NUTS & VOLTS
MAGAZINE

OUR 16th YEAR

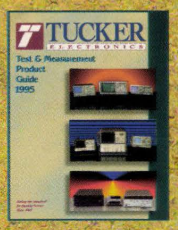
$3.50
VOL. 16 NO. 7
JULY 1995

Exploring Electronics And Technology For The Hobbyist And Professional

ATMOSPHERIC RADIO REFRACTION
FROM HEADACHES TO WORLD RECORDS

- Servo Spinal Tap Makes Your Projects Move
- Introduction to Stepper Motors
- Conquering Data Sheet Block
- Goodyear's Super Skytacular Night Sign
- Frequency Standards

Think of it as the Test Instrument Encyclopedia!



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The Most Practical, Compact, Inexpensive DMMs Available

B&K Precision Tool Kit Series

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Measure voltage, resistance, current and lots more! 0.5% DC accuracy.

New Tool Kit™ DMMs from B&K PRECISION are the industry's best values for performance, features and dependability. Compare these ruggedized testers with all comers— at up to twice the price. You'll be sold on the Tool Kit.

All four Tool Kit™ DMMs measure DC current to 10 Amps, have large 3½ digit LCD readouts, and a continuity beeper. The Model 2704A adds AC current, capacitance and transistor tests. The Model 2706 adds temperature measurement. The Model 2707 is like a 2704A with frequency counting and logic probe functions.

Model	2703A	2704A	2706	2707
DCV	●	●	●	●
RES	●	●	●	●
CAP		●	●	●
FREQ				●
LOGIC				●
PRICE	$39	$59	$79	$89

Free UHF Probe "T" Connector

20 Hz to 700 MHz, 300 VAC

Tucker PRE-OWNED Quality

Hickok 1605M Electronic Multimeter $169

- Measures a wide range of AC voltage, DC voltage, current and resistance
- AC voltage can be measured from 0.5 to 300 V rms from 20 Hz to 700 MHz
- DC voltmeter range is from 0 to ±1500 V, accuracy: ±2% of full scale value at any point on the scale
- DC current range 0 to 150 mA with special ranges of ±1.5, 5 and 15 nA (using the DC voltmeter probe)
- Resistance measurements can be made from <1 Ω to >500 MΩ
- Similar to HP 410C
- For a limited time, receive a free UHF Probe "T" Connector which allows AC probe to be connected to signal path

AC or Battery Operation

Hewlett Packard 204C 5 Hz-12 MHz Oscillator $249

Tucker PRE-OWNED Quality

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 1.2 MHz in 6 overlapping ranges with a flatness of ±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.

An Incredible Deal . . . A Complete System, A New CRT, and A New Low Price!

Hewlett Packard 141T/8552B Plus RF Plug-In of Your Choice!

Tucker PRE-OWNED Quality

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Brand New CRT & 1 Year Warranty!

With 8555A RF Section . . . $2495

- Frequency Range: 0.01-18.0 GHz (w/internal mixer), 12.4-40.0 GHz (w/external mixer)
- Scan Width: 16 calibrated scan widths from 2 kHz/div to 200 MHz/div in a 2, 5, 10 sequence
- Bandwidth Range: selectable 3 dB bandwidths from 100 Hz to 300 kHz in a 1, 3, 10 sequence
- Measurement Range: -60 dBm to +10 dBm (Log ref. level); 0.1 µV/div to 100 mV/div (Linear sensitivity)

With 8553B RF Section . . . $1995

- Frequency Range: 1 kHz to 110 MHz
- Scan Width: 18 calibrated scan widths from 20 Hz/div to 10 MHz/div in a 1,2, 5 sequence
- Bandwidth Range: selectable 3 dB bandwidths from 10 Hz to 300 kHz in a 1, 3, 10 sequence
- Measurement Range: -130 dBm to +10 dBm (Log ref. level); 0.1 µV/div to 100 mV/div (Linear sensitivity)

All Test Instruments Include Manuals and are Completely Operational Unless Otherwise Stated.

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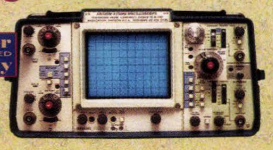
Tektronix 465M 100 MHz Portable Oscilloscope $695

Why Pay Over $1200 For A New 50 MHz Or 60 MHz Dual Trace Oscilloscope, When You Can Own A Tektronix 100 MHz Scope For Only $695?



Tucker PRE-OWNED Quality

Here's your chance to own a version of one of the most popular oscilloscopes Tektronix ever made and at a price that everyone can afford! Tektronix built these instruments rugged, with ease of serviceability in mind. The 465M is a solid-state, dual channel, 100 MHz, delayed sweep, general purpose oscilloscope. Each of the two channels have a vertical range from 5 mV/div to 5 V/div (10 calibrated steps). The horizontal system ranges from 0.05 µS/div to 0.5 S/div (22 calibrated steps) and delayed sweeps rates of 0.05 µS/div to 50 mS/div (19 calibrated steps). An X10 magnifier expands each horizontal sweep rate to a maximum of 5 nS/div An X-Y display mode is provided through vertical mode and horizontal sweep speed selection. Includes probes and manual. Ease-of-use, functionality, reliability, and ruggedness, this scope will provide years of service, so order your 465M today!

Universal TPI P600S

X1/X10 Switchable Probe . . . $19.95

FACTORY NEW

Brand new with accessories and data sheet.
Durable and comfortable in your hand. Very reliable.

	X10 Position	X1 Position
Bandwidth:	60 MHz	6 MHz
Rise time:	5.5 nS	50 nS
Compensation range:	15 to 35 pF	
Input resistance:	10 MΩ	1 MΩ
Input capacitance:	18 pF	100 pF
Max. input voltage:	600 VDC	200 VDC

10 to 480 MHz

Hewlett Packard 608E Signal Generator $279

Tucker PRE-OWNED Quality

The HP 608E provides high-quality, versatile performance with distinctive ease of operation. Offers an adjustable, calibrated output of 0.1 µV to 1 V rms from 10 to 480 MHz. 0 to 95% AM, +CW or Pulse modulation. Basic accuracy of ±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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- Low-profile case for 5.25" drives
- Perfect for lower-power drives
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- 50-pin SCSI daisy-chain connectors
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- Uses External 15-16VDC, 1-2A Supply (Not Included)
- Internal Regulator board can deliver +5, +12 @ 1.5A

HSC# 15245 Low-Profile 5.25" Drive Case $17.95

Computer Parts Specials!

A. Western Digital WD1003V-MM1 MFM Disk Controller
- New in box with inst. 16-Bit, No Floppy controller.

HSC# 15362 $9.95

B. Miniscribe 8425 Hard Disk -- MFM 21 MB 5.25" HH
- Four Heads, 615 Cyls, 17 Sectors, New, 90-days

HSC#15354 $17.50

C. 3.5" Floppy Drive Adapter Bracket for 5.25" bay
- Includes hardware, faceplate, connector adapters

HSC# 15124 $1.95

Connect with LapLink!

- LapLink Release III by Traveling Software
- Links two computers via Serial or Parallel Ports
- Transfer Data at 200K to 500KBPS
- Complete Universal SIO/PIO Cable Set included
- Full Documentation
- 3.5" & 5.25" Versions Included

HSC# 15361 $19.95

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 $.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

Multimedia Speakers

- Two styles to choose from, both new in OEM box
- White plastic enclosures, grey grilles
- MSS-1000 has Volume control, Bass boost switch, uses 3 C-cells per side, measures 3.5" x 3.5" x 5"
- MSS-2000 has Volume control, Bass & Treble boost switches, uses 2 C-cells / side, measures 3.75" x 4" x 6"

MSS-1000 HSC# 15127 Pair/ $6.95

MSS-2000 HSC# 15126 Pair/ $8.95

Serial Smartswitch

- Two computers can share one serial printer or plotter
- Automatically detects and switches to active line
- User-selectable Auto form-feed ensures each print job starts on new page
- Printer-ready light shows status at a glance
- X-on / X-off light show print job status
- External power supply, instructions included
- New in box, 90-day warranty

HSC# 15449 $19.95

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:

HSC# 15218 Yellow, HSC# 15219 White
HSC# 15221 Green, HSC# 15222 Red
Your Choice $1.95 ea.

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

Tektronix Test Equip.

- Previously-owned, tested Tektronix Scopes & Plug-ins
- In-stock items as of press time, call for current selection
- Mainframes:

7603	100MHz 3-bay	$195
7704A	200MHz 4-Bay	$325
7834	400MHz Storage 4-Bay	$800
7844	400MHz Dual Beam 4-bay	$695

- Vertical Amplifier Plug-ins:

7A13	150MHz Differential Comp.	$400
7A16A	225MHz 5mV-5V Single Trace	$100
7A24	350MHz 5mV-1V Dual Trace	$400
7A26	200MHz 5mV-5V Dual Trace	$175
7A29	1GHz 10mV-1V Single Trace	$625

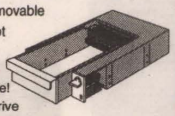
- Timebase Plug-ins:

7B10	2nS-.2S 1GHz Triggering	$325
7B15	2nS-.2S Delaying, Delta-T	$350
7B71	2nS-5S Delaying, x1, x10	$125
7B85	1nS-5S Delaying, x1, x10	$250
7B92A	.5nS-.2S Dual, Delay	$300

- Miscellaneous Plug-ins:

7D11	100nS-1S Digital Delay	$195
7D13A	3.5 Digit DMM, CRT R/O	$125
7D15	225MHz Universal Counter, R/O	$275
7T11	0pS-5mS Sampling Sweep Unit	$750

IDE Docking Bay



- Makes 3.5" IDE Drives removable
- Fits in 5.25" half-height slot
- Plastic construction
- Remove drive for security
- New in box, New Low Price!
- Power interlock protects drive
- Includes data & power connections

HSC# 15304 $29.95

Network Card Bargain!

- Racal Interlan 16-Bit Ethernet Cards
- High Quality Dual Interface, 10-Base-T or Coax
- Manual, Software, BNC tee included
- NE2100 Compatible, NI6510 Compatible
- Handy 5-pack contains 5 cards, 1 Manual and 2-disk software pack)

HSC# 15364 $149.95 / 5pk.

- Other Network Cards Avail. -- Call for details

CD/ROM Specials!

- Tested Good CD/ROM Drives removed from systems
- 90-Day Warranty
- 2x and 3x Speeds available
- NEC Drives are standard SCSI 50-pin interface
- Phillips drives are proprietary 16-pin interface

Phillips CM-206 2X-Drive HSC#15366 $49.95

NEC CDR-55JD 2X-Drive HSC# 15386 $99.00

NEC CDR-510 3X-Drive HSC# 15327 $139.95

Computer Case Close-out!

- Mini Tower Case (no power supply) 16.25" x 6.75" x 13.25"
- Hardware kit, stand, One 5.25" bay, two 3.5" bays

-or-

- Baby-AT style Desktop Case, 16.5" x 17" x 6.75"
- Hardware kit, 200W Power Supply, three 5.25 bays, two 3.5" bays. Both cases are new with 90 day warranty.

Mini-Tower Case HSC# 15356 $19.95

Baby-AT Style Case HSC# 15355 $34.95

Trackball for Mac!

- Mouse Systems A³ Trackball for ADB-type Mac's
- "Three-button Power Control Panel" Software
- High Resolution (680 dpr) for smooth, fingertip operation
- 100% A/UX, MacX, X Window and Mac OS compatible
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- Reassignable buttons for left- or right-handed use
- New in box with software, 90-day warranty

HSC# 15432 $27.50

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- "Baby AT" Size 386DX-33 Motherboard, no CPU
- 64K Cache included, SIMM Sockets for 8 modules
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- Chips & Technology Chipset, Co-processor Socket
- New in Box, with Book, 90-day Warranty
- Two speeds of CPU chips available

HSC# 15359 386DX Motherboard $24.95
HSC# 15375 386DX-25 CPU w/ 50MHz Osc. $19.95
HSC# 80357 386DX-33 CPU (Limited Avail.) $29.95

HiFi Speaker Special!

- 40W Max, 20W RMS Woofer, 4Ω
- 5.5" dia. mounting, 1.7 lb. overall weight
- Black Injection-molded Graphite Cone
- Foam Suspension, Plastic Trim Ring
- Two-way Crossover Network with connection panel from same speaker system, freq. unknown

5.5" Woofer, new HSC# 15295 $9.95

Crossover, new HSC# 15296 $3.95

Digital Bathroom Scale

- General Electric Model EDS1B3 Digital Bathroom Scale
- Weighs from 25 to 299 lbs.
- LED Readout, attractive beige case
- Requires 9V Battery (Not Included)
- Strain-gauge transducer and readout unit should be useful for many electronic "Hacker" applications
- Easily adjustable offset for calibration

HSC# 15336 $12.50

Tiny Trackball for DOS!

- Mouse Systems NewPoint Trackball for DOS/Windows
- Portable Trackball for the Laptop on the go!
- High Resolution in a small package
- 100% DOS and Windows compatible
- Mini-trackball with two buttons, ergonomic shape
- Clamps to keyboard, comes with padded carrying case
- New in box with software, 90-day warranty

HSC# 15433 $19.95

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- 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

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

Easy File Transfers!

- SmartSync Software by Nomadic Systems
- Provides easy way to keep multiple computers in synch
- Fast and efficient, transfers only the changes
- Works with modems, cables or diskettes
- Automatically updates multiple files, single and multi-user
- Prevents accidental overwrites, can remotely copy

HSC# 15305 $19.95

Total Communication!

- National Semi Ty-IN 2000 Voice / Fax / Data Modem
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- CCITT Group III Fax @ 9600bps, 2400bps data modem
- Digital Voicemail, Voice Compression, Unlimited Mailboxes
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- Software Upgradeable, New in Box, 90-day Warranty
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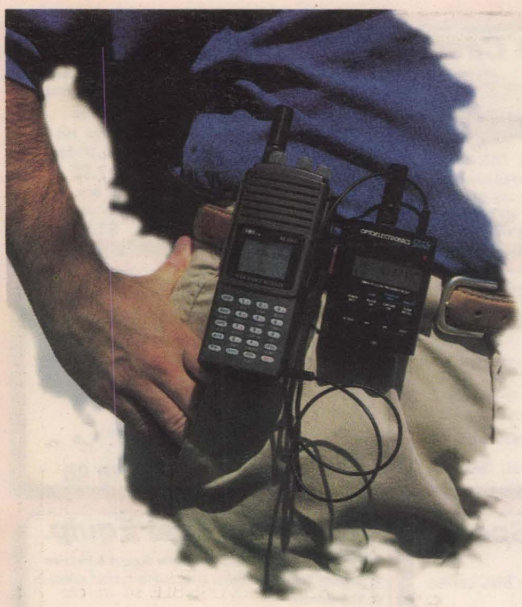

You Won't Miss a Thing With SCOUT™ Reaction Tune

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The SCOUT™ Has Taken Tuning Your Receiver To a New Dimension

Featuring Automatic Tuning of your AR8000 and AR2700 with the Optoelectronics Exclusive, Reaction Tune (Pat.Pend). Any frequency captured by the Scout will instantly tune the receiver. Imagine the possibilities! End the frustration of seeing two-way communications without being able to pick up the frequency on your portable scanner. Attach the Scout and AR8000/2700 to your belt and capture up to 400 frequencies and 255 hits per frequency. Or mount the Scout and AR8000/2700 in your car and cruise your way into the future of scanning. A simple interface cable will connect you to a whole new dimension of scanning.

The Scout's unique Memory Tune (Pat.Pend.) feature allows you to capture frequencies, log into memory and tune your AR8000/2700 at a later time. A distinctive double beep will inform you when the Scout has captured a new frequency, while a single beep indicates a frequency that has already been recorded. For discreet monitoring, a pager style vibrator will inform you of any hits the Scout captures.

The Scout will also Reaction Tune and Memory Tune Icom CI-V receivers: (R7000, R7100, and R9000) and (Pro 2005/6 equipped with OS456, Pro 2035 equipped with OS535). Download the Scout frequencies to a PC with the Scout Utility Disk and CX-12AR (optional), then compare them to the Spectum CD-ROM/PerCon FCC Database (optional).

Act Now!! Let the Scout Reaction Tune you into The World of Scanning

SCOUT™ $449

Features

- Automatically tunes these receivers with Reaction Tune (Pat.Pend.) CI-V receivers (ICOM's R7000, R7100, and R9000), (Pro 2005/2006 equipped with OS456, Pro 2035 equipped with OS535) or AOR models (AR2700 and AR8000).
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- Records 255 hits on each frequency in memory
- Digital Filter and AutoCapture (Pat.Pend.)
- 10MHz-1.4GHz single frequency range
- View frequencies in RECALL mode
- 10 digit LCD with EL Backlight
- 16 Segment RF signal strength bargraph
- CX-12AR Computer Interface (optional)
- PC Utility Disk for downloading memory to PC
- Rapid charge NiCads with 10 hour discharge time
- Scout Spectrum CD-ROM/PerCon FCC database (optional)
- AC Adaptor/Charger
- DB 32 VHF/UHF mini-antenna shown with Scout (optional)
- Distinctive Beeper/Vibrator indicate frequency hits

At right: Scout shown with CLIPMATE™. A handy windshield mount for Scout, for quick access and visibility.

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Publisher
Jack Lemieux
N6ZTD

—

Editor
Larry Lemieux
KD6UWV

—

Managing Editor
Robin Lukasik
KD6UWS

—

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Call or write for current advertising rates.

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reader FeedBack

Dear Don Lancaster:

My colleagues and I were very pleased to read your May 1995 *Nuts & Volts* Resource Bin "New Opportunities in Home Automation." We've been following the trends in home automation for the better part of the last decade and have encouraged the hobbyist and amateur electronic engineer to experiment and create projects for computer control of home electronics. We're pleased that your fine magazine is taking a greater interest in the field as it is a great resource for anyone interested in electronic applications.

Thank you for making mention of **CompCo Engineering, Inc.**, in the article. This type of exposure is most welcome. Through my oversight, our zip code was incorrect. To update your records, our true address is *611 Parkway Suite D-4, Gatlinburg, TN 37738.*

I'd like to address some of your comments from the article.

Noise and filters interfering with X-10. It is true that some devices and appliances create noise in the powerline's command frequencies, interfering with normal operation. Those devices with noise filters built in do tend to shut out control, as well. Now the good news. Noisy devices *whether they have a filter of their own or not* can be plugged through an X-10 filter to the powerline to quench their noise without interfering with normal X-10 operation. The X-10 filter is manufactured by Advanced Control Technologies (ACT) and the model number is AF100. It retails for about $29.00.

Phase legs, distance problems, and user conflicts. To transmit X-10 signals down long powerline distances or across 110 volt legs, two options are available to help. The more economical booster module strengthens the X-10 signals and bridges 110 volt legs. Both Leviton and ACT manufacture a passive bridge. The Leviton model number is 6299 and runs about $40.00 retail. For about the same cost, ACT's model number is CP000. For better performance, ACT manufactures an active bridge which not only bridges the 110 volt legs, but also boosts and repeats X-10 signals from one circuit to the next. The ACT model number is CR230 and retails for about $200.00 retail.

To isolate your X-10 signals from the neighbors, use a different house code. While this does limit the total number of house/unit code combinations available (maximum of 256 to begin with) it's the easy way to avoid conflicts.

In all truth, we've never experienced conflicts with other X-10 users. Some areas just don't have many X-10 users close by or in rural/suburban areas the houses are far enough apart so that the signals don't make it that far anyway. (Is that something good about the X-10 distance limit?) The only conflict problems arise within the same building, like an apartment complex, and individual house codes can be set. Even in the X-10 saturated environment at Habitech 95, different companies found ways to get along and still have their demonstrations work without conflicts. If more protection is needed or all 16 house codes must remain available, a circuit isolator is available. The isolator prevents X-10 signals from leaving a circuit and prevents outside signals from entering. It is installed in the circuit breaker box, is manufactured by ACT (model number CP303) and retails for about $95.00.

Two-way communication. We agree with you that the new spread-spectrum carrier technology will revolutionize the industry, especially with its promised two-way communication, but there is no reason to throw the baby out with the bath water. X-10 is very widely spread and no one wants to throw away their investment for the "latest and greatest." At last report CEBus and X-10 can get along and work on the same powerline, so upgrades can be gradual and affordable rather than all-or-nothing.

CompCo's R&D is researching a CEBus add-on for our modules to prepare for the eventual revolution, however, our main area of research is pushing the limits of X-10 back much, much further. After over a decade of BSR, there is still an uncharted frontier to be explored and CompCo is leading the way with ***two-way closed-loop*** X-10 communication with ***command verification*** through ***acknowledgment response*** and ***polling/reporting.*** While our R&D policies prohibit me from being more specific, expect a line of affordable X-10 compatible products which combine the "control from anywhere" power of X-10 with the "many commands available" ability of IR and use the above two-way protocols.

In all fairness to X-10, some two-way ability exists right now and can be used in a limited fashion. The TW-523 Two-Way Powerline Module (the standard black-box gateway to X-10) has an extended command set including a *request status* command which instructs certain modules to send a *status report*, transmitting whether they are on or off. The only modules we know of which will respond and transmit their status are the wireless transceivers (you can identify these because they have a telescoping antenna on the side). The Radio Shack catalog numbers are 61-2675 and 61-2663R. The reason that these modules can report is because they have a powerline transmitter built-in, which is necessary for them to send X-10 commands in response to the wireless RF commands they receive from a pendant or remote. Since these modules transmit anyway, X-10 activated their reporting commands, as well. If anyone knows of other modules or products which support the two-way protocols, we'd be pleased to hear about them.

Continued on page 135

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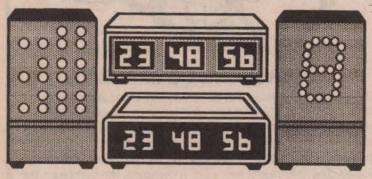

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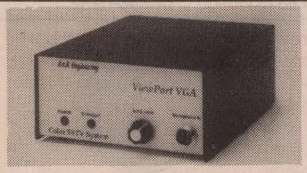

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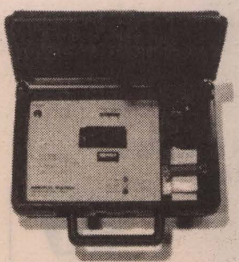

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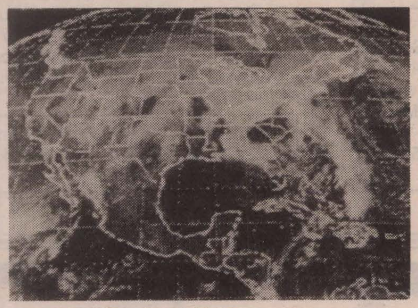

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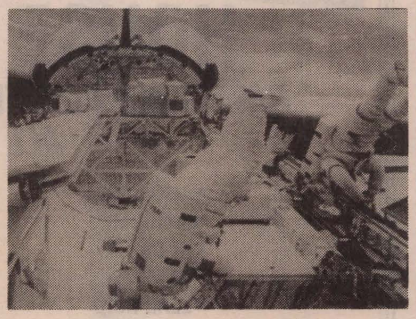

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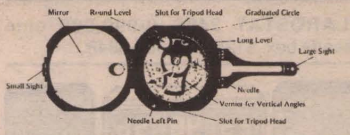

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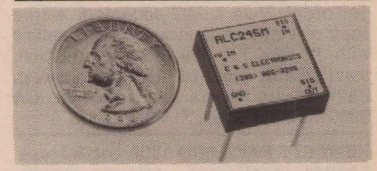

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Radio Science Observing

Open Channel

by Joseph J. Carr
K4IPV

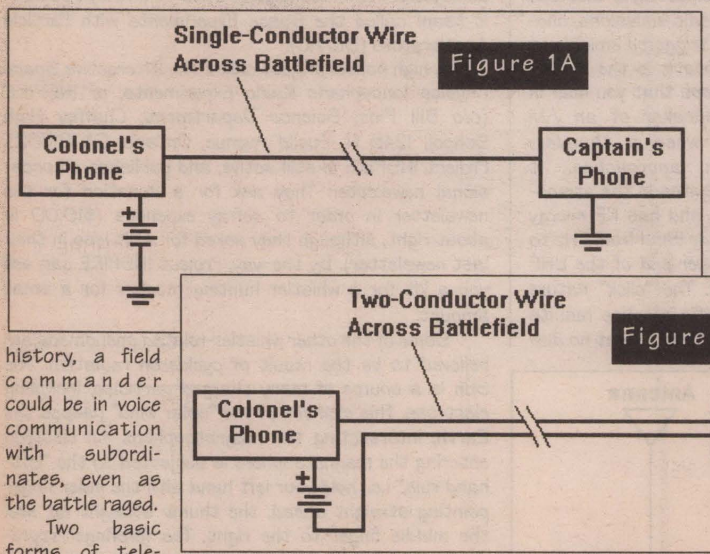
In the first installment of the newly revised Open Channel column, I covered amateur radio astronomy; the response was quite satisfying — a number of very positive letters were received. This month, we are going to look at additional ways that you can use your radio receiver, or one that you build, to do natural science observations.

It seems that Nature makes its own radio "transmissions" and you can easily observe most of them using receiving equipment that you already own (eepecially if your general coverage or ham radio receiver tunes down into the VLF region). Most modern receivers will tune down to 30 KHz or 50 KHz, even if the performance in those bands is not as good as it is in the high-frequency (HF) shortwave bands.

Alternatively, you can also build very simple radio very low-frequency (VLF) radio receivers — not big, honkin' superheterodynes, but simple tuned radio frequency jobs with but a few transistor or IC stages. Anyone who can build an audio amplifier on Radio Shack hobby printed circuit boards can easily build one of these VLF receivers. But more on that later.

Background

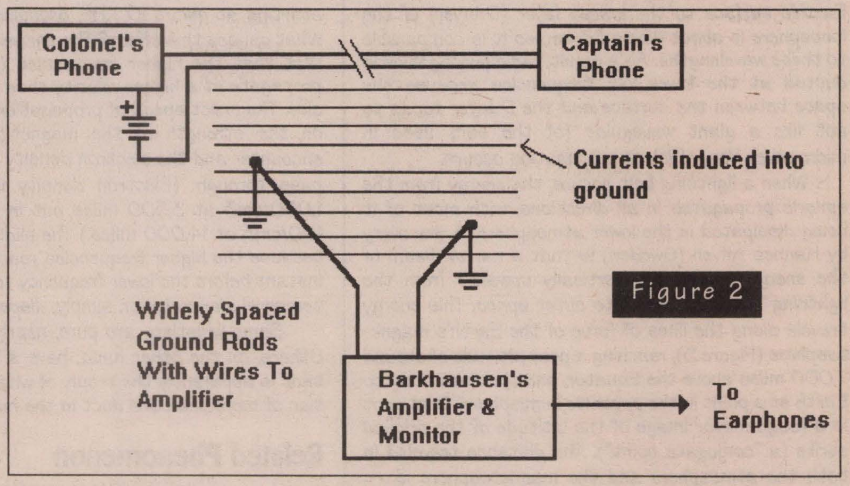
When World War I erupted in Europe telephone technology was already quite mature, even though it was primitive by our modern standards. Long distance networks existed in both North America and Europe, although trans-Atlantic service was still in the future. (Trivia question: When was the first trans-Atlantic telephone cable laid? See end of article.) When the war broke out, both sides made extensive use of telephone communications on the battlefield. For the first time in history, a field commander could be in voice communication with subordinates, even as the battle raged.



Two basic forms of telephone circuit were tried. The simplest (Figure 1A) required laying a single conductor wire from one point to another. Large reels of wire were carried by two soldiers, dodging sniper fire, shell explosions, and the rest of the tender mercies that the enemy could visit on them (it must have been a dicey job!). The return circuit was the ground. One side of each telephone (and its power supply) was connected to a ground rod shoved into the earth.

The second, and probably most common, form was the two-wire version shown in Figure 1B. Neither side of either telephone is grounded; the return circuit is carried in a second conductor. The wire was usually a "twisted pair" — a form of communications wire that's still used in some cases.

Any electronic advance in warfare is met with an electronic counter measure (ECM). During World War I, German physicist Heinrich Barkhausen, who later worked out the principles of oscillator operation, theorized that he could pick up Allied field telephones by detecting leakage and induced currents from the telephones in the ground. Vacuum tubes were available by then, so he used a high gain vacuum tube audio am-plifier connected through long wires to ground stakes driven into the earth, and spaced a very wide distance apart. This method also worked today, but there are easier ways to detect whistlers and related phenomena.



Barkhausen was successful in detecting Allied telephone conversations, and continuous monitoring was initiated. At times, however, the operators reported strange whistles, howls, and other sounds that interrupted spying on the enemy's conversations. Initially, Barkhausen thought it was an amplifier defect, but he could not duplicate it in the laboratory. One of the most common sounds was the "whistler" (i.e., an audio pitch) that starts at about 10 KHz and then descends to frequencies down to about 1 KHz. The time re-quired may be a few hundred milliseconds to several seconds.

Although the whistler is in the "audio" range where humans can hear, you cannot hear a whistler without a radio receiver tuned to those frequencies. The reason is that your ear responds to acoustical waves, i.e., vibrations in the air, while whistlers and related phenomena are electromagnetic, i.e., radio waves.

Similar sounds had been heard as early as the 1880s. When long telephone lines began to web the cities together, operators and users would occasionally report descending pitch howls similar to those that Barkhausen later observed. Unfortunately, nothing was done about it at the time.

Barkhausen theorized that the whistler phenomenon was atmospheric. Researchers in the 1920s and 1930s recognized that many whistlers were preceded by a click. If, as theorized, the whistler was due to lightning bolts, as suggested by T.L. Eckersley in 1935, then there was a "wee little problem" as my scottish ancestors might say. The time differential between the click and the whistler suggested distances up to 15,000 miles, even when the lightning could be correlated to local storms. If the click indeed resulted from a lightning bolt (i.e., "static"), then it couldn't be so far away because the energy would be absorbed in the lower atmosphere, and would therefore be so attenuated by a 15,000 mile trip that it would be too far down in the noise to be detected.

Another phenomenon noted by L.R.O. Storey in the 1950s was that storms less than 600 miles from his monitoring site usually made whistlers, and with storms in the 600 to 1,200 mile range the whistlers became steadily weaker. To discover how these are related, let's look at the RF nature of lightning.

Lightning

Lightning results when differences in electrical potential in the atmosphere become high enough to overcome the dielectric strength of the atmosphere. Although normally associated with thunderstorms, lightning without thunderstorms also exists. These magnificent bolts of lightning are basically a natural electrical arc with potentials on the order of 250,000,000 volts, and currents up to 250,000 amperes. Lightning is not one bolt from A to B, but rather it oscillates back and forth between A and B.

As with all electrical arcs, the bolt of lightning produces a huge amount of radio frequency (RF) energy that can interfere with radio reception. That RF ranges from 1 Hz to the upper VHF or lower UHF region, but most of it is concentrated in the 1 to 30 KHz region

(with peaks between 2 and 7 KHz). RF events resulting from lightning strikes are called "atmospherics" or just plain "spherics."

You can hear this lightning generated RF energy on radio receivers. Nearly all of us have heard lightning crashes on AM broadcast band receivers. If you have an LF or VLF receiver, then the crashes are even louder, but on the HF bands they drop off in intensity as the frequency gets higher.

But still, the mystery of the 15,000 mile propagation, which had good evidence in support of it, still remained. The answer comes from noting the nature of spherics and their propagation.

In the VLF region, wavelengths are long. For example, at 30 KHz, the wavelength (300,000/30 KHz) is 10,000 meters, or 10 kilometers. At 1 KHz, that wavelength is on the order of 300,000 meters, or 300 km. Radio signals with wavelengths ranging from 10 to 300 km behave very differently from the shorter wavelengths of higher frequencies. The distance from the Earth's surface to the lowest layer (D-layer) of the ionosphere is about 45 to 85 km, so it is comparable to these wavelengths. As a result, radio propagation is ducted at the lower VLF frequencies because the space between the surface and the D-layer tends to act like a giant waveguide (of the sort used in microwave). Very efficient propagation occurs.

When a lightning bolt occurs, the energy from the spheric propagates in all directions, with most of it being dissipated in the lower atmosphere. A discovery by Hannes Alfven (Sweden) is that a narrow beam of the energy propagates vertically upwards from the lightning bolt, and then into outer space. This energy travels along the lines of force of the Earth's magnetosphere (Figure 3), reaching a peak altitude of around 7,000 miles above the Equator, and then returning to Earth at a point in the opposite hemisphere. That spot is a rough mirror image of the latitude of the original strike (a "conjugate point"). The distance traveled in both the atmosphere and the magnetosphere is — hold your hat — about 15,000 miles. During this trip, the higher frequencies travel faster than the lower frequencies; an important point it turns out.

Recall that some whistlers are observed with a click preceding the characteristic descending tone, while some are not. It is believed that the "clickless" whistlers traverse the magnetosphere in only one direction. The original click was the bolt of RF energy produced by the lightning (i.e., a "static" click), but it was absorbed in the lower atmosphere so did not propagate all the way to the opposite hemisphere.

The whistlers preceded by a click, on the other hand, made a two-way trip. They originated in the same hemisphere where they were observed, and then traversed the magnetosphere to the approximate conjugate point in the opposite hemisphere. The wave was then reflected back along the same magnetic line of force, and traveled back to a point within about 1,200 miles of its point of origin. Some whistlers produce multiple "trains" of echos, indicating multiple bounces.

What Causes the Sliding Tone?

The whistler sound is a descending sliding tone starting at about 10 KHz, dropping to about 1 KHz. What causes this effect? The answer is apparently the fact that the higher frequencies (close to 10 KHz) propagate at a higher velocity than the lower frequencies. The exact speed of propagation depends, in part, on the strength of the magnetic field that they encounter and the electron density of the region they pass through. (Electron density is typically about 1,000/cm3 at 3,500 miles out in space, and about 100/cm3 at 14,000 miles.) The sliding tone is caused because the higher frequencies reach your receiver an instant before the lower frequency tones. This is called *temporal dispersion* or, simply, *dispersion*.

Some whistlers are pure, nearly sinewave, tones. Others, on the other hand, have a "swish-like" sound that is apparently the result of whistler-mode excitation of more than one duct in the magnetosphere.

Related Phenomenon

Whistlers are not the only phenomenon found in the VLF radio bands; others include hiss, discrete emissions ("fallers," "risers"), periodic emissions, chorus, quasi-periodic emissions, and triggered emissions.

Static is the bursts and pops that you hear in the speaker of an AM radio when a thunderstorm approaches. It propagates in the atmosphere, and has RF energy in a wide band from 1 Hz to the lower end of the UHF region. The "click" nature of static crashes results from the fact that no dispersion of the frequencies takes place.

The hiss phenomenon is pretty much like it sounds from the phonetics: it is a hiss like that on the FM band between stations. Unlike Gaussian noise, the VLF hiss is bandwidth limited. The appearance of hiss is occasional, and it may be either unstable and fluctuating, or appear to be stable for periods up to several hours.

Tweeks are spherics in the atmosphere below the ionosphere. They are subjected to dispersive distortion, producing a descending tone on the order of 25 to 150 milliseconds (as opposed to hundreds of milliseconds to several seconds for whistlers). Tweeks are generally best heard during the winter and early spring at night.

Hooks are whistler-like sounds that descend in frequency, and then do a reversal and begin to rise a short distance to a higher frequency. Risers increase in tone, not decrease.

The Dawn Chorus can consist of risers, hooks, hiss, and other phenomena, usually prior to sun-up. The Dawn Chorus is most likely to occur following geomagnetic storms.

The triggered emissions include the natural versions (whistlers triggered by lightning), and *Artificially Stimulated Emissions* (ASE). Nuclear explosions can trigger such events, but they can also be triggered by less drastic things. For example, in the 1950s, high powered military and naval VLF radio stations were found to be stimulating emissions.

An ASE research project in the 1970s and 1980s studied the effect. A powerful VLF transmitter was placed at Siple Station in Antarctica, and a monitoring station was placed at a magnetic conjugate point near Roverval, Quebec, in Canada. They also had satellite monitors operating within the Earth's magnetosphere.

There has even been school and amateur monitoring of both natural and ASE phenomenon. In early 1992, the NASA launched the Atmospheric Laboratory for Applications and Science (ATLAS II). It deployed a VLF modulated (50 Hz to 7 KHz) electronic beam called the Space Experiments with Particle Accelerators (SEPAC).

A high school project called the INteractive Space Physics Ionospheric Radio Experiments, or INSPIRE (c/o Bill Pine, Science Department, Chaffey High School, 1245 N. Euclid Avenue, Ontario, CA 91762). Project INSPIRE is still active, and publishes an occasional newsletter. They ask for a donation for the newsletter in order to defray expenses ($10.00 is about right, although they asked for a bit less in their last newsletter). By the way, Project INSPIRE can sell you a kit for a whistler hunting receiver for a small amount.

Some of the other whistler-related phenomena are believed to be the result of cyclotron radiation. The Sun is a source of many charged particles, including electrons. This element of the "solar wind" passes the Earth, intersecting the magnetosphere. An electron entering the magnetosphere is subjected to the "left-hand rule," i.e., hold your left hand with the index finger pointing straight ahead, the thumb straight up, and the middle finger to the right. The forefinger represents the direction of the magnetic field, while the

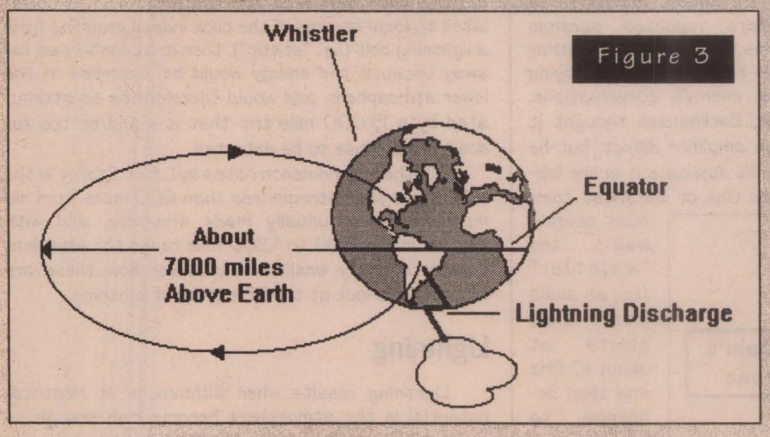


Figure 3

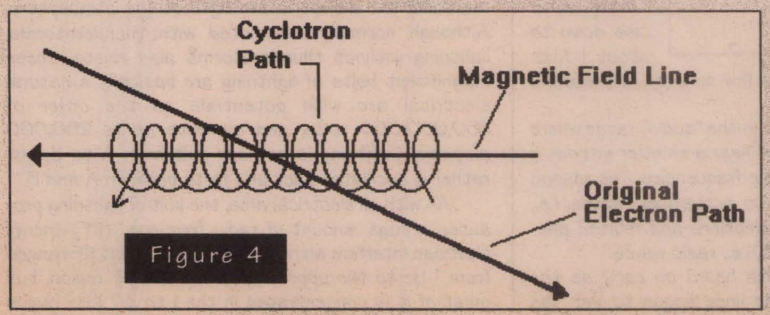


Figure 4

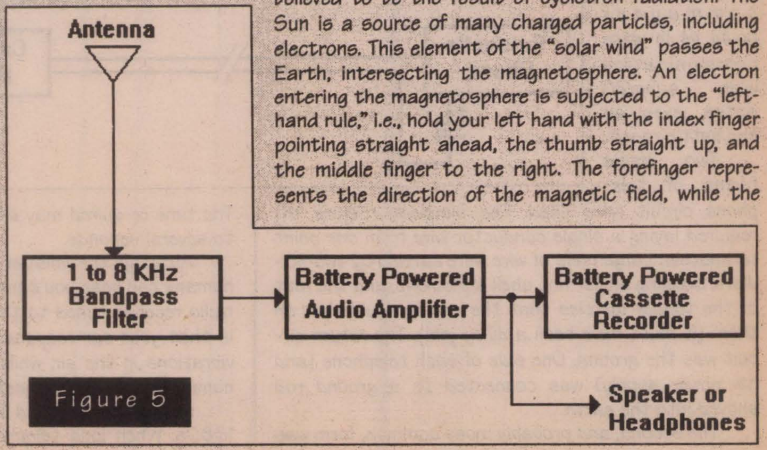


Figure 5

middle finger represents the original direction of the electron travel. The electron entering the magnetic field feels a force pushing it in the direction of the thumb. The particle thus pushed, thus spins around the magnetic line of force in a helical motion (Figure 4) that may be the source of some of the strange VLF emissions.

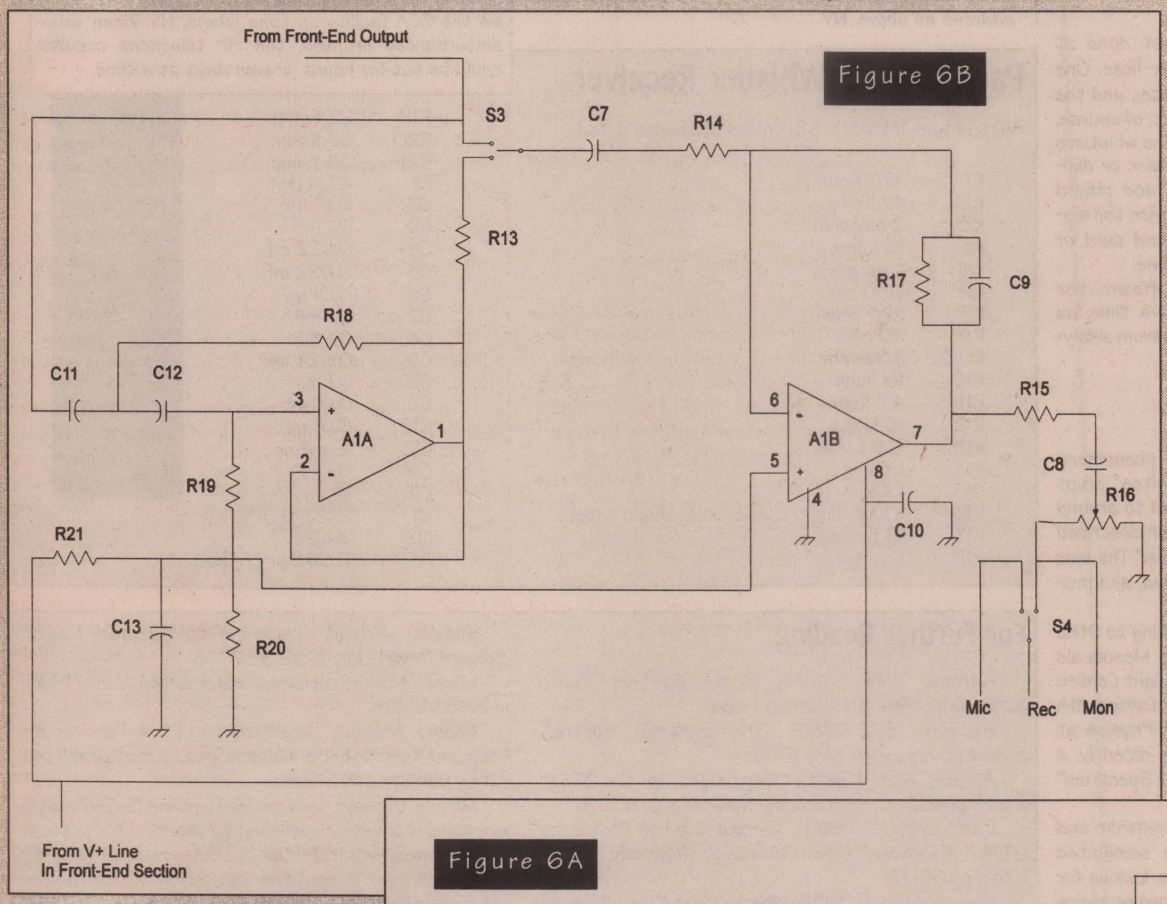
sinewave, but is distorted. That means lots of harmonics way up into the VLF region of the radio spectrum. Although some experimentation has been done to use comb filters to notch out the harmonics of 60 Hz, the best solution seems to be using a high-pass filter with a 1 KHz cut-off frequency, and a low-pass filter with a 7-8 KHz cut-off frequency ahead of the amplifier (Figure 5). The low-pass filter is required to eliminate interference from OMEGA navigation stations operating in the 10 to 14 KHz region.

Another reason for the high-pass filter is to eliminate interference from local AM broadcasting stations. When a high powered AM signal is nearby, RF enters the audio amplifier input via the antenna and, through the process of *autorectification*, the AM signal is demodulated; you hear the radio station in your whistler receiver, not the VLF stuff you want to hear.

Various receiver circuits have been published, and among the most popular are the various versions of the RS-4 receiver that appear in Mike Mideke's *A Whistler Hunter's Guide*, and in the literature of Project INSPIRE. The two sections of the RS-4 receiver are shown in Figures 6A and 6B. The front-end section (Figure 6A) consists of a filtered amplifier connected to the antenna. A switch and resistor in the amplifier input (S2) serves to desensitize the receiver when strong signals or interference are received; otherwise these might overload the receiver.

The output section of the receiver consists of a pair of operational amplifiers (on the same chip). Switch S3 selects whether or not the high-pass filter (A1A) is in or out. Switch S4 selects whether the input of the cassette tape recorder is connected to a microphone (MIC) for voice annotation of your observations, or the output of the front-end section of the receiver. A separate battery powered audio amplifier, with loudspeaker or earphones, can be connected

Figure 6B



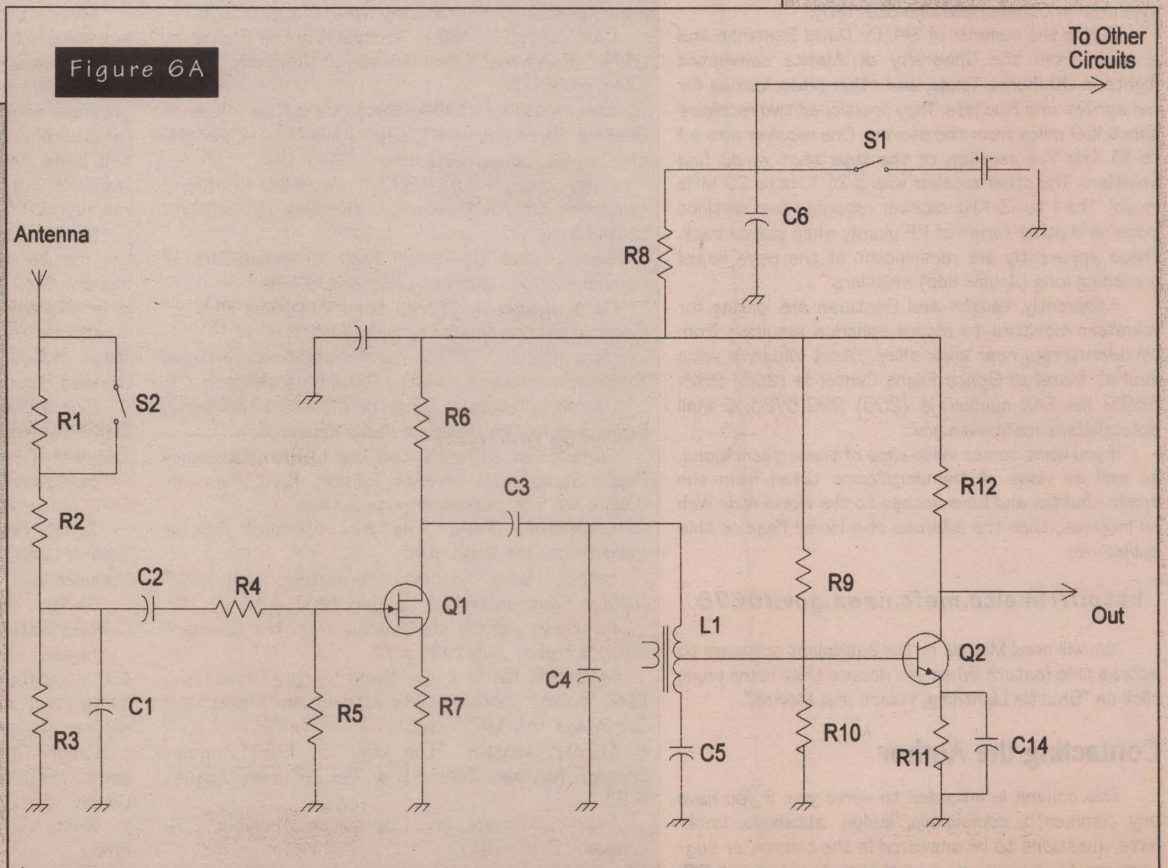
Wideband VLF Receiver for Detecting Whistlers and Other Phenomenon

Whistlers and many of the other phenomena discussed in this article are electromagnetic (radio) waves occuring in the 1 to 10 KHz frequency band, a region of the very low frequency (VLF) band. Although it's possible to build tunable receivers for this region, they don't do a very good job of picking up a whistler, which descends through the entire frequency range. So how do you make a broadband VLF receiver covering 1 to 10 KHz? Would you believe that an audio amplifier will do the trick? If an antenna is connected to the input of an audio amplifier, then it's technically possible to receive whistlers.

But, then again, you might not. If you are anywhere within a kilometer or so of a power line, connecting an antenna to the input of an audio amplifier will more likely produce only a loud 60 Hz hum.

So put a 60 Hz notch filter at the input to be rid of the 60 Hz hum, you say? Nope! That trick won't work because the 60 Hz "sinewave" produced flowing in the power line is not a pure

Figure 6A



to the MON terminal. See the box for parts values.

At last word, a receiver very much like this one can be purchased from Project INSPIRE for a nominal sum. A number of people, however, have built these receivers on Radio Shack hobby board printed circuit stock.

Whistler Hunting

Whistler hunting expeditions are best done at sites selected to be far away from power lines. One authority recommends at least one kilometer, and the more distance the better. That requirement, of course, means battery power for the equipment. The whistlers can be recorded on a cassette tape recorder, or digitized by a laptop computer sound card and played back later. If you opt for the cassette recorder, the signals can be digitized by a computer sound card or other form of A/D converter later, back home.

If you have the correct computer software, the whistlers can be diagramed for frequency vs. time, as well as intensity, by using the proper spectrum analysis program.

Red Sprites and Blue Jets

Researchers have discovered some phenomena associated with thunderstorms. "Red sprites" erupt from the tops of storms, and shoot upward to around 95 km, and as low as 65 km. They have been described as "large [red] jellyfish with trailing tendrils." The blue jets move outward from the top of the cloud, and proceed upwards for about 33 km.

I learned about these phenomenon talking to Otha H. "Skeet" Vaughn, principal investigator, Mesoscale Lightning Experiment, at Marshall Space Flight Center. Previously, I had heard of the phenomona in talking with Dr. Charles Geilker, of the Department of Physics at William Jewell College in Liberty, MO. More recently, a sidebar to Peter Taylor's column "The Solar Spectrum" appeared in *Communications Quarterly*.

During the summer of '94, Dr. David Sentman and a team from the University of Alaska conducted flights in Oklahoma, Texas, and other sites, looking for red sprites and blue jets. They positioned two receivers about 150 miles from the storms. One receiver was a 1 to 13 KHz VLF receiver, of the type that would find whistlers. The other receiver was a 20 KHz to 20 MHz model. The 1 to 13 KHz receiver recorded two distinct 'pops' and other forms of RF energy when played back. These apparently are reminiscent of the pops heard preceding long (double hop) whistlers.

Apparently, Vaughn and Sentman are looking for volunteer monitors to record spherics resulting from thunderstorms near their sites. Skeet Vaughn's voice mail at Marshall Space Flight Center is (205) 992-5893; his FAX number is (205) 992-5723; E-Mail skeet@sferic.msfc.nasa.gov

If you want to see video clips of these phenomona, as well as views of thunderstorms taken from the space shuttle, and have access to the World Wide Web on Internet, then the address of a Home Page on this subject is:

http://rimeice.msfc.nasa.gov:/5678

You will need Mosaic or the equivalent software to access this feature. When you access that home page, click on "Shuttle Lightning, Videos and Movies."

Contacting the Author

This column is intended to serve you. If you have any comments, complaints, kudus, attaboys, brickbats, questions to be answered in the column, or suggestions for future columns, then contact me at **P.O. Box 1099, Falls Church, VA 22041.**

Note: My wife, Bonnie Carr, is a musical composer. She digitized some recorded whistlers and some pulsars recorded at a radio astronomy laboratory, and used them in a pair of musical compositions called "Whistlers" and "Pulsars." If you want an audio tape of these numbers, then send her $10.00 at the same address as above. **NV**

Answer to Trivia Question

The first trans-Atlantic telephone cable was laid in 1955. The underwater cables prior to that time were telegraphic circuits, and were laid a century earlier. Prior to 1955, trans-Atlantic telephone circuits were carried over HF shortwave links, such as the RCA facility on Long Island, NY. When solar disturbances erupted, the HF telephone circuits could be out for hours or even days at a time.

Parts List for Whistler Receiver

All resistors 1/4-watt, 5%, unless otherwise noted

R1	470 Kohm
R2	47 Kohm
R3	2 megohm
R4	15 Kohm
R5	2 megohm
R6	680 ohm
R7	220 ohm
R8	20 ohm
R9	33 Kohm
R10	10 Kohm
R11	4.7 Kohm
R12	10 Kohm
R13	6.8 Kohm
R14	1 Kohm
R15	1 Kohm
R16	100 Kohm potentiometer, audio taper
R17	10 Kohm
R18	11 Kohm
R19	22 Kohm
R20	33 Kohm
R21	33 Kohm
C1	27 pFSM
C2	0.01 mF
C3	0.1 mF
C4	0.022 mF
C5	0.022 mF
C6	0.01 mF
C7	0.1 mF
C8	0.1 mF
C9	0.022 mF
C10	0.1 m
C11	0.01 mF
C12	0.01 mF
C13	10 mF
C14	1.0 mF
C15	10 mF
Q1	2N3819 JFET
Q2	2N2222A
A1	TL082 or LF-353

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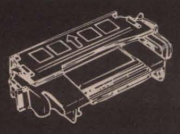

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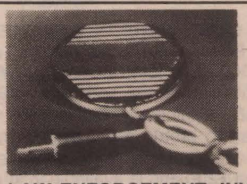

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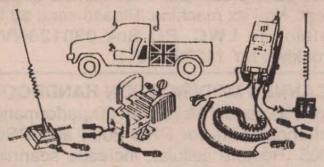

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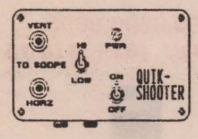

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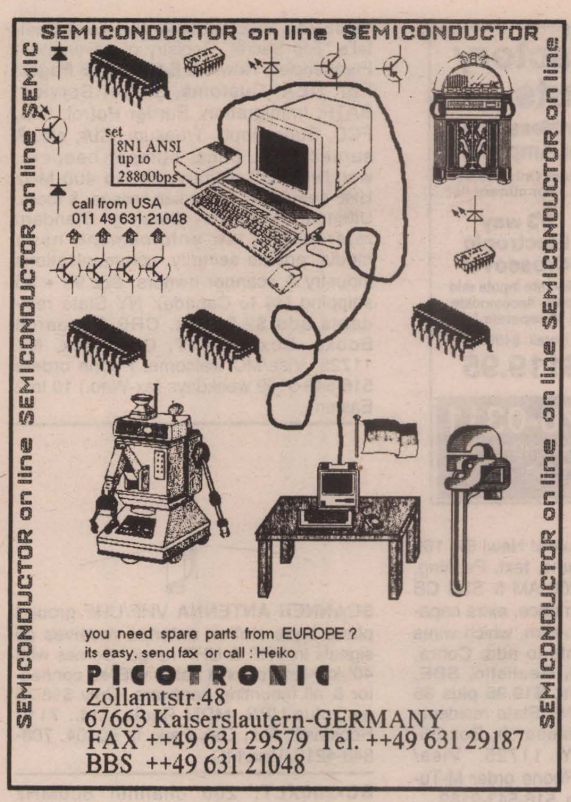

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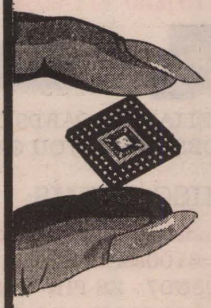

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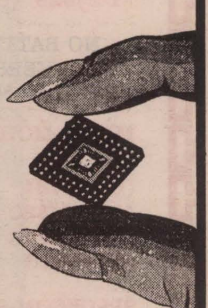

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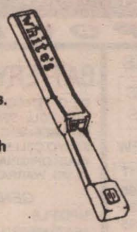

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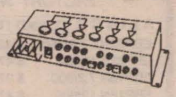

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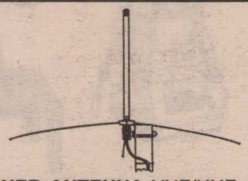

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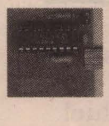

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Goodyear's Super Skytacular Night Sign

by Fred Blechman

If you see a procession of colorful messages, cartoons, and animated designs floating across the night sky, don't start tidying up for extraterrestrial visitors. Chances are the nocturnal show is being provided by "Super Skytacular," a programmed assembly of more than 7,500 colored lights on one of Goodyear's three blimps operating in the United States and Canada. With the blimp flying 1,000 feet above the local terrain, the night sign can be read by people on the ground from one mile on either side of the airship.

Messages in the Sky

Goodyear put its first flying billboard into the skies more than 60 years ago when one of the early blimps was emblazoned with Goodyear's company name and winged-foot trademark painted on its side. The next step in the evolution of today's night sign was having the blimps tow advertising banners up to 200 feet long. For a short time in the 1930s, loudspeakers were attached to the airships to permit voice contact with persons on the ground. The practice was short-lived, however, because people didn't like "the voice in the sky."

The late 1930s saw the installation of the first illuminated signs on Goodyear airships. Specially designed, lightweight frames carrying white neon tubing were strapped to the sides of the blimps. Known as "Neon-O-Gram," each sign consisted of 10 individual panels with neon tubing shaped to permit the formation of any number or letter. The Neon-O-Gram saw service with the Goodyear airship fleet until the beginning of World War II, when the blimps were drafted into the service of the U.S. Navy for coastal reconnaissance and convoy escort duties.

Following the war, Goodyear engineers developed a new sign using incandescent lamps instead of neon. This sign also had 10 panels, with 182 individual lamps on each panel, arranged in the same pattern as the Neon-O-Gram to form any letter or number.

For a period in the late 1940s, one Goodyear airship was outfitted with a type of running-copy illuminated sign, but without color or animation. This was the "Trans-Lux" sign, an aerial copy of the familiar Times Square scrolling sign in New York City. However, the weight of the equipment necessary to run it required a large airship with sufficient lift. Goodyear used it on a 250-foot long K-type blimp which it had purchased from the Navy after World War II. The cost of operating the K-ship was a big factor in the eventual decision to discontinue the Trans-Lux sign.

In 1964, Goodyear began developing the first airborne illuminated sign employing both color and animation. The result was "Skytacular," first installed on the airship Mayflower in 1966. That sign was 105 feet long, the same as the present Super Skytacular, but only 14.5 feet high, 10 feet less than the current signs. There were a total of 3,080 lamps on both sides of the blimp. Although the initial version of Skytacular proved highly successful, Goodyear engineers continued to work on an even more versatile sign system, and in 1969, Super Skytacular was introduced.

Super Skytacular

The present Super Skytacular night sign system is a marvel of electronic engineering. Messages to be run on the sign are born on exotic electronic equipment in a special lab in Akron, OH. A technician "draws" each animation and copy on a cathode ray tube with a special "light beam" pencil. From there a computer takes over. The process results in a programmed disk file. A typical six-minute program file consists of 40 million bits of on-off information which, when run through a computer to inter-

Shortly after Fred Blechman wrote this story for *Nuts & Volts*, the same Goodyear Blimp, the Eagle, crashed into a fence on landing, due to a sudden wind reversal. The Blimp envelope was NOT repairable. A new "Eagle," probably with a new night sign design, should be flying around September of this year.

LOS ANGELES DAILY NEWS SUNDAY MAY 28, 1995

Goodyear blimp crashes into fence

CARSON — A severe shift in the wind sent a blimp swaying 100 yards into a fence Saturday, leaving it with a 9-foot tear and scattering golfers nearby.

None of the five passengers on Goodyear's Airship Eagle nor pilot Joel Chamberlain was injured, said authorities and Nick Nicolary, pilot-in-charge.

The blimp was landing when the wind shifted at about 2:30 p.m. It hovered just above the ground when the wind changed 180 degrees within a second or two, Nicolary said.

"It doesn't look too pretty but nobody got hurt," Nicolary said.

The blimp can hold six passengers and a pilot.

Associated Press

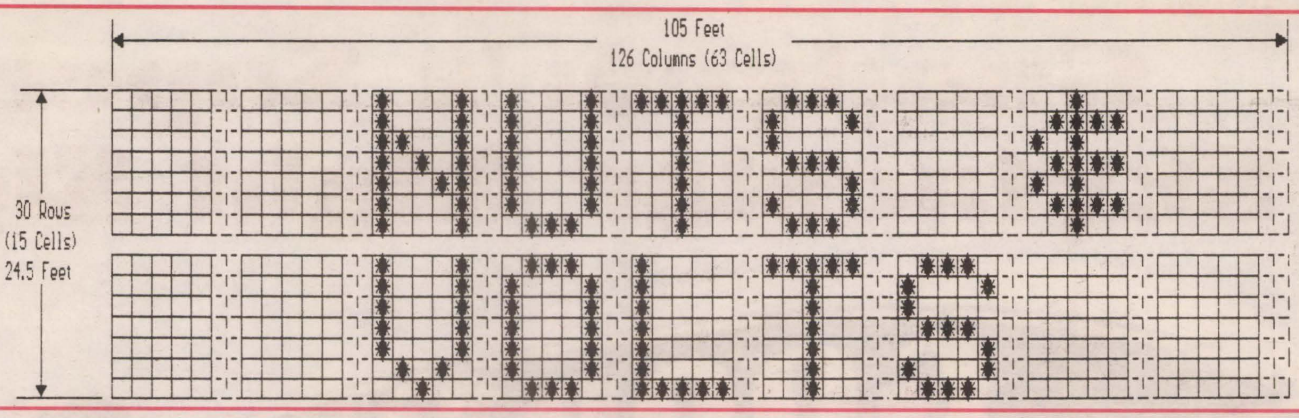


FIGURE 1. Goodyear's "Super Skytacular" night sign is 105 feet long and 24.5 feet high. It has 1,890 light "cells," each with four different colored lights.

face lamp drivers aboard the airship, controls lamp and color selection, and the speed at which messages are run.

Up until recently, a Digital Equipment Corporation (DEC) minicomputer and a dumb terminal were used to control the light patterns on the night signs. An assembly language program, compiled into DEC language, was commanded by the dumb terminal to display entered text, or to run custom display files from the computer's hard disk drive. In the field, the operator could program text — two lines of nine characters each — and run graphic and animation programs provided by the home office at Akron.

By the time you read this, all three blimps should be using a new computer system, although the light matrix and interface will be the same. The new arrangement completely replaces the relatively large and heavy DEC minicomputer, dumb terminal, and color monitor with a small Toshiba Model 4600 486DX2/33MHz laptop!

Not only that, but the new Toshiba laptop contains two proprietary computer programs, written in the "C" language. One is for Windows and one for DOS. Field versions of these programs are about 250K each. The field Windows program is used to CREATE limited night sign designs and effects. The DOS program is used in the field to RUN the complex signs, or to create simple text with limited effects.

The new programs used by Akron now allow fonts that are larger (up to the full sign height!) or smaller than the previous fonts. Over 1,000 predesigned signs have been created for use anywhere.

Words or messages and animation can run in either direction, as well as up or down. Approximately 50 percent of the messages run on "Super Skytacular" are devoted to public service messages in behalf of non-profit and service organizations. The remainder are devoted to Goodyear marketing and dealer support promotions.

How It Works

The present Super Skytacular electric sign, essentially identical for all three blimps, is 105 feet long and 24.5 feet high on each side. See Figure 1. Each side is composed of a matrix of 3,780 miniature incandescent bulbs, for a total of 7,560 on both sides.

The bulbs used are General Electric #356 aircraft incandescent lamps designed to produce approximately 3.5 candlepower. They are rated for 170 milliamperes at 28 volts direct current (4.76 watts). Each bulb has a miniature bayonet base and is placed inside an individual reflector socket with a red, blue, green, or yellow plastic cover. The 7,560 bulbs are all connected together in pairs — one on each side of the blimp — and connected by more than 80 miles of wiring!

The easiest way to describe the sign light matrix is to discuss "cells," which I'll define as consisting of four lights — one of each color — as shown in Figure 2.

Each cell uses two vertical lines ("columns") and two horizontal lines ("rows"). Since the entire sign uses 126 columns, there are 63 cells in the

The blimp's gondola is suspended by cables from a curtain inside the top of the envelope. Placement of 25- and 50-pound ballast bags is monitored 24 hours a day when moored to keep the blimp grounded.

Goodyear Airship Operations

She gets plenty of exercise, but it doesn't make one bit of difference in her mammoth measurements, which are 192 feet long, 57.5 feet high, and 46 feet wide, with a maximum gross weight of 12,840 pounds! Her sausage shape is maintained by 202,700 cubic feet of non-inflammable helium gas inside her two-ply neoprene-impregnated polyester fabric envelope.

This rotund lady is the airship "Eagle," typical of the three non-rigid "blimps" owned and operated by The Goodyear Tire and Rubber Company of Akron, OH. Goodyear has constructed more than 300 airships since 1917, including 65 commercial blimps and 250 airships built under contract for the Army or Navy.

The Eagle may be correctly referred to as a blimp, airship, or dirigible. A blimp is "any steerable powered ballon with no internal support or framework, kept in shape by internal gas pressure." A dirigible is defined as "a lighter-than-air craft that is engine-driven and steerable." Only a rigid airship with internal framework can correctly be called a zeppelin — but blimps, dirigibles, and zeppelins can ALL be called airships.

For exercise, the Eagle, and her sister ship, the "Spirit of Akron" and the newer slightly-different "Stars & Stripes," travel more than 100,000 air miles a year as goodwill ambassadors for the company. The Eagle spends six months of the year at its winter base near Los Angeles, CA; the other six months she "barnstorms" throughout the continental U.S. and Canada. The Spirit, based in Akron, OH, and the Stars & Stripes in Pompano Beach, FL, have similar schedules.

Safety is the primary factor in the overall airship operation. Although it is possible to fly in some types of adverse weather (and the pilots are all instrument rated), the Eagle remains moored to her mast when there is rain, fog, and/or wind in excess of 20 miles per hour. Goodyear airships, past and present, have operated for six decades without a single passenger fatality.

Each of the airships carries approximately 8,000 passengers annually, five or six at one time. Because of the heavy demand, rides are by INVITATION ONLY. Guests who have been for a ride on a Goodyear blimp are presidents, congressmen, city and state officials, astronauts, authors, scientists, and key Goodyear customers.

In addition to serving Goodyear's own public relations programs, the airships also are in great demand by the nation's news media, particularly television networks, for use as aerial camera platforms for special events. The Goodyear blimps have carried cameramen over just about every major city in the United States. Exciting and unusual aerial pictures obtained from the blimps have appeared in newspapers and magazines throughout the United States, or have been beamed to television viewers across the country.

Goodyear's GYROCAM 360, a specially designed TV camera and gyro-stabilized platform system, is used for the telecasts. The camera pod is suspended below the cabin and remotely controlled by the cameraman. Camera signals are sent via a microwave transmitter to the ground, where they are picked up by a dish antenna. The cameraman videos the action from the blimp while a crewman on the ground keeps the dish antenna positioned skyward to receive the microwave signals. Both the pilot and the cameraman listen for cues from the control network booth to position the airship for the next "live shot."

Fans have received spectacular blimp-eye views of Rose Bowl and Orange Bowl football games, Indianapolis and Daytona 500-mile auto races, America's Cup yacht races, and baseball's World Series, just to name a very few events covered regularly by Goodyear's blimps.

Maintaining an airship is no simple task. The Eagle is staffed with a crew of 22 — five pilots, a public relations representative, and 16 crewmen that include engine, radio, electronics, and structural experts. With four specially-equipped ground-support vehicles, the Eagle crew is almost self-sustaining in the field as far as maintenance and operation of the blimp.

Moving from city to city, this caravan of vehicles travels by highway, with the blimp flying overhead. A large tractor-trailer rig serves as a mobile maintenance facility. The tractor unit includes a machine shop, night sign, and television equipment lab. The trailer also carries the main mast, spare parts, and supplementary equipment.

A bus, specially designed for this operation, serves as a command center and communications headquarters on tour. It is equipped with a two-way aviation radio, all administrative aids necessary for the operation, and a special mast for mooring the blimp if an alternate landing site should be chosen during a cross-country mission.

Two passenger vans round out the rolling stock and are used for public relations, ground liaison work, and crew transportation. All special vehicles are equipped with two-way radios for contact with each other and the airship.

It should be noted that when the blimp is tied to its mast, it weathervanes in the wind, leading some to call it "The World's Most Expensive Windsock!"

105-foot sign width. Since there are 125 spaces in the 105-foot width, that means the lights are about 10 inches apart. Similarly, there are 30 rows (15 cells) in the sign's 24.5-foot height. With 29 spaces between rows, that means they are about 10.14 inches apart.

One of the standard text fonts uses a 35-cell character space, 5-cells-wide by 7-cells-high, as shown in Figure 3. With two cells after each character used for spacing, nine characters use all 63 horizontal cells. With one space between text lines, two text lines use all 15 vertical cells.

Of course, graphics and animation get far more complex, and the new computer system's various fonts provide a great deal more flexibility in text displays.

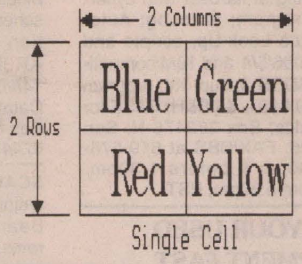


FIGURE 2. A single cell has four different colors.

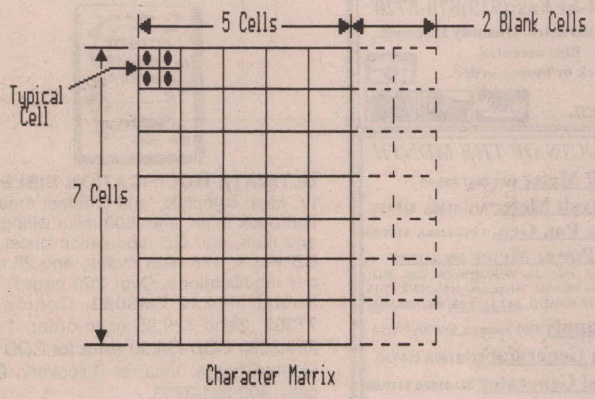


FIGURE 3. A standard 5x7 text character matrix. Two columns of blank cells follow each character.

Flying The Blimp

Power for the Eagle is supplied by two six-cylinder Continental 210-horsepower air-cooled piston engines with reversible-pitch propellers. These give the blimp a cruising airspeed of 35 statute miles per hour, with a top speed of 50 miles per hour.

Flight altitude is normally between 1,000 and 3,000 feet, with a maximum ceiling of 10,000 feet above sea level. The helium in the blimp is considerably lighter than the air it displaces, thus making the blimp as a whole slightly lighter than its own volume of air. It therefore tries to rise until it has reached a height where the air is thinner, and so light enough to balance the lift and weight.

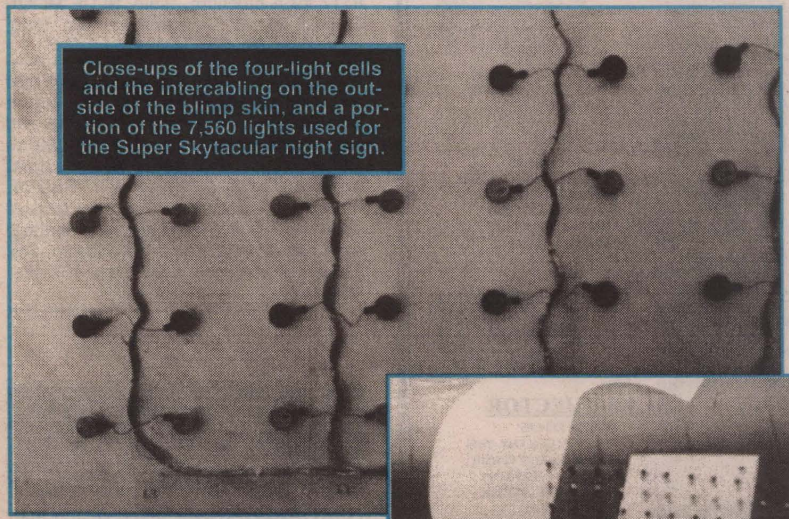
Obviously, this has to be controlled to make an airship workable. In the past, various combinations of ballast (weights) and gas release were used. Blimps use a system with "ballonets," collapsible air bags within the blimp envelope. By using pumps to vary the amount of air in the ballonets, the volume in the rest of the envelope can be changed.

The internal pressure of the helium maintains the shape of the polyester skin. Front and rear ballonets are inflated or deflated with air to compensate for ambient pressure differences due to outside air temperature and pressure, as well as the heating effects of the sun that cause gas expansion. The differential pressure required for proper blimp inflation is from 1.25 to 1.50 inches of water, which amounts to only about .05 pounds per square inch!

The "gondola" (cabin), which is suspended by several cables from a curtain inside the top of the envelope, can be quickly changed to one of three configurations — passengers, camera, or night sign. No passengers are carried in either the camera or night sign configurations.

Flight attitude — nose up or nose down — is controlled by the amount of air in the front or rear ballonets. Flight direction is controlled by rudders and elevators on the rear fins. The rudders are moved by pushing rudder pedals for and aft through a substantial distance. The elevators are moved up or down by rolling a large wheel forward (nose down) or back (nose up), like a giant trim tab.

The pilot must constantly monitor three pressure gauges (opening and closing ballonet and helium valves as required to maintain altitude and attitude), and watch a large array of flight, engine, and navigational instruments while operating the rudders and elevators. He has the help of an on-board GPS (global positioning system) receiver, as well as complete aviation communication equipment. He's one busy guy — with no co-pilot!

