NUTS & VOLTS
MAGAZINE

OUR 18th YEAR

$3.50
VOL. 18 NO. 5
MAY 1997

Exploring Electronics And Technology For The Hobbyist And Professional

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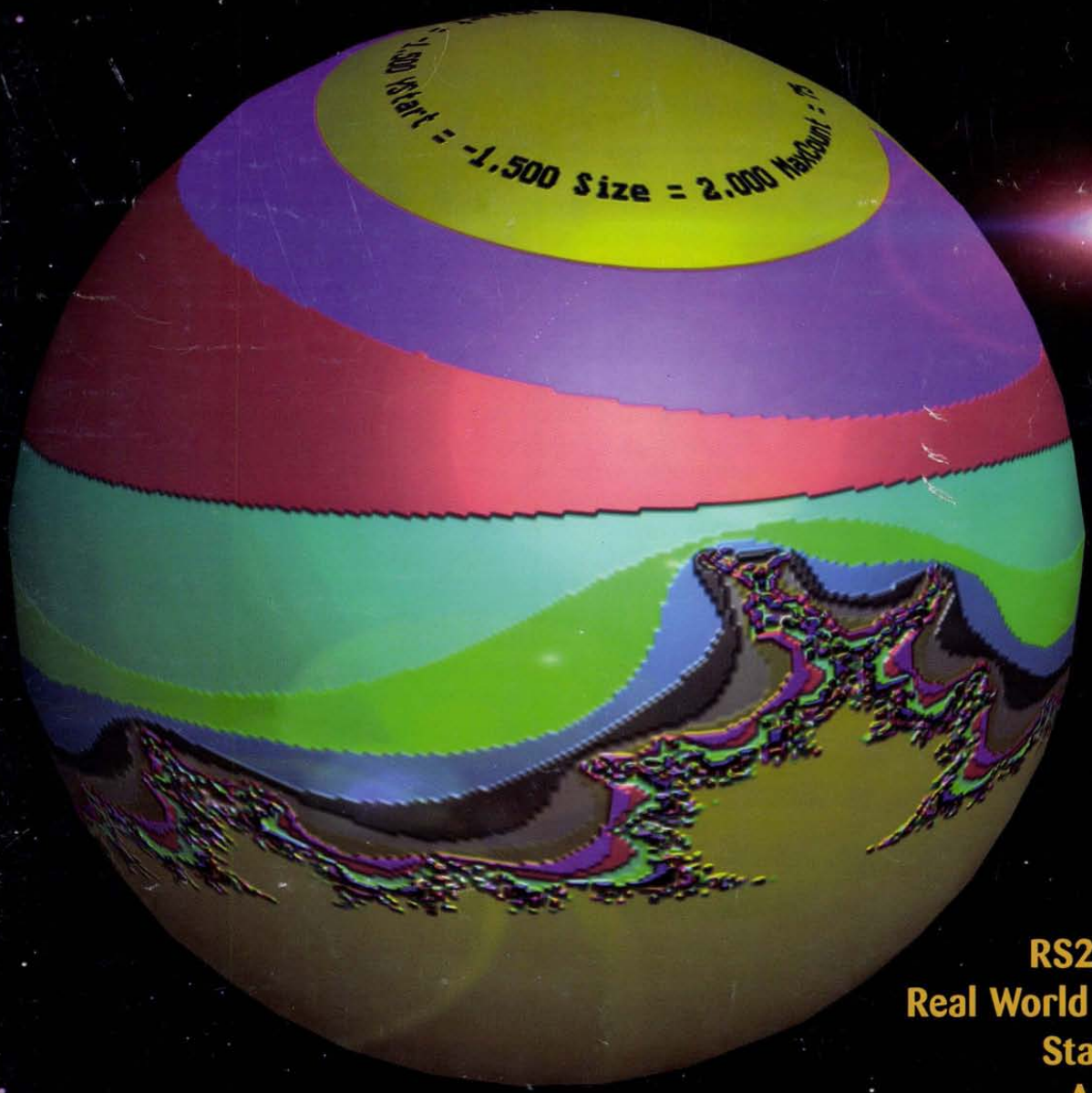

Solar Workshop
RS232 Analog Input
Real World Control For PCs
Stamp Applications
Amateur Robotics
Software Wizardry
And More!!

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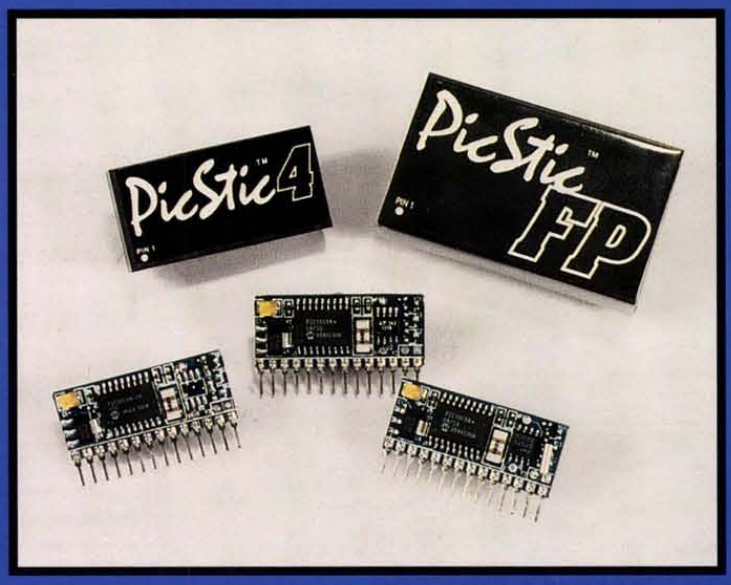
PicStic™ FAMILY VALUES

PicStics are component-sized programmable computers designed to fill a multitude of embedded control tasks. Programmed either in BASIC or assembly language, PicStics combine fast develoment with cost-effective, efficient end-use implementation.



PicStic™ PicStic (PS1–PS3) is a low-cost 0.85-in² controller that is pin compatible with the BASIC Stamp I. Versions include enhancements like 2-channel 12-bit ADC, hardware real-time clock, more instruction space, interrupts, and 2 additional I/O lines. It runs the same PBASIC program 15 times faster. PS1–PS3: $29 and $39 each. PS1–PS4 development system: $179.

PicStic4 PicStic4 is an enclosed 32-pin DIP that combines the speed and economy of a PicStic1 with a powerful I/O coprocessor in one package. Programmable in PicBasic, a PicStic4 gives you 19 I/O bits, 4-channel 8-bit ADC, 2-channels each of 12-bit ADC and DAC, 2-KB EEPROM data memory, hardware real time clock, and a powerful set of firmware functions which include measuring frequency, generating PWM, controlling an LCD and keypad, and more. PS4: $59 to $89 each. PS1–PS4 development system: $179.

NEW FLOATING POINT PICSTIC

PicStic FP PicSticFP is an enclosed 40-pin DIP that combines a full floating-point BASIC interpreter with a Pic I/O coprocessor. PicSticFP contains 32-KB SRAM, 32-KB EEPROM, 28 bits of parallel I/O, a 2-channel 12-bit ADC, and built-in firmware functions like PWM, frequency measurement, and I²C expansion. FP: $109 to $139 each. FP development system: $99.

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- Overall size of board is 15/16" square!
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- Resolution is 505 x 230 pixels, RGB delta pattern
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- One LCD and one backlight board is $9.95/set
- Buy two sets for only $17.50!
- Includes data sheet with pinouts, specs
- Plastic optics assemblies from Virtual Reality headsets allow viewing images up close
- Surface mount connector available for LCD ribbon cable

HSC# 16536 Tiny LCD/Backlight set **$9.95 ea.**
HSC# 16537 Left & Right Optics units **$7.95 pr.**

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- Orchid Technology Kelvin MPEG Video Card
- 64-bit graphics with MPEG Video on one card!
- Full screen 30 Frames/sec MPEG video plus audio
- 1MB version will display up to 800 x 600, 64K colors, or 1024 x 768, 256 colors
- Manual, audio cable & driver software included
- Note, the MPEG portion is not Win95 compatible, but the video portion is. Everything works fine with Windows 3.1
- OEM pack, ninety day HSC warranty

HSC# 16124 Now -- Closeout Price! **$29.00**

Tower Case Closeout!

- Looking for an inexpensive case to put that spare motherboard into? Look no further!
- Brand new in box mid-size tower case
- 15" tall, 17"deep, 7" wide
- Includes hardware kit (standoffs, etc.)
- Power supply not included...inquire about availability of mini-tower supplies to fit.

HSC# 16642 **$19.95**

SCSI Drive Case Deal!

- Low-profile case for 5.25" drives
- Perfect for CD-ROM drive
- 9.75" x 2.25" x 11" overall size
- 50-pin SCSI daisy-chain connectors
- Internal 50-pin cable, SCSI ID switch
- 30-watt power supply, DC Fan cooled
- New case is attractive grey color, has 90-day warranty

HSC# 16185 Low-Profile 5.25" Drive Case **$29.95**

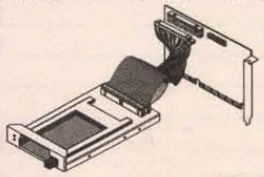
Peltier Cooler at a Price!

- Made for cooling ceramic Pentium Processors (not metal)
- Heatsink is 2" x 2.875", .5" thick
- Mounted 12VDC fan
- Peltier device is 1.125" square, has copper plate for thermal mounting on CPU
- Unit is new, and much cheaper than the separate parts!
- Perfect for Peltier experiments!

HSC# 16106 **$24.95**

PCMCIA Card Reader

- IBM Compatible Reader/Writer for PCMCIA Cards
- SwapBox by SCM Microsystems with 16-bit ISA Bus card
- Convenient front access for slots (not in rear of system)
- Fits in 3.5" drive bay, or use included 5.25" bracket
- Dual slot, Type I, II or III, hot swappable
- Perfect for transferring data or hardware from laptops, notebooks or Kodak Cameras to desktop PC's
- Includes driver disk, manuals, cable, internal card, bracket
- New in OEM package (white box), 90-day warranty



HSC#15954 **$79.95**

Rock-Bottom Reno!

- This is the Last Stock of Media Vision *Reno*:
  - Consists of new external Reno CD/ROM drive, docking bay with SCSI2 port, AC Adapter, cables
  - Uses NiCad battery pack(s), **not included**
  - Double-speed 180mS drive is lightning fast!
  - Drive detaches from docking bay, use with headphones as a portable personal audio CD player
  - Great for Mac or IBM (adaptor bracket included)
  - Mac software included
  - SCSI Controller & software required for IBM use
  - Brand new, 90-day warranty
- **Media Vision *Reno* Kit HSC#15586 includes:** Reno Cable Kit (SCSI2 - DB25 cable, 50p. ribbon cable, internal & external audio patch cables), padded travel pouch, headphones, Mac software, IBM Adapter bracket.

A. B. **$69.00**

Available Separately:
A. Rechargeable Battery Pack (for early-style Reno, will not recharge in late-model Reno) **HSC#15587 $14.95**
B. Macintosh Powerbook SCSI Adapter (HDI-30 to 25-pin D connector) **HSC#15704 $12.50** If purchased alone, or with purchase of Reno Kit, **$5.00**

Mini Trackball - Hot to Go!

- KraftμTrak Mini-trackball -- small trackball has bracket to attach to right or left side of keyboard (if desired) -- New in box.
- Comes with carrying case for portability.
- Software disk has drivers with cursor sensitivity & accelleration controls. Windows compatible.

HSC#16641 **$4.95**

Hobby Parts Potpourri!

- Copper Foil Tape - .5" x 18 yd. roll, adhesive is conductive! **HSC#16189** **$4.95**
- Karaoke-style microphone, good quality, black & gold **HSC#16156** **$2.95**
- Small flexy solar panel - 1.6VDC @ 350mA - 6" x 1.75" **HSC#16133** **$5.95**
- Desk stand microphone, multimedia-type, beige **HSC#16157** **$6.95**
- Nidec 12VDC tiny squirrel-cage blower, 3" x 3" x 1.125" **HSC#16166** **$9.95**
- Genuine IBM PS/2-style keyboard, 101 key **HSC#16218** **$14.95**
- Arcade game joystick (not for computers), 4 switches, Heavy duty! Choose red, blue, green, or black handle **HSC#15227** **$6.95**
- Coiled cigarette lighter extension cord, plug to jack **HSC#15640** **$2.95**

Audio Hacker's Dream

- Super-source of high-power parts for audio hobbyists!
- Unit is believed to be amplifier from surround-sound sys.
- Parts include four 50W high-performance audio amp chips (TDA1514A), two tone-control circuit chips (TDA1524A), with related circuitry, and four LM1037 analog switches.
- Amplifiers are mounted on 12" x 1.5" x 2" heatsink
- Unit looks like it would take 24VAC to supply power to circuit (hefty bridge rectifier, fuses and filter capacitors are already installed), or remove parts for your own project!

HSC#16496 **$24.95**

PCMCIA Sound Card

- Turtle Beach Systems "Audio Advantage" Card
- Add multimedia capability to your PCMCIA notebook
- Windows drivers, sound program etc. in "Zip" file
- Adapter plug allows connection of speakers, microphone
- New, OEM packaged, ninety day HSC warranty
- Mfr. offers fax-back or e-mail support for this product

HSC#16521 **$79.95**

SCSI Device Cases

16560 16559 16558 16575

- Upright Case, 3.5" x 5.5" x 8.125" for 3.5" hard disk drives, 20 watt fan-cooled power supply **HSC#16560** **$29.95**
- Upright Case, same size as above, has front opening, 20 watt power supply, no fan **HSC#16559** **$24.95**
- Horizontal Case, 7.75" x 2.25" x 10", for 5.25" or 3.5" drives, approx. 30 watt fan-cooled power supply **HSC#16558** **$39.95**
- Deluxe quality case, 7" x 4.5" x 10.75", mad for Olympus Optical, has 5.25" open front bay, SCSI diagnostic indicator on rear panel, 30 watt fan-cooled power supply, IEC power cord included. Assembled in USA. **HSC#16575** **$49.95**

All cases are new, and feature 50-pin Centronics-style daisy-chain connectors, internal 50-pin cable and SCSI ID switch.

New Optical Drive Media

- Generic brand 600 MB double-sided write-once cartridge
- Works with Tahiti III, MOST drives **HSC#16577** **$9.95**
- Maxoptix "Data Lock" 1.0 GB optical glass write-once
- Works in Tahiti IIm multifunctional drives only **HSC#16578** **$14.95**
- Maxoptix "Max-GL" 1.3 GB optical glass write-once cart.
- Works with Tahiti, other magneto-optical drives **HSC#16576** **$17.50**

Hobby Parts Potpourri!

Wondering what to do with that old PC now that you have upgraded? Make it into a game system for the kids! Use the controllers below, load up the games and you can have your new computer all to yourself...for your own games? Better buy extra controllers at these prices!

- Kraft KC3 Joystick -- small IBM compatible joystick with dual-axis centering controls, two fire buttons for use with either hand, plus joystick button. **HSC#16638** **$1.95**

- Kraft μPad Game Controller -- use your Nintendo/Sega skills on your PC! Four buttons plus mini-stick for two handed action...plugs into game port (see below). **HSC#16639** **$3.95**
- Kraft Game Port Card -- single port can operate two joysticks with Y-cable (not included). Switch selectable bus speeds up to 35 MHz. **HSC#16640** **$1.95**

Diamond Multimedia VLB - VGA Bargains!

Stealth-64 Graphics 2000 Accellerator
- VESA-Local Bus with 64-bit S-3 graphics accellerator chip
- Onboard 1MB DRAM, can be upgraded to 2MB
- Displays up to 800 x 600 pixel, 24-bit true color, or 1152 x 864 pixel, 65K color

HSC#16587 **$19.95**

DIAMOND MULTIMEDIA

Viper Pro Video
- VESA-Local Bus card, Weitek "Power 9100" chip-set
- Onboard 2MB VRAM, can be upgraded to 4MB
- Capable of full screen, 30 fps 1280 x 1024 video
- Can display following resolutions (and more):

Resolution	2MB	4MB
1024 x 768 pixel	256, 65K color	16M color
1280 x 1024 pixel	256 color	65K, 16M color
1600 x 1200 pixel	256 color	65K color

HSC#16586 **$29.95**

Both boards are new, OEM packed and have photocopied manuals, driver/utility disks, and have a 90-day HSC warranty. Diamond Multimedia has a comprehensive help website.

Ethernet Card Closeout

- 10-Base-T style Network card for ISA Bus computers
- NE-2000 compatible, for twisted pair networks
- AE2/T by Artisoft -- Name brand quality!
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- Driver software is on 5.25" disks -- be forewarned: if you only have a 3.5" drive, you will have to get a friend to copy!
- Note: not for "dumb" nodes, does not have boot ROM

HSC#16539 **$19.95**

Infrared PCMCIA Card

- IBM "Options" series PCMCIA card will add industry standard infrared communications capability to your laptop or notebook computer!
- Allows wireless connection to compatible notebooks, workstations, printers, and other peripherals supporting the Infrared Data Association (IrDA) standard.
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NUTS & VOLTS MAGAZINE

Published Monthly By
T & L Publications, Inc.
430 Princeland Court
Corona, CA 91719
(909) 371-8497
FAX (909) 371-3052

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

Subscription Order ONLY Line
1-800-783-4624

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

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

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Nuts & Volts Magazine is published monthly for $19.00 per year by T&L Publications, Inc., 430 Princeland Court, Corona, CA. Application to mail at 2nd class postage rates is pending at Corona and San Diego. POSTMASTER: Send address changes to Nuts & Volts Magazine, 430 Princeland Court, Corona, CA 91719.

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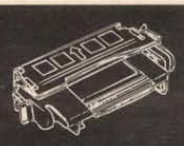

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reader FeedBack

Dear Nuts & Volts:

I have been reading Fred Blechman's article, "Semiconductor Parts Substitution," in the Dec. '96 *Nuts & Volts*. I enjoyed reading it, as well as his earlier articles, and personal correspondence with him about some material he has written.

His description of the three semiconductor replacement manuals is good. I would like to add an additional use for these manuals. The inclusion in the manuals of pinouts and basic specifications is a good source of data for an unfamiliar semiconductor. Simply look up the replacement, and refer to the data for that replacement.

Mr. Blechman did not mention that, for nearly all parts, the NTE and ECG replacement numbers are the same. It is still a good idea to have both manuals, however, as some original part numbers will be listed in one, but not the other.

Often, but not always, the NTE, ECG, or SK replacement part will be higher in price (sometimes a lot higher) than the original part (when it is available). Several mail order electronics parts suppliers have large stocks of original number parts. If you can wait a few days, you can often save by ordering the original part number. Also, at least two of these companies, **MCM Electronics** (650 Congress Park Dr., Centerville, OH 45459-4072, **1-800-543-4330**) and **Dalbani Corp.** (4225 N.W. 72nd Ave., Miami, FL 33166, **1-800-325-2264**), have in their catalogs a several-page "reverse cross-reference," giving original part number equivalents for NTE/ECG part numbers. When using these reverse cross-references, I always check the specs of the original part numbers given, in case of an error in the listings. (This should also be done when using ECG, NTE, or SK part numbers; I have seen a few errors in their listings.)

I hope this additional information will help someone who is looking for an odd-ball part.

Bill Stiles
Hillsboro, MO

Dear Nuts & Volts:

A question asked TJ Byers in last month's issue was on capacitors as ballast for fluorescent lamps. I don't know about single fluorescent lamps, but back in the late 50s, early 60s, there were high-frequency lighting systems developed and used. Aircraft with their 400 cycle systems may have used them.

One purpose of the high-frequency fluorescent system was reduction in the cost of the ballast, as well as a reduction in weight when used in aircraft. The use of the capacitor as a ballast did that. The basis for a magnetic ballast is to limit the current flow through the tube, as well as give a voltage boost with some tubes to start the tube arc.

One of the hobby magazines from that era had an article on how a ballast could be replaced with a 40-watt incandescent lamp bulb. The tube current flow through the incandescent bulb element (resistance) would maintain enough voltage to fire the arc, once it fired. I think the article implied that 70 volts would maintain the arc. A special push-button off/on switch or a off/on toggle switch with a spring return to an intermediate position, similar to the operation of an automobile operation switch, could be used to short out the incandescent lamp or capacitor when starting. When the lamp fired, releasing the switch would automatically insert the current limit (ballast device) in series with the tube.

Incandescent light bulbs have an approximate 10 to 1 ratio, cold resistance to hot resistance and a special switch may not be needed.

Edward L. Mills
Quincy, IL

Dear Nuts & Volts:

The answer given in the Mar. '97 issue, for question #2975 was not entirely correct. It states that telephone ringers can be powered from 120 VAC 60 Hz power through a dropping resistor. That's correct ONLY for the newer electronic ringers. The older bell-type ringers have a mechanical assembly which is

Continued on page 114

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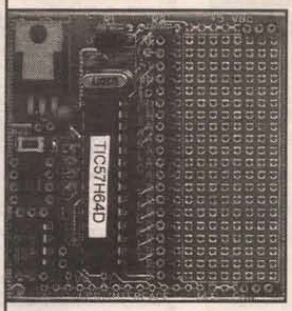

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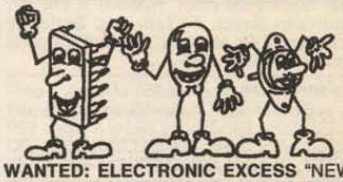

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```
#include <16C71.H>
#use delay(clock=15000000)
#use rs232(baud=9600,
           xmit=PIN_B0,rcv=PIN_B1)

main() {
   int value;

   setup_port_a(ALL_ANALOG);
   setup_adc(ADC_CLOCK_INTERNAL);
   set_adc_channel( PIN_A1 );

   printf("Sampling pin A1:\r\n") ;

   do {
     value = read_adc();

     printf("A/D value: %2x\r\n", value);
     delay_ms(1000);

   } while (TRUE);
}
```

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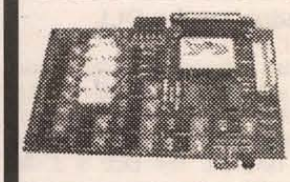

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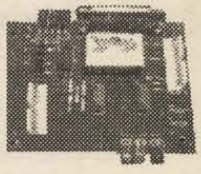

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Quick & Easy Real-World Control for PCs

by Jan Axelson

BASIC has long been a favorite programming language for real-world projects that access the world beyond a computer's keyboard, display, and the usual assortment of peripherals. If you have a project that involves flipping switches, reading sensors, spinning motors, or controlling or watching the outside world in a unique way, a BASIC program and an available port can often do the job.

If your program will run under Windows, you can create it with Microsoft's Visual Basic, whose ease of use and many abilities have made it one of the PC's most popular programming languages. But there's one hitch – unlike other BASICs, Visual Basic includes no way to read and write directly to ports. The solution is to use a DLL (dynamic linked library) that enables any Windows 3.x or Windows 95 program to access ports.

In this article, I'll show you how to use Visual Basic to access the PC's standard parallel port, as well as ports on custom I/O cards. I'll also present an example program to get you started.

What's a Port?

One of the main jobs of every PC is to move information about. The CPU (the brains inside the PC) understands two types of locations for data: memory and ports. The CPU uses different instructions and addressing to access each.

Memory includes the system RAM, which provides temporary storage for currently running programs, application files, and other information that the system may need quick access to.

The CPU uses ports to communicate with just about everything else, including standard components like drives, displays, modems, and printers, as well as custom and homebuilt devices. Each device uses one or more port registers, which are storage locations that both the CPU and the device can read and write to. Every PC has at least 1024 possible register addresses, from 0 to 3FFh, though many of these are reserved for standard components.

How to Access Ports

For many common devices, Windows has built-in routines that simplify communications. For example, an application may call Windows' StartDoc function to send a file to a printer. The application doesn't have to concern itself with knowing how to communicate with specific printers, because the operating system handles the details.

If you've built your own device that connects to a port, there are no built-in routines; you have to write your own. You can do so if your programming language includes the ability to read and write to ports. Other BASICs, including QuickBasic and QBasic for DOS, include Inp and Out keywords for this purpose. For example, this QBasic statement writes the value 55h to a port at 378h:

```
Out &h378, &hA5
```

(In this article, I use the conventional trailing h to indicate a value expressed as a hexadecimal number, while the BASIC code requires a leading &h.)

If you prefer decimal numbers, the statement looks like this:

```
Out 888, 165
```

This statement reads the value of a port at 379h into the variable ByteRead:

```
ByteRead = Inp(&h379)
```

Or in decimal:

```
ByteRead = Inp(889)
```

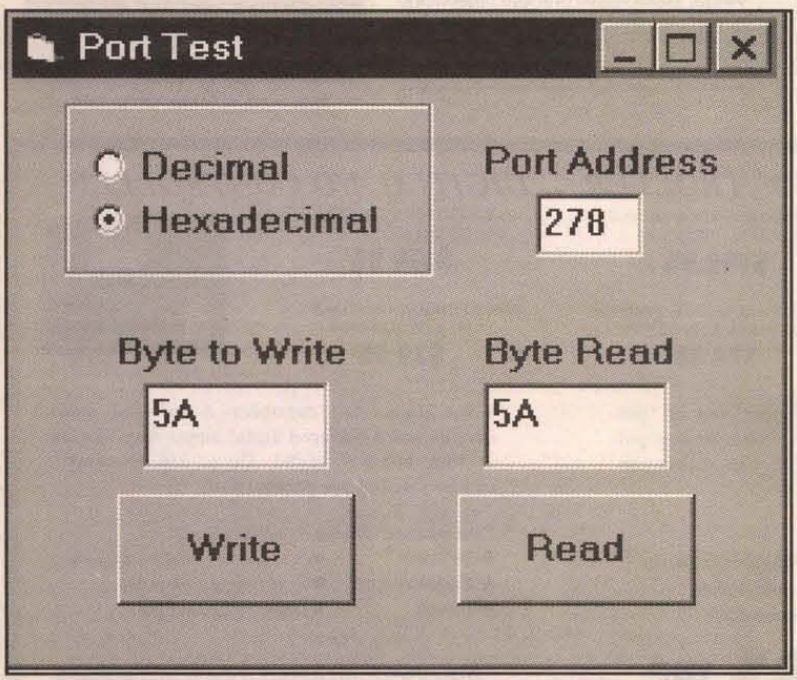


Figure 1. Use this Visual-Basic program to experiment with reading and writing to the standard parallel port and custom I/O ports.

Introducing the DLL

Under Windows 95 and Windows 3.x, you can use a DLL to enable your Visual Basic programs to access ports just as in other BASICs. The DLL is a file that contains program routines for reading and writing to ports.

The DLL itself must be stored on the user's system, and an application that uses the DLL must include a declaration for each routine it calls. The declarations tell the operating system where to find the routines.

When the application runs, the DLL loads into system memory and the application may call any of the declared routines. The Visual-Basic statements that call the DLL's routines are identical to QBasic's Inp and Out statements.

Where can you find a DLL for port I/O? I've made two DLLs available for free downloading on my web site at http://www.lvr.com — Inpout16.dll is for use with 16-bit programs, and Inpout32.dll is for use with 32-bit programs. Although the program code to call the Inp and Out routines is identical for both types, each requires a different DLL and declarations.

Which DLL to use depends on which version of Visual Basic you're using. A 32-bit program requires Windows 95, while a 16-bit program may run on Windows 3.x or Windows 95. Programs created with Visual Basic Version 3 (VB3) are 16-bit. The Professional edition of Version 4 (VB4) includes both 16-bit and 32-bit versions, while the Standard edition of Version 4 and all editions of Version 5 are 32-bit only.

Using the DLL

The parallel printer port is one of the standard ports found on every PC, so it's a natural choice for testing and experimenting with the Inpout DLLs.

Although originally intended for printer communications, the parallel port has also become popular as an interface to many other devices, including homebuilt projects of all types. The basics of the parallel port have been covered many times in this magazine and elsewhere, so this time around I'll include only the essential information for accessing a port with my example program. (See the Sources box for more on parallel-port access and interfacing.)

Most parallel ports are located at a base address of 378h, 278h, or 3BCh. In Windows 95, to find the base address of a parallel port, open

the Control Panel, then click on System, Device Manager, Ports, select an LPT port, then click the Resources tab. The addresses of installed parallel ports are also displayed in the CMOS set-up screens that you can access on bootup.

Figure 1 is the user screen for a program that tests the DLL's operation. Because some prefer hexadecimal numbers while others prefer decimal, the program allows a choice. To use the program, you enter the address of your port in the Port Address text box. To write a value to the port, enter the value in the Write text box and click the Write command button. To read the port, click the Read command button and the Read text box will show the value read.

A caution: this program allows you to attempt to write to any port address. Under Windows, many system-critical ports are protected from unauthorized access, but the chance remains that writing to a port can crash your system or, in rare cases, even cause permanent damage. Writing to a standard parallel-port address is safe if nothing is connected to the port. Disconnect the cable to any device connected to a port before you experiment with the port. Reading of any port will do no harm.

Listing 1 is the code for the example program, and Listing 2 has declarations for the DLLs.

The program was created with VB4, and will run under either the 16-bit or 32-bit edition of VB4. To run in VB3, you need to edit the declarations so they include only the lines between #Else and #Endif, and in the remaining two declarations delete the word Public and the underscore (line continuation) characters. In VB3, each declaration must be entered as a single line, with no carriage returns or line feeds.

The DLL (either inpout16.dll or inpout32.dll) must reside on any system that runs the program. Windows will search for the DLL in the following locations: the default Windows directory (usually \Windows), Windows' System directory (usually \Windows\System), and the project's working directory. (When you run the program in the Visual Basic environment, the working directory is your Visual-Basic directory.) Copy the appropriate DLL into any of these locations before you run the program. If you want to store the DLL in a different location, include its path in the Declarations.

Listing 1.
Source code for Figure 1's program.

```
Option Explicit
Dim PortAddress%
Dim Hexadecimal%
Dim ByteToWrite%
Dim ByteRead%
Dim ValueToWrite$
Dim ValueRead$
Dim PortAddressAsText$

Private Function fncConvertValueToText$(ValueToConvert%)
'Converts an integer to a string
'that displays the integer's hex or decimal value.
If Hexadecimal Then
   fncConvertValueToText = Hex(ValueToConvert)
Else
   fncConvertValueToText = Str(ValueToConvert)
End If
End Function

Private Function fncDecimalToHex$(ValueToConvert$)
'Converts a string's decimal value to hexadecimal.
fncDecimalToHex = Hex(Val(ValueToConvert))
End Function

Private Function fncGetValueOfString%(StringToConvert$)
'Returns the hex or decimal value of a string.
If Hexadecimal Then
   fncGetValueOfString = (Val("&h" & StringToConvert))
Else
   fncGetValueOfString = Val(StringToConvert)
End If
End Function

Private Function fncHexToDecimal$(ValueToConvert$)
'Converts a string's hexadecimal value to decimal.
fncHexToDecimal = Str(Val("&h" & ValueToConvert))
End Function

Private Sub cmdReadPort_Click()
'Read the port and display the value read in the Read text box.
ByteRead = Inp(PortAddress)
txtReadPort.Text = fncConvertValueToText(ByteRead)
End Sub

Private Sub cmdWriteToPort_Click()
'Get the value in the Write text box and write it to the port.
ByteToWrite = fncGetValueOfString(ValueToