PA - MONROEVILLE — 23rd Annual Hamfest/Computer Fair. **SPONSOR:** Two Rivers Amateur Radio Club. **LOCATION:** Greater Pittsburgh EXPO-MART. **HOURS:** 8am-3pm. **ADMISSION:** \$4. **DEALER INFO:** 6' tables \$12, setup Sat: 4:30pm-10pm, Sun: 6:30am-8am. **CONTACT:** Two Rivers ARC, POB 225, Greenock PA 15047.

RI - SMITHFIELD — MarketPro Computer Show & Sale. **LOCATION:** Bryant College. **HOURS:** 9:30am-4pm. **ADMISSION:** \$6, under 12 free. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

MARCH 31-APRIL 1

FL - GAINESVILLE — 8th Annual Poorman's Hamfest & Computer Show. **LOCATION:** Alachua County Fairgrounds. **HOURS:** Fri: 5pm-11pm, Sat: 8am-4pm. **ADMISSION:** \$5. **FEATURES:** C - DP - F - FP - H. **DEALER INFO:** Tailgate \$6, Tables \$7. Setup 12 noon Fri & 6am Sat. Overnight camping \$10 per night. **CONTACT:** Bill Wells, K4ROP, POB 1397, High Springs, FL 32643. 904-454-3105.

APRIL 1

CT - WATERFORD — Ham Radio Auction. **SPONSOR:** Radio Amateur Society of Norwich. **LOCATION:** Waterford Senior Center. **HOURS:** 10am. **ADMISSION:** Free. **TALK-IN:** 146.730(-). **FEATURES:** FP. **CONTACT:** Tony, AA1JN, 203-859-0162, or Mike, N1HFX, 203-546-9498.

MA - WEST SPRINGFIELD — MarketPro Computer Show & Sale. **LOCATION:** Eastern States Exposition. **HOURS:** 9:30am-4pm. **ADMISSION:** \$6, under 12 free. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

NJ - HACKENSACK — Computer Show. **LOCATION:** Fairleigh Dickinson Univ., Rt. 4 to Hackensack Ave. S, left at Temple Ave. traffic light, near GW Bridge. **HOURS:** 9:30am-4:30pm. **FEATURES:** C. **DEALER INFO:** 500+ tables. **CONTACT:** KGP Computer Show.*

NY - WHITE PLAINS — Computer Show & Sale. **SPONSOR:** Allied Expositions. **LOCATION:** Westchester County Center. **HOURS:** 10am-3pm. **FEATURES:** AC - C - FP. **DEALER INFO:** Tables \$45. **CONTACT:** Allied Exposition, 44 Pinnacle Rock

Rd., Stamford CT 06903. 203-329-2141.

PA - LEBANON — ARRL Hamfest. **SPONSOR:** Appalachian Amateur Radio Group. **CONTACT:** Homer Luckenbill, WA3YMU, 105 Walnut St., Pine Grove PA 17963. 717-345-3780.

APRIL 1-2

MD - GAITHERSBURG — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Montgomery County Fairgrounds. **HOURS:** 9:30am-4:30pm. **ADMISSION:** \$6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-530-2355.

PA - ALLENTOWN — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Allentown Fairgrounds. **HOURS:** 9:30am-4:30pm. **ADMISSION:** \$6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-530-2355.

APRIL 2

CT - CROMWELL — MarketPro Computer Show & Sale. **LOCATION:** Radisson Cromwell. **HOURS:** 9:30am-4pm. **ADMISSION:** \$6, under 12 free. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

CT - SOUTHTON — Flea Market. **SPONSOR:** Southington ARC. **LOCATION:** DePaolo Jr. High School, Pleasant St. **HOURS:** 9am-1pm. **ADMISSION:** \$10 8:30am-9am, \$3 after 9am. **TALK-IN:** 145.490, 147.345, 224.800, 444.250. **FEATURES:** C - DP - EX - F/R - H. **DEALER INFO:** Tables: \$12 adv., \$18 door. Set up 6:30am. **CONTACT:** Steve, N1GCV, 203-621-6191. Southington ARC, POB 873, Southington CT 06479.

NH - MANCHESTER — Computer Shows & Sales. **SPONSOR:** Northern Computer Shows. **LOCATION:** Center of NH. Expo Complex at Holiday Inn, I-293 Exit 5 or 6. **HOURS:** 10am-3:30pm. **ADMISSION:** \$7, under 14 free w/adult. **FEATURES:** C - FP. **DEALER INFO:** Setup 8am. **CONTACT:** Northern Computer Shows.*

NJ - TRENTON — Hamcomp '95. **SPONSOR:** Delaware Valley Radio Assoc. **LOCATION:** Trenton State College, Student Rec Center. **HOURS:** 7:30am-1pm. **ADMISSION:** \$5. **TALK-IN:** 146.67 (2m), 442.650 (70cm). **FEATURES:** FP - F/R. **DEALER INFO:** Tables: \$20, Tailgaters \$12. Set-up 6:30am. **CONTACT:** DVRA Hotline, 609-882-2240.

APRIL 7-8-9

GA - ATLANTA — Ham Radio '95. **SPONSOR:** South Eastern DX Club. **LOCATION:** North Atlanta Trade Center at Exit 38 I-85. **FEATURES:** Fri: 1pm-6pm, Sat: 9am-5pm, Sun: 8am-1pm. **FEATURES:** B - CB - FM - RV-H - T. **DEALER INFO:** Exhibit Booths 200 - 204. Flea Market tables \$25 ea., Tailgate \$10 ea. **CONTACT:** Ham Radio Foundation, 4343 Shallowford Rd. E-6, Marietta GA 30062. 404-518-7376.

APRIL 8

KY - BOWLING GREEN — Hambore '95. **SPONSOR:** Kentucky Colonels ARC. **LOCATION:** Knights of Columbus Hall, 911 Searey Way. **HOURS:** 7am-3pm. **ADMISSION:** \$4. **TALK-IN:** 146.25/85, 147.93/33. **FEATURES:** AC - C - CB - E - EX - F - F/R - H - T. **DEALER INFO:** Tables \$10. Set-up Fri: 6pm-7:30pm, Sat: 6am. **CONTACT:** Leon Garrett, 502-842-5307. Don Meredith, 502-781-6600. Hambore '95, POB 9781, Bowling Green KY 42102-9781.

MA - WESTPORT — Computer Shows & Sales. **SPONSOR:** Northern Computer Shows. **LOCATION:** White's Hospitality Ctr., Exit 9 E or IOW off I-95. **HOURS:** 9:30am-2pm. **ADMISSION:** \$7, under 14 free w/adult. **FEATURES:** C. **DEALER INFO:** Setup 8am. **CONTACT:** Northern Computer Shows.*

ME - PORTLAND — Hamfest. **SPONSOR:** Portland Amateur Wireless Assoc. **LOCATION:** University of Southern Maine, Sullivan Gymnasium, Falmouth St. **HOURS:** 6:30am-8am Earlybird, 8am-1pm. **ADMISSION:** \$6 Earlybird & vendors, \$4 door. **TALK-IN:** 146.73/13. **FEATURES:** DP - E - EX - FM - F/R. **DEALER INFO:** Tables free. Setup 6:30am. **CONTACT:** Marty Feeney, K1OYB, 207-772-1682.

NJ - WEST ORANGE — Hamfest. **SPONSOR:** Irvington - Roseland ARC. **LOCATION:** West Orange High School, 600 Pleasant Valley Way. **HOURS:** 8am-2pm. **ADMISSION:** \$5 - under 12 free. **TALK-IN:** 146.520 Simplex. 147.415m/146.415out. **FEATURES:** C - CB - DP - E - FP - F/R - H. **DEALER INFO:** Table - First \$10, addl \$9 + \$2 for elec. Set up 6:30am - sellers only. **CONTACT:** Jim Howe NZTDL 201-402-6066, Liz Howe NZ2GWH.

VA - ANNANDALE — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Northern Virginia Community College (NOVA). **HOURS:** 9:30am-4:30pm. **ADMISSION:** \$6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-530-2355.

APRIL 8-9

NY - STONY BROOK — MarketPro Computer Show

Events CALENDAR

& Sale. **LOCATION:** Stony Brook University. **HOURS:** 9:30am-4pm. **ADMISSION:** \$6, under 12 free. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

OH - SHARONVILLE — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Sharonville Convention Center. **HOURS:** 9:30am-4:30pm. **ADMISSION:** \$6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-530-2355.

TN - NASHVILLE — Nashville Area Computer Show. **LOCATION:** Tennessee State Fairgrounds, Wedgewood & Rains Ave. **HOURS:** Sat: 9am-5pm, Sun: 9am-5pm. **ADMISSION:** \$5 both days, \$4 Sun. only. **FEATURES:** C - C - DP - FP. **DEALER INFO:** 8-ft tables \$35. **CONTACT:** Computer Show, POB 295, Riverdale GA 30274. 800-746-9001.

APRIL 9

MA - FRAMINGTON — Spring Flea Market. **SPONSOR:** Framington ARA. **LOCATION:** Framington High School, A Street. **HOURS:** Early Bird: 9am. General: 10am-7. **ADMISSION:** Early Bird: \$5. General: \$2. **TALK-IN:** 147.15. **FEATURES:** C - DP - E - EX - FM - FP - F/R - H - T. **DEALER INFO:** Tables: \$10 adv., \$14 door + 1 free admission. Tailgate space: \$10. Setup 8am. **CONTACT:** Lew Nyman, KIAZE, c/o FARA, POB 3005, Framingham MA 01701. 508-879-7456.

MD - UPPER MARLBORO — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** The Showplace Arena. **HOURS:** 9:30am-4:30pm. **ADMISSION:** \$6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-530-2355.

ME - PORTLAND — Computer Shows & Sales. **SPONSOR:** Northern Computer Shows. **LOCATION:** Verrillo's Conv. Ctr. at Howard Johnson Motor Lodge, I-95 (Maine Tpk.) Exit 8. **HOURS:** 10am-3:30pm. **ADMISSION:** \$7, under 14 free w/adult. **FEATURES:** C. **DEALER INFO:** Setup 8am. **CONTACT:** Northern Computer Shows.*

NC - RALEIGH — RARSfest '95, 23rd Annual Hamfest/Computer Show. **SPONSOR:** Raleigh ARS. **LOCATION:** NC State Fairgrounds, Jim Graham Building. **HOURS:** 8am-4pm. **ADMISSION:** \$5 adv., \$6 door. **TALK-IN:** 146.04/64 & 146.28/88. **FEATURES:** CB - DP - EX - F - FM - FP - F/R - RV-H - RV-S. **DEALER INFO:** Flea market space: 8 ft. table w/2 chairs \$10, Elec. \$10 per connection. **CONTACT:** Rollin Ransom, NFAP, 1421 Parks Village Rd., Zebulon, NC 27597, 919-269-4406

APRIL 14-15-16

GA - AUGUSTA — World Wide Break. **SPONSOR:** Garden City Channel Masters CB Club, Inc. **LOCATION:** Radisson Hotel & Conference Center, Two 10th Street. **REGISTRATION:** \$25. **MONITORING:** Channels 6 & 8. **FEATURES:** DP - F/R - H. **CONTACT:** Moses, 706-793-7828; Charlie Diggs, 706-736-1545; Tom Thomas, 706-793-7211.

APRIL 15

NJ - FAIRFIELD — MarketPro Computer Show & Sale. **LOCATION:** Radisson Fairfield. **HOURS:** 9:30am-4pm. **ADMISSION:** \$6, under 12 free. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

PA - WILKES BARRE — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Genetti's Best Western Hotel & Conv. Center. **HOURS:** 9:30am-4:30pm. **ADMISSION:** \$6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-530-2355.

VA - GOOCHLAND — 3rd Annual SMART Swapfest. **SPONSOR:** Six Meter Amateur Radio Team. **LOCATION:** Goochland County Fairgrounds, Rt. 522 & 632. **HOURS:** 8am-3pm. **ADMISSION:** \$5 includes tailgating. **TALK-IN:** 53.06-147.27 +. **FEATURES:** C - DP - EX - FM - FP - F/R - H - RV-H - RV-S - S - T. **DEALER INFO:** Tables \$10. **CONTACT:** Buddy Travis, KA4NNN, 703-894-0406.

VA - VIRGINIA BEACH — ARRL Hamfest. **SPONSOR:** Chesapeake AR Service. **CONTACT:** Preston Ippock, N4SHI, 1026 Calloway Ave., Chesapeake VA 23324. 804-543-4610.

APRIL 16

MA - CAMBRIDGE — Tailgate Electronics, Computer & Amateur Radio Flea Market. **SPONSOR:** MIT Radio Society and Harvard Wireless Club. **LOCATION:** Albany & Main Sts. **HOURS:** 9am-2pm rain or shine. **ADMISSION:** \$2. **TALK-IN:** 146.52, 449.725/444.725 - pl 2A - W1XMR. **FEATURES:** C - FP - H - T. **DEALER INFO:** Tailgate room for 600 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:** W1GSL, POB 397082 MIT BR., Cambridge MA 02139.

APRIL 22

AL - TALLADEGA — TRACFEST. **SPONSOR:** Talladega ARC. **LOCATION:** National Guard Amory.

HOURS: 9am. **ADMISSION:** \$2. **FEATURES:** CB - EX - FM - F/R - T. **DEALER INFO:** Tables \$5, Tailgating \$2. **CONTACT:** JT Martin, 4181 Allison Mill Rd., Talladega AL 35160, 205-362-0478, or call Linda Pettis at 205-362-5212.

APRIL 22-23

GA - MARIETTA — Marietta Area Computer Show. **LOCATION:** Cobb County Civic Center, 548 S. Marietta Parkway, Exit 112 at I-75 (Hwy. 120 West). **HOURS:** Sat: 9am-5pm, Sun: 10am-4pm. **ADMISSION:** \$5 both days, \$4 Sun. only. **FEATURES:** AC - C - DP - FP. **DEALER INFO:** 8' tables \$40. **CONTACT:** Computer Show, POB 295, Riverdale GA 30274. 800-746-9001.

NJ - WEST WINDSOR — 20th Annual Trenton Computer Festival '95. **LOCATION:** Mercer County Community College. **HOURS:** Sat: 10am-6pm, Sun: 10am-4pm. **ADMISSION:** \$8. **FEATURES:** B. **CONTACT:** TCF '95, POB 129, Kirkwood PA 17536-0129. 717-529-6134.

APRIL 23

MD - TOWSON — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Towson State University. **HOURS:** 9:30am-4:30pm. **ADMISSION:** \$6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-530-2355.

VA - TYSONS CORNER — CMA Computer Show. **LOCATION:** Holiday Inn. **HOURS:** 9:30am-3:30pm. **ADMISSION:** \$6. **FEATURES:** C - S. **DEALER INFO:** \$60/table, 7am-9am setup. **CONTACT:** CMA Shows, POB 13813 Richmond VA 23225. 804-272-1570.

CT - HARTFORD — Fire-fighting Home Robot Contest. **SPONSOR:** Trinity College & The Connecticut Robotics Society. **LOCATION:** Trinity College. **CONTACT:** Jake Mendelsohn, c/o Trinity College Engineering Dept., Hartford CT 06106.

DE - NEW CASTLE — Hamfest '95. **SPONSOR:** Penn-Del ARC. **LOCATION:** NUR-Temple, Rt. 13. **HOURS:** 8am-2pm. **ADMISSION:** \$5, XYL & kids free. **TALK-IN:** 224.220 & 147.225 +. **FEATURES:** C - DP - E - EX - F - FM - H - T. **DEALER INFO:** Tables Adv. only, \$15 w/elec., \$10 w/o. Set up 6:00am, Tailgating \$8 per space. **CONTACT:** Hal Frantz, KA3TWG, 302-798-7270, Mon-Fri, 8-5pm EST.

MA - PITTSFIELD — Fleamarket. **SPONSOR:** North Berkshire ARC. **LOCATION:** Taconic High School, Valentine Rd. **HOURS:** 8am-2pm. **ADMISSION:** \$2. **TALK-IN:** 146.91. **FEATURES:** CB - EX - FM. **DEALER INFO:** Vendors: \$5 adv., \$7 door. Setup 7am. **CONTACT:** Chuck Lowery NZ1Z, 413-447-8377.

MAY 6

MD - STEVENSVILLE — Hamfest & Computer Flea Market. **SPONSOR:** Kent Island ARC. **LOCATION:** Grasonville VW, located behind Sleep Inn. **HOURS:** 8am-2pm. **ADMISSION:** \$4 donation, tailgate free. **TALK-IN:** 146.94/146.34. **FEATURES:** C - DP - FM - F/R - H - T. **DEALER INFO:** Tables & tailgating spaces are free w/admission. **CONTACT:** Glen, WN3G @ 410-643-1125; Jim K3UBC @ 410-643-3338.

NJ - WAYNE — Computer Show. **LOCATION:** William Paterson College, Recreation Center, near I-80, Rt. 23 & Rt. 46. **HOURS:** 9:30am-4:30pm. **FEATURES:** C. **DEALER INFO:** 500+ tables. **CONTACT:** KGP Computer Show.*

NY - OWEGO — Southern Tier Hamfest. **SPONSOR:** Southern Tier ARC. **LOCATION:** Marvin Park Fairgrounds, Rt. 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 - H - T. **DEALER INFO:** Tables \$15. **CONTACT:** STARC, POB 7082, Endicott, NY 13761-7082.

SC - GREENVILLE — Hamfest. **SPONSOR:** Blue Ridge ARS. **LOCATION:** Anderson County Fairgrounds. **HOURS:** 8am-5pm. **TALK-IN:** 146.01/146.61, 146.22/146.82. **FEATURES:** DP - EX - F/R - T. **CONTACT:** Jeff WA4EFT or Kay KE4NHX, Borke, 403 Aster Dr., Simpsonville, SC 29681. 803-967-3284, or E-Mail borke@aol.com.

VA - MANASSAS — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Prince William County Fairgrounds (Manassas Fairgrounds). **HOURS:** 9:30am-4:30pm. **ADMISSION:** \$6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-530-2355.

MAY 6-7

AL - BESSEMER — Birmingham Area Computer Show. **LOCATION:** Bessemer Civic Center, 1130 9th Ave, Exit 108 at I-20/I-59. **HOURS:** Sat: 9am-5pm, Sun: 10am-4pm. **ADMISSION:** \$5 both days, \$4 Sun. only. **FEATURES:** AC - C - DP - F/R. **DEALER INFO:** 8-ft tables \$35. **CONTACT:** Computer Show, POB 295, Riverdale GA 30274. 404-907-6225.

PA - ALLENTOWN — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Allentown Fairgrounds. **HOURS:** 9:30am-4:30pm. **ADMISSION:** \$6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB

41044, Bethesda MD 20814. 301-530-2355.

MAY 7

NY - POUGHKEEPSIE — ARRL Hamfest. **SPONSOR:** Mt. Beacon ARC. **CONTACT:** Ken Akasofu, KL7JQC, 316 Titusville Rd., Apt. 4, Poughkeepsie NY 12603-2944. 914-485-9617.

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:** 440.425MHz PL 156.7, 223.760MHz PL 67.0, 146.910Hz, 443.350MHz PL 156.7. **FEATURES:** DP - EX - FP - F/R. **DEALER INFO:** Setup 7am, \$19 1st table, \$15 ea. All tables 30"x5", or bring your own at \$14 per 6' space. Tables \$25 ea. at door, \$20 per 6' space. Full payment due w/registration. **CONTACT:** Otto Supliski WB2SLQ, 914-969-1053.

PA - WRIGHTSTOWN — ARRL Hamfest. **SPONSOR:** Warminster ARC. **CONTACT:** William Gorodetzer, K3MFI, 25 Fawn Dr., Holland PA 18966. 215-968-2504.

VA - ANNANDALE — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Northern Virginia Community College (NOVA). **HOURS:** 9:30am-4:30pm. **ADMISSION:** \$6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-530-2355.

MAY 14

MD - HAGERSTOWN — Great Hagerstown Hamfest & Computer Show. **SPONSOR:** Antietam Radio Assoc. W3CWC. **LOCATION:** Hagerstown Jr. College, Athletic & Recreation Center. **HOURS:** 8:30am-3pm. **ADMISSION:** \$5, under 12 free. **FEATURES:** C - DP - EX - H - T. **DEALER INFO:** Tailgate spaces \$5 - first come, first serve. Indoor tables - Adv. \$15, door \$20. Set up 6:30pm-9:30pm, May 13. **CONTACT:** Fred Bailey N3HTN, 301-416-8079, 301-714-0688.

WV - WHEELING — 18th Annual Wheeling Hamfest/Computer Show. **SPONSOR:** Triple States Radio Amateur Club. **LOCATION:** Wheeling Park, off I-70. **HOURS:** 8am-3pm. **ADMISSION:** \$2 adv., \$3 door. Women & 17 or younger, free. **TALK-IN:** 146.910 & 146.715. **FEATURES:** B - C - CB - DP - EX - FM - FP - F/R - H - RV-S - S - T. **DEALER INFO:** Flea market - free w/admission. Set up 6am. Tables sliding scale amount. **CONTACT:** TSRAC, Box 240, RR#1, Adena, OH 43901. Ph/FAX 614-546-3930.

MAY 19-20-21

NY - ROCHESTER — 61st Annual Hamfest & Computer Show. Combined with the Atlantic Division/New York State ARRL Convention. **LOCATION:** Monroe County Fairgrounds Rt. 15A & Calkins Rd. **ADMISSION:** \$6, adv., \$8 door. **FEATURES:** B - C - CB - FM - H. **DEALER INFO:** Flea market - 10 x 20 tailgate space \$10. **CONTACT:** Rochester Hamfest, 716-424-7184.

MAY 20

KY - PADUCAH — ARRL Hamfest. **SPONSOR:** Paducah ARC. **CONTACT:** David Fraser, KQ4IU, 5715 Blandville Rd., Paducah KY 42001. 502-554-7999.

NJ - BELVIDERE — ARRL Hamfest. **SPONSOR:** Cherryville Repeater Assn. **CONTACT:** Marty Grozinski, NS2K, 6 Kirkbridge Rd., Flemington NJ 08822. 908-806-6944.

NJ - WILMINGTON — Computer Show. **LOCATION:** Shriner's, N of Boston at I-93 Exit #39, right at bottom of ramp, follow signs. **HOURS:** 9:30am-4:30pm. **FEATURES:** C. **DEALER INFO:** 500+ tables. **CONTACT:** KGP Computer Show.*

MAY 20-21

AL - BIRMINGHAM — ARRL Hamfest. **SPONSOR:** Birmingham ARC. **CONTACT:** Bill Levey, WA4FAT, 2953 Donita Dr., Birmingham AL 35243. 205-967-6122.

MAY 21

NY - WOODBURY — ARRL Hamfest. **SPONSOR:** Long Island Mobile ARC. **CONTACT:** Neil Hantman, WE2V, 2 Majestic Ct., Dix Hills NY 11746. 516-462-5549.

EVENTS CALENDAR Month at a Glance

MARCH 1995

MARCH 4

CA - Santee - Ham Radio, Computer & Electronics Swapmeet
AL - Tuscaloosa - Black Warrior Swapfest
IL - Sebring - Sebring's 2nd Annual Hamfest
IA - Cedar Rapids - Annual Eastern Iowa Computer Fair
MI - Waterford - Computers & You Computer Show

NJ - Absecon - Springfest '95
OK - Elk City - ARRL Hamfest

MARCH 4-5

CA - Sacramento - MarketPro Computer Show*
MA - Waltham - MarketPro Computer Show*

MARCH 5

CA - Livermore - Swapmeet
CA - San Diego - MarketPro Computer Show*
MA - Northampton - MITARA Amateur Radio Fleamarket
MA - Taunton - Northern Computer Shows*
MI - Southgate - Computers & You Computer Show

MARCH 7-8-9

TX - Dallas - Computer Telephony Conference/Exposition

MARCH 10

MO - St. Louis - Annual Ham Radio Auction

MARCH 10-11-12

LA - Lafayette - ARRL Hamfest

MARCH 11

AZ - Scottsdale - ARRL Hamfest
CA - Santa Rosa - MarketPro Computer Show*
FL - Lake Worth - Free Flea
IN - Indianapolis - AGI Computer Fair*
ND - Fargo - Amateur Radio & Computer Fair
NJ - Parsippany - MarketPro Computer Show*
OH - Akron - Computer Mania Computer Show
TX - Wichita Falls - ARRL Hamfest
VA - Annandale - MarketPro Computer Show*
WA - Puyallup - ARRL Hamfest

MARCH 11-12

CA - Ventura - MarketPro Computer Show*
NC - Charlotte - Charlotte Hamfest & Computerfair
NJ - Pennsauken - KGP Computer Show*
PA - Willow Grove - PC Dealer Showcase

MARCH 12

CA - Fresno - MarketPro Computer Show*
CA - Lancaster - MarketPro Computer Show*
CT - Bristol - Hamfest
IN - Indianapolis - Indiana Hamfest & Computer Show
MD - Annapolis - MarketPro Computer Show*
MD - Frederick - MarketPro Computer Show*
MI - Lansing - Computers & You Computer Show
NH - Portsmouth - Northern Computer Shows*
NY - Stony Brook - MarketPro Computer Show*
OH - Circleville - ARRL Hamfest
OH - Cleveland - Computer Mania Computer Show
OH - Columbus - Computer Festival
OH - Conneaut - 9th Annual Hamfest & Computerfest
PA - York - 8th Annual York Springfest

MARCH 18

CA - Santee - Ham Radio, Computer & Electronics Swapmeet
CA - Marietta - ARRL Hamfest
KS - Colby - Hamfest
MI - Livonia - Computers & You Computer Show
MI - Marshall - 34th Annual Michigan Crossroads Hamfest
NH - Salem - Northern Computer Shows*
OH - Dayton - MarketPro Computer Show*
VA - Annandale - CMA Computer Show

MARCH 18-19

CA - Vallejo - MarketPro Computer Show*
FL - Ft. Walton Beach - ARRL Hamfest/Swapfest
GA - Norcross - Atlanta Area Computer Show
MD - Annapolis - MarketPro Computer Show*
NJ - Wayne - KGP Computer Show*
PA - Easton - PC Dealer Showcase
TX - Midland - St. Patrick's Day Swapfest

MARCH 19

AZ - Phoenix - Computer & Electronics Swapmeet
IL - Orland Park - Orland Park Computer Show
IL - Sterling - 35th Annual Hamfest
MD - New Carrollton - CMA Computer Show
MI - Ann Arbor - Great Lakes Computer Expo & Sale
MI - Madison Heights - Computers & You Computer Show
NH - Nashua - Northern Computer Shows*
NY - Yonkers - WECAST '95
OH - Columbus - AGI Computer Fairs*
OH - Columbus - MarketPro Computer Show*
OH - Maumee - 1995 TMRA Hamfest/Computer Fair
OR - Milton Freewater - 49th Annual W7DP Swapfest
WI - Jefferson - Hamfest

MARCH 25

FL - Ft. Lauderdale - Narisam Computer Show*
IN - Michigan City - Hamfest & Computer Flea Market
MA - Wilmington - KGP Computer Show*
MI - Westland - Great Lakes Computer Expo & Sale
NY - Rye - MarketPro Computer Show*
TX - Texarkana - ARRL Hamfest

MARCH 25-26

CA - Del Mar - MarketPro Computer Show*
CA - Sacramento - MarketPro Computer Show*
MD - Baltimore - PC Dealer Showcase
MD - Timonium - Hamboree & Computerfest
PA - Pittsburgh - MarketPro Computer Show*

MARCH 26

CA - Stockton - MarketPro Computer Show*
FL - West Palm Beach - Narisam Computer Show*
IL - Grayslake - Lamarsfest '95
IL - Palantine - Computer Central Computer Show
KY - Louisville - Computer Fair South
MI - Ann Arbor - Colossal Computer Sale
MI - Dearborn - Computers & You Computer Show
MI - Flint - Five Star Productions Computer Show
NC - Kinston - 5th Annual Down East Hamfest
NY - Hempstead - KGP Computer Show*
NY - Poughkeepsie - ARRL Hamfest
OH - Madison - ARRL Hamfest
OH - Toledo - Computer Festival
PA - Monroeville - 23rd Annual Hamfest/Computer Fair
RI - Smithfield - MarketPro Computer Show*
WV - Charleston - ARRL Hamfest

Events CALENDAR

MARCH 27-28-29-30-31

CA - Santa Clara - BUS Industry Conference & Exposition

MARCH 31-APRIL 1

AR - Little Rock - Hamfest & ARRL State Convention
FL - Gainesville - Poorman's Hamfest/Computer Show

APRIL 1995

APRIL 1

CA - Hanford - Hams & Hackers Swapmeet
CA - Santee - Ham Radio, Computers & Electronics Swapmeet
CO - Longmont - LARCFEST
CT - Waterford - Ham Radio Auction
IN - Columbus - Hamfest
MA - West Springfield - MarketPro Computer Show*
MI - Jackson - Computers & You Computer Show
NJ - Hackensack - KGP Computer Show*
NY - White Plains - Computer Show & Sale
PA - Lebanon - ARRL Hamfest
WA - Spokane - Hamfest & Computer Show

APRIL 1-2

MD - Gaithersburg - MarketPro Computer Show*
PA - Allentown - MarketPro Computer Show*
WA - Spokane - ARRL Hamfest

APRIL 2

CA - Livermore - Swapmeet
CA - Oxnard - MarketPro Computer Show*
CT - Cromwell - MarketPro Computer Show*
CT - Southington - Flea Market
IN - Noblesville - AGI Computer Fairs*
MI - Flint - Computers & You Computer Show
MI - Novi - Great Lakes Computer Expo & Sale
NH - Manchester - Northern Computer Shows*
NJ - Trenton - Hamcomp '95
OH - Cleveland - Computer Mania Computer Show
WI - Madison - 23rd Annual Madison Swapmeet

APR 7-8

OK - Lawton - Lawton-Ft. Sill ARC Hamfest

APRIL 7-8-9

GA - Atlanta - Ham Radio '95

APRIL 8

CA - Fresno - MarketPro Computer Show*
KY - Bowling Green - Hamboree '95
MA - Westport - Northern Computer Shows*
ME - Portland - Hamfest
MN - Fergus Falls - Hamfest
MO - Joplin - JARC Hamfest '95
NJ - West Orange - Hamfest
OK - Lawton - 49th Annual Hamfest
VA - Annandale - MarketPro Computer Show*
WI - Green Bay - Swapfest

APRIL 8-9

NY - Stony Brook - MarketPro Computer Show*
OH - Sharonville - MarketPro Computer Show*
TN - Nashville - Nashville Area Computer Show

APRIL 9

CA - Lancaster - MarketPro Computer Show*
CA - Stockton - MarketPro Computer Show*
IL - Rockford - Electronics Expo & Hamfest '95
MA - Framington - Spring Flea Market
MD - Upper Marlboro - MarketPro Computer Show*
ME - Portland - Northern Computer Shows*
MI - Troy - Computers & You Computer Show
NC - Raleigh - RARSfest '95, Hamfest/Computer Fair
OH - Cleveland - Computer Mania Computer Show
OH - Lima - Computer Festival

APRIL 14-15-16

GA - Augusta - World Wide Break

APRIL 15

CA - San Diego - MarketPro Computer Show*
CA - Santa Rosa - MarketPro Computer Show*
CA - Santee - Ham Radio, Computer & Electronics Swapmeet
IN - Indianapolis - AGI Computer Fair*
MI - Grand Rapids - Computers & You Computer Show
NJ - Fairfield - MarketPro Computer Show*
OH - Toledo - Computer Mania Computer Show
PA - Wilkes Barre - MarketPro Computer Show*
VA - Goochland - 3rd Annual SMART Swapfest '95
VA - Virginia Beach - ARRL Hamfest

APRIL 16

MA - Cambridge - MIT Fleamarket

APRIL 19-20-21

NV - Las Vegas - Electronic Distribution Show & Conference

APRIL 22

AL - Talladega - Tracfest
IL - Kankakee - Computer Expo
MI - Brighton - Computers & You Computer Show
MI - Westland - Great Lakes Computer Expo & Sale

APRIL 22-23

CA - Ventura - MarketPro Computer Show*
CA - Marietta - Atlanta Area Computer Show
NJ - West Windsor - 20th Annual Trenton Computer Festival

APRIL 23

CT - Hartford - International Robotics Contest
DE - New Castle - Hamfest '95
IL - Arthur - 33rd Annual Hamfest
IL - Glen Ellyn - Computer Central Computer Show
IL - Sullivan - ARRL Hamfest
KY - Louisville - Computer Fair South
MA - Pittsfield - Fleamarket
MD - Towson - MarketPro Computer Show*
MI - Southgate - Computers & You Computer Show
OH - Perrysburg - CDE Computer Expo
VA - Tysons Corner - CMA Computer Show

APRIL 28

OH - Dayton - Annual Banquet

APRIL 28-29-30

OH - Dayton - Hamvention

APRIL 29

CA - Sonoma - Hamfest
CA - Vallejo - MarketPro Computer Show*

APRIL 29-30

CA - Del Mar - MarketPro Computer Show*

APRIL 30

CA - Sacramento - Ham Radio/Computer Swapmeet
CA - Sacramento - MarketPro Computer Show*
IL - Orland Park - Orland Park Computer Show
MI - Ann Arbor - Great Lakes Computer Expo & Sale
MI - Madison Heights - Computers & You Computer Shows
OH - Toledo - Computer Festival

MAY 1995

MAY 6

AL - Bessemer - Birmingham Area Computer Show
AR - Russellville - ARRL Hamfest
CA - Santee - Ham Radio, Computer & Electronics Swapmeet
MD - Stevensville - Hamfest & Computer Flea Market
NJ - Wayne - KGP Computer Show*
NY - Owego - Southern Tier Hamfest
SC - Greenville - Hamfest
TX - Amarillo - ARRL Hamfest
VA - Manassas - MarketPro Computer Show*

MAY 6-7

PA - Allentown - MarketPro Computer Show*
TX - Abilene - ARRL West Texas Convention & Hamfest

MAY 7

CA - Livermore - Swapmeet
CA - Santa Rosa - MarketPro Computer Show*
IN - Indianapolis - AGI Computer Fair*
MN - Bemidji - Hamfest
NY - Poughkeepsie - ARRL Hamfest
NY - Yonkers - Giant Electronic Fleamarket
OH - Columbus - Computer Festival
PA - Wrightstown - ARRL Hamfest
VA - Annandale - MarketPro Computer Show*

MAY 12-13

NE - South Sioux City - Iowa State Convention & Hamboree

MAY 13

WI - Manitowoc - Lakeshore Hamfest & Swapfest

MAY 14-15

CA - Sacramento - MarketPro Computer Show*

MAY 14

CA - San Diego - MarketPro Computer Show*
MD - Hagerstown - Great Hagerstown Hamfest & Computer Show
WV - Wheeling - 18th Annual Hamfest/Computer Show

MAY 15

IN - Indianapolis - AGI Computer Fair*

MAY 19-20-21

NY - Rochester - Hamfest/Computer Show/State Conv.

MAY 20

CA - Fresno - MarketPro Computer Show*
CA - Santee - Ham Radio, Computer & Electronics Swapmeet
IN - Indianapolis - AGI Computer Fair*
KY - Paducah - ARRL Hamfest
MA - Wilmington - KGP Computer Show*
MI - Westland - Great Lakes Computer Expo & Sale
MO - Kansas City - Missouri State Convention
NJ - Belvidere - ARRL Hamfest
TX - Arlington - Calculator/Antique Instrument Convention

May 20-21

AL - Birmingham - ARRL Hamfest
OH - Cincinnati - Computer Fair
NM - Ruidoso - ARRL Hamfest
WA - Yakima - ARRL Hamfest

MAY 21

AZ - Phoenix - Computer & Electronics Swapmeet
CA - San Rafael - MarketPro Computer Show*
CA - Stockton - MarketPro Computer Show*
IA - Burlington - ARRL Hamfest
IL - Glen Ellyn - Computer Central Computer Show
IL - Peotone - ARRL Hamfest
IN - Wabash - ARRL Hamfest
MA - Cambridge - MIT Fleamarket
NY - Woodbury - ARRL Hamfest
OH - Findlay - Computer Festival

MAY 26-27-28

OK - Tulsa - Oklahoma State Convention

MAY 27-28

MD - Gaithersburg - MarketPro Computer Show*
PA - King of Prussia - MarketPro Computer Show*
WY - Casper - ARRL Hamfest

MAY 28

IL - Orland Park - Orland Park Computer Show
MD - Bowie - Hamfest

JUNE 1995

JUNE 4

CA - Livermore - Swapmeet
IL - Princeton - Hamfest & Computer Show

JUNE 9-10-11

TX - Arlington - '95 West Gulf Div ARRL Convention

JUNE 10

NC - Winston-Salem - Hamfest/Computer & Electronics Fair

MARCH 1996

MARCH 9-10-11

FL - Orlando - 50th Annual Orlando HamCation

*See Computer Show Promoter Info Box

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**READ BY 80,000 QUALIFIED ELECTRONIC BUYERS,
SELLERS AND TRADERS EVERY MONTH!**

TYPE or PRINT your "electronically related" ad copy **CLEARLY (not all caps)** on the form provided or on a separate piece of paper. Calculate the number of words and multiply it by the appropriate rate (see DETERMINING YOUR RATE PER WORD section). Include any charges for **Bold** and/or **CAPPED** words, any photo costs that would be applicable and/or costs for boxing your ad (explained below). Choose the appropriate classification for your ad(s) to appear in (see right). Enclose your name, address and account number (if available) for identification purposes. Include full payment — **CLASSIFIEDS ARE RUN ON A PRE-PAID BASIS ONLY** — and mail your completed order to:

NUTS & VOLTS MAGAZINE
430 Princeland Court
Corona, CA 91719

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.

A photo or drawing may be run at the top of your classified ad for an additional **\$10.00 (one inch max.)** for camera ready art. No wording is allowed in this area. Add a one-time charge of **\$5.00** to enlarge or reduce line art or **\$8.00** for halftone of photographs. To **BOX** your ad, include an **additional \$25** for copy-only ads **OR \$50** for ads with artwork or photos.

Words to be set in **bold** or CAPS are each **10¢** extra PER WORD. **BOLD CAPS** are **20¢** extra per word. Indicate bold words by Underlining. Words normally written in caps (e.g., IBM) and accepted abbreviations such as VAC or MHz are NOT charged as all cap words. Use a 2-letter abbreviation for states (e.g., Ohio = OH). A phone number is one word. It will be most helpful if you would spell out words when submitting handwritten copy.

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.

Select the appropriate classification for your ad(s) to appear in and mark it in the space provided below. If no classification is indicated, the ad(s) will be placed in the Miscellaneous Section or wherever we deem most suitable. Available classifications to choose from are:

- | | |
|-------------------------------|---|
| 10. Ham Gear For Sale | 115. Telephone - Fax |
| 20. Ham Gear Wanted | 120. Components |
| 30. CB - Scanners | 130. Antique Electronics |
| 40. Music & Accessories | 140. Publications |
| 50. Computer Hardware | 150. Plans - Kits - Schematics |
| 60. Computer Software | 155. Manuals - Schematics Wanted |
| 70. Computer Equipment Wanted | 160. Miscellaneous Electronics For Sale |
| 80. Test Equipment | 170. Miscellaneous Electronics Wanted |
| 85. Security | 180. Education |
| 90. Satellite Equipment | 190. Business Opportunities |
| 100. Audio - Video - Lasers | 200. Repairs - Services |
| 110. Cable TV | |

PLEASE TYPE or PRINT CLEARLY — ONE WORD PER SPACE—

AD #1 - CLASSIFICATION # _____

1. 姓名	2. 性别	3. 年龄	4. 职业
5. 籍贯	6. 民族	7. 宗教信仰	8. 婚姻状况
9. 教育程度	10. 健康状况	11. 兴趣爱好	12. 其他
13. 住址	14. 联系电话	15. 电子邮箱	16. 其他
17. 工作单位	18. 入职时间	19. 离职时间	20. 其他
21. 工资水平	22. 福利待遇	23. 工作满意度	24. 其他
25. 生活满意度	26. 社会参与	27. 志愿服务	28. 其他
29. 未来规划	30. 其他	31. 其他	32. 其他

_____ X _____ = _____ + _____ + _____ = _____ X _____ = _____	
Total Words	<input type="checkbox"/> 30% Paid Sub or <input type="checkbox"/> 60% Non Sub
Subtotal	<input type="checkbox"/> Bold/ <input type="checkbox"/> Caps and/or <input type="checkbox"/> Art/Photo
BOX IT!	<input type="checkbox"/> \$25 copy only <input type="checkbox"/> \$50 copy/art
Subtotal	No. of Issues
Total	

AD #2 — CLASSIFICATION # _____

[illegible]

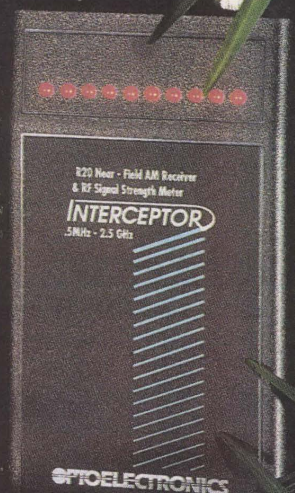
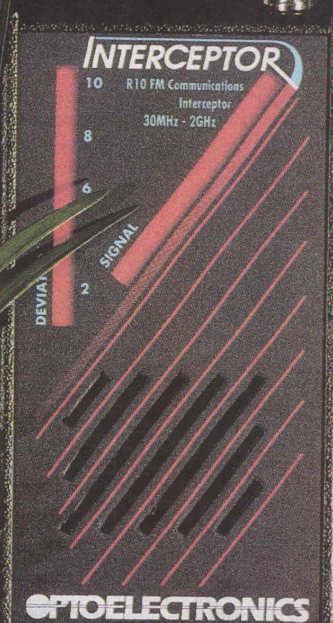
_____		×	_____	=	_____	+	_____	+	_____	=	_____	×	_____	=	_____
Total Words	<input type="checkbox"/> 30% Paid Sub or <input type="checkbox"/> 60% Non Sub		Subtotal		<input type="checkbox"/> Bold/ <input type="checkbox"/> Caps and/or <input type="checkbox"/> Art/Photo		BOX IT! <input type="checkbox"/> \$25 copy opt <input type="checkbox"/> \$50 copy/art		Subtotal		No. of Issues		Total		

Account Number _____

Total Enclosed

REMEMBER: All Ads Must Be PREPAID. \$4.50 min. per ad per insertion.
Classified ads will not be processed until payment is complete.
No refunds. Credit only.

YOU CAN'T HIDE



FROM THE INTERCEPTORS

The New and Improved Model R10 FM Communications Interceptor®

If RF security is a concern then the R10 Interceptor® may be the answer. FM signals just can't hide from the R10. It provides a shield of protection that no FM signal can penetrate without being detected.

The proprietary circuitry was developed exclusively by Optoelectronics. Thousands of customers including security professionals, radio technicians, and monitoring enthusiasts appreciate the near field capabilities of the R10.

For the first time since its introduction two years ago the R10 has been upgraded with a new high intensity bargraph LED display, a

low battery indicator and a delayed squelch. The new squelch circuit provides continuous reception of a signal during most multi-path drop outs. Now when used with our DC440 Decoder, Digital Coded Squelch codes can be checked as well as CTCSS Tones and DTMF Characters.

- Check deviation with 10KHZ (1KHZ step) or 100KHZ (10KHZ step) range.
- Check relative signal strength.
- Skip button lets R10 scan to next signal.
- Continuous 30MHz to 2GHz coverage in less than one second.
- Completely automatic with no tuning required.
- 400 foot pick up range from hand held radios. (Distance will vary with RF background.)
- Use built in speaker or earphone/headphones.

Model R20 Interceptor/Bug Detector AM Communications Interceptor®

The R20 is a compact RF signal strength detector with a 10 segment bargraph display. There is also an audio output from the detector that is processed for constant volume for use with ear phone.

The audio output is useful for room sweeps where in close proximity to a transmitter a quieting effect can be heard due to detector saturation.

Transmitters can be easily checked for output and AM modulation.

- The 10 segment LED bargraph responds to all RF signals with nominal 3dB increments
- Pocket sized with built in telescoping antenna.
- 9 Volt battery operation.
- Monitor Aircraft, CB, AM broadcast transmissions when close.
- Check Microwave oven leakage.
- Wide .5MHz - 3GHz+ frequency range.

OPTOELECTRONICS

Order Line: **1-800-327-5912** Fax **305-771-2052**

305-771-2050 • 5821 NE 14 Avenue, Fort Lauderdale, FL 33334
Visa, Master Card, C.O.D., Cash or Money Order • Shipping Charges Additional.
All specifications & prices are subject to change without notice or obligation.



R10 checks coded squelch codes with DC440 Decoder

R10 FM Communications Interceptor®.....	\$359.
R20 AM Communications Interceptor®.....	\$119.
DC440 Decoder.....	\$259.
CX12 RS-232C Interface Converter (Interface DC440 to PC).....	\$ 89.

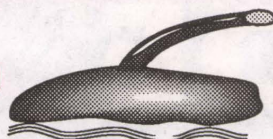
AMAZING

Electronic and Scientific Products

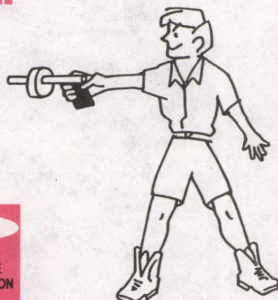
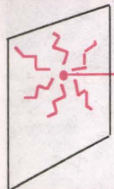
Mystery Levitating Device!

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



DANGER

INVISIBLE LASER RADIATION
AVOID EYE OR SKIN EXPOSURE
TO DIRECT OR SCATTER RADIATION
CLASS IV LASER PRODUCT

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



Shocker Force Field/Vehicle Electrifier

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!

SHK1KM Easy to Assemble Electronic Kit \$24.50

Blaster Pulser

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

Listen Thru Walls, Floors

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

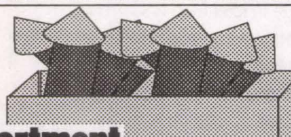
Shirt pocket size electronic device produces time variant complex shock waves of intense directional acoustic energy, capable of warding off aggressive animals, etc.

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 lite 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!

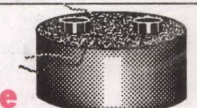
- Low Cost • Ultra-Hi Lite Amplification!
- Auto Brightness Control
- Limited Amount Available
- Made in USA • Night surveillance • Animal studies, etc.

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



3 Mile FM Wireless Microphone

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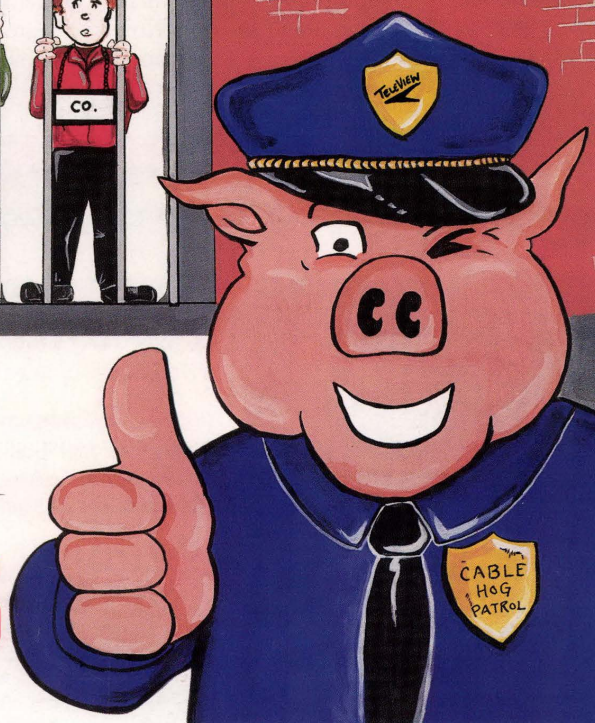
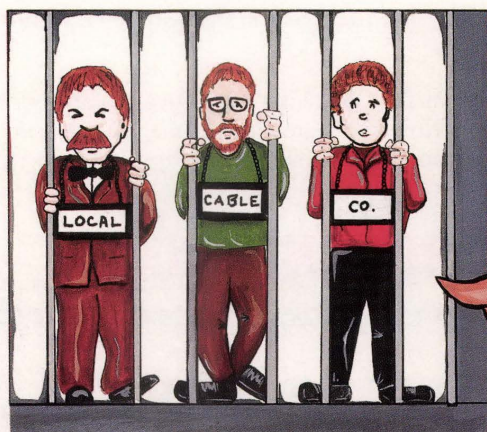
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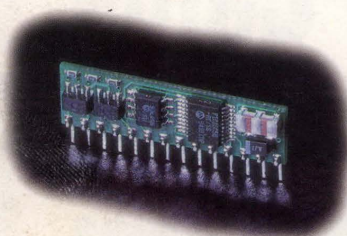
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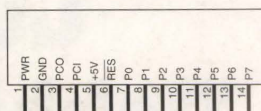
* Carrier boards provide battery clips, prototyping area, programming connector, and reset button (BS1-IC carrier shown).

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256-byte program space (100 instructions)
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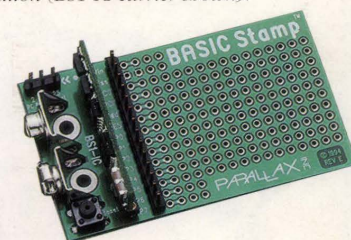
BS1-IC



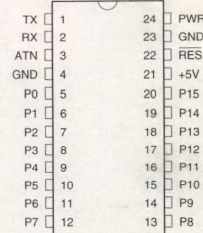
These new BASIC Stamp modules are the latest in BASIC Stamp computers. They're perfect for numerous applications, from controlling model trains to monitoring factory sensors. They have 8 or 16 I/O lines, which can be used for a variety of digital and analog purposes. And like the original BASIC Stamp, these modules are programmed in BASIC. Our special "PBASIC" language includes familiar instructions, such as GOTO, FOR...NEXT, and IF...THEN, as well as SBC instructions for serial I/O, pulse measurement, and button debounce.

The BASIC Stamp Programming Package contains everything you need to program Stamps using your PC. The package includes our editor software, programming cables, manuals, application notes, and free technical support. The package is available for \$99; Stamps must be purchased separately.

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BS2-IC



BASIC Stamp II Module (BS2-IC)

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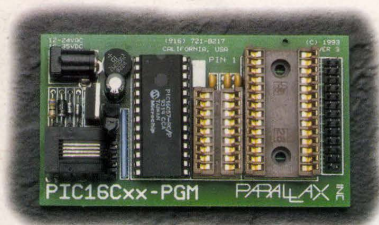
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