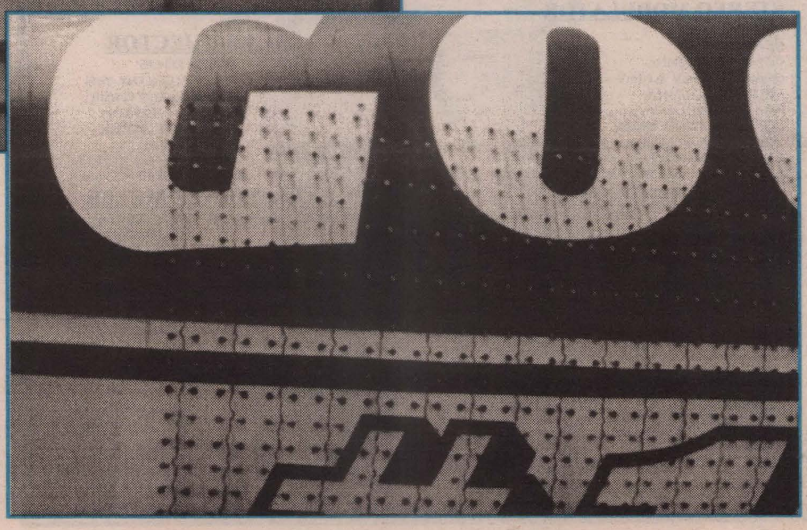


Close-ups of the four-light cells and the intercabling on the outside of the blimp skin, and a portion of the 7,560 lights used for the Super Skytacular night sign.

Power supplied by the airship's regular generators is not sufficient for the night sign's electrical requirements, so an auxiliary power unit — powered by a jet turbine engine — is mounted on the outside of the blimp's gondola only during night sign flights. Although this unit is, in effect, a small jet engine enclosed in a pod, it is designed to operate without developing any appreciable forward thrust for the airship. Its primary purpose is to generate up to 500-amperes of 28-volt direct current (14 kilowatts) for the night sign. This is enough to light about 3,000 bulbs at one time; to light all 7,560 bulbs at one time would take 30 kilowatts, and is not necessary.

Four interface cabinets, one for each color, weigh about 90 pounds each. Each cabinet connects to the night sign through six two-inch diameter cables with a 166-pin connector at the end of each. Since there are a total of 24 cables and connectors, and each connector has 166 pins, a total of 3,984 pins are available to control the 3,780 lights on one side. Since the lights on each side are paired together, the same display appears simultaneously on each side.

The interface cabinets house lamp driver circuitry, which consists primarily of silicon-controlled rectifiers (SCRs). Each SCR is turned on and off by a serial data stream from the computer, so any bulb in any cell can be addressed at any moment in any sequence. Because there are four colors in each cell, single colors or color combinations can be programmed.



Animation

Animation possible on Super Skytacular includes a golfer driving his ball toward the green, then putting the final distance to the hole; a game of table tennis; a football player making good on a field goal attempt; a sharp-shooting basketball player sinking a foul shot; and a baseball player rapping a solid-line drive and almost taking off the pitcher's head in the process!

Special animated messages in color have been developed for the holiday seasons. Santa, his sleigh and his reindeer flash across the Yuletide skies; the Magi and their camels follow the Star of Bethlehem; a turkey runs to escape an ax-wielding man intent on securing Thanksgiving dinner; and a youngster lights a giant Fourth of July firecracker which explodes to form an American Flag.

Coming Up

The new computer system has not required a change — yet — to the present interface circuitry, which was built in 1968. However, word has it that an entire new display currently in development, perhaps using fiber optics, "will make this sign look very, very antique," according to an inside source . . . NV

#30 CB – SCANNERS *cont.*

BC220XLT BEARCAT scanner, new in original box with all attachments, never used. Retail $240, sell $150. BC200XLT $125, new unused. George Demaris, 7387 Pershing Ave., Orlando, FL 32822. 407-277-3746.

CELLULAR RESTORATION on your 800MHz scanner performed expertly for $40 including return shipping. Guaranteed. Keith Perry, 607 Osage Dr., PO Box 816, Leander, TX 78641. Phone 512-259-4770.

BARCODE SCANNERS from $225. 1-800-343-7773, FAX 408-425-7888 EGER.

SALES, SERVICE: CB equipment, radios, modifications, power mics, echo-reverb boxes, kits, meters, filters, antennas, noise toys, mounts, hard to find items. Partial list $1, complete list $4. D&R Electronics, 10 Park St., Thomaston, CT 06787. 203-283-9492.

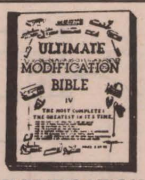
SCOPE BOOSTER. Increase the input frequency of your oscilloscope to 30MHz and beyond. Requires no internal connections. Great for checking transmitters on CB, ham, modulation, etc. Assembled: $49.95. Kit $29.95. S&H $3.50. Creative Technology, PO Box 1401, Torrington, CT 06790-1401.

CE-232 SCANNER/Computer Interface! VHF-UHF scanning at its best with cyber-powered AutoProgram; AutoLog; Auto-BirdieReject; Auto Look Up; scripts and more for PRO-2006/5/4 and IBM/compatibles w/512K, MSDOS 3.1/up! Kit, program disk, manual: $194.95 + $5 S&H; SASE for info: COMMtronics; Box 262478-N; San Diego, CA 92196. FAX/BBS at 619-578-9247, after 5:30pm & before 1:30pm. Voice only: 1:30pm-5:30pm, PST.

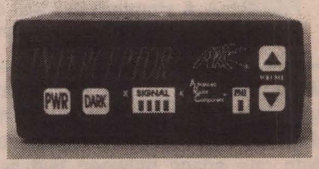
SELL YOUR USED EQUIPMENT FAST. USE THE CLASSIFIEDS

THE RCI 2950/2970 Service & Modification handbook $37, blueprint sized schematics $20. Other service & modification handbooks: HR 2510 $27, AR3300/3500 $27, Cobra 2000 $27, 148/Grant XL $20. Caller ID blocker $109 Catalog $3. Amex, check, MO. Maxtech, Box 8086, New York, NY 10150. 718-547-8244.

SCANNER HACKERS BIBLE 112 modifications. PRO-2004/5/6, Yaesu, Kenwood, Bearcat, Icom. Frequency fixes, scan rates, interfaces, programmable channels, improving operation, antennas, and MORE!! $33.45. VOLUME 2 covers ICOM + KENWOOD $33.45. **VISA/MC** 602-782-2316. **TELECODE**, Box 6426-NV, Yuma, AZ 85366-6426.



ULTIMATE MODIFICATION BIBLE Vol. IV. Most complete, and greatest modification book in its time. 800 mike wirings CB and ham, 400 CB modulation boost, 200 CB PLL's, 175 ham radios, and 25 scanner modifications. Over 200 pages. KDC Sound, 17294 FM3083, Conroe, TX 77302. Send $29.95 or to order: 1-800-256-9895 COD ($4.50 extra for COD fee), MasterCharge, Visa, or Discovery. Other calls: 409-231-3753.



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Features: Assembly language coding, assembler, disassembler, single step and multi-break-point program debugger, display and rewrite registers, download/upload programs from/to external systems, I/O drivers, 56-key large size keyboard, LCD display, RS-232, UART, printer interface, two expansion slots, ±5V, ±12V switching power supply, 20 I/O controls available, e.g. servo and stepping motor control, dot matrix display, D/A, A/D, sensors, ...
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EDS-8802 $109.00 Dynamic scanning controls.
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EDS-8805 $239.00 Servo and stepper motors controls.
EDS-8806 $159.00 Basic I/O application experiments.
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PRODUCTS OF THE MONTH

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TV Color Pat. Gen. CPG-1366A $159.95
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1.8-500MHz; RF power: 20mW/200mW/2W; Imp.: 50Ω; Accuracy: ±10% full scale; N-type connector;SWR <1.15 **341 $219.00**; 500-800MHz. **342 $219.00**; 800-1000MHz
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Function Generator FG-2100A $169.95.
RF Signal Generator SG-4160B $119.00
Frequency Counter FC-5250C $119.95.
VHF/UHF Attenuators RT8815/RT8815U $199/$359.0
See Specifications Below or Call

DC POWER SUPPLY

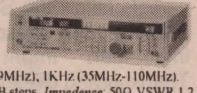
PS-303 $159.00
0-30VDC, 0-3A; 0.02%+2mV line regulation; 0.02%+3mV load regulation; 1mVrms noise & ripple; Short circuit overload protection, constant current constant voltage (CC & CV).
PS-303D $314.95 dual outputs.
PS-305 $219.95, 0-30VDC, 0-5A.
PS-305D $399.95, dual outputs.

8110 $289.95 0-60VDC, 0-3A
8112 $399.95 0-60VDC, 0-5A
8108(8109) $549.95($699.95) 0-60VDC, 0-3A(5A), dual, independent tracking. Low ripple.
8102(8103) $399.95($489.95) dual 0-30VDC/0-3A(5A), fixed 5VDC/3A, indepedent tracking operation, constant voltage and constant current. Slave/Master, Serial/Parallel connection.
PS-1610S(8107) $289.00($399.95) 0-16VDC(0-30VDC), 0-10A.
PS-2243(2245) $139.00($159.00) 0-12/0-24VDC,3A(5A).
8200(8201) $179.95($239.95) 0-30VDC(digital meter), 0-3A(5A).
8210(8211) $199.95($259.95) 0-30VDC, 3A/(5A). 2 digital meters.
8202(8203) $499.95($549.95) 3 outputs, digital display, dual 0-30VDC/0-3A(5A), a fixed 5VDC/3A, indepedent tracking operation, constant voltage and current.

AM/FM SWEEMAR SCOPE

SM-6225B/C $1999.95
Freq Range: (AM)490KHz, (FM) 10-11.4MHz, *Accuracy:* ± 0.1%
Marker: (AM)455KHz, ±5KHz, ±10KHz, (FM)10.7MHz, ±7.5KHz, ±150KHz.
STEREO SCOPE OS-7505B $369.00 trigger, 0-10MHz.
ALIGMENT SCOPE OS-7001A $369.00 0-200KHz.

AM/FM STD SIGNAL GEN.



SG-4110A $1799.00
Freq: 100KHz-110MHz
Display: 6-digit LED
Accuracy: <±(5x10-E5 ±1 count)
*Resolution:*100Hz (100-34.99MHz), 1KHz (35MHz-110MHz).
Output: -19dBu, -99dBu, 1dB steps. *Impedence:* 50Ω VSWR 1.2.

TV COLOR PATTERN GEN.

CPG-1366A $159.95
VHF NTSC;
Freq.: 45.75, 175.25, 187.25 MHz;
RF Output: 10mV.
Impedence: 75 Ohm;
Video Output: BNC, 1Vp-p

SWR/RF POWER METER

310 $89.95
Freq.Range: 1.8-150MHz.
RF Power: 0-4W/20W/200W
SWR Measure.: 1.0 - ∞, 4W min.
Accurcy: 5%-10%; SO-239 plugs.
Insertion Loss: O.3dB.
Input/Output Imp.: 50Ω.
320 $89.95, 130-520MHz.
330 $119.95, 1.8-520MHz.

SWR-3P $26.95 1.7-150MHz.
RF Power: 0.5-10W, 0.5W-100W.
SWR-2P $22.95, 1.7-30MHz; *RF Power:* 0.5-10W.
PM-330 $136.00 1.8-500MHz; 0-5W/20W/120W.

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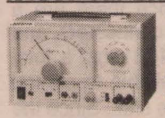
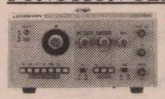
SG-4160B $119.00
100KHz-150MHz up to 450MHz on 3rd harmonics; 6 ranges; AM modu-lation.
RF Output: 100mVrms to 35MHz.
Modulation: Int. 1KHz AM, Ext. 50Hz-20KHz AM.
Audio Output: 1KHz, 1Vrms.
SG-4162AD $229.95, with Freq. Counter 1Hz-150MHz, 6 digits, for internal & external signals. Specification see SG-4160B above.

AUDIO GENERATOR



AG-2601A $119.00
10Hz-1MHz, 5 ranges;
Output Level: sinewave 0-8Vrms, square 10Vp-p.
Output Impedence: 600 Ohm.
Distortion: <0.05% 500Hz-50KHz, <0.5% 50KHz-500KHz.
AG-2603AD $229.95, with Freq. Counter 1Hz-150MHz, 6 digits, for internal & external signals. Specification see AG-2601A above.

FUNCTION GENERATOR



FG-2100A $169.95
0.2Hz-2MHz in 7 ranges; Sine, Square, Triangle, Pulse & Ramp
Output: 5mVp-p-20Vp-p, 1% distortion.
VCF: 0-10V control freq. to 1000:1.
FG-2102AD $229.95 generates signals same as FG-2100; 4-digit counter display, TTL & CMOS outputs, 30ppm ±1 count accuracy.
FG-2020B $159.00 0.5Hz-500KHz; Sine, Square, Triangle.
(FG)2103 $329.95, Digital sweep generator, 0.5Hz-5MHz in 7 ranges.
Operating Mode: sweep, AM, gated burst, VCG.
Freq. Counter: Int. 0.5Hz-5MHz, Ext. 5HZ-10MHz

STEREO MODULATOR

AG-2011A $549.00
RF SECTION:
Carrier: 98MHz ±2MHz.
Output: 10mV, 1mV & 0.1mV
COMPOSITE SIGNALS:
Pilot: 19KHz ±2Hz, 0.8Vrms
INT. MODULATION: 400KHz, 1KHz ±1%, 1Vrms, distortion < .5%;*L-R Seperation:* >50dB.
EXT. MODULATION: Freq.: 50Hz-15KHz
L-R Seperation: >45dB 100Hz-3KHz; >35dB 50Hz-15KHz..

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OS-622B $344.95 20MHz, dual trace.
OS-653 $699.95 50MHz, dual, delay sweep, ALT triggering, TV syn.
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Modulation: = 2KHz Sinewave. *Crystal Oscillator:* 1-15MHz.
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DM-3104A $799.95
MEASUREMENT:
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Freq.: 400Hz±10%, 1000Hz±10%(HPF).
Input: 3mV-100V, ratio measuring 20dB.
Auto. Switching Ranges: Fundamental Freq. = (fo)±10%;
Fund. Rejection: >-80dB at (fo)±5%; >-70dB at (fo)±10%.
Harmonic Accuracy: ±0.5dB, 1.8(fo)-20KHz.
DM-3204 $1,599.00 dual channels.

FREQUENCY COUNTER

FC-5250C $119.95
Freq. Range: 10Hz-220MHz (HF)10Hz-20MHz, (VHF)10MHz-200MHz.
Gate Time: 0.1 & 1sec.
Max. Input: 10Vp-p.
Input Sensitivity: 35mV 10Hz-200MHz.
Input Imped.: (HF) 1MOhm, (VHF) 50Ohm.
FC-5260A $146.00
10Hz-600MHz.

FC-5270 $149.95
10Hz-1.2GHz.
FC-5600B $321.00
10Hz-600MHz.
(FC)5700 $329.95 10Hz ~ 1.3GHz.

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SE-6100 $134.95
TRACER: Gain Max. 60dB
Attenuation: 0/20/40/60dB
Input Imped.: 100KOhm
Output Imped.: 600Ohm;
Speaker: 8 Ohm.
INJECTOR: *Freq.:* 1KHz S-quarewave; *Output Level:* Continuously variable 0 - 4.5Vp-p.

AUTO. CAPACITANCE METER

CM3300A $139.00 10 ranges, 99.9pF ~ 99.9mF, fully automatic.
Resolution: 0.1pF lowest, 0.1% full scale.
Accuracy:
0.5% of full scale±1digit to 99.9μF,
1% of full scale±1digit to 99.9μF.
Display: 3 digit LED.
Unit indicator: pF, nF, μF, mF. Overrange indicator.

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WF-3103A $699.95
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JIS/CCIR, 3.15KHz±10% DIN.
Range: 0.03/.1/.3/3% full scale.
Accuracy: ±5%.
WF-3105A $799.95, digital;
Function: LIN/WOW/Flutter/WTD.
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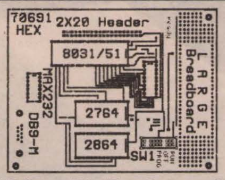
DEC VT-100 Terminal with keyboard. $100. DECLA 120 $200. Lear Siegler ADM12 w/kybd, $125. 818-989-3848.



8051 SBCs with Bootstrap Loader, Economical SBC with 128 byte memory, 24 I/O Ports. Contains preprogrammed Bootstrap software that allows loading of .OBJ files to EEPROM through Serial Port of PC. Run programs without burning EPROMs. IBM DOS compatible Utility Disk included (3.5 or 5.25 in). $59 plus S/H. Also; Learn Assembly code with the perfect 70691HEX companion; "Assembly Language BASICs". A 64pg booklet devoted to the programming of the 8031/51. Written with the novice programmer in mind. $15 plus S/H. Suncoast Technologies, Spring Hill, FL. 904-596-7599. V/MC Accepted.

CD-ROM DRIVES REALLY CHEAP!!! CM-205 Kit including card, cables, drive, and software only $45. Toshiba 3201B Internal SCSI CD-ROM $40. Toshiba External 3301B SCSI 2 CD-ROM $65. Ideal for the Macintosh or add a PC interface for $20. Call UTWE, 818-797-2569 or fax 818-797-0384 or E-Mail JohnUTWE @aol.com or BobUTWE@aol.com

LASER PRINTERS. Xerox 4045 (NBI 10) $200. QMS KISS (similar to HP I) $200. 818-989-3848.

1-800-458-6778 FLOPPY DRIVE REPAIRS $1-$15. Consistently reliable since 1983. 2 day avg. turnaround, 6 mo. warranty. **ISR**, 2217 Downing Ln., Leander, TX 78641.

COMPUTER SOURCES: foreign and domestic wholesale suppliers of computers, components and peripherals. Save or make $$. (>300 domestic & >300 foreign suppliers.) Send $10 to Allmedia, 611 Jodi Dr., Hammond, LA 70493 for a full listing incl. addresses & phone numbers.

CANON BUBBLEJET, Apple Writer Ink Jet Refill Kit, highest quality complete with instruction and 10 refills, $29.95. LOALCO, Box 7117, Delray Beach, FL 33482. 407-241-9990.

3 AXIS DNC Workcenters. Neat 3 axis, 12.0"x16.0"x2.0" $2,500. Rapidril 3 axis, 11.0"x11.0"x6.0" $3,500. Techno 3 axis, 19.0"x20.0"x4.0" $5,500. Gerber 3 axis, 22.0"x16.0"x6.0" $6,000. All centers include software, controller, motors and cables. 508-685-9584.

HEWLETT PACKARD Plotters. HP 7475A $199.95, HP 7550A $299.95. Both do up to 11x17 Drawings, and work with all popular CAD and graphics programs. Comes with pens too! Stewart & Associates. 314-240-6500.

MOTHERBOARDS UPGRADE 286, 386 with ease, PCI, VL, AT bus, IDE cards, I/O cards, SVGA cards, tower cases. Call for catalog, GCS, 1-800-386-0577.

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HISTORIC AND CLASSIC hardware support magazine. **The Computer Journal** provides how-to information on keeping S-100, Kaypro, Z80, 6809, CP/M, and PC/XT systems running. Over TEN years of hardware, software projects. 6 issues $24. Free sample. 1-800-424-8825. TCJ, PO Box 535, Lincoln, CA 95648.

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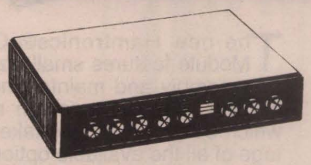
JUMBO LEDs

Liton # LTL 327C - 8MM
Ideal for eye-catching indicators and displays. A recent quantity purchase of these BIG, 8mm diameter, red diffused LEDs enables us to provide some very special pricing. The leads on these devices are 0.325" long with plenty of room for soldering.

5 for $1.00 CAT# LED-23
100 for $ 15.00
1000 for $ 120.00

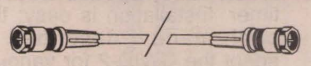
VIDEO SWITCHING CENTER



Gemini # SC1600
Special purchase of these video signal switching centers allows us to sell them for 65% to 75% less than their original price. Enables five signal input to be switched to your TV or three signal inputs to be switched to your VCR. Watch one channel while recording another. F connectors on input. Use with antenna, CATV, VCR, laser disc, game or computer. 6.37" X 4.7" X 1.58". Brand-new, individually boxed, includes instructions.

CAT# SC-1600 **$8.00 each**

6 FOOT VIDEO HOOK-UP CABLE



High quality 6' video patch cables. Belden # 9104 "Duobond" dual shielded RG-59 cable with heavy-duty F connectors hex-crimped onto each end.
Large quantity available.
CAT# VHU-6S **$1.00 each**
10 for $7.50 • 100 for $60.00

INCREDIBLE SAVINGS! 30' CABLE

A GREAT DEAL!

Originally made to connect Digital Audio Tape machine to a remote controller, this "snake" cable consists of four separate 9 conductor plus drain wire, foil-shielded cables in one jacket. The conductors are stranded 24 AWG wire. Each end of each smaller cable is terminated with DB-9P connectors. The cable is well-made and quite flexible for its size. Snake cable nominal O.D. is 0.52". Interior cable O.D. is 0.15". The outer jacket can be slit and re-moved if only the 9 conductor cable is required. DB-9 connectors include thumbscrew hold-downs. If you are using multiconductor shielded cable this is a great deal.

$5.50 each
CAT# CBL-3
2 for $10.00

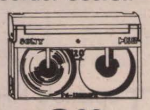
7 Vdc MOTOR

Matsushita
MMX- 7AC O 8A
1.25" diameter x 1.25" high motor. Prepped with 1.61" diameter flywheel, pulley and fiber glass mounting board.

$1.00 each
CAT# DCM-54
10 for $9.00
100 for $80.00

"HI-8" VIDEO CASSETTE (USED)

8 mm Video Camcorder Users!.



SONY Hi-8
Top quality, metal particle 120 minute video cassettes. Used for a short time, then bulk-erased. Each cassette has its own plastic storage box. Satisfaction Guaranteed.

$3.00 each
CAT # VCU-8
10 for $28.00
100 for $250.00

9 VOLT 60 MA SOLAR PANEL

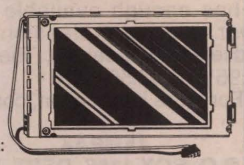
These 6" X 6" glass enclosed photovoltaic panels produce 9 Vdc at 60 mA. Ideal for charging batteries and powering small devices. Put two or more together for more current and voltage. Includes metal connectors and instructions for soldering directly to panel.

CAT # SPL-960
$5.25 each

640 X 480 LCD PANELS WITH BUILT-IN DIGITIZER

Two sizes available, both originally designed for laptop computer/note pad. Built-in digitizer to be used with a stylus for hand written notations. Onboard drivers operate on 5 vdc (logic) and 18 vdc (LCD). Full documentation on both units.

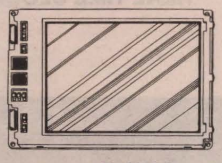
SHARP LM64P90



Built-in CCFT backlight.
Overall dimensions: 10.19" x 7" x 0.35"
Viewing area: 7.88" X 6"
Dot size: 0.27mm X 0.27mm.
White dots on black background. **CAT # LCD-31**

$40.00

SHARP LM64194F



Overall dimensions: 8" x 5.75"
Viewing area: 6" X 4.5".
Dot size: 0.21mm X 0.21mm
Black dots on white background. **CAT # LCD-32**

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NEW PRODUCT EDITOR,
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JAMPAK PORTABLE PERSONAL MUSIC AMPLIFIER

JAMPAK is small enough to fit in your shirt pocket. It can be used indoors or out, practice and play anywhere, without disturbing others around you.

It's easy to use; a single on-off/volume control and LED indicator shows when the power is on.

JAMPAK has one jack for the instruments another for your headset (Jampak can even drive speakers). The third jack is for optional external power (8-15 volts DC).

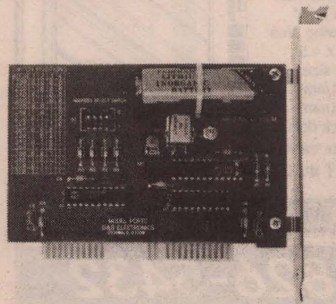
JAMPAK operates on a standard inexpensive 9-volt battery, and provides many hours of operation. It provides high volume and clear tones over a wide frequency range.

JAMPAK will operate with all standard Walkman type headsets, but has enough available output power to drive professional type headsets and speakers. The cost is $39.95 plus $3.50 S&H.

For more information, contact:

JAMPAK
P.O. BOX 1166, DEPT. NV
MEAD, WA 99021-1166

REAL TIME CLOCK



B&B Electronics' Model PCRTC is an accurate, temperature stable, real time clock for PCs. Replacing the inaccurate clock found in most PCs with the PCRTC makes your computer a reliable timekeeper. Based on a highly stable oscillator circuit, the PCRTC's clock uses a software driver to update the DOS clock every minute. This allows the user and all applications to access the correct time without using any special commands or function calls.

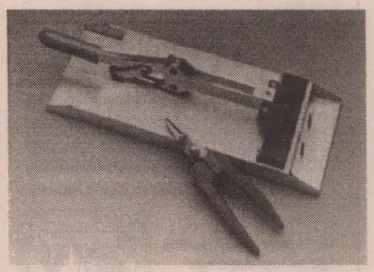
The 8-bit (short slot) PCRTC card, which does not require IRQ lines, reduces your computer's clock error to 15 seconds/month, or less than 5 seconds/month if operating in a temperature stable environment. When power is off a 3.6V lithium battery maintains the clock. Features include a battery status function that lets you replace a low battery before time is corrupted, and a register that helps you log and determine the time of last power loss or reset.

The PCRTC is priced at $129.95 and includes the software driver, a timesetting utility, and a simple command library on a 3.5" floppy disk.

For more information, contact:

B&B ELECTRONICS
MANUFACTURING CO.
707 DAYTON RD., P.O. BOX 1040,
DEPT. NV
OTTAWA, IL 61350
815-434-0846
FAX: 815-434-7094 BBS: 815-434-2927:
Internet: catrqst@b&b-elec.com

SMD TAPE SPLICING TOOL



TopLine's HRS4 tape splicing tool allows the user to add a fresh reel of SMD components without line shutdown. All you have to do is splice the leader of the new reel to the trailer of the old. The HRS4 is extremely easy to use.

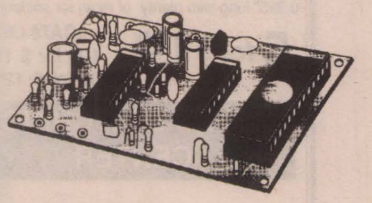
The HRS4 manual tape splicer joins all widths of SMD carrier tape. It fits 8 mm, 12 mm, 16 mm, 24 mm, 32 mm, and 44 mm tape without tooling change. The HRS4 splices plastic or metal carrier tape in seconds. Portable and completely manual, the HRS4 weighs 2.5 lbs. and is 12" x 4" x 3" in size. The HRS4 fits on a table or wagon and no batteries are required.

The complete HRS4 set includes splicing tape, cutter, and splicing tool. Extra strips of splicing tape, two types of cutting tools, and punch block and punch support are also available. Splicing tape comes in quantities of 1,000 or 10,000 pieces.

For further information and pricing, please call:

TOPLINE
310-433-7000 FAX: 310-498-0490

CWID MODULE



The new Hamtronics® CWID-2 Module features small size, ease of assembly and maintenance, versatility, and a thorough manual which describes how to take advantage of all the available options.

The CWID-2 module uses all CMOS logic. It operates on 7-15V at only 3 mA. It is easy to fit into existing enclosures because of its small size, only 1-3/4 x 3-1/8 inches. The factory programmed EPROM saves assembly time and allows longer messages than their earlier diode-matrix type CWID module, enough room for up to 200 characters. The CWID-2 can also be set to repeat a message continuously for beacon operation.

The unit has adjustable output level, tone, speed, and interval timer. Installation is easy; the thorough manual describes how to adapt the CWID-2 for various applications.

For more information, contact:

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

BEBOP TO THE BOOLEAN BOOGIE

Bebop to the Boolean Boogie is not your ordinary technical book. Engineers, electronics and computer engineers in particular, have always maintained a somewhat off-grid sense of the world seldom reflected in their technical literature. Bebop is an exception. The title alone provides some hint of what the reader can expect, namely, the unexpected. The author, Clive ("call me Max") Maxfield, an Intergraph engineer, has managed to compile a comprehensive, informative, and thoroughly engaging reference to the world of modern electronics.

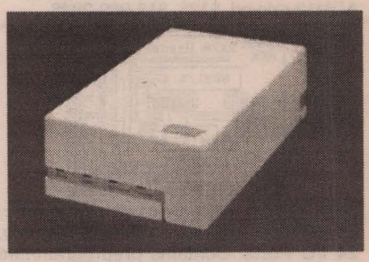
Starting with analog versus digital, Maxfield wends his way through Boolean algebra, alternative numbering systems, Karnaugh mapping, state diagrams, integrated circuits, hybrids, programmable ICs, ASICs, circuit boards, multichip modules, and the very latest technologies, such as optical memories and protein switches. In fact, there's not much that isn't covered in this 500-page tome, it even includes a recipe for seafood gumbo! Over 350 figures and tables illustrate every concept clearly and simply, and an extensive glossary provides additional insight into even the most esoteric of terms. Seven appendices cover a variety of topics in more detail.

This book is a perfect introduction for anyone interested in electronics, even those without a technical background, although this is definitely a technical book. It's an indispensable reference for anyone in the electronics industry: practicing engineers, students, technical writers, technicians, and sales/marketing personnel.

For more information, contact:

HIGHTEXT PUBLICATIONS, INC.
125 N. ACACIA AVE., STE. 110,
DEPT. NV
SOLANA BEACH, CA 92075
619-793-4141 FAX: 619-793-1955

LAWN II



OCI announces the introduction of LAWN II. The pioneer of spread spectrum radio modem for wireless RS-232 connection — LAWN finally retires after six years of service. LAWN provides a transparent RS-232 link for any equipment like, computer, printer, plotter, modem, industrial controller, robot, and instrument.

LAWN II supports all the functions of LAWN with 100% improvements in both the coverage range and speed. LAWN II's typical indoor range is 300 feet and the throughput is 38.4 Kbaud. With all these improvements, LAWN II's price remains the same as LAWN which has a list price of $275.00.

OCI had sold more than 25,000 LAWN to customers in the US and Canada. Using advanced spread spectrum and packet radio technologies, LAWN II provides a secure and transparent link for any RS-232

connection.

For more information, contact:

OCI
2445 MARYLAND RD., DEPT. NV
WILLOW GROVE, PA 19090
215-830-1200 FAX: 215-830-1207

DATA ACQUISITION

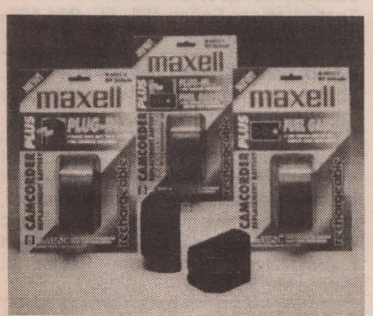
B&B Electronics Manufacturing Company introduces the 232SDA10 module, part of their new low-cost serial data acquisition line. Your choice of a 10-bit or 12-bit A/D converter, offering 11 channels of 0 to 5 VDC input, is available. Additionally, three digital inputs with a range of -30 VDC to +30 VDC, and three digital outputs with a range of 0 to 5 VDC are provided. The I/O lines are available through a female DB-25 connector.

RS-485 modules are also offered in 10-bit and 12-bit A/D formats. Both RS-232 modules can be port-powered. Only three commands are required to operate these modules, and all have automatic baud rate detection (from 1200 to 9600 baud). Each module includes demonstration programs in Quick Basic, and a data logging utility that lets you import data into other programs.

For more information, contact:

B&B ELECTRONICS MANUFACTURING CO.
707 DAYTON RD., P.O. BOX 1040
DEPT. NV
OTTAWA, IL 61350
815-434-0846
FAX: 815-434-7094 BBS: 815-434-2927
Internet techsupt@bb-elec.com:

CAMCORDER PLUS



Maxell Corporation of America announces its new Camcorder Plus battery line, including units with built-in self-charging plugs that allow convenient recharging anywhere there's an outlet, regardless of whether or not the camcorder's charging unit is present.

Other new units in the Camcorder Plus line include the Fuel Gauge battery, with a built-in LED indicator to tell the user how much power the battery has remaining. The Combination battery pack, which combines the built-in charger and fuel gauge features with high-capacity (200 mAh) cells, delivers two hours of running time, instead of the standard 1.5 hours.

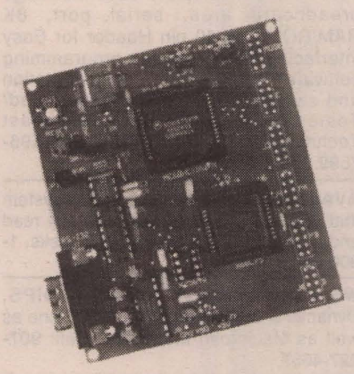
The Camcorder Plus line units are universal batteries that fit most 8 mm and VHS-C format camcorders, including Sony, Sharp, and JVC.

All batteries in the Camcorder Plus line are covered by Maxell's warranty. Suggested retail pricing for this line is as follows: Fuel Gauge (M-6033/1) $59.00, Self-Charging (M-6033/2) $69.00, and Combination (M-6033/3) $99.00.

For more information, contact:

MAXELL CORP. OF AMERICA
BATTERY PRODUCTS DIVISION
22-08 RT. 208, DEPT. NV
FAIR LAWN, NJ 07410
201-794-5900 FAX: 201-796-8790

SBC-8K MICROCONTROLLER



LDG Electronics has expanded its line of single board computers with the low-cost SBC-8K. The microcontroller, intended for embedded control, data logging, and educational applications, is one of the first 68HC11 based development systems available with the Xicor X68C75, 8K EEPROM, and Port Replacement device.

The board comes with a DB-9 RS-232 port, eight 8-bit A to Ds, 16 programmable and eight fixed I/O lines, 8704 bytes of EEPROM, 272 bytes of RAM, and socket for optional 8K Serial EEPROM. Operation is from a single 5-volt source and current consumption is less than 60 mA.

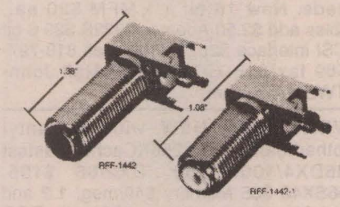
Through the new CodeLoad+ 2.0 development software, users can program the internal, external, or serial EEPROM with S19 records via RS-232. The Memory Dump command can display internal, external, or serial memory contents and store to a PC file. Program code can also be commanded to execute via RS-232. The terminal emulator allows users to send ASCII codes to SBC-8K and log received RS-232 data to a file.

The software development package included with the SBC-8K contains CodeLoad+ 2.0, source files for all sample programs and complete documentation. The SBC-8K sells for $79.95 in single quantities and the 8K Serial EEPROM option sells for $10.00.

For more information, contact:

LDG ELECTRONICS
1445 PARRAN RD., DEPT. NV
ST. LEONARD, MD 20685
410-586-2177 VOICE/FAX

RFF-1442 SERIES RIGHT ANGLE PCB MOUNT



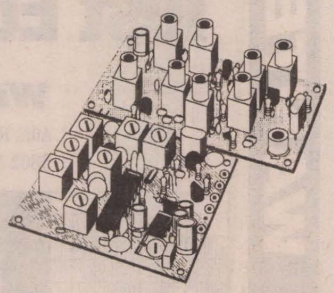
The RFF-1442 series is a cost effective OEM answer to applications involving the flow of video signal from point to point. For applications requiring 75 ohm impedance matched video circuitry, the RFF-1442 series of connectors delivers high performance while maintaining cost effectiveness.

The RFF-1442 series is currently available in two lengths. Both connectors are comprised of nickel plated bodies, Delrin dielectric, tin plated contracts.

For more information, contact:

RF INDUSTRIES, LTD.
7610 MIRAMAR RD., DEPT. NV
SAN DIEGO, CA 92126-4202
619-549-6340 FAX: 619-549-6345
1-800-233-1728

R120 VHF AIRCRAFT BAND RECEIVER



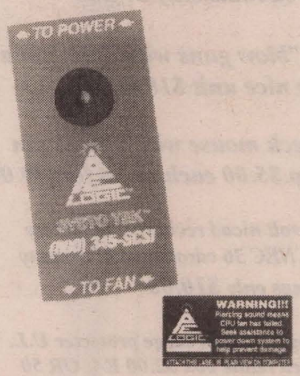
The new Hamtronix® R120 consists of two PC board modules: an IF board and a VHF converter board. It has a sensitivity of 0.2 µV. The modules are easy to build and align if you prefer to build your own kits.

The kit price is only $99.00. Assembly is relatively simple if you have built any kits before, but a signal generator is required for alignment. It is also available wired and tested for $219.00. A channel crystal is only $12.00.

For more information, contact:

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

SYSTO-TEK™



Practical Enhanced Logic, Corp., announces the release of phase one of a new product line designed for the detection of CPU fan failure on Pentium and 486DX systems. This warning device, Systo-Tek™, will emit a piercing sound should the CPU miniature cooling fan fail.

Most of today's high-speed, high-power microprocessors such as Pentium and 486DX incorporate the miniature fan technique. Failure of this fan can overheat the CPU thus causing erroneous data, processor damage, thermal damage, or even motherboard damage.

Since the system is enclosed, there is no visible detection of this problem. The piercing sound emitted from Systo-Tek will alert the operator that the CPU fan has failed. Should this occur, the operator can simply power down the system and replace the fan.

Additionally, an exterior warning label is supplied to reduce confusion of the sound alert, as well as to supply information and instruction on how to resolve this matter.

Systo-Tek installs simply between the existing fan and its current power source. No additional tools or hardware are required.

Systo-Tek is offered at a suggested retail price of $19.95.

For more information, contact:

PRACTICAL ENHANCED LOGIC, CORP.
22695 OLD CANAL RD., DEPT. NV
YORBA LINDA, CA 92687
714-282-6188 FAX: 714-282-6199

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2x cd roms only $74.00

36"blow guns with darts not a toy nice unit $18.00

Atech mouse with 9 to 25 pin adp. $5.00 each or 10 for $40.00

12 volt nicad rechargable battery for NEC 36 cdrom good for many things only $10.00

Single plug in surge protecter U.L. listed retale box $2.00 EA. OR 50 FOR $50.00

How to book on 40 top games on your computer from years past only $1.50

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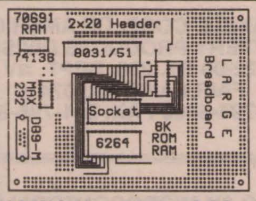

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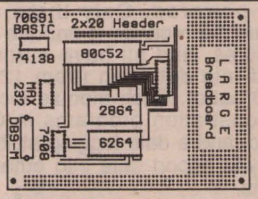

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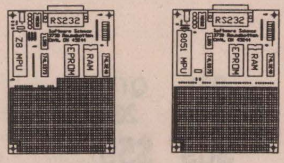

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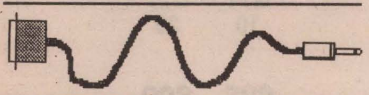

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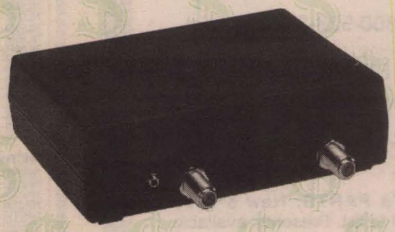

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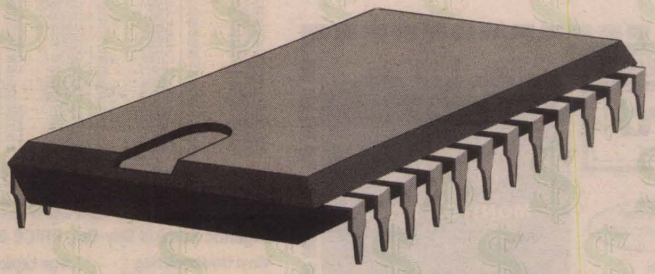

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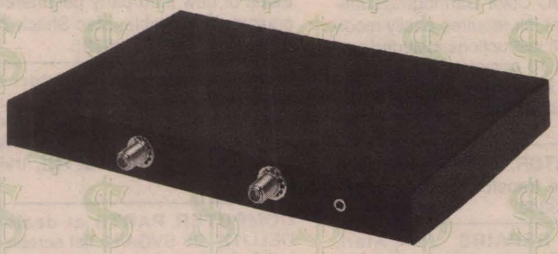

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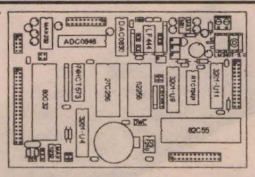

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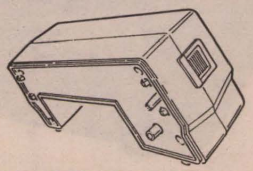

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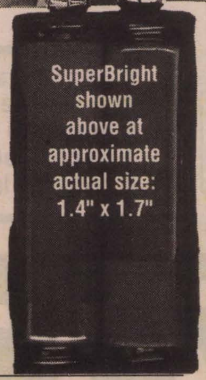

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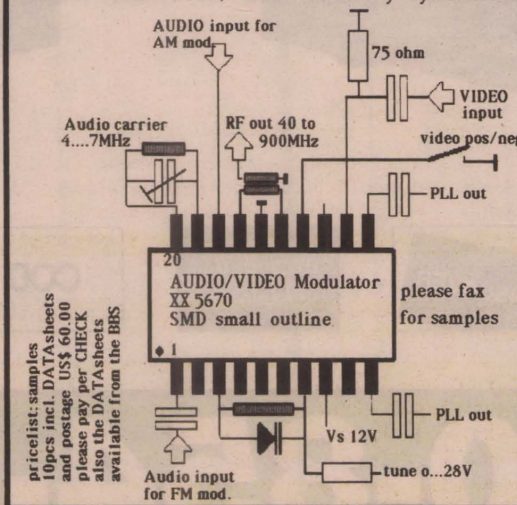

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AMATEUR ROBOTICS

by Karl Lunt

This month, I'll take you well down the path to getting the Practical Peripherals 14.4 KBaud ProClass external modem (PP144Pro) robot-ready. Be warned, this requires some very delicate work, so make sure you have a fine-tipped soldering iron, an Exacto knife, and a magnifying glass.

As mentioned in previous columns, Practical Peripherals makes two versions of an external modem. The regular class uses an embedded 8051 variant, and provides an excellent set of resources for robot hackers looking to develop with that chip.

The ProClass modems, however, use an embedded Motorola 68302 MCU. Working with this chip is normally beyond the reach of hobbyists, due to the extremely fine leads and close pin spacing.

But the PP144Pro modem design offers a unique opportunity to bolt a powerful MCU, loaded with high-speed I/O, into your robot. You just have to buy the modem, make some cuts and jumpers, and write your own robot code. This article will take care of the second item, and get you started on the third.

The tool set

This project calls for some unusual tools. The list starts with an EPROM programmer that supports the 32-pin 27c1001 EPROMs. I have been using the Needham's PB10 programmer, available from Digi-Key and other mail order houses.

The PB10 consists of a PCB that plugs into a slot inside your PC, and a 40-pin ZIF socket on a frame, which sits outside your PC and connects to the card via a supplied ribbon cable.

The PB10 comes with software that provides a crucial function in 68302 development. The PP144Pro uses two EPROMs, one containing the odd bytes of the executable program, the other containing the even bytes. To successfully develop code for the 68302, you must have some means of splitting your executable files into these two halves.

For the PB10, the O- option lets you split an object file into two or more sections, then program selected sections into each EPROM. Note that this splitting only occurs during EPROM programming. The PB10 does not generate separate, split files.

I have mixed feelings about the B10. It certainly does everything I need to do regarding EPROM programming, it is very fast, and it handles some large devices.

But I find the standard display colors awful, and the mouse cursor is a large blinking block that annoys me to no end. I wouldn't mind a block that doesn't blink, but the flashing cursor is too much. Unfortunately, Needham's couldn't provide me with a way to turn off the cursor or stop its blinking.

The PB10 supports macros, and you can customize the initialization file, if necessary. You can also buy separate adapters to go with your PB10, so it can handle programmable MCUs and other devices..

And the price, about $140.00 from Digi-Key, is quite reasonable. In all, this is a solid tool for any development requiring EPROM support.

You will also need a 68000 assembler or compiler. The 68302 uses a 68000 as its core CPU, so you can use nearly anything that generates 68000 executable files. I found a few public-domain 68000 assemblers on the Internet, and for now have settled on ASM.

If you use a C (or other) compiler for your development work, you must be able to insert a run-time initialization file, so your code can set up the 68302 before running your main program. I'll get to the reasons for this shortly.

You will also need an EPROM eraser and a supply of 27c1001 EPROMs. I use the Walling MOD-D II UV eraser, available from Digi-Key for about $40.00 Walling makes two models: one with an adjustable timer and one without the timer.

I strongly prefer the unit that lacks the timer. Invariably, the timer, even at its maximum setting, doesn't completely erase whatever EPROM I'm using. Then, the timer goes off and shuts down the eraser. So besides having the irritating timer sound, I still have to run the eraser one more time.

So I just use the cheaper model and let it go. Sometimes, I forget and erase the EPROMs for a couple of hours, but haven't damaged anything that way, at least not yet.

As to the EPROMs, I bought six chips from Prime Electronic Components, who advertise regularly in *Nuts & Volts*. They shipped quickly, sent confirming paperwork, and took plastic over the phone. They have good prices, too.

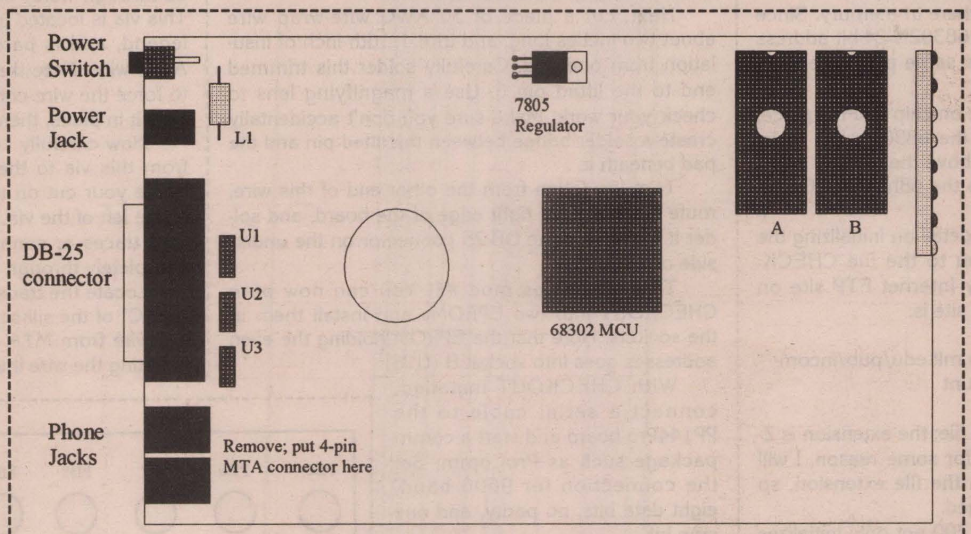


Diagram of PP144 board layout

Last month . . .

I started this hack last month; please review that column for background details.

The 68302 contains three very sophisticated serial communications controllers (SCCs), which provide serial I/O. Though vaguely related to the 68hc11's serial communications interface (SCI), the SCCs provide far more complex features, and are naturally far more difficult to set up.

The 68302 SCC contains hardware (actually, RISC microcode) support for serial formats such as HDLC, BiSync, DDCMP, and V.110 protocols. Each of the three separate SCCs can handle up to eight transmit and eight receive DMA buffers, and can use either internal or external clocks. Clock rates using the 68302's internal clock generator can hit 5.56 MHz, which translates into 347 KBaud.

With some work, you can even set up an SCC to act as a 9600 baud UART.

I will never again complain that the 68hc11 SCI is complicated or hard to use. Not after struggling through the ritual needed to set up one of the 68302's SCCs.

I started with code contained in the Motorola *MC68302 Integrated Multiprotocol Processor User's Manual*, available from the Motorola literature center or through your local Motorola field office. The literature number for this book is MC68302UM/AD.

Don't even think about using the 68302 without a copy of this book. If you want to hack the 68302, but don't have a copy already, stop reading this article right now and go order one.

The sample code contained in the User's Manual sets up SCC3 as a plain-vanilla UART, using two DMA buffers for both transmit and receive. All buffers are only one-byte long, so this code creates a double-buffered UART.

The code was designed to run on some type of commercial 68302 development platform, so by the time this code actually started running, the 68302 would have already been fully initialized. Unfortunately, I needed to add custom code to initialize the PP144Pro before I could run the UART code.

The PP144Pro, like most 68000 systems, uses a two-step configuration process immediately following power-up. Initially, the EPROM resides at address $0, where the 68000 expects to find its reset and interrupt vectors.

Eventually, however, the application program will want RAM in the $0 address space. This lets the program modify the interrupt vectors in low memory.

Thus, the start-up code must begin running in the $0 area, then somehow move itself to a higher address range and move RAM down into the $0 area.

The 68302 makes this process fairly easy, as it has four software-configurable chip select lines and

1152 bytes of on-chip RAM.

The upper half of this RAM is assigned to support the SCCs; these 576 bytes are called parameter RAM. The lower 576 bytes can be used for any purpose, such as stack space or data storage. Motorola calls this section of on-chip memory system RAM.

The technique for shifting memory devices then becomes straightforward. The application program writes a few bytes of executable code into an area of system RAM, then jumps to the code. This code shifts the memory devices as needed, then jumps back to the correct address in the newly-moved ROM.

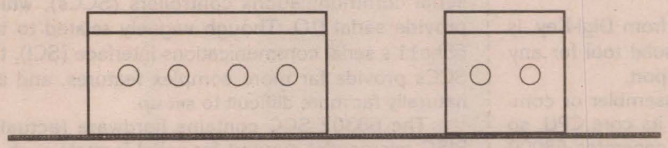


Diagram showing wiring and mounting of MTA connectors

Note that your code must first position this block of on-chip RAM somewhere in memory. Since it can reside anywhere in the 68302's 24-bit address space, my code puts it in the same place the sample code did, at $700000.

When your code fixes the on-chip RAM in place, it also sets the addresses of the 68302's I/O registers. These registers sit just above the on-chip RAM, and serve functions similar to the 68hc11's I/O registers.

I won't go into any more detail on initializing the 68302. Instead, I'll refer you to the file CHECKOUT.Z00, available from my Internet FTP site on cherupakha. The URL for this site is:

ftp://cherupakha.media.mit.edu/pub/incoming/karl_lunt

Note that this is a ZIPped file; the extension is Z-zero-zero. If I update the file for some reason, I will change the last two digits in the file extension, so you can tell the file has changed.

The code in CHECKOUT.Z00 not only initializes the 68302 on the PP144Pro board, it also sets up SCC3 to echo any characters it receives via the board's RS-232 connector.

Unfortunately, the stock PP144Pro modem board isn't wired properly to do this. Therefore, you will have to modify the board before you can use its serial port for your own programs.

Hardware mods

I'm going to describe three different mods, the first two involving the RS-232 serial connector. The first mod lets you use the original RS-232 connector for your serial hookup. The second mod disables the original connector, replacing it with my standard four-pin MTA male connector.

The third mod makes your PP144Pro modem board completely battery powered, ready for installation in a robot frame.

If you want, you can perform just the first mod, and continue to use the RS-232 connector for communication. You can always perform the second and third mods later, if necessary.

If, however, you intend to use the PP144Pro as the heart of a robot, you will eventually have to perform the last two mods.

Note that the CHECKOUT program will work with all mods.

First, a comment about orientation. Whenever I describe the location of landmarks on the PP144Pro PCB, I am viewing the board with the DB-25 connector to the left and the LEDs in the upper-right corner. Refer to the accompanying layout diagram.

Mod #1 is straightforward. You must unsolder and lift pins U3-3 and U3-6 from their respective pads. Finally, you need to run a wire from the lifted pin 6 of U3 to pin 3 of the DB-25 connector.

This is easy to say, but can be difficult to do. Begin by locating U3, a surface-mount (SMT) chip mounted just to the right of the DB-25 connector. This is a 1488 level shifter, though the chip on my board is numbered 5788.

Use a fine-tipped soldering iron and a piece of high-grade copper braid to wick the solder from pins 3 and 6 of this device. Using the soldering iron and an Exacto blade, carefully heat one of these leads and pry it up far enough to clear the board. Do the same on the other lead.

Next, cut a piece of 30 AWG wire-wrap wire about two inches long, and trim 1/16th inch of insulation from one end. Carefully solder this trimmed end to the lifted pin 6. Use a magnifying lens to check your work. Make sure you don't accidentally create a solder bridge between the lifted pin and the pad beneath it.

Trim insulation from the other end of this wire, route it around the right edge of the board, and solder it to pin 3 of the DB-25 connector on the underside of the board.

This completes mod #1. You can now burn CHECKOUT into two EPROMs and install them in the sockets. Note that the EPROM holding the even addresses goes into socket B (U16).

With CHECKOUT installed, connect a serial cable to the PP144Pro board and start a comm package such as ProComm. Set the connection for 9600 baud, eight data bits, no parity, and one stop bit.

Plug the PP144Pro wall-wart into the power connector and turn on the board's switch. Three LEDs should light on the front panel; the green LED nearest the board's center will blink. If you press a key on the PC, you should see the character echoed on the screen.

Congratulations! You now have access to an extremely powerful robot brain. Now would be a good time to look through the 68302 User's Manual, to get a feel for all the other resources on this chip besides what I've discussed here.

To give you an idea of the processor's speed, the blinking LED changes state after running through a polling loop $ffff times. Those of you used to the 68hc11's speed are in for a pleasant surprise.

Mod #2 configures the PP144Pro board to use my standard serial connector. This mod is more involved than mod #1, and requires some careful trace cutting.

Begin by cutting four pieces of 30 AWG wire-wrap wire, each about 2.5 inches long. Solder one end of each wire to a pin on a four-pin MTA male connector. Refer to the accompanying diagram for pin identification.

The next step requires clearing some space on the PCB for mounting the MTA connector. Since I no longer need this board to work as a modem, pulling off all the modem components makes sense.

If you hold the PCB up in front of a strong light, you will clearly see where the opaque ground plane ends and the translucent modem area begins.

I sat down at my work bench and begin removing components from the modem area of the PP144Pro board. The first items I removed were the two phone jacks, J3 and J4, located just below the DB-25 connector. This clears the space for mounting the MTA serial connector later.

I also pulled off C22, C23, and U5. This frees up some important solder pads that you will use in a moment. Do not remove any components, other than C22, C23, and U5, that are not mounted wholely within this modem area! I ended up leaving the small SMT parts in place, because it was too much hassle to try and remove them.

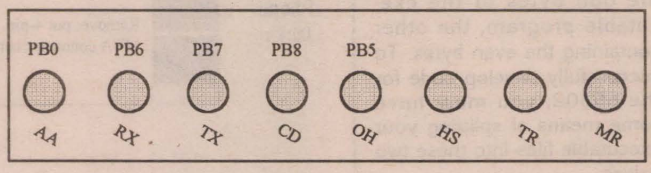
Now you can finish wiring up the MTA serial connector. Solder the wire from MTA pin 1 to the upper pad of C23. This is the ground connection for the serial port.

Solder the wire from MTA pin 2 to pad 5 of U5. This is the +5 connection for the serial port.

Solder the wire from MTA pin 3 to the via (plated-through hole) between pads 10 and 11 of U3. This via is located just above the "R4" silk-screened legend, and is barely large enough to take a 30 AWG wire. Note that you will probably not be able to force the wire completely through the via. Simply hold it in place, then add a touch of solder.

Now carefully cut the trace that runs diagonally from this via to the underside of U3. Be sure you make your cut on the diagonal length of the trace, to the left of the via. Do not damage any of the adjacent traces or connections, and verify that you cut completely through the trace.

Locate the trace running to the via that is inside the "C" of the silkscreen for C19. You must connect the wire from MTA pin 4 to this trace. You can try inserting the wire into the via and soldering it.



Port assignments for PP144-PRO panel LEDs

You can also do what I did, which was to carefully scrape some of the solder mask off of this trace, immediately to the right of the "C19" legend, then solder the wire to the exposed copper.

Now, turn the PP144Pro PCB over, and orient it so the DB-25 connector lies to the right and the modem area to the lower right. Locate the trace that comes from the via labeled T131 and runs to the right, passing just below resistor R60.

This via is electrically connected to the trace now wired to MTA pin 4. You can verify this with an ohmmeter.

Cut this trace, using an Exacto knife or other sharp blade.

This completes mod #2. The DB-25 connector is no longer available; all serial communications must now go through the MTA serial connector.

Remember that the MTA serial connection is digital, not RS-232. You must provide some external means of translating the digital signals at the MTA connector to the RS-232 levels needed by your PC. I suggest you use one of my MAX232 adapters, described in previous columns.

You should be able to run the CHECKOUT program as before, now using the MTA connector.

The CHECKOUT program serves as a good verification tool. If you make other mods to the PP144Pro PCB, you can always plug the CHECKOUT EPROMs into the board and verify that everything still works. If the board no longer echos characters, stop and figure out what you changed, and fix it before continuing.

Robot-ready

Unfortunately, you cannot use the PP144Pro PCB on a robot in its present state. The 1488 and 1489 RS-232 drivers require +12 volts and the +12 VDC power supply circuitry is still on-board.

The following mod fixes that. Note that you cannot proceed until you have installed and tested the second mod described above.

The first step towards making the PP144Pro robot-ready involves removing the 1488 and 1489 drivers. This is a simple, though brutal, task.

Using a pair of sharp, fine-tipped diagonal cutters, carefully cut each lead on the right-hand side of U3, U2, and U1. Cut each lead as close to the body of the chip as you can. Make sure you don't accidentally damage any of the nearby traces or components.

After these leads have been cut, carefully lift the right-side edge of one chip, hinging it up on the left-side leads. Work the chip body up and down through about a 45-degree arc, fatiguing the left-side leads until they all break.

Do NOT try to pull the chip free of the left-side traces; you will destroy the board. Simply hinge the chip back and forth until the leads all break from fatigue.

Repeat this procedure on the other two chips.

Now use a fine-tipped soldering iron to carefully clean all of the IC pads of metal chips and solder. Make sure you don't accidently leave a solder bridge between pads or to adjacent traces.

This removes nearly all of the on-board ICs that use +12 VDC. I say "nearly," because the LM386 amplifier chip (U4), used to drive the speaker, remains. I decided for now to leave the chip in place. I may later add enough voltage to power the LM386 back up, and it would be fun to have an amplifier already available.

Next up, you need to remove the on-board power supply so you can run your 68302 system from batteries. Begin by removing the power jack, located between the power switch and the DB-25 connector.

Next, lift only the lower lead of ferrite bead inductor L1, mounted next to the power switch. This isolates one of the switch leads, which we will later use as a power supply point.

Now clip all three leads from the 7805 voltage regulator. This is the flat three-pin device riveted to the PCB, about midway across the top of the board. I don't recommend trying to drill out the rivet; just cut all the leads off and unsolder the clipped leads from the board.

Clip the cathode lead of a 1n4001 diode to about one inch long, then solder this lead to the center lug of the power switch.

Twist a pair of wires, one red and one black, into a two-conductor cable about three inches long. Be sure to use stranded wire; 28 to 22 AWG should be fine.

Strip about 3/8-inch insulation from all ends of the wires.

Slide a short length of thin heat-shrink over one end of the red wire. Solder this wire to the anode end of the 1n4001, then shrink the insulation in place using the tip of your soldering iron.

Solder the matching end of the black wire to the negative terminal of the large electrolytic capacitor, located near the now-defunct 7805 voltage regulator.

Solder a two-pin male MTA connector to the other ends of this power cable. Watch the polarity of the hookup; use the accompanying diagram for reference.

Finally, cut a piece of stranded wire about three inches long. Solder one end to the free lead of ferrite bead inductor L1. Dress this connection so it does not contact any other circuitry. If you like, you can slide a piece of heat-shrink over the connection and shrink it down.

Solder the remaining end of the this wire to the lowest of the three cleared pads to the left of the 7805 regulator. This connection provides power to the board when the power switch is closed.

This finishes the power supply circuitry. The board will work just fine with a power supply made of four alkaline C-cells. The diode provides polarity protection, so you don't burn up your board by accidently installing the batteries backwards.

The diode also provides about 0.7 VDC drop. The board contains a couple of 74ls parts, which require a power supply more nearly +5 VDC than the 'hc parts.

Note that four alkalines provide roughly +6 VDC, but four NiCds only give about +4.8 VDC. If you know you will only use NiCds in your battery pack, you can try using a Schottky diode, such as the 1n5817, in place of the 1n4001.

A Schottky diode only gives about 0.2 VDC drop, which could leave enough juice for the board. I haven't tried this, though, so check your voltage measurements before actually turning on the board.

All that remains is a little cleanup. Use some five-minute epoxy or hot-glue to glue the four-pin MTA serial connector to the board, in the same location previously used by the phone jack nearest the DB-25 connector. Similarly, glue the two-pin power connector in place, in the same location previously used by the power jack.

While the glue sets, find the plastic case originally used to house the modem board. (You did save the case, didn't you?)

Using a small file, rough out the power jack hole in the case until it is large enough to provide access to your power connector through the case wall.

When the glue has cured completely, carefully slide the PCB back into its case. Bolt the board into place using the original 4-40 hardware.

Put two four-inch strips of double-sided foam tape on the top of the case, over the slots originally used as a speaker baffle. Press a plastic four-cell C-size battery holder onto the foam tape strips. Add a suitable power connector, hook up your power cable, and throw the switch. If you made all of your mods correctly, the LEDs should blink in their familiar pattern.

As always, you can reach me at:
Karl Lunt
2133 186th Pl., S.E.
Bothell, WA 98012
E-Mail: karl@mav.com

Wrapping up

This completes the major effort in turning a PP144Pro modem into a robot brain. You can now begin the job of writing your robot code, using the CHECKOUT program as a starting point.

Next month, I will show you how to convert the now-defunct DB-25 connector into an I/O port for experimentation. This conversion will let you hook a ribbon cable, terminated in a DB-25 pin connector, into the modem's electronics. The cable, in turn, brings selected I/O pins out to a header for easy access.

For now, feel free to hack away. Refer to the accompanying chart of LED connections for details on a few of the I/O lines. You can tie into these lines temporarily, to try some quick experiments. Remember that the LEDs are active low; you must write a 0 to the I/O port pin in order to turn on the LED.

Brain exercise

I often worry that my creativity doesn't get enough workout. Yes, I design robots and robot subsystems, but that just exercises the same brain areas that I usually exercise. What about those brain cells that I don't use so often? How do I keep them in shape?

A couple we know recently introduced Linda and me to Tangoes. Those of you with small children probably already know about these little plastic geometric puzzles.

For the rest of you, Tangoes consists of seven flat shapes, usually made of brightly colored plastic. You can arrange the plastic pieces in seemingly endless patterns, creating everything from geometric designs to stylized pictures of animals or other objects.

To provide both challenge and instruction, you can buy separate decks of Tangoes cards. Each card contains two large (usually black) designs for you to try duplicating, one design on each side of the card. Each side also contains the solution to the design pictured opposite, with the proper arrangment outlined in white.

Note that you can get Tangoes card decks in three different difficulty levels. Linda and I started with level two.

My first attempt was pretty discouraging. It was as if my brain simply lacked some key element, as if I had a sponge where there should have been neurons. I spent several minutes just pushing the pieces around on the table, hoping that my efforts would create a solution out of simple Brownian motion.

Eventually, though, I began to "see" differently. The pictured shapes I was trying to make would take on internal lines that matched the available Tangoes pieces. After enough practice, I could imagine the Tangoes pieces moving about on the design, rearranging themselves, until the solution appeared.

Those of you accustomed to working and thinking in graphics images may find this pretty small potatoes. But I've always been a text-based life form, and graphics has never held much fascination for me. Consequently, I've let that section of my brain grow dormant; at least that's how it seems to me.

Doing the Tangoes puzzle forces me to exercise that little-used section of my brain, and I could "feel" those neurons rousing themselves from their long naps, stretching themselves, and starting to move about.

And who knows; perhaps this creative stimulation will result later in a cool robot design or mondo hack that I might have missed otherwise.

Regardless, I'll continue to work the Tangoes. If you want to try your hand at this ancient Chinese puzzle, hit a nearby toy store. Four sets of pieces and a deck of cards will only set you back about $12.00. Consider it an investment in your brain's good health. **NV**

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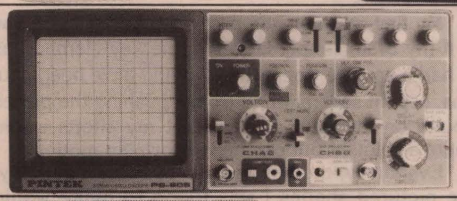

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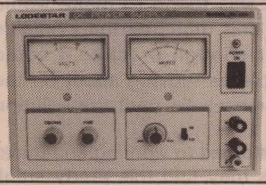

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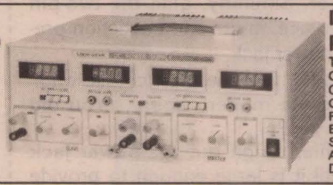

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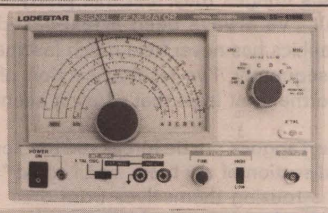

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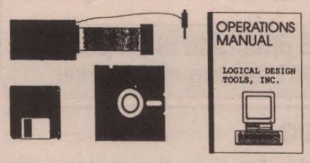

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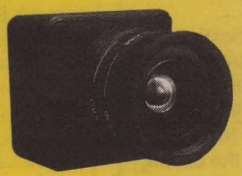
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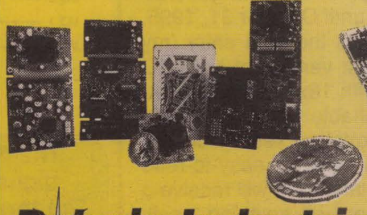

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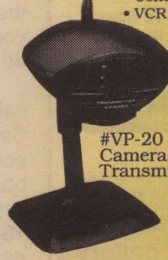
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Stamp Applications:

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

by Scott Edwards

This month's first application was contributed by Guy Marsden of ART TEC, Oakland, CA. Guy, a former visual effects specialist for the movies *(Star Trek the Motion Picture, Ghostbusters, 2010)* makes his living helping artists incorporate electronics into their work.

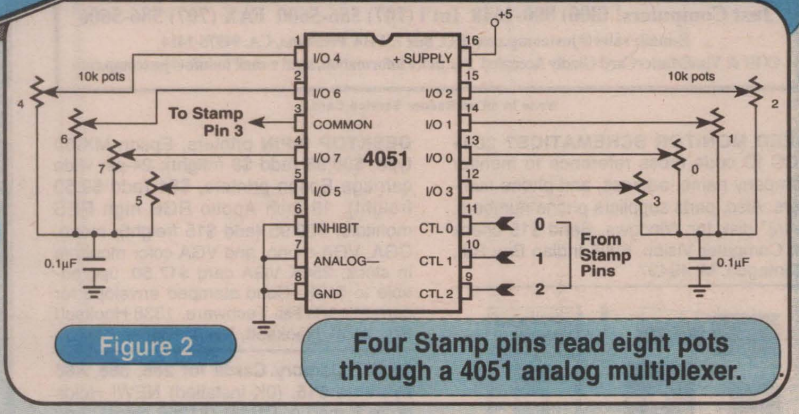

Figure 2

Four Stamp pins read eight pots through a 4051 analog multiplexer.

Checking Battery Condition, Adding I/O Lines, And a Contest for a Free LCD Serial Backpack!

One such work was powered by a 12-volt lead-acid battery, and Guy devised a simple, effective way for the Stamp to monitor the battery and sound an alarm at charging time.

Figure 1 and Listing 1 show Guy's method. He's using the brightness of the LED as a relative indication of battery voltage. The Stamp reads this brightness as a variable resistance across the photocell. When the photocell resistance exceeds a preset limit, the Stamp sounds an alarm.

Although Guy used a commercially-made optoisolator, you should get similar results with a roll-your-own version. Just mount an LED facing a photocell and cover the assembly to block outside light.

This approach can be used more generally to convert a variable voltage into a form that can be read with the Pot command. Just keep a couple of LED characteristics in mind:

> LEDs have a relatively high forward voltage of approximately 1.5 to 2.1 volts. They don't light at all if the input voltage is below their forward voltage. They require a series resistor to make sure that the current through them is reasonable (usually up to 25 mA continuous). To calculate the value of this resistor, use the following formula:

Series Resistor = (Input Voltage — LED Forward Voltage) / LED current

For example, suppose your input is 9 volts. Just guessing, you figure the LED forward voltage at 1.9 volts. And you decide that 10 milliamperes is a safe bet for current. (Remember that most electronic formulas involving current want the value in amperes; 10 mA = 0.01 amperes.) The series resistor should be (9-1.9)/0.01 = 710 ohms. Pick the closest standard value (or the closest value that you have on hand) and you're done.

> An LED's forward voltage decreases with temperature, increasing the current that will pass through it with a given series resistance. More current usually means more light output, but brightness decreases with temperature. To make matters worse, data isn't available for most common LEDs. Even when data is available, it doesn't usually provide much detail on these effects.

So I'm wondering: Is Guy's circuit usable across a wide range of temperatures, or is it restricted to the great indoors? I started to set up an experiment to find out, then decided that a contest would be more fun.

Here's the deal: Design and construct a Stamp project to test the output of Guy's circuit over a range of at least 32 to 90 degrees F with a steady input voltage. (Temperature control can be as simple as an ice bucket in which the ice is allowed to melt.) Send me a drawing of the circuit, the BASIC program listing, a brief description of your procedure, and a copy of the data generated by it. I'll accept entries until October 31, 1995.

The reader who submits the best entry (my call) will receive the newest version of the LCD Serial Backpack display with 16x1 LCD. This latest model features switchable 2400- or 9600-baud operation, low-voltage reset circuit, improved contrast control, and an easy-to-read 16-character display. All runners-up will receive a coupon good for 10 percent off anything I sell; see the Sources box.

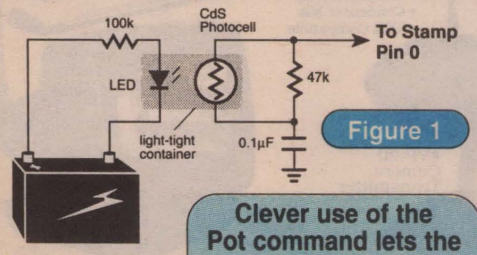

Figure 1

Clever use of the Pot command lets the Stamp monitor battery voltage.

Double Your I/O

The next application is for those of you who can never have enough input/output (I/O) lines. Although I'm demonstrating it with the Pot command, the same method will work with almost any Stamp input or output statement.

Take a look at Figure 2 and Listing 2. It's based around a 4051 multiplexer/demultiplexer chip. This device works like a digitally controlled rotary switch, shown conceptually in Figure 3. Depending on the binary number on its control bits, the chip connects one of eight I/Os to a single common pin. This connection is analog and bi-directional, so you can use it for input, output, or both. The Pot command is a good example of both, since it switches back and forth between input and output as it measures the time required to discharge a capacitor through an unknown resistance.

For an investment of four pins — three control bits and one common — you receive a dividend of eight I/Os. Better than Wall Street most days.

There are a few limitations to this trick. The first is evident if you try the pot demonstration. You can never quite get a reading of zero; the lowest the readings will go is about eight. This is because the 4051's electronic rotary switch isn't perfect — it has a resistance of approximately

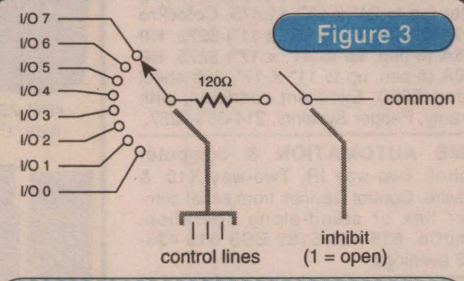

Figure 3

The 4051 multiplexer works like a digitally controlled rotary switch. The three control bits select I/O 0 (000 binary through 7 (111 binary).

Stamp Applications:

Listing 1. BASIC Stamp Battery Monitor

```
' CHEAP AND SIMPLE LOW BATTERY WARNING
' Guy Marsden, March 1995. tekart@well.com
'
' Uses a Cds opto coupler with LED input such as: CLM6000.
' Put a 33 or 47K resistor across cell and a .1uF cap to gnd.
' Use a high value resistor in series with the LED wired directly
' to the battery. I used 100K for a 12 volt system. This value is
' enough to produce a resistance of 20K at nominal battery voltage.
'
' When the voltage drops, the Cds resistance increases. By setting
' the SCALE of the POT function under a low battery condition, you
' will then have a range to work with. Determine your setpoint
' using a variable bench supply and a DVM.

symbol Batt = b2
symbol LoBatt = 220

CheckBatt:
    pot 0,76,Batt              ' check battery voltage
    if Batt > LoBatt Alarm     ' if less than established value
goto CheckBatt

Alarm:
    sound 1,100,100            ' beep piezo alarm
    pause 100
goto Alarm
```

Listing 2. Multiplexing Stamp I/O Lines

```
' Program: MULTIPOT.BAS (Multiple pots using a 4051 multiplexer)
' This program demonstrates how to connect and measure multiple
' pots using a 4051 multiplexer chip. The 4051's control inputs
' (11,10,9) connect to Stamp pins 0, 1, and 2, respectively.
' The common I/O pin (3) of the 4051 goes to Stamp pin 3.
' By writing a value between 0 and 7 to its pins, the Stamp can
' select one of eight variable-resistance inputs through the
' 4051. See the schematic for details.

SYMBOL pot_sel = b2   ' Pot number 0-7 selected through 4051.
SYMBOL pot_val = b3   ' Result of the pot measurement.

Let dirs = %0111      ' Make the lower 3 pins outputs to drive 4051.
Again:
  for pot_sel = 0 to 7      ' For each of the eight pots:
  let pins = pot_sel        ' Write pot number to the 4051.
  pot 3,150,pot_val         ' Perform pot measurement on selected pot.
  debug "pot #",#pot_sel," ",#pot_val,cr  ' Display result.
  next pot_sel              ' Read the next pot.
  pause 2000                ' Wait two seconds.
  debug cr                  ' Insert a carriage return on screen.
goto Again                  ' Do it again (endless loop).
```

120 ohms.

A second limitation is that inputs to the 4051 must never exceed 0.5 volts above the supply voltage or below ground. This means that the 4051 can't be used to directly receive RS-232 serial signals through a series resistor as the Stamp's I/O pins can.

The last restriction is common to both the 4051 and the Stamp, so it really isn't much of a limitation: Current through the 4051 should never exceed 25 mA.

If you like the 4051, but still need more I/O, try the 4067. It can provide 16 I/Os at a cost of five Stamp pins. Check your favorite data book (such as the *CMOS Cookbook* by Don Lancaster) for details. NV

Sources

Enter the LCD Serial Backpack contest and win a new LCD display for your Stamp projects (a $40.00 value) or 10 percent off Stamp accessories and microcontroller projects seen here in *Nuts & Volts*. Entries (or questions, suggestions, requests) to: **Scott Edwards Electronics**, 964 Cactus Wren Lane, Sierra Vista, AZ 85635; phone **(602) 459-4802**; fax **(602) 459-0623**; E-Mail (CompuServe) at **72037,2612**; Internet **72037.2612@compuserve.com**

For more information on the BASIC Stamp, contact **Parallax** Inc., 3805 Atherton Road No. 102, Rocklin, CA 95765; phone **(916) 624-8333**; Fax **(916) 624-8003**; BBS **(916) 624-7101**.

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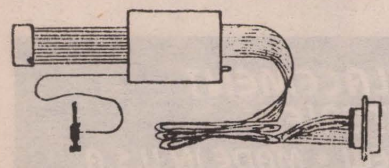

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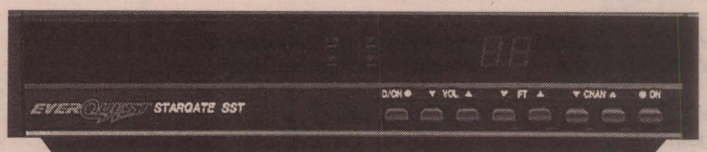

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3. Place paper face down on T-shirt and iron the back of paper to transfer the image.

Available in red, green, blue, or black at **$10.95** each for the following printers *(specify make and colors wanted)*: Panasonic 1080/1180/1090/1190/1123/1124; IBM Proprinter; Epson MX/FX/RX 80/85/86e/LX800/LQ500/LQ510/LQ570/L1000; Star NX/NL/ NP10; Seikosha SP800/1000, Tandy DMP130; Apple Imagewriter, Citizen 120D/180D/GSX140; Okidata 182/192/320.

$11.95 each for Epson MX/FX-100/286e, LQ1000/1050, LQ2500/2550/EX800/1000/LQ860, AP3250/LQ100 Star NX1020/2400/2410/2415/2420, Panasonic KX-P 2180/2123/2124/1624/1524, Toshiba P321/351/1340. **$5.95** each for Okidata 82/92/83/93, Gemini 10X/15X.

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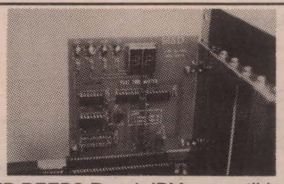

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FNB-33(S)	4.8v @	1500 mAh
FNB-35SS	7.2v @	1500 mAh
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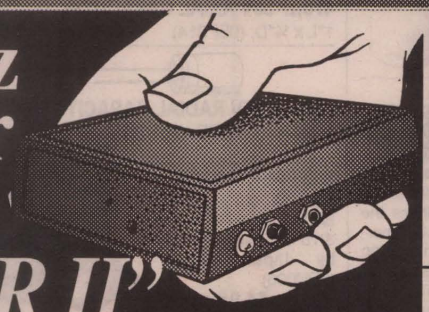
The 10GHz transmitter is back... The "ZAPPER II"



Rainbow's new amateur radio transmitter.

With it's new and improved design it will not only test your radar detector... BUT it's tuned to the amateur radio band.

- While your out on American highways personally test yours and your fellow travelers radar detectors.

The "ZAPPER II" is a 10.450 GHz to 10.550 CW oscillator. It has a code key jack installed for those who want to send Morse code.

BUILT $49.95

KIT $39.95

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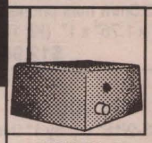

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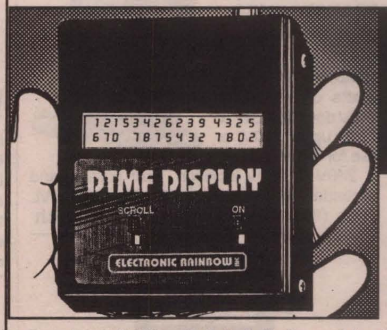

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Connects to any phone, scanner,or amateur radio.

DECODES ANY DTMF SIGNALS

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  - * Is someone hiding the numbers they are calling by using another credit card?
  - * See the hidden phone numbers in your software.
  - * Great for telephone installers
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NOTE: All TV Filter Kits are sold for educational purposes only. You must obtain permission from your local cable company before using these filters on your cable system.

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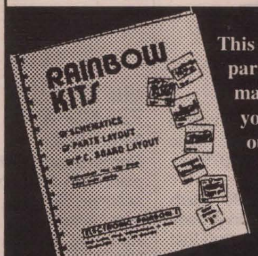

This Manual contains schematics, parts lists & P.C. board layouts for many of the Rainbow Kits. Use your own parts to construct our kits.

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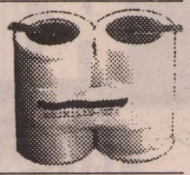
Strapped in pairs with welded contacts. May be separated with care. (94E009)
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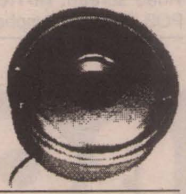
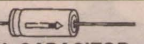
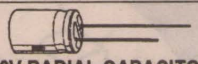
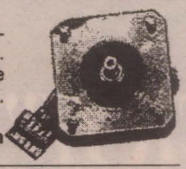

Loud and annoying. 2" dia., 7/8" thick. (95U008)
$1.49 each



470µF 50V AXIAL CAPACITOR
1"L x ½"D. (95P014) **100 for $39.95**



3300µF 16V RADIAL CAPACITOR
1.375"L x 0.625"D. (95P012)
50 for $19.95

STEPPER MOTOR

12V, 1A, 0.9°/step. 1-5/8" square x ¾" deep. 3/16" x ½" shaft. Made by Japan Servo. (95M006)
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+5VDC @ 500mA, +12V or -12V DC @ 415mA. (95E023) **$9.95 each**

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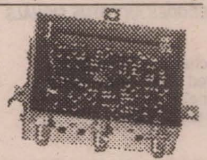
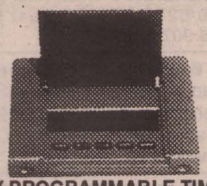

Contains two transistors with FT of 4GHz 10dB gain, 3dB NF. Soup up that VHF receiver, scanner, FM tuner, VHF-TV reception or whatever. Actually has two preamps in one case. Runs on 12VDC. Schematics included and hints for broadband use. (92A026)
$7.95 each



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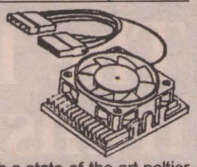
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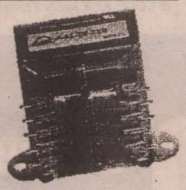
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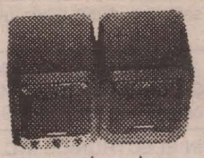
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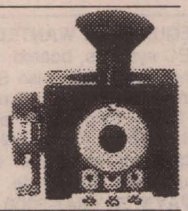
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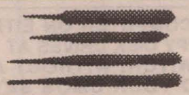

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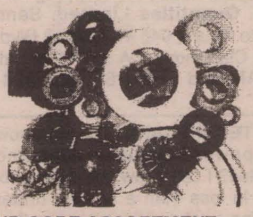

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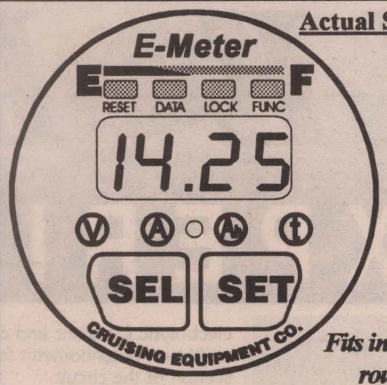

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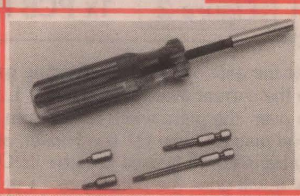

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THE LASER EXPERIMENTER

Conducted by
Anthony Charlton

Welcome! This installment we continue with our discussion of Single Heterostructure (SH) pulsed laser diodes that operate in the infrared region at 904 nM. And we shall build a 9-volt portable power supply for them.

The photograph shows the 120-volt supply discussed in the last column, and the 9-volt supply talked about here. Both these power supplies comply to the parameters required by this kind of diode. Two of those parameters are: that the pulse width for driving the diodes must not exceed 200 nanoseconds;and that the maximum duty cycle not exceed 0.1%. Both parameters are required to prevent the overheating of the SH laser's semiconductor junction. However, it is an interesting trade-off that the power available from these diodes averages over 10 watts.

Pulse Width Modulated Power Supply

The Pulse Width Modulated (PWM) type of power supply is the most efficient I've worked with so far for high-voltage inverting-type power supply circuits. With a PWM supply — which we've discussed in this forum before — the driving waveform at the primary side of the transformer is varied in width, but stable in fundamental frequency. This results in adjustable power and voltage under load at the secondary. It also means you can peak the efficiency of the inverting circuit by finding the best combination of frequency vs. pulse width.

The tiny transformer used in this project is capable of developing over 300 volts from a 9-volt battery. We need a high-voltage, in order to cause the driver transistor, Q1, to operate in an AVALANCHE MODE, as discussed in the previous column. In our case, the transformer is not operated at its full capacity, but will still produce several hundred volts, and that is stored in an electrolytic capacitor and current regulated by a multi-turn potentiometer to operate the SH driver section of the circuit.

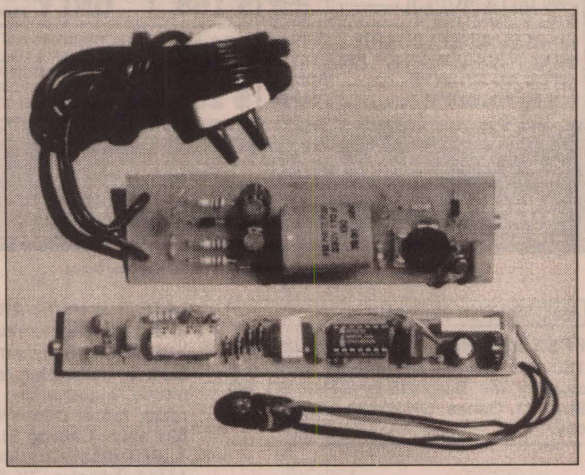
Consulting Figure #1, we can trace how the circuit works. Nine volts DC from a battery or regulated power supply is input to the circuit. D1 protects the circuit from destruction in case of accidental polarity reversal of the battery. Gate A of a Schmitt Trigger, which has a total of six inverting gates, forms an oscillator along with the frequency-determining components R1 and C1. This oscillator runs at approximately 25 KHz, although this frequency will change depending upon who manufactured IC1, because it's a fact that the Schmitt Trigger parameters will vary from batch-to-batch and manufacturer to manufacturer If need be, you can substitute a potentiometer for R1 to adjust the frequency for maximum efficiency.

Gate B squares up the output from the oscillator. Along with it are components C2, VR1, R2, R3, D2, and C3. They form the PWM part of the circuit. When VR1, the SYSTEM POWER ADJUSTMENT control, is set to maximum, the minimum width of the PWM pulse will occur. This is inverted by four Schmitt gates so that the maximum pulse width — when VR1 is set to its maximum adjustment position — is seen at the gate of Q1. The inverting gates C-F also increase the current available to drive Q1, and as said, they flip over the pulse width for us from narrow to wide. One may ask why Q1 is a Hexfet, and not an ordinary transistor. It is used because its ON resistance is so low it will drive the primary of T1 at the most efficient switching rate. That increases the power available over a normal transistor for the same input power. The ON resistance for this particular part is typically only 0.1 ohms.

T1's output current from its secondary is rectified by the four rectifiers D2-D5 and stored in C5 as a high-voltage, smoothed DC current.

This voltage may range up to 450 VDC under no load conditions. So, you can use this circuit for other high-voltage DC projects that require low-current consumption, if you wish.

I1, a common NE-2 neon indicator light, shows the presence of the high voltage. When I1 is on, you should consider the SH laser operating. Be careful! Wear oxy-acetylene welder's goggles or an approved pair of laser safety goggles if you intend to work close to the laser, or around a collimated beam especially. Output may be detected by the means discussed in last month's previous column, or by the amplifier parts of the circuit we'll see in the last section of this column.



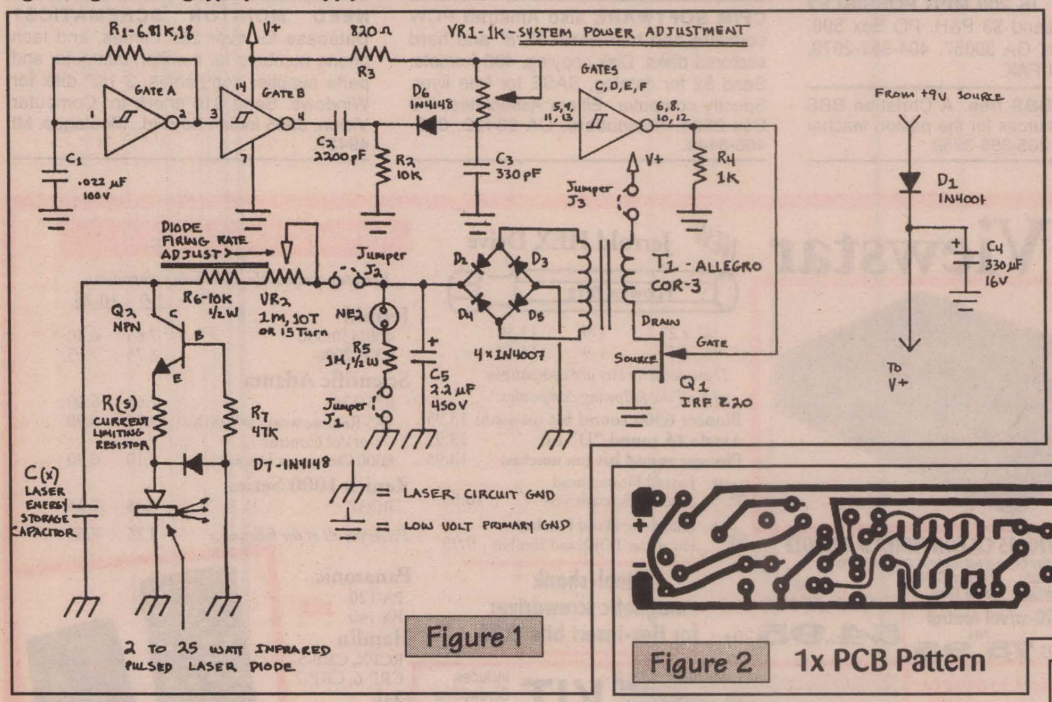


Figure 1

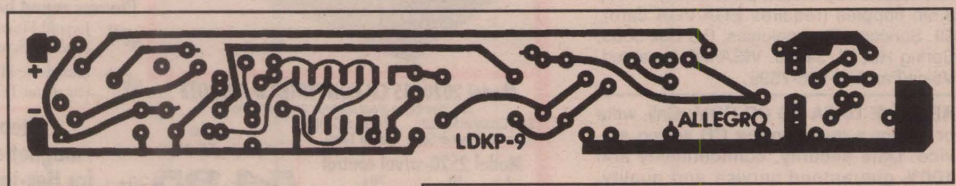


Figure 2 1x PCB Pattern

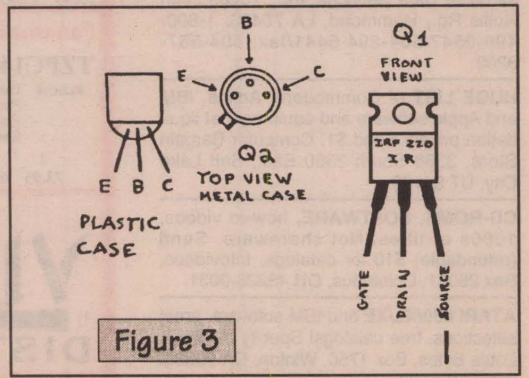


Figure 3

This Circuit Can Shock You!

Although not dangerous, you can still receive a jolt from the circuit, even if it has been sitting unplugged for awhile. This is due to the storage ability of C5, and the fact I1 cuts off before zero voltage is reached, leaving a residual charge on C5. That charge tends to slowly creep upward, to a 40 or so volt level, possibly due to the ambient 60 Hz electrical field in our houses (?). I don't know, but I would like to hear your theories if you'll write me at the Laser Experimenter's P.O. Box listed elsewhere in this column. In fact, while preparing this work, I picked up the prototype and got enough of

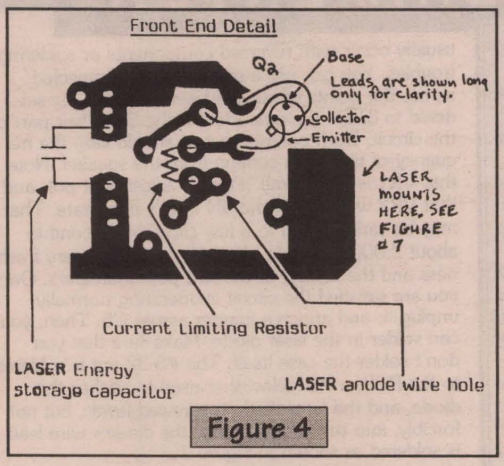
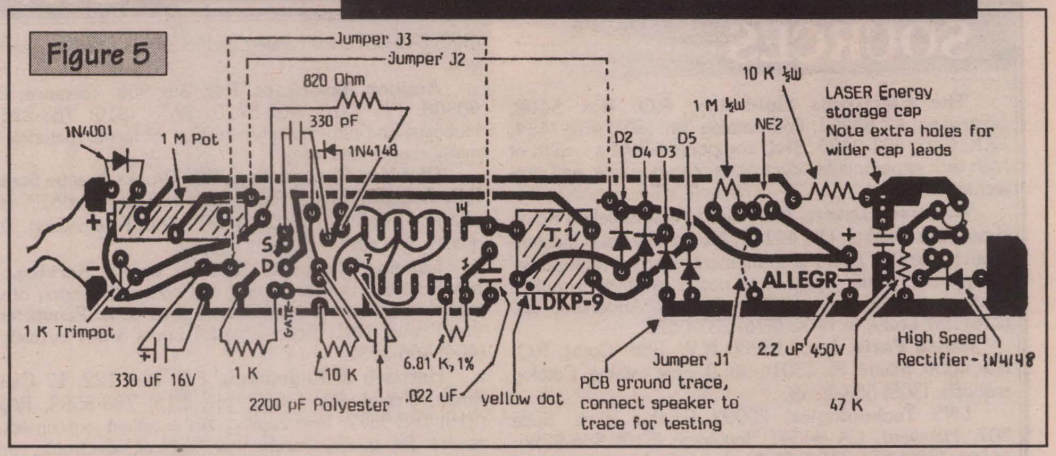


Figure 4



a shock to drop it, even though the power had been unplugged for several days. An interesting fact is: Large capacitors, such as used in industrial-sized pulsed-laser power supplies, always include a bleed resistor in the circuit to avoid a possibly lethal charge accumulating on them from this "memory" effect. If you are more comfortable with this idea, include a 22 megohm bleed resistor across C5. I'll even send you one FREE if you write the Laser Experimenter's P.O. Box.

The next part of the circuit consists of the SH laser diode (LD) driver. VR2 and R6 control the amount of power being fed to this circuit. It is important to remember that the SH laser diode will always receive exactly the same amount of power per pulse from transistor Q2, the only difference being due to ambient temperature affecting the avalanche point of Q2. VR2 is set to its minimum value for the maximum rate of pulsing from the SH laser diode. The Laser Energy Storage Capacitor, C(x), will determine the pulse width of the SH laser. Again: Width is NOT to exceed 200 nS with this type of laser! (nS = nanoseconds: One nanosecond is equal to 1/1000th of a microsecond — and at the speed of light which is 186,292 miles per second — light will travel only 11.8 inches in that time period. So you get the idea that a nanosecond is rather a short time interval, eh?)

Chart 1 shows the recommended values for R(s) and C(x) for different sized diodes. If you have access to sophisticated instrumentation (which I don't), you can fill in the blanks where the DRIVE CURRENT and PULSE WIDTH are calculated and/or observed under real-life conditions. Basically, the circuit is an R * C time constant, and the diode will operate for about one C time constant period (63% of the charge on the capacitor) before cutting off its laser mode, and falling back to non-laser operating mode.

Then its output becomes incoherent and the laser acts simply like a high-power LED. You should find it easy to calculate the values for various R and C sizes, given this information.

Tested Printed Circuit Board Pattern

Figure 2 shows a full-sized PCB pattern for the 9-volt driver circuit. We have made these traces short in the SH laser section to minimize inductance, and also heavy for the same reason. This pattern is the FOIL side, so your components are mounted to the back of the board. I might suggest once again checking out DynaArt Designs for their PCB fabbing equipment; we have been hearing a lot about these folks in print lately, due to the fact they take all the trouble out of fabbing PC boards in small to medium quantities. See the "Sources" section for info on how to contact them. Watch that the small traces don't get dissolved in the fabrication process. Those traces interconnect IC1. Also, the holes for the rectifiers, T1 and Q1, will be slightly larger than the standard 1/32" drill size commonly used for ICs and most other components. Size these larger holes at 3/64" and that should fit the parts nicely.

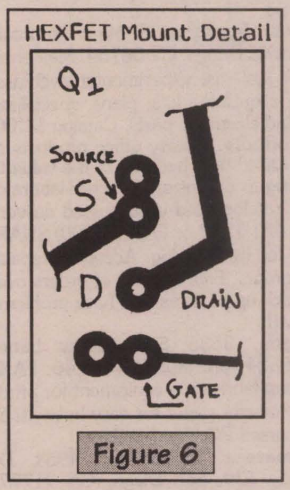
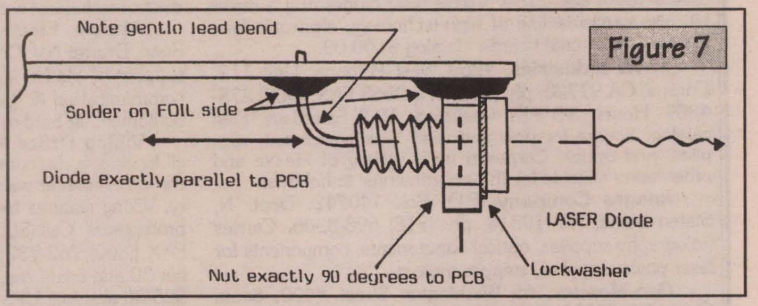
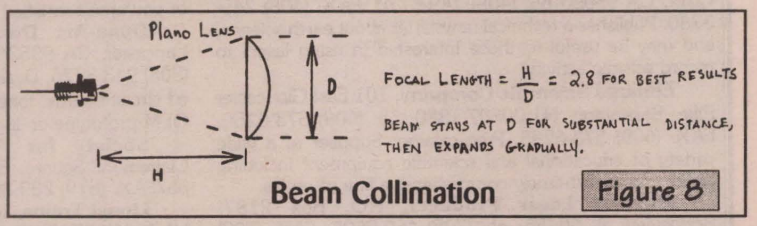


Figure 6





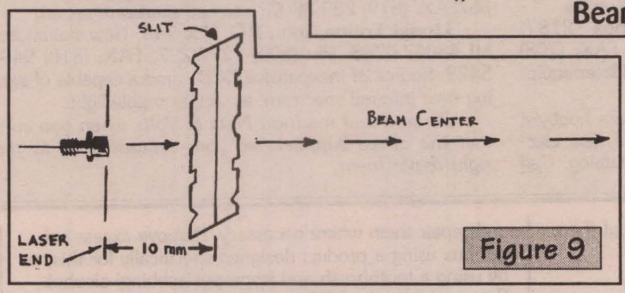


Figure 3 shows the pinout for both the versions of Q2, the 2N2222 transistor, and for Q1, the Hexfet transistor. Again, let's be sure we keep Q2's leads short, so as to minimize inductance.

Figure 4 shows the lead placement of Q2 in close-up detail.

Figure 5 depicts the parts placement guide for all the on-board components. Only the 9V battery is not shown here. This guide portrays components like you had X-Ray vision; in other words, like one was looking THROUGH the PCB from the FOIL side.

Figure 6 shows the detail of mounting the Hexfet to its location on the PCB. Use static-protective techniques for this component if your assembly location or set-up is subject to same. Although the next figure shows how to install the laser diode, hold up on soldering it in until the circuit can be tested.

Figure 7 is a re-iteration of a sketch presented in last month's column. In case anyone missed that column, we stressed the importance of mounting the SH laser diode in the manner presented, because we want to minimize lead length, eliminate sharp lead bending so as to minimize inductance effects, and also to reduce the stress on the laser diode itself. It may become damaged if there is too much of a sharp bend in its lead, and that would manifest itself after the soldering process. At several dollars per diode, one does not want to destroy them by accident!

Construction proceeds normally with this circuit, the exception being that some of the parts are rather tight-fitting, and you may want to dry-fit them in place before you solder. Use a small iron, and keep the tip good and clean. Resistors want to be installed standing up, to minimize crowding. Pay attention to the orienta-

Chart 1

C(x) uF	Drive Current, Amps		Pulse Width, ns.	Rec. Diode, watts	Resistor R(s)
.0047	(Calc)	(Obsv)	(Calc)	2-5	5.1Ω
.0068	"	"	"	5-8	3.9
.01	"	"	"	8-12	3.0
.015	"	"	"	12-16	2.0
.022	"	"	"	16-20	1.5
.033	"	"	"	20-25	1.0Ω

SOURCES

The Electronic Goldmine, P.O. Box 5408, Scottsdale, AZ 85261. Free catalog. Ph: (602) 451-7454, FAX: (602) 451-9495. SMC components and a wealth of high-tech experimenter electronics, components, and project kits.

Anderson Lasers, Inc., 2883 West Royalton Road, Broadview Heights, OH 44147. New and surplus industrial and scientific lasers & equipment. Carries high-power commercial grade equipment, not a hobbyist supplier. Professional inquiries contact: Richard Anderson, ph: (216) 237-6629, or FAX: (216) 237-0656.

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tion of the polarized components, so that none of them are accidentally installed backwards.

Testing

Check for solder bridges and "cold" solder joints, and repair them where necessary. Remove excess solder flux using a product designed specifically for this, or by using a toothbrush and isopropyl (rubbing) alcohol. Set potentiometer VR1 to midpoint, and power up the circuit using a 9-volt source. You should see the neon indicator lamp come on almost immediately. Problems usually occur with reversed components or soldering troubles. You can use a small speaker connected across the points where the laser diode will be soldered to detect the operation of the SH driver part of the circuit. Both potentiometers should vary the frequency of the clicks coming from the speaker. Note that VR1 is the overall "Power" adjustment pot, and that VR2 will control the SH laser's firing rate. That may be varied down to a few clicks per second to about 2,000 or so Hz, depending upon battery freshness and the setting of the two potentiometers. Once you are satisfied the circuit is operating normally, unplug it, and attach a jumper across C5. Then, you can solder in the laser diode. Make sure that you don't solder the case itself. The #8-32 nut is soldered to the PCB, a #8 lockwasher used to anchor the diode, and the laser diode is screwed firmly, but not forcibly, into these, and finally, the diode's wire lead is soldered as shown in Figure 7.

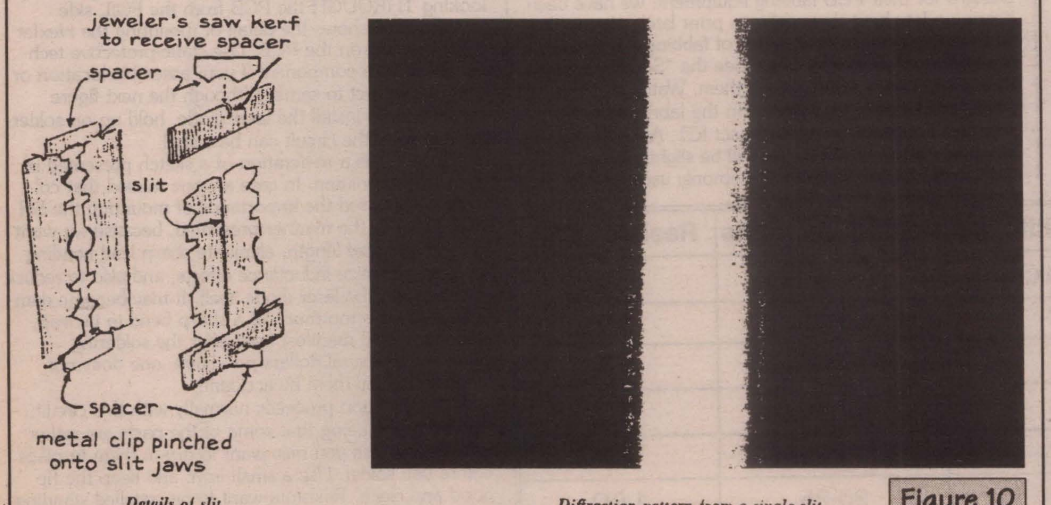

Figure 10

Diode Laser Collimation

Laser diodes of this type have an extremely divergent angle on the horizontal plane, typically 20-40 degrees. This results in rapid attenuation of the beam's power over distances. One way to correct this problem is through a specially designed lens called an ASPHERE, but the problem here is they are not readily available at a cheap price. But a reasonable solution is to use a standard plano-convex glass lens as shown in Figure 8. A 1" nominal lens has worked fine for my experimental setups, although you can use other diameters if you follow the formula given in that figure for SH laser placement and lens focal length dimensions.

Experiments

Figure 9 is a fun experiment, especially if you have purchased the inexpensive IR-sensitive CCD camera from Lionel (in "Sources" and mentioned in detail in the previous column). The purpose of this experiment is to demonstrate the dual wave/particle nature of light. If light was just a particle, there would be little or no diffraction from the slit. But since it contains both properties, we get the lines of interference characteristic of wavelike nature, where the waves re-inforce and cancel each other out through their interactions.

A slit is formed from two new razor blades evenly separated by about 0.005-0.010 inches. The SH laser is positioned about 1/2" away from the assembly. The laser does not have to be collimated, but that does improve the desired effect. The CCD camera is positioned at a point along the beam center wherever the effect wants to be observed at. I would suggest about two feet for an uncollimated beam. The room lights are extinguished, and at that point, you will notice the appearence of the slit diffraction effect on your camera's TV monitor. Black and white televisions work the best for this model of camera, as logically enough, its video output is in black and white format. By varying the width of the slit, and the distance of the laser/slit/CCD camera set-up, you can get some very interesting results from this experiment.

Figure 10 shows how to make the slit, although you can always position the two blades satisfactorily by anchoring them in a substance such as clay. Note the diffraction photograph. I wish this picture was better, but it won't come across as well after being copied and then printed in a magazine as nicely as viewing it in real life on your TV.

Fire a Strobe At Will!

The SH laser, with its high power, enables a COLLIMATED beam to fire off a strobe at a substantial remote distance. You can construct a simple peripheral circuit to trigger the laser as your camera is triggered, to respond to wildlife tripping an electronic fence at night, burglars (?), etc. The idea is the laser is invisible, so whatever trips it and correspondingly activates the

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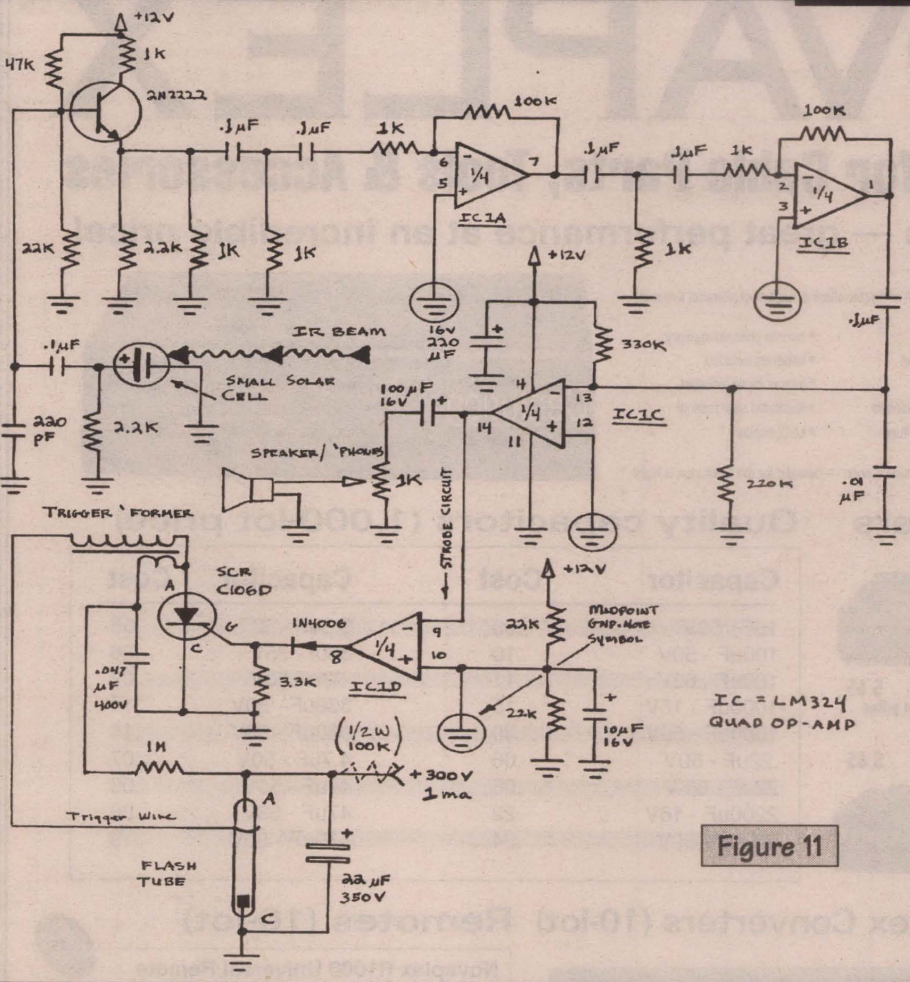

Figure 11

Parts List

T1 — Micro-sized step-up transformer, Allegro stock no. COR-3 or equiv. *(See below)*
IC1 — #74C14-ND hex Schmitt Trigger integrated circuit
Q1 — #IRF-Z20-ND Hexfet
Q2 — PN2222 or 2N2222 NPN silicon transistor
D1 — 1-A, 100 PIV rectifier, 1N4001 or equiv.
D2-D4 — 1-A, 1000 PIV rectifier, 1N4007 or equiv.
D7 — #1N4148CT-ND switching diode

R1 — 6,800-ohm (or value to suit) metal film resistor
R2 — 10,000-ohm, 1/4 watt carbon film resistor
R3 — 820-ohm, 1/4 watt carbon film resistor
R4 — 1,000-ohm, 1/4 watt carbon film resistor
R5 — 1-megohm, 1/2 watt carbon film resistor
R6 — 10,000-ohm, 1/4 watt carbon film resistor
R7 — 47,000-ohm, 1/4 watt carbon film resistor
R(s) — Current limiting resistor, 1/2 watt carbon film
VR1 — 1,000-ohm trimmer potentiometer
VR2 — #3600P-105-ND, 1-megohm, 15-turn, 3/4 watt cermet potentiometer

C1 — .022 uF, 100 volt (nominal) polyester or Mylar capacitor
C2 — 2200 pF, polyester or Mylar capacitor
C3 — 330 pF, NPO type ceramic disc capacitor
C4 — 330 uF, 25 WVDC electroytic capacitor
C5 — 2.2 uF, 450 WVDC electrolytic capacitor
C(x) — Laser energy storage capacitor, low inductance type. *See text*

I1 — NE-2 neon indicator lamp

Laser — Single Heterostructure pulsed infrared laser diode, 2-25 watts. Only this type!

Misc. — 9-volt alkaline battery, battery snap, enclosure, etc.

Note: The following part is available from Allegro Electronic Systems (see "Sources") for $4.00 postpaid: T1, stock no. COR-3, with instructions and an additional application schematic and data. Parts prefaced with a pound (#) sign are Digi-Key part numbers and substitutions are not recommended.

Strobe Experiment Circuit

These parts are obtainable through almost any electronic supply house, Radio Shack, Digi-Key, Electronic Goldmine, or Mouser. See "Sources."

remote strobe, won't know it until the strobe is fired.

Figure 11 shows a simple circuit designed to amplify the narrow laser pulses and trigger the strobe when they are received. A small solar cell is used as the sensing mechanism. A small cell is required because a large one will have too much capacitance, and that will prevent it from sensing the narrow laser pulses fast enough to activate the circuit.

IC1 is the popular LM324 quad op-amp. This circuit operates best from a +12-volt battery, however, you can operate it from a 9-volt with lessened sensitivity. Sections A and B of IC1 form a high gain amplifier with the resistive and capacitative components arranged so that they form a high-pass filter, eliminating almost all the interference from low to medium frequency sources. The laser pulses, at 200 nS down to 100 nS, correspond to a frequency of 5-10 MHz, respectively. IC1-C is an audio amp, which enables you to hear the pulses as they are picked up by the solar cell.

IC1-D is an inverter that fires the gate of an SCR when the circuit detects a "hit" by an IR laser pulse. The trigger transformer generates a pulse of several KV to ignite the Xenon flashlamp. The charge on the capacitor connected across the flashlamp determines its light output. With the values shown, it generates about a 1 watt/second flash. You can operate this circuit from a second power supply of the same type as presented in this column, omitting the components to fire the SH laser. About a minute is required between flashes to charge up the large capacitor to firing level.

Use a 100K resistor of 1/2-watt or more (as required) in series with the power supply if it generates a high current. Note the voltage divider for IC1 which generates a pseudo-split power supply for it. That is required for this kind of amplifier circuit.

There is nothing critical about this circuit, but be sure and keep the high-voltage components separated rom the low-voltage ones, especially the 4 KV+ output from the secondary of the trigger transformer. It may be very low current, but still has the potential for destroying other components despite that fact. Also, if you place the solar cell inside a paper towel tube that has been painted black inside, you'll greatly increase the sensitivity of the circuit (especially if you use a lens to focus the infrared laser pulses directly on the solar cell).

Enjoy, and we shall see you again in the next installment of The Laser Experimenter with a brand new and fun project! **NV**

CLOSING QUOTE:

"Nothing has such power to broaden the mind as the ability to investigate systematically and truly all that comes under thy observation in life."
— Marcus Aurelius, Roman Emperor/Philosopher (A.D. 121-180)

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 and software for microprocessor-based process control systems and electronic design. His hobbies include lasers, gardening, target shooting, and model rocketry.

The Laser Experimenter is a reader-interactive column. We like to hear from the readers, 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.

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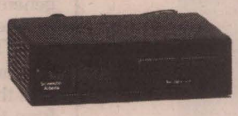

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.22uF - 50V	.06	4.7uF - 50V	.07
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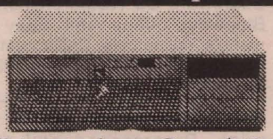

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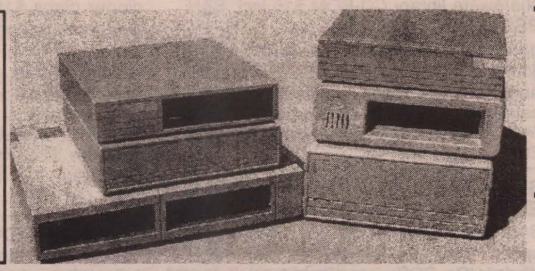

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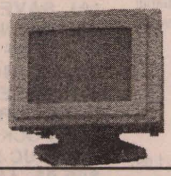

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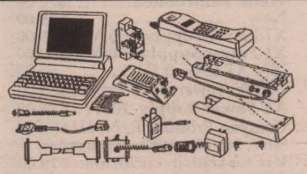

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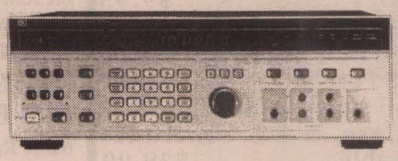

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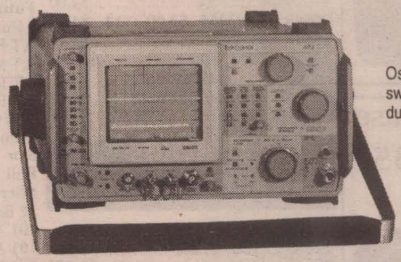

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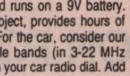

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Part 16

Electric Car Tires

by Shari Prange

You're probably thinking, "Aw, come on, how much is there to say about tires?" Actually, tires are one of the most important factors in an electric car's daily performance.

Goodyear's Momentum tire, with a 40% reduction in rolling resistance over standard original equipment tires, helped a Solectria battery-powered pickup truck log a world's record for distance in a 24-hour period.

Friction

Part of a tire's job is to provide friction between the car and the road. Friction is what allows the tires to "grab," to propel the car forward, to steer it through the corners, and to bring it to a stop. When you don't have friction — on a sheet of ice, for example — you don't have control of the car.

However, friction causes heat. Heat represents lost energy, energy that is being consumed out of your fuel, but is not being used to move the car down the road. Excess heat will stress and damage components.

Finding the optimum amount of friction is a delicate balance.

Rolling Resistance

The portion of the equation relevant to an electric car is called rolling resistance. This is measured by the amount of energy it takes to overcome the resistance and move the car. Part of the rolling resistance comes from things like wheel bearings and transmission fluid, but a significant part of it comes from the tires, and can be minimized.

The first requirement for electric car tires is that they are radials. Bias ply tires will not stand up to the demands of a heavy electric vehicle, and they will not give efficient performance.

With that said, it would seem that the trick to low-rolling resistance is a small contact patch with the ground. You should buy really skinny tires, and pump them up as hard as possible, right?

Wrong.

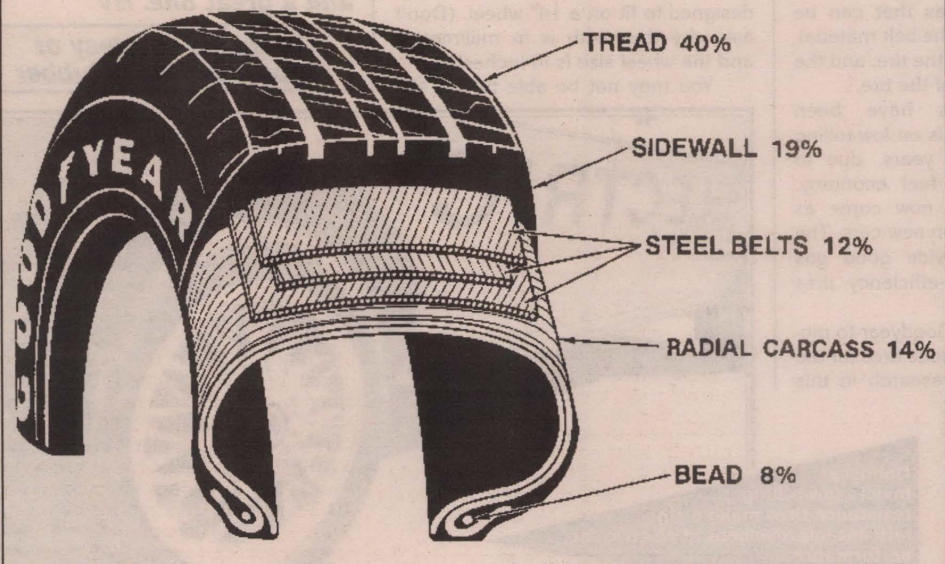
The size of the contact patch is part of that delicate balance we were talking about. Too little contact, and you won't have safe control of the car for steering or braking.

Air Pressure

Also, the relationship between tire pressure and rolling resistance is not linear. It reaches a plateau, after which handling decreases while rolling resistance does not.

It's easy to experiment with tire pressure to demonstrate this for yourself. On a straight, flat, empty stretch of road, drive your electric car at a constant speed and check the ammeter. Now vary the air pressure up or down and repeat the test. You can see the difference in energy used, and you can feel the difference in ride and handling. If you have a safe location, try braking and steering at different

TIRE COMPONENTS CONTRIBUTING TO ROLLING RESISTANCE



Fuel-efficient tires are tested by Goodyear designers using customized computer software.

pressures.

Generally, you will want to run the tires close to the rated limit, which is around 35 psi. With a little experimentation, you can find a pressure that gives good performance while maintaining a comfortable level of safety and control. You can't just set the tire pressure and forget it, either. You should monitor it regularly to be sure you don't have a slow leak.

Internal Construction

Sixty percent of the rolling resistance in tires comes from factors other than the tread. These factors can be manipulated independent of the size of the contact patch.

The tires flex as they move down the road, and the different parts of the tire move and pull against each other. This generates heat, which indicates rolling resistance and wasted energy.

Rolling resistance can be diminished by making the tires out of a compound that runs cooler, while still providing adequate "stickiness" to the tread. Other areas that can be manipulated include the belt material, the size and shape of the tire, and the internal architecture of the tire.

Tire companies have been putting more emphasis on low-rolling resistance in recent years, due to demands for better fuel economy. Some of these tires now come as standard equipment on new cars. The same tires that provide good gas mileage will be high-efficiency tires for an electric car.

GM worked with Goodyear to pioneer low-rolling resistance tires for the Impact. Goodyear's research in this area also produced their Invicta GAL and GLR low-rolling resistance tires, which are on the market in sizes for many cars. Other companies such as Firestone, Bridgestone, Goodrich, and Michelin have produced low-rolling resistance tires, as well.

Consumer Reports magazine is a good source for tire information. They test tires about once a year, and list rolling resistance.

Tire Size

Two tires of identical construction, but different sizes will have different rolling resistances. In general terms, the larger diameter tire will have a lower rolling resistance.

This is not due directly to the diameter, but to the aspect ratio. The aspect ratio is the ratio of the sidewall (from the bead to the tread) to the width of the tire in cross section. For example, a tire with an aspect ratio of 70 would have a sidewall height that is 70% of the tire's width.

A larger diameter tire probably has a higher aspect ratio — but not if it is also a very fat tire, or fits on a larger diameter wheel.

The aspect ratio is printed in code on the sidewall of the tire. On a typical tire, the code might read, "P185/70R14." The "P" indicates it is a passenger car tire. The "185" is the width of the tire's cross section, measured in millimeters. The "70" is the aspect ratio. The "R" means the tire is a radial. The "14" means the tire was designed to fit on a 14" wheel. (Don't ask why the width is in millimeters and the wheel size is in inches!)

You may not be able to find the low-rolling resistance tires you want in the exact same size that is currently on your car. If the new tires are taller or wider, you should check carefully with a tape measure to be sure they will fit in the wheel well. Be sure there is no interference, even when the spring is fully compressed going over a bump, or the car is making a hard turn to the right or left.

You may also discover that the tires you want aren't available for the size wheels you have. It can be a bit of a search to find a different size wheel that fits your lug pattern. However, if it makes it possible to get the low-rolling resistance tires, it's worth it. The difference in performance is readily apparent. After driving with the low-rolling resistance tires, your old tires will feel like driving with the handbrake on.

Balance & Alignment

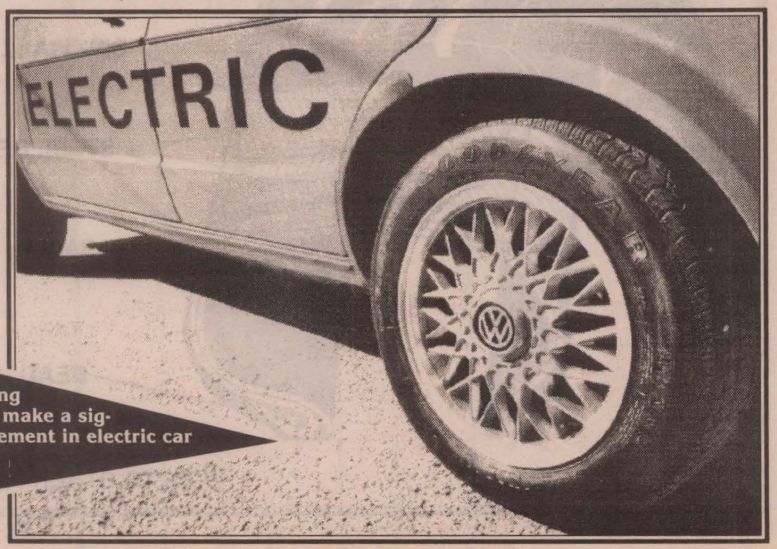
When you get your new tires, have them spin balanced as they are being installed. This will give you their optimum efficiency, as well as a smooth ride.

At the same time, take the car in for an alignment. A poor alignment will wear out your new tires unevenly and prematurely, and it may wear them on the inside edges where it isn't easily visible. The energy that's going into wearing out the tires isn't going into moving the car down the road. A bad alignment will make your car inefficient, with a higher current draw and shorter range.

You should choose an alignment shop based on a recommendation from someone you trust. Some cars have alignment adjustments in the rear, as well as the front. If this applies to your car, have both ends aligned.

There is nothing electronic — or even electric — about tires. However, they can make the difference between a good electric car and a great one. NV

Graphics courtesy of Goodyear Tire & Rubber



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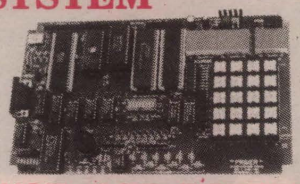

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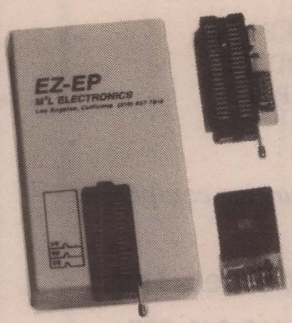

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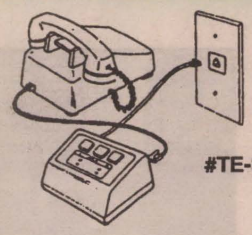

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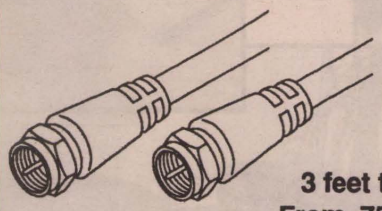

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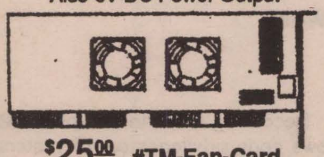

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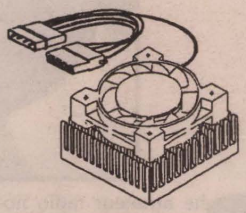

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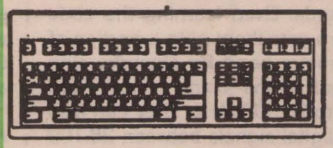

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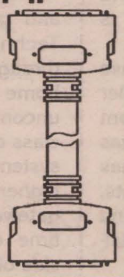

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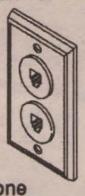

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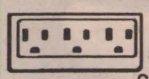

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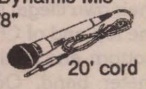

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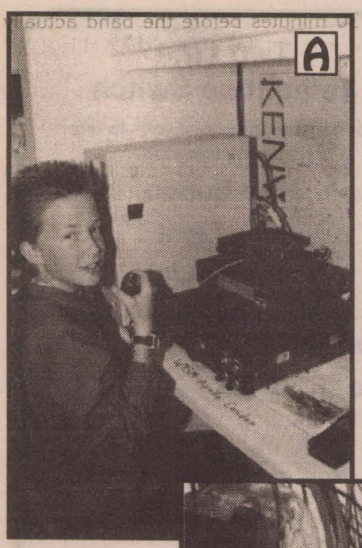
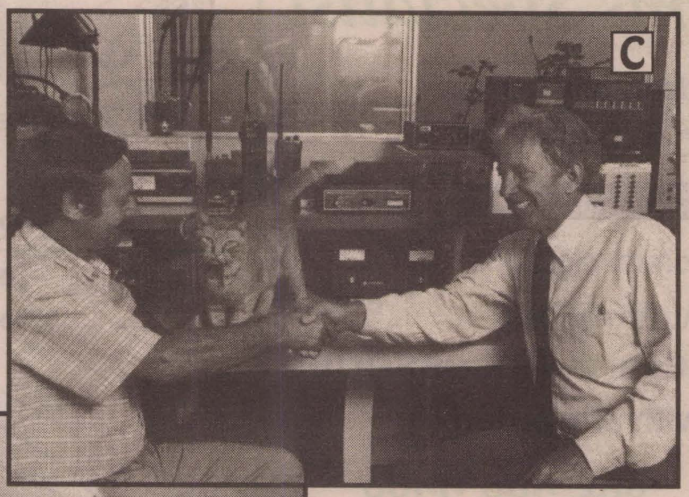




A.
No code hams can work skywave DX on six meters this summer!

B.
Author West (R) congratulates a new ham for his first six-meter E-Skip contact.

C.
Maria Lopez, KC6ABM, tunes into six-meter DX from the Kenwood Club base station.

NO-CODE HAMS GET SKIP FREQUENCIES

by Gordon West

The amateur radio no-code Technician class license has exceeded the popularity contest beyond anyone's wildest dreams. The amateur radio service is growing by leaps and bounds, and the quality of the new "no-coders" is superb.

"I figured the no-code license would open up the floodgates to CBer mentality," comments a ham from the Pacific Northwest. "But I was wrong — the no-code license has brought in engineers, airline pilots, lawyers, electronic technicians, and computer hobbyists with terrific talent."

CB radio operators who no longer need a license did not flood the ham radio ranks of no-code Technician class because they already enjoy a license-free communications service at 27 MHz. The "pirate" CB radio operators who transmit between 27.405 to 28.000 MHz have no reason to look toward ham radio as something to do because they already have their own illegal radio service between the top end of CB Channel 40 and the bottom end of the amateur radio 10-meter band. Occasionally they get caught, but the FCC's lack of enforcement has given them free reign to do their thing, and they can talk just about around the world on their illegal frequencies and extraordinary amounts of power output. But they are constantly looking over their shoulder . . .

The no-code amateur radio license, called Technician no-code, is pretty much considered a local-only type of radio service using repeaters, point-to-point, mobile-to-mobile, and short-range packet radio. However, Technician no-code operators have zero restraints to confine their communications to just a few miles or line-of-sight distances.

Through packet radio networks and gateway systems, the no-code Technician can intercommunicate throughout the world easily on their home or lap-top computers. It's not uncommon for no-code Technician class operators to work into a packet system where a General class (or higher) ham offers high-frequency gateway communications for real-time communications to the other side of the world via packet radio.

The no-code Technicians can also enjoy working the OSCAR satellites. This, too, will lead to intercontinental communications in real time. And voice, too. Even slow-scan television, too.

The no-code Technician can also talk literally "out of this world" by communicating directly with the orbiting space shuttle. On almost every space shuttle mission, licensed hams aboard the shuttle will take time out of their busy schedule and stay in touch with hams back down on earth.

The amateur radio two-meter band is the big collection point for new no-code Technician class operators. On two meters they can hook up with the space shuttle, they can tie into digital networks, and they can even try some long-range tropospheric ducting which we talked about a few issues ago.

BUT WE WANT SKIP COMMUNICATIONS

Many times you might hear no-code Technician class amateur radio operators discussing their plans to upgrade to General class to gain skywave "skip" conditions on the world-wide bands. Even learning the code at 5 wpm gets them onto a portion of the 10-meter band for skywave skip communications using voice from 28.300 to 28.500 MHz. They can also "skip" digital signals between 28.100 to 28.300. They can also play CW (Morse Code) skywaves from 28.1 to 28.5. But they must learn the code at a minimum rate of 5 wpm to add a "plus" to their license class, Technician-plus — plus the code at 5 wpm.

Becoming a Technician-plus also allows code privileges on 15 meters, 40 meters, and 80 meters, in addition to the code and voice privileges on a portion of the 10-meter band.

But what about the amateur operator who plans to NEVER EVER learn the code at 5 wpm, but still wishes to experiment with skip communications. Is there any band that supports skip within the no-code Technician privileges? Are the skip communications going to be predictable, reliable, and worldwide?

A big YES for the no-code Technician class operator.

— No-code Technician skip band: 6 meters, 50 MHz-54 MHz
— Allowable power output: 1,500 watts
— Skywave range:

A small six meter FM set like this can easily work six-meter sporadic-E DX.

Listening to how close in 10 meter skip is will be an indicator of six-meter band openings.

1,500 miles-3,000 miles typical
— Morse Code test requirements: Absolutely none

Technician no-code operators have full access to the amateur radio six-meter band. This band is regularly effected by a summertime condition called "sporadic-E," abbreviated "Es." It's this ionospheric phenomena that gives no-code Technician class operators all of the excitement of skywave skip communications that are enjoyed by higher class operators on the worldwide bands.

July is the peak period for sporadic six-meter band. The conditions begin around June 22nd, and they become less frequent around August 25th. But in July, it's an almost everyday occurrence out there on the airwaves.

WHAT IS SPORADIC-E?

During daylight hours, the sun "super-charges" the four ionospheric layers to stratify and become the D-layer, the E-layer, the F1-layer, and the F2-layer. We are at the very bottom of solar cycle 22, and this means that sunspot activity is at a minimum. This means don't count on the higher F-layer for reliable six-meter contacts. In fact, you probably won't get any F-layer "bounces" off of the ionosphere for the next four years on six meters.

But the solar cycle has nothing to do with the highly ionized dense patches within the E-layer called "sporadic-E" clouds. These are not clouds that you can see. These are invisible blobs of intense ionization triggered by high altitude wind shears that become so reflective to radio signals that they reflect and refract them back to earth on frequencies in the VHF spectrum, including six meters, sometimes two meters, and every now and then the 222 MHz band. 222 MHz and two meter "skip" communications are rare — but on six meters, summertime skywave conditions are a common occurrence, peaking in July.

The E-layer of the ionosphere is up approximately 60 to 120 miles. It's present only during daylight hours, and a few hours after sunset. The E-layer itself is relatively predictable — it will normally support maximum usable frequencies up to 20 MHz for skywave communications during daylight hours. But within the E-layer are densely ionized patches that are so intense with electron activity, they cause VHF six meter signals and higher VHF radio waves to bounce off of them and come back down to earth thousands of miles away.

Some experts feel the "bounce back" is caused by reflections. Others feel it's a combination of reflection and refraction within the cloud that gives six-meter signals a terrific kick back to earth. It's probably a combination of both, and you can even get cloud-to-cloud bounces that will sometimes produce coast-to-coast sporadic-E contacts on the six-meter band.

You can calculate VHF radio line-of-sight (LOS) range to the horizon by taking the height of the signal and doubling it in feet, and then taking the square root of that to come out in miles. Since the height of our signal is off of the sporadic-E cloud at approximately 100 miles up, here are the calculations:

- 100 miles = 528,000 feet
- 2 X 528,000 = 1,056,000 feet
- The square root of 1,056,000 = 1,027 miles

For a six-meter station in the middle of the United States, an E-cloud just coming up from the west will be approximately 1,000 miles away. For a station on the West Coast, that same E-cloud getting ready to go over the horizon to the east will be 1,000 miles away. If both stations have a line-of-sight range to the same E-cloud just above the horizon, 2,000 miles of six-meter range is indeed possible.

The E-clouds normally travel from west to east, and their velocity is usually much greater than the lower jet stream, and is said to be approximately 500 miles per hour. Depending on how many sporadic-E patches are associated with this ionospheric phenomena, six-meter skywave communications over 1,000 miles to 3,000 miles may last from a few minutes to an hour or so.

The sporadic-E cloud is considered invisible and made up solely of highly ionized electrons from the ultraviolet radiation from the sun. Yet some six-meter enthusiasts say they can spot a sky formation that spawns sporadic-E skip. They say to look for ultra-high cirrus clouds, and these are usually associated with sporadic-E propagation. I have never seen this phenomena myself, and most folks feel that sporadic-E is absolutely independent of the weather conditions that might cause other radio phenomena, such as tropospheric ducting, static crashes, and high noise levels.

However, sporadic-E has been documented as a result of major thunderheads containing lightning that rise above 60,000 feet. Ham operators watching storm fronts will aim their six meter antennas at a distant storm cloud, and many times hook up with other hams on the other side of the storm front (usually equidistant) for up to 800 miles communications. As the storm cloud moves from west to east, so do the communication possibilities with different stations with the cloud in between!

Sporadic-E peaks in July, so there's no question that ultraviolet radiation from the sun at its highest point above the United States plays an important factor in creating E-skip. There are also the theories of high altitude wind shears creating E-skip, and all of this combined with the very predictable increase in E-skip activity during the summer months makes working the six-meter ham band, for the no-code Technician, just as much a kick as working 20 meters on the worldwide bands with a General class or higher license.

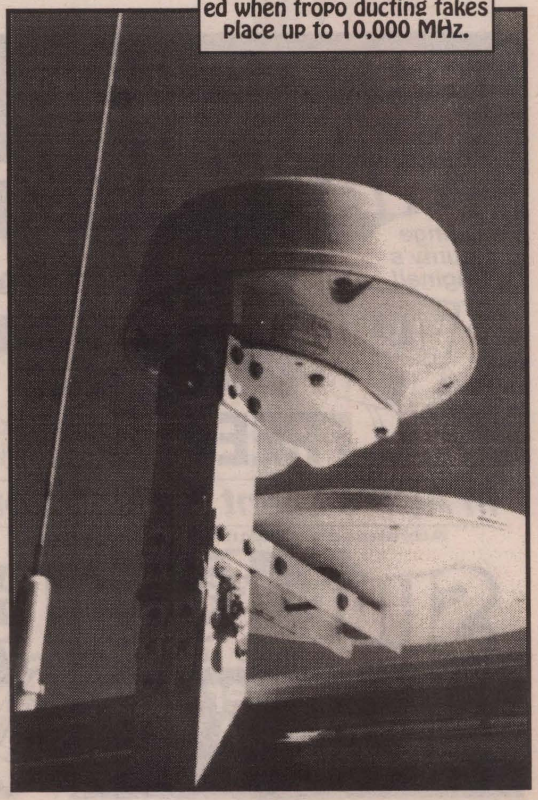
"I work both six-meters FM as well as SSB, and in the SSB mode, I can hear little ZZZIIIPPPSSS about 30 minutes before the band actually opens up for some short-skip DX," comments Margaret Foster WA6BWH. "I also listen to WWV at 18 minutes past the hour for tips on six-meter activity, too," adds Foster. She speaks of monitoring the WWV 5, 10, and 15 MHz signals at 18 minutes past the hour and noting the A and K indices where higher numbers along with "disturbed" ionospheric propagation reports mean sporadic-E activity might be in the making.

Another way to anticipate a sporadic-E opening on the amateur radio six-meter and even the two-meter band is to monitor skywave activity on 10 meters. You would never have a sporadic-E six-meter opening unless the 10-meter band was also active with skywave communications. While some experts claim that six meters has been open, and 10 meters with no skywave activity, I am convinced that they must have had their 10-meter antenna buried in the ground. I have always found 10 meters full of activity when the six meter and two meter band open up for skywave E-skip.

As 10-meter stations begin to skip in closer and closer, the chances of six-meter band openings get greater. When you begin to hear 10-meter skywave stations coming in within 500 miles of your location, switch up to six meters and see what's happening. When six-meter contacts begin to close into 500 miles, then switch up to two meters and see what happens. A couple of years ago, two-meter contacts closed in as close as 500 miles, and there was a brief three-minute opening up on 223 MHz!

The intensity of a skywave signal

Even radar range is extended when tropo ducting takes place up to 10,000 MHz.



from sporadic-E short-skip will knock your socks off. Your headphones, too. Skywave signals from sporadic-E are normally "full tilt," signal strength 9+++. Sporadic-E clouds cause little attenuation of the signal, and free-space loss over a couple of thousand miles path from a 50-watt signal still gives you ample copy with a relatively simple antenna system. Like ocean waves, the 10-meter, six-meter, and two-meter skywaves will build and then recede, build and then recede, and keep repeating this pattern over and over again building and receding several times a minute. You can always count on the distant station giving its QSL address just when the signals take a nosedive for a few seconds. But a few seconds later, they will build back again, loud and clear. And just as quickly as they came, they leave. They take about three nosedives, and that's it. However, your ham buddies a few miles away may still be in the reflection zone, and they'll get a few more minutes of contacts before the contact zone continues to scoot across the United States.

Simple vertical antennas for 10 meters, six meters, and two meters can work strong sporadic-E openings. Beam antennas will work the opening first, and hold it a lot longer after it disappears from the simple omni-directional vertical antenna. Polarization to a sporadic-E opening doesn't seem to make much difference. Most everyone agrees the up-and-down fading action of sporadic-E is caused by the tumbling of the polarization of the incoming waves. Maybe. I have both horizontal and vertical antennas; and when the signal takes a nosedive, it gets weak with both polarizations — so I'm not convinced that polarization fading is the culprit.

If you have an old television set hooked up to an outside antenna — not on cable — you can many times spot a sporadic-E short skip opening by the big black horizontal bars that will slowly drift from the bottom of the screen to the top of the screen over a five second period of time. This is co-channel interference from another TV station hundreds of miles away. Switch to another TV channel below Channel 7, and see what you can pick up. Channels 2, 3, and 4 are your best TV channels for spotting sporadic-E co-channel interference. But you must have some sort of an outside TV antenna, or a set of really good rabbit ears.

If you're into FM band DXing, a sporadic-E opening will trigger unused FM channels in your area to become alive with stereo sounds. Many FM receivers have mute circuits, so select some popular channels that are not active in your area — popular in other areas about 500 miles away — turn up the volume, and wait until they start coming in loud and clear to alert you that a sporadic-E opening is taking place.

The best time for listening for a sporadic-E opening is in the early evening hours. They say that sporadic-E also peaks right after sunrise, but I have always found more openings at sunset. Maybe more people are at home listening to their radios.

Looking over statistical data gathered by enterprising hams, July 15th through the 26th are the most common daily openings for short skip. You could expect a band opening almost every other day for a few hours. From June 22nd to August 24th, band openings will occur at least every three or four days, with that big peak at the end of July.

While there's much conjecture on how these invisible sporadic-E clouds form, there's no question that the maximum usable frequency for skywave propagation easily rises to, and above, the amateur radio Technician class band where no-code operators have full access to frequencies 50 to 54 MHz. If all you have is an FM transceiver, program in a whole bunch of repeaters, plus program the 52.525 MHz Simplex calling frequency, set the squelch, and get set for activity. If you have a multi-mode, six-meter, SSB transceiver, such as the new Kenwood, Yaesu, ICOM, and Alinco HF sets with six-meter capabilities, listen around 50.125 MHz for SSB activity.

And when conditions really get hot, you might also take a listen up at 144.200 MHz SSB on the two-meter band, too. All single sideband emissions are upper sideband.

So get set for skip that's coming in right now. If you're not a ham, listen to it on an FM broadcast radio, or see it in action on your television any hot summer evening. Although the skywaves are independent of local weather conditions — other than major thunderstorms — that warm summer evening is bound to give you some real excitement thanks to the E-layer and those invisible sporadic-E clouds.

Enjoy! **NV**

#80 TEST EQUIPMENT *cont.*

ACME P5 2L-1000 electronic load $675/offer. Dexis 612-944-7670.

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HP 8640B OPT 323 solid state signal generator frequency range 450KHz to 512MHz to 1100MHz with external frequency doubler. 713-473-6462, $850.

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HP 3325A Synthesizer/function gen. $2,150. Dexis, 612-944-7670.

TEST EQUIPMENT SALE: Freed 1620A megohmeter, $300; Biddle 335 TDR, $800; Boonton 91CA RF voltmeter, $250, Clarostat 240 decade power resistor $100; EIP KS\2144 Western electric 300MHz counter, $250; EIP 12.5 GHz counter, $500; Environmental Instruments RDM 101, resperable dust monitor, $300. A-Comm Electronics, 303-290-8012.

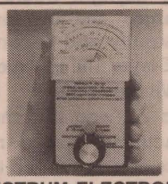
TIRED OF paying high prices to get Tektronix, Hewlett Packard, Wavetek, IFR, etc., repaired, calibrated, certified? Give us a call. Free estimates, fast service. We also sell and rent test equipment. For information: Feitek, 2752 Walton, St. Louis, MO 63114. 314-423-1770.

HP 5328B Universal counter. $995. Dexis, 612-944-7670.

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.

TEKTRONIX ACCESSORIES, 7A13 LED $175; Mechanical $100; 7A26 $75, 7B50 $50, 7B50A $75; 7B71 $70, 7B80 $80, 7B85 $90. **S-2** $85; **S-3A** $100 **TEK 465** portable scope $300. 134 current probe amplifier $95. **DC-501A** OPT1 $150, DC-505A, $195; DM-502A, $150; DD-501 $90; PG-501, $150 TM 506 $95. 1101A opt A4 FET power supply $125. 453 $150. **7912AD** Programmable digitizer $250. **1360P** Programmable switch $200., all as new condition. Call for FAX list of surplus test equipment. Psitech Plus, 707-745-4804. FAX 707-747-5277.

TEK R520 NTSC waveform monitor. Good condition, bright CRT. $400. OBO. 504-446-9564. Leave message.



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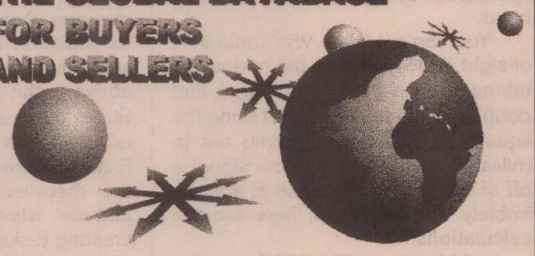

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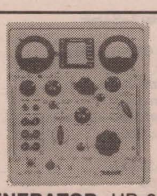


SIGNAL GENERATOR, HP 608 equivalent, (TS 510 A/U), 10-420 MHz, with transit case, operating manual, sold "as-is," tested for output only, $85 ea. FOB. Kemner Enterprises, 17 Lightcap Rd., Pottstown, PA 19464. 610-495-5367 lv. messages. Looking for other good deals? Get on mailing list, $2, cash OK, deduct 1st order. SASE.

TEST EQUIPMENT: PRD/HP USM-37A X,H Slotted line vswr kit, $400; GR1567 Sound level calibrator, $80; GR1921 Real time ana $900, GR1925, multichannel filter $600; Gr1826C, $400 megohmmeter, GR1926 multichannel KMS detector, $600; GR1216A IF unit, $75, A-Comm Electronics, 303-290-8012.

SCOPES: (3) unused Kikusui COS6100M, 100MHz, 5 channel, 12 trace, w/ probes, cover etc. $700; (1) used, only w/manual, $350; Tek 454A $400: Tek 453, $250; Tek 465M $325; Tek 434, $400; Tek 485, $695; HP 1720A, $450; HP 1725A $500' HP 1722B $500; HP 180C/1805A/1825A $300. Generators: (3) HP 8640B/323, $600, $700, $800; HP 8640B/003, $1,100. Counters: (5) HP 5328A/096 (500MHz), $200 each; (4) unused HP 5345As, $750 each. Call John, 912-922-8244.

EQUIPMENT MANUALS we have 1000's of service and operators manuals for all types of test and measurement equipment from 1950 to present. All test equipment manufacturers are represented. Call, write, or fax your want list. Please include mfg.'s manual P/N unit serial no's if known. **Manuals Plus**, Box 937, Spanaway, WA 98387. 206-531-8031 or FAX 206-536-1121.

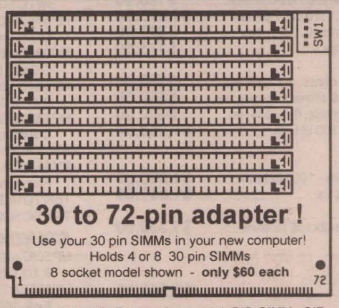
INSTRUMENTATION TAPE-RECORDERS, HP 3968A, 8 Channel IRIG. 6 FM, 2 direct. 1/4" tape, 7" reels, 6 speeds 15/32" through 15"/sec. FM DC-5KHz, direct 200Hz-75KHz. With instruction manual $1,995. **SABRE 80**, model 834-M19. IRIG. 14 channel 1" tape, up to 14" reels. 8 speeds 15/16" through 120"/sec. Wideband 2. Direct record and reproduce. Response; 300Hz through 2MHz +/-3dB. Build in 4 pass and 2 pass stitch. Repro output monitor. Spin-physics heads. IEEE488 $2,999. **SABRE VI**, model 632. IRIG. 14 channel 1" tape, up to 14" reels. 8 speeds 15/16" through 120"/sec. Wideband 1. FM record and reproduce. Record is all speeds. Reproduce is configured for 3 speeds. Response DC-120KHz. Voice track $3,999. **SABRE VI**, model 632. Same as above, but intermediate band. Response DC-40KHz $2,999. **ERAC CO.**, 619-679-6360, FAX 619-679-6670.

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.

TEK 491-10MHz to 40GHz $995; TEK 465M 100MHz scope, $425; TEK 475 200MHz scope $525. All of these units have been reconditioned and are in excellent working condition. Unconditionally guaranteed for 90 days. ISA, PO Box 6955, Laguna Niguel, CA 92607. 714-488-0010, FAX 714-488-0299.

DATA ACQUISITION. FLUKE 2240C, 60 Channel data logger, 40 channel low level DC or Thermocouple, 10 channel 100 uV and up, 8 channel RTD input. RS232 interface. With manual, calibrated $699. **VISHAY 4000,** 16 channel strain, 16 channel Thermocouple, PC based controller $1,899. **DAYTRONICS 770,** 7 digit straingage display/conditioner. Balance, span, 5V-10V-15 Volt excitation and analog output. Full, 1/2 or 1/4 bridge $199. Action Instr. **VISIPAK 524W,** 7 digit, 2 channel programmable loadcell display/conditioner, span, tare, net, gross $199. **Gimini 3300,** 2 channel up based, programmable timer/counter, 6 digit process indicator $79. **ERAC Co.,** 619-679-8360 FAX 619-679-6670.

LOGIC ANALYZERS: HP1630D logic analyzer (100MHz timing, 25MHz state) $995. **Pods** for HP 1600A $39 each. **Tek 7DO1/DF1** logic analyzer plug-in (to 100MHz) $225. **Tek DAS 9129** color systems, up to 660MHz — low prices. Analyzers sold with pods, warranty. Pepper Systems, 214-353-0257.



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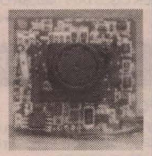

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GR 1432-N 5-Decade Resistor, to 11,111 ohms, 0.1 ohm res. $275.00
GR 1432-U 4-Decade Resistor, 0-111.10 ohms, 0.01 ohm resolution $175.00
GR 1433-X 6-Decade Resistor, to 111,111.0 ohms, 0.1 ohm res. $550.00
GR 1434-G 7-Decade Resistor, 0-1,111,111.0 ohms, 0.1 ohm res. $500.00
GR 1434-N 5-Decade Resistor, 0-11.110 kilohms, 0.1 ohm res. $300.00
GR 1491-G 5-Decade Inductor, 0-11.110 H, 100 uH res. $1,250.00

HI & LO RESISTANCE

GR 1666 DC Resistance Bridge, 1 micro-ohm - 100 kilohms $1,000.00
HP4328A-001 Milliohmeter, 0.001-100 ohms f.s., battery option $1,350.00
HP4329A High Resistance Meter, 500K ohm- 2x10E16 ohm, 10-1000V $1,350.00

CURVE TRACERS

TEK 577D1/177 Storage Curve Tracer, with standard test fixture $2,250.00
TEK 577D2/177 Curve Tracer, with standard test fixture $1,950.00
TEK 7CT1N Curve Tracer, to 0.5W, 7000 series $500.00

T.D.R.

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-05R06 5kV CV/CL Power Supply, to 6mA $500.00
HP6002A-001 Programmable Power Supply, 0-50 V / 0-10 A / 200 Watts $875.00
HP6023A Autoranging Power Supply, to 20 V / 30 A / 240 Watts $1,000.00
HP6207B 160 V at 200 mA CV/CC Power Supply $300.00
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
HP6267B 40 V at 10 A CV/CC Power Supply $550.00
HP6268B 40 V at 30 A CV/CC Power Supply $850.00
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
SORENSON DCR 110-45T 110 V at 45 A CV/CC Power Supply $2,200.00
HP6227B Dual 25 V at 2 A CV/CC Power Supply $650.00
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
ACME PS2L-1000 Programmable Load, 0-75 V / 0-150 A / 1000 Watts max. $450.00
HP59501A HPIB Isolated DAC/Power Supply Programmer $175.00
HP6824A Bipolar Power Supply/Amplifier, to 50 V, 1 A $400.00
HP6827A Bipolar Power Supply/Amplifier, to 100 V, 500 mA $800.00
KEPCO BOP-100-4M 100 V, 4 A Four Quadrant Bipolar Supply / Amplifier $1,000.00
KEPCO BOP-15-20M Bipolar Amplifier / Power Supply, to 15 V, 20 A $875.00
KEPCO BOP-36-5M Bipolar Op Amp/Power Supply, to 36 V, 5 A $550.00

TIME & FREQUENCY

UNIVERSAL COUNTERS

HP5314A 100 MHz/100 nS Universal Counter $225.00
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, HPIB $750.00
HP5316A-003 100 MHz/100 nS Universal Counter, HPIB, 1.0 GHz C-chan. $1,000.00
HP5335A 200 MHz Universal / Statistical Counter $1,500.00
HP5370B-001 100 MHz Univ. Time Int. Counter, 20 pS single shot,OCXO $2,250.00
HPE1420A-010,030 VXI card 200 MHz/ 2 nS Univ. Counter,TCXO& 2.5 GHz C-ch $1,500.00
PHILIPS PM6654/056 120 MHz/ 2 nS OCXO,GPIB Programmable High Res. Counter, ... $950.00
RACAL-DANA 1992-opt.04A 100 MHz/6.25 nS Universal Counter, 1.3 GHz C-chan.,OCXO $800.00
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, TM500 series $500.00
TEK DC509 135 MHz High Resolution Universal Counter/Timer, TM500 ..... $700.00
TEK DC510 350 MHz/3.125 nS Universal Counter, TM500 series $900.00

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-001,011 18 GHz Frequency Counter, OCXO reference, HPIB $1,900.00
HP5342A-01,04,05,11 24 GHz Frequency Counter, OCXO, DAC, and HPIB $3,900.00
HP5345/5355/5356A-006 Pulsed/CW Frequency Counter, pulse 0.4-18.0 GHz, 75 nS $3,500.00
HP5361A-006 20 GHz Pulsed/CW Frequency Counter, 10 Watt protection $6,750.00
SYSTRON-DONNER 6054B 24 GHz Frequency Counter $1,875.00
SYSTRON-DONNER 6054B-opt.05,26 26.5 GHz Frequency Counter, GPIB $2,400.00
TEK 7D14 525 MHz Frequency Counter, 7000 series $175.00
TEK DC504 80 MHz Frequency Counter $125.00

STANDARDS

HP5087A-031 Distribution Amp., h 0.1/1.0/5.0 MHz x 4 channels eac $1,800.00
HP5359A Time Synthesizer, pulse width 5 nS-160 mS, jitter<200pS $2,000.00

AUDIO & BASEBAND

SPECTRUM ANALYZERS

HP3580A-002 Spectrum Analyzer, 5 Hz-50 kHz, 1 Hz res., bal. input $1,850.00

Write in 218 on Reader Service Card.

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

HP3581A Wave Analyzer, 15 Hz-50 kHz $1,000.00
HP3582A FFT Spectrum An., 25.6 kHz max., dual channels, HPIB $2,500.00
HP3585A Spectrum Analyzer, 20 Hz-40 MHz, 3 Hz res., HPIB $6,000.00
HP3586C Selective Level Meter, 50 Hz-32.5 MHz, 50 & 75 ohms $1,750.00
HP8556A LF Section, 20 Hz-300 kHz $500.00

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
TEK DA4084 Programmable Distortion Analyzer, 0.0025% THD, w/frame $1,500.00

RMS VOLTMETERS

FLUKE 8920A True RMS Voltmeter, 180 uV-700 V, 10 Hz-20 MHz $700.00
HP3400A RMS Voltmeter, 10 Hz-10 MHz $250.00
HP400FL AC 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
HP204C Oscillator, 5 Hz-1.2 MHz, 5 VRMS $150.00
HP204D Oscillator, 5 Hz-1.2 MHz, 5 VRMS, 80 dB step attenuator $200.00
HP209A Sine/Square Wave Generator, 4 Hz-2 MHz, 5 VRMS max. $225.00
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

HP3575A-002 Phase-Gain Meter, 1 Hz-13 MHz, dual display $900.00
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, 0.001 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
TEK AM502 Differential Amplifier, 0.1 Hz-1 MHz, TM500 series $575.00

RF & MICROWAVE

SPECTRUM ANALYZERS

HP 11970A WR28 Harmonic Mixer, 26.5-40 GHz $1,100.00
HP 11970Q WR22 Harmonic Mixer, 33-50 GHz $1,400.00
HP 11970U 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
HP8445B Preselector, 1.8-18.0 GHz, for HP 8555A $800.00
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
HP8555A/8552B/8445/141 As above, w/1.8-18 GHz Preselector, opt.003 freq.display $3,000.00
HP8558B/181TR Spectrum Analyzer, 0.1-1500 MHz, 1 kHz res., w/display $2,250.00
HP8559A/181TR Spectrum Analyzer, 0.01-21 GHz, 1 kHz res., w/display $4,500.00
TEK 496P Spectrum Analyzer, 10 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

HP 11665B Modulator, 0.15-18.0 GHz, for use with 8755/6/7 ..... $375.00
HP8405A Vector Voltmeter, 1-1000 MHz $700.00
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, 10 MHz-18 GHz, N(f), for 8755/6/7 ..... $1,200.00
HP85050D APC7 Calibration Kit, for 8510 series $1,100.00
HP8754A-H26/8748A-H26 Vector Network An., 4-2600 MHz, w/S-Parameter Test Set $7,000.00
HP8755C/11666A-02/181T Scalar Network An. w/dir. bridge, 10 MHz-18 GHz & frame $1,750.00
HP8756A Scalar Network Analyzer $3,000.00
NARDA 7000A/7202/7206 Microwave Multimeter System: scalar analysis 0.1-18 GHz $1,950.00
WILTRON 560/ 3x-7S50 Scalar Network Analyzer, w/3 detectors, 0.01-18.5 GHz $2,000.00
WILTRON 560/ 560-98K50 Scalar Network Analyzer, w/VSWR Autotester 0.01-40 GHz $2,950.00
WILTRON 640/G50/E(2)/7B50(2) Network An., w/1-1500 MHz source, (2) log amp, (2) det. $1,675.00

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
FLUKE 6060A-488 Synth. Signal Gen., 100 kHz-1040 MHz, 100 Hz res., GPIB $3,500.00
FLUKE 6060A/AN Synthesized Signal Gen., 10 kHz-520 MHz, 10 Hz res,GPIB $2,000.00
GIGATRONICS 605/0.01-8.0, opt.3 Synthesized Source, 10 MHz-8 GHz, 1 kHz res. $3,000.00
GIGATRONICS 605/10-18, opt.3 Synthesized Source, 10-18 GHz, 1 kHz res. $3,000.00
GIGATRONICS 605/6-12, opt.3 Synthesized Source, 6-12 GHz, 1 kHz res. $3,000.00
GIGATRONICS 875/50 Levelled Multiplier, x4, 50.0-75.0 GHz output, -3 dBm $3,500.00
GIGATRONICS 875/86 Levelled Multiplier, 26.5-40.0 & 50.0-75.0 GHz outputs $7,000.00
GIGATRONICS 905/0.05-18, opt.10 Synthesized Source, 50 MHz-18 GHz, 1 MHz res., +10 dBm $4,250.00
GIGATRONICS 905/2-18, opt.10 Synthesized Source, 2-18 GHz, 1 MHz res., +10 dBm out $3,750.00
HP85100V Frequency Mult., 10-15 GHz in / 50-75 GHz out >0 dBm $4,250.00
HP8656A Synthesized Signal Gen., 0.1-990 MHz, 100 Hz res., HPIB $3,250.00
HP86601A RF Plug-in, 10 kHz-110 MHz, for 8660 series $650.00
HP8660C/86602B/86633B Synthesized Signal Generator, 1-1300 MHz, AM, FM, HPIB $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

SWEEP GENERATORS

EIP 928-opt.9201 Sweep Gen.,1.0-18.6 GHz, step atten.,power sweep, GPIB $4,000.00
GIGATRONICS 900/0.05-12, opt.3 Synthesized Sweep/Sig. Gen., 50 MHz-12 GHz, 1 kHz res. $4,500.00
HP8350A/86290B-H08 Programmable Sweep System, 2.0-22.0 GHz, +4 dBm lvl'd $5,500.00
HP8601A Generator/Sweeper, 0.1-110 MHz, +20 dBm levelled $500.00
HP8620C Sweep Oscillator Frame $550.00
HP8620C-011 Sweep Oscillator Frame, HPIB programmable $675.00
HP86210A RF Plug-In, 3-350 MHz, +13 dBm levelled $450.00
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
HP86240B RF Plug-in, 2.0-8.4 GHz, +13 dBm levelled $1,000.00
HP86240C RF Plug-in, 3.6-8.6 GHz, +16 dBm levelled $1,200.00
HP86241A-001 RF Plug-in, 3.2-6.5 GHz, +8 dBm levelled $500.00
HP86242D-004,008 RF Plug-In, 5.9-9.0 GHz, +10 dBm levelled $500.00
HP86260A RF Plug-in, 12.0-18.0 GHz, +10 dBm unlevelled $1,000.00
HP86290A RF Plug-in, 2.0-18.0 GHz, +7 dBm levelled $1,750.00
HP86290B RF Plug-In, 2.0-18.6 GHz, +10 dBm levelled $2,000.00
WAVETEK 1001A Sweep Generator, 0.5-300 MHz $350.00
WAVETEK 1067 Sweep Generator, 1-400 MHz, +10 dBm, 75 ohms ... $500.00
WAVETEK 2002 Sweep Gen., 1-2500 MHz in 4 bands, +10 dBm levelled $1,500.00
WAVETEK 954 Signal/Sweep Generator, 3.7-7.6 GHz, +7 dBm unlevelled $2,000.00
WAVETEK 962 Sweep Generator, 1.0-4.0 GHz, markers, +12 dBm unlvld $2,500.00

POWER METERS

BOONTON 42B/41-4E Analog Power Meter, with 1 MHz-18 GHz sensor $650.00
BOONTON 42B/42A-S3 Analog Power Meter, with 1 MHz-8.4 GHz N(f) sensor $375.00
GENERAL MICROWAVE 476/4240A Power Meter & Sensor, 0.01-18 GHz, -35 to +10 dBm $375.00
HP 11683A Range Calibrator, for HP 435/6/7/8 ..... $750.00
HP432A/478A Power Meter, 0.01-10 GHz, -20 dBm to +10 dBm f.s. ... $375.00
HP432A/8478B Power Meter, 0.01-18 GHz, -20 to +10 dBm f.s. $500.00
HP432C Autoranging Digital Power Meter, 10 uW-10 mW f.s. $425.00
HP435A/8481A Power Meter, 10 MHz-18 GHz, -30 to +20 dBm $1,000.00
HP435A/8482A Power Meter, 0.1-4200 MHz, -30 to +20 dBm $1,000.00
HP435A/8482H Power Meter, 0.1-4200 MHz, -15 to +34 dBm $1,150.00
HP435A/8484A Power Meter, 10 MHz-18 GHz, -70 to -20 dBm $1,000.00
HPK486A WR42 Thermistor Mount, 18.0-26.5 GHz, for 432 series $400.00
HPQ8486A Power Sensor, 33.0-50.0 GHz, WR22 waveguide $1,500.00
HPR486A WR28 Thermistor Mount, 26.5-40.0 GHz, for 432 series $400.00
WAVETEK 1034A Portable Analog Power Meter, 1 MHz-18 GHz $375.00

RF MILLIVOLTMETERS

MILLIVAC MV-723BBRS RF Millivoltmeter, 10 kHz-1.2 GHz, 1 mV-30 V $375.00
RACAL 9303 TRMS Level Meter, 10 kHz-2 GHz, -77 to +23 dBm, GPIB $875.00

AMPLIFIERS, MISCELLANEOUS

AILTECH 7616 Noise Source, 1.0-12.4 GHz, N(m), 15 dB ENR $375.00
AILTECH 7618E Noise Source, 10 MHz-18 GHz, SMA(m), 15 dB ENR $500.00
AMPLIFIER RESEARCH 1W1000 Amplifier, 30 dB gain, 1-1000 MHz, 1 Watt output $650.00
BOONTON 82AD FM/AM Modulation Meter, 10-1300 MHz $1,000.00
ENI 240L Amplifier, 50 dB, 20 kHz-10 MHz, 40 Watts $1,250.00
ENI 403LA Amplifier, 37 dB gain, 150 kHz-300 MHz, 3 Watts $700.00
ENI 600L Amplifier, 24 dB, 0.8-1020 MHz, 150 mW $450.00
ENI A150 Amplifier, 55 dB, 0.3-35.0 MHz, 150 Watts $2,000.00
ENI A300 Amplifier, 55 dB, 0.3-35.0 MHz, 300 Watts $3,500.00
M.P.D. LAB2-1020-2A Amplifier, 34 dB, 1.0-2.0 GHz, 2 Watts $1,000.00
M.P.D. LAB2-110-1E Amplifier, 30 dB, 100-1000 MHz, 1 Watt $700.00
M.P.D. LAB2-714-3A Amplifier, 34 dB, 0.7-1.4 GHz, 3 Watts $1,000.00
MICROWAVE SEMI.CORP. MC5112 Noise Source, 25.5 dB ENR, 1.0-12.4 GHz, N(m), +28 VDC $325.00

COAXIAL & WAVEGUIDE

ANZAC MDC-171 Mixer, RF/LO=4-18 GHz, LO +7 dBm, IF=DC-4 GHz, SMA $135.00
AVANTEK YO83-4037 YIG Tuned Osc.,5.4-10 GHz, +15/-5 V, TUNE & FM coils,NEW $100.00
EM SYSTEMS A6110 Dual Polarized Horn, 0.5-2.0 GHz, 0-10 dBi gain, N(f,f) $750.00
GR 874-LTL Constant Impedance Trombone Line, 0-44 cm, DC-2 GHz $450.00
GR 900-LB Precision Slotted Line, 0.3-8.5 GHz, 50 Ohms 0.1% tol. $450.00
GR 900-Q GR900 14mm Interseries Adapters $125.00
HP 11691D Directional Coupler, 22 dB, 2-18 GHz $500.00
HP 11692D Dual Directional Coupler, 22 dB, 2-18 GHz $900.00
HP33330D Detector, 0.01-33.0 GHz, APC3.5(m)/SMC(f) $275.00
HP778D-011 Dual Directional Coupler, 20 dB, 100-2000 MHz $400.00
HP779D Directional Coupler, 20 dB, 1.7-12.4 GHz $375.00
HP8472A Crystal Detector, 10 MHz-18 GHz, neg. pol., SMA(m) $150.00
HPK532A WR42 Frequency Meter, 18.0-26.5 GHz $500.00
HPK752A WR42 Directional Coupler, 3 dB, 18.0-26.5 GHz $425.00
HPK752C WR42 Directional Coupler, 10 dB, 18.0-26.5 GHz $425.00
HPK752D WR42 Directional Coupler, 20 dB, 18.0-26.5 GHz $425.00
HPQ752D WR22 Directional Coupler, 20 dB, 33-50 GHz $650.00
HPR375A WR28 Variable Attenuator, 0-20 dB, 26.5-40.0 GHz $375.00
HPR532A WR28 Frequency Meter, 26.5-40.0 GHz $500.00
KRYTAR 202020016 Directional Det., 2-20 GHz, SMA(f/m)/SMC(f), 10 uV/uW $200.00
M/A-COM 3-19-300/10 WR19 Directional Coupler, 10 dB, 40-60 GHz $450.00
MAURY MW J320-series WR22 33-50 GHz Calibrated Mismatches ... $375.00
MILLIWAVE S90-1060 Amp., 8 dB, 18-26.5 GHz, +19 dBm Po, 5V 500mA, SMA(f) $475.00
MILLIWAVE S91-1777B Amp., 8 dB, 18-26.5 GHz, +16.5 dBm Po, 12V 600mA,SMA(f) $325.00
MILLIWAVE S91-1777B Amp., 2.75 dB, 18.0-26.5 GHz,+19 dBm Po,12V 200mA,SMA(f) $150.00
MINI-CIRCUITS ZHL-2-8 Amplifier, 27 dB, 10-1000 MHz, +29 dBm Po, 24V 0.6mA $225.00
MITEQ AMP-1269 Amplifier, 30 dB gain, 700-1200 MHz, 1 Watt, 24V 500mA $175.00
NARDA 26298 20 dB Attenuator, 150 Watts, DC-1 GHz, N(f/f) $200.00
NARDA 3000-SERIES Directional Couplers $150.00
NARDA 3090-SERIES Precision High Directivity Couplers $225.00
NARDA 4000-SERIES SMA Miniature Directional Couplers $75.00
NARDA 4203-6 Directional Coupler, 6 dB, 2-18 GHz, SMA(f/f/f) $225.00
NARDA 5070-SERIES Precision Reflectometer Couplers $300.00
NARDA 792FF Variable Attenuator, 0-20 dB, 2.0-12.4 GHz $375.00
OMNI-SPECTRA 2082-5810-02 Adj.Phase Trimmer, 8-18 GHz, 10 deg./GHz range,SMA(m/f) $50.00
PASSIVE MW. RHG-1003 WR28 Isolator, 20 dB, 26.5-40.0 GHz, loss <1 dB $250.00
PRDN233A/232 Slotted Line, 3-12 GHz, N(m/f), w/carriage & detector $175.00
RLC AV-70124-R Level Set Attenuator, 0-20 dB, 7.0-12.4 GHz, SMA(f/f) $75.00
SPACEK LABS DQ-1 WR22 Flat Broadband Detector, 33-50 GHz $550.00
SPACEK LABS Q-3X 33-50 GHz Tripler, >+3 dBm out for 11-17 GHz +20 dBm in $875.00
SPACEK LABS U-3X40-60 GHz Tripler, >0 dBm out for 13-20 GHz +20 dBm in $875.00
TRGB510 WR22 Precision Rotary Vane Atten., 0-50 dB, 33-50 GHz $1,000.00
TRGB551 WR22 Frequency Meter, 33.0-50.0 GHz $550.00
TRGV510 WR15 Precision Rotary Vane Atten., 0-50 dB, 50-75 GHz $1,000.00
TRGV551 WR15 Frequency Meter, 50.0-75.0 GHz $600.00
WEINSCHEL 1515 Power Divider, DC-18 GHz, SMA(f/f/f) $125.00
WEINSCHEL 1579 Power Divider, DC-26.5 GHz, APC3.5(f/f/f) *NEW* $275.00
WEINSCHEL 3200-1 Programmable Step Atten., 0-127 dB, DC-2 GHz, SMA *NEW* $200.00
WILTRON 60A50-opt.1 SWR Bridge, 5-2000 MHz, APC7 test port, 46 dB directive $550.00
WILTRON 60NF50-opt.1 SWR Bridge, 5-2000 MHz, N(f) test port, 46 dB directive $550.00
WILTRON 64A50 VSWR Bridge, 3-8 GHz, 36 dB dir., APC7 test port $400.00
WILTRON 87A50 VSWR Bridge, 2-18 GHz, 35 dB dir., APC7 test port $950.00

LOGIC

HP5005A Signature Multimeter $350.00
HP8170A-002 Logic Pattern Generator, 2 MB/s, address driver option $1,400.00

COMMUNICATIONS

HP3551A Transmission Test Set $750.00
HP4935A Transmission Test Set, 20 Hz-110 kHz $1,675.00
HP59401A HPIB Bus Analyzer $700.00
TEK 1410R-opt.04 NTSC Test Signal Gen. w/SPG2,TSG1,TSP1,TSG3,TSG5,TSG6 ..... $2,750.00
TEK 1411R-opt.04 PAL Test Gen. w/SPG12, TSG11,TSP11,TSG13,TSG15,TSG16 ..... $2,750.00
TEK 144 NTSC Test Signal Generator $675.00
TEK 147A NTSC Test Signal Generator, with noise test signal $950.00
TEK 1485R Dual Standard Waveform Monitor, NTSC & PAL $1,850.00
TEK 521A PAL Vectorscope $1,500.00

MISCELLANEOUS

FLUKE 2190A/2300A/1120A 10-Chan. Scanning Thermometer, types J,K,T,R,C, GPIB $875.00
FLUKE 2190A/Y2003/Y2001 Temperature Calibration System $950.00
HP59307A HPIB VHF Switch $200.00
P.A.R. 5205-94,95,96,98 Lock-In Amp, 20 Hz-20 kHz, int. osc., lin/log, GPIB $2,750.00
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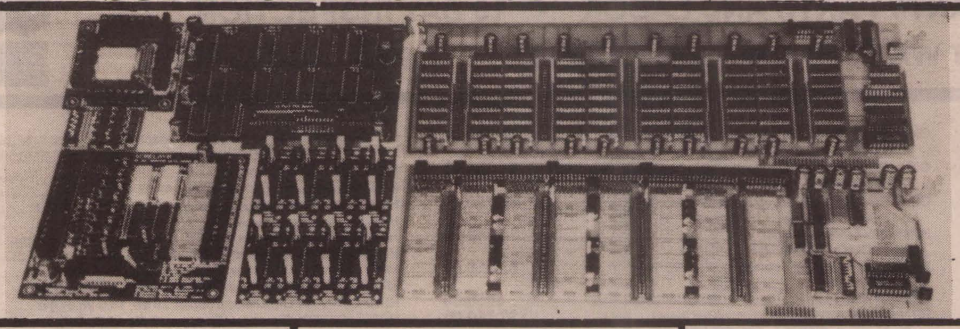

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As an engineer, you certainly do it!
As a technician, you might do it!
As a hobbyist, you rarely do it!

Conquering Data Sheet Block: It's as Easy as ABC

by Ronald Reis

Yet, all who engage in electronics beyond simple assembly should at least give it a try. Mining the wealth of information contained in component data sheets is essential to amplifying one's understanding of electronic components and circuits.

There's great stuff in those sheets. Component features and description, pin configurations, logic symbols, logic diagrams, function tables, operating parameters, and application notes are the bedrock of every component data sheet. Best of all, these sheets are often free, just for the asking.

In this article, we'll dig step-by-step through key elements of an electronic component data sheet. We will show you what is important to know and what can safely be ignored. When you're through, you'll not only know how to interpret data sheets, you will be eager to do so.

Data Sheets and Data Handbooks

Data sheets are published by component manufacturers. They are available as separate sheets for each component or, more often, compiled into a data handbook, with a given handbook for a particular component family or subfamily. The data sheet we will be using for analysis (actually five sheets of paper) is for the FAST TTL 74F85, 4-Bit Magnitude Comparator. Permission to reprint the sheets is granted by Philips Semiconductors.

Two quick points before we begin. First, this article is not about the 74F85; it is about data sheets. We use the 74F85 to illustrate how data sheets in general are structured and how information is presented.

Second, semiconductor manufacturers will, for the most part, classify their handbooks into two series: Integrated Circuits and Discrete Devices. The material presented here pertains primarily to the former, though it is certainly applicable to the latter.

The Data Sheet – What to Look For

Figure 1

Philips Semiconductors FAST Products — Product specification

4-bit magnitude comparator — **74F85**

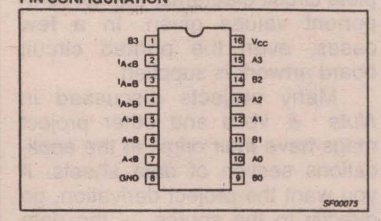
FEATURES

- High-impedance NPN base inputs for reduced loading (20µA in High and Low states)
- Magnitude comparison of any binary words
- Serial or parallel expansion without extra gating

DESCRIPTION

The 74F85 is a 4-bit magnitude comparator that can be expanded to almost any length. It compares two 4-bit binary, BCD, or other monotonic codes and presents the three possible magnitude results at the outputs. The 4-bit inputs are weighted (A0–A3) and (B0–B3) where A3 and B3 are the most significant bits. The operation of the 74F85 is described in the Function Table, showing all possible logic conditions. The upper part of the table describes the normal operation under all conditions that will occur in a single device or in a series expansion scheme. In the upper part of the table the three outputs are mutually exclusive. In the lower part of the table, the outputs reflect the feed-forward conditions that exist in the parallel expansion scheme. The expansion inputs $I_{A>B}$, and $I_{A=B}$ and $I_{A<B}$ are the least significant bit positions. When used for series expansion, the A>B, A=B and A<B outputs of the lease significant word are connected to the corresponding $I_{A>B}$, $I_{A=B}$ and $I_{A<B}$ inputs of the next higher stage. Stages can be added in this manner to any length, but a propagation delay penalty of about 15ns is added with each additional stage. For proper operation, the expansion inputs of the least significant word should be tied as follows: $I_{A>B}$ = Low, $I_{A=B}$ = High, and $I_{A<B}$ = Low.

PIN CONFIGURATION



TYPE	TYPICAL PROPAGATION DELAY	TYPICAL SUPPLY CURRENT (TOTAL)
74F85	7.0ns	40mA

ORDERING INFORMATION

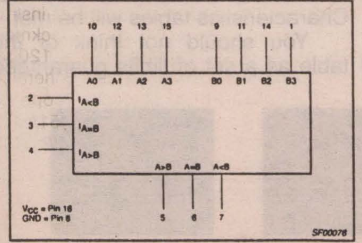
DESCRIPTION	COMMERCIAL RANGE V_{CC} = 5V ±10%, T_{amb} = 0°C to +70°C
16-pin plastic DIP	N74F85N
16-pin plastic SO	N74F85D

INPUT AND OUTPUT LOADING AND FAN OUT TABLE

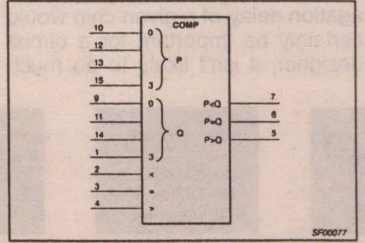
PINS	DESCRIPTION	74F (U.L.) HIGH/LOW	LOAD VALUE HIGH/LOW
A0–A3	Comparing inputs	1.0/0.033	20µA/20µA
B0–B3	Comparing inputs	1.0/0.033	20µA/20µA
$I_{A<B}$, $I_{A=B}$, $I_{A>B}$	Expansion inputs (active High)	1.0/0.033	20µA/20µA
A<B, A=B, A>B	Data outputs (active High)	50/33	1.0mA/20mA

NOTE: One (1.0) FAST unit load is defined as: 20µA in the High state and 0.6mA in the Low state.

LOGIC SYMBOL



IEC/IEEE SYMBOL



Most integrated circuit data sheets can be broken down into three discernible parts. Part A, *basic product specifications,* tells you what you need to know to select and work with a given component. Part B, *application diagrams (notes),* shows how to use the component and, in some cases, contains complete project schematics. Part C, *chip characteristics,* provides the design parameters every engineer, and many technicians, must be familiar with. We'll examine each part. While doing so, you will want to refer to Figures 1-5.

Part A: Basic Product Specifications

This part usually contains six distinct elements, although some manufacturers will combine various elements.

1) *Identification Number and Functional Description.* Under identification number the series, function, and subfamily (if required) are given. The functional description is the complete device name.

Looking at Figure 1, the identification number is 74F85. The 74 is the *series,* in this case TTL commercial. The 85 represents the *function,* comparator. The F designates the *subfamily,* FAST, a high-speed version of the basic TTL series.

The functional description is for a 4-Bit Magnitude Comparator.

2) *Features.* Here are presented the chip's "selling" points, its capabilities. In Figure 1, we see that, among other features, with enough 74F85s, binary words of any size can be compared without extra gating.

3) *Description.* With this element we get down to detail: basic operating characteristics, what pins do what, and whether they are active-LOW or active-HIGH.

As we see in Figure 1, the description (which includes the Input and Output Loading and Fan Out Table) will often refer to other elements, such as the logic symbols and function table.

4) *General Parameters.* Here is provided a quick overview of basic guidelines — typical supply current and typical propagation delay, for instance.

Our 74F85 (as shown in Figure 1, right) operates with a typical propagation delay of 7.0 ns and a total supply current of 40 mA.

5) *Ordering Information.* These specifications are usually limited to packaging styles and supply voltage range.

The 74F85 comes in a DIP (dual-in-line package), through-hole version and an SO (small outline) surface mount configuration (Figure 1). Supply voltage is typical for commercial TTL: 5V with a tolerance of plus and minus 10%.

6) *Pin Configuration, Logic Symbols, Logic Diagram,* and *Function Table (Truth Table).*

The *pin configuration* shows the top view of the component (IC) with pin 1 in the upper left corner and the last pin in the upper right corner. The configuration identifies input, output, and supply voltage pins.

The *logic symbols* depict, in simplified form, the relationship of each input of a digital logic circuit to each output.

There are two types of logic symbols. The conventional symbol explicitly shows the internal logic (except for complex logic). The other is the ANSI/IEEE logic symbol. The latter has two advantages over the former. One, it is much simpler, since no internal logic is depicted. Two, many circuit characteristics for which there were no previous symbolic representation can now be portrayed — open-collector, open-emitter, and three-state outputs, to name just a few.

The *logic diagram* is often, but not always, included (Figure 2). It shows the internal logic of a digital IC, gate-for-gate. While the user has no control over what's inside, having the diagram to peruse often relieves the claustrophobic "black box" feeling one gets when working with such chips.

Finally, there is the *function table,* or *truth table,* one of the most important elements in a digital IC data sheet. The table lists all input and output possibilities.

Examining the function table for the 74F85, Figure 2, we see that there are four pairs of inputs and three outputs. There are also three expansion inputs. The description element details what is taking place in the function table. However, with experience, you should be able to read a function table with little or no accompanying written explanation.

If you're a hobbyist, or even a technician, you'll probably get more from Part A than either Parts B or C. It is in Part A, with its six elements, that the main features of a given component are illustrated and explained.

Part B: Application Diagrams (Notes)

Part B doesn't always exist; when it does, consider it a bonus from the manufacturer.

In some cases, with small-scale integration (SSI), for instance, there isn't much to say with regard to applications. Discrete gates, such as are found in a 74F00 Quad 2-Input NAND Gate or a 74F04 Hex Inverter have uses, of course, yet they are rarely seen by themselves. But as we move to medium-scale integration (MSI) and beyond, application notes become invaluable.

Often the note will simply illustrate and explain how a chip can be cascaded or otherwise expanded. In Figure 3, we see a parallel expansion scheme that demonstrates the most efficient way to increase word length by using a number of 74F85s. In the illustration, two 24-bit words are compared.

The final outputs will tell us whether word B is greater than word A (A<B output goes HIGH), whether word B is less than word A (A>B output goes HIGH), or whether word B is equal to word A (A=B output goes HIGH). As the table in the figure indicates, the parallel technique can be expanded to any number of bits.

The application in Figure 3 is given in block diagram form. To build the actual circuit, you have to turn the block into a complete, working schematic.

Luckily for the hobbyist and technician, many manufacturers are providing complete circuit diagrams, with all component values given. In a few cases, even the printed circuit board artwork is supplied.

Many projects discussed in *Nuts & Volts* and other project mags have their origin in the applications section of data sheets. If you want the project derivation, go directly to the source — the data sheet application notes.

Part C: Chip Characteristics

It is here, at the door to Part C, that some folks begin to stray. Most hobbyists, and not a few technicians, are ready to abandon Part C, with its absolute maximum ratings, recommended operating conditions, DC and AC electrical characteristics, and various waveforms and test circuits, to the circuit design engineer. That's understandable. While knowing the propagation delay of a given chip would certainly be important for a circuit designer, it isn't likely to do much for the hobbyist during assembly or the technician while troubleshooting. Nonetheless, hobbyists and technicians should have at least a passing familiarity with material in this section. Let's take a look.

The *Absolute Maximum Ratings* table carries the maximum limits to which the part can be subjected without damaging it. That's not the same thing as saying the part will function at these extreme conditions, however. Thus, specifications such as the most negative voltage that may be applied to the outputs, V_{out} in Figure 4, for example, only insures that if less than -0.5V is applied to the output pin, after the voltage is removed, the part will not be shorted.

The *Recommended Operating Conditions* table does two things. One, it sets environmental conditions, the ambient air temperature, for operation. Two, it sets the conditions under which the limits set forth in the DC and AC Electrical Characteristics tables will be met.

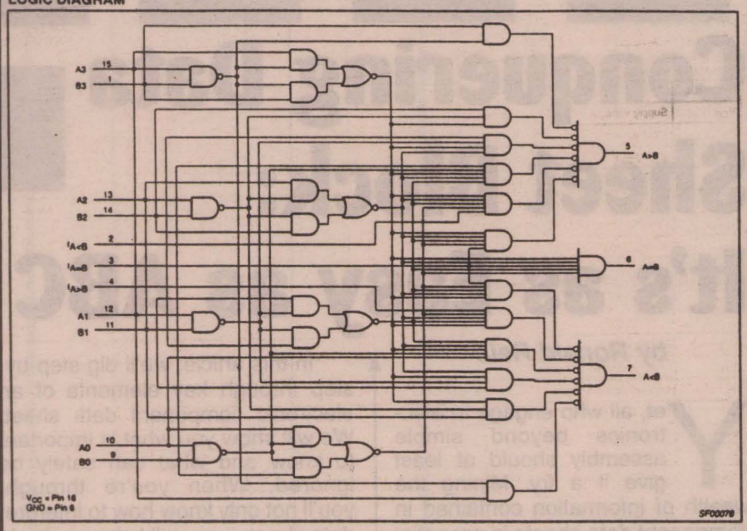
You should not think of the table as a set of limits guaranteed

Figure 2

Philips Semiconductors FAST Products — Product specification

4-bit magnitude comparator — 74F85

LOGIC DIAGRAM



FUNCTION TABLE

COMPARING INPUTS				EXPANSION INPUTS			OUTPUTS		
A3,B3	A2,B2	A1,B1	A0,B0	$I_{A>B}$	$I_{A<B}$	$I_{A=B}$	A>B	A<B	A=B
A3>B3	X	X	X	X	X	X	H	L	L
A3<B3	X	X	X	X	X	X	L	H	L
A3=B3	A2>B2	X	X	X	X	X	H	L	L
A3=B3	A2<B2	X	X	X	X	X	L	H	L
A3=B3	A2=B2	A1>B1	X	X	X	X	H	L	L
A3=B3	A2=B2	A1<B1	X	X	X	X	L	H	L
A3=B3	A2=B2	A1=B1	A0>B0	X	X	X	H	L	L
A3=B3	A2=B2	A1=B1	A0<B0	X	X	X	L	H	L
A3=B3	A2=B2	A1=B1	A0=B0	H	L	L	H	L	L
A3=B3	A2=B2	A1=B1	A0=B0	L	H	L	L	H	L
A3=B3	A2=B2	A1=B1	A0=B0	L	L	H	L	L	H
A3=B3	A2=B2	A1=B1	A0=B0	X	X	H	L	L	H
A3=B3	A2=B2	A1=B1	A0=B0	H	H	L	L	L	L
A3=B3	A2=B2	A1=B1	A0=B0	L	L	L	H	H	L

H = High voltage level
L = Low voltage level
X = Don't care

Figure 3

Philips Semiconductors FAST Products — Product specification

4-bit magnitude comparator — 74F85

APPLICATION

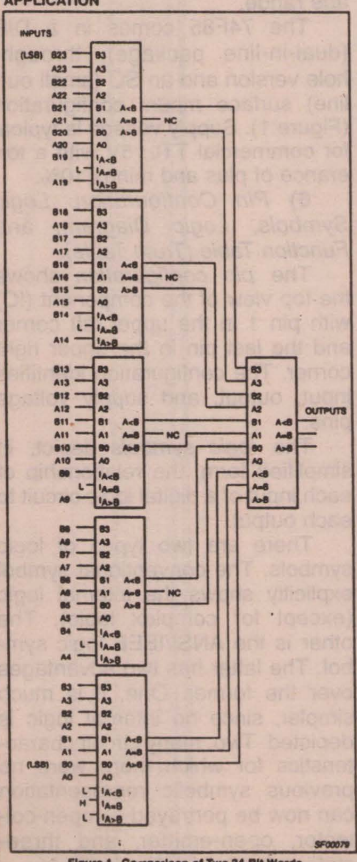


Figure 1. Comparison of Two 24-Bit Words

The parallel expansion scheme shown in Figure 1 demonstrates the most efficient general use of these comparators. The expansion inputs can be used as a fifth input bit position except on the least significant device, which must be connected as in the serial scheme. The expansion inputs used by labeling $I_{A>B}$ as an "A" input, $I_{A<B}$ as a "B" input and setting $I_{A=B}$ = Low. The 74F85 can be used as a 5-bit comparator only when the outputs are used to drive the (A0–A3) and (B0–B3) inputs of another 74F85 device. The parallel technique can be expanded to any number of bits as shown in Table 1.

Table 1.

WORD LENGTH	NUMBER OF PACKAGES	TYPICAL SPEEDS 74F
1–4 bits	1	12ns
5–24 bits	2–6	22ns
25–120 bits	8–31	34ns

Philips Semiconductors FAST Products — Product specification

4-bit magnitude comparator — 74F85

ABSOLUTE MAXIMUM RATINGS

(Operation beyond the limits set forth in this table may impair the useful life of the device. Unless otherwise noted these limits are over the operating free-air temperature range.)

SYMBOL	PARAMETER	RATING	UNIT
V_{CC}	Supply voltage	−0.5 to +7.0	V
V_{IN}	Input voltage	−0.5 to +7.0	V
I_{IN}	Input current	−30 to +5	mA
V_{OUT}	Voltage applied to output in High output state	−0.5 to V_{CC}	V
I_{OUT}	Current applied to output in Low output state	40	mA
T_{amb}	Operating free-air temperature range	0 to +70	°C
T_{stg}	Storage temperature range	−65 to +150	°C

RECOMMENDED OPERATING CONDITIONS

SYMBOL	PARAMETER	LIMITS			UNIT
		MIN	NOM	MAX	
V_{CC}	Supply voltage	4.5	5.0	5.5	V
V_{IH}	High-level input voltage	2.0			V
V_{IL}	Low-level input voltage			0.8	V
I_{IK}	Input clamp current			−18	mA
I_{OH}	High-level output current			−1	mA
I_{OL}	Low-level output current			20	mA
T_{amb}	Operating free-air temperature range	0		+70	°C

DC ELECTRICAL CHARACTERISTICS

(Over recommended operating free-air temperature range unless otherwise noted.)

SYMBOL	PARAMETER	TEST CONDITIONS[1]		LIMITS			UNIT
				MIN	TYP[2]	MAX	
V_{OH}	High-level output voltage	V_{CC} = MIN, V_{IL} = MAX, V_{IH} = MIN, I_{OH} = MAX	±10%V_{CC}	2.5			V
			±5%V_{CC}	2.7	3.4		
V_{OL}	Low-level output voltage	V_{CC} = MIN, V_{IL} = MAX, V_{IH} = MIN, I_{OL} = MAX	±10%V_{CC}		0.30	0.50	V
			±5%V_{CC}		0.30	0.50	
V_{IK}	Input clamp voltage	V_{CC} = MIN, I_I = I_{IK}			−0.73	−1.2	V
I_I	Input current at maximum input voltage	V_{CC} = 0.0V, V_I = 7.0V				100	µA
I_{IH}	High-level input current	V_{CC} = MAX, V_I = 2.7V				20	µA
I_{IL}	Low-level input current	V_{CC} = MAX, V_I = 0.5V				−20	µA
I_{OS}	Short-circuit output current[3]	V_{CC} = MAX		−60		−150	mA
I_{CC}	Supply current (total) I_{CCH}	V_{CC} = MAX	V_{IN} = GND		36	50	mA
	Supply current (total) I_{CCL}		An = Bn = $I_{A=B}$ = GND, $I_{A>B}$ = $I_{A<B}$ = 4.5V		40	54	

NOTES:
1. For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable type.
2. All typical values are at V_{CC} = 5V, T_{amb} = 25°C.
3. Not more than one output should be shorted at a time. For testing I_{OS}, the use of high-speed test apparatus and/or sample-and-hold techniques are preferable in order to minimize internal heating and more accurately reflect operational values. Otherwise, prolonged shorting of a High output may raise the chip temperature well above normal and thereby cause invalid readings in other parameter tests. In any sequence of parameter tests, I_{OS} tests should be performed last.

Figure 4

by a manufacturer. Rather, see it as the conditions the company (in our example, Philips Semiconductors) uses to test the parts and guarantees that they will then meet the limits set forth in the DC and AC Electrical Characteristics tables. Thus, in Figure 4, if V_{CC} is between 4.5 and 5.5 volts; if V_{IH} stays above 2.0 volts; if V_{il} is held to a maximum of 0.8 volts; and if I_{IK}, I_{OH}, and I_{OL} do not exceed -18mA, -1mA, and 20mA, respectively, Philips Semiconductors guarantees the data in the DC and AC Electrical Characteristics tables, Figures 4 and 5. Of course, the operating free-air (ambient) temperature range must remain between 0 and +70 degrees Centigrade.

The *DC Electrical Characteristics* table reflects the DC limits used by the manufacturer during their testing operations conducted under the conditions set forth in the Recommended Operating Conditions table. If we compare both tables in Figure 4, we see V_{OH} is guaranteed to be no less than 2.7V when tested with V_{CC} = 4.5V, V_{IH} = 0.8V across the temperature range of 0 to 70 degrees Centigrade, and with an output current of I_{OH} = 1.0mA.

Finally, the *AC Electrical Characteristics* table contains the guaranteed limits when tested under the conditions set forth in the *AC Test Circuits* and *Waveforms* section (Figure 5). The latter shows a test circuit and accompanying input pulse waveforms.

Don't let data sheet letter symbols, with their various subscripts, intimidate you. Remember, the subscript simply limits, or narrows, the main term. Take the symbol V_{IH}, for example. The V indicates voltage. The two subscripts, $_I$ and $_H$, clarify what voltage: minimum input voltage ($_I$) when the gate is HIGH ($_H$).

All data handbooks provide symbol definitions, usually in the front of the manual. It is a good idea to look over this, and other introductory material, before attempting to analyze individual component information. Thus equipped, you'll be ready to chop away at any data sheet you encounter.

Building Your Own Data-Sheet Library

You don't have to be a working engineer to acquire data sheets. As a hobbyist or technician, you can develop your own reference library of data handbooks and sheets. Here is the what, how, and where of ordering.

1) *What to Order.* If you have a particular component in mind, then order the data sheet for that component. In some cases, however, you may be sent the entire handbook. If the latter is what you want in the first place, specify the type of handbook by family or subfamily — for example, with ICs, *TTL Data Handbook* or *High-Speed CMOS Data Handbook.*

2) *How to Order.* Just ask, by phone, fax, or mail. Don't feel intimidated just because you may be a hobbyist. Remember, data handbooks advertise a company's product line; the company will willingly give them away to anyone who can use them.

3) *Where to Order.* Most of the larger semiconductor companies are listed in various manufacturers' indexes. If you can't find such an index, simply look for the company's name in the phone book. You may get the local distributor who will then turn you over to the company's Technical Literature and Documentation Department.

Remember, keep your requests modest. Don't just say, "Send me everything you have." A specific request will ensure a prompt and satisfactory response.

Hopefully, with this introduction, you feel a bit more at ease about data sheets and handbooks. Although you will encounter more complex data sheets than the one examined here, most will contain the three parts and various elements discussed.

Identify the parts and elements first. You might even clock them out with a pencil or highlighter. Then begin your analysis. Any data block you may have had should erode with every new sheet you attack. **NV**

Figure 5

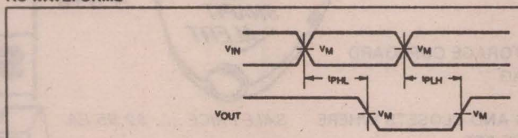
Philips Semiconductors FAST Products — Product specification

4-bit magnitude comparator — 74F85

AC ELECTRICAL CHARACTERISTICS

SYMBOL	PARAMETER	TEST CONDITION	LIMITS: V_{CC} = +5.0V, T_{amb} = +25°C, C_L = 50pF, R_L = 500Ω			LIMITS: V_{CC} = +5.0V ± 10%, T_{amb} = 0°C to +70°C, C_L = 50pF, R_L = 500Ω		UNIT
			MIN	TYP	MAX	MIN	MAX	
t_{PLH} t_{PHL}	Propagation delay A or B to A<B, A>B	Waveform 1 3 logic levels	6.0 7.0	8.5 9.5	11.0 14.0	5.5 6.5	13.0 15.5	ns
t_{PLH} t_{PHL}	Propagation delay A or B to A=B	Waveform 1 4 logic levels	6.5 7.0	9.0 9.5	11.5 14.0	6.0 6.5	14.0 14.5	ns
t_{PLH} t_{PHL}	Propagation delay $I_{A<B}$ and $I_{A=B}$ to A>B	Waveform 1 1 logic level	3.0 3.0	5.0 6.0	7.5 9.0	2.5 2.5	9.0 10.0	ns
t_{PLH} t_{PHL}	Propagation delay $I_{A=B}$ to A=B	Waveform 1 2 logic levels	2.5 3.5	4.5 7.5	7.0 10.0	2.0 2.5	9.0 12.0	ns
t_{PLH} t_{PHL}	Propagation delay $I_{A>B}$ and $I_{A=B}$ to A<B	Waveform 1 1 logic level	3.0 3.0	5.0 6.0	8.0 9.0	3.0 2.0	9.5 9.5	ns

AC WAVEFORMS

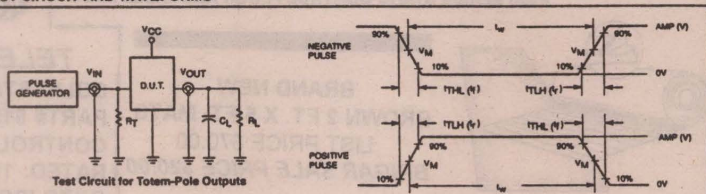


SF00080

Waveform 1. Propagation Delay Input to Output

NOTE:
For all waveforms, V_M = 1.5V.

TEST CIRCUIT AND WAVEFORMS



Test Circuit for Totem-Pole Outputs

DEFINITIONS:
R_L = Load resistor; see AC ELECTRICAL CHARACTERISTICS for value.
C_L = Load capacitance includes jig and probe capacitance; see AC ELECTRICAL CHARACTERISTICS for value.
R_T = Termination resistance should be equal to Z_{OUT} of pulse generators.

Input Pulse Definition

family	INPUT PULSE REQUIREMENTS					
	amplitude	V_M	rep. rate	t_W	t_{TLH}	t_{THL}
74F	3.0V	1.5V	1MHz	500ns	2.5ns	2.5ns

SF00009

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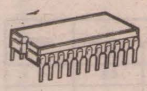

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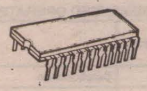

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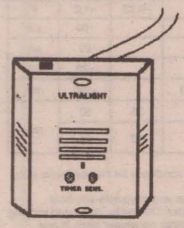

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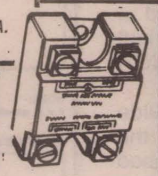

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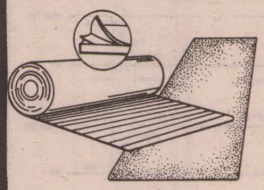
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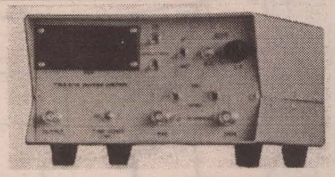

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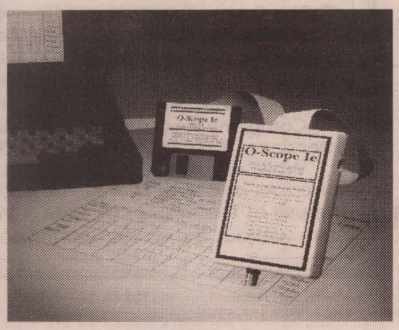

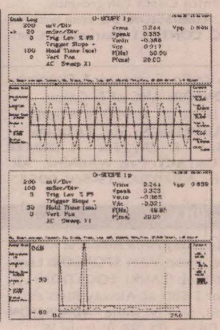

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Events

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 the person to contact, and phone number.

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

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

All listing information should be sent to:
Nuts & Volts Magazine
Events Calendar
430 Princeland Court
Corona, CA 91719
Phone 909-371-8497
Fax 909-371-3052
CompuServe 74262,3664
Internet
74262,3664@compuserve.com

WESTERN REGION

JULY 1

CA - ANTIOCH — MarketPro Computer Show & Sale. **LOCATION:** Contra Costa 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-? **ADMISSION:** 50¢. **TALK-IN:** 146.520. **FEATURES:** C - E - FM - F/R - H. **DEALER INFO:** $7 vehicle. **CONTACT:** Pat, WA6MHZ, ARCEC, Box 50, El Cajon CA 92020. 619-561-0052.

JULY 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) from W, 145.350- (PL 100) from E. **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 - 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.*

JULY 8

CA - ANAHEIM — Robert Austin Computer Show. **LOCATION:** Anaheim Stadium, Conference Level. **HOURS:** 10am-4pm. **FEATURES:** C. **CONTACT:** Robert Austin Corp, 1-800-346-0100, FAX 415-347-0350.

CA - FONTANA — Amateur Radio & Electronic Equipment Swap Meet. **SPONSOR:** Inland Empire ARC & A.B. Miller High School ARC. **LOCATION:** A.B. Miller High School, 6821 Oleander Ave. **HOURS:** 7am-? **ADMISSION:** Free. **FEATURES:** E - EX - FP - F/R - H. **DEALER INFO:** Set-up 6am. **CONTACT:** Bill Gruber 909-822-4138 eves.

CA - OAKLAND — Robert Austin Computer Show. **LOCATION:** Oakland Convention Center, Exhibit Hall West. **HOURS:** 10am-4pm. **FEATURES:** C. **CONTACT:** Robert Austin Corp, 1-800-346-0100, FAX 415-347-0350.

CA - RESEDA — Computer Marketplace. **SPONSOR:** National Productions. **LOCATION:** Sherman Square Entertainment Center, 18430 Sherman Way. From 101 Freeway take Reseda offramp, turn left to Sherman Way, turn right. Go 1 blk to Canby St. **HOURS:** 10am-5pm. **ADMISSION:** $5. **CONTACT:** National Productions, 408-778-5200 or 1-800-800-5600. FAX 408-779-1374.

WA - VANCOUVER — Electronic Flea Market. **SPONSOR:** Clark County ARC. **LOCATION:** Clark County P.U.D., 1 blk E of I-5 at Mill Plain Exit. **HOURS:** 8am-11:00. **ADMISSION:** Free. **FEATURES:** C - E - EX - FM - H. **DEALER INFO:** Tables: Adv $7, Door $10. Tailgating: $5. **CONTACT:** 360-896-8909.

JULY 9

CA - BUENA PARK — Computer Marketplace. **SPONSOR:** National Productions. **LOCATION:** Sequoia Conference Center. Take Beach Blvd exit off 91 Freeway. Go 1 blk N to 7530 Orangethorpe. **HOURS:** 10am-5pm. **ADMISSION:** $5. **CONTACT:** National Productions, 408-778-5200 or 1-800-800-5600. FAX 408-779-1374.

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.*

JULY 14-15-16

ID - BOISE — Convention 1995. **SPONSOR:** International Radio Club of America. **LOCATION:** Owyhee Plaza Hotel. **HOURS:** Fri: 10am-11pm; Sat: 10am-11pm; Sun: 10am-3pm. **FEATURES:** DP - F. **CONTACT:** 208-377-5346.

JULY 15

CA - SAN FRANCISCO — Robert Austin Computer Show. **LOCATION:** Cow Palace, Hall DEF. **HOURS:** 10am-4pm. **FEATURES:** C. **CONTACT:** Robert Austin Corp, 1-800-346-0100, FAX 415-347-0350.

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

JULY 15-16

CA - POMONA — Computer Marketplace. **SPONSOR:** National Productions. **LOCATION:** Fairplex Exposition Center, Exit Highway 10 at Fairplex Dr. Go N to McKinley Ave, turn right. Turn left on White Ave to Gate 14. **HOURS:** 10am-5pm. **ADMISSION:** $7. **CONTACT:** National Productions, 408-778-5200 or 1-800-800-5600. FAX 408-779-1374.

JULY 16

AZ - PHOENIX — Computer & Electronic Swap Meet. **SPONSOR:** Electronic Materials & Computers. **LOCATION:** Electronic Materials & Computers parking lot, 3102 W. Thomas Rd. #902. **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 - SACRAMENTO — MarketPro Computer Show & Sale. **LOCATION:** Scottish Rite Center. **HOURS:** 10am-5pm. **ADMISSION:** $6, free w/membership. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

NV - CARSON CITY — Swap Meet. **LOCATION:** Custom Computer Concepts parking lot, Hwy. 50 E, N of high school. **HOURS:** 8am-noon. **ADMISSION:** Free. **DEALER INFO:** Sellers, $3 space. Set-up 7:30 am. **CONTACT:** 702-883-8900.

JULY 21-22-23

AZ - FLAGSTAFF — Ft Tuthill Hamfest. **SPONSOR:** AR Council of AZ. **LOCATION:** Coconino County Fairgrounds. **ADMISSION:** Free. **TALK-IN:** 146.98. **FEATURES:** B - CB - EX - F - H - T. **CONTACT:** ARCA, POB 32756, Phoenix AZ 85064-2756.

JULY 22

CA - SANTA BARBARA — Computer Marketplace. **SPONSOR:** National Productions. **LOCATION:** Earl Warren Showgrounds. Take Highway 101 to Las Positas Exit. Follow signs to fairgrounds. **HOURS:** 10am-5pm. **ADMISSION:** $5. **CONTACT:** National Productions, 408-778-5200 or 1-800-800-5600. FAX 408-779-1374.

OR - NORTH BEND — 5th Annual Southern Oregon Coast Hamfest. **SPONSOR:** Coos County ARC. **LOCATION:** Junior High School Gym, on Hwy 101. **HOURS:** 9am-5pm. **ADMISSION:** Adv: $4, Door: $5. **TALK-IN:** 146.01/61 K7CCH. **FEATURES:** CB - DP - EX - FM - FP - F/R - H - RV-S. **DEALER INFO:** Tables: $10. **CONTACT:** Coos County ARC, POB 3494, Coos Bay OR 97420. 503-396-4479 or 503-396-5778.

JULY 22-23

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

WA - RENTON — 1995 Pacific NW DX Convention. **SPONSOR:** Western Washington DX Club. **LOCATION:** Renton Holiday Inn, 800 Rainier Ave S. **ADMISSION:** $49 both days (includes banquet), $17 program only. **FEATURES:** B - DP - EX - F - S. **CONTACT:** WWDXC, POB 224, Mercer Island WA 98040. Joe W7QN, 206-784-1089.

JULY 23

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

JULY 29-30

CA - ANAHEIM — Robert Austin Computer Show. **LOCATION:** Anaheim Stadium, Conference Level. **HOURS:** 10am-4pm. **FEATURES:** C. **CONTACT:** Robert Austin Corp, 1-800-346-0100, FAX 415-347-0350.

JULY 30

CA - SACRAMENTO — Ham Radio Swap Meet and Picnic. **SPONSOR:** River City ARCS. **LOCATION:** California State University @ Sacramento, Parking lot 'A'. **HOURS:** 8am-Noon. **ADMISSION:** Free. **TALK-IN:** 145.250 (-) CTCSS 162.2Hz. **FEATURES:** E - F/R - H. **DEALER INFO:** Vendors: $10 for two parking spaces. **CONTACT:** Troy, KDHOJ, 916-725-8152. E-Mail: johna@clselis.com.

CA - SANTA ANA — ACP Computer Swap Meet. **SPONSOR:** Advanced Computer Products. **LOCATION:** 1310 E. Edinger. **HOURS:** 8am-2pm, rain or shine. **ADMISSION:** Free. **FEATURES:** C - E - FP. **CONTACT:** 714-558-8813.

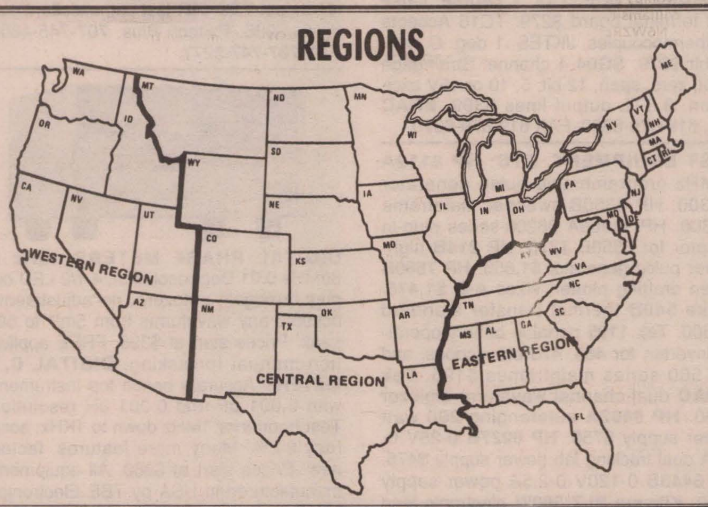
AUGUST 5

CA - OAKLAND — Robert Austin Computer Show. **LOCATION:** Oakland Convention Center, Exhibit Hall West. **HOURS:** 10am-4pm. **FEATURES:** C. **CONTACT:** Robert Austin Corp, 1-800-346-0100, FAX 415-347-0350.

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

AUGUST 5-6

CA - POMONA — Computer Marketplace. **SPONSOR:** National Productions. **LOCATION:** Fairplex Exposition Center, Exit Highway 10 at Fairplex Dr. Go N to McKinley Ave, turn right. Turn left on



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) — 301-365-2424
N.E. (CT, MA, NJ, NY, RI) — 201-265-1075
NARISAAM Computer Shows — 800-436-6707
Northern Computer Shows — 508-744-8440

Events CALENDAR

White Ave to Gate 14. **HOURS:** 10am-5pm. **ADMISSION:** $7. **CONTACT:** National Productions, 408-778-5200 or 1-800-800-5600. FAX 408-779-1374.

WA - SPOKANE — The Original Spokane Hamfest. **SPONSOR:** The ARCs of the Spokane Area. **LOCATION:** University High School, 10212 E. 9th Ave. **HOURS:** Sat: 9am-5pm, Sun: 8am-Noon, under 12 free. **ADMISSION:** $4 adv, door $5. **TALK-IN:** 146.52 147.38+ 223.90-. **FEATURES:** CB - DP - EX - F/R - S. **DEALER INFO:** Swap tables $5, Set-up 6pm-9am Fri., 8am-9am Sat. **CONTACT:** KBARA - JoAnn Gemmrig, 6812 E. Third, Spokane, WA 99212. 509-928-1808, 509-448-8445.

AUGUST 6

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) from W, 145.350- (PL 100) from E. **FEATURES:** E - H - FP - F/R. **DEALER INFO:** Set-up after 7am only. $10 space fee. Covered spaces avail. if rain. **CONTACT:** Noel Anklam KC6QZK, 510-447-3857 eves or 510-783-2803 message days.

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

AUGUST 12

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

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

CA - FONTANA — Amateur Radio & Electronic Equipment Swap Meet. **SPONSOR:** Inland Empire ARC & A.B. Miller High School ARC. **LOCATION:** A.B. Miller High School, 6821 Oleander Ave. **HOURS:** 7am-? **ADMISSION:** Free. **FEATURES:** E - EX - FP - F/R - H. **DEALER INFO:** Set-up 6am. **CONTACT:** Bill Gruber 909-822-4138 eves.

CA - LONG BEACH — Amateur Radio Ham Auction. **SPONSOR:** Long Beach ARA & Police Athletic League Hams. **LOCATION:** PAL-HAM facility, 1401 W 9th St. **HOURS:** Preview 7am-9am, Auction: 9am-2pm. **TALK-IN:** 145.550 Simplex. **CONTACT:** Mike Levonius KC6YHF, 714-539-5353 aft 6pm. Chuck Williams KN6DB, 310-431-3488. Packett address: N6WZR@N6YN#SOCAL.CA.USA.NA

CA - RESEDA — Computer Marketplace. **SPONSOR:** National Productions. **LOCATION:** Sherman Square Entertainment Center, 18430 Sherman Way. From 101 Freeway take Reseda offramp, turn left to Sherman Way, turn right. Go 1 blk to Canby St. **HOURS:** 10am-5pm. **ADMISSION:** $5. **CONTACT:** National Productions, 408-778-5200 or 1-800-800-5600. FAX 408-779-1374.

WA - TACOMA — Electronics Flea Market. **SPONSOR:** Radio Club of Tacoma. **LOCATION:** Charles Wright Academy, 7723 Chambers Creed Rd West. **HOURS:** 9am-3pm. **ADMISSION:** $4, under 12 free. **TALK-IN:** 147.28+. **FEATURES:** C - CB - DP - E - EX - FM - FP - H - RV-S. **DEALER INFO:** Tables: Commercial $40, non-commercial $15. Set-up: Fri 5pm-9pm, Sat 5am-9am. **CONTACT:** Radio CLub of Tacoma, Box 11188, Tacoma WA 98411. Alan Hughes, 206-840-4947, pager 206-596-7472.

AUGUST 13

CA - BUENA PARK — Computer Marketplace. **SPONSOR:** National Productions. **LOCATION:** Sequoia Conference Center. Take Beach Blvd exit off 91 Freeway. Go 1 blk N to 7530 Orangethorpe. **HOURS:** 10am-5pm. **ADMISSION:** $5. **CONTACT:** National Productions, 408-778-5200 or 1-800-800-5600. FAX 408-779-1374.

CA - GOLETA — 75th Anniversary Hamfest. **SPONSOR:** Santa Barbara ARC. **LOCATION:** Elk's Lodge #613, 150 N Kellogg Ave. **HOURS:** 8:30-? **TALK-IN:** 146.19/.79 PL 131.8. **FEATURES:** DP - EX - FM - FP - F/R - H. **CONTACT:** SBARC, POB 3232, Santa Barbara CA 93130-3232. 805-569-5700.

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.*

AUGUST 19

CA - ANAHEIM — Robert Austin Computer Show. **LOCATION:** Anaheim Stadium, Conference Level. **HOURS:** 10am-4pm. **FEATURES:** C. **CONTACT:** Robert Austin Corp, 1-800-346-0100, FAX 415-347-0350.

CA - SAN FRANCISCO — Robert Austin Computer Show. **LOCATION:** Cow Palace, Hall DEF. **HOURS:** 10am-4pm. **FEATURES:** C. **CONTACT:** Robert Austin Corp, 1-800-346-0100, FAX 415-347-0350.

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

WA - LONGVIEW — 4th Annual Ham Radio, Computer & Electronic Swap Meet. **LOCATION:** Lower Columbia ARA. **LOCATION:** Cowlitz County Fairgrounds. **HOURS:** 9am-3pm. **ADMISSION:** $3. **TALK-IN:** 147.26+. **FEATURES:** C - CB - DP - E - FM - H - RV-H - T. **DEALER INFO:** Tables: Commercial $15. Others: Before Aug 5 $12, after $15. Tailgating : $5. Set-up: Fri 5pm-9pm, Sat 6am-8:45am. **CONTACT:** LCARA, POB 906, Longview WA 98632. 360-425-6076, 360-425-9184.

AUGUST 19-20

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

AUGUST 20

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

NV - CARSON CITY — Swap Meet. **LOCATION:** Custom Computer Concepts parking lot, Hwy. 50 E, N of high school. **HOURS:** 8am-noon. **ADMISSION:** Free. **DEALER INFO:** Sellers, $3 space. Set-up 7:30 am. **CONTACT:** 702-883-8900.

AUGUST 26-27

CA - POMONA — Computer Marketplace. **SPONSOR:** National Productions. **LOCATION:** Fairplex Exposition Center, Exit Highway 10 at Fairplex Dr. Go N to McKinley Ave, turn right. Turn left on White Ave to Gate 14. **HOURS:** 10am-5pm. **ADMISSION:** $7. **CONTACT:** National Productions, 408-778-5200 or 1-800-800-5600. FAX 408-779-1374.

CENTRAL REGION

JULY 1

MI - TROY — Computer Trade Show. **LOCATION:** American Polish Cultural Center, 2975 E. Maple Rd (15 Mile) corner of DeQuindre. **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.

JULY 1-2

IL - CHICAGO — Computer/Home Office Show & Sales. **SPONSOR:** ComShow Productions. **LOCATION:** DePaul University Stuart Center, Lincoln Park Campus. **HOURS:** 10am-4pm. **ADMISSION:** $6. **FEATURES:** AC - C - E - FP - F/R. **CONTACT:** Karen, 312-665-4817.

JULY 8

MI - PETOSKEY — Swap & Shop. **SPONSOR:** Straits Area ARC. **LOCATION:** Emmet County Fairgrounds. **HOURS:** 8am-1pm. **TALK-IN:** 146.68. **CONTACT:** Harry Leiber N8OIV, 616-347-6610.

OH - PERRYSBURG — CDE Computer Expo. LOCATION: Holiday Inn French Quarter @ the intersection of Interstate 75 & State Rte 20. **HOURS:** 10am-4pm. **FEATURES:** C. **DEALER INFO:** 8' tables $35, Set-up 8:30-10:00. **CONTACT:** David Fleitz, 419-352-9316. Internet CDE3007@aol.com, CDE Computer Products, 635 Flanders Ave, Bowling Green OH 43402-1520.

WI - OAK CREEK — 26th Annual Swapfest. **SPONSOR:** South Milwaukee ARC. **LOCATION:** American Legion Post #434, 9327 S. Shepard Ave. **HOURS:** 7am-2pm. **ADMISSION:** $4. **TALK-IN:** 146.52 Simplex. **FEATURES:** DP - EX - FP - F/R. **CONTACT:** 414-762-3235.

JULY 8-9

IN - INDIANAPOLIS — Hamfest & Central Division Convention. **SPONSOR:** Indianapolis Hamfest Assn. **LOCATION:** Marion County Fairgrounds. **HOURS:** Sat: 6am-5pm, Sun: 7am-3pm. **FEATURES:** B - CB - FM - H - RV-S. **CONTACT:** Indianapolis Hamfest Assn. POB 11776, Indianapolis IN 46201, 317-251-4407.

JULY 9

IL - HINSDALE — Hamfest Computer Show '95. **SPONSOR:** DuPage ARC. **LOCATION:** Santa Fe Park, 91st & Wolf Rd. **HOURS:** 8am-3pm. **ADMISSION:** $4 adv, $5 door. **TALK-IN:** 145.250. **FEATURES:** DP - FP - F/R. **CONTACT:** DARC, Hamfest '95, 7511 Walnut Ave, Woodridge IL 60517. 708-985-9256.

MI - DEARBORN — Computer Trade Show. **LOCATION:** Adray Sports Arena, 14900 Ford Rd (M-153), 1 blk E 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 - JACKSON — Hamfest & Computer Show. **SPONSOR:** Cascades ARC. **LOCATION:** Jackson County Fairgrounds. **HOURS:** 8am-3pm. **ADMISSION:** $3.50 adv, $5 gate. **FEATURES:** C - CB - DP - EX - H - T. **DEALER INFO:** 8' table - $10 adv., $15 gate. Trunk sale spaces $4 adv., $5 gate. Set-up Sat. 5pm-10pm, Sun 5am-8am. **CONTACT:** Terry, KD8B, 517-784-2398 or CARS, POB 512, Jackson MI 49204.

OH - BOWLING GREEN — Ham-A-Rama & Computer Show. **SPONSOR:** Wood County ARC. **LOCATION:** Wood County Fairgrounds. **HOURS:** 8am-1pm. **ADMISSION:** Free. **TALK-IN:** 147.180+. **FEATURES:** C - DP - EX - FP - H - T. **DEALER INFO:** Inside Tables $10, Trunk Sales $5 per space. **CONTACT:** WCARC, POB 534, Bowling Green OH 43402. 419-372-2936.

JULY 14-16

MT - EAST GLACIER — Montana State Convention/Hamfest. **SPONSOR:** Montana State Convention & Glacier/Waterton Int'l Hamfest. **CONTACT:** Darrell Thomas, N7KOR, 743 33rd Ave NE, Great Falls MT 59404. 406-453-8574.

JULY 15

IN - BLOOMINGTON — Hamfest. **SPONSOR:** AR Gogetters. **LOCATION:** Monroe County Fairgrounds, Community Bldg, Hwy 45 towards airport. **HOURS:** 8am-3pm. **ADMISSION:** $5. **TALK-IN:** 147.18/.78. **FEATURES:** CB - EX - FM - FP - F/R - H. **DEALER INFO:** Inside tables $15, outside space $10. Hamfest, 215 N Johnson, Lot 14, Bloomington IN 47404-2885. **CONTACT:** J. Robert Myers K9KTH, 306 S Fairview St, Bloomington IN 47403-2229. 812-332-1105.

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

LA - LEESVILLE — Hamfest. **SPONSOR:** West Louisiana ARC. **LOCATION:** Forestry Grounds (fairgrounds), Shrine Building, Hwy 8, 2 mi W of Hwy 171. **HOURS:** 7am-3pm. **ADMISSION:** $2, under 12 free. **TALK-IN:** 145.310. **FEATURES:** DP - F/R - H - RV-H - RV-S. **CONTACT:** Robert H. Partigianoni, 101 Nelda St., Leesville PA 71446, 318-239-7613. FAX: 318-239-4573.

MI - SHIAWASSEE — Hamfest. **SPONSOR:** Shiawassee ARA. **LOCATION:** Shiawassee County Fairgrounds, Rte 52 N of I-69 to Hibbard Rd, Go E. **ADMISSION:** $3. **TALK-IN:** 147.02. **FEATURES:** F/R - T. **CONTACT:** Bill Blick AA8GL, 517-675-5558.

MI - TAYLOR — Computer Trade Show. **LOCATION:** Democratic Club of Taylor, 23400 Wick Rd, 4 blks E of Telegraph. **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 — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Ohio Expositions Center. **HOURS:** 10am-4pm. **ADMISSION:** $6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-365-2424.

OH - DAYTON — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Montgomery County Fairgrounds. **HOURS:** 10am-4pm. **ADMISSION:** $6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-365-2424.

OH - WELLINGTON — Noarsfest '95. **SPONSOR:** Northern Ohio ARS. **LOCATION:** Lorain County Fairgrounds, Rte 18. **ADMISSION:** Adv $4, Door $5. **TALK-IN:** 146.10/70. **FEATURES:** C - CB - DP - EX - FM - RV-S. **DEALER INFO:** Indoor tables $10, Outdoor Flea Market $5 per space. **CONTACT:** Stan Zupan AA8IN, 32549 Walker Rd, Avon Lake OH 44012-2228. 216-933-4261 before 9pm.

JULY 16

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

KY - LOUISVILLE — Computer Fair South. **SPONSOR:** MEKA Enterprises, Inc. **LOCATION:** Executive West Hotel, I-65 & 264 Freedom Way at the Fairgrounds **HOURS:** 10am-3pm. **ADMISSION:** $4. **CONTACT:** William Ibarra, Meka Enterprises, 2656 E. 2nd St, Bloomington IN 47401. 812-333-4484, FAX: 812-333-4650.

MI - LANSING — Computer Trade Show. **LOCATION:** Holiday Inn South Convention Center, 6820 S Cedar St, Exit 104 off of I-96. **HOURS:** 10am-4pm. **ADMISSION:** Adults $4; Seniors & students w/ID $3; under 12 free w/adult. **FEATURES:** C - DP. **CONTACT:** Computers & You, 313-283-1754.

MO - WASHINGTON — 33rd Annual Hamfest. **SPONSOR:** Zero Beaters ARC. **LOCATION:** Washington City Park. **HOURS:** 6am-? **ADMISSION:** Free. **TALK-IN:** 147.20. **FEATURES:** EX - H - T. **DEALER INFO:** Tailgate spaces $5. **CONTACT:** ZBARC, POB 24, Dutzow MO 63342, or Dave Randolph, N0GLN. 314-532-2477 days, 314-764-4999 eves.

OH - VAN WERT — Hamfest '95. **SPONSOR:** Van Wert ARC. **LOCATION:** Van Wert County Fairgrounds, Commercial Bldg. US 127 South. **HOURS:** 8am-3pm. **ADMISSION:** $4. **TALK-IN:** 146.850. **FEATURES:** C - CB - DP - E - EX - FP - F/R - H - T. **DEALER INFO:** 8' tables $10 + admission, space only $6 + admission, trunk sales $6 + admission. **CONTACT:** Bob High 419-795-5763 before 5pm; Bob WD8LPY, 419-238-1877 after 5pm.

JULY 22

LA - SLIDELL — Hamfest '95. **SPONSOR:** OARC/PRCARC. **LOCATION:** Slidell Municipal Auditorium. **TALK-IN:** 147.27+. **FEATURES:** CB - DP - FM - F/R - H. **CONTACT:** David Hartley, 504-863-3439, or Rhetha and Clayton Martin, 504-641-7471.

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 - MIO — Swap-N-Shop. **SPONSOR:** Ausable Valley ARC. **LOCATION:** Mio Ausable High School on M-72, 1 mi. W of the blinker. **HOURS:** 8am-? **ADMISSION:** $3. **TALK-IN:** 145.35/144.75 146.52. **FEATURES:** FP - F/R. **DEALER INFO:** Tables $5, Trunk sales $2. **CONTACT:** Ausable Calley ARC, POB 1, Mio MI 48647. 517-848-5996 or 517-826-6454.

OH - BEREA — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Cuyahoga County Fairgrounds (Cleveland). **HOURS:** 10am-4pm. **ADMISSION:** $6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-365-2424.

WI - CHIPPEWA FALLS — Swapfest. **SPONSOR:** Eau Claire ARC. **LOCATION:** State Fairgrounds. **HOURS:** 7:30am-2:30pm. **ADMISSION:** $4. **TALK-IN:** 146.31/91 Repeater. **FEATURES:** C - CB - DP - EX - FP - F/R - H. **DEALER INFO:** Commercial tables $10, Non-commercial tables $15, Set-up 5pm July 21. **CONTACT:** N9TUA, Carol Ceraso 715-723-9205 or N9EQR, Liz Searing 715-834-1303.

JULY 23

IL - SUGAR GROVE — Hamfest. **SPONSOR:** Fox River Radio League. **LOCATION:** Waubonsee Community College, Rte 47 at Harter Rd. **HOURS:** 8am-? **ADMISSION:** $4 adv, $5 door. **TALK-IN:** 147.210 (+600) (PL 103.5/107.2). **FEATURES:** C - CB - DP - E - EX - FM - FP - F/R H. **DEALER INFO:** 8' indoor tables $10. Flea Market free with paid admission. Set-up 6am. **CONTACT:** Diana, WD9API, or Fox River Radio League, POB 673, Batavia, IL 60510. 708-293-7485.

IN - CRAWFORDSVILLE — Computer Fair. **LOCATION:** Holiday Inn. **HOURS:** 10am-3pm. **ADMISSION:** $4, under 12 free. **FEATURES:** C - DP. **CONTACT:** Ben Yanto, AGI Computer Fairs.*

OH - CANTON — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Stark County Fairgrounds. **HOURS:** 10am-4pm. **ADMISSION:** $6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-365-2424.

JULY 28-29

OK - OKLAHOMA CITY — Ham Holidays '95. **SPONSOR:** Central Oklahoma Radio Amateurs. **LOCATION:** Oklahoma State Fair Park, Arts & Crafts Bldg. **HOURS:** Fri: 5pm-8pm, Sat: 8am-5pm. **ADMISSION:** $6 adv., $8 door. **TALK-IN:** 146.67. **FEATURES:** C - CB - DP - EX - F - FM - FP - F/R - H - RV-S - S. **DEALER INFO:** Flea Market $10/table. **CONTACT:** Ham Holidays '95, POB 851281, Yukon OK 73085-1281. CompuServe 75672,3475.

JULY 29

IL - MACOUPIN — Computer Fair/Hamfest. **SPONSOR:** Macoupin County ARC. **LOCATION:** Macoupin County Fairgrounds, 1/2 mi N of Carlinville on Rte 4. **HOURS:** 8am-? **ADMISSION:** $2. **TALK-IN:** 146.82, 443.44. **FEATURES:** C - CB - EX - FM - H. **DEALER INFO:** Doug KA9HDZ, 618-488-7249. **CONTACT:** Dennis N9LQC, 217-854-2365.

Continued on page 136

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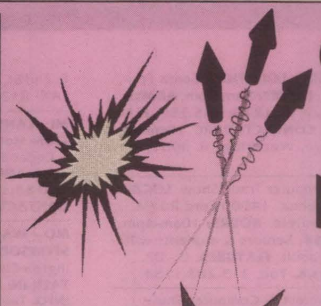

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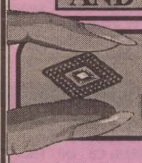

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#80 TEST EQUIPMENT *cont.*

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THIS LOW circuit loading SCOPE PROBE produces a 60dB **SPECTRUM ANALYZER** display on **your** inexpensive scope. Excellent EMI/compliance tool. Request Technical Tips for line conduction, field strength, and current probe. 255 Spectrum Probe 30KHz to 2.5MHz $279. 107 Probe 1 to 100 MHz $249 ($279 extra shielding). Accessory Current Adapters: IA5 $19, IA7 $29. **SMITH DESIGN**, 215-661-9107, 207 E. Prospect Ave., N. Wales, PA 19454.

HP 3580A Audio spectrum analyzer $850, noise figure meter Rohde Schwarz SKTU 1 to 1,000MHz range $275. Tektronix 1,000MHz sampling storage oscilloscope model 564/3S1/3T77A $350, 110MHz spectrum analyzer with tracking generator HP141T system complete $1,000. 513-658-4951.

WANTED: SERVICE monitors-IFR, Motorola, Marconi, HP, Hewlett Packard signal generators, etc. 716-661-9964 or FAX 716-763-0371.

RF EQUIPMENT: HP 5342A/1 18GHz microwave counter (oven time base) $2,220. **Tek TR 503** .1 to 1800MHz tracking generator, calibrated $1,400. **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, 100dB dynamic range, with phase-lock option 005 and HP 8501A storage normalizer. Bright CRT. $3,700. **Tek P6201** 900MHz active probe $350. Excellent condition, with warranty. Pepper System, 214-353-0257.

WANTED: MEASURING & Test equipment, microwave components, RF connectors, etc. **Top price paid!** Write or FAX you list to: **Steigerwald GmbH,** Ungererstrasse 180, D-80805 Munich, Germany. FAX 011-49-89-3615899.

LOW-COST AUTOMATIC wire & tubing measure/cut machine, the Model PMC-110 by Red Line Mfg., Co. 314-831-3014. FAX 314-831-3927.

WANTED DOLCH model **ALP44** active logic probes (and possibly other 4850A compatible accessories) 708-358-3275.

TEKTRONIC D/A. 4041/03/30, IEEE488 system controller, 2 RS232C ser. ports, SCSI port, program development ROMs $999. Two **MI5010**, Programmable multi-function interface with 3 **50M10** programmable A/D converters each, 12 bit, 32 usec. **MX5010** Extender with 1 50M10 $1,999. **TM5006** 6 wide mainframe $249. **AM501** Op. amp. $169, **TSS41-01** (new) QTY 3 20 channel low level scan card <1uV offset $249 each. **TSS42** 30 channel scan card $149. **TSS44** coax scanner module $149. **ERAC Co.**, 619-679-8360, FAX 619-679-6670.

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GENERAL RADIO 1650-B impedance bridge $325, Dexis 612-944-7670.

TEKTRONIX TEST EQUIPMENT FOR AUDIO, BROADCAST, VIDEO: AM 503 & A6302 current probe & amplifier (to 5 A/div; DC to 50MHz) $890. **FG 502** audio to 11MHz funtion generator $275. **FG 504** audio to 40MHz function generator, lin/log sweep $750. **PG 508** 50MHz pulse generator (variable rise, fall times) $325. **DM 502A** auto-ranging multimeter $215. **AA 501** distortion analyzer $1,250. **DA 4084** distortion analyzer (like AA 5001) $1,250. **466** 100MHz portable storage oscilloscope $845. **485** 350MHz portable oscilloscope $795. **7633** 100MHz storage mainframe $475. **7A22** high-sensitivity differential vertical amplifier $375. **AM 502** high-sensitivity differential amplifier $375. **7854** 400MHz oscilloscope mainframe: digital storage, waveform processing, GPIB $975. **7D20** digital storage plug-in: cursor measurements, min/max enveloping, signal averaging $825. **149A** NTSC generator $775. Excellent condition, with warranty. Pepper Systems, 214-353-0257.

TEST EQUIPMENT Manuals, mostly **Hewlett Packard** and **Tektronix**. Buy, sell, trade. Send us your want list. **Ed Matsuda**, PO Box 390613 San Diego, CA 92149. 619-479-0225, FAX: 619-479-1670.

HP 3964A Instrumentation recorder. $2,200/offer. Dexis, 612-944-7670.

HP 1747A 275MHz storage oscilloscope excellent condition $700, obo, comes with time interval multimeter. 415-383-4705.

Introduction to Stepper Motors

by John Iovine

Stepper motors have widespread applications in robotics, automation, and positioning control. These motors are an integrated component in many commercial and industrial type equipment. For home PC users, stepper motors can be found in disk drives and printers.

Stepper motors are unique in that they are easily controlled by digital circuits and capable of precise positioning. We will build a simple stepper motor interface to the PC parallel port to examine the operating principles of stepper motors.

Stepper motors differ from typical electric motors. When power is applied to a standard electric motor, the rotor begins turning smoothly. Speed and position of the motor's rotor are a function of voltage, load on the motor, and power on time. Precise positioning of the rotor is not possible.

A stepper motor, however, runs on a sequence of electric pulses to the windings of the motor. Each pulse to a winding turns the rotor by a precise predetermined amount. The incremental movement of the rotor are often called steps. Hence the name, stepper motors.

Not all stepper motors rotate the rotor by the same amount per step. Stepper motors are manufactured with different degrees of rotation per step (or pulse). The optimum degrees per step a stepper motor should have will depend upon the application. Stepper motor specifications clearly state the degree of rotation per step. You can find a variety of stepper motors whose range of rotation per step can vary from a fraction of a degree (i.e., 72 degrees) to many degrees (i.e., 22.5 degrees).

Basic Operations

Stepper motors are constructed using strong permanent magnets and electromagnets. The permanent magnets are located on the rotating shaft; called the rotor. The electromagnets or windings are located on the stationary portion of the motor called the stator. Figure 1 illustrates a stepper motor stepping through one complete rotation. The stator surrounds the rotor.

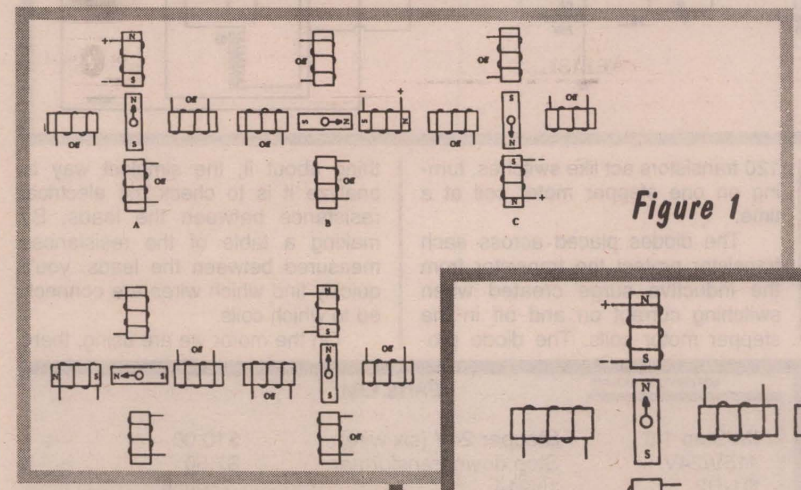

Figure 1

In Figure 1 position A, we start with the rotor facing the upper electromagnet that is on. Moving in a CW (clockwise) rotation, the upper electromagnet is switched off, as the electromagnet on the right is switched on. This moves the rotor 90 degrees in a CW rotation, shown in position B. Continuing in the same manner, the rotor is stepped through a full rotation untill we end up in the same position we started in.

Resolution

The degree of rotation per pulse is the resolution of the stepper motor. In the illustrated example of Figure 1, the rotor turned 90 degrees per pulse, not a very practical motor. A practical stepper motor has a greater resolution, for instance, one that rotates its shaft one degree per pulse (or step). This motor requires 360 pulses (or steps) to complete one revolution.

When a stepper motor is used for positioning in a linear motion table, it becomes apparent that each step of the motor defines a precise increment of linear movement.

In comparing two potential stepper motors, the ability to locate and position more precisely on the table would be the stepper motor with the higher resolution. (One that requires the most steps per revolution.)

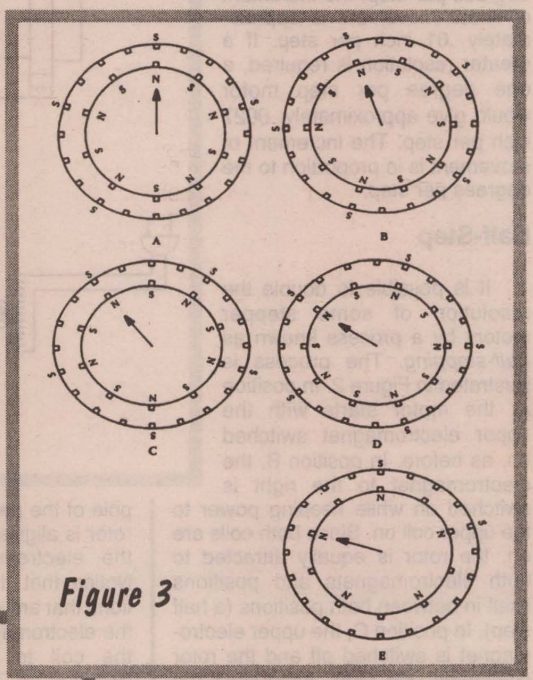

Figure 3

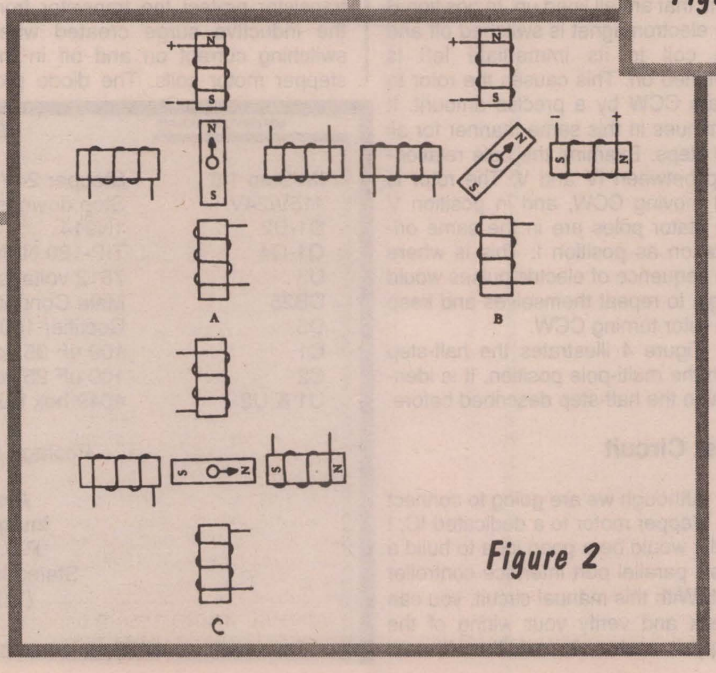

Figure 2

Table One

Full-Step				Parallel Port Output (decimal)
Q1	Q2	Q3	Q4	
on	–	–	–	1
–	on	–	–	2
–	–	on	–	4
–	–	–	on	8

Table Two

Half-Step				Parallel Port Output (decimal)
Q1	Q2	Q3	Q4	
on	–	–	–	1
on	on	–	–	3
–	on	–	–	2
–	on	on	–	6
–	–	on	–	4
–	–	on	on	12
–	–	–	on	8
on	–	–	on	9

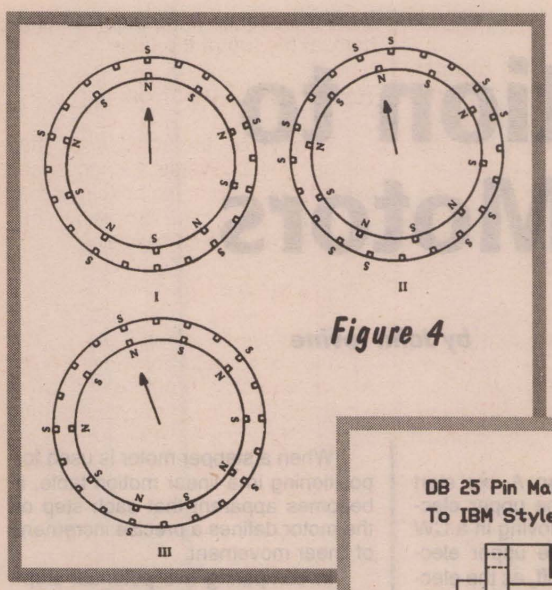

Figure 4

The mini-poles reduce the degrees per step and improves the resolution of the stepper motor. Although Figure 3 appears more complex, its operation is identical to the previous illustrations.

The rotor in Figure 3 is turning in a counter clockwise (CCW) rotation. In position A the north pole of the permanent magnet on the rotor is aligned with the south pole of the electromagnet on the stator. Notice that there are multiple positions that are all lined up. In position B the electromagnet is switched off and the coil to its immediate left is switched on. This causes the rotor to rotate CCW by a precise amount. It continues in this same manner for all the steps. Examine the pole relationship between IV and V. The rotor is still moving CCW, and in position V the stator poles are in the same orientation as position I. This is where the sequence of electric pulses would begin to repeat themselves and keep the rotor turning CCW.

Figure 4 illustrates the half-step with the multi-pole position. It is identical to the half-step described before.

Test Circuit

Although we are going to connect the stepper motor to a dedicated IC, I feel it would be a good idea to build a basic parallel port interface controller first. With this manual circuit, you can check and verify your wiring of the stepper motor. In addition it's an excellent tool to use if you're checking out a different stepper motor from the one used in this article.

Look at Figure 5. The output lines from the parallel port are buffered using two 4049 hex inverter chips. Since each inverter inverts the signal from the line, each output line is connected to two inverters to make the output signal the same as the input signal.

Each buffered signal line is connected to an NPN transistor. The TIP 120 transistor is actually a NPN Darlington. In the schematic, it is shown as a standard NPN. The TIP 120 transistors act like switches, turning on one stepper motor coil at a time.

The diodes placed across each transistor protect the transistor from the inductive surge created when switching current on and off in the stepper motor coils. The diode provides a safe return path for the reverse current. Without the diodes, the transistor will be more prone to failure and/or shorter life.

Stepper Motors

Figure 6 is an electric equivalent circuit of the stepper motor we are using. The stepper motor has six wires coming out from the casing. We can see from Figure 6 that three leads go to each half of the coil windings, and that the coil windings are connected in pairs. If you just picked this stepper motor and didn't know anything about it, the simplest way to analyze it is to check the electrical resistance between the leads. By making a table of the resistances measured between the leads, you'll quickly find which wires are connected to which coils.

On the motor we are using, there

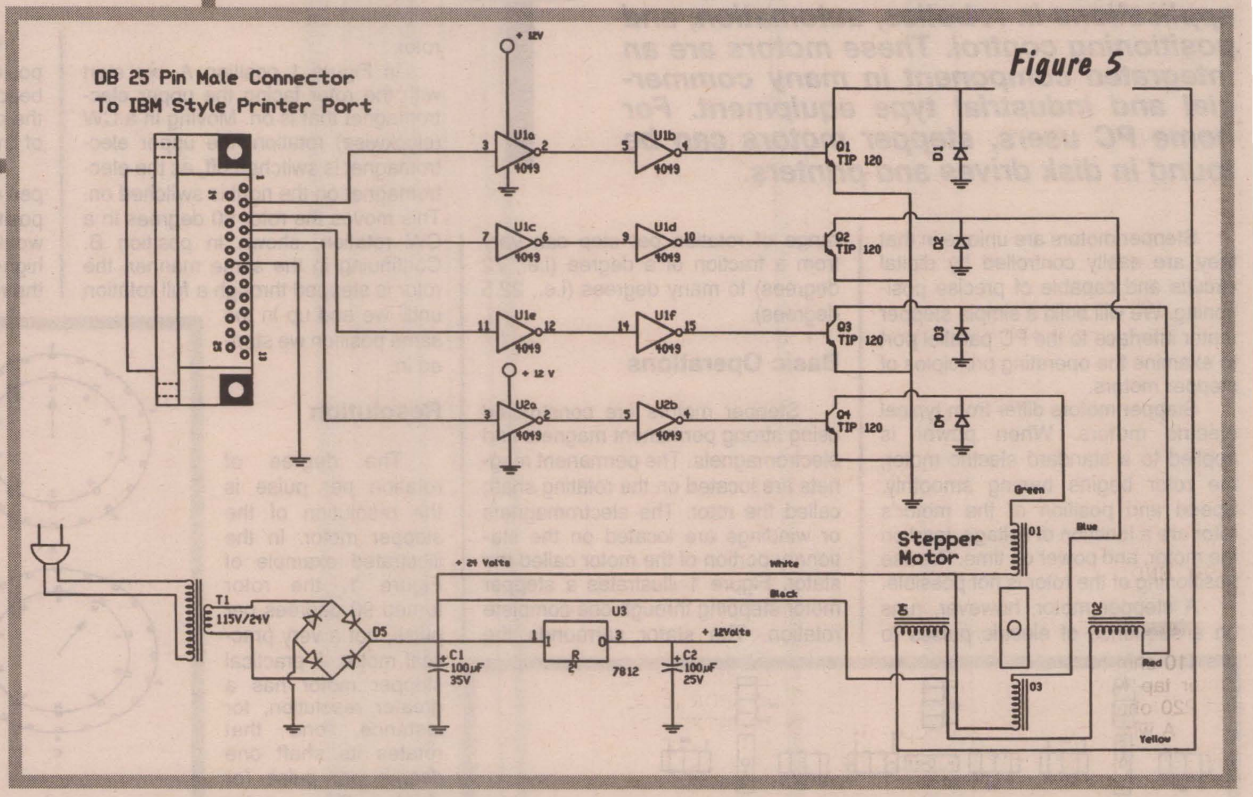

Figure 5

Assume that one revolution of the motor is equal to one inch of linear travel on the table. A stepper motor that rotates 3.75 degrees per step, the increment of linear movement is approximately .01 inch per step. If a greater resolution is required, a one degree per step motor would give approximately .0027 inch per step. The increment of movement is in proportion to the degrees per step.

Half-Step

It is possible to double the resolution of some stepper motors by a process known as *half-stepping*. The process is illustrated in Figure 2. In position A, the motor starts with the upper electromagnet switched on, as before. In position B, the electromagnet to the right is switched on while keeping power to the upper coil on. Since both coils are on, the rotor is equally attracted to both electromagnets and positions itself in between both positions (a half step). In position C, the upper electromagnet is switched off and the rotor completes one step. Although I am only showing one half-step, the motor can be half-stepped through the entire rotation.

Other Types of Stepper Motors

There are four wire stepper motors. These stepper motors have two coils, with a pair of leads to each coil. Although the circuitry of this stepper motor is simpler than the one we are using, it requires a more complex driving circuit. The circuit must be able to reverse the current flow in the coils after it steps.

Real World

The stepper motor illustrated rotated 90 degrees per step. Real world stepper motors employ a series of mini-poles on the stator and rotor.

Parts List

IM-Step 1.8	Stepper 24V (six wire)	$10.00
115V/24V	Step down transformer	$7.50
D1-D2	1N914	.25each
Q1-Q4	TIP-120 NPN Transistor	$1.50 each
U3	7812 voltage regulator	$1.25
DB25	Male Connector	$2.00 each
D5	Rectifier 100V 1 amp	$1.25 each
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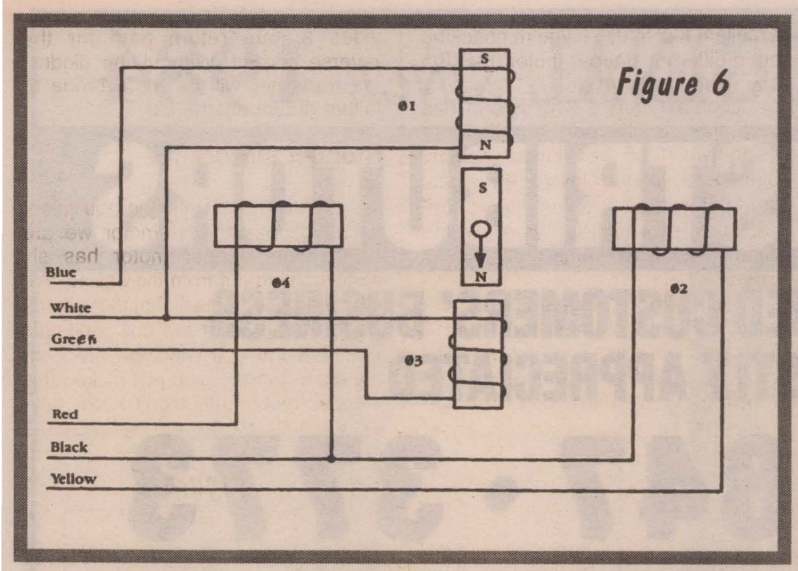

Figure 6

```
5 REM  Stepper Motor Controller
10 REM John Iovine  6-1-95
15 REM First find the Printer Port Address
20 DEF SEG = 0
25 a = (PEEK(1032) + 256 * PEEK(1033))
30 REM set table to rotate stepper motor using full steps
40 DATA 1, 2, 4, 8
50 FOR i = 1 TO 4
55 READ r(i): NEXT
56 FOR c = 1 TO 4
60 OUT a, r(c)
65 FOR t = 1 TO 50: NEXT t
70 NEXT
80 IF INKEY$ = "" THEN 56
85 OUT a, 0
90 END
```

```
5 REM  Stepper Motor Controller
10 REM John Iovine  6-1-95
15 REM First find the Printer Port Address
20 DEF SEG = 0
25 a = (PEEK(1032) + 256 * PEEK(1033))
30 REM set table to rotate stepper motor using half steps
40 DATA 1, 3, 2, 6, 4, 12, 8, 9
50 FOR i = 1 TO 8
55 READ r(i): NEXT
56 FOR c = 1 TO 8
60 OUT a, r(c)
65 FOR t = 1 TO 50: NEXT t
70 NEXT
80 IF INKEY$ = "" THEN 56
85 OUT a, 0
90 END
```

is a 110 ohm resistance between the center tap wire and each end lead, and 220 ohms between the two end leads. A wire from each of the separate coils will show an infinitely high resistance (no connection) between them.

Armed with this information, you can just about tackle any six wire-stepper motor you came across. The stepper motor we are using rotates 1.8 degrees per step.

Test Circuit Demo

After you have finished the test circuit, run the Step1.bas program. You can use Table 1 and Table 2 to follow the logic for the two stepper motor programs.

When you reach the end of the table the sequence repeats, starting back at the top of the table.

One Rotation

Using whole steps, the stepper motor requires 200 pulses to complete one rotation (360 degrees 1.8 degrees per step). Controlling the positioning and rotation of the stepper motor is determined by the amount of pulses the program feeds the stepper motor. By controlling the pulses, you control the stepper motor.

In the program I have written, the program stops when any key is pressed. Just before the program ends, it throws out a 0 (zero) to the parallel port. This turns off all the transistors and stops any current drain through the stepper motor coils.

In some instances, you may want to keep some coils energized. When the coils are energized, it is much harder to rotate the shaft. Therefore, if one has a need to lock the stepper in position, this is a technique that will do so. Prepare for the current drain and the subsequent heating of components.

Half-Stepping

Half-stepping the motor effectively doubles the resolution. In this instance, it requires 400 pulses to complete one rotation.

When you reach the end of the table the sequence repeats, starting back at the top of the table.

Reversing Direction

To reverse the rotation of the stepper motor, reverse the sequence of the table. Start at the bottom of the table and work up, repeating the sequence as long as needed.

Troubleshooting

If you use the stepper motor listed in the parts list, I don't think you'll run across any problems. If you should, the first thing to check is the diodes. Make sure you have them in properly, facing in the direction shown in the schematic.

If the stepper motor moves slightly and quivers back and forth, you may need to check the following items:

1) If you are using batteries, the batteries may be too weak or worn out to power the motor.

Solution: Replace them with fresh batteries. Note: Batteries wear out quickly.

2) If you substituted the TIP NPN transistor for another one of lower quality.

The transistor may not be switching properly or the current load of the stepper motor may be too great.

Solution: Use TIP 120 transistors.

3) You have the stepper motor improperly wired into the circuit.

Solution: Check the coils using an ohmmeter and rewire, if necessary.

Going Further

Next month, we will incorporate dedicated integrated circuits, powering, and controlling stepper motors. This will allow the parallel port to control a multiple amount of stepper motors easily. In addition, we will use our stepper motor circuit to create a linear motion table. Till next time . . . **NV**

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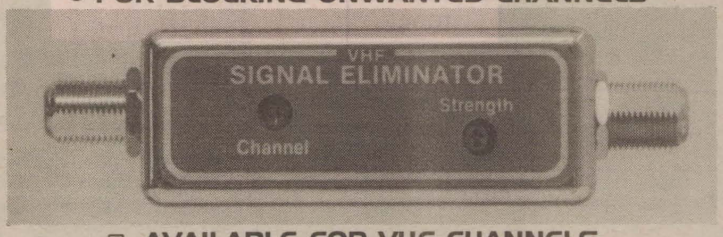

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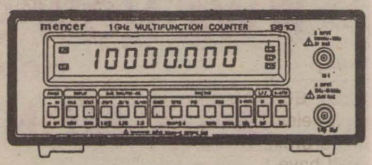

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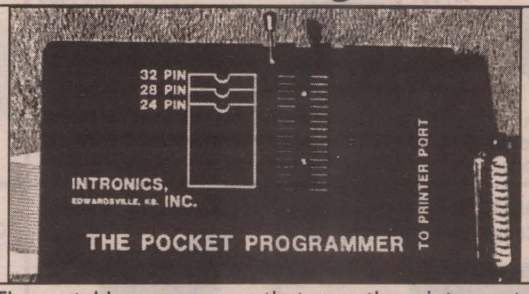

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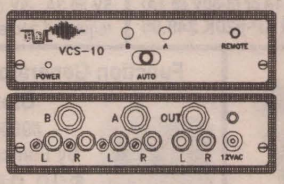

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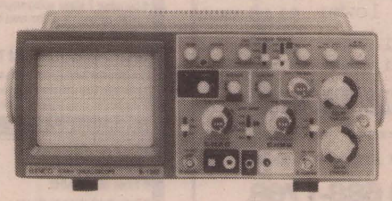

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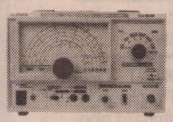

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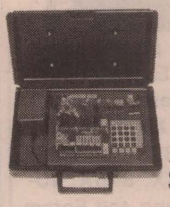

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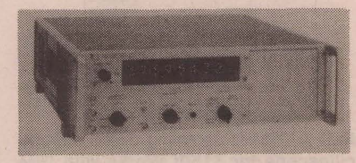

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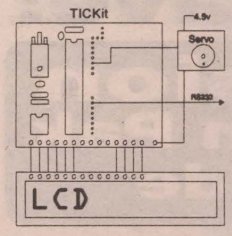

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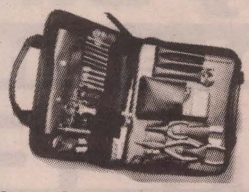

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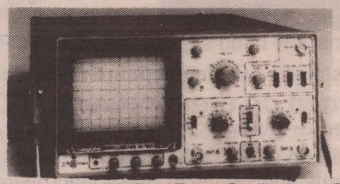

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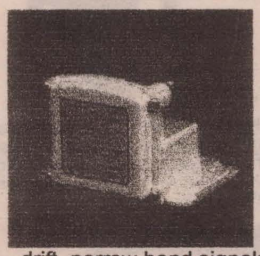

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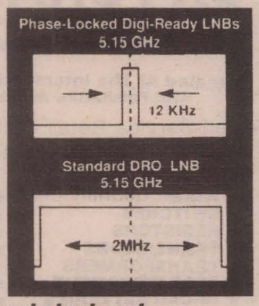

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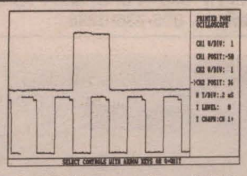

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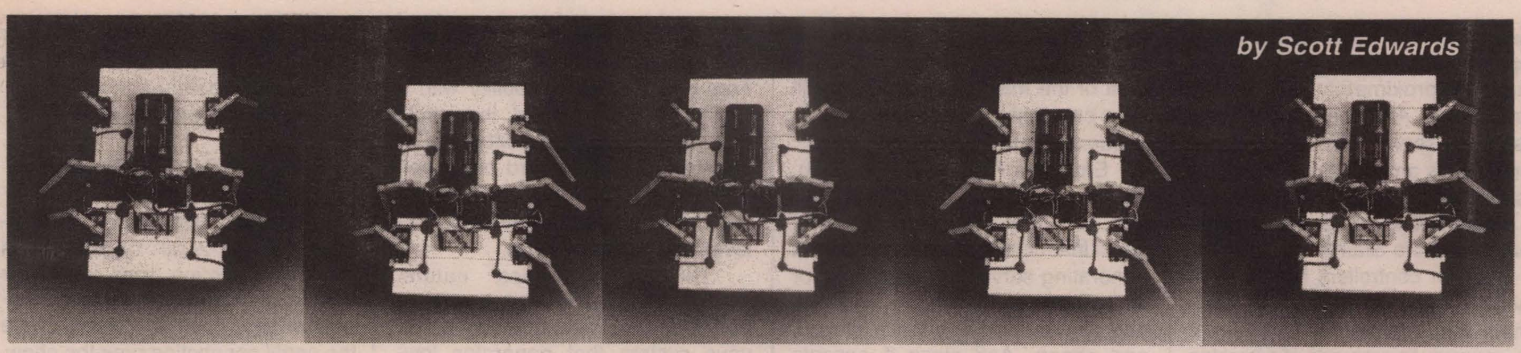


by Scott Edwards

Servo Spinal Tap Makes Your Projects Move

Build an eight-channel Servo Controller for $29.00: Turn Your Projects from Static to Startling!

By now, you probably know about servos — the mechanical muscles used in radio-controlled models — and their fantastic applications in automation, animatronics, and especially robotics. Today, you'll learn about an easy, cheap way to control servos from your desktop PC, controller, or BASIC Stamp computer — the Mini Serial Servo Controller (Mini SSC).

The Mini SSC is a single-chip controller that accepts commands from a serial port at 2400 or 9600 baud and continuously controls eight servos. Up to 32 Mini SSCs can share a single serial port to control a total of 256 servos. The Mini SSC's serial receiver is compatible with RS-232, RS-422, and logic-level signals. And thanks to optical isolation, servo motor noise need never crash your system again!

At $29.00 (kit), the Mini SSC is an exceptional bargain. Let's see . . . 29 bucks divided by eight servos . . . that's only $3.63 per servo. With careful shopping for the servos, you could save enough to call the Mini SSC free! Building your own servo control system and don't want to start from scratch? Mini SSC chips are available for $10.00, with deep discounts for quantity purchases.

What Servos Are and How They Work

I've presented a couple of servo-control projects here before (Serial Servo Controller, Feb. '94; Motion Memory II, Mar. '95) so many of you are already familiar with servo-control basics. For the rest, here's a quick recap:

A servo is a 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 shows pulse width versus servo position.

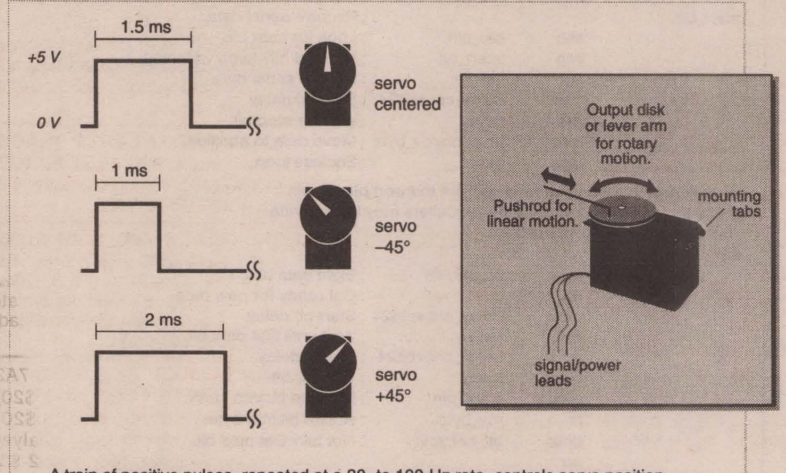
Radio-controlled models use servos to operate the steering, throttle, landing gear, sails, and a host of accessories. These models range from tiny (under a foot) to gigantic (12-foot wingspans aren't uncommon). Servos are available in a similar range of sizes and capabilities.

In direct wired- or wireless-control applications, the pulses that control the servos are usually generated with a timer circuit. Figure 2 is based on an example from the 1976 Signetics (now Phillips) data book. While the simplicity of this circuit is wonderful, it doesn't offer an easy route for the computer control we're after.

Computers and controllers with precision-timing capabilities can control servos themselves, but at the expense of processing power. Everyone's favorite tiny computer, the BASIC Stamp, is a prime example. A servo-control program can be as simple as this:

```
Servo:
Pulsout 0,150
                    'Send a 1.5-ms
                    'pulse to pin 0.
Pause 15            'Wait 15 ms.
Goto Servo          'Do it again.
```

The trouble here is that in a real application, everything other than



A train of positive pulses, repeated at a 30- to 100-Hz rate, controls servo position.

Figure 1. Quick review of servo-control principles.

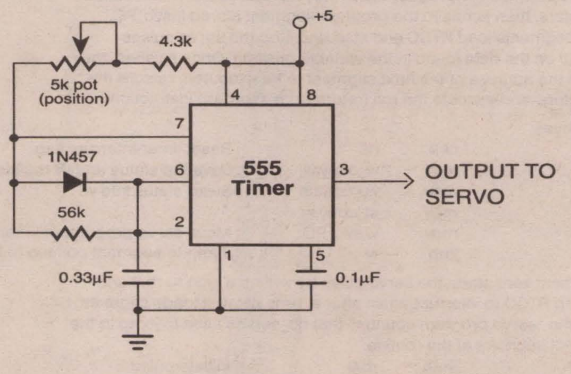


Figure 2. This circuit positions a servo in response to pot setting, but, alas, no computer control.

generating the servo pulse must happen during a span of 15 ms. That's approximately 30 Stamp instructions. And that's controlling just one servo. Each additional servo steals an additional 2 ms (four instructions). So it takes some heroic programming to control multiple servos with the Stamp.

Fancier controllers have it a bit easier. They're equipped with timers that can be set to interrupt the program in progress at a precise time interval. Using this capability, it's possible to generate servo signals as a background task that takes place more-or-less independent of the main program. This still saps processing power, but the consequences are less drastic.

Enter the Mini SSC (Figure 3). It's an interrupt-equipped controller that has only two jobs: receiving serial instructions from its boss, and generating servo-control signals for its outputs. By limiting its role, we end up with a module that's efficient and cheap. And since it accepts serial signals in a variety of flavors, it allows a project to grow independent of what kind of computer is in charge. A project might begin tethered to a PC; gain mobility with a BASIC Stamp on board; then grow in sophistication with a Motorola or Intel-based single-board computer. Throughout this evolution, there would be no need to write new low-level, servo-control code.

The idea mimics nature. There's the brain, for high-level control, then there's the autonomic nervous system that generates low-level control signals to regulate breathing, pulse, digestion, temperature, etc. This division of labor gives the brain control over the activity of a creature without becoming overloaded with trivial details.

The Mini SSC Hardware

The Mini SSC receives commands via a 2400- or 9600-baud serial connection and interprets them to set the widths of eight channels of servo-control pulses. Since the serial connection runs the show, let's start there.

The Mini SSC receives serial

Listing 1. Assembly Language Demo of Mini SSC PIC Firmware

```
; Program: SSC_DEMO.SRC (Mini SSC educational demo).
; Written in Parallax dialect of PIC assembly language.
; This program is a demo version of the firmware for the Mini SSC,
; a device that controls eight radio-control servos in accordance with
; instructions received over a 2400- or 9600-baud serial hook-up. The
; commercial Mini SSC also recognizes individual board IDs, allowing up
; to 32 controller (256 servos!) on one serial port. This demo version
; is not addressable, works at a fixed rate of 2400 baud, and controls
; just one servo. However, it has the same basic structure as the full-up
; program. It is provided for novice PIC users interested in a method for
; running two time-sensitive processes concurrently.

; Serial data is accepted through ra.3; servo pulses (1 to 2 ms, repeated
; approx. 60 Hz) are output at rb.0. This program runs properly on a
; PIC16C61, 71, or 84 with an 8 MHz clock. At the time this program was
; written, the 16C61 was new, and PASMX/PEPX did not recognize it as a
; valid device. Fortunately, the '61 programs just fine from code generated
; for a 71 or 84 (provided you don't use the special features of those
; devices). If you program a 61, be sure that PEPX is set for a 71 — setting
; it for an 84 will cause programming errors.

                device pic16c71, xt_osc, wdt_off, protect_off, pwrt_off
                id 'SVDM'

; Symbols (constants) used in the program.
one_ms          =       6               ; Value to load into RTCC for 1-ms delay.
ser_pin         =       ra.3            ; Serial-input pin.
stb24           =       44              ; Start delay for 2400 bps @ 8 MHz.
bit24           =       164             ; Full delay for 2400 bps @ 8 MHz.

; Variable declarations. Variables for this program begin at address
; 0C hex, placing them above the PIC's special-function registers.
                org 0Ch
svo_PC          ds      1               ; Program segment counter for servo ISR.
w_copy          ds      1               ; Copy of w register made by ISR.
st_copy         ds      1               ; Copy of status register made by ISR.

delay_cnt       ds      1               ; Counter for serial delay routines.
bit_cnt         ds      1               ; Number of received bits.
rcv_byte        ds      1               ; The received byte.
temp            ds      1               ; Reusable temporary storage.
position        ds      1               ; Position value.
end_frame       ds      1               ; Counter for end-of-frame delay.

; Upon reset, the PIC first executes the code located at address 0. In this
; case, it jumps to the beginning of the foreground program located at
; "start." When an interrup occurs, the PIC jumps to address 4. This is
; where the interrupt handler is located.

                org     0
                jmp     start           ; The reset vector.
                org     4               ; The interrupt handler.

; The interrupt-service routine (ISR). When RTCC overflows, the resulting
; interrupt sends the program here. This ISR stores the w and status
; registers, then jumps to the program segment stored insvo_PC.
; The segments load RTCC and start and stop the servo pulses
; based on the data found in the variable position. Once finished, they
; store the address of the next segment to be executed, restore the
; registers, and execute the reti (return from interrupt) instruction.

do_servos
                clrb    rtif            ; Reset timer-interrupt flag.
                mov     w_copy,w        ; Save the status and W registers.
                mov     w,<>status      ; Swap status into w.
                mov     st_copy,w
                mov     w,svo_PC        ; Move servo program counter to w.
                jmp     w               ; Jump to segment pointed to by svo_PC.

; Segment zero starts the servo pulse by writing a high to rb.0 and
; setting RTCC to interrupt again after a 1-ms delay. It loads segment 1
; into the "servo program counter" that do_servos uses to jump to the
; correct segment of the routine.
seg_0           setb    rb.0            ; Initiate pulse.
                mov     rtcc,#one_ms    ; Set up 1-ms delay.
                mov     svo_PC,#seg_1   ; Execute next segment at 1-ms timeout.
                mov     w,<>st_copy     ; Restore the status register and W.
                mov     status,w
                swap    w_copy
                mov     w,<>w_copy      ; Return from interrupt.
                reti

seg_1           mov     w,/position     ; Load the inverse of the position value
                mov     rtcc,w          ; into the rtcc to create delay.
                mov     svo_PC,#seg_2   ; Execute next segment after timeout.
                mov     w,<>st_copy     ; Restore the status register and W.
                mov     status,w
                swap    w_copy
                mov     w,<>w_copy
                reti                    ; Return from interrupt.

seg_2           clrb    rb.0            ; End the pulse.
                mov     w,position      ; Load the non-inverted position value
                mov     rtcc,w          ; into rtcc to create a pad delay.
                mov     svo_PC,#seg_3   ; Execute next segment after time out.
                mov     end_frame,#14   ; Wait 14 ms before seg_0 (see seg_3).
                mov     w,<>st_copy     ; Restore the status register and W.
                mov     status,w
                swap    w_copy
                mov     w,<>w_copy
                reti                    ; Return from interrupt.

seg_3           mov     rtcc,#one_ms    ; Set up a 1-ms delay
                djnz    end_frame,:cont ; Repeat this segment until end_frame = 0
                mov     svo_PC,#seg_0   ; When end_frame runs out, point to seg_0.
:cont           mov     w,<>st_copy     ; Restore status register and W.
                mov     status,w
                swap    w_copy
                mov     w,<>w_copy
                reti                    ; Return from interrupt.

; Start marks the beginning of the initialization code that sets up the
; program. It configures the RTCC to increment off the system clock
; through a divide-by-8 prescaler. At 8 MHz, that makes one RTCC tick
; equal to 4 microseconds — the desired resolution of our servo-pulse
; generator. Start also sets the servo routine's program counter to
; segment 0.
start           mov     svo_PC,#seg_0   ; Point to base segment of ISR.
                setb    rp0             ; Switch to register page 1.
                clr     wdt             ; Transfer the prescaler to RTCC.
                mov     option, #10000010b ; and set it for /8.
                clrb    rp0             ; Back to page 0.
                mov     intcon, #10100000b ; Turn on RTCC interrupt.

main            mov     ira,#1000b      ; Serial input is ra.3.
                mov     irb,#0          ; Make rb all outputs.
:start_bit                              ; Receive serial data.
                snb     ser_pin         ; Look for start bit.
                jmp     :start_bit      ; No start bit? keep watching.
                call    serl_in         ; Get the serial data.
                mov     delay_cnt,#bit24 ; Stop-bit delay.
                call    delay           ; Wait for stop bit.
                mov     position,rcv_byte ; Move data to position.
                goto    main            ; Endless loop.

; Subroutine to read in serial data from the port bit ser_pin.
; Note that there's no stop-bit delay. Callers may incorporate
; this delay into other operations.
serl_in
                mov     bit_cnt, #8     ; Eight data bits.
clr             rcv_byte                ; Get ready for new data.
                mov     delay_cnt,#stb24 ; Start-bit delay
                call    delay           ; Wait until first data bit.
:rcv            mov     delay_cnt,#bit24 ; Full-bit delay.
                call    delay           ; Wait for bit.
                movb    c,ser_pin       ; Put data bit into carry.
                rr      rcv_byte        ; Rotate bit into byte.
                djnz    bit_cnt,:rcv    ; Not full? Get next bit.
                ret

; Simple do-nothing loop for variable length delays. Program must
; load delay_cnt before calling this routine.
delay           jmp     $+1
                djnz    delay_cnt,delay
                ret
```

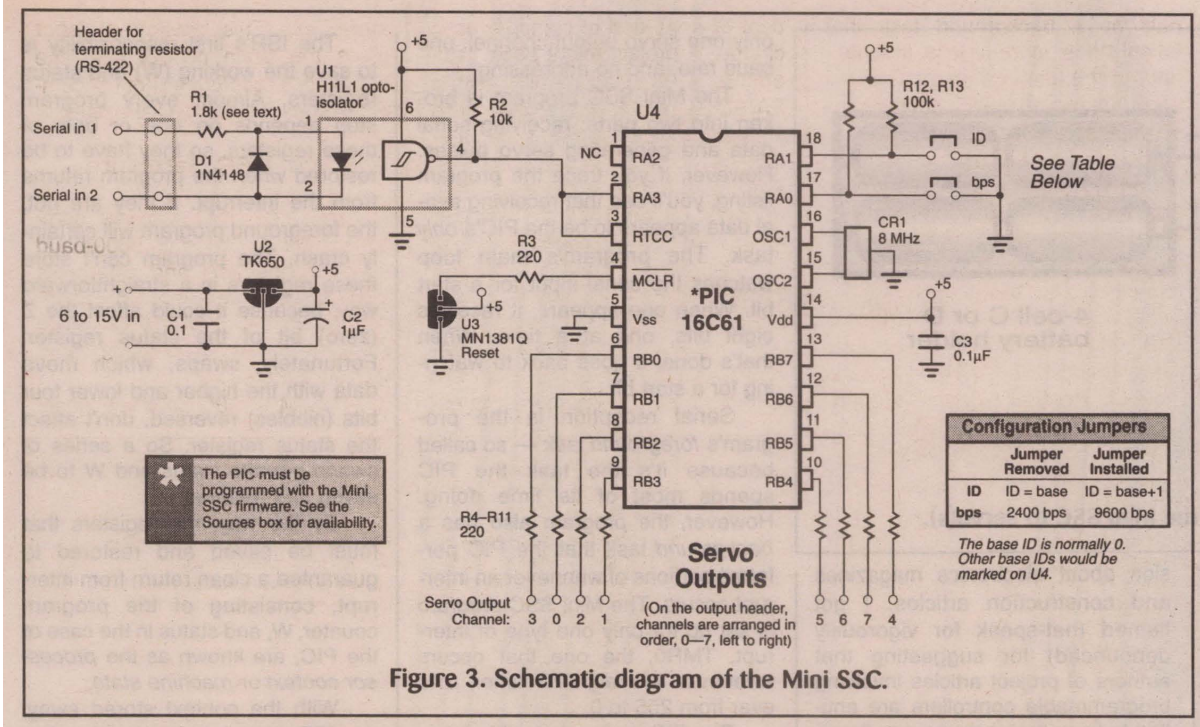


Figure 3. Schematic diagram of the Mini SSC.

data through U1, an H11L1 Schmitt-Trigger optoisolator. This device consists of an LED aimed at a snap-action light detector. The Schmitt-Trigger's snap action (or hysteresis) ensures that even if the LED comes on slowly, the output snaps on at a precise trigger point, and doesn't turn off until the LED brightness falls well below that point. This is an effective way of squaring up the edges of a serial data stream that may have been rounded off by influences like cable capacitance and noise.

The input LED requires 1 mA (1.6 mA max) to reach the Schmitt Trigger's threshold brightness. It will withstand continuous current of up to 60 mA. Its peak reverse voltage, the maximum voltage that can be applied in the reverse (non-conducting) direction, is 6 volts. To round out the specs, the LED's forward voltage is 1.5 volts (maximum; typically 1 volt or less).

R1 and D1 work together to ensure that the LED gets the proper care and feeding from a wide range of serial inputs. D1 limits reverse voltage across the LED to 0.7 volts. R1 limits forward current into the LED as follows: At 12 volts input, the current is (12-1.5)/1800 = 5.83 mA; at 5 volts, (5-1.5)/1800 = 1.94 mA. In theory, the lowest input voltage that will reliably trigger the optoisolator is 4.2 volts. In practice, since the LED's forward voltage drops to less than 1 volt with reduced input current, it'll work down to 3.7 volts.

If there's some doubt that the signal source can deliver the minimum +3.7-volt signal — with TTL gates, it might be a close call — you can add a pull-up resistor of perhaps 1K to the output. Alternatively, you could substitute a 1K resistor for R1.

Why cut it that close? Well, TTL-level outputs are the exception rather than the rule, and the high value of R1 allows several Mini SSCs to be connected in parallel to a single serial port or Stamp pin. The Stamp can drive nine Mini SSCs; a standard RS-232 port can drive at least two.

Using an optically isolated line receiver has several advantages for the Mini SSC. First, it's compatible with RS-232, RS-422, CMOS, and TTL-level signals without any configuration hassles. Second, it allows reception of true or inverted signals by just reversing the connections to the LED; not recommended with a normal ground-referenced line receiver! But the most important advantage is that it allows the host computer to be completely isolated from the potentially noisy, disruptive servos and their power supply.

Other aspects of the Mini SSC are similarly designed for reliability. Check out the MN1381 low-voltage detector in the schematic. When power is first connected to the circuit, this component holds the PIC controller in reset until the voltage rises to 4 volts. If the supply drops below 4 volts, the MN1381 resets the PIC. This helps prevent the erratic behavior that can result from the PIC operating outside its rated voltage range.

The Mini SSC also features a low-dropout voltage regulator, the TK650. It will supply regulated 5 volts to the circuit until the input voltage falls below 5.2 volts. This allows the circuit to suck every last drop of energy out of a typical 9V battery power source.

Other than the PIC, the remaining circuitry consists of: bypass capacitor C3, which satisfies the sudden current demands of the PIC's fast CMOS switching; R12/13, which hold configuration inputs RA.0 and RA.1 at +5 volts unless a jumper is installed to pull them to ground; and R4 through R11, which

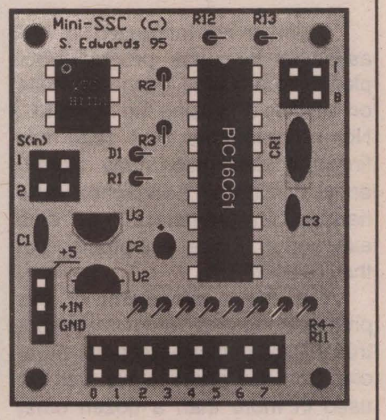


Figure 5. Parts placement diagram for the Mini SSC.

Listing 2. QBASIC Program Demonstrating the Mini SSC

```
DEFINT A-Z
Sync.byte = 255

' The line below assumes that the B jumper is installed for
' 9600-baud operation.
OPEN "com1:9600,N,8,1,CD0,CS0,DS0,OP0" FOR OUTPUT AS #1
CLS
PRINT              " MINI SERIAL SERVO CONTROLLER"
PRINT : PRINT
PRINT "At the prompt, type the servo number (0 to 7), a comma,
PRINT "and a position value (0 to 254)."
PRINT "Press <CNTL> - <Break> to end."
Again:
  LOCATE 8, 1
  PRINT "                                "
  LOCATE 8, 1
  INPUT "Servo,position>", Servo, Position
' Perform some basic error trapping
  IF Servo > 7 THEN Servo = 7
  IF Servo < 0 THEN Servo = 0
  IF Position > 254 THEN Position = 254
  IF Position < 0 THEN Position = 0
  PRINT #1, CHR$(Sync.byte); CHR$(Servo); CHR$(Position);
GOTO Again
```

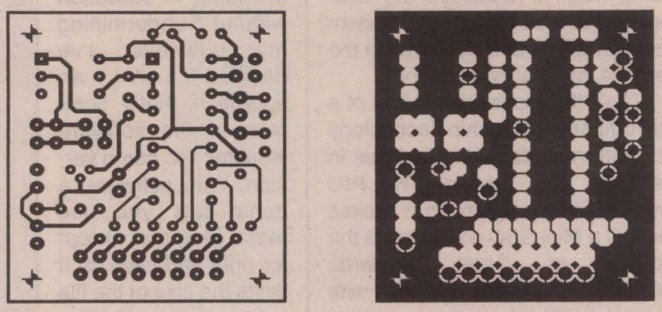


Figure 4. Printed circuit board artwork for the Mini SSC (actual size).

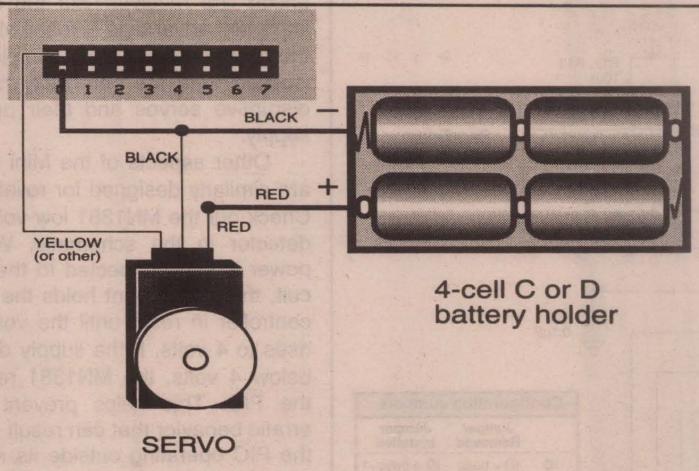


Figure 6. Connecting the Mini SSC to servo(s).

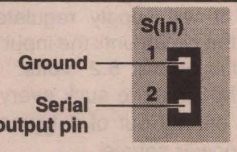


Figure 7. Stamp serial hookup.

protect the servo outputs from excessive current draw in the event that they're shorted together (or to ground or +5) while the circuit is powered up.

Mini SSC Firmware and Mini SSC Demo

If you're not interested in PIC assembly language programming, please skip ahead to the sections on building and using the Mini SSC. Non-programmers who read this firmware description may experience dizziness, headaches, and nausea. Programmers may also experience these symptoms, but they're used to it.

The main component of this project is the PIC 16C61 microcontroller. It's a minimal computer-on-a-chip from the same family that I've used in more than a dozen other construction projects. PICs power my BASIC Stamp peripherals (LCD Serial Backpack, Stamp Stretcher; see Sources box), as well as the Stamp itself. I discussed the concept of PICs as homebrew custom ICs in an article that appeared in the Dec. '94 issue of *Nuts & Volts.*

The PIC chip is the product of a big company, Microchip Technology Inc., with manufacturing facilities in the U.S. and Taiwan. The PIC firmware, the program that makes this PIC a Mini SSC controller, is the product of Scott Edwards Electronics, my small business with a single facility in southern Arizona and a merry band of occasional contractors around the country.

As I was working on this article, I participated in an Internet discussion about electronics magazines and construction articles. I got flamed (net-speak for vigorously denounced) for suggesting that authors of project articles involving programmable controllers are entitled to keep their programs to themselves. I asserted that the only way to make a living at this is to be a manufacturer, and manufacturers have to protect trade secrets from other manufacturers. If they don't, unscrupulous competitors run them out of business.

Denizens of the net are not swayed by arguments having to do with anybody making a living, and they made some valid points about the educational value of studying others' source code. They got to my soft spot with this, since I've poured considerable effort into educating people about PIC programming through application notes for Parallax (manufacturer of PIC programming tools) and my *PIC Source Book* (see the Sources box).

So my dilemma became how to serve the cause of education without undermining my business. I've decided on an approach that's common in the software industry: the demo version. With software, a demo lets you use most features except for print and save, or it limits the size of the file you can work with. The Mini SSC demo program in Listing 1 works much like the real thing, but supports only one servo output channel, one baud rate, and no addressing.

The Mini SSC program is broken into two parts: receiving serial data and generating servo pulses. However, if you trace the program listing, you'll see that receiving serial data appears to be the PIC's *only* task. The program's main loop watches the serial input for a start bit. When one appears, it receives eight bits, one at a time. When that's done, it goes back to watching for a start bit.

Serial reception is the program's *foreground* task — so called because it's the task the PIC spends most of its time doing. However, the program also has a *background* task that the PIC performs portions of whenever an interrupt occurs. The Mini SSC program is set up for only one type of interrupt, TMR0, the one that occurs whenever the eight-bit timer rolls over from 255 to 0.

The PIC responds to this interrupt as though a subroutine call occurred. It stores the program counter on the hardware stack, and jumps to program memory address 4. This address, the interrupt vector, is set by the manufacturer and cannot be changed, so it must contain the beginning of the interrupt service routine (ISR) or a jump to the ISR.

The ISR's first responsibility is to save the working (W) and status registers. Almost every program step depends on one or both of these registers, so they have to be restored when the program returns from the interrupt. If they are not, the foreground program will certainly crash. The program can't store these registers in a straightforward way, because it could affect the Z (zero) bit of the status register. Fortunately, swaps, which move data with the higher and lower four bits (nibbles) reversed, don't affect the status register. So a series of swaps permits status and W to be saved and restored.

By the way, the registers that must be saved and restored to guarantee a clean return from interrupt, consisting of the program counter, W, and status in the case of the PIC, are known as the *processor context* or *machine state.*

With the context stored away, the ISR next has to decide what segment of the background task to perform. In the demo, the segments consist of turning on the output bit to begin the pulse, a 1-ms base delay, an additional 0- to 1-ms delay based on the position data, the end of the pulse, and the delay between pulses. At startup, the program initializes the variable svo_PC — the program counter for the servo-dri-

Listing 3. BASIC Stamp Program Demonstrating Table Look-up of Servo Data

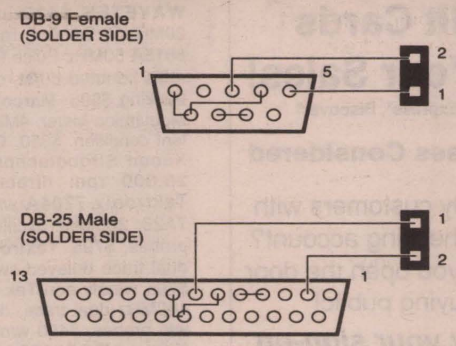
```
' Program: LEGS.BAS
' This program demonstrates servo control using the Mini SSC.
' It commands six servos through a simplified, insectile walking
' sequence. The servo identifiers and positions are stored in a
' pair of tables in the routine Servo_value.

SYMBOL  steps = b0          ' Current place in step sequence.
SYMBOL  servo = b3          ' Servo being addressed.
SYMBOL  position = b4       ' Servo position value.
SYMBOL  temp = b5           ' Temporary variable used in table lookup.
SYMBOL  delay = w5          ' Delay between leg movements; controls speed.

let delay = 1000        ' 1 second between steps.

again:
  for steps = 0 to 13
    gosub servo_value           ' Get the servo no. and position value.
    serout 0,n2400,(255,servo,position)       ' Send to the SSC.
    if bit0 = 0 then skip_delay ' Delay after every 2nd xmission.
    pause delay
skip_delay:
  next steps
goto again              ' Endless loop.

' Look up the servo number and position value. Since the same data is
' sent to two different servos, the position table is half the length
' of the servo table. Looking up the correct position entry requires
' dividing the step number by 2.
Servo_value:
  look-up steps,(1,4,0,2,1,4,0,2,3,5,1,4,3,5),servo
  let temp = steps/2
  look-up temp,(80,200,170,50,50,80,200),position
return
```



Note: The additional connections shown above are loopbacks for the handshaking lines. These deactivate hardware handshaking required by some software.

Figure 8. Mini SSC serial connections for PCs and other compatibles.

ver — with the first segment. After that, each segment stores the next segment address into svo_pc.

By dividing the background process into small segments, the program ensures that any disruption to the foreground process of receiving serial data is kept to a minimum. To compensate for time lost to interrupts, the serial routine samples incoming bits earlier than the normal halfway point. That way, even if reception is interrupted several times during an incoming byte, the only effect is to cause the bits to be sampled a little later during their valid time.

By now you may be wondering, why not make the servo pulses the foreground task and receive serial data in the background, like a PC that can print in the background? While serial reception can work just fine with somewhat sloppy timing, servo control cannot. Even a 4-microsecond glitch in the servo pulses could cause a noticeable tremor in the servos.

The rest of the demo program's inner workings are described in the comments to Listing 1.

Building the Mini SSC

Figure 4 is the two-sided circuit-board artwork for the Mini SSC. Do not adjust your magazine; the top-layer artwork is supposed to look like that. It's a *ground plane*, a mostly solid area of copper that distributes the ground connection where it's needed. Ground planes, as compared to ground traces snaking all over the board, have the virtues of low resistance, high-current capacity, and low inductance. These help make digital circuits less electrically noisy and more reliable. In high-speed systems, circuit board designers often specify planes to carry both ground and the positive supply, resulting in a board with four or more layers. Not suitable for kitchen-sink construction.

With a little care you can construct the Mini SSC board at home using toner-transfer or photoresist methods. The May '95 issue of *Nuts & Volts* covered the basics of toner transfer. Just remember that when you assemble your homemade board, you must solder components on the top (ground plane) layer wherever there's a pad with a cross through it. The cross is called a thermal relief, and it connects the pad to the ground plane electrically, but isolates it thermally. This prevents the plane from siphoning off soldering heat.

If you purchase the kit, you'll get a commercially made board with solder mask, plated-through holes, and a parts-placement legend.

Figure 5 shows the placement of components on the board. Note that all of the resistors and the diode are mounted on end. Bend them into hairpin shapes and insert them into appropriate holes in the board for soldering. Install the diode as shown with the striped end upward (away from the board).

Once you have soldered the components to the board, you're ready for a preliminary test. Connect a servo as shown in Figure 6 and apply power to the Mini SSC board. The servo should swing to its centered position and stay there. Try to turn the servo output away from this position; it will hold firm.

Using the Mini SSC

Figure 7 shows how to connect the Mini SSC to a BASIC Stamp or other source of serial data; Figure 8 shows the pinout of standard PC serial port connectors.

Controlling the Mini SSC's servos is a piece of cake. Leave the configuration posts marked B and I open. Connect the Stamp or PC as shown in Figure 7 or 8. Send the following data to the Mini SSC serially at 2400 baud (no parity, eight data bits, one stop bit; default for the Stamp):

255 (start marker), servo number (0 to 7), position value (0 to 254)

For example, from the Stamp:

```
Serout 0,N2400,255,4,50
' Servo 4 to position 50.
```

Of course, things get really interesting when you use values calculated by a program to run things. Here's a Stamp program fragment to cycle eight servos back and forth in slow motion:

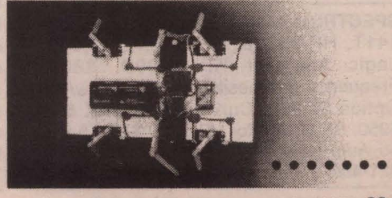
```
    Again:

for b3 = 0 to 254
  ' Positions 0 to 254.
for b2 = 0 to 7
  All 8 servos.
Serout 0,N2400,255,b2,b3
  ' Send servo b2 to position b3.
 next b2
 next b3
Goto Again
  ' Endless loop.
```

Listing 2 shows how to command the Mini SSC from a PC running QBASIC; Listing 3 is a Stamp program that generates a walking sequence for the six-servo insectile robot shown in the photos. The current version of this robot is pretty clumsy, but skitters across smooth floors at a respectable clip. It'll serve as a testbed for ideas that will go into the next version, which will use two servos per leg for true all-terrain mobility. See the Sources box for a mail-order hobby dealer who carries inexpensive, respectable quality servos.

Conclusion

The Mini SSC is an inexpensive way to harness the mechanical power of servos for applications in robotics, automation, and special effects. Special features make it an ideal companion to the BASIC Stamp, BS2, or other computer with serial capabilities. **NV**



Parts List

Semiconductors
U1 — QTC H11L1 Optoisolator (Digi-Key H11L1QT-ND)
U2 — TK11650 low-dropout 5-volt regulator (Digi-Key TK11650CT-ND)
U3 — MN1381 reset circuit (Digi-Key MN1381-Q-ND)
U4 — PIC16C61 microcontroller programmed with Mini SSC firmware. (See Sources.)
CR1 — three-terminal 8 MHz ceramic resonator (Integrity Tech ZTS 8.00M. See Sources.)
D1 — 1N4148 diode (Digi-Key 1N4148CT-ND)

Resistors (all are 1/8 W)
R1 — 1800 ohms
R2 — 10,000 ohms
R3-R11 — 220 ohms
R12, R13 — 100,000 ohms

Capacitors
C1,C3 — 0.1µF 50 WVDC ceramic with 0.1" lead spacing
C2 — 1µF 16 WVDC tantalum

Hardware and Miscellaneous
Header stakes: two 2x2, one 2x8, and one 1x3 header strip; 9V battery and clip; shorting jumpers for baud rate (B) and address/ID (I)

Sources

Digi-Key, 701 Brooks Avenue South, P.O. Box 677, Thief River Falls, MN 56701-0677; phone **(800) 344-4539**. Semiconductors, resistors, capacitors, headers.

High-Tech Direct, 114 Morrison Drive Suite 200, Ottawa, Ontario, Canada K2H 8S9; phone **(613) 596-4845**; fax **(613) 820-8111**. Integrity Technology ceramic resonators such as ZTS 8.00M.

Tower Hobbies, P.O. Box 9078, Champaign, IL 61826-9078; phone **(800) 637-4989** or **(217) 398-3636**; fax **(800) 637-7303** or **(217) 356-6608**. Good prices on house-brand servos; huge selection of servo linkages, hardware, and accessories.

Parallax, Inc., 3805 Atherton Road # 102, Rocklin, CA 95765; phone **(916) 624-8333**; fax **(916) 624-8003**; BBS **(916) 624-7101**; Internet parallaxinc.com. Manufacturer of the BASIC Stamp microcomputer and PIC programming tools. Listing 1 (SSC_DEMO.SRC) is available from their BBS or ftp site on the Internet.

Scott Edwards Electronics
964 Cactus Wren Lane
Sierra Vista, AZ 85635
PH **(520) 459-4802**/FAX **(520) 459-0623**
E-Mail **72037.2612@compuserve.com**
Mini SSC in complete kit form: $29.00.
Mini SSC assembled: $44.00.
Mini SSC controller, PIC16C61: $10.00.
All prices are postpaid (express shipping and CODs extra). Visa, MasterCard, American Express accepted for phone/fax orders. POs accepted on approved credit. Personal checks, money orders welcome for orders by mail. Scott carries other servo-control products, and peripherals for the BASIC Stamp, including a serial LCD display, and 16-channel I/O expanders.

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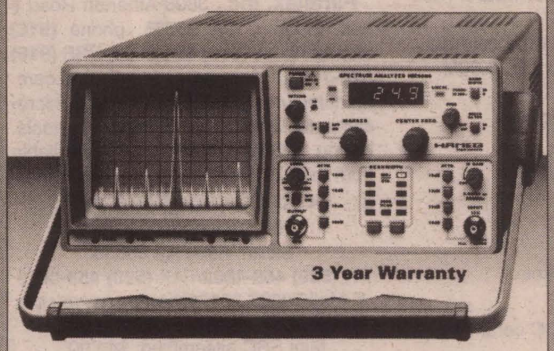

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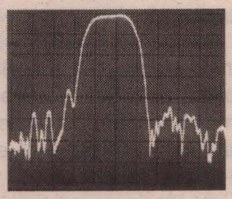

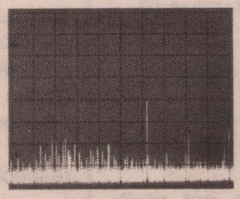

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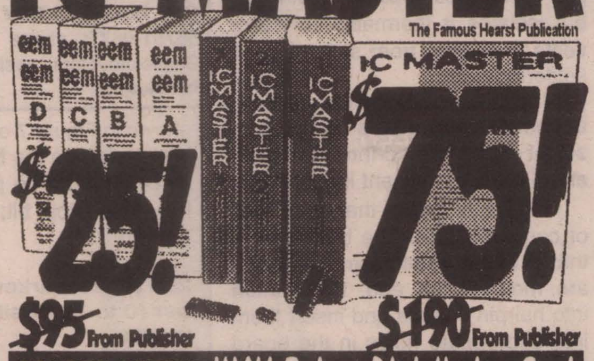

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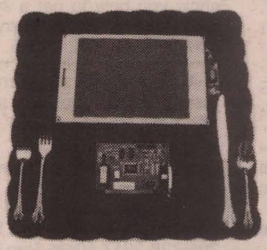

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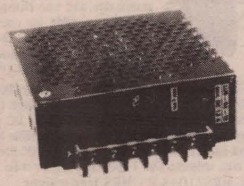

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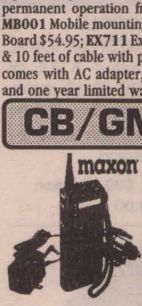

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SYNC-A-LINK UNIVERSAL VIDEO SYNC GENERATOR is an educational troubleshooting tool for those persons seeking technical support for evaluating different types of video difficulties. It will restore all horizontal & vertical sync lines from standard or 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.

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VIDEOCYPHER 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.

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

KU-BAND satellite TV systems: 2 ft. dish w/mount, 0.9dB H/V LNBF, Horizon 2000 C/KU receiver w/150 ch. program capacity $269.95 + S&H. 2 ft. KU band dishes w/mount $39.95 + S&H. Great for DSS. Dealer inquiries welcome, quantity discounts available. Call 813-886-8669.

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OAK DECODERS, movies, sports, news. **New Filipino channel.** Guaranteed best prices! Call, 514-458-3063 FAX 514-458-0798.

WANTED: BMI (BONNEVILLE) stock and commodity quote FM receiver set. Set has 2 boxes, data receiver and data converter. Will consider either piece separately. Satellite set may be the same. I need a back-up set. Call, describe your box or set. I will call back. Tom, 312-271-8066.

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VHS-VCR Repair Solutions Sets I through IX. Each contains 150 symptoms and cures, free assistance, $19.95 each, all nine $39.95 plus $3.00 shipping. Visa/MC. FAX 219-272-6612. Eagle Electronics, Box C, 52053 Locks Lane, Granger, IN 46530.

WANTED: SCHEMATICS, parts, or information regarding Australian made Optro models #1000 24 track and #1100 2 track open-reel studio tape recorders. Any help would be greatly appreciated. Scott, 708-545-2155 eve. or leave message.

SIMPLEX 35MM XL Telecine projector w/telemation camera PAL NTSC $4,000. 818-352-6619.

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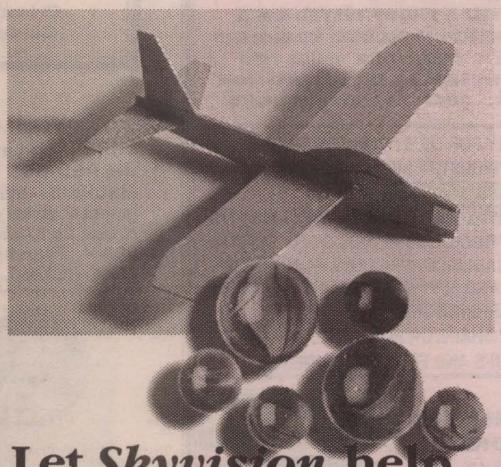

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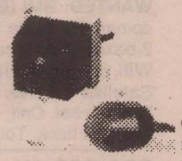

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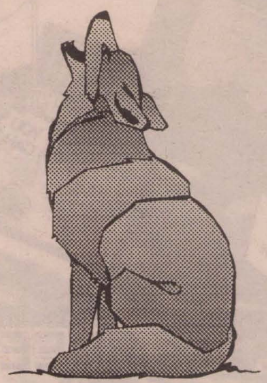

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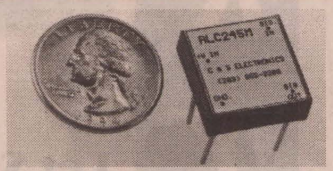

THE ALC245M AUTOMATIC VOLUME CONTROLLER will keep your transceiver or scanner volume constant from a whisper to a scream. $29.95. Other models are also available. FREE BROCHURE. C&S Electronics, PO Box 2142, Norwalk, CT 06852-2142. Phone/FAX 203-866-3208.

BEAMSCAN BY RED LINE self-contained microprocessor controlled laser scanning systems, $595 complete. Red Line Laser Products, 1935 Fernwood Trail Dr., St. Louis, MO 63031. Tel: 314-831-3014, FAX: 314-831-3927.

BUYING TOCOM, SCIENTIFIC ATLANTA 8536s, 8550s, 8580s, 8590s, and 8600s. **JERROLD** DPV and DPBB. **PIONEERS**, all, and Zeniths, all. Any quantity. Top $$$ paid. Contact National Cable Brokers, Plymouth, IN. Phone 219-935-4128.

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

LASER ILLUSIONS is now producing low cost systems for professional laser shows. Display ILDA animation clipart. Create moving graphics in 8 colors and save in ILDA format. Record and play shows on a standard cassette player. Includes beam effects and abstract pattern generation. Laser Illusions, Box 754, Anaconda, MT 59711. 406-563-7506.

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FIBER OPTIC Video transmission system. Transmits RS-170 video over multimode fiber (ST connectors). Range up to 5km. Equipped with AGC, color compatible. Surplus, unused units (Terrahertz Technologies, Inc. V-250) consist of transmitter, receiver and associated wall mount supplies. $295. Send SASE for specs. EO Techniques, 16 Slusser Ave., New Hartford, NY 13413-2117, phone 315-736-3642.

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

WANTED: EQUIPMENT to remove various kinds of noise from early tape recordings. Also looking for an old ribbon microphone. Randy Seden, 1272 Harold Ave., Simi Valley, CA 93065.

NIGHT VISION Moonlight Products. MPN-60K night scope with ALP-1 IR illuminator handgrip and padded hardcase $875. Phil. 714-636-4641.

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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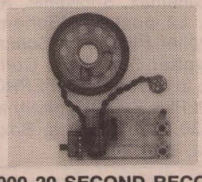

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Questions & Answers
TECH FORUM

This is a READER TO READER Column. All questions AND answers will be provided by *Nuts & Volts readers* and are intended to promote the exchange of ideas and provide assistance for solving problems of a technical nature. All questions submitted are subject to editing and will be published on a space available basis if deemed suitable to the publisher. All answers are submitted by readers and *NO GUARANTEES WHATSOEVER* are made by the publisher. The implementation of any answer printed in this column may require varying degrees of technical experience and should only be attempted by qualified individuals. Always use common sense and good judgement!

QUESTIONS

I have an NEC Radio Pager FCC RX Data #PR-150V2-10A. The pager uses sequential tone activated squelch and operates on 152.0075 MHz. I would like to convert the unit to carrier squelch operation if possible, and re-crystal it for use on the local fire frequency. Any information, such as a schematic diagram, theory of operation, or the crystal frequecy formula, would be greatly appreciated.

7951 **Brian Pliler**
Baxter Springs, KS

I need information, schematics, and sources to build an ultrasonic cleaner. I have the stainless tank, heater, and timer. I would like to be able to adjust the frequency.

7952 **Chris Morley**
Redondo Beach, CA

I have an Intermec 9422 portable laser bar code scanner that I would like to interface to my computer to do inventory. However, I do not have a software program that will read the inputs (RS-232) from the scanner and make them available for use in a database program or inventory program. Can anyone recommend an inexpensive inventory control software program that will work with this bar code scanner?

7953 **Michael E. Young**
Newville, AL

Recently, the horizontal hold on my Montgomery Ward Signature 2000 Series 25" color TV (Model 12025) went out of sync. Because it is an all electronic set — i.e., there are no external controls available and all adjustments must be made via on-screen menus — I consulted the owner's manual for pertinent information on how to adjust the vertical and horizontal hold on the set. To my surprise, no information is given on how to access what has always been an end user control. Instead, I was told by the vendor that those options have been relegated to the "Service Menus" which are not available to the end user. Can anyone tell me what the keystroke sequence to call up the "service menu" might be? Incidentally, the set appears to be manufactured by Zenith and given the store label.

7954 **Thomas Fuhlery**
Baltimore, MD

I need a schematic or service manual for a Vidicraft commercial cutter called a CCU-120 (Model CED-100, Serial #01976). This unit apparently cannot see the video signal. Vidicraft stopped making this unit about five years ago and could not find any documentation for it. I also need the VCR programming codes which were stickered to the back of the instruction manual, but fell off. I can be reached at Tel 216-368-4086, at address 21610 Miller Avenue, Euclid, OH 44119, or by E-Mail at pts2@po.cwru.edu.

7955 **Paul Szozdowski**
Euclid, OH

I need a method to detect out-of-phase speakers in multi-speaker auditoriums. The speakers are usually in a high ceiling and are driven by 70-volt transformers whose polarity leads have been known to be mismarked on occasion. If possible, I would desire a test arrangement that would use only one microphone due to the distance between each speaker.

7956 **Gary Casper**
Wichita, KS

I have security lighting around my home manufactured by The Brinkman Corp. of Dallas, TX. My problem is: Every time I keyed a transmitter, the system activates and all the lights turn on. I am a ham, and there are always RF systems on in the house. Police, ambulances, tow trucks, and everything with two-way radios keyed close to my house activate the system.

7957 **Rafael Acosta**
Rio Piedras, PR

I need to find a source for a tracking system like LOJAC which can be used with two or four antennas for strength and direction for "Fox and Hounds" and other such purposes.

I also need a PLL crystal controlled, tunable FM (88-108 MHz) transmitter that can be used, hopefully, within FCC type 15 levels.

7958 **Jonathan Muller**
Conyers, GA

There is a computer readout unit for Chrysler auto products which is able to read trouble codes and reset (clear) memory of the on-board engine computer. Does anyone have a design or source for a similar Miller Tool DRB II?

7959 **Bruce Heatley**
Buffalo, NY

Does anyone have a sample schematic for an IBM-compatible PC switching power supply?

79510 **Peter Skye**
Glendale, CA

How does one interface a thermocouple (eight of them) to a microcomputer? Perhaps a domino or a Basic stamp?

79511 **Paul Skrobarczyk**
Corpus Christi, TX

I need information on reprogramming a Heath HW24HT to transmit on CAP frequencies.

79512 **David Schoepf**
Somerville, AL

Can I program a specific channel via the keypad into my Motorola bag phone and DPC 550, so I can monitor it when not talking?

79513 **Grant Maxwell**
British Columbia, Canada

My Commodore C128-1571 will load and run all of my 64/128 programs, but when I try to boot the two CPM+ source disks I have, it boots then locks up and displays (NO SYS FILE). Why?

79514 **Eldon Wright**
Norton, KS

I received a used Sharp IQ organizer (AKA The Wizard 8200 Organizer). I'm looking for the IC cards and I can't seem to find them or anything about them anywhere. Sharp has given me names and numbers of places who sell their stuff, but when I call, I'm told they have stopped selling Sharp products.

79515 **J. Bautista**
Phoenix, AZ

I had a simple schematic for a video inverter that used a 75W input and output impedance and used only three transistors, such as 2N222, etc. It was from ATV Research, and I don't think they are around any longer. I want to use this to change a simple B&W image (printed text) from a book to white text on a black background for a video enlarger set-up for the visually impaired.

79516 **Gerald Koske**
Wonder Lake, IL

Can IC LM555s be utilized to generate audible tones in the 700 to 1700 Hz range for DTMF and CCITT controller circuits? In practice, F=1.44/(R4+2R3) C2 is not stable on high end of frequency range. Schematic of two audible tone generators = 700 Hz + 90 Hz utilizing 555s would be helpful.

79517 **Charles Dearing**
Oakdale, LA

I have a KLH 14" VGA monitor, model #MN195-1, made by KLH Computers, a division of Premier Innovations. KLH is no longer in business and I am looking for any documentation on this monitor, especially schematics. The monitor was given to me as it no longer has a sufficiently bright display. The brightness gradually decreased over three to four months; it also began to take longer for the display to warm up when the monitor was powered up.

I would appreciate any suggestions on how to fix the monitor and a copy of any documentation.

79518 **Clinton Troutman**
Fort Worth, TX

I need source information on where I can obtain repair parts or even defective OLD junker Mitsubishi MP286L PCs. The computer is: Mitsubishi MP286L Laptop Model #MP-2120.

Specifically, the 3.5", 1.44 MB flop-

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 3) Problem Solving
2) Electronic Theory 4) Other Similar Topics

INFORMATION/RESTRICTIONS

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

HELPFUL HINTS

- Be brief but include all pertinent information. If no one knows what you're asking, you won't get any response (and we probably won't print it either).
- Write legibly (or type). If we can't read it, we'll throw it away.
- Include your Name, Address and Phone Number. Only your name will be published with the question, but we may need to contact you.

TECH FORUM

py disk (Model #MF355C-399M) has gone bad. I cannot use a normal off-the-shelf floppy drive as this one has its own cable attached with special pin outs. The computer will not get by the initial turn-on self test ("FDD failure") to the hard drive without an operational floppy disk. The bios can only be accessed through an executable program. With NO c:> prompt, I'm stuck.

79519 **Dale R. Kubichek**
Manitowoc, WI

Where might I find a reference source that would list the precise precious metals composition of all soldering alloys and contact points used by the major manufacturers of ICs and other such electronic components in large photocopying machines, computers, CADD workstations, etc.?

79520 **Gerry LaBorde**
Gretna, LA

Can someone suggest a universal noise blanker circuit that can be added to the 455 KHz IF of small AM and SW radios to eliminate normal household electrical pops? It should run on 6-9 volts. I have tried making a couple from CB schematics without success.

79521 **Steven Garren**
Winder, GA

I have an I/O board for a PC by Contec #P20-16/16L(PC). I would like any information on this board and/or how to contact Contec.

79522 **John McComic**
Memphis, TN

I have a Notebook computer that has lost its backlighting. The backlight is a six inch long fluorescent .125" diameter bulb. It appears the ballast DC (±12 VDC) to AC (unknown output) converter circuit (PCB .75" wide x 3" long x .35" high) is what has failed and may have taken the bulb with it. I'm looking for information and sources as to where to obtain a placement bulb and DC-to-AC ballast converter circuit/parts. This particular backlighting uses a 5.5K ohm potentiometer for intensity control.

The USA OEM parts source wants over $150.00 for replacement parts. I only paid $125.00 for the entire Ultra 386SX Notebook at a yard sale. I've looked into Electro-Luminescence as a viable substitute. The ONLY problem is the size of the required inverter to power up 47 square inches of EL is over an inch tall. I've got NO room in the Notebook for this large an inverter.

79523 **Dale R. Kubichek**
Manitowoc, WI

I'm looking for data on GPS selective availability. How is it implemented? My application is frequency calibration using the time interval technique. Ret: HP AW-52-2 bibliographic Ret and or Algorythum to wash it out of the data.

79524 **Brian M. Chesire**
Tucson, AZ

I would like to construct/design/customize my own "Roger-beep(s)" and use inline with/between the microphone (4-pin) and the CB (PDC-29/Paradynamics). What type of chip(s) would be needed to create an almost perfect digital "Roger-tone." Direct my interest to any reference(s), that would be of any help at all in designing this piece of equipment.

Also, I hear the RCI 2950/2970 can be modified to operate on the II meter band (CB), and, also split-channels can be programmed. Am I correct on this?

79525 **Sean Ingram**
Amelia, VA

Need pin out of remote control plug for a Teac A-5500 reel-to-reel recorder. This unit will not operate with this plug in place. Right?

79526 **Robert Eshoo**
Santa Monica, CA

I am looking for a way to take a 1V P-P video analog signal and convert it to a frequency signal that can be transmitted through any standard audio transmitter such as walkie talkie or CB and then decoded back to a standard video output with only a very limited amount of parts?

79527 **Mark Tadlock**
Redwood City, CA

Where can I get a driver (software) for the Headstart & HST/PLUS mouse (proprietary)? The system is an XT with a 20 meg. HD and 5-1/4 DSDD floppy drive. I paid $85.00 for the mouse and no driver. They said we can get you the driver for $20-$30!? This was over 1-1/2 years ago. Are there any Headstart & HST/PLUS users groups, or SIGs, or forums?

79528 **A. Canales, Jr.**
El Paso, TX

I was using a book called *High Frequency Apparatus* when it disappeared. I need to find another copy!

79529 **Tracy Middleton**
Portland, OR

Several years ago, I purchased a Rainier Technologies voice/data switch Model TB-201. I have lost the owner's manual and the company is apparently out of business. Can anyone help with the programming procedures?

79530 **Dave Hampton**
Reno, NV

I would like information on how to modify a linear brand garage door opener manufactured by Moore-O-Matic for more RF output power. It is powered by a 9-volt battery, has an eight-position DIP switch, and transmits on 310 MHz using a saw resonator. I estimate the present output power to be 15 milliwatts, and would like to increase it to approximately 100 milliwatts.

79531 **Joe Howard**
Lansing, KS

I have in the past used T-Shirt transfer ribbons for my computer, but the price is a bit out of line. My question is exactly what is it made of? Is it carbon particles and ink? I am sure, after re-inking my ribbons, there is a way to re-ink a T-Shirt transfer ribbon. If so, and I am sure you can, what materials or chemicals do I need to "Re-ink" my heat transfer ribbon?

79532 **Kevin Cramer**
White Lake, MI

I am looking for a power supply CRT which will allow 0-5V and 0-20 amps DC to be adjusted independently, or a DC-DC CRT which will take a battery charger input 12V DC and allow me to adjust the voltage and current separately.

79533 **Butch Lowe**

Help! I need service info on old 1986-1989, 19"-21" Greyscale, B/W monitors that are broken. A LaserView LDM-1019B, MEGASCREEN VY-1000 & Apple (Philipps) two-page monochrome monitor. Can anyone help with a schematic, service manual, etc.?

79534 **Joseph Wegner, Jr.**
Glendale, CA

I have found some software that will emulate CP/M, read various 5-1/4" & 8" formats and allow me to transfer all my old stuff into DOS files. I have been told that some of the older floppy controllers were capable of being modified to operate 8" drives. I desire information regarding hardware and software drivers that would allow the installation of 8" DSDD drives onto an ISA/PCI bus machine without the loss of my present floppies.

79535 **Carl Camper**
Colstrip, MT

ANSWERS

ANSWER TO #6954 – JUNE 1995

The quickest way to secure a multi-entrance garage with a local alarm, is to hook-up a "wall-wart" power module and a small relay in series with the PIR. Connect the X-10 to the normally closed output of the relay. When the PIR trips, it will open the relay contacts and trip the X-10. The relay and power module should be low current as the switched output of PIRs cannot handle a large amount of current.

You may want to check your PIR as some have a relay in the output and it is easy to change them over to a normally-open output.

Charles Laye
Thonotosassa, FL

ANSWER TO #6951 – JUNE 1995

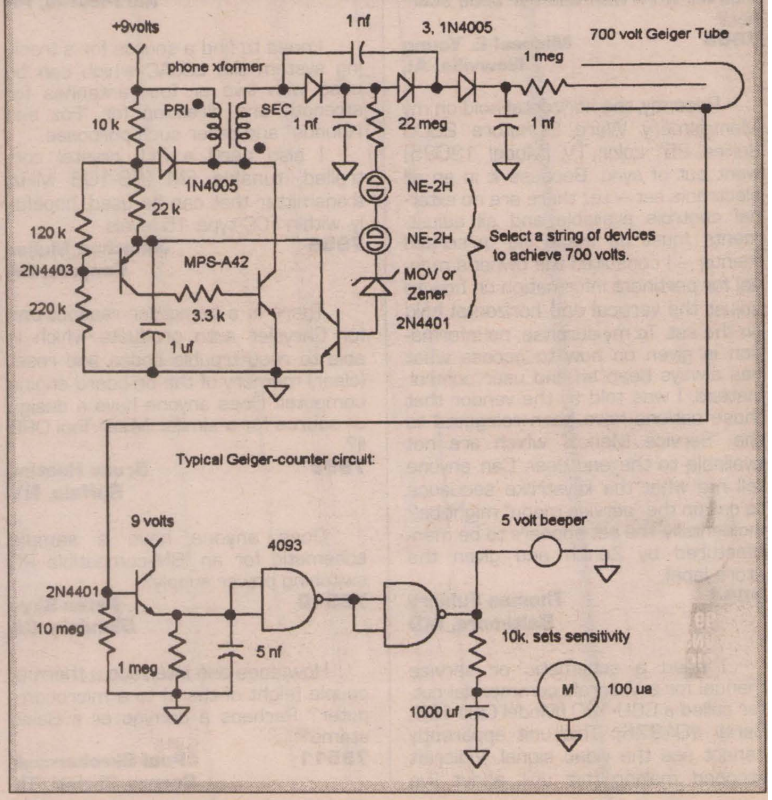
A cost-effective way to prototype a controller is to use an old PC with off-the-shelf plug-in cards for A/D, D/A, digital I/O, power I/O, mass storage, LCD displays, and just about anything

Continued on page 135

ANSWER TO #6959 – JUNE 1995

Here is a 700 volt power supply for powering a Geiger tube. The circuit is similar to an answer I gave a few months ago, except that this circuit uses a 1:1 telephone isolation transformer typically used in modems instead of an audio transformer and values have been modified to work with the lower inductance. The voltage is determined by the string of devices including the neon bulbs. Select a combination of neon lamps, varistors, or zeners to achieve the desired voltage. This circuit will not supply 250 uA as you requested, but if your Geiger tube ever draws that much current, you will be concerned about more pressing matters! Geiger tubes draw about 100 uA when they pulse, but the pulses are very short and relatively far apart so the supply need only source a few micro-amps to the output capacitor. This circuit is nice because it cuts back current consumption to less than 1 mA when the load current is low. It works well from either 9 or 12 volts, but it will supply more current with higher supply voltages. A typical Geiger-counter circuit is included for reference

Charles Wenzel
Austin, TX



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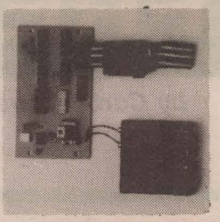

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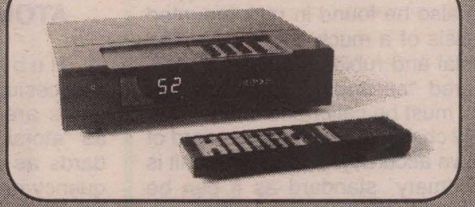

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FREQUENCY STANDARDS

FREQUENCY STANDARDS

by Corby Dawson

So, you've decided to add a frequency standard to your collection. No matter your need – calibration, design, testing, or just plain fooling around – a precision frequency standard can enhance your lab. There are, however, a few misconceptions about such standards. This article is an attempt to answer some of the most commonly asked questions.

USES

There are a myriad of uses for frequency standards, and as many different fields to use them in. Here is a partial list of uses.

Calibration — Counters, synthesizers, signal generators, timing systems, etc.

Measurement — Anywhere a precise measure of time or frequency is required. Such as astronomy, seismology, nuclear physics, LASER systems, navigation systems, deep space ranging systems, RADAR, etc.

Telecommunication — Stable references for frequency agile and spread spectrum systems.

TYPES

There are three broad categories of common precision standards: crystal, rubidium, and cesium. The smallest are about 1.5" x 1.5" x1.5" for crystal, 2" x 3" x 4" for rubidium, and 5" x 7.5" x15.5" for cesium. All three types can also be found in rack mounted chassis of a much larger size. The crystal and rubidium units are considered "secondary" standards as they must be calibrated and periodically checked against a standard of known accuracy. The cesium unit is a "primary" standard as it can be calibrated against itself to a known high degree of accuracy.

QUARTZ CRYSTAL

The basic crystal oscillator is not considered "precision" as it is quite temperature sensitive and has a poor accuracy in the neighborhood of 10ppm (1x10-5). The next step up is the temperature compensated crystal oscillator or TCXO, again not normally considered precision. It is accurate to maybe .1ppm (1x10-7) and is relatively insensitive to changes in temperature. The ovenized crystal oscillator or OXO can be precision or not, depending on the quality of the crystal and the design of the oven and oven controller.

A typical precision unit has one or two ovens with a proportional controller that limits temperature swings. Typical accuracies are 1X10-10 with aging rates between ±5X10-11 to ±5X10-10 per day. Aging is the amount the frequency will change over time with all other factors — temperature, power supply voltage, loading, etc., remaining constant. It is determined mainly by the quality of the crystal, the type of crystal cut, the crystal drive AGC circuits, and the ability of the oven controller to limit temperature transients. These units are the workhorses of the electronics world. At the heart of both rubidium and cesium standards resides a high-quality precision ovenized quartz VCXO (voltage controlled crystal oscillator).

ATOMIC STANDARDS

Rubidium and cesium standards are known as "atomic" standards as the frequency determining factor is the interaction of the atoms of rubidium or cesium inside the standard. The particular isotopes (rubidium 85 and 87 or cesium 133) are not, however, radioactive!

RUBIDIUM STANDARDS

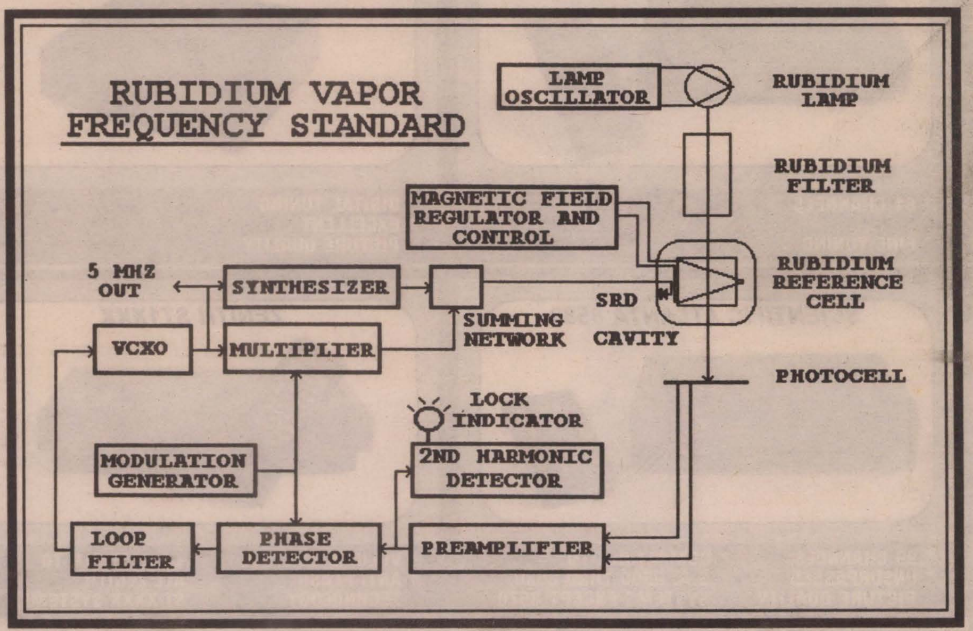
The rubidium standard, as shown, takes the 5 MHz from a precision VCXO and multiplies it up to 60, 90, or 120 MHz depending on the design. This frequency is summed with a synthesized frequency of 5.31510107 MHz. These two signals are applied to a step recovery diode (SRD) inside a microwave cavity tuned to the rubidium resonance frequency. The 6.840 GHz harmonic and the 5.31510107 MHz are mixed in the SRD with the difference frequency of 6.83468489893 GHz falling at the rubidium resonance frequency.

The cavity contains a hermeticaly sealed glass resonance cell containing a small amount of rubidium metal and some buffer gases. Shining through openings in the cavity is light from an RF discharge excited glow lamp, containing again rubidium metal and a buffer gas.

The light from this lamp is filtered, usually through a separate filter, containing (you guessed it) rubidium metal and a buffer gas. The light exiting the cavity falls on a silicon photocell.

All rubidium components are heated by controlled ovens to between 60 and 110 degrees centigrade to vaporize the rubidium inside. The filtered light from the lamp "pumps" the atoms in the resonance cell to a specific energy state. This state is highly sensitive to the frequency of the microwave radiation inside the cavity and allows the greatest amount of light through to the photocell.

Inside the multiplier the RF signal is phase modulated by a low-frequency signal lying between 107 and 165 Hz. This causes the microwave signal to vary back and forth across the resonance frequency. When the resonance frequency is matched, the atoms are forced to "fall out" of the pumped state reducing the amount of light impinging on the photocell. Since this action occurs at the modulation rate the



output of the photocell will vary at the same rate.

The amplified photocell signal is synchronously phase detected and filtered. It is then used to drive the 5 MHz VCXO to match the resonance frequency.

Due to the physics of the interaction, when the 5 MHz is precisely on frequency, the modulation component of the photocell output is doubled in frequency. This causes the second harmonic content of the preamplifier output to dominate. The harmonic signal is sent to a level detector which drives the lock indicator.

The resonance frequency of the atoms inside the cavity is sensitive to a "C" or constant magnetic field. Adjusting its strength is the method used for fine frequency adjustments.

The synthesizer and resonance frequencies in this discussion will vary among manufacturers depending upon the design pressure and mix in the resonance cell. Typical accuracies are ± 1X10-11 with long term aging rates between ± 1X10-11 to ± 6X10-11 per month. Some units are specified to age less than ±5X10-11 per year.

CESIUM

The cesium standard as shown should seem familiar now! As you can see the main differences are that the cesium beam tube replaces the rubidium vapor components, and the synthesizer frequency changes to 12.6317716 MHz. The harmonic at 9.180 GHz and the synthesizer frequency are mixed in the SRD with the sum frequency of 9.1926317716 GHz falling at the cesium resonance frequency.

The cesium tube has a current output in the tens of nanoamps range. As in the rubidium standard, the modulation signal will appear on the output of the tube and control the VCXO via the phase detector and loop filter.

Inside the tube, a cesium reservoir is heated, causing cesium atoms to discharge into the tube proper. These atoms are collimated and then "selected" using fixed state selector magnets at both ends of the microwave drift cavity. The input state selector allows only those atoms to pass that are in a state that will be affected by the microwave signal.

As these atoms "drift" across the cavity, their quantum mechanical state will be changed by the microwave signal at the resonance frequency.

The beam of atoms then passes through the output state selector magnet which directs the state changed atoms onto the hot wire ionizer.

The ionized atoms then traverse a mass spectrometer, which passes only cesium ions, to impact a detector plate. This plate is the input to an electron multiplier chain (EM) that raises the current to a useable level. The EM output current is directly proportional to how close the microwave signal is to the resonance frequency.

One of the interesting features of the cesium tube is its own internal vacuum ion pump. The inside of an operating tube is outgassing continuously. This action would quickly ruin the high vacuum required inside the tube.

The ion pump ionizes the stray atoms and "buries" them within its electrodes. The ion pump, in conjunction with getter materials to trap the used cesium atoms, thus maintains the vacuum required. Typical accuracies are between ±5X10-12 and ±3X10-11. The aging rates are extremely small to nonexistant.

PROS AND CONS

So that's how they work and how accurate they are. Now, let's talk reliability and maintainability! Precision quartz oscillators are the most reliable, but also need the most frequent calibration. If you have access to an accurate source to calibrate against — WWVB, LORAN-C, GEOS, GPS, cesium standard, etc., then a good quality quartz standard may fit your requirements.

The main failure mode for quartz oscillators is failure or erratic operation of the temperature controller/oven. Also some older units will have aged past the adjustment range of their tuning elements. Rubidium standards are also quite reliable, again needing a source to calibrate against, but at longer intervals than quartz. I've observed some working rubidium units that are over 30 years old!

Weak or noisy lamps or lamp oscillators are the predominant cause of failure. These lamps are model specific and can be replaced if available. Cesium standards are reliable with observed lifetimes of greater than 25 years (short term stability suffers on older units, but for most calibration applications this is not important). There is a higher risk of failure with cesium units as there are four main failure modes.

1 Since the cesium reservoir discharges atoms continuously, it can eventually run out of ammunition! (To conserve tube life, some units have cesium off switches that allow you to use the quartz VCXO as the standard, only turning on the cesium portion when high accuracy is needed.)

2 The electron multiplier gain decreases slowly with age until the point is reached where all your adjustments are at maximum, but insufficient output current is available to lock the standard.

3 The hot wire ionizer filament, like all filaments, can burn out causing total failure of the tube.

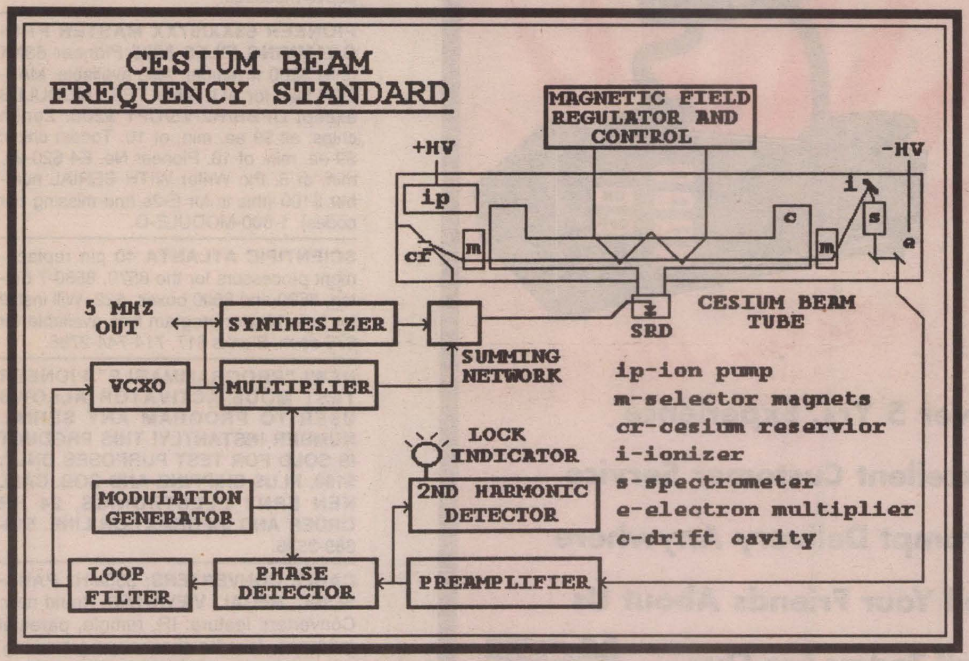
4 By and large, the most common failure is when the ion pump cannot pump down the tube properly. This can be caused by a leak in the tube, not operating the tube for an extended period of time with the pressure in the tube rising past the ion pump operating region, or failure of the ion pump itself. Replacement tubes are prohibitively expensive, although some sources exist for good used tubes albeit somewhat expensive also!

FUTURE STANDARDS

Future standards in the used market will be hydrogen MASER oscillators and atomic mercury standards. Some soviet-built MASERS are appearing, but the mercury standard is not commercially available yet.

IN CONCLUSION

Remember the cesium standard does not need periodic calibration to maintain its accuracy. The rubidium and quartz do drift with the quartz having 30-100 times more drift than the rubidium, thus requiring more frequent calibration. Good used units are available at reasonable prices. Non-working units are much cheaper, but it's best to avoid them unless you have had some experience in their repair. **NV**



Corby Dawson has been involved in repair and calibration of frequency standards since the early 70s. He is also employed by LORAL Aerospace at Vandenberg Air Force Base where he is an Automated Remote Tracking Station (ARTS) Controller. This site performs commanding, tracking, and telemetry functions for on-orbit military satellites.

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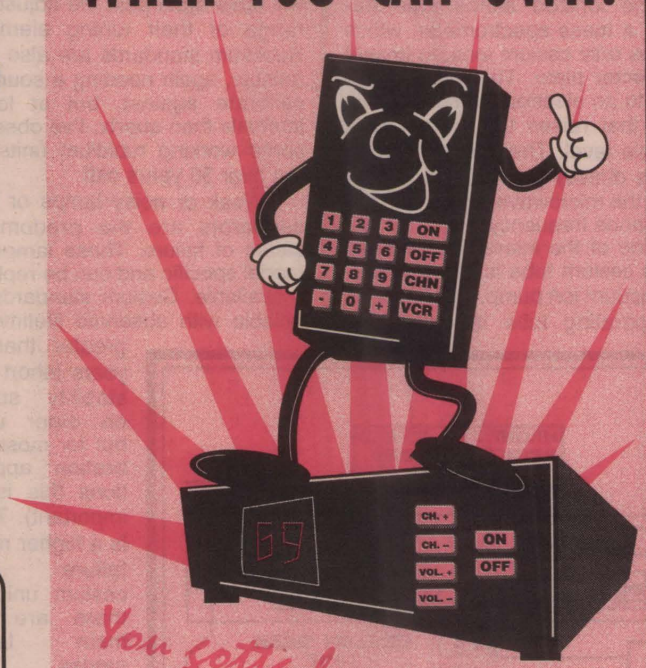

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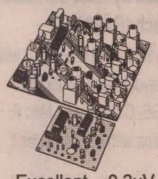

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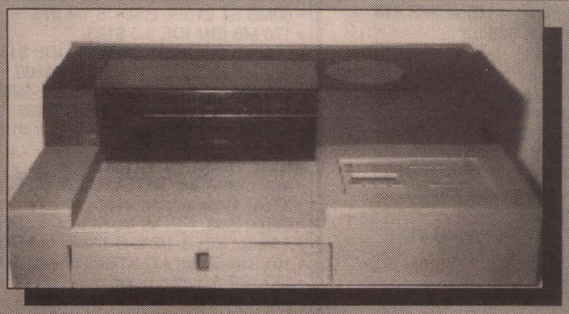

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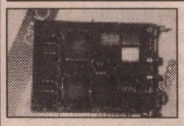

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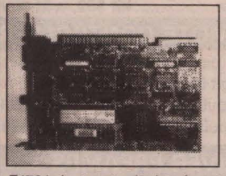

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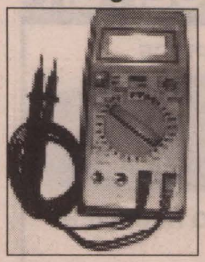

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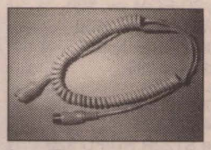

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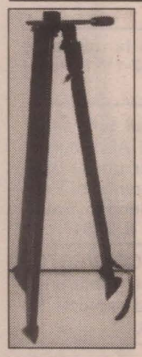

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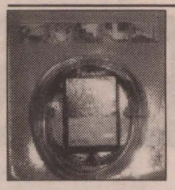

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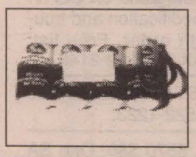

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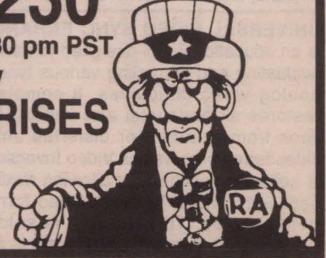

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Inside Wire Maintenence Part 4

by
Daniel B. Levels

E=I/R
Even I remember.

Do you recall learning this phrase to help memorize Ohms Law? Does it surprise you to learn that modern communication engineers still use this simple formula to verify design efforts? In the age of palm-top computers, it never hurts to grab a pencil and double-check your numbers!

In previous articles, we have explored methods for troubleshooting transmission impairments such as noise, static, Radio Frequency Interference (RFI), Electromagnetic Interference (EMI), and Power Line interference (PI). If you missed these segments, contact *Nuts & Volts* for reprints. This month, we will review procedures for testing and correcting telephone line signalling problems.

Our investigation of noise troubles includes an overview on measurements for both metallic (transverse mode), and grounded (common mode) signals, and readings will be expressed in terms of power (dBm, dBrnc). As we consider signalling issues, we will be measuring DC values in terms of volts and milli-amps. For ringing signals, we will express readings of AC volts peak-to-peak (VPP) and RMS, as well as frequency in Hertz (Hz).

In review, the local telephone company (telco) installs switching equipment at strategic locations throughout their areas. Large switching centers called "Central Offices" (COs) provide service to customers located within a reach of 10-15 thousand feet. Smaller switching units are extended to subdivisions and rural areas. These "Remote Units" are usually connected to the closest CO via fiber optic cables.

Installing remote units allows the telco to provide a higher grade of service, while reducing costs associated with maintaining long runs of copper cable.

Telephone cables, service wires, and your Customer Provided Equipment (CPE) comprise the make-up of an electrical circuit called the Local Loop (see Figure 1A).

The telco delivers service to a "point of demarcation" (demarc), located on the side or rear of your home. Modern demarc devices are equipped with RJ11-type jack/plug combination that provides a quick way to determine if a problem is in the telco network or your CPE. Why provide a test point for network/CPE isolation? To avoid trip charges incurred when telco employees discover trouble in your CPE! Locating your own trouble before calling the telco can save $45-$65 per occurrence!

WARNING!

Use caution when testing telephone lines and equipment. Normal 50 VDC @ 60 mA will jump to 90-130 VAC during ringing cycles. Additionally, longitudinal currents due to power-line induction can lead to dangerous voltage levels. Use insulated equipment and avoid contact with wiring and test points.

The local loop is engineered to meet a set of parameters associated with the type of service ordered. We have already reviewed some of these parameters for (POTS) lines. As we discovered last month, the noise parameters for POTS lines require circuit noise (metallic) to be less than 20 dBrnc, while the PI (Power Influence/Interference) should be less than 80 dBrnc.

The telco Outside Plant (OSP) engineer bears the responsibility for designing a local loop that will meet the electrical parameters for the type of service for which you are paying. A key component of the process involves selection of cable size (pair count) and conducator wire gauge (see Table 1.)

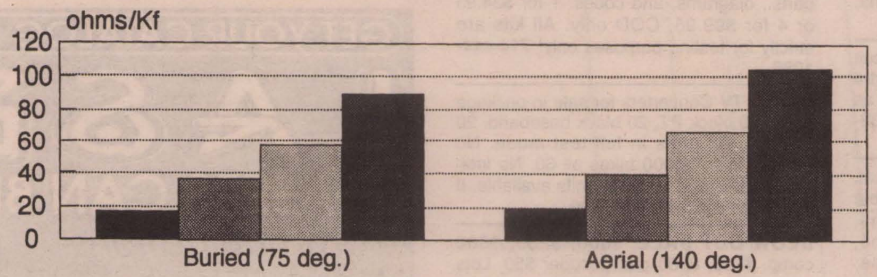
Table 1 identifies the loop resistance in "ohms per kilofeet" for several common cable wire sizes, from 26 gauge to 19 gauge. These figures are used to determine the appropriate wire gauge for a given cable route to the customer(s).

The gauge is selected to achieve a minimum of 20 mA in the loop. Loop current can be verified by placing a 430-ohm resistor in series with an analog or digital VOM, as shown in Figure 1B. Be aware that you are actually "pulling dialtone" through the meter, so choose a scale which will read up to 100 mA DC. Cables that are bridge spliced along the route do NOT affect the amount of loop current delivered to the customer, unless electrical faults exist on the bridged legs.

Conductor size (AWG #26, #24, #22, etc.) has a direct effect on several parameters, such as operating current and signal loss, and the installed facilities must be tested to insure that the expected results have been achieved. The projected "Expected Measured Loss" (EML) is compared with the "Actual Measured Loss" (AML) and deviations from standard must be resolved. This article examines how these measures affect the operation of your customer provided equipment, which includes phones, fax and answering machines,

Table 1

Cable Data
Engineering Worksheet



	Buried (75 deg.)	Aerial (140 deg.)
19 Ga.	17.68	20.18
22 Ga.	35.75	40.79
24 Ga.	56.52	64.48
26 Ga.	90.74	103.52

Figures are for DC Loop Resistance/Kf

19 Ga. 22 Ga. 24 Ga. 26 Ga.

Loop ohms /Kf (Includes both conductors)

Fig. 1A
The Local Loop

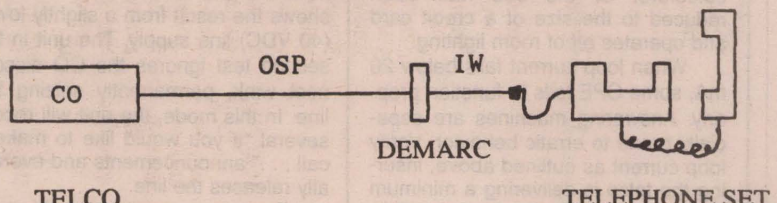


Fig. 1B
Loop current

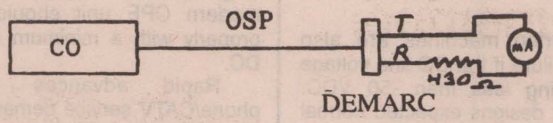
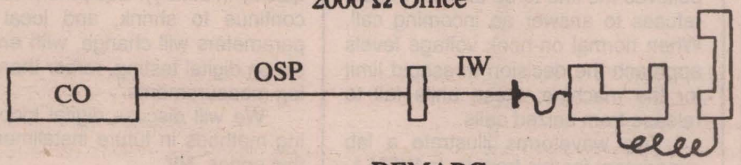
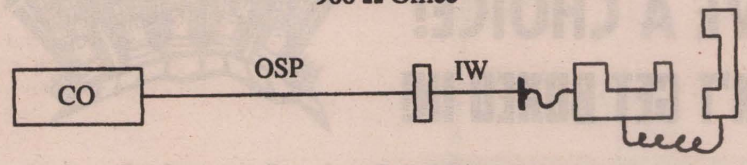


Fig. 2
Loop Resistance
2000 Ω Office



CO	OSP	IW	Phone
450 Ω	1570 Ω	30 Ω	400 Ω

Fig. 3
Loop Resistance
900 Ω Office



CO	OSP	IW	Phone
450 Ω	470 Ω	30 Ω	400 Ω

alarms, and modems.

When your service is installed, the technician completes a series of acceptance tests on the loop. The order is not completed until quality results are achieved. How many of you pay the phone bill each month and really know what you are paying for? The telco has gone to great lengths in providing a bill that is easy to understand. After all the taxes from city, state, and federal government, what are you really paying for?

You are paying for parameters! The standard POTS line is intended for voice grade usage and has a predictable set of electrical parameters which are measurable. Here they are:

```
Loop Current: >20 mA @ 430 ohm DC
term.
Loop Loss: @ 1KHz < 8.5 dBm @ 600
ohm Z, term.
Circuit Noise (metallic): < 20
dBrnc, term.
Power Influence (noise to ground):
< 80 dBrnc hi Z.
Balance: 60 or greater.
```

In previous articles, we reviewed circuit noise, power influence, and balance. This month, let's take a closer look at loop current. However, notice there was no minimum voltage limit! You are used to working with different DC voltage levels when you put batteries into your tape player or portable TV, etc. The tape player may require 9 volts DC, while the TV may require 12-13 volts. Some CPE technicians incorrectly believe the telco has to supply -50 volts DC battery supply. This is not true! You are paying for a level of *current*, not voltage.

The following analogy will give a clearer understanding of this principle. When you get into your car, you don't care if the battery is charged to 12 volts DC or to 13.5 volts DC. What you really care about is that when you turn the key, the engine starts. The starter will require a certain amount of *current* to operate. The electrical system could be designed to operate at a number of different voltages to achieve the needed operating current. If the car's battery were 100 feet away from the car, we may need 70 to 80 volts DC to operate the starter. You see, the closer you get to the *current source*, you can use a lower voltage and still operate efficiently.

The power company steps up its voltage to thousands of volts for transmission lines running long distances, yet converts back to 220/110 volts close to your home. To restate, the closer you get to the *current source*, the less voltage required to achieve a given operating condition. The closer to the source, the lower the loop resistance (because of less cabling). This is why there is no requirement for a certain voltage on the telephone line. For many years, the telco supply was -50 volts DC, but today it could be any value from -28 to -52 volts DC. The important parameter is "loop current." The minimum acceptable loop current is 20 mA, or .020 amps.

Manufacturers of the telco's central office switching equipment, design and engineer their products to operate under a uniform set of electrical standards. CPE manufacturers also design products to function properly within these same "electronic rules." The OSP engineer must be aware of the limits of each piece of equipment installed into the network, and design the local loop accordingly.

For instance, the lower limit for loop current for a POTS line is 20 mA, or .020 amps. The CO limit will be listed as "xx ohm loop" and the engineer will select the appropriate OSP cable wire size (gauge) to achieve a maximum length. The "xx Ohm loop" designation means that the switch will provide a minimum of 20 mA to a loop with a maximum resistance of xx ohms.

The engineer must also allow for the standard telephone (SET) DC resistance of 400 ohms, and an additional 30 ohms for the Inside Wiring (IW). Let's add these up for a 2000 ohm office and see where that leaves us.

Starting with the CO limit of 2000 ohms, we must subtract the resistance for the SET and IW (400 ohms + 30 ohms = 430 ohms), arriving at the maximum allowable resistance for cable and service drop. In this example, the loop resistance allotment for cable is 1570 ohms, (2000 ohms - 430 ohms = 1570 ohms). (See Figure 2.)

Let's double-check our figures by calculating the loop current and make sure this loop will achieve a minimum of 20 mA. The CO equipment provides 50 VDC to achieve the operating current. Therefore, 50 VDC/2000 ohms = .025 amps, or 25 mA. Looks like we have an additional 5 MA of current to play with, right? Wrong!

The CO has an internal resistance of 450 ohms and will add to the 2000 ohm OSP limit for a total of 2450 ohms. Let's re-figure our loop: 50 VDC/2450 ohms = .020 amps, or 20 mA. Don't take my word for it, get your calculator and perform this exercise!

For many years, 50 VDC was the nominal operating voltage used to achieve an operating current of (at least) 20 mA. However, there is no requirement to provide a certain operating voltage. In urban areas, CO switches serve tens of thousands of customers within a short physical distance. A typical office will have an external (OSP) resistive limit of 900 ohms. However, the same CO internal resistance and SET/IW values still apply.

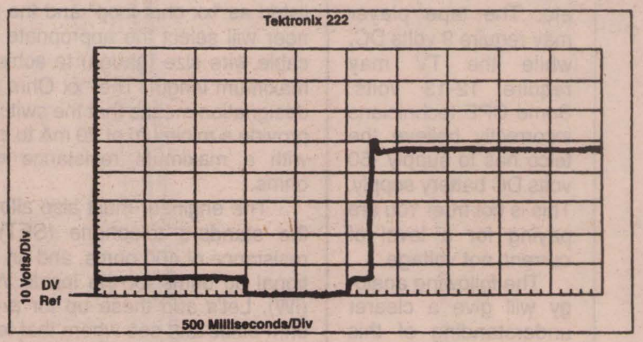
Remember that the 900 ohms includes the set/IW resistance. (See Figure 3.)

Using our previous example, let's perform some loop calculations: 50 VDC/(900 ohms + 450 ohms) = .037, or 37 mA. This would be an overkill at 50 VDC, so let's see what operating voltage would be better.

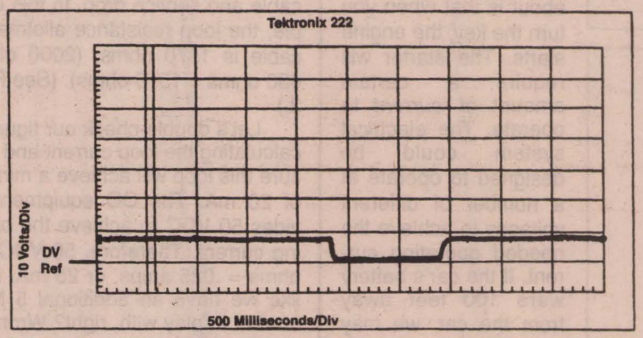
To calculate, multiply the required current by the total loop resistance: .020 amps x (900 ohms + 450 ohms) = 27 VDC. Therefore, with a CO voltage of 27 VDC, we will achieve 20 mA with a total OSP resistance of 900 ohms. If we subtract the SET/IW resistance, (400 ohms and 30 ohms), we can allow a total of 470 ohms for the OSP cable and service drop.

Our main concern is to achieve at least 20 mA to the customer. Lower

WFM 1-1A
CO Disconnect Wink



WFM 1-1B
CO Disconnect Wink



voltage designs offer smaller packages at more attractive prices and higher efficiencies. The floor model calculator of the 50s has been reduced to the size of a credit card and operates off of room lighting.

When loop current falls below 20 mA, some CPE fails to function properly. Answering machines are especially prone to erratic behavior. Verify loop current as outlined above, insuring the telco is delivering a minimum of 20 mA to the demarc point. This reading should be obtained with all CPE disconnected. If voltage drops when CPE is reconnected, suspect faulty IWs or CPE instruments. The Jan. '95 edition of *Nuts & Volts* contains an article that describes proper methods for correcting faulty CPE wiring.

Answering machines are also prone to failure if the CO line voltage is something less than -50 VDC. Older CPE designs expected normal on-hook (idle) voltage to be -50 VDC. When normal on-hook voltage levels are lower, such as 28 VDC, the answering machine is programmed to interpret any value less than 45 VDC as an off-hook condition and, since it believes the line to be already in use, refuses to answer an incoming call. When normal on-hook voltage levels approach the decision threshold limit for the machine, these units fail to release from seized calls.

Two waveforms illustrate a lab experiment for this trouble. In WFM 1-1a, the normal voltage is nearly 50 VDC, and the answering machine responds to the disconnect wink sent from the CO. However, WFM 1-1b shows the result from a slightly lower (40 VDC) line supply. The unit in the second test ignores the CO disconnect wink, permanently seizing the line. In this mode, the unit will record several "If you would like to make a call . . ." announcements and eventually releases the line.

If you are experiencing this type of behavior from some of your CPE, verify the loop voltage and loop current for your line. If loop current is below 20 mA, consult your local telco. If current is greater than 20 mA, contact your CPE vendor (store, etc.). Regardless of voltage levels, any modern CPE unit should operate properly with a minimum of 20 mA DC.

Rapid advances in telephone/CATV service demand shorter loops, and the chosen method is to relocate portions of the CO switching equipment closer to the customer. Some day the CO equipment link will be digital down to the handset (unless we can learn to speak very quickly in binary). Equipment size will continue to shrink, and local loop parameters will change, with emphasis on digital testing, rather than analog measurements.

We will discuss digital loop testing methods in future installments of this series. **NV**

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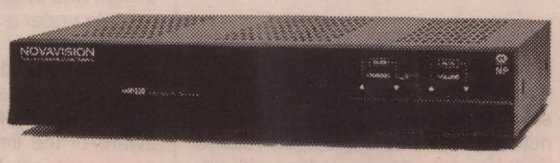

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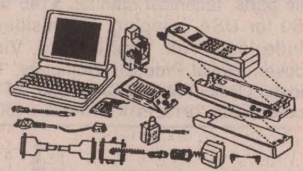

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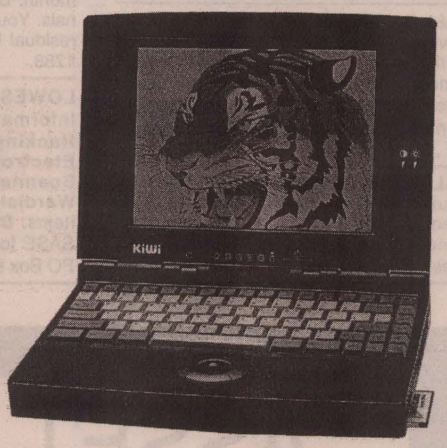

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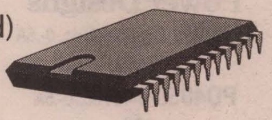
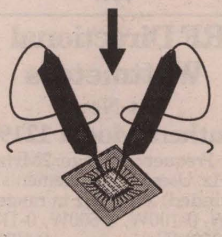
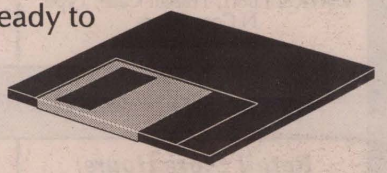


2. Reading the chip's contents.



3. The chip's data, ready to use.



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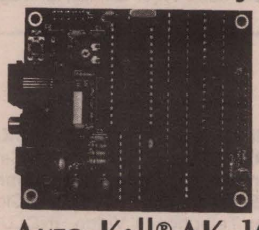

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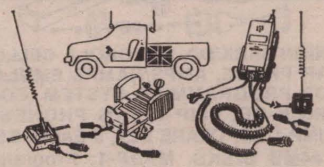

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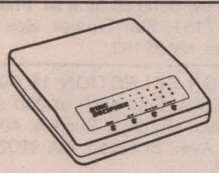

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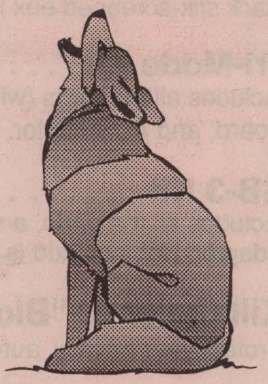

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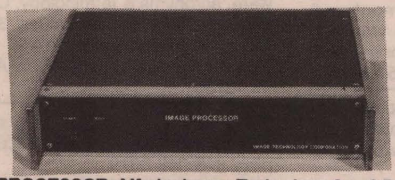

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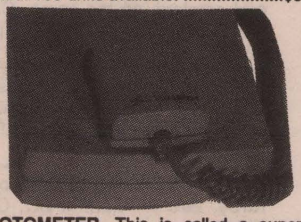

RGBPHOTOMETER. This is called a supermatch display calibrator pro. Made by Supermac Technologies. Contains three detectors, each with a filter in front (red,green blue). Was used to calibrate monitors. Useful for many other purposes. At press time no schematic or manual was available, but we are trying.
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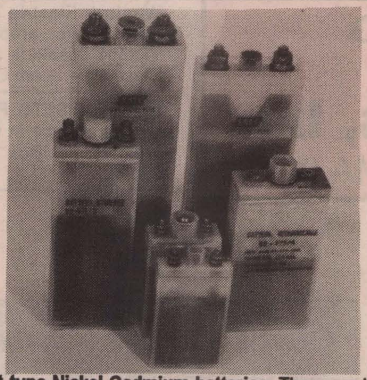

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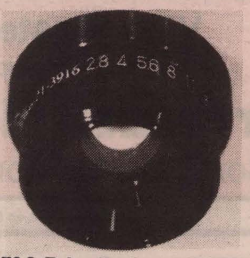

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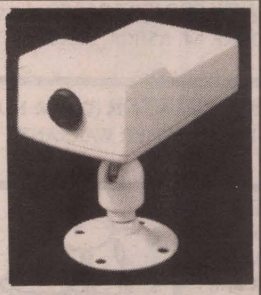

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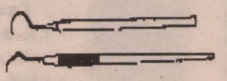

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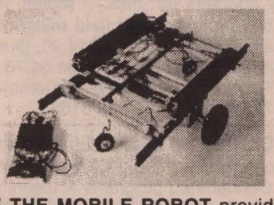

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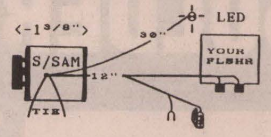

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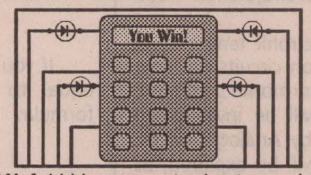

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```
#include <PIC16C56.h>
#use Delay(Clock=20000000)
#use RS232(Baud=9600,Xmit=pin_1,RCV=pin_2)

main () {
   printf("Press any key to begin\n") ;
   getc();
   printf("1 khz signal activated\n") ;
   while (TRUE) {
         output_high(pin_8) ;
      delay_us(500) ;
      output_low(pin_8) ;
      delay_us(500);
   }
}
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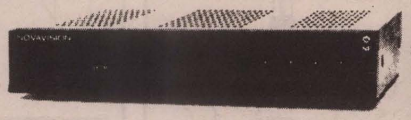

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THE SOLDERLESS BREADBOX

by Donald Wilcher

Experimenting With The TMP01 Electronic Sensor IC

Temperature sensing is very important when it comes to automotive and industrial applications. The automobiles that we drive provide comfort when it's hot or cold by adjusting the temperature control unit. The temperature that is displayed on the overhead console gives us an indication of the weather conditions surrounding the vehicle.

In an industrial environment, the control panels responsible for moving the conveyors in the assembly plant can be affected by heat. These units have fans to keep the electronics from approaching thermal melt down. The paint booths used for painting automobiles have controllers that monitor and control the temperature within the stations.

What do all of these examples have in common? The answer is temperature! Temperature sensing is a unique engineering concept and is derived from the physical sciences realm. Temperature is one of those physical items that we can definitely get our hands around.

To measure it, we can use a thermometer and to control it, we use a switch. The switch allows us to turn on or off the temperature, depending on what the thermometer reads. In both industrial and automotive applications, temperature is pretty much maintained by this concept of sensing and controlling.

There are various means in which to measure temperature. Thermometers, semiconductors, and thermistors are examples of detecting temperature. Relays, motors, and switches are components used to control temperature. When detection is combined with control, a temperature controller system is created.

Recently, developments in electronic temperature sensing have been made. Detection circuits are now packaged onto a small IC. In this month's column, electronic temperature sensing will be investigated using the TMP01 IC developed by Analog Devices. The IC's electronic construction will be explored, as well as the usual discussions on experimental circuits.

So, before we begin our discussion of the TMP01 IC, let's take a look at temperature sensing basics.

What is Temperature?

Simply put, temperature is the hotness or coldness of an object. The easiest way to measure temperature is to use a thermometer. Temperature is usually measured in degrees of Celsius (or Centigrade) or Fahrenheit. The temperature conversion scale shows that water boils at 212 degrees Fahrenheit or 100 degrees Celsius. To convert from Celsius to Fahrenheit, one can use a conversion chart listed in the back of science books or two simple equations can be used. To equate the equivalent Fahrenheit degrees for Celsius, use the formula:

$$F = (C \times 9/5) + 32$$

If you want to know what Celsius temperature is equal to a known Fahrenheit reading, use the formula:

$$C = 5/9 \times (F - 32)$$

For those who are not familiar with these two formulas, try converting 100 degrees Celsius to Fahrenheit. This answer should be 212. The Celsius scale is part of the SI (System International) or metric units for indicating temperature. Another temperature scale used to calculate extremely hot or cold temperatures is the Kelvin. Water freezes at 273 K (Kelvins), and boils at 373 K. To convert a temperature given in

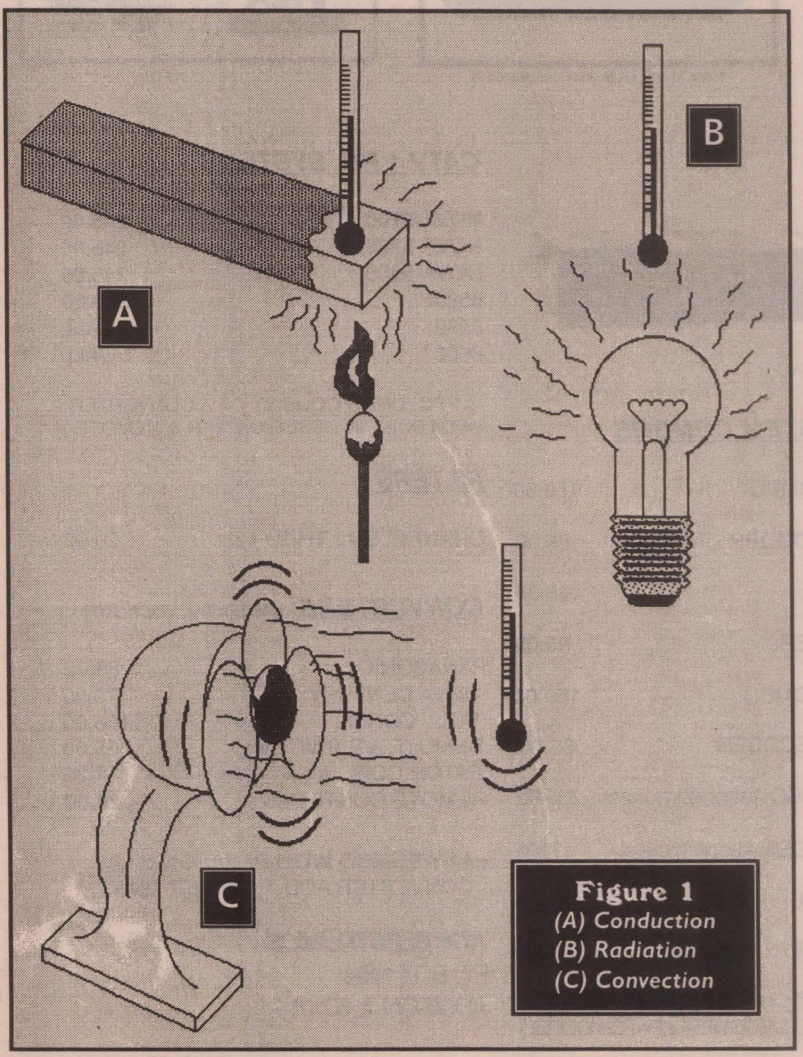

Figure 1
(A) Conduction
(B) Radiation
(C) Convection

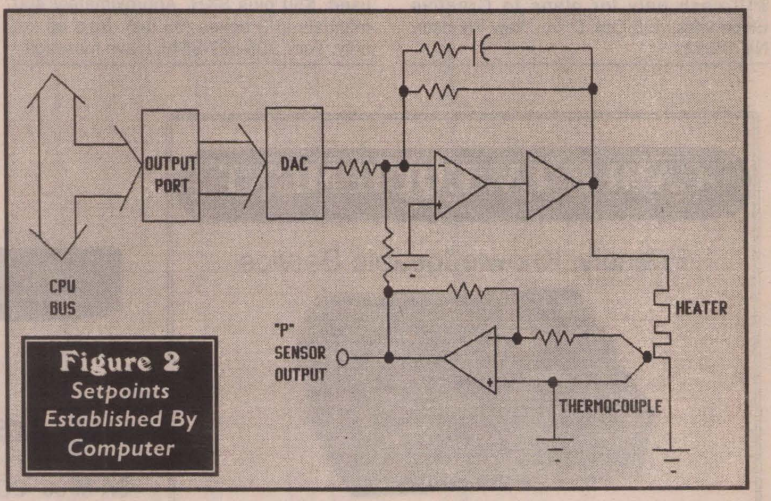

Figure 2
Setpoints Established By Computer

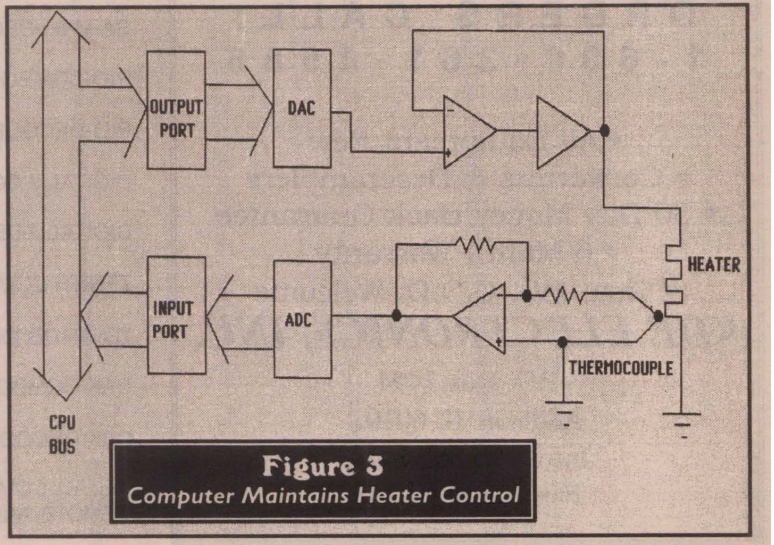

Figure 3
Computer Maintains Heater Control

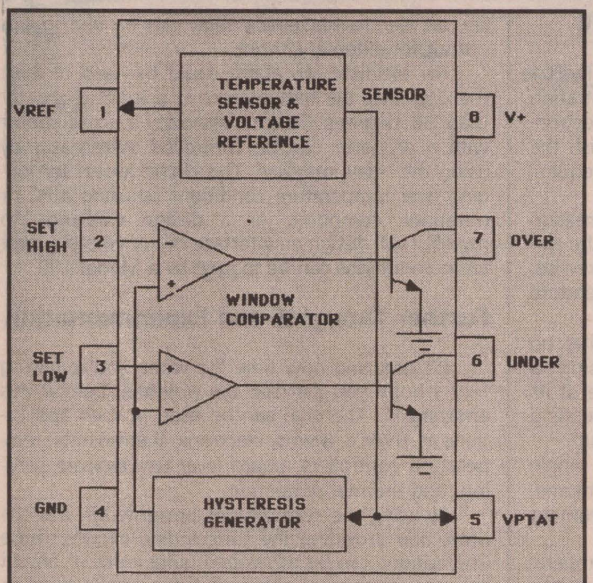

Figure 4
Pinout For The TMP01 Electronic Sensor IC

Celsius to Kelvin, add 273 to the number.

Temperatures can be generated by various means such as convection, radiation, and conduction. Convection is basically ambient (room) temperature surrounding an object. A fan blowing cold air on a soldering iron is an example of convection. The air circulating the soldering iron is the convection temperature surrounding the tool.

Radiation is the method of producing hot or cold air by a transmitting source. Transmitting in this context means being able to emit the solar or polar temperatures from the object. The sun is a good example of a radiation source because heat is emitted from the brilliant ball of light.

Last, conduction relates to how an object can absorb hot or cold air from a source. An example of conduction would be the heating elements in a toaster. The heaters absorb heat because of the metal grids they are made from. Metal is a conductor for both hot and cold temperatures.

The mercury that is inside of a thermometer is a good conductor for hot and cold temperatures because it transmits the hotness or coldness to the red dye. The dye reacts to the temperature by moving up the scale when it's hot, and down the scale when it's cold.

Figure 1 shows examples of convection, radiation, and conduction. To make temperature measurements using electronic sensors, one or all methods of temperature dissipation discussed are used.

The heart of a temperature control or measurement system is based on the sensitivity of the sensor used in the application. Temperature detection is only as good as the design of the system.

So, what's involved in a temperature measuring system?

Designing a Temperature Controller

A temperature controller is a device that can measure hot or cold temperatures. Two approaches on design are illustrated in Figures 2 and 3. Figure 2 shows the computer (which is not part of the control loop) providing the set point value(s). This controller assumes that the set point (SP) command is correctly executed by the analog controller. The SP establishes the trip points of the temperature controller for actuating an alarm. The sensor output marked "P" could be interfaced to an ADC (Analog-Digital-Converter) so the computer can check for reliable operation.

A comparator can also be used to check the difference between the DAC (Digital Analog-Converter) and the sensor outputs and raise a flag in the I/O port if the differential value is excessive. In any case, the computer's attention is only needed to vary SP to respond to a control failure.

The temperature controller in Figure 3 depends on the computer to maintain the correct value for the heater voltage. This is done by reading the value sensor output value through the ADC and calculating the appropriate response.

There are three devices that are used for temperature sensing: thermistors, thermopiles, or photodiodes. The thermistor will vary the amount of input current into the op-amp by the heat it detects. As temperature increases, the thermistor's resistance will decrease.

The thermopile, on the other hand, produces a voltage proportional to the amount of heat sensed. At high temperatures, more voltage will be applied to the input circuit of the op-amp.

Last, the photodiode provides current to the op-amp circuit by the amount of temperature it detects. Temperature is indirectly applied to the photodiode by the amount of light intensity. With more light intensity, the current flow is excessive into the circuit. Temperature will increase with this light level change, as well.

The trip points of both systems can be changed quite easily by modifying the software. The most unique feature about these controllers is that any computer can be used to monitor the temperature levels by the sensor. To control an alarm requires that an electronic switch be connected to the output of the system. Now, let's see how the TMP01 can be used as a temperature controller.

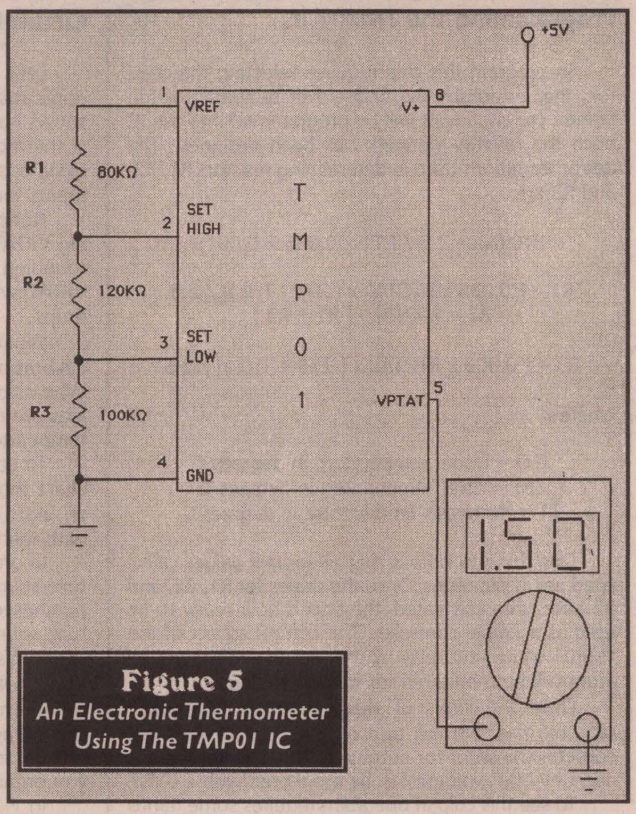

Figure 5
An Electronic Thermometer Using The TMP01 IC

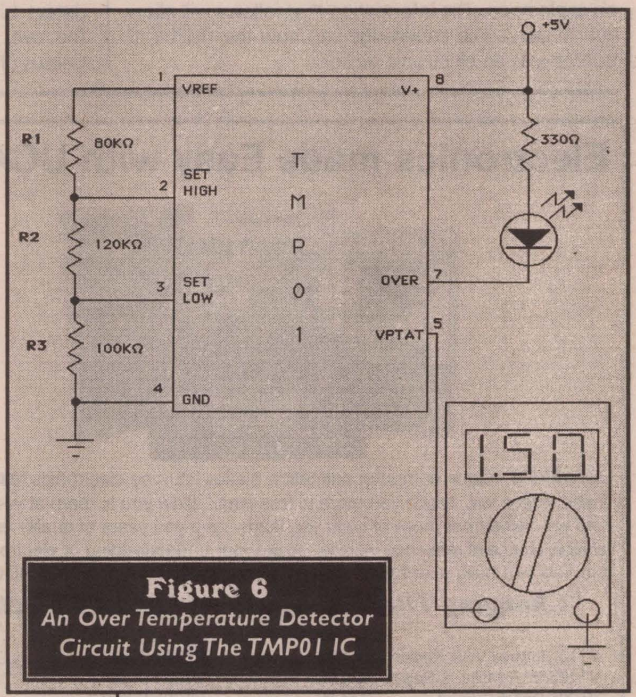

Figure 6
An Over Temperature Detector Circuit Using The TMP01 IC

The TMP01 Electronic Temperature Sensor

The TMP01 is an electronic temperature IC sensor which generates an output voltage proportional to absolute temperature. This nifty eight pin DIP (Dual-In-Line package) marvel, manufactured by Analog Devices, has two outputs that are triggered when the sensor detects an over temperature or under temperature condition. Figure 4 shows the pinout for the TMP01 IC.

Both the under and over temperature points are determined by user selected external resistors. This feature provides "programmability" to the IC. The temperature threshholds (hysteresis) is also determined by the resistive network, as well.

Inside of the TMP01 chip is a pair of matched comparators that monitor the input voltage established by the network with a 2.5V internal reference voltage. The comparators will generate a voltage proportional to absolute temperature (VPTAT), which has a nominal value of 1.49V at +/25 degrees Celsius.

The TMP01 has a set of open collectors that output signals related to over/under temperature detection. These output ports are set upon the chip exceeding the temperature setpoints. The open collector outputs are capable of sinking 20mA, thereby enabling the TMP01 to drive electro-mechanical relays directly. The operating voltage range for the chip is 4.5V to 13.2V (single supply) and has a temperature detection limit of -55 degrees Celsius to +125 degrees Celsius (-67 degrees Fahrenheit to + 257 degrees Fahrenheit).

In order to program the chip for the desired temperature detection points, the correct resistors must be selected. How does one program the TMP01 IC for temperature monitoring?

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Programming the TMP01 IC

To program this chip requires selecting the resistors that establish the under/over temperature trip points. The hysteresis will be programmed into the IC once the resistive network has been designed. The design equations used in determining resistors R1, R2, and R3 are:

$$RTOTAL = 2.5 / (T1 \times 0.005 + 0.001)$$

$$R1 = [0.005 \times RTOTAL \times (277 - THI)] / 2.5$$

$$R2 = RTOTAL - (R1 + R3)$$

$$R3 = [0.005 \times RTOTAL \times (273 + TLO)] / 2.5$$

where :

TLO = Under temperature in degrees C
THI = Over temperature in degrees C
T1 = Hysteresis temperature in degrees C

One thing to note is that all resistor values calculated are in kilo-ohms. Once the values for R1, R2, and R3 have been calculated, the chip is now ready to be used as a simple controller. The control aspect of the TMP01 comes into play by the fact that the temperature will be monitored for hi/low readings.

Once the limits of these readings have been reached, the chip will turn on the appropriate open collector transistor for output control. The continuous output (VPAT) voltage can be monitored with a DVM.

To see this chip in operation requires some hands on exploration. The information that follows will allow you to gain some knowledge into how the TMP01 IC operates as an electronic sensor.

Circuit Examples Using the TMP01 IC

Let's jump right into the discussion of TMP01 applications by looking at Figure 5. This illustration shows how simple it is to use the IC as an electronic thermometer. The values for R1-R3 establish the hysteresis and the under/over temperature requirements for the chip.

Notice where the DVM is attached for measuring VPTAT. The output voltage will go up as the surrounding temperature of the IC increases. Likewise, VPTAT will decrease as TMP01 chip's temperature drops.

What makes this chip so appealing is that no calibration is required. The days of using a Wheatstone Bridge with a thermistor as one of its legs are no more. The TMP01 is capable of reading temperatures instantly upon being powered up.

To correlate voltage with temperature, a simple chart should be constructed. By using a thermometer, note the temperature reading of the instrument with the output voltage shown on the DVM.

In order to create this chart, a variable temperature source is required. I used an old hair dryer I purchased at a garage sale as my variable temperature source. This unit has cool, medium, hot, and very hot settings. By setting the switch to each position, I was able to read the temperature from the thermometer and record the corresponding IC output voltage. The table created using this procedure will be useful with other TMP01 circuit applications you dream up.

In Figure 6, we see the TMP01 being used to detect high temperatures. The circuit will turn on the over temp LED when it exceeds 38 degrees Celsius (100 degrees Fahrenheit). As mentioned earlier, an electro-mechanical relay can be tied to this output for external control.

For example, an alarm could be used to alert the user that the temperature in a room is greater than 38 degrees Celsius. Likewise, a small motor with a propeller can be controlled quite easily by using this relay interface. This circuit allows for logging over temperature conditions by using a PC or notebook computer. As a design challenge to myself, I will design an interface circuit whereby over temp conditions can be logged by a Model 100.

Further Thoughts and Experimentation

It's amazing how time flys when you're having fun! I hope you can see the potential behind this amazing IC. The chip can be used in such applications as HVAC systems, electronic thermostats, temperature controllers, board level temperature sensing, and thermal protection.

By using the core designs presented in this column, and providing the surrounding circuits, these applications can be developed quite easily. If any of you can implement some of these applications or dream up some of your own, drop me a line in care of this magazine's editorial department or by E-Mail. I'll be interested in seeing some of your results. My E-Mail box is t6790dw@infoctr.chrysler.com

Enuf said, see ya next month in the breadbox!!

NV

Resources:

To obtain cost and ordering information on the TMP01 IC, call Analog Devices at (617) 329-4700.

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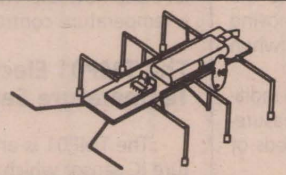

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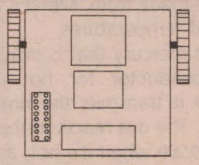

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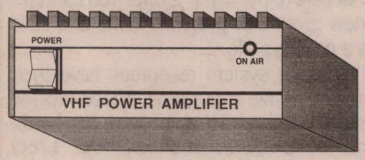

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SOFTWARE WIZARDRY

by Harry Helms

Understanding File Formats

One of the lingering problems with software development under Win-dows 3.1 is that we're still stuck with MS-DOS file name conventions. That means all file names must have no more than eight characters. Each file name can have an extension of one to three letters, separated by a dot (period), following the name itself.

For example, the file name I used for this month's column was "filename.doc." The name itself is "filename," and the ".doc" extension indicates that the file was a word processing document. If you do much word processing, you know that ".doc" is used by many popular word processing packages to indicate the file is a document produced by the program.

Another common extension is ".exe," which is used to indicate the file is a compiled, executable program that can be run on a PC. Popular software development tools, like Microsoft's Visual Basic and Borland's Turbo C, all produce .exe files when programs developed under them are compiled. All software applications on your PC will have one or more .exe files somewhere in their directories. The programming language source code files used to produce the .exe files will have their own distinctive extensions, such as .c (for C), .bas (for BASIC), and .pas (Pascal).

Keeping track of various file extensions is a real headache for Windows software developers. One big problem is that you can stick any three letter extension you like on a Windows (or MS-DOS) file. However, there have been attempts to standardize file extensions for different types of files. Not only does this help identify files for programmers and users, it also makes it possible to develop programs that can sort or locate file types by using the extension as an identifier. Since the file name extension is the key to understanding what the file is used for (and often which software produced the file), it's essential to be able to "decode" file name extensions. This month, we'll look at common, *de facto* standard file name extensions and what they all mean.

Main Windows Files

Certain files are used with a variety of Windows applications and you'll frequently run across them in original software development work. One of the most common file extensions is .drv, which identifies a device driver file. For example, a file named "svga.drv" would likely be the device drive for a SVGA monitor. Another common extension is .dll, which identifies files that are part of a *dynamic link library* (DLL). DLLs are, in effect, collections of subroutines that are linked to Windows applications as needed during program execution. Most Windows applications, especially in multimedia, will make extensive use of DLLs.

Windows "remembers" your settings and preferences for the desktop through initialization (.ini) and group (.grp) files. When you use the control panel in Windows to change things like the color of the title bar of a window, you are changing the .ini file responsible for setting the color. Groups are collections of program items. For example, the file manager, control panel, print manager, and clipboard viewer are all part of the same group. You can create new groups of program items and save them as a new .grp file.

Individual Windows system resources have their own files and matching file extensions. These include the Calendar (.cal), Clipboard (.clp), Card file (.crd), Terminal (.trm), Write (.wri), and Recorder (.rec) resources.

Different type fonts used to display text in an application are contained in files ending with the .fon extension. A file named "courier.fon" would probably contain the information necessary to display and/or print courier type. Fonts using Microsoft's TrueType technology are often contained in files with the .ttf extension.

Some file extensions used in Windows are carried over from MS-DOS. Systems files containing information about hardware use the .sys extension. Files containing MS-DOS commands executed as a single set (a batch) have the .bat extension. Command files are similar to executable files and use the .com extension. And assembly language files still have the .asm extension. If you run the MS-DOS chkdsk command, lost clusters found on a hard drive will be placed into files ending with the .chk extension. Older MS-DOS applications can more easily interact with Windows applications if program information files (PIFs) are used. PIFs tell Windows how much memory to set aside for the application, what input and output system resources are needed, etc. PIF files have the .pif extension.

Text File Types

As mentioned, ".doc" is a common file name extension used by word processing packages to indicate the file is in the format of that word processor (some word processor packages use their own extensions, however). Such .doc files are loaded with formatting and style commands in addition to the actual text. As a result, .doc files produced by a package like

Table 1

Common File Extensions and Their Meanings

Extension	Meaning
.aif	Macintosh-developed sound file
.asm	assembly language file
.ats	OpenScript file
.avi	Video for Windows video file
.bas	BASIC language source code file
.bat	batch files
.bmp	bitmap graphics file
.c	C language source code file
.cal	Calendar system resource file
.cgm	vector graphics metafile
.chk	lost cluster file produced by the chkdsk command
.clp	Clipboard system resource file
.com	command file
.cpf	clip library file
.crd	Cardfile system resource file
.cur	Cursor system resource file
.dbf	dBase and FoxPro database files
.dib	device independent bitmap graphics file
.dic	dictionary file
.dif	data interchange format file
.dll	dynamic link library file
.doc	word processor file
.dot	Microsoft Word template file
.drv	device driver file
.drw	Micrografx Designer or Draw file
.dxf	AutoCAD two-dimensional graphics file
.eps	encapsulated PostScript file
.exe	executable file
.flc	Autodesk Animator file
.fli	Autodesk 3-D Studio file
.flm	FilmStrip video file
.flx	Tempra Animation Editor video file
.frm	Visual Basic form
.gif	CompuServe image format files
.grp	group files
.h	header files in a C program
.hgl	Hewlett-Packard graphics file
.icb	Truevision Targa graphics file
.ico	icon graphic used with controls
.iff	Macintosh-developed sound file
.igs	interplatform CAD graphics file
.img	GEM Paint graphics file
.ini	initialization file
.jif	JPEG image file
.jpg	JPEG image file
.lbm	Deluxe Paint graphics file

Microsoft Word are not compatible with those produced by a package like WordPerfect. Fortunately, many word processing packages include a routine to recognize "non-standard" .doc files, and many include conversion routines to change the .doc file into one the word processor can use.

A .txt file is nothing but the ASCII characters making up the text. None of the formatting or style commands of a word processor document are included in a .txt file. However, some word processors don't produce perfectly "clean" .txt files; there may be some random characters (especially at the beginning and end) that are not part of the text itself in the file and words that are in bold face or italics in the text may be bracketed by formatting characters.

A rich text format (.rtf) file can be thought of as an interim step between .doc and .txt files. An .rtf file includes basic paragraph and character (size, font, etc.) formatting, but does not include all the formatting features of a .doc file (for example, .rtf does not generally support subscripts or superscripts). The main use of .rtf files was originally as an easy means of exchanging files between different word processors, but now many multimedia development tools (like Microsoft Viewer) can best handle text files if they're in .rtf form.

Some word processors support *templates*, which can be thought of as models for documents. Template files are identified by the .dot extension.

Sound Files

Sound is a big part of multimedia and is showing up in other applications. For example, it's now possible to embed sound files in some word processing documents. The most popular sound file format is the *wave* format, identified by the .wav extension. Wave files are created by sampling an analog audio signal to create a digital representation of the audio waveform. The size of wave files depends upon the sampling rate, the number of bits used to represent the sound, and whether the file is for mono or stereo sound. The higher the sampling frequency and the greater the number of bits, the larger the resulting .wav file. Stereo files will be larger than mono ones. A few seconds of music in stereo sampled at a high frequency and with a large number of bits can produce a .wav file of several megabytes! Any sound – music, human speech, random noises, etc. – can be digitized as a .wav file.

Sound files developed on a Macintosh can be converted to Windows by using such tools as WaveEdit (WaveEdit is part of Microsoft's Multimedia Extensions for Windows). Files developed on a Macintosh may have file names with .aif, .iff, or .snd extensions prior to conversion to Windows. When the conversion process is completed, the converted file is usually given a .wav extension.

A standard for driving music synthesizers through PCs is musical instrument digital interface (MIDI). A file for driving a MIDI device is identified with the .mid extension. A .mid file can also be used with many PC sound cards that have a small synthesizer chip included on the board. .mid files can only be used to place music, and the quality of music reproduction will depend on the quality of the music synthesizer being driven (the sound quality of .mid files played on most sound cards will be poor). One big advantage of .mid files for music is that they will require only a fraction of the memory of a comparable .wav file. This is because .mid files consist of instructions to the music synthesizer to play music (something analogous to digitized sheet music) rather than the music waveform itself, and the instructions take about the same amount of memory as any other computer code.

Graphics Files

This is where things start to get really complex. There is a bewildering variety of different file formats for images, and many are incompatible with each other. If you do any sort of software development involving the display or manipulation of images, the different file formats for graphics will probably be your biggest problem.

The basic graphics file format is the bitmap, which uses the .bmp extension. A bitmap image is just what the name implies, namely a "map" of bits that defines the image and such attributes as color and intensity. The PC Paintbrush program included on every Windows PC can produce images stored as .bmp files, and most other drawing and painting programs can generate bitmap files if desired. The run-length encoding method allows compression of bitmap images under Windows. Such files are indicated by the .rle extension.

PC Paintbrush can also produce files containing custom colors. These are stored in files with the .pal extension. Another Microsoft product, Paint, produces files with the .msp extension.

A graphics format unique to Windows is the Windows metafile (.wmf). A metafile represents a figure through directions on how the figure should be drawn. Metafile graphics use less memory space than bitmaps and the image size can be changed without distorting the image.

Sometimes you might want to use graphics developed in a non-Windows environment in a Windows application. Usually the best way to do this is with a *device-independent bitmap* file, identified by the extension .dib. These files include information that allows Windows to properly interpret the graphic image and set colors properly. Other bitmap formats are identified by the .pcx and .xbm extensions; the latter is often used for Unix system graphics.

The *tagged interchange file format* (TIFF) was developed as a universal standard for bitmap images regardless of hardware and software. It hasn't worked out quite that way, although most drawing and paint packages for Windows or the Macintosh can handle TIFF files. In Windows, these files are identified by the .tif extension. A variation of TIFF expressly for Windows is the resource interchange file format (RIFF), and this is used in RIFF device-independent bitmaps, denoted by the extension .rdi.

What has emerged as something of a *de facto* universal standard for exchanging images in desktop publishing is *encapsulated PostScript* (EPS). EPS files are in the PostScript language, and can contain text, as well as graphics. EPS files are identified by the .eps extension. Unfortunately, most multimedia authoring tools do not support the use of EPS files since they are too slow for most multimedia purposes.

Another attempt at a standard file format for graphics is the CompuServe graphics interchange format (GIF). These files are identified by the .gif extension. GIF files have been widely used for on-line graphics (such as those on the World-Wide Web) and are compressed to save space and on-line transmission time. But CompuServe recently announced its intention to collect royalties on each image using the GIF format. For this reason, many developers are shying away from the GIF format until this situation is resolved.

Finally, icon images use the .ico extension. Icon images include arrows, traffic signs (like stop signs), and similar things used on controls in multimedia and visual programming environments to indicate the purpose of the control. For example, an icon of an arrow

.lzh	LHArc compressed file
.mac	MacPaint-developed graphics file
.mak	Programming language project file
.mid	MIDI synthesizer file
.mmm	Macromedia video file
.mnu	Menu system resource file
.mov	QuickTime video files
.msp	Microsoft Paint graphics files
.out	index log file
.ovd	Borland ObjectVision file
.pal	Palette system resource file
.pas	Pascal language source code file
.pcd	Kodak Photo CD image file
.pcx	Windows graphics file
.pic	Apple Macintosh PICT graphics file
.pif	program information file
.pld	Adobe Premiere Library image file
.plt	AutoCAD graphics file
.ppj	Adobe Premiere Project image file
.ppt	PowerPoint presentation file
.psd	Adobe Photoshop image file
.psq	Adobe Premiere Sequence image file
.qtw	QuickTime for Windows video file
.rdi	resource interchange file format device-independent bitmap file
.ras	Sun raster graphics file
.rec	Recorder system resource file
.rle	run-length encoded bitmap graphics file
.sam	AmiPro word processor file
.sbf	Superbase 4 database file
.sbk	ToolBook system book
.snd	Macintosh-developed sound file
.sst	index settings file
.sst	Super Show & Tell presentation file
.sys	system files
.tbc	cache file on a hard disk
.tbk	ToolBook file
.tga	Truevision Targa graphics file
.tif	tagged interface file format graphics file
.trm	Terminal system resource file
.ttf	TrueType font file
.txt	ASCII text file
.vbx	custom control file for use with Visual Basic, Delphi, etc.
.vda	Truevision Targa graphics file
.vst	Truevision Targa graphics file
.wks	Lotus 1-2-3 spreadsheet file
.wmf	Windows metafile
.wpg	DrawPerfect graphics file
.wri	Write system resource file
.xbm	Unix bitmap graphics file
.xlc	Excel spreadsheet file

SOFTWARE WIZARDRY

pointing to the right would typically be used to indicate the control is used to move to the next screen in an application. Icons are normally "loaded" onto controls by setting the control's properties.

There are numerous other graphics image formats. Table 1 lists those I'm aware of that are available in Windows; I'm sure there must be several others I've missed!

Video Files

Microsoft has pushed developers to use its Video for Windows as the standard for video presentation in Windows applications. The technology used in Video for Windows is called *audio/video interleaving*, and the files produced by Video for Windows have the .avi extension. Almost any Windows application or development tool that will let you use video will be able to work with .avi files.

Apple implements video on the Macintosh with its QuickTime technology. Files developed using QuickTime can be converted for use under Windows, and the resulting files have the .qtw extension. Macintosh-format QuickTime video files may have the .mov extension before conversion to .qtw format.

Video for Windows and QuickTime for Windows are the two main "open" file formats for Windows. A wide variety of video and animation software packages can produce files in those two formats. Beyond these two, however, are several proprietary video file formats. Autodesk's Animator software produces files with the .flc extension while their 3-D Studio software creates .fli files. Another common proprietary format is the one used by Macromedia's products (such as Director for Windows, etc.). These files have the extension .mmm. Another format is Tempra's Animation Editor, and those files share the extension .flx.

Table 1 is one I've compiled to keep track of common file name extensions I've run across in my Windows development work. This list is far from complete, but hopefully it will be a good start in developing your own list! NV

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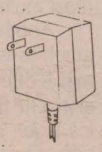
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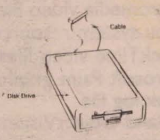

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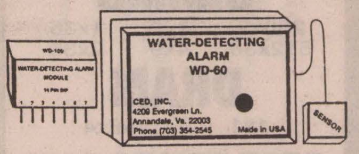

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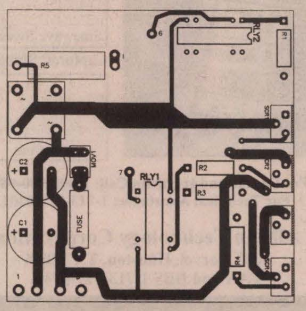

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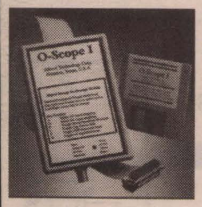

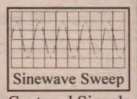
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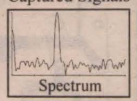
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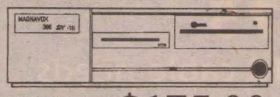

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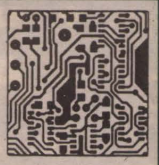

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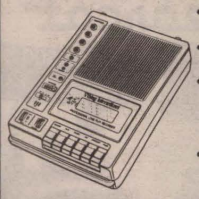

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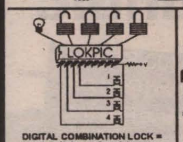

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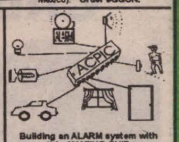

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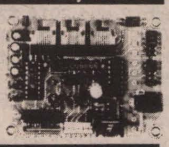

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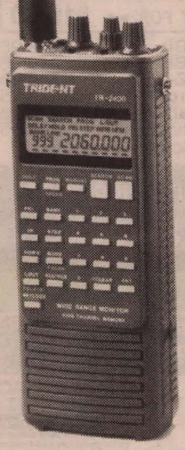

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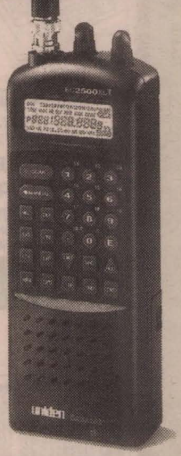

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Don Lancaster's

RESOURCE BIN

number forty-two

Alternate desktop publishing opportunities

Our usual reminder here that the *Resource Bin* is now a two-way column. You can get tech help, consultant referrals, and off-the-wall networking on nearly any electronic, *tinaja questing*, personal publishing, money machine, or computer topic by calling me at (520) 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.

GEnie now offers far lower daytime rates, a direct Internet access, plus a Windows graphics interface, so it's an even better deal than ever.

See the trailer blurb for details.

The Alternate Desktop

Several months ago, we looked into *book-on-demand* opportunities making use of PostScript and laser printers. This month, I thought we might take a quick look at papers.

And then focus on desktop's "other stuff" category. Obscure goodies. You can use PostScript and a printer to make a buck, or fill some community need. Stuff that requires only a few nickels' worth of supplies and takes a few minutes of your time to create a unique personal product.

Paper Sources

Just in case you hadn't noticed, the price of paper just doubled in the last twenty minutes. On the other hand, there are lots of new papers that are more laser friendly, more permanent, and in far more colors, weights, and styles than ever before.

Start with a local store in the *Paper Plus* chain. Or check into the dozens of laser-specific direct mail outfits that stock mind-boggling selections. But at somewhat higher prices. A random sampling includes *Paper Access, On Paper, Impact, Paper Direct, Queblo, Premier, Great Papers, Beaver Prints, Paper Design, Quill, Viking*, and *Paper Adventures.*

Badges

Custom badges can be simple and cheap to do. Parts cost can be as little as twelve cents each. The most obvious source here is *Badge-a-Minit*, who offer all sorts of free catalogs and clip art. Plus a $29.00 start-up kit. One cheaper parts source is *Super Badge and Button.*

NEXT MONTH:
Don looks at old and new resources for electronic music.

One major warning on using those Badge-a-Minit presses: Get some help from a five-year-old child! They will instantly *glomp-snip-glomp-snap* any badge for you.

Any adult puzzling over the same process will take several hours.

An alternate circle cutter that works better is the *NT Cutter C-1500P* sold by *Clotilde*. Either circle cutter works best over a plastic cutting mat.

Circular justification routines are found in KCIRCTEXT.GPS.

A variant on badges are cups and mugs that accept "drop in" graphics. *Neil Enterprises* and *Inkadinkado* are two leaders here.

Business Cards

Cutting custom business cards used to be real bad news. Besides being a tedious hassle, if you were off even a little bit, the cards looked awful.

Today, there are all sorts of pre-cut business card blanks. Two examples include *Cards Now* and *Blanks USA*. Do note that their layouts are slightly different. Different programming is required for either system. Also note that you can print a dozen cards per page with your own routines, but only 10 with commercial blanks.

Card durability could be improved with *Laser Buddy* spray, laminating, or *Bakerizing*. With Bakerizing, you place your cards (or other toner product) in contact with a gloss mylar sheet and apply heat and pressure. Which will calender the finish. Making all the toner unbelievably glossy, durable, and black.

A sneaky trick I've used to pick up spot color: Print bold characters white on any solid black background. Then, use ordinary page highliters to color the characters. On the latest printers, most of the blacks are dense enough to *completely* erase the overprint. You end up with pastel over black.

Obvious other approaches to color include color papers, color toners, or those hot stamp foils.

Yeah, plain old business cards are available cheap, in quantity. And it is hard to beat those $9.90 per thousand thermography versions that advertise in the business mags. But what you could do is offer instant availability of just a few cards. Better yet, you could offer personal graphics the big guys won't dream of touching.

Ferinstance, *maps* are easily added to any custom business card. And the potential for personal "here's how to get to our house" cards is still largely untapped. And wide open.

See GURU41.PDF for further details. Additional card layout utilities are in BLANKSUSA.GPS, CARDSNOW.GPS, PCARDADD.GPS, and NUTS12.PDF.

Stepping & Repeating

The key secret to any smaller sized speciality desktop product is a strong *step and repeat* routine. Which lets you, ferinstance, do 10 to 12 business cards, half a dozen badges, or three bumper stickers on each sheet.

But simply any old repeating utility won't do. What you really want is a step-and-*almost* repeat. This one lets you make up sequentially numbered tickets, or automatically customized awards with your recipient's names. Sequential entries in a special array get used to customize each result.

I have posted the step-and-repeat routine I use as STEPN-RPT.PS. There are dozens of templates here.

Padding Compound

Magic *Padding Compound* glop lets you do a removable binding for such things as note pads or calendars. In our PostScript class, pre-

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scription pads seemed real popular.

All of your sheets *must* get jogged before padding. Preferably by using a real printer's jogger.

After jogging, you can clamp your sheets in a homemade squasher and paint the edge with the glop. Two or three thin coats are better.

Then dry overnight. A giant stack can be padded at once and then torn apart into individual projects.

One welcome and cheap gift is to take any stack of Astrobright papers, and add a child's custom name to the top sheet. Perhaps as "Mellissa's very own paper" and some crayon art.

Or the ultimate padding compound ploy: Go to the bank and get yourself 100 new and sequentially numbered one dollar bills. Then long edge bind them using padding compound. Add a "time to reorder" form between bills number 20 and 21. And add the usual cardboard sheet on the bottom.

A tip on smaller prescription pads: Do the step and repeat in such a way that your to-be-bound edges all end up *portrait left* and *portrait right.*

Certain jobs will end up rotated or flipped on the page.

Then pad up the full stack of whole sheets at once. Finally, cut the pads to size. This shares your clamping and padding labor efforts.

Padding compound is available for around $6.00 a quart from *Paper Plus* or just about any printing supply house. While white and pink are the stock colors, you can add ink or easter egg dye to the white for full color.

Custom Post-It Notes

Those "Post-it" notes are related to padding compound. You can buy the removable adhesive glop in roller or liquid form at a large office supply. While *3-M Post-It* does make nine-up notes for laser printing, these can be costly and hard to find.

Another alternative is to print the outlines of several post-it notes onto a carrier, stick the notes exactly to the outlines, and then send it through a laser printer. This gets handy for full custom on oddball colors.

Hot Stamp Foils

This stuff used to be known as *Kroy Color.* Toner is a thermoplastic glue as well as a coloring agent. Should you put hot toner in pressure contact with a hot stamp foil, the toner will remelt, grabbing to the foil. The result can convert toner into brilliant colors.

Brights, pastels, or metallics.

Most direct mail paper sources do offer the small quantity foil kits. The simplest method is to tape a precut piece of foil on a select toner area, and run the sheet back through any laser printer having a straight path.

Sadly, there was this chicken-egg problem that kept all this stuff from really taking off. The special machines (which require very careful control of temperature and pressure) remained outrageously expensive and hard to get. And the sheets themselves tend to be way overpriced.

All of which still leads us to a great untapped opportunity. Sources of hot foils include *Crown Roll Leaf, Hoechst,* and *Transfer Print Foils.* The latter has a great *Foiled Again* newsletter.

There's also a hot stamp foil trade journal called *Inside Finishing.*

A superb source for intermediate quantities of foil rolls is *FoilMax.* You can find more on building your own foil fusion machines in HACK11.PDF or in GURU43.PDF.

Rubber Stamps

"Rubber" stamps are not made from rubber. Chemical *photopolymers* get used instead.

Because of the photo process, you can image *any* combination of text, clip art, and custom graphics you like.

Even photos.

To make a stamp, you first create a 1:1 negative of your desired artwork. Direct PostScript laser printing onto polyester works just fine.

A fairly thick photopolymer layer gets spread out and carefully spaced between two glass panels. The first side is then flash exposed *without the negative* with UV light. The exposure time is selected to precisely harden *one half* of the polymer thickness.

You'll then flip your photopolymer over. This time, you expose *through* your negative. This creates a "mesa" effect, where the entire bottom of the stamp is hardened, sloping on up to a precise artwork match.

The remaining liquid polymer is then washed out, followed by another exposure to complete the hardening. You then add the usual soft backing and a suitable handle.

To make the process economic and worthwhile, you normally will make a larger sheet with bunches of stamp projects on it. These can then be cut up into individual stamps.

The usual starting point on all this is *Grantham Polly-Stamp.* In medium quantities, the glop is available from *R. A. Stewart.* For railroad tank car lots, use *Hercules-Merigraph.*

Do-it-yourself stamp projects are in our *PostScript Beginning Projects.*

The big boys use *flexographic* plates instead. Which are just giant rubber stamps, optimized for press uses. And often used for such things as printing shipping cartons and such. A review of photopolymers in general appeared back in HACK66.PDF.

Silk Screening

The silk-screening process gets used for everything from T-shirts to posters, to advertising signs to greeting cards, to playbills to circuit boards.

Traditionally, original artwork got photographed and processed. Ending up with a silk or metal screen having holes where ink is to go and block out where ink is to be stopped.

The screen is then tightly stretched into a hinged frame, and gets held a fraction of an inch above what you are printing. A squeegee forces special ink on through the screen. Contacting only where pressure is applied.

RESOURCE BIN

Some inks air dry. Others cure with heat or ultraviolet light.

Two major suppliers of silk screen products are *Southern Sign Supply* and *Advance Process*. The leading mag is *Screen Printing*. One direct mail source for smaller quantities is *Dick Blick*. Two trade journals specific to T-shirts are *Impressions* and *PrintWear*.

One ultra low end artsy-craftsy silk screen creating machine is *Gocco*. And available from *Think Ink*. An ordinary flashbulb is used to expose the film.

If you really want to go whole hog, *Gerber* makes an incredible PostScript to silk screen mastering machine. It functions sort of like an inkjet printer. Except that your blocking resist goes directly onto the screen itself.

Precise multi color, too.

All the photo chemistry and all the slopping in the slush is eliminated in one swell foop. This one is expensive.

About the same as a new car.

"Fuzzy" lettering and such can be done using a sneaky process called a *hot split plastisol*. Any letter, such as a football jersey number, becomes heat bonded to the fabric. While it is still hot, the letter is literally rent asunder. Leaving half of the chemistry on the backing sheet and half of it on your fabric. The violent tearing gives you the final fuzzy surface. The leading supplier of this sort of stuff is *Stahl's*. They've also got several free videos available on their offerings. *Gerber* also stocks large quantities of hot split plastisols. And related inks.

Direct thermal transfer materials are also available. Try out *Wyndstone*. Or check into the *Transfer Magic*.

When you are instead interested in "instant felt" flocking, one supplier is *Don Jer*. The old way was to apply liquid glop and then spray on all the flock itself with a cabbage duster type of beastie. A second route is offered by *Hop Industries*. They offer precut and prepatterned transfers.

More on flock in GURU74.PDF.

Pad Printing

One really obscure alternate to silk screening is known as *Pad Printing*. Pad printing gets used for advertising specialties and such. It is particularly useful for printing on 3-D surfaces. Even eggshells can be pad printed.

To pad print, ink gets placed on an etched plate called a *caliche*. And then wiped using a *doctor blade*. A silicon rubber pad picks up the ink and then rolls it onto your pen or golf ball or whatever. A carefully chosen *involute* pad shape prevents distortion.

Suppliers do include *Barton-Nelson, Print Central, Service Tectonics*, and *Basco*. One source for etched plates in general is *Owosso Graphics*.

More on pad printing is found in PADPRINT.TXT and GURU59.PDF.

Other Opportunities

For *thin* self-stick full color photos in various sizes, *PhotoLabels*.

For glass etching *Armour Products, Professional Glass Consultants, National Sandblast*, or *Victory Glass*.

For quality embroidery machines, one leader is *Meistergram*. For metal signs or dials, *Fotofoil, Metalphoto*, or *3-M Dynamark*. For vinyl signcutters, *Roland* or Gerber.

For glow-in-the-darks, prismatics, holographics, and whatevers, *Coburn*. For heavier material stock in general, *FomeBords*. For applications help, the *POP & Sign Design* mag.

Your cheapest and best source for lamination machines and materials is *USI*. Also check pricey *GBC*.

For tickets, *Quick Tickets* or *Ticket Express*. For stock die cuts, *Die-O-Perf* or *Blanks USA*. Free samples.

Low-cost scoring systems by *Martin Carbone*. Also *H.S. Boyd*.

Special scissors for fancier paper edging from *Black Street Designs*. A big warning here: Seamstresses will react violently when you even glance sideways at their pinking shears!

For heavier, high gloss and brightly colored laserpapers: *LaserCraft* from *Darcy Paper*. Great stuff.

For laser printer parts and training, *Don Thompson*. For effective binding systems *Unibind*. Especially their new *Pentabind* product.

For certificate stock, use *Paper Plus* in small lots. Or *Goes Lithography* or *Action Communications* in bulk.

For custom consulting and design on products that successfully sell in a small town, *Special Editions*.

This Month's Contest

Let's have two contests this month. Either (A) Tell me about an alternate desktop opportunity or resource I do not yet know about, or (B) Dream up the most fiendish possible routine to go with the "dollar ripoff" ploy.

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.

For More Information

The dozens of free printshop trade journals are superb starting points for exploring alternate desktop concepts. *Quick Printing* is pretty near the best. Especially its *Helene's Helpline* product locator service. *Instant Printing* can be a second good choice.

My favorite two regional printer's classifieds are *California Printer* and *Horse Trader*. The *Printer's Hot Line* is a useful nationwide pub.

There are several more.

Plus, of course, *Recharger Magazine*. Printer's shareware is available from an outfit that goes by the catchy name of *Printer's Shareware*.

But note that *Printer's Shopper* is *not* a shopper at all. It is instead a useful wide range and a full line catalog of print supplies. Most at list price.

Of my own products, my *PostScript Beginning Projects* and *Book-on-demand Publishing Kit* can give you lots more insider info. You can check my nearby *Synergetics* ad for details.

Or call me for details. There's lots I had to cut to get this column down to size. Bumperstickers, announcements, custom papermaking, and more.

Besides the mentioned files, there's bunches more up on my *GEnie* PSRT. Plus preprints and reprints of all my columns and stories.

Let's hear from you. **NV**

Microcomputer pioneer and guru Don Lancaster is the author of 32 books and countless tech articles. Don maintains his no-charge tech helpline found at ***(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 an offer code, 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

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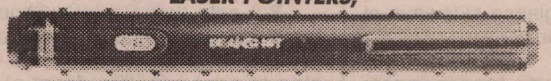
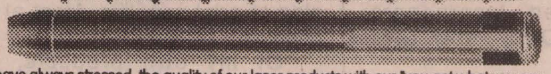


B.



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(A.) Machined from a super tough aluminum extrusion. Brass inserts for battery cap and grippers on the side. You could stand on it! Looks very HI -TECH. A real pushbutton switch at the beam end makes for steady operation.
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MODEL (A.) boxed.....$49ea. MODEL (B.) w/presentation case.....$59ea.

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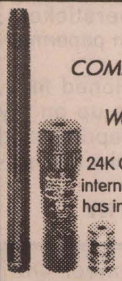
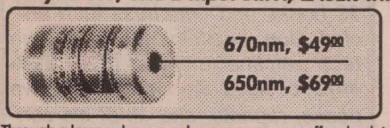


24K Gold plated, laser pen, operates from 2 AAA cells. Lab style has internal X/Y adjustment screws. The wide input vol;tage laser module has internal SMT pwr supply! All provide 800 Yard range and 1.5mrad divergence. Performance you can afford.

PEN...$159, LAB STYLE....$149, LDM....$129

Easy to use, WIDE Input 5mW, LASER with 3V to 6VDC power!



SPECIFICATIONS:
DC Power, 3 - 6Vdc, @65mA
Power out, 5mw max.
Range, 100-300 Meters
Glass Collimator (fixed @ inf.)
Size, 0.41"diam. x 0.7"L

Through a large volume purchase we can now offer absolutely the best value and best quality available on our commercially made, 670nm and 650nm, subminiature, laser diode modules. A glass collimating lens provides adjustment free <1.5mRad performance. (comparable to HeNe lasers.) NEW wide input range, internal surface mount power supply operates from 3 to 6 Volts DC. The package is machined brass for excellent thermal characteristics. These are THE quality laser modules.

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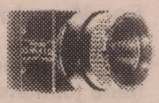

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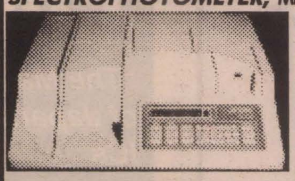

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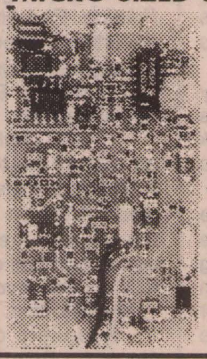

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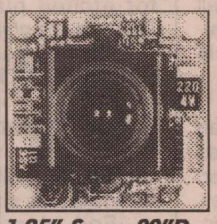

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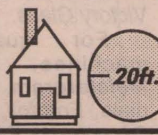

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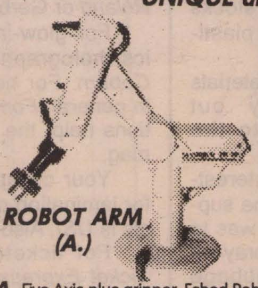

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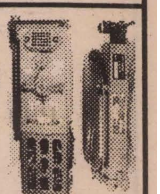

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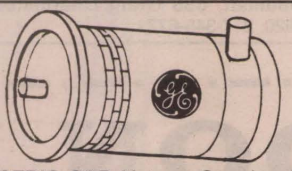

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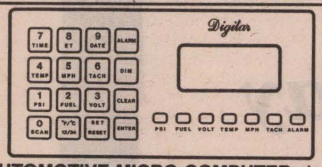

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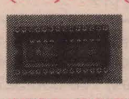

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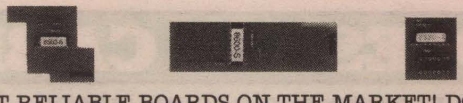

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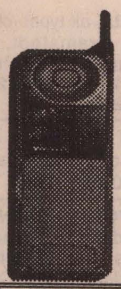

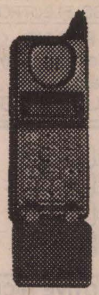

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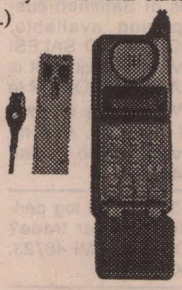

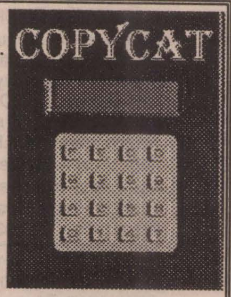

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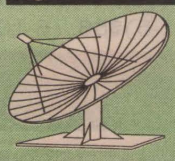

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ATMOSPHERIC RADIO REFRACTION

FROM HEADACHES TO WORLD RECORDS

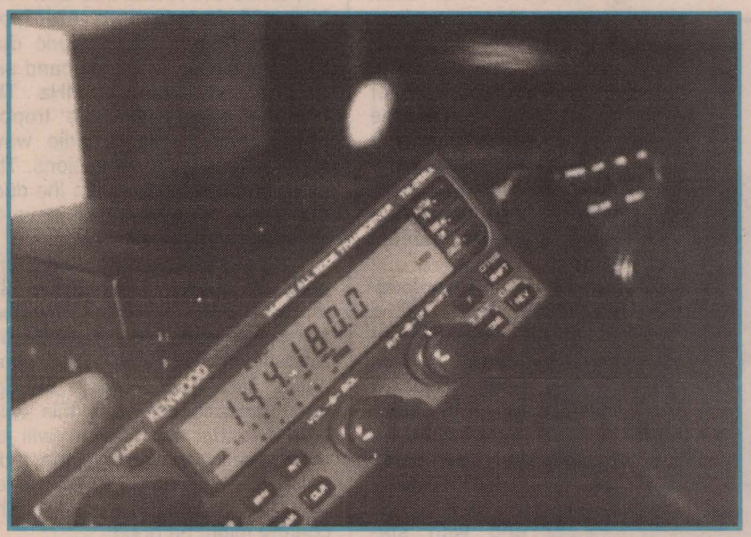
by Gordon West

Every June, July, and August, VHF and UHF radio and television waves take some strange twists out in the atmosphere. Summertime means tropo time, and to two-way radio dispatchers, tropospheric ducting can be a real headache when trying to communicate with a mobile unit that is being drowned out by another base station dispatcher 800 miles away.

2,700 mile TV reception from Hawaii to California on 434 MHz. Tropospheric ducting made it all possible!

For the amateur radio operator, summertime tropo means big possibilities on shattering world records on how far the ham stations can intercommunicate on normally line-of-sight frequencies above 144 MHz.

"Summertime tropospheric ducting affects everyone on the VHF and UHF radio bands," comments Bill Alber WA6CAX, a sheriff dispatcher, licensed ham, and private pilot. "Last summer, the aeronautical bands (110 MHz-136 MHz AM) were affected by a tropospheric duct that veteran pilots couldn't believe," adds Alber. He refers to several incoming commercial aircraft on approach to San Francisco airport overhearing a Tokyo air traffic controller clearing a jumbo jet for a Pacific crossing.



New Kenwood 2-meter SSB Mobile, popular with tropo operators.

To the surprise of a police dispatcher in Nova Scotia, Canada, public safety officers in the Miami Keys were responding back with similar-numbered mobile units. It took several minutes before both agencies got a grasp on what was occurring on their normally "private channel."

This summertime VHF and UHF "super range" has absolutely nothing to do with ionospheric skip. Although there are sporadic-E summertime conditions that will cause VHF aeronautical and VHF FM land mobile, marine, and ham signals to bounce off the ionosphere and come back down 1,000 miles away, sporadic-E skip is limited to only 30 or 40 minutes at a time, and is easily recognized by rapidly changing signal strengths that will literally pin a signal strength meter and then 10 seconds later drop out into the noise, and then 10 seconds later reappear as strong as local signals for another few seconds.

But the enhanced super-range found during the summer months associated with the atmosphere does not rely on the 100-mile-up ionosphere for any of its excitement. Rather, tropospheric ducting of VHF and UHF signals occurs only in our lower atmosphere (hence the name, tropospheric ducting), and most of the signal is trapped below 10,000 feet in altitude. Many times an enhanced VHF or UHF signal traveling hundreds and sometimes thousands of miles carries only a few hundred feet above earth or the water.

Tropospheric ducting of VHF and UHF signals is the result of atmospheric super-refraction. Normal atmospheric refraction of VHF and UHF radio waves will give them an additional 15 percent boost over the geometric horizon. The geometric horizon can be calculated by multiplying your VHF antenna elevation over ground by 2, and then taking the square root of that to end up with miles to the geometric horizon. Add 15 percent, and that is your radio communications horizon during normal atmospheric conditions.

A VHF or UHF base station antenna mounted 50 feet up on a small building will have a typical VHF range to the horizon of about 11-1/2 miles. Two times 50 equals 100, and the square root of 100 is 10, and add about 15 percent of that for the normal refraction of a radio signal under normal conditions.

It's a refraction that causes an optical illusion. When you put a rod in a container of water, the glass container will make the rod look bent. That's refraction. When you see a mirage by looking down at hot asphalt ahead or over sand, super-refraction from the super-heated air causes lightwaves from above to refract off of this hot air boundary layer and give you the optical illusion of shimmering blue water over the roadway which is nothing more than the refraction of the blue sky above.

VHF and UHF radio and television signal tropospheric ducting is an inverted mirage where distant signals well over the horizon are refracted back to our station hundreds and sometimes thousands of miles away by a hot air boundary above us, instead of below us like we see as a common mirage. This would be an inverted mirage, and there have even been reports of images of upside down distant cities and upside down boats magically appearing on the horizon when the elevated duct has a temperature inversion so intense that light and

optical images begin shimmering well over the horizon.

It is a widespread high pressure system that will usually trigger a distinct layering effect of air temperature, water vapor, and air pressure. This stratification can be easily seen as smog hanging on the horizon where you can see relatively clean air below it, and nice clear blue air above it. This is the same stratification where you see smoke rising, and then abruptly turning horizontal, trapped within a distinct hazy boundary. Your night-time weather forecasters will simply call it smog trapped in an inversion layer, but for the radio enthusiast this warm air inversion layer will trigger some real interesting radio reception on frequencies above 50 MHz.

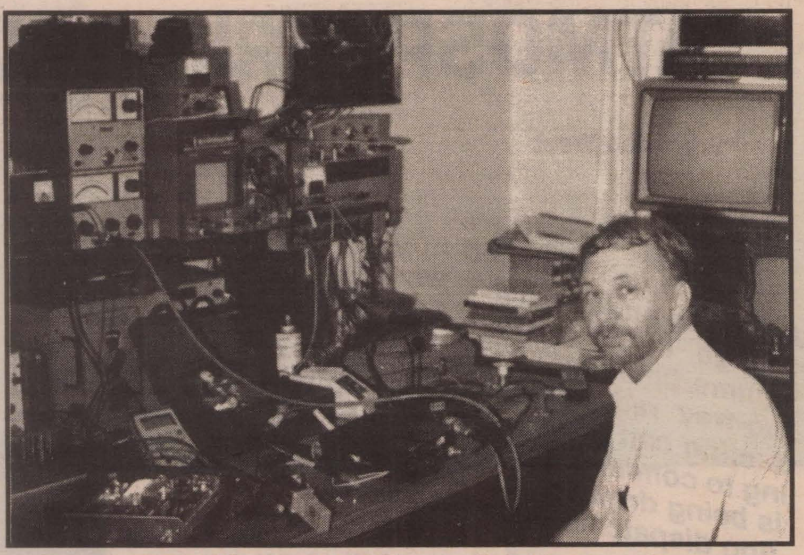
The normal decrease of temperature, pressure, and water vapor creates a normal refractive index for air, represented by the symbol "n" for normal. Specifically, normal radiowave refraction in typical windy air is 1.000345. Pressure decreases with height in a logarithmic manner at 1 millibar for every 10 meters of altitude. Temperature decreases 20 degrees Fahrenheit for every mile of increasing altitude, and water vapor also drops in a likewise manner.

During summertime periods of static high pressure systems, all that air within the high pressure system begins to sink. This is called subsidence, and as the air sinks it becomes more compressed against the surface of the earth or sea water below — and as air is squeezed within this sinking high pressure system, it gets warmer. Gentle ocean breezes above the ocean or coming off a nearby water mass may keep this hot air from eventually touching down to earth or the ocean. This high pressure "cap" may only be 100 feet in thickness, and on a windless day rest 1,000 feet above the surface of the earth or water. As long as there are no major weather patterns near the high pressure cell, the high pressure system just sits there, giving sailors below it doldrums of no wind, and a visual spectacle of smoke hanging over the horizon.

Some of the best known North American summertime highs occur between California and Hawaii, the Bermuda high, an occasional high pressure system slowly drifting across the United States mid-continent, and a late summer high that many times develops off the Atlantic northeast coast with an extension all the way down to Florida.

The world's record over water VHF/UHF tropospheric duct occurs between California and Hawaii where the Pacific high forms up every June, and guarantees an almost always July and August VHF/UHF band opening between Hawaii and the United States. Paul Lieb KH6HME, takes a two hour drive up the slopes of the Mauna Loa volcano, and provides ham radio operators the opportunity to talk VHF, UHF, and microwave from the West Coast to Hawaii on frequencies that would normally only travel a couple hundred miles line-of-sight.

"I have spent days on the volcano giving out hundreds of contacts, and the ham operators cannot believe their ears when they discover their small 50-watt VHF FM transceiver is working direct from their antenna to my antennas here on the slopes of the Mauna Loa volcano," comments Lieb. "As I drive up the hill to my operating beacon facility at the 5,000 foot level, I can feel and see a definite increase in air temperature," adds Lieb.



Tropo expert Jim Ford N6JF, puts finishing touches to a microwave beacon system.

Reviewing his files illustrates a 10-degree increase in air temperature at 5,000 feet above sea level usually leads to successful 2,700 mile contacts on VHF and UHF on 144.2 MHz, 432 MHz, 1296 MHz, and his record-breaking contacts at 3456 MHz. Paul is presently working on the 10 GHz (10,000 MHz) record that is presently held by the boys down under. Old recently unclassified records by the U.S. Navy "Tradewinds" VHF/UHF propagation studies between Hawaii and San Diego revealed that even microwaves near 10 GHz have been detected over the 2,700 mile path during a widespread tropospheric ducting episode during the summer months.

Similar long-range VHF/UHF propagation has been observed by amateur operators between hams in Maine speaking for hours on end with stations down in Florida on two meters and 440 MHz. Unlike sporadic-E ionospheric skip that only lasts for about a half hour, tropospheric ducting from a stationary high-pressure system can last for days and sometimes weeks. The signals also remain steady, usually building around sunrise and sunset as the trapped warm air re-stratifies from the sun coming up and the sun going down over the horizon.

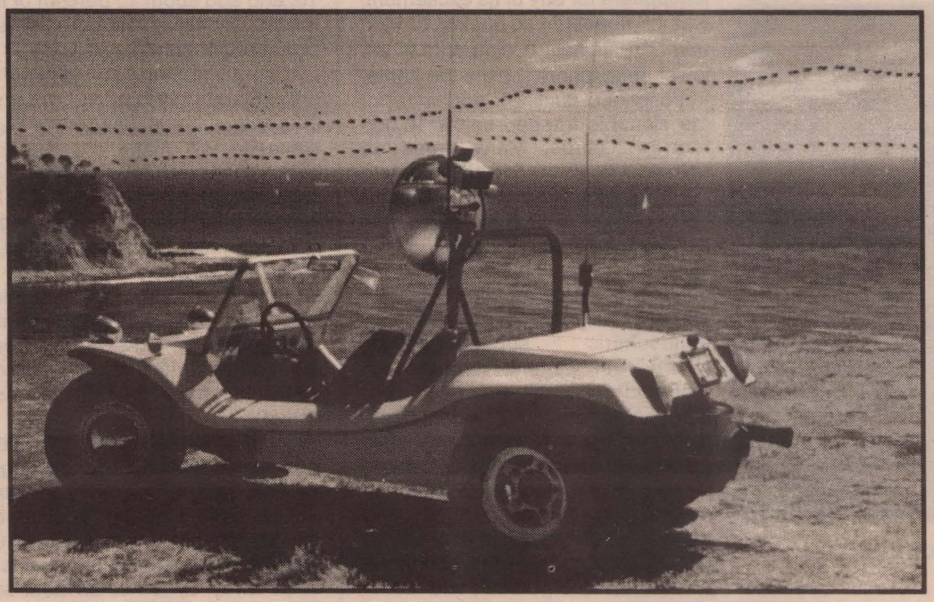
For land mobile radio operators, VHF/UHF tropospheric ducting is a nuisance. "I'm trying to dispatch police cars on 460.075 MHz in the Bay Area, and local Southern California police cars over 400 miles away are overriding our portable units down on Van Ness Avenue," comments one police dispatcher from the Bay Area. "And I'm not talking about problems that last a few minutes — during hot summer months, this problem may last for several days," adds the dispatcher.

There are times that UHF 440 MHz-460 MHz circuits are more affected from a tropospheric duct than traditional VHF high-band signals at 140 MHz-160 MHz. The characteristics within the tropospheric duct create a radio wave guide with varying dimensions. The more pronounced and thin the duct, the greater refraction it will have on shorter and microwave lengths.

It takes temperature, vapor, and pressure balloon soundings by the military and National Weather Service to accurately illustrate the refractive index within the tropospheric duct, and hopefully through the information highway this valuable weather information will be more readily available to the radio enthusiast looking to predict when the path to a distant part of the country might be open.

Amateur radio beacons on two meters, 222 MHz, 432 MHz, and 1296 MHz are one way to tune into a band opening alert to a distant transmitting station. Local ham radio clubs who take part in VHF and UHF experiments may have a list of propagational beacon stations that may be easily tuned in during the summer months.

"When I hear FM stations coming in from California, I know it's



Perfect microwave tropo weather for author West and his mobile 10 MHz station. (Dotted lines show tropo duct.)

time to get ready for some state-side tropo," comments Russ KH6FOO, in Maui. Russ also reports that he can hear a dramatic increase in random noise in the direction of the tropospheric duct.

Long-range communications via tropospheric ducting do not rely on any one communications mode. While upper sideband and CW work best when conditions are weak, FM and even television can travel hundreds and thousands of miles via tropo ducting without getting scrambled. This author was the first to see Hawaiian amateur television signals here in the United States during a big tropo opening last summer. The 2,700 mile TV pictures were so clear that they even came out in color!

A simple scanner receiver hooked up to an outside ground plane antenna is more than capable of tuning in a widespread tropo opening. Try a distant weather channel that may not be normally received in your local area:

- 162.550 MHz
- 162.400 MHz
- 162.475 MHz

Or try tuning in 155.160 MHz, a regional search and rescue frequency that could give you radio calls from a ski patrol 500 miles away. Or try 156.800 marine VHF Channel 16, and see whether or not you hear the Coast Guard coming in 1,000 miles away. It could happen this summer.

On television, unscrew the cable connection, reconnect that old TV antenna on the roof, and start flipping channels until you see something in the snow that appears to be getting stronger and stronger as the high-pressure system builds between you and that distant TV station. Who knows — on VHF or UHF channels, you could pull in a TV station more than 500 miles away. Stations in Texas regularly watch television out of St. Petersburg, Fl!

Keep track of your local weather system, and watch for the stalled high-pressure system between you and a potential distant station that can be tuned in on VHF or UHF. Keep in mind that sunspots, solar flares, sporadic-E, D-layer, and F-layer ionospheric skip have zero effect on tropospheric ducting. It's the local weather that's going to spell some long-range reception on VHF and UHF; and when the temperature exceeds 10 degrees within the tropo duct, get set for some radio fireworks this summer! **NV**

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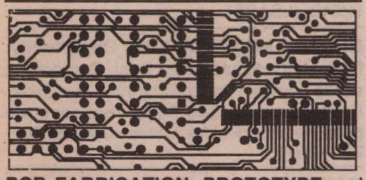

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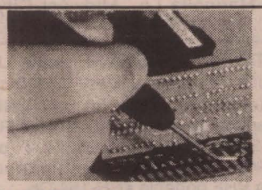

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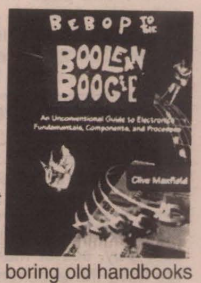
Bebop to the Boolean Boogie

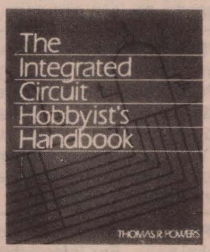
An Unconventional Guide to Electronics Fundamentals, Components, and Processes
by Clive (Max) Maxfield



This is the damnedest book on electronics you've ever seen! It's a thorough A to Z guide to contemporary electronics laced with the author's sometimes bizarre sense of humor. You'll find useful, real-world information about finite state machines, multichip modules, circuit board design, integrated circuit fabrication, and logic family interfacing techniques along with a recipe for terrific seafood gumbo and tips on the best times of day to eat smoked fish. Pete Waddell of *Printed Circuit Design* magazine says, "This is a dangerous book. . . . not only do you stand a chance of learning something from it, but ten years from now you will still remember it." Replace those boring old handbooks on your shelf with this hip, heavily-illustrated, 500+ page wonder! A steal at $35.00.

The Integrated Circuit Hobbyist's Handbook

by Thomas R. Powers



Like to build stuff using ICs or design your own circuits on a breadboard? If so, you need this book! It discusses the major types of ICs—op amps, linear, TTL, and CMOS—and how to breadboard circuits using them. There are also details on interfacing different device families, power supplies, and "deglitching" techniques. There's in-depth treatment of the most popular ICs, complete with pin numbering diagrams, internal circuit diagrams, logic tables, specifications, and a ton of applications information. Includes hundreds of applications circuits on its 8.5x11" pages. Don't buy another IC without buying this book first! Only $19.95.

AND DON'T FORGET THESE OTHER GREAT BOOKS. . . .

CONTROLLING THE WORLD WITH YOUR PC by Paul Bergsman shows how to control stepper and servo motors, monitor fluid levels, switch appliances on and off, and do other neat things using circuits connected to the parallel port of IBM-compatible PCs. Includes schematics, operational theory, construction hints, and control software source code in BASIC, Pascal, and C for each circuit. Accompanying HD disk includes all source code plus compiled .EXE files. A lot of cool stuff for just $29.95!

THE FORREST MIMS ENGINEER'S NOTEBOOK by Forrest Mims (who else?) is the latest edition of his classic guide to IC applications. Includes pin-outs, logic tables, specs, and plenty of applications circuits. What?!?! You don't have a copy yet??? Grossly underpriced at $14.95.

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reader FeedBack

Continued from page 6

Being able to poll the status of just two models of module isn't that helpful, though it is a start. The user still needs an intelligent X-10 controller capable of transmitting the status request and monitoring the powerline for the response. CompCo's RID (Remote Interface Device) was designed to do this, among its many other features.

Using this method, verification of on/off is a three-step process. **1)** Send the X-10 command, **2)** Request the module's status, **3)** Receive the response. If the module isn't in the desired mode, the command can be re-sent. A better method being developed by CompCo will automatically send the status when a command is executed and will be able to detect *whether the actual device is on or off,* not just the module itself.

Collision Detection and limited number of commands. Detecting collisions is possible with the TW-523 and CompCo's RID takes advantage of this, reporting X-10 collisions and allowing the host computer to resend commands. There is also an extended data transmit capability of the TW-523 that will effectively eliminate the 256 command limit of X-10, allowing new CompCo modules to send data for a wide range of home automation uses.

I'm sorry I can't address the problems of slow communication, but six out of seven isn't too bad. To review the features of our current product line (the RID/REB/RIB) system, the RIB (Remote Interface Board) wires to touch-panel controls like those on a remote control or faceplate of a VCR, switcher, etc., and simulates key closures. This allows the RIB to be a universal/learning infrared remote transmitter and control options not on a remote control through direct hardware. The RIB uses a parallel interface to the computer and two RIBs can be connected to one parallel port.

The REB (RIB Expansion Board) allows up to eight RIBs per REB and two REBs can be used together for a whopping 16 RIBs per parallel port.

The heart of the system, RID (Remote Interface Device) has a parallel output port so that REBs and RIBs plug directly into it; a serial port connects the RID to a host computer or other serial device, reporting activity and receiving commands. The RID receives infrared, reports it to the host and transmits infrared through a RIB. The RID monitors the powerline for X-10 activity, reports it to the host computer and transmits X-10 commands, as well. There is a stand-alone mode so that the RID can transmit X-10 and/or IR based on IR input — without a host computer connected. A long series of X-10 and/or IR can be sent based on a single input (macros) and "bank select" allows the same inputs to perform different macros depending on which mode is selected. Stand-alone mode doesn't disable the host reporting or control, so a host computer can still monitor and augment activity. The RID includes an expansion port for dedicated I/O) (TTL) and the HouseBus (CompCo's data/low voltage conduit). This is ideal for applications including relay boards, sensors, caller ID, user interfaces, other controllers, and future expansion.

Thank you again for the note in the column. We would like to stay in contact with you and discuss your input on the above and related topics. CompCo feels that the more people know about home automation, the more they can accomplish and we'll be glad to help them with affordable powerful products and intelligent support.

Patrick G. Lane
CompCo Engineering, Inc.

Dear Nuts & Volts

Re: your May '95 issue, page 130, third paragraph.

The writer, Shari Prange mentions that 25 amps @12 volts requires a different wire gauge than 25 amps @ 6 volts. . . .WRONG!

The only requirement of the National Electrical Code with regard to the voltage carried by a conductor is the amount of insulation.

Sorry Shari, but 25 amps is 25 amps is 25 amps!

The remainder of the article was very well presented and contained a lot of common sense hints. I would score the article a B-plus.

Robert Tiffany
Seabrook, NH

Shari responds

Sorry, Robert, but I stand by my original statement. People don't usually pay attention to voltage because it's either standard household 115V or standard automotive 12V. However, comparing wire gauge charts will tell the story. For example, my reference chart conveniently lists wire gauges for automotive 6V, 12V, and household 115V side by side. If I hold the current constant at 20 amps and the wire run constant at 30 ft., I find that a 6V system requires 8 ga wire, a 12V system calls for 10 gauge wire, and a 115V system specifies 12 ga. wire.

Shari Prange

TECH FORUM

Continued from page 90

else. Knowing the number and types of inputs and outputs is not sufficient to design an embedded controller. Data rates, response time, also need to be specified. When a PC is used, it is easy to change configuration by plugging in different cards, also if desired, graphical software design tools eliminate writing of any code. For limited budget designs, C code is an alternative. When everything works, a small format PC system can be substituted.

Non-PC controllers make sense only for small size, simple, or volume applications. A flash disk can be used as nonvolatile mass storage.

A PC 104 size final system is an economical choice since cards are available from many sources. These include Ampro, Z-World, Ziatech, M-Systems, and dozens more. Contacts can be found in computer magazines.

Jan Zaluda
Mountain View, CA

ANSWER TO #68513 – JUNE 1995

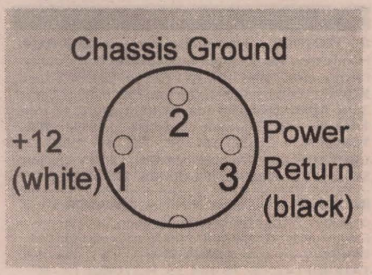
Maxim makes several video multiplexer ICs that can be used to make a video switcher. Digi-Key sells the MAX454CPD for about $10. This is a four-channel video Mux that takes a two-line binary input to select which video signal you want to look at. The circuit requires a bunch of 75 ohm resistors and a few capacitors, but not much else. Maxim also makes an eight-input Mux. They have very good data sheets and application notes; these will show how to build the switcher. I used this chip to make a computer-controlled audio/video/serial Mux.

Robert Zusman
Scottsdale, AZ

ANSWER TO #69510 – JUNE 1995

The connector on the Compaq monitor you have is a standard 180 degree, three-pin male DIN. Information on the monitor says 12 VDC at 2 amps, though the Zenith chassis hiding inside says 13 VDC at 1.4 amps. Connect your choice as follows:

pin 1 positive 12 to 13 VDC
pin 2 chassis ground
pin 3 minus power connection



Richard M. Nelson
Newport News, VA

ANSWER TO #6957 – JUNE 1995

Electrochemical rust control indeed works. Rust inhibitors can be either active or passive. The operating principle of passive control uses difference in oxidation potential of different metals. A metal which has higher oxidation potential than the metal to be protected, is buried nearby, and electrically connected to the object to be protected. For example, magnesium can be used to protect iron. Magnesium then preferentially donates electrons, and corrodes away, while the iron is relatively untouched.

In an active system, electrons can be donated by a power supply The anode then has to be connected to the earth, or the sea to complete the circuit. This would work with parked cars also.

Jan Zaluda
Mountain View, CA

ANSWER TO #6956 – JUNE 1995

No cross compatibility exists between cable descrambling systems. The descramblers are designed specifically to descramble the exact codes coming over the cable wire. If you tried to use your Hamlin, for instance, in an area that uses Jerrolds it wouldn't be able to recognize and descramble the codes and vice versa, if you tried a Jerrold in an area that uses Hamlin. The electronic components are built for that specific signal.

Travis White
Laguna Niguel, CA

ANSWER TO #69515 – JUNE 1995

An easy way to maintain charge of a lead acid battery is to use a small solar panel of appropriate size and voltage. Such a charger is self-contained, requires no maintenance, is current limited, if reasonably sized, and is easy to use. Just connect it up, and forget it. Nothing could be more simple.

Jan Zaluda
Mountain View, CA

ANSWER TO #6955 – JUNE 1995

My company, EFJ Devices, offers two power combiners — the PC1500 and PC4000 — for 25 to 30 MHz use. Each consists of a signal splitter and power combiner in one package. The inputs are rated at 100 watts and 600 watts, respectively. AMPs 1 & 2 outputs should be within 10% of each other. These power combiners were designed with data from the Motorola RF Data Manual, Second Edition, Third Printing, Copyrighted Motorola 1982. This data is not in the new edition. The reference specifically is AN-749 on page 2-62, prepared by Helge O. Granberg.

It should be noted that doubling the signal to the antenna will only increase its strength by 3 dB. This is 1/2 of an "S" unit and barely discernible by the human ear.

Combiners allow the amps to share the load permitting twice the "key down" time.

Carl Motsinger
Old Hickory, TN

ANSWER TO #6953 – JUNE 1995

UHF antenna information, with some design software can be found in the ARRL antenna book and compendium series, available from ARRL, 203-666-1541. Another, more powerful and rather expensive software tool is the Microwave Explorer from Compact Software, 201-881-1200. The Explorer can be used to model any radiating structure in three dimensions.

Jan Zaluda
Mountain View, CA

Events CALENDAR

Continued from page 67

IN - INDIANAPOLIS — Atarifest VII. **SPONSOR:** Mid-Indiana St, Atari Users Group. **LOCATION:** Best Western Waterfront Plaza Hotel. **HOURS:** 10am-3pm. **CONTACT:** Mail: 551 Mooreland, New Whiteland IN 46184-1263. Voice: ASCII Secretary Charlie Sears, 317-535-4829 or at work 317-878-5311. BLAST Secretary Stu Huffman 812-988-7558. FidoNet, 1:231/310.0, AtariNet 51:203/8, SBE Net Internat: shuffman@idea-net.doe.state.in.us. Crossroads BBS 317-878-4069 (S. Indianapolis), 317-780-5473 (W & NE Indianapolis) BLAST BBS 812-988-1069 (Bloomington Area).

IN - INDIANAPOLIS — Indianapolis Computer Fair. **LOCATION:** National Guard Armory. **HOURS:** 10am-3pm. **ADMISSION:** $4, under 12 free. **FEATURES:** C - DP. **CONTACT:** Ben Yanto, AGI Computer Fairs.*

MI - MERRIMAN — Upper Peninsula Hamfest. **SPONSOR:** Mich-A-Con ARC. **LOCATION:** United Sportsman Club, Mountain-Kingsford Area. **HOURS:** 8am-? **TALK-IN:** 146.85. **DEALER INFO:** Tables $6, Set-up 7am. **CONTACT:** William Bertoldi KB8SBP, 709 Hamilton Ave, Kingsford MI 49801. 906-774-0419. OR Lou Gembolis KG8NK, 906-774-2930.

MI - WESTLAND — Great Lakes Computer Expo & Sale. **SPONSOR:** Progressive Computer Productions. **LOCATION:** Wayne-Ford Civic League, 1645 Wayne Rd, 1 blk S of Ford Rd. **HOURS:** 10am-4pm. **ADMISSION:** Adults $4, Seniors/Students $3, under 12 free w/adult. **FEATURES:** C - DP - FP - F/R - S. **DEALER INFO:** Covered 8' table $35 ea. **CONTACT:** Progressive Computer Productions, 23814 Michigan Ave, Ste 237, Dearborn MI 48124. 313-425-9276.

MI - WYANDOTTE — Computer Trade Show. **LOCATION:** Yack Arena, 3131 3rd St, 1 blk N of Eureka, 1 blk W of Biddle (Jefferson). **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 - XENIA — Hamfest & Computer Expo. **LOCATION:** Heartland Flea Market & Bingo Hall, Corner of Allison. **HOURS:** 8am-3pm. **ADMISSION:** Free. **FEATURES:** FP - T. **DEALER INFO:** Inside space, $15 per table, $25 per table w/electric, tailgate spaces $10. **CONTACT:** High Noon Trading Co., 4230 Dayton-Xenia Rd, Ste 500, Beavercreek OH 45432, 513-429-5403.

TX - TEXAS CITY — ARRL Hamfest. **SPONSOR:** Tidelands ARS. **CONTACT:** Bill Steele, WA5WVP, POB 892, Texas City TX 77590. 409-948-0308.

JULY 29-30

SD - CLEAR LAKE — Hamfest. **SPONSOR:** Deuel County Hamfest. **LOCATION:** Ulven Park, on E edge of Clear Lake on Hwy 22. **TALK-IN:** 145.39/144.79, 147.18/.78. **FEATURES:** EX - FM. **DEALER INFO:** Tables $5. **CONTACT:** Don N7AXW, 605-876-2671.

JULY 30

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 - STICKNEY — ARRL Hamfest. **SPONSOR:** DuPage ARC. **CONTACT:** Edwin Weinstein WD9AYR, 7511 Walnut Ave, Woodridge IL 60517. 708-985-0527.

MI - FLINT — Five Star Productions Computer Show. **SPONSOR:** Five Star Productions. **LOCATION:** Flint Holiday Inn, Gateway Centre, US-23 at Hill Rd Exit 2 mi S of I-69. **HOURS:** 10am-4pm. **ADMISSION:** $4, $3 w/this ad. **FEATURES:** AC -C - CB - DP - FP - F/R. **CONTACT:** Five Star Productions, 2436 Nerredia St, Flint MI 48532. 810-768-6058 (pager), 810-230-0988 (after 4pm).

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

MI - PORT HURON — Hamfest. **SPONSOR:** Eastern Michigan ARC. **LOCATION:** St. Clair County Community College, Student Center, 323 Erie St. **HOURS:** 8am-2pm. **ADMISSION:** Adv $3, Door $4. **TALK-IN:** 147.3/.9, 146.52. **FEATURES:** EX - F - H - T. **DEALER INFO:** Tables $12, tailgating $6 per space, set-up. **CONTACT:** Hank Kohl, K8DD, 1640 Henry St, Port Huron, MI 48060.

OH - ASHTABULA — Hamfest & Computer Show. **SPONSOR:** Ashtabula County ARC. **LOCATION:** Nappi's Party Center, 2255 West Ave. **HOURS:** 8am-2pm. **ADMISSION:** $4 adv, $5 door. **TALK-IN:** 146.715. **FEATURES:** AC - C - CB - DP - E - FM - FP - F/R - H - T. **DEALER INFO:** First table $8, addtl table $6. 7am set-up. **CONTACT:** Ken Stenback AI8S, 722 Lyndon Ave, Ashtabula OH 44004. 216-964-7316 eves.

WI - RACINE — Racine Hamfest '95. **SPONSOR:** Racine Megacycle Club. **LOCATION:** South Hills Country Club. **HOURS:** 8am-2pm. **ADMISSION:** $3 adv, $4 door. **TALK-IN:** 147.87/27 Lakeshore Repeater. **FEATURES:** AC - CB - DP - EX - F - FM - FP - F/R - H - T. **DEALER INFO:** 8' tables $8, electricity $1. **CONTACT:** Racine Megacycle Club, POB 3, Racine WI 53401-0003.

AUGUST 2-3-4-5

IL - ELGIN — Radiofest '95. **SPONSOR:** Antique Radio Club of Illinois. **LOCATION:** Holiday Inn Holidome and Convention Center, 345 River Rd. **FEATURES:** B - FM. **CONTACT:** Jeff Aulik, 1708 Parkview Ave, Rockford IL 61107, 815-399-1902 eves.

AUGUST 4-5-6

TX - AUSTIN — West Gulf Division Convention. **SPONSOR:** Austin ARC & Austin Repeater Assn. **LOCATION:** Wyndham Southpark Hotel, 4140 Governor's Row. **HOURS:** Fri 7pm-9pm; Sat 8am-5pm; Sun 8am-noon. **ADMISSION:** Adv $7, door $9, under 17 free. **TALK-IN:** 146.34/.94. **FEATURES:** B - CB - EX - F - FM - F/R. **DEALER INFO:** Tables $8 Fri thru Sun, and $6 Sat only. **CONTACT:** Summerfest, Box 13473, Austin TX 78711-3473; Joe Makeever W5EBJ, 512-345-0800.

WY - JACKSON HOLE — Rocky Mountain Division Convention, WIMU '95. **LOCATION:** Virginian Hotel. **HOURS:** Fri: 5pm-8pm; Sat: 8am-?; Sun: 8am-?. **ADMISSION:** Adv. $10, Door $13. **FEATURES:** CB - DP - EX - F - FM. **CONTACT:** Warren (Rev) Morton, 1341 Trojan Dr, Casper WY 82609, 307-235-2799.

AUGUST 5

IN - VALPARAISO — Porter County Hamfest & Computer Show. **SPONSOR:** Porter County ARC. **LOCATION:** Porter County Expo Center, US 30 & Ind 49. **HOURS:** 8am-? **ADMISSION:** $4 adv, $5 door, under 12 free. **TALK-IN:** 146.775/-6kc 131.8 PL 146.520 Simplex. **FEATURES:** C - EX - FP - F/R - H - T. **DEALER INFO:** Indoor tables $8, w/elec $13. **CONTACT:** PCARC, POB 1782, Valparaiso, IN 46384-1782. Rich N9QLQ, @ 219-762-8701.

MI - TAYLOR — Computer Trade Show. **LOCATION:** Democratic Club of Taylor, 23400 Wick Rd, 4 blks E of Telegraph. **HOURS:** 10am-3pm. **ADMISSION:** Adults $4; Seniors & students w/ID $3; under 12 free w/adult. **FEATURES:** C - DP. **CONTACT:** Computers & You, 313-283-1754.

MO - SPRINGFIELD — Hamfest. **SPONSOR:** Southwest MO ARC. **LOCATION:** University Plaza Trade Center. **HOURS:** 8am-3pm. **TALK-IN:** 146.91. **FEATURES:** EX - F. **CONTACT:** Ernie DeCamp, % SMARC, POB 11363, Springfield MO 65808; 417-831-8611.

AUGUST 5-6

IL - CHICAGO — ComShow Computer/Home Office. **LOCATION:** Inland Expo Center in Westmont. **HOURS:** 10am-4pm. **ADMISSION:** $6. **FEATURES:** AC - C - E - FP - F/R. **CONTACT:** Karen, 312-665-4817.

WY - JACKSON HOLE — Convention. **SPONSOR:** Rocky Mountain Division Convention (WIMU '95). **CONTACT:** Warren G. (rev) Morton WS7W, 1341 Trojan Dr, Casper WY 82609. 307-235-2799.

AUGUST 6

IL - PEOTONE — Hamfesters Hamfest. **SPONSOR:** Hamfesters Radio Club. **LOCATION:** Will County Fairgrounds, Take I-57 to Peotone Exit 327 East. **HOURS:** Exhibits 8am-?, Outside flea market 6am-3pm. **ADMISSION:** $4 adv, $5 door, under 12 free. **TALK-IN:** 146.52 Simplex, 146.64-, 146.94-. **FEATURES:** AC - C - CB - FM - FP - F/R - H - RV-S. **CONTACT:** John Fleming N9NDH, 13800 Division St, Lot 215, Blue Island IL 60406. 708-489-5872.

IN - ANGOLA — Annual Hamfest. **SPONSOR:** Land of Lakes ARC. **LOCATION:** Steuben County 4-H Fairgrounds, @ 200 W & 200 N, at Crooked Lake. **HOURS:** 7am-2pm. **ADMISSION:** Adv $3, door $4. **TALK-IN:** 147.18/.78 444.35. **FEATURES:** EX - FP - F/R - H - T. **DEALER INFO:** Tables $8, set-up Sat 3pm-10pm & Sun 4am-7am. Trunk sales $2. **CONTACT:** Sharon Brown WD9DSP, 905 W Parkway Dr, Pleasant Lake IN 46779. 219-475-5897.

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 - RANDOLPH — Portage Hamfair '95. **SPONSOR:** Portage ARC. **LOCATION:** Portage County Fairgrounds on St. Rte 44, 3 mi South of I-76. **HOURS:** 8am-4pm. **ADMISSION:** $4 adv., $5 door. **TALK-IN:** 145.39 -600MHz 28.390MHz. **FEATURES:** C - DP - FM - FP - H. **DEALER INFO:** Indoor tables $8, Flea Market Space $3. **CONTACT:** Joanne Solak KJ3O, or Portage ARC, 9971 Diagonal Rd, Mantua OH 44255. 216-274-8240.

AUGUST 12

IL - QUINCY — Ham Radio & Computer Swapfest 1995. **SPONSOR:** Western Illinois ARC. **LOCATION:** Eagles Alps Grounds, 3737 N. 5th Street.. **ADMISSION:** $2.50 adv, $3 door. **TALK-IN:** 147.63/03. **FEATURES:** C - EX - FM - F/R - H. **DEALER INFO:** Indoor Flea Market table $5, Outdoor tailgating free. **CONTACT:** Randy Jackson N9REY, 217-223-7226; or WIARC, POB 3132, Quincy IL 62305.

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

KS - CHANUTE — Hamfest '95. **SPONSOR:** Chanute Area ARC. **LOCATION:** Chanute National Guard Armory, 3051 S. Santa Fe. **HOURS:** 8am-2pm. **ADMISSION:** $5, under 12 free. **TALK-IN:** 146.745. **FEATURES:** DP - FM - H. **DEALER INFO:** Flea Market tables $5. **CONTACT:** Jerry Young, 316-431-3268 eves, Charlie Ward 316-431-6402 eves, Ted Nantz 316-537-6001 eves.

OH - SHARONVILLE — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Sharonville Convention Center. **HOURS:** 10am-4pm. **ADMISSION:** $6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-365-2424.

SD - HURON — Amateur Electronics Swapfest. **SPONSOR:** Huron ARC. **LOCATION:** National Guard Armory, SD State Fairgrounds. **HOURS:** 8am-3pm. **ADMISSION:** $3. **TALK-IN:** 146.82(-), 146.22/.82MHz. **FEATURES:** DP - E - EX - FM - F/R. **DEALER INFO:** Tables $5, Set-up 7am. **CONTACT:** Lloyd Timperley, WB0ULX, POB 205, Huron SD 57350. 605-352-7896 eves.

WI - SUGAR CAMP — Northwoods Hamfest. **SPONSOR:** Rhinelander Repeater Assn & Northwoods ARES. **LOCATION:** SugarCamp Town Hall, N of Rhinelander on Hwy 17 to Camp Four Rd. **HOURS:** 8am-2pm. **ADMISSION:** $2. **TALK-IN:** 146.940. **FEATURES:** DP - EX - F/R - H. **DEALER INFO:** Tables $5. **CONTACT:** Mary Berger NS9Q, 367 Lois St, Rhinelander WI 54501. 715-362-9296.

AUGUST 12-13

LA - Bossier City — ARRL Hamfest. **SPONSOR:** Shreveport ARA. **CONTACT:** Alice Prudhomme KG5ZZ, 171 Sloan Rd, Mansfield LA 71052. 318-872-5988.

OH - PAULDING — 5th Annual Hamfest & Saturday Nite Flea Market. **SPONSOR:** Paulding County Hamfest. **LOCATION:** Paulding County Fairgrounds. **HOURS:** FleaMarket: Sat 3pm-8pm. Hamfest: Sun 8am-4pm. **ADMISSION:** Sat FleaMarket: Free. Sun Hamfest $3, under 12 free. **TALK-IN:** 147.285+/444.225+. **FEATURES:** CB - DP - EX - FM - F/R - H. **DEALER INFO:** Sat Flea Market: Space/table $2, Sun Hamfest 8' inside table $10, outside space $4 + admission. **CONTACT:** Jerry or Dorothy Rhodes, 10392 SR 500, Paulding OH 45879. 419-399-4507.

AUGUST 13

IA - Cedar Rapids — ARRL Hamfest. **SPONSOR:** Cedar Valley ARC. **CONTACT:** Wayne Kolosik, N0UGK, 65 Samoa Dr, Hiawatha IA 52233. 319-393-4224.

KY - LOUISVILLE — Computer Fair South. **SPONSOR:** MEKA Enterprises, Inc. **LOCATION:** Executive West Hotel, I-65 & 264 Freedom Way at the Fairgrounds. **HOURS:** 10am-3pm. **ADMISSION:** $4. **CONTACT:** William Ibarra, Meka Enterprises, 2656 E. 2nd St, Bloomington IN 47401. 812-333-4484, FAX: 812-333-4650.

MI - DEARBORN — Computer Trade Show. **LOCATION:** Adray Sports Arena, 14900 Ford Rd (M-153), 1 blk E 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.

AUGUST 13-14-15-16-17

MI - DETROIT — The 61st Annual Conference of the Associated Public Safety Communications Officials - Interntl. **LOCATION:** COBO Conference/Exposition Center. **CONTACT:** APCO, 1-800-949-2726 ext. 249, 250, 226.

AUGUST 19

OH - AKRON — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** University of Akron. **HOURS:** 10am-4pm. **ADMISSION:** $6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-365-2424.

AUGUST 20

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

MI - MADISON HEIGHTS — Computer Trade Show. **LOCATION:** UF & CW, 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 - BROADWAY — Hamfest & Computer Show. **SPONSOR:** Union County ARC. **LOCATION:** Community & Civic Complex on Rte 347, 1 mi West of St. Rte 31. **HOURS:** 8am-2pm. **ADMISSION:** $4 adv., $5 door. **TALK-IN:** 147.39+ no pl. **FEATURES:** C - CB - EX - FM - F/R - H. **DEALER INFO:** Inside table $15, 10' flea market space $5, Set-up, Sat noon-9pm or Sun 6am-8am. **CONTACT:** Gene Moore, 24461 Claibourne Rd, Marysville OH 43040. 513-246-5943.

OH - CLEVELAND — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Cuyahoga County Fairgrounds. **HOURS:** 10am-4pm. **ADMISSION:** $6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-365-2424.

OH - WARREN — 38th Annual Hamfest. **SPONSOR:** Warren ARA. **LOCATION:** Kent State Univ, Trumbull Branch Campus @ State Rte 5, bypass and State Rte 45. **HOURS:** Outside Area open @ 6am. Inside area opens @ 8am. **ADMISSION:** $4, under 12 free. **TALK-IN:** 146.97MHz 443.00MHz. **FEATURES:** AC - DP - EX - F - FM - H. **DEALER INFO:** Ouside Flea Market $3/10' space. **CONTACT:** WARA, POB 809, Warren OH 44482. Al Van Slyke, N8IKX, 216-889-3378.

AUGUST 26

MI - WESTLAND — Great Lakes Computer Expo & Sale. **SPONSOR:** Progressive Computer Productions. **LOCATION:** Wayne-Ford Civic League, 1645 Wayne Rd, 1 blk S of Ford Rd. **HOURS:** 10am-4pm. **ADMISSION:** Adults $4, Seniors/Students $3, under 12 free w/adult. **FEATURES:** C - DP - FP - F/R. **DEALER INFO:** Covered 8' table $35 ea. **CONTACT:** Progressive Computer Productions, 23814 Michigan Ave, Ste 237, Dearborn MI 48124. 313-425-9276.

TX - GAINESVILLE — Cooke County Hamfest. **SPONSOR:** Cooke County ARC. **LOCATION:** Civic Center. **HOURS:** 7am-5pm. **ADMISSION:** $5 adv., $6 door. **TALK-IN:** 147.34MHz 443.125MHz. **FEATURES:** AC - CB - DP - EX - FM - H - T. **DEALER INFO:** Tables: $8 adv., $10 door. Outside tailgate $6. **CONTACT:** James Floyd, N5ZPU, 817-668-7511. Or: Cooke County Hamfest, POB 100, Gainesville TX 76241.

NM - ALBUQUERQUE — Duke City Hamfest. **LOCATION:** Natioal Guard Armory, 600 Wyoming Bl, NE. **FEATURES:** DP - EX. **DEALER INFO:** Tables $10 prior to Aug 21. Set-up Aug 25 6pm. **CONTACT:** 505-821-2771.

AUGUST 26-27

CO - WOODLAND PARK — 14th Annual MARC Campfest-Swapfest. **SPONSOR:** Mountain ARC. **LOCATION:** Quaker Ridge Camp. 6.5 mi N of Woodland Park City Center on Hwy 67 North. **TALK-IN:** 146.82R-. **FEATURES:** DP - F/R - T. **DEALER INFO:** $10 per space daily. **CONTACT:** MARC, POB 1012, Woodland Park, CO 80866. Fred N0PKA, or Patty N0PSD, 719-687-9727, or Don AA0NW, 719-687-3692.

EASTERN REGION

JULY 1

NC - MOORE COUNTY — Mid-Atlantic Star Party & Swap Meet. **LOCATION:** Boy Scout Camp Reeves, S of Robbins. **HOURS:** 8am-5pm. **ADMISSION:** $10. **FEATURES:** C - CB - DP - E - FM - FP - F/R - RV-S - S. **DEALER INFO:** One space free w/paid admission. **CONTACT:** E-Mail: starman@email.unc.edu. Voice Mail: 919-362-5194 or send SASE to: MASP, Occoneechee Council BSA, POB 41229, Raleigh NC 27629.

NY - BUFFALO — MarketPro Computer Show & Sale. **LOCATION:** Buffalo State College. **HOURS:** 9:30am-4pm. **ADMISSION:** $6, under 12 free w/adult. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

OH - TOLEDO — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Seagate Convention Center. **HOURS:** 10am-4pm. **ADMISSION:** $6. **FEATURES:** C. **CONTACT:** MarketPro.*

VA - VIENNA — Computer Show & Sale. **SPONSOR:** Local Area Vendors. **LOCATION:** Vienna Community Center, Park & Cheri, Off Rte 123 . **ADMISSION:** $4. **FEATURES:** C - DP - FP. **CONTACT:** Simon Sakkab, 703-255-3235.

JULY 2

IN - FORT WAYNE — Computer Show & Sale.

Events CALENDAR

SPONSOR: MarketPro. **LOCATION:** Allen County Fairgrounds. **HOURS:** 10am-4pm. **ADMISSION:** $6. **FEATURES:** C. **CONTACT:** MarketPro.*

NY - HENRIETTA — MarketPro Computer Show & Sale. **LOCATION:** The Dome Center. **HOURS:** 9:30am-4pm. **ADMISSION:** $6, under 12 free w/adult. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

PA - LEHMAN — 16th Annual Wilkes-Barre Hamfest & Computer Fest. **SPONSOR:** Murgas ARC. **LOCATION:** Luzerne County Fairgrounds, Rte 118. **HOURS:** 8am-? **ADMISSION:** $3 adv, $4 door, XYL & under 16 free. **TALK-IN:** 146.52 146.61. **FEATURES:** C - CB - DP - E - EX - FM - F/R - H. **DEALER INFO:** Inside table $12, 8' outside space, 1 free w/admission, addt'l space $5. **CONTACT:** KA3A: 717-824-5724, days; 717-825-3940, eves.

JULY 4

PA - HARRISBURG — 23rd Annual Firecracker Hamfest & Computer Show. **SPONSOR:** Harrisburg ARC. **LOCATION:** Bressler Picnic Ground. **HOURS:** 8am-?. **ADMISSION:** $4 XYL, YL & Kids free. **TALK-IN:** 146.16/76MHz 146.52MHz Simplex. **FEATURES:** DP - F/R . **DEALER INFO:** Tables w/electricity, adv $12, door $15, tailgate space $5. Set-up 6am. **CONTACT:** 717-232-6087.

JULY 8

MD - GAITHERSBURG — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Montgomery County Fairgrounds. **HOURS:** 10am-4pm. **ADMISSION:** $6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-365-2424.

NC - SALISBURY — The Firecracker Hamfest. **SPONSOR:** North Carolina Alligators Group. **LOCATION:** Civic Center. **LOCATION:** Civic Center. **HOURS:** 8am-? **ADMISSION:** $3 adv, $4 door, XYL's free. **TALK-IN:** 146.625. **FEATURES:** AC - EX - FM - FP - F/R - H. **DEALER INFO:** Inside flea market tables $5 + admission, set-up 9pm Fri 7/7, or 7am Sat 7/8. **CONTACT:** Walter "Alligator" Bastow, 3045 High Rock Rd, Gold Hill NC 28071.

JULY 8-9

IN - INDIANAPOLIS — Convention. **SPONSOR:** Central Division Convention. **CONTACT:** Jim Rinehart, WB9CEP, 1455 N Shannon Ave, Indianapolis IN 46201. 317-356-1908.

JULY 9

FL - SAINT PETERSBURG — Computronics Fest. **SPONSOR:** "We're Show Offs!" **LOCATION:** Best Western Mirage Hotel, 5005 34th St. N. (US 19 N). **HOURS:** 10am-3pm. **ADMISSION:** Adults $4, $3 w/ad, under 12 free. **FEATURES:** AC - C - DP - E - FP - H. **DEALER INFO:** Adv tables $30/1, $55/2, $20/ea additional table. **CONTACT:** "We're Show Offs!" 813-545-5265.

MD - BALTIMORE — Hamfest & Computer Fest. **SPONSOR:** Baltimore Radio Amateur Television Society. **LOCATION:** Timonium Fairgrounds, York Rd off I-695, I-83. **ADMISSION:** Under 12 free. **TALK-IN:** 147.03/+ 224.96/-. **FEATURES:** AC - C - DP - EX - FM - F/R - T. **CONTACT:** BRATS, POB 5915, Baltimore MD 21208. 410-467-4634.

MD - HAGERSTOWN — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Hagerstown Ramada. **HOURS:** 10am-4pm. **ADMISSION:** $6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-365-2424.

NY - ALEXANDER — Batavia Hamfest. **SPONSOR:** Genesee Radio Amateurs. **LOCATION:** Alexander Fireman's Grounds, 8 mi S of Village of Alexander on Rte 98. **ADMISSION:** $3 adv, $5 door, under 12 free. **FEATURES:** FM - F/R. **DEALER INFO:** 8' table $15, flea market space $1, $2 under cover. Dealer contact: Deb Johnson 716-757-9213. **CONTACT:** Knute Carlson, 26 Burke Dr, Batavia NY 14020. 716-343-5580.

PA - PITTSBURGH — 10th Annual Hamfest. **SPONSOR:** North Hill ARC. **LOCATION:** Northland Public Library, 300 Cumberland Rd. **HOURS:** 8am-3pm. **ADMISSION:** Free. **TALK-IN:** 147.09. **FEATURES:** DP - FP - F/R - H - T. **DEALER INFO:** First tailgate space free, addtl space $5 each. **CONTACT:** Gregg Corsello K3QK, 2021 Red Coach Road, Allison Park, PA 15101. 412-366-7006.

JULY 15

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.*

ME - CLINTON — ARRL Hamfest. **SPONSOR:** Maine Council of AR Clubs. **CONTACT:** Robin Walls, N1NFK, 34 Tufton St, Brunswick ME 04011. 207-442-9405.

NC - CARY — 23rd Annual Mid-Summer Swapfest. **SPONSOR:** Cary ARC. **LOCATION:** Cary Community Center. **HOURS:** 8am-? **ADMISSION:** $4 adv, $5 door. **TALK-IN:** 147.75/15. **FEATURES:** DP. **DEALER INFO:** 6' tables, $10 each. **CONTACT:** CARC, POB 53, Cary NC 27512.

NH - NEWPORT — Hamfest. **SPONSOR:** Newport Chamber of Commerce. **LOCATION:** Town Common. **HOURS:** 8am-3pm. **ADMISSION:** Free. **TALK-IN:** 146.76. **FEATURES:** CB - E - EX - FM - F/R - H - T. **DEALER INFO:** Tailgating $6. **CONTACT:** Rob Boyd N1CIR, 648 Rte 103, Newport NH 03773; 603-863-5383.

NH - NASHUA — Computer Shows & Sales. **SPONSOR:** Northern Computer Shows. **LOCATION:** Stanislaus Hall, 1/4 mi E of Rte 3 (Everett Turnpike), Exit 6. Follow show signs. **HOURS:** 10am-3:30pm. **ADMISSION:** $7, under 14 free w/adult. **FEATURES:** C. **DEALER INFO:** Set-up 8am. **CONTACT:** Northern Computer Shows.*

NJ - HIGHTSTOWN — Antique Radio Club Summer Meet/Auction. **SPONSOR:** New Jersey Antique Radio Club. **LOCATION:** Hightstown Country Club. **HOURS:** 7am-1pm. **CONTACT:** Tony or Kathleen Flanagan, 908-462-6638.

NY - SKANEATELES — Skanfest. **SPONSOR:** Skaneateles Lions Club. **LOCATION:** Allyn Areana, Austin St. **HOURS:** 7:30am-3pm. **ADMISSION:** $3 adv, $4 door, under 12 free. **TALK-IN:** 147.00. **FEATURES:** C - DP - EX - FM - F/R - H. **DEALER INFO:** Indoor 8' table: $8 adv, $9 door. Outdoor flea market: $3 adv, $4 door. **CONTACT:** Skanfest '95, Skaneateles Lions Club, POB 302, Skaneateles NY 13152.

JULY 15-16

GA - ATLANTA — 1995 Atlanta Hamfestival. **LOCATION:** Cobb Galleria Center, US Hwy 41. **HOURS:** Sat: 9am-4pm, Sun: 9am-3pm. **ADMISSION:** $6 adv., $8 door. **TALK-IN:** 2 meters at 146.82. **FEATURES:** C - CB - DP - E - EX - F - FM - H - T. **DEALER INFO:** 8' Flea Market table $25, Tailgate spot $10. **CONTACT:** Atlanta Hamfestival, PO Box 80947, Atlanta, GA 30366.

GA - PERRY — Southeast Computer & Camera Fair. **LOCATION:** Georgia National Fairgrounds, Heritage Hall, 401 Larry Walker Pkwy, I-75 Exit 42. **HOURS:** 10am-4pm. **ADMISSION:** Adults $3, Seniors $2.50, Age 6-12 $1, under 6 free. Immediate family $7. **FEATURES:** AC - C - CB - FM - FP - F/R - RV-S. **DEALER INFO:** 8' table $40. **CONTACT:** Southeast Model Train & Toy Shows, POB 360033, Decatur GA 30036. 404-987-2773.

JULY 16

FL - PALM BEACH GARDENS — Narisaam Computer Show. **SPONSOR:** Narisaam, Inc. **LOCATION:** Palm Beach Gardens Marriott, 4000 RCA Blvd. **HOURS:** 9:30am-3:30pm. **ADMISSION:** $5, $4 w/ad, under 12 free. **FEATURES:** AC - C - FP. **CONTACT:** Narisaam.*

MA - CAMBRIDGE — Tailgate Electronics, Computer & Amateur Radio Flea Market. **SPONSOR:** MIT Radio Society and Harvard Wireless Club. **LOCATION:** Albany & Main St. **HOURS:** 9am-2pm rain or shine. **ADMISSION:** $2. **TALK-IN:** 146.52, 449.725/444.725 - pl 2A - W1XM/R. **FEATURES:** C - FP - H - T. **DEALER INFO:** Tailgate room for 600 sellers. $10 per space at gate, $8 adv includes 1 admission. Set-up 7am. For info call 617-253-3776. Mail advance reservations before the 5th. **CONTACT:** W1GSL, POB 397082 MIT BR., Cambridge MA 02139.

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:** Set-up 8am. **CONTACT:** Northern Computer Shows.*

NJ - AUGUSTA — Hamfest. **SPONSOR:** Sussex County ARC. **LOCATION:** Sussex County Fairgrounds, Plains Rd off Rte 206. **HOURS:** 8am-? **ADMISSION:** $5 XYL's & Harmonics free. **TALK-IN:** 147.90/30 222.50 146.52 Simplex. **FEATURES:** DP - FP - F/R - H. **DEALER INFO:** Indoor space $10, Tailgate space $9. **CONTACT:** Dan Carter N2ERH, 8 Carter Lane, Branchville, NJ 07826. 201-948-6999.

JULY 22

MA - WALTHAM — MarketPro Computer Show & Sale. **LOCATION:** Hillcrest. **HOURS:** 9:30am-4pm. **ADMISSION:** $6, under 12 free w/adult. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

NH - NASHAU — Flea Market. **SPONSOR:** New England Antique Radio Club Resurrection Center Church. **ADMISSION:** $5 at 8am; $1 at 9am. **CONTACT:** 617-923-2665.

NY - FRANFORT — Hamfest/Computer Fair. **SPONSOR:** Utica ARC. **LOCATION:** Herkimer County Fairgrounds, Cemetary St, off NYS Rte 55. **HOURS:** 8am-2pm. **ADMISSION:** $3. **TALK-IN:** 145.45. **FEATURES:** C - CB - EX - FM - H - T. **DEALER INFO:** Spaces: Indoor $3+ adm, outdoor $2 + admission. **CONTACT:** UARC, POB 71, Utica NY 13503. Bob Decker AA2CU, 315-797-6614 or Howie.

PA - HUNTINGTON MILLS — Hamfest. **SPONSOR:** Jonestown Mountain Repeater Assn. **LOCATION:** Huntington Valley Volunteer Firehall & Grounds. **ADMISSION:** $2. **TALK-IN:** 146.205/.805, 146.52. **FEATURES:** EX - FP - F/R - H - T. **CONTACT:** Charles Hooker AD3L, POB 23, Huntington Mills PA 18622. 717-864-2571.

JULY 22-23

PA - KING OF PRUSSIA — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Valley Forge Convention Center. **HOURS:** 10am-4pm. **ADMISSION:** $6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-365-2424.

JULY 23

MA - FITCHBURG — MarketPro Computer Show & Sale. **LOCATION:** Royal Plaza Trade Center. **HOURS:** 9:30am-4pm. **ADMISSION:** $6, under 12 free w/adult. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

MD - BRUNSWICK — Sweatfest '95. **SPONSOR:** Mid Atlantic DX & Repeater Assn. **LOCATION:** Brunswick Train Museum. The MARC Train Station. **ADMISSION:** $5. **TALK-IN:** 147.060 448.125MHz repeaters. **FEATURES:** CB - EX - FM - F/R - S. **DEALER INFO:** Indoor Space $20, Covered Flea Market $10, Flea market $5. **CONTACT:** MADRA Sweatfest '95, 230 N. Potomac St. #2B, Hagerstown MD 21740. Voice BBS 301-416-8447 Box 109.

PA - INDIANA — 3rd Annual Hamfest & Computer Fair. **SPONSOR:** Indiana County ARC. **LOCATION:** Red Barn Sportman Club. **HOURS:** 8am-? **ADMISSION:** $2, under 12 free. **TALK-IN:** 146.91. **FEATURES:** C - DP - H - T. **DEALER INFO:** Inside tables $15, 2 for $25, 5 for $50: Outdoor tables $10, 3 for $25 under a pavilion: Tailgate $5/space. **CONTACT:** Tim Ringler, WA3W, 412-349-8847. Gary Robinson, K3SJX, 412-459-8941.

JULY 29

FL - TAMPA — 4th Annual "Last Minute" Hamfest. **SPONSOR:** Univ. of South Florida Radio & Electronics Club. **LOCATION:** University of South Florida on Fletcher Ave between I-75 & I-275. **HOURS:** 9am-3pm. **ADMISSION:** $3.75. **TALK-IN:** 147.240. **FEATURES:** AC - EX. **DEALER INFO:** Swap Tables $10 + admission. Set-up, Fri: 6pm-9pm, Sat: 8am. **CONTACT:** USF-REC Hamfest, CTR 2416, Tampa FL 33620.

MD - FREDERICK — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Frederick Fairgrounds. **HOURS:** 10am-4pm. **ADMISSION:** $6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-365-2424.

NC - HAYWOOD COUNTY — 20th Annual Western Carolina Hamfest. **SPONSOR:** Western Carolina ARS. **LOCATION:** Haywood County Fairgrounds. **HOURS:** 8am-4pm. **ADMISSION:** $4 adv, $5 door. **TALK-IN:** 146.76 146.91. **FEATURES:** EX - F - H. **DEALER INFO:** 8' x 8' covered tailgate space $5 + admission, tables $8 per, uncovered tailgate space admission only. **CONTACT:** Tom Queen, 704-258-2639.

NJ - PENNSAUKEN — Computer Show. **LOCATION:** South Jersey Expo Center, off NJ Tpke. Exit #4 on Rte 73. **HOURS:** 10am-3pm. **FEATURES:** C. **DEALER INFO:** 500+ tables. **CONTACT:** KGP Computer Show.*

PA - BERWICK — Hamfest-Computerfest. **SPONSOR:** Columbia Montour ARC. **LOCATION:** Nescopeck Township Firehall Grounds. 5.2 mi S of Berwick on Rte 93. **HOURS:** 8am-? **ADMISSION:** $3 XYL & under 12 free. **TALK-IN:** 147.225 (+600), 146.52 Simplex. **FEATURES:** EX - F/R. **DEALER INFO:** Indoor table $10 + admission, tailgating space $1 + admission. Set-up 6am. **CONTACT:** Dave, WC3A, 717-752-6851.

JULY 29-30

NH - MANCHESTER — ARRL New England Division Convention. **SPONSOR:** North East Convention Associates. **LOCATION:** New Hampshire Holiday Inn & Convention Center. **ADMISSION:** Adv $7, door $8. **TALK-IN:** 146.850. **FEATURES:** CB - DP - EX - F - FM - F/R - H. **CONTACT:** North East Convention Associates, Inc., POB 475, Goffstown, NH 03045.

PA - ALLENTOWN — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Allentown Fairgrounds. **HOURS:** 10am-4pm. **ADMISSION:** $6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-365-2424.

JULY 30

NH - PORTSMOUTH — Computer Shows & Sales. **SPONSOR:** Northern Computer Shows. **LOCATION:** Frank Jones Center, Exit 5 off I-95 to Rte 1 Bypass South (behind U-Haul). **HOURS:** 10am-3:30pm. **ADMISSION:** $7, under 14 free w/adult. **FEATURES:** C. **DEALER INFO:** Set-up 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 w/adult. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

VA - MANASSAS — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Manassas Fairgrounds. **HOURS:** 10am-4pm. **ADMISSION:** $6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-365-2424.

AUGUST 5

IN - VALPARAISO — ARRL Hamfest. **SPONSOR:** Porter County ARC. **CONTACT:** Richard Ard N9QLQ, POB 1782, Valparaiso, IN 46384-1782. 219-762-8701.

MA - MARLBOROUGH — Computer Show. **LOCATION:** Royal Plaza Trade Center, near Boston, Mass. Tpke to I-495, 4 mi, use Exit #24-B, 1/2 mi. on right. **HOURS:** 10am-3pm. **FEATURES:** C. **DEALER INFO:** 500+ tables. **CONTACT:** KGP Computer Show.*

MD - WEST FRIENDSHIP — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Howard County Fairgrounds. **HOURS:** 10am-4pm. **ADMISSION:** $6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-365-2424.

NC - HIGH POINT — Lomer L. McMahan Memorial Hemfest. **SPONSOR:** High Point ARC. **LOCATION:** National Guard Armory, off Hwy 29-70, Business I-85. **HOURS:** 8am-3pm. **ADMISSION:** $4 adv., $5 door. **TALK-IN:** 147.765/.165MHz. **FEATURES:** CB - EX - FM - H. **DEALER INFO:** Tables $12, Inside flea market table $8 + $4 admission. Outside flea market $2 space + admission/tables $6. Set-up 6am. **CONTACT:** HPARC Hamfest, POB 1163, Jamestown NC 27282-1163. 910-887-3039.

NJ - RIVERDALE — Hamfest. **SPONSOR:** Split Rock & West Morris ARC's. **LOCATION:** National Guard Armory, Newark Pompton Turnpike (Rte 23). **ADMISSION:** $5. **TALK-IN:** 146.985/.385, 223.86/222.26. **FEATURES:** EX. **CONTACT:** Bernie Brownstein WB2YOK, POB 251, Flanders NJ 07836. 201-584-5399 or Steve KF2TI, on line KF2TI@AOL.COM.

NJ - SOMERSET — MarketPro Computer Show & Sale. **LOCATION:** Garden State Exhibit Center. **HOURS:** 9:30am-4pm. **ADMISSION:** $6, under 12 free w/adult. **FEATURES:** C. **CONTACT:** MarketPro Computer Shows.*

NY - CLAYTON — Hamfest. **SPONSOR:** Jefferson County RAC. **LOCATION:** Clayton Recreation Park Arena. **HOURS:** 7am-5pm. **ADMISSION:** $3. **TALK-IN:** 146.70/.10. **FEATURES:** CB - EX - FM - F/R - T. **DEALER INFO:** Flea Market: 10' x 10' booth w/table $5. **CONTACT:** Jefferson County RAC, POB 523, Brownville NY 13615. Janet Long N2ZMA, 315-788-8543.

WV - MINERALWELLS — Hamfest '95. **SPONSOR:** Mid-Ohio Valley ARC. **LOCATION:** Wood County 4-H Grounds, Near Parkersburg WV. **ADMISSION:** $4. **TALK-IN:** 146.745. **FEATURES:** C - CB - DP - E - FP - F/R - H - T. **DEALER INFO:** Inside tables $5, Outside tables $4, Tailgating free. **CONTACT:** Bill McClure, C/O MOVARC, POB 791, Parkersburg WV 26102. 304-485-7777.

AUGUST 5 & 6

FL - JACKSONVILLE — 22nd Annual Amateur Radio & Computer Show. **SPONSOR:** Greater Jacksonville Hamfest Assn. **LOCATION:** Prime F. Osborn Convention Center. **HOURS:** Sat: 9am-5pm; Sun: 9am-3pm. **ADMISSION:** $8. **FEATURES:** AC - CB - DP - EX - F - FP. **DEALER INFO:** Swap tables $20 both days + admission. Contact: Karl Hassler N4DHG, 904-268-2302, 2767 Scott Cir., Jacksonville, FL, 32223. **CONTACT:** Greater Jacksonville Hamfest Assn, POB 27033, Jacksonville FL 32205.

AUGUST 6

MA - WELLESLEY — Ham Flea Market. **SPONSOR:** Wellesley ARS. **LOCATION:** Pepsico Pavilion, Babson College. **HOURS:** 9am-2pm. **ADMISSION:** Indoor: $2, Tailgate area: free. **TALK-IN:** 147.03/.63 repeater. **TALK-IN:** AC - EX - FM - H - T. **DEALER INFO:** Indoor tables: $10 adv., $14 door., Tailgate area: adv., $7, door $10. **CONTACT:** Barbara Holdridge N1ICQ, 107 Church St, Westwood MA 02090, 617-329-2628. Gerry Driscoll NV1T, 617-444-2686.

MD - BALTIMORE — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Martins East. **HOURS:** 10am-4pm. **ADMISSION:** $6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-365-2424.

ME - PORTLAND — Computer Shows & Sales. **SPONSOR:** Northern Computer Shows. **LOCATION:** Verrillo's Conv. Ctr at Howard Johnson Motor Lodge, I-95 (Maine Turnpike) Exit 8. **HOURS:** 10am-3:30pm. **ADMISSION:** $7, under 14 free w/adult. **FEATURES:** C. **DEALER INFO:** Set-up 8am. **CONTACT:** Northern Computer Shows.*

PA - NEW KENSINGTON — Hamfest. **SPONSOR:** Skyview Radio Society. **LOCATION:** Washington Township Volunteer Fire Dept, Rte 66 near Intersection of Rte 380. **HOURS:** 8am-3pm. **ADMISSION:** $3 or 2/$5. **TALK-IN:** 146.64 - 444.900+ . **FEATURES:** DP - FM - F/R - H. **DEALER INFO:** Indoor

Events CALENDAR

tables $8, each addl table $5, flea market space $2. **CONTACT:** Bob Reihms N3NOS, 412-727-2194.

PA - WARRINGTON — Hamfest '95. **SPONSOR:** Mid Atlantic ARC. **LOCATION:** Bucks County Drive-In theater, Rte 611. **HOURS:** 8am-?. **ADMISSION:** $5. **TALK-IN:** 147.06/R 145.35/R. **FEATURES:** F/R - H. **DEALER INFO:** Selling spaces $5. **CONTACT:** Hamfest Info, Box 352, Villanova PA 19085. Bob WA3PZO, 215-624-4034, eves.

VA - BERRYVILLE — 45th Annual Winchester Hamfest & Computer Show. **SPONSOR:** Shenandoah Valley ARC. **LOCATION:** Clarke County Ruritan Fairgrounds. **HOURS:** 6am-? **ADMISSION:** $5, under 16 free. **TALK-IN:** 146.22-82 & 52 Simplex. **FEATURES:** C - CB - DP - E - EX - FM - F/R - H - T. **DEALER INFO:** Commercial & indoor tables call IRV Barb, 703-955-1745, Tailgate Space $7 + admission. **CONTACT:** Irv Barb, KD4BHV, Rte 3, Box 5385, Berryville VA 22611.

AUGUST 7-8-9-10-11

VA - MCLEAN — 7th Annual Surveillance Expo '95. **LOCATION:** McLean Hilton. **DEALER INFO:** Michael Sheehan, Ross Engineering, Inc., 127 E. Third St, Brooklyn NY 11218. 718-437-0160, FAX 718-437-0161. **CONTACT:** Marilyn Roseberry, American Technology Assn, POB 20254, Washington DC 20041. 202-331-1125. FAX: 703-318-8223.

AUGUST 11-13

VT - CHARLOTTE — ARRL Hamfest. **SPONSOR:** Burlington ARC. **CONTACT:** Ralph Stetson KD1R, RR 1, Box 185, Westford, VT 05494. 802-878-6454.

AUGUST 12

NJ - HACKENSACK — Computer Show. **LOCATION:** Fairleigh Dickenson University, Rothman Athletic Center, Rte 4 to Hackensack Ave. South, left at first light (Temple Ave.), near NYC. **HOURS:** 10am-4pm. **FEATURES:** C. **DEALER INFO:** 500 tables. **CONTACT:** KGP Computer Show.*

NY - DRYDEN — Finger Lakes Hamfest. **SPONSOR:** Tompkins County ARC. **LOCATION:** Dryden High School, near the intersection of Rte 13 & Rte 38. **ADMISSION:** $4 adv, $5 door, under 18 free. **TALK-IN:** 146.97 (-600). **FEATURES:** C - CB - E - EX - FM - F/R - H - RV-S. **DEALER INFO:** Indoor flea market 6' space w/table $6, Outdoor flea market 8' space only $2. **CONTACT:** Richard Spingarn, 607-387-5251 or, TCARC, 6067 Sirrine Rd., Trumansburg, NY 14886.

NY - ITHACA — ARRL Hamfest. **SPONSOR:** Tompkins County ARC. **CONTACT:** Richard Spingarn, N2IYS, 6067 Sirrine Rd, Trumansburg, NY 14886. 607-387-5251.

VA - ANNANDALE — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Northern Virginia Community College. **HOURS:** 10am-4pm. **ADMISSION:** $6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-365-2424.

WV - ONA — TARA Hamfest & Computer Show. **LOCATION:** Cabell-Midland High School US Rt 60. **HOURS:** 9am-2pm. **ADMISSION:** $5. **TALK-IN:** 146.76 146.64 146.52 444.85 +. **FEATURES:** AC - C - CB - DP - EX - F - FM - FP - F/R - H. **CONTACT:** Mike Taylor, KB8GCA, 304-429-1667. or TARA, POB 4120, Huntington WV 25729.

AUGUST 12-13

PA - MONROEVILLE — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Pittsburgh Expo Mart. **HOURS:** 10am-4pm. **ADMISSION:** $6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-365-2424.

AUGUST 13

KY - FT. MITCHELL — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Drawbridge Estate. **HOURS:** 10am-4pm. **ADMISSION:** $6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-365-2424.

NC - CHARLOTTE — Hamfest & Computer Fair. **SPONSOR:** Charlotte ARC. **LOCATION:** Roll-A-Round Skate Center, 8830 E. Harris Bl. **HOURS:** 8am-4pm. **ADMISSION:** $4 adv., $5 door. **TALK-IN:** 147.06-. **FEATURES:** C - DP - FM - FP - H - T. **DEALER INFO:** 8' tables. Adv. $8, Door $10, Chairs $1, Tailgaters $2 per space & admission - first come. **CONTACT:** Buck Escott, 704-522-4971 x3330. Or Charlotte ARC, POB 33582, Charlotte, NC 28233-3582.

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. **DEALER INFO:** Set-up 8am. **CONTACT:** Northern Computer Shows.*

MD - BOWIE — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Bowie State University. **HOURS:** 10am-4pm. **ADMISSION:** $6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-365-2424.

MD - WESTMINSTER — Carroll County Computer & Hamfest. **SPONSOR:** Summit ARA. **LOCATION:** Carrol County Agricultural Center at the end of Smith Ave. **HOURS:** Tailgating @ 6am. **ADMISSION:** $5. **TALK-IN:** 224.68, 224.64, 146.52. **FEATURES:** T. **DEALER INFO:** Inside tables, $10; tailgating $5 per space. **CONTACT:** Alan Parker KS3L, 410-859-1475, OR SARA Hamfest, 607 Brentwood Rd., Linthicum, MD 21090.

PA - EASTON — Hamfest. **SPONSOR:** Delaware Lehigh ARC. **LOCATION:** Career Institute of Technology. **HOURS:** 8am-? **ADMISSION:** $4, unlicnesed spouce & under 12 free. **TALK-IN:** 146.70. **FEATURES:** C - DP - E - EX - F - F/R - H - T. **DEALER INFO:** Indoor tables $25 (includes one admission), tailgaters $7 (includes one admission). **CONTACT:** Chuck Drake, KD3SQ, 610-866-4714 or DLARC, 610-820-9110.

AUGUST 18-19-20

AL - HUNTSVILLE — Hamfest & Amateur Radio Group National Convention. **LOCATION:** Von Braun Civic Center. **HOURS:** 9am-? **ADMISSION:** $5 for both days, children free. **TALK-IN:** 146.94 (-600)MHz, onsite 145.38 (-600)MHz. **TALK-IN:** B - CB - DP - F - FM - H. **CONTACT:** Huntsville Hamfest, POB 12534, Huntsville AL 35815. 205-534-7175.

AUGUST 19

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.*

VA - MECHANICSVILLE — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** The Showplace (Richmond, VA). **HOURS:** 10am-4pm. **ADMISSION:** $6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-365-2424.

AUGUST 19-20

GA - MARIETTA — Charlotte 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-ft tables $35. **CONTACT:** Computer Show, POB 295, Riverdale GA 30274. 800-746-9001.

PA - KING OF PRUSSIA — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Valley Forge Conv. Center. **ADMISSION:** $6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-530-2355.

AUGUST 20

DE - GEORGETOWN — Delmarva Hamfest. **SPONSOR:** Sussex ARA. **LOCATION:** Delaware Technical & Community College, Rte 18. **HOURS:** 8am-2pm. **ADMISSION:** $4, XYL & Children free. **TALK-IN:** 147.075 224.84. **FEATURES:** EX - F/R - H. **DEALER INFO:** Inside table $8, Tailgating $5. **CONTACT:** Delmarva Hamfest, Rte 2, Box 244G, Georgetown DE 19947.

FL - WEST PALM BEACH — Narisaam Computer Show. **SPONSOR:** Narisaam, Inc. **LOCATION:** Palm Beach Airport Hilton, 150 Australian Ave. **HOURS:** 9:30am-3:30pm. **ADMISSION:** $5, $4 w/ad, under 12 free. **FEATURES:** AC - C - FP. **CONTACT:** Narisaam.*

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 - W1XM/R. **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.

MA - SWANSEA — Computer Shows & Sales. **SPONSOR:** Northern Computer Shows. **LOCATION:** Venus De Milo, Rte 6 (Exit 3 off I-195). **HOURS:** 10am-3:30pm. **ADMISSION:** $7, under 14 free w/adult. **FEATURES:** C. **DEALER INFO:** Set-up 8am. **CONTACT:** Northern Computer Shows.*

VA - VIRGINIA BEACH — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Virginia Beach Pavillion. **HOURS:** 10am-4pm. **ADMISSION:** $6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-365-2424.

AUGUST 25-26-27

CT - VERNON — 21st Eastern VHF-UHF Conference. **LOCATION:** Quality Inn & Conference Center. **HOURS:** Conference: Fri 4pm-?, Sat 8am-5pm. Swapmeet/Sun 8am-?. **ADMISSION:** Conference: adv $20, door $25. Swapmeet only/Sun $5. **FEATURES:** B - F. **CONTACT:** Rae Bristol K1LXD, 328 Mark Dr, Coventry CT 06238, 203-742-8650.

AUGUST 26

NJ - BRIDGEWATER — Hamfest. **SPONSOR:** Somerset County ARS. **LOCATION:** Somerset County 4-H Center, Milltown Rd off Rte 202. **HOURS:** 8am-1pm. **TALK-IN:** 448.175. **CONTACT:** Eric NW2P, 908-753-8290, SCARS, PO Box 742, Manville, NJ 08835.

NY - CHAFFEE — Hamfest. **SPONSOR:** Pioneer Radio Operators Society. **LOCATION:** Manion Park. **HOURS:** 7am-3pm. **ADMISSION:** $3 adv, $4 door. **TALK-IN:** 145.39. **FEATURES:** CB - DP - FP - F/R - H - T. **DEALER INFO:** Flea market free w/paid admission. **CONTACT:** Michael Buttino, 716-496-8241.

NY - SYRACUSE — 40th Annual Hamfest. **SPONSOR:** Radio Amatuers of Greater Syracuse. **LOCATION:** Academy Green American Legion, one blk W of Rte 173 & South Salina St. **HOURS:** 8am-? **ADMISSION:** $5, under 16 free. **FEATURES:** C - DP - EX - F - FM - F/R - H. **DEALER INFO:** 10' space: $3, set-up 7am. **CONTACT:** Mike Meltzer K2SDD, 315-469-0590, Rags, POB 88, Liverpool NY 13088.

PA - HARRISBURG — Computer Show & Sale. **SPONSOR:** MarketPro. **LOCATION:** Harrisburg Farm Show Complex. **HOURS:** 10am-4pm. **ADMISSION:** $6. **FEATURES:** C - FP. **CONTACT:** MarketPro, POB 41044, Bethesda MD 20814. 301-365-2424.

FOREIGN

JULY 15 & 16

CANADA - BRITISH COLUMBIA, MISSION — 2nd Annual Valley Hamfest '95. **SPONSOR:** Mission, Maple Ridge & Abbotsford ARCs. **LOCATION:** Mission Fairgrounds, 7th & Talbot. **ADMISSION:** Adv $8/both days; Door $5 per day. **TALK-IN:** 146.600-, 144.300. **FEATURES:** CB - E - FM - H - S. **DEALER INFO:** Tables: $10 per day, $15 both days, includes one free admission. Kerry Atkinson VE7YXD, 604-467-8904, Ron Horstman VE7JOK, 604-826-8445. **CONTACT:** Rick Ross VE7FWP, 604-826-8119, Voice-mail 604-820-3788, FAX 604-826-8633.

EVENTS CALENDAR Month at a Glance

JULY 1995

JULY 1

CA - Antioch - MarketPro Computer Show*
CA - Santee - Ham, Computer & Electronic Swap Meet
MI - Troy - Computers & You Computer Show
NC - Moore County - Mid-Atlantic Star Party & Swap Meet
NY - Buffalo - MarketPro Computer Show*
OH - Toledo - MarketPro Computer Show*
VA - Vienna - Computer Show & Sale

JULY 1-2

IL - Chicago - Computer/Home Office Show & Sale

JULY 2

CA - Livermore - Swap Meet
CA - San Diego - MarketPro Computer Show*
CA - Santa Rosa - MarketPro Computer Show*
IN - Fort Wayne - MarketPro Computer Show*
NY - Henrietta - MarketPro Computer Show*
PA - Lehman - 16th Annual Hamfest & Computerfest

JULY 4

PA - Harrisburg - Fire Cracker Hamfest/Computer Show

JULY 8

CA - Anaheim - Robert Austin Computer Show
CA - Fontana - Amateur Radio & Electronic Swap Meet
CA - Oakland - Robert Austin Computer Show
CA - Reseda - Computer Marketplace
MD - Gaithersburg - MarketPro Computer Show*
MI - Petoskey - Swap & Shop
NC - Salisbury - The Firecracker Hamfest
OH - Perrysburg - CDE Computer Expo
WA - Vancouver - Electronic Flea Market
WI - Oak Creek - 26th Annual Swapfest

JULY 8-9

IN - Indianapolis - Hamfest & Central Division Convention

JULY 9

CA - Buena Park - Computer Marketplace
CA - Lancaster - MarketPro Computer Show*
CA - Stockton - MarketPro Computer Show*
FL - St. Petersburg - Computer Fair
IL - Hinsdale - Hamfest/Computer Show '95
MD - Baltimore - Hamfest & Computer Fest
MD - Hagerstown - MarketPro Computer Show*
MI - Dearborn - Computers & You Computer Show
MI - Jackson - Hamfest & Computer Show
NY - Alexander - 1995 Batavia Hamfest
OH - Bowling Green - Ham-A-Rama & Computer Show
PA - Pittsburgh - 10th Annual Hamfest

JULY 14-15-16

ID - Boise - Convention 1995
MT - East Glacier - Montana State Convention & Hamfest

JULY 15

CA - San Francisco - Robert Austin Computer Show
CA - Santee - Ham, Computer & Electronic Swap Meet
FL - Ft. Lauderdale - Narisaam Computer Show*
IN - Bloomington - Hamfest
IN - Indianapolis - AGI Computer Fair*
LA - Leesville - Hamfest
ME - Clinton - ARRL Hamfest
MI - Shiawassee - Hamfest
MI - Taylor - Computers & You Computer Show
NC - Cary - 23rd Annual Mid-Summer Swapfest
NH - Nashua - Northern Computer Show*
NH - Newport - Hamfest
NJ - Hightstown - Antique Radio Summer Meet/Auction
NY - Skaneateles - Skanfest
OH - Dayton - MarketPro Computer Show*
OH - Wellington - NOARSFEST '95

JULY 15-16

CANADA - British Columbia - Mission - 2nd Valley Hamfest
CA - Pomona - Computer Marketplace
GA - Atlanta - 1995 Atlanta Hamfestival
GA - Perry - Southwest Computer & Camera Fair

JULY 16

AZ - Phoenix - Computer & Electronic Swap Meet
CA - Sacramento - MarketPro Computer Show*
FL - Palm Beach Gardens - Narisaam Computer Show*
IL - Orland Park - Orland Park Computer Show
KY - Louisville - Computer Fair South
MA - Cambridge - MIT Fleamarket
MA - Tauton - Northern Computer Show*
MI - Lansing - Computers & You Computer Show
MO - Washington - 33rd Annual Hamfest
NJ - Augusta - Hamfest
NV - Carson City - Swap Meet
OH - Columbus - MarketPro Computer Show*
OH - Van Wert - Hamfest '95

JULY 21-22-23

AZ - Flagstaff - Ft. Tuthill Hamfest

JULY 22

CA - Santa Barbara - Computer Marketplace
LA - Slidell - Hamfest '95
MA - Waltham - MarketPro Computer Show*
MI - Livonia - Computers & You Computer Show
MI - Mio - Swap-N-Shop
NH - Nashau - Flea Market
NY - Frankfort - Hamfest/Computer Fair
OH - Berea - MarketPro Computer Show*
OR - North Bend - 5th Southern Oregon Coast Hamfest
PA - Huntington Mills - Hamfest
WI - Chippewa Falls - Swapfest

JULY 22-23

CA - Oxnard - MarketPro Computer Show*
PA - King of Prussia - MarketPro Computer Show*
WA - Renton - 1995 Pacific NW DX Convention

JULY 23

CA - Fresno - MarketPro Computer Show*
IL - Sugar Grove - Hamfest
IN - Crawfordsville - AGI Computer Fair*
MA - Fitchburg - MarketPro Computer Show*
MD - Brunswick - Sweatfest '95
OH - Canton - MarketPro Computer Show*
PA - Indiana - 3rd Annual Hamfest & Computer Fair

JULY 28-29

OK - Oklahoma City - Ham Holidays '95

JULY 29

FL - Tampa - 4th Annual "Last Minute" Hamfest
IL - Macoupin - Hamfest/Computer Fair
IN - Indianapolis - AGI Computer Fair*
IN - Indianapolis - AtariFest VII
MD - Frederick - MarketPro Computer Show*
MI - Merriman - Upper Peninsula Hamfest
MI - Westland - Great Lakes Computer Expo & Sale
MI - Wyandotte - Computers & You Computer Show
NC - Haywood County - 20th Western Carolina Hamfest
NJ - Pennsauken - KGP Computer Show*
OH - Xenia - Hamfest & Computer Expo
PA - Berwick - Hamfest - Computerfest
TX - Texas City - ARRL Hamfest

JULY 29-30

CA - Anaheim - Robert Austin Computer Show
NH - Manchester - New England Division Convention
PA - Allentown - MarketPro Computer Show*
SD - Clear Lake - Hamfest

JULY 30

CA - Sacramento - Ham Radio Swap Meet
CA - Santa Ana - ACP's Computer Swap Meet
IL - Glen Ellyn - Computer Central
IL - Stickney - ARRL Hamfest
MI - Flint - Five Star Computer Show
MI - Madison Heights - Computers & You Computer Show
MI - Port Huron - Hamfest
NH - Portsmouth - Northern Computer Show*
NY - Stony Brook - MarketPro Computer Show*
OH - Ashtabula - Hamfest & Computer Show
VA - Manassas - MarketPro Computer Show*
WI - Racine - Hamfest '95

AUGUST 1995

AUGUST 2-3-4-5

IL - Elgin - Radiofest '95

AUGUST 4-5-6

TX - Austin - West Gulf Division Convention
WY - Jackson Hole - WIMU/Rocky Mtn Division Convention

Events CALENDAR

AUGUST 5
CA - Oakland - Robert Austin Computer Show
CA - Santee - Ham Radio,Computer & Electronic Swapmeet
IN - Valparaiso - Porter County Hamfest & Computer Show
MA - Marlborough - KGP Computer Show*
MD - West Friendship - MarketPro Computer Show*
MI - Taylor - Computers & You Computer Show
MO - Springfield - Hamfest
NC - High Point - Lomer L. McMahan Memorial Hamfest
NJ - Riverdale - Hamfest
NJ - Somerset - MarketPro Computer Show*
NY - Clayton - Hamfest
WV - Mineralwells - Hamfest '95

AUGUST 5-6
CA - Pomona - Computer Marketplace
FL - Jacksonville - 22nd Amateur Radio & Computer Show
IL - Westmont - ComShow Computer/Home Office Show
WA - Spokane - Hamfest
WY - Jackson Hole - Rocky Mountain Division Convention

AUGUST 6
CA - Livermore - Swap Meet
CA - Stockton - MarketPro Computer Show*
IL - Peotone - Hamfesters Hamfest
IN - Angola - Annual Hamfest
MA - Wellesley - Ham Flea Market
MD - Baltimore - MarketPro Computer Show*
ME - Portland - Northern Computer Show*
MI - Grand Rapids - Computers & You Computer Show
OH - Randolph - Portage Hamfair '95
PA - New Kensington - Hamfest
PA - Warrington - Hamfest '95
VA - Berryville - Winchester Hamfest & Computer Show

AUGUST 7-8-9-10-11
VA - McLean - 7th Annual Surveillance Expo

AUGUST 11-12-13
VT - Charlotte - ARRL Hamfest

August 12
CA - Antioch - MarketPro Computer Show*
CA - Bakersfield - MarketPro Computer Show*
CA - Fontana - Amateur Radio & Electronics Swapmeet
CA - Long Beach - Amateur Radio Auction
CA - Reseda - Computer Marketplace
IL - Quincy - Ham Radio and Computer Swapfest
IN - Indianpolis - AGI Computer Fair*
KS - Chanute - Hamfest '95
NJ - Hackensack - KGP Computer Show*
NY - Dryden - Finger Lakes Hamfest
NY - Ithaca - ARRL Hamfest
OH - Sharonville - MarketPro Computer Show*
SD - Huron - Amateur Electronics Swapfest
VA - Annandale - MarketPro Computer Show*
WA - Tacoma - Electronics Flea Market
WI - Sugar Camp - Northwoods Hamfest
WV - Ona - T.A.R.A. Hamfest & Computer Show

AUGUST 12-13
LA - Bossier City - ARRL Hamfest
OH - Paulding - 5th Hamfest & Saturday Nite Flea Market
PA - Monroeville - MarketPro Computer Show*

AUGUST 13
CA - Buena Park - Computer Marketplace
CA - Goleta - 75th Anniversary Hamfest
CA - Santa Rosa - MarketPro Computer Show*
IA - Cedar Rapids - ARRL Hamfest
KY - Fort Mitchell - MarketPro Computer Show*
KY - Louisville - Computer Fair South
MD - Bowie - MarketPro Computer Show*
MD - Westminster - Carroll County Computer & Hamfest
MI - Dearborn - Computers & You Computer Show
NC - Charlotte - Hamfest & Computer Fair
NH - Manchester - Northern Computer Show*
PA - Easton - Hamfest

AUGUST 13-14-15-16-17
MI - Detroit - 61st Annual APCO Conference & Expo

AUGUST 18-19-20
AL - Huntsville - Hamfest & A.R.G. National Convention

AUGUST 19
CA - Anaheim - Robert Austin Computer Show
CA - San Francisco - Robert Austin Computer Show
CA - Santee - Ham, Computer & Electronic Swap Meet
FL - Ft. Lauderdale - Narisaam Computer Show*
OH - Akron - MarketPro Computer Show*
VA - Mechanicsville - MarketPro Computer Show*
WA - Longview - Ham, Computer & Electronic Swap Meet

AUGUST 19-20
CA - Sacramento - MarketPro Computer Show*
GA - Marietta - Atlanta Area Computer Show
PA - King of Prussia - MarketPro Computer Show*

AUGUST 20
CA - Oxnard - MarketPro Computer Show*
DE - Georgetown - Delmarva Hamfest
FL - West Palm Beach - Narisaam Computer Show*
IL - Orland Park - Orland Park Computer Show
MA - Cambridge - MIT Fleamarket
MA - Swansea - Northern Computer Show*
MI - Madison Heights - Computers & You Computer Show
NV - Carson City - Swap Meet
OH - Broadway - Hamfest & Computer Show
OH - Cleveland - MarketPro Computer Show*
OH - Warren - 38th Annual Hamfest
VA - Virginia Beach - MarketPro Computer Show*

AUGUST 25-26-27
CT - Vernon - Eastern VHF-UHF Conference & Swapmeet

AUGUST 26
MI - Westland - Great Lakes Computer Expo & Sale
NM - Albuquerque - Duke City Hamfest
NJ - Bridgewater - Hamfest
NY - Chaffee - Hamfest
NY - Syracuse - 40th Annual Hamfest
PA - Harrisburg - MarketPro Computer Show*
TX - Gainesville - Cooke County Hamfest

AUGUST 26-27
CA - Pomona - Computer Marketplace
CT - Vernon - 21st Eastern VHF/UHF Conference
CO - Woodland Park - 14th MARC Campfest-Swapfest

AUGUST 27
IL - Danville - 26th Annual Hamfest & Computer Show
IL - Oak Brook Terrace - Summer Hamfest
IL - Woodstock - Hamfest & Computer Show
MA - Rockland - Northern Computer Show*
MI - Corunna - Five County Swap-N-Shop
MI - Fowlerville - Livingston County Hamfair
MI - Lansing - Computers & You Computer Show
NY - Yonkers - Hamfest/Computerfest '95
TN - Lebanon - Hamfest

SEPTEMBER 1995

SEPTEMBER 1-2-3
CA - Long Beach - HAMCOM 95-Southwest Div Convention

SEPTEMBER 2
CA - Santee - Ham, Computer & Electronics Swap Meet
IN - Indianapolis - Hoosier Hamfest & Computer Show

SEPTEMBER 2-3
NC - Shelby - 39th Annual Hamfest

SEPTEMBER 3
CA - Livermore - Livermore ARC Swap Meet

SEPTEMBER 8-9-10
CANADA - Manitoba - Austin - Hamfest
TX - Arlington - Digital Communications Conference

SEPTEMBER 9
CANADA - Ontario - Lindsay - Radio/Computer Flea Market
CA - Fontana - Amateur Radio & Electronics Swap Meet
CA - Reseda - Computer Marketplace
IL - Rolling Meadows - ARRL W9DXCC Convention
IN - Fort Wayne - Summit City Computer Show & Hamfest
IN - Indianapolis - AGI Computer Fair*
IN - Laporte - Hamfest
NY - Ballston Spa - 10th Saratoga RACES Hamfest
PA - Erie - ARRL Hamfest

SEPTEMBER 10
CA - Buena Park - Computer Marketplace
FL - Boca Raton - Narisaam Computer Show*
IA - Dubuque - Hamfest/Radiofest/Computer Expo
IL - Harrisburg - Hamfest
IL - Joliet - Hamfest '95
KY - Louisville - Computer Fair South
MD - Gaithersburg - F.A.R. Fest '95
NH - Portsmouth - Northern Computer Show*
NY - Brewster - Pearlfest '95
PA - Butler - Hamfest

SEPTEMBER 15-16-17
IL - Peoria - Superfest '95

SEPTEMBER 16
AZ - North Scottsdale - Family Amateur Radio Event
CA - Santa Barbara - Computer Marketplace
CA - Santee - Ham, Computer & Electronics Swap Meet
MI - Hudsonville - Super Swap '95
NM - Santa Fe - Hamfest
NY - Hamburg - Western NY Section Convention/Hamfest
SC - Anderson - Hamfest & Computer Show
VA - South Boston - Fallfest
VT - Randolph - Fall Foliage Hamfest & Computer Show

SEPTEMBER 16-17
IL - DesPlaines - ComShow Computer/Home Office Show
OR - Portland - Ham Fair

SEPTEMBER 17
AZ - Phoenix - Computer & Electronic Swapmeet
CT - Newton - Western CT Hamfest
IL - Glen Ellyn - Computer Central
MA - Cambridge - MIT Flea Market
MA - Pittsfield - Hamfest
MI - Flint - Five Star Computer Show
MI - Mt. Clemens - ARRL Hamfest
NV - Carson City - Swap Meet
OH - Cincinnati - ARRL Hamfest
NY - Woodbury - ARRL Hamfest

SEPTEMBER 22
OH - Cleveland - Computerama USA

SEPTEMBER 22-23-24
OR - Milton-Freewater - ARRL Hamfest

SEPTEMBER 23
OR - Bend - Northwest VHF/UHF Conference

SEPTEMBER 23-24
IL - Grayslake - Radio Expo '95
NC - Charlotte - Atlanta Area Computer Shows
VA - Virginia Beach - State Convention/Hamfest

SEPTEMBER 24
CA - Santa Ana - ACP's Computer Show
FL - New Port Richey - Hamfest and Computer Show
IL - Orland Park - Orland Park Computer Show
IN - Crawfordsville - AGI Computer Fair*
MA - Framingham - Fall Flea Market
NY - Yonkers - Electronic Flea Market
OH - Cleveland - ARRL Hamfest

SEPTEMBER 30
FL - Fort Lauderdale - Narisaam Computer Show*
IN - Peru - ARRL Hamfest
MI - Westland - Great Lakes Computer Expo & Sale
See Computer Show Promoter Info Box

OCTOBER 1995

OCTOBER 1
FL - West Palm Beach - Narisaam Computer Show*
NY - Queens - Semi Annual Hamfest
See Computer Show Promoter Info Box

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►►►► USE THE CLASSIFIEDS ! ! ◄◄◄◄

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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:

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430 Princeland Court
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DETERMINING YOUR RATE PER WORD

The ad rate for **current PAID subscribers** is **30¢** per word. **All others** pay **60¢** per word. These rates apply to the first 150 words of your ad. From 151-200 words, the rate per word doubles to 60¢ and $1.20 respectively. We do not accept ads over 200 words. There is a $4.50 minimum charge per ad per insertion.

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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.

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WHEN YOUR AD WILL BE PRINTED

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.

SOME THINGS YOU SHOULD KNOW BEFORE SUBMITTING A CLASSIFIED AD

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.

FAXING IN AD COPY

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.

CHOOSING A CLASSIFICATION

Select the appropriate classification for your ad(s) to appear in and mark it in the space provided below. If no classification is indicated, the ad(s) will be placed in the Miscellaneous Section or wherever we deem most suitable. Available classifications to choose from are:

10. Ham Gear For Sale
20. Ham Gear Wanted
30. CB/Scanners
40. Music & Accessories
50. Computer Hardware
60. Computer Software
70. Computer Equipment Wanted
80. Test Equipment
85. Security
90. Satellite Equipment
95. Military Surplus Electronics
100. Audio/Video/Lasers
110. Cable TV
115. Telephone/Fax
120. Components
125. Microcontrollers
130. Antique Electronics
135. Aviation Electronics
140. Publications
150. Plans/Kits/Schematics
155. Manuals/Schematics Wanted
160. Miscellaneous Electronics For Sale
170. Miscellaneous Electronics Wanted
175. BBS & Online Services
180. Education
190. Business Opportunities
200. Repairs/Service

PLEASE TYPE or PRINT CLEARLY — ONE WORD PER SPACE—

AD #1 — CLASSIFICATION # _____

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Total Words | ☐ 30¢ Paid Sub or ☐ 60¢ Non Sub | Subtotal | ☐ Bold/☐ Caps and/or ☐ Art/Photo | BOX IT! ☐ $25 copy only ☐ $50 copy/art | Subtotal | No. of Issues | Total

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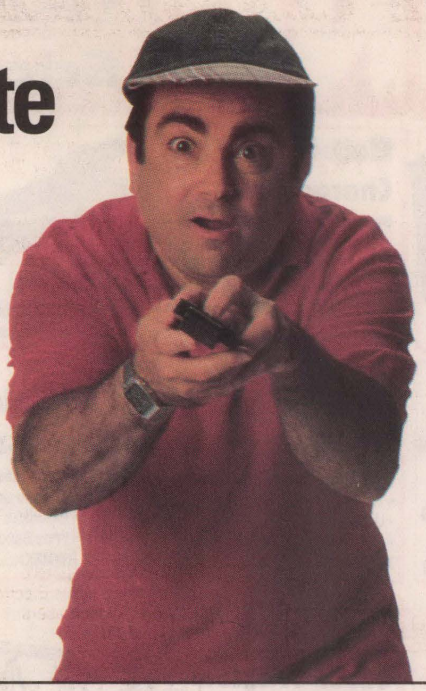
REMEMBER: All Ads Must Be PREPAID. $4.50 min. per ad per insertion. Classified ads will not be processed until payment is complete. No refunds. Credit only.

Put the remote back into your remote control!

Amazing new device attaches to your existing remote control giving it the power to transmit anywhere, even through walls!

By Charles Anton



It's Thursday evening and you have dinner guests. The kids are watching TV but it's too loud. Without embarrassing yourself or the kids by yelling to turn it down, you pick up your remote with Leapfrog long range power and turn it down without a hassle.

Until now remote control has never been very "remote." Even with the best equipment you had to be right in front of your stereo, TV, VCR, etc. to make it work. Now you can operate your entire entertainment system from anywhere in your home with Leapfrog, the next generation in remote systems.

How "remote" is it? Imagine yourself at home enjoying a relaxing evening of movies on your VCR. You decide to stop the movie so you can get yourself a snack. You aim the remote and click, but nothing happens! You grow more and more irritated, and finally have to stand right in front of the VCR before you can get it to stop the movie. You find yourself wondering why they call it a "remote" in the first place.

Why all the hassle? Typical remotes use infrared technology. In order for the process to work, the remote must be in direct line-of-sight with the audio-visual equipment. The equipment must "see" the signal.

Radio revolution. The Leapfrog transmitter never needs to be perfectly "lined-up" with the TV, etc. Why? Because the transmitter doesn't rely on an infrared signal. You can even point it in the wrong direction and it still works. Leapfrog overcomes all the headaches of obsolete remote controls through the use of radio waves.

Radio waves work anywhere within a 150 foot range. The signals pass through walls, doors, ceilings and floors, letting you control your equipment from any room of your home. You cannot aim and miss.

Infrared to radio. The Leapfrog transmitter, which attaches to your existing remote control, sends radio signals to the Leapfrog receiver. This receiver then transmits the signal to your audio-visual equipment with infrared technology.

Versatile uses. This amazing new remote control modifier works with any infrared remote. Just imagine the convenience of controlling your VCR, TV, stereo, cable converter box, speakers in multiple rooms, or any other audio-visual system throughout your home.

Leapfrog is also ideal for use with universal remotes. Control it all with just one remote.

How does Leapfrog work?

Leapfrog converts your infrared remote signal to radio frequency. Radio frequencies enable the signals to pass through walls and other obstacles. It also allows signals to transmit up to 150 feet without staying in line-of-sight with your equipment. Leapfrog then re-transmits the signal to the receiver, which forwards it to your audio-visual equipment.

Leapfrog installs in minutes. The transmitter attaches to your current remote. Plug the receiver into any outlet and place it in line with your audio-visual equipment.

Leapfrog sends radio signals which pass through any non-metal obstacle, giving you complete control of your personal electronics system.

Talented remote. The Leapfrog is not another hand-held remote control. This powerful innovation actually modifies your current remote, thus enhancing its value. You can control your stereo, your VCR, your TV, etc. from anywhere. From across the room or from across the house.

You can even use Leapfrog from outside. This is a fantastic feature to have when you're out by the pool, on your patio, or in your garage.

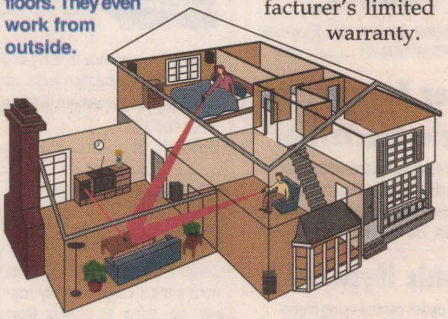
Factory direct. You would expect an innovative device like this to cost several hundred dollars. That might be the case if we sold only through exclusive high-end audio-visual dealers. But we bring the good news straight to you. You save money with factory direct prices.

Why Leapfrog beats infrared

- **Range.** You can control electronics from up to 150 feet away.
- **Aim.** You can't miss. Point your remote in the wrong direction and it'll still work.
- **Value.** It lets you get the most out of your audio-visual equipment by making use of it throughout your home.
- **Flexibility.** Because it sends signals through barriers, it lets you store your equipment behind cabinet doors.

Try it risk free. We are so confident that you will love Leapfrog that we've backed it up with our "No Questions Asked" 30 day money-back guarantee. If you are not completely satisfied for any reason, just return it for a full refund. Plus, it comes with a full one year manufacturer's limited warranty.

Leapfrog transmits signals in a range of up to 150 feet. Signals actually pass through walls, ceilings and floors. They even work from outside.



Leapfrog Remote Range Extender $79 $6 S&H

Please mention promotional code **192-NV-5815**

For fastest service call toll-free 24 hours a day

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READY TO USE

STUN1X - 80,000 Volts.....$29.95
STUN2X, 100,000 Volts.....$39.95
STUN4X, 200,000 Volts.....$69.95
Check Local & State Laws Before Ordering

Electric Charge Gun

Stuns Attacker Up to 15' Range

- Legal In Most States
- More Knock Down Power Than Most Handguns
- No Permanent Injury - Ready to Use with Identifying Code

Special Introductory Offer Includes our 80KV Stun Gun

ECG10N .....$249.50 Data Pack, creditable toward purchase ...$10.00

TV Joker

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 Kit .$24.50

ALL NEW! Powerful Home Security Telecom - Infinity Transmitter

Access on premises, ongoing phone calls, phone break-in capabiltiy, control of electrical functions such as lights, alarms etc. *Caution - Check Legality in Your State!*

TELECOM2KN Kit, w/PC board ..... $149.50 TELECOM20N Ready to Use $199.50

FM Telephone 3 Mi Transmitter

Listen to calls over any FM radio

- Tunable 70 - 130 MHz
- Undetectable
- Only transmits during phone use

XFT300KN.....$29.50

Wireless Wizard Transmitter

Rebroadcast VCR, Tape Recorders, Stereo to any TV or FM Radio

- Eliminates Wires & Cables
- Wide Band Operation • 70-130 MHz

RWM3KN.....$24.50

Tracking / Beeper Transmitter

For Homing & Tracking up to 3 Mi

- Works with any FM radio • 70 - 130 Mhz
- Use for Hunt Games, Vehicles, Animals, etc. HOD1KN.....$24.50

High Voltage 50,000 VDC Lab Supply

- Sub Mini Design
- Universal Battery/12VDC/115VAC oper.
- Many HV applications and experiments

HV50N Ready to Use $149.50

Build a Handheld Ultrasonic Blaster for Self Defense

Phasor Pain Field for Property Protection or High Powered Animal Control System. Many uses. Inlcudes high efficiency transducer. ULDR1KN $39.95

Laser Window Bounce Listener

Aim at room window and listen to sounds from within using reflected light. *Caution - Not for Illegal Use!* Includes ready-to-use 5mw laser gun sight and long range laser receiver kit. # LWB3KN.....$149.50

Ion Ray Gun

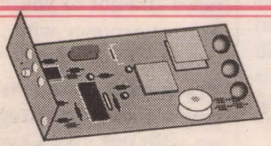
Projects charged ions that induce shocks in people and objects without any connection! Great science project as well as a high tech party prank!

IOG30N Ready to Use $99.50

Higher Powered Lab Version:

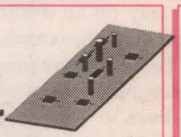
IOG7KN Kit $99.50
IOG70N Ready to Use $149.50

Universal High Voltage Power Supply Module



Self adjusting, current limited, switching, high output, efficient battery or line powered, Intended for capacitor charging when used with pulsed lasers, magnetic guns, plasma pyrotehcnics, etc. Includes triggered spark gap switch for high energy pulse applications. Many lab and R&D uses. Easy to assemble kit. HVPS1KN $99.50

Super Sensitive Amplifier



- Hear an insect walk! • Hear through walls!
- Build a Long Range Parabolic Mike or Super Directional Shotgun Mike!

AG7KM Kit $29.95

World's Smallest Tesla Coil

Neat little device will light a 40W fluorescent lamp without contact, yet is smaller than a pack of cigarettes. Many interesting applications. 12VDC or 115VAC.

BTC2N Kit $29.95

Jacob's Ladder

Visual display of plasma pyrotechnics. 3" arc travels 30" from top to bottom. Unique solid state 12KV transformer, safety shutdown. Req's wood enclosure and readily availble hardware.

JKC1KN 12KV Transformer $74.50

Build a Stun Gun, Flame Thrower...

....Pulsed Shocker, ignitor, etc. Electronic Module Kit. PSHK1KN Kit $29.50

Shocker Force Field/ Vehicle Electrifier

Neat device - Make hand and shock balls, shock wands, electrify objects, charge capacitors. Great payback for those wise guys! SHK1KN EZ Assembly Kit $24.50

Electronic Hypnosis

Puts subjects under control using highly effective electronic stimuli. Intended for entertainment- Must be used with caution. Includes valuable text book reference and plans. EH2N Plans and Text Book.. .$19.50

Tesla Coil

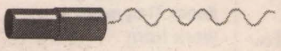
10 to 14" Streamers!

- Wireless Energy
- Plasma Pyrotechnics
- Corona / St Elmo's Fire
- Lightning

Torioid Terminal Optional

BTC3KN Kit $299.50

Body Heat Telescope



Detects the presence of living bodies, warm and hot spots, insulation leaks, etc. Use for security, law enforcement, R&D, etc. Dual mode operation.

BHTIKN Kit $99.50

Ultrasonic Cleaner Kit

Cleans PC boards, jewelry, coins, small parts,. Large capacity hopper, operates at 30KHz from 115VAC. ULCL1KN..... $79.50

1000 Ft++ Spud Cannon

NOT A TOY. Uses electronic or piezo ignition. CAUTION REQUIRED!

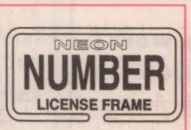
POT1 Plans.(Dangerous Product) $10.00

FireBall Gun

Shoots flaming ball - two shot capacity. Great for special effects and remote fire starting. CAUTION REQUIRED!

FIREBALL Plans (Dangerous Product) $10.00

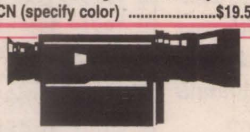
NEON License Frames



Easy to install, high brightness units. Available in purple, green, or pink. Specify color when ordering. *While They Last!*

LICN (specify color) $19.50

See in Total Darkness



- Includes laser illuminator kit
- Light amplification • With camera adapter
- Hi quality optics • Viewer Ready to Use!

NVW10N with Laser Kit..... $395.00

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.

ANT1KN Easy to Assemble Kit $19.50

Extended Play Tel. Taping System

Automatically records both sides of a call. CAUTION: check local laws for alerting beeper requirements. Ready to use with X4 recorder. TAP40XN $84.50

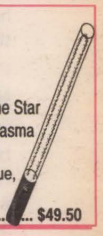
Mind Machine

Create Spectacular Hallucinations!

- New Technology Utilizes *Electro-Brainwave Coherence!*
- Uses No Drugs! • Must be over 18

MIND1N Plans $10.00

Plasma Neon Fire Saber



Active energy field produces the Star Wars effect, visible length of plasma field controlled by grip contact. Choose your color: Photon Blue, Neon Red, Phasor Green or StarFire Purple. FS2KN $49.50

Plasma Pen

write with the burning fire of electronic plasma!

- For FUN and PROFIT!
- Pen Sized - Easy to Use
- Baggage and Identification
- Create Spectacular Designs

PLPEN10N $29.50

SUPER VALUE! 3 for 1 HIGH PERFORMANCE Home Surveillance Kits -

You Get ALL 3 for only $29.95!!!

Telephone Tape Recorder Switch
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+ Long Range 2 mi+ Voice Transmitter
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Write in 209 on Reader Service Card.

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 broad cast transmissions when close.
- Check Microwave oven leakage.
- Wide .5MHz - 3GHz+ frequency range.

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All specifications & prices are subject to change without notice or obligation.

R10 checks coded squelch codes with DC440 Decoder

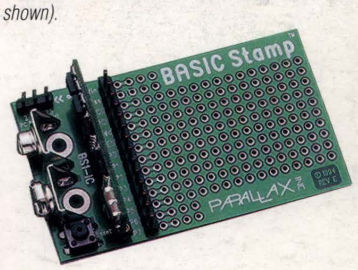
R10 FM Communications Interceptor®	$359.
R20 AM Communications Interceptor®	$119.
DC440 Decoder	$259.
CX12 RS-232C Interface Converter (Interface DC440 to PC)	$ 89.

Write in 118 on Reader Service Card.

BASIC STAMP MODULES!®

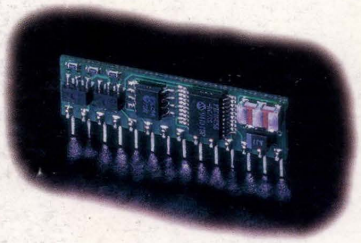
Stamp-Sized Modules Run BASIC Programs

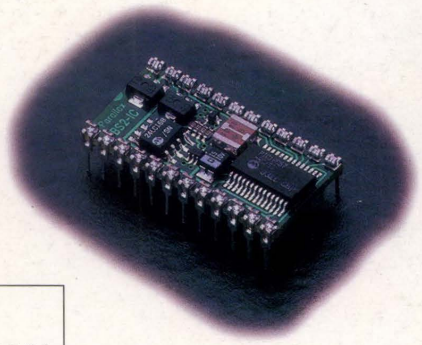
** Carrier boards provide battery clips, prototyping area, programming connector, and reset button (BS1-IC carrier shown).*

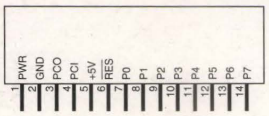


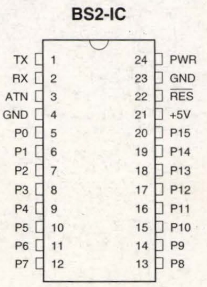
BASIC Stamp I Module (BS1-IC)

8 general-purpose I/O lines
256-byte program space (100 instructions)
4-MHz clock (2400 baud serial, etc.)
$34, $54 with carrier board*









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.

The BASIC Stamp I will always be the smallest and least expensive Stamp. For many applications, it's the most prudent solution. However, a growing number of customers need the additional features of the Stamp II. We hope you'll find both Stamps useful and fun.

BASIC Stamp II Module (BS2-IC)

16 general-purpose I/O lines
2048-byte program space (600 instructions)
20-MHz clock (9600 baud serial, etc.)
$49, $69 with carrier board*

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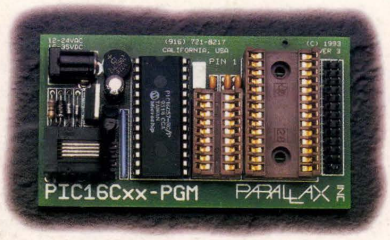
PIC®16/17Cxx DEVELOPMENT TOOLS

New prices make PIC development more affordable



You've probably seen the articles about PIC microcontrollers. They're popular because they're cheap and efficient. Which is why we chose PICs for our BASIC Stamps. A typical PIC has 18 or 28 pins, 1K of program space, and 32 bytes of RAM, all for around $5. If you'd like to program PICs in assembly language or C, we offer the hardware and software tools to get you going.

PIC16Cxx Programmer

Programmer for PIC16C5x/64/71/74/84/...
Printed manuals; cables; power supply • **$199**
Docs on disk; user-supplied cables* • **$99**

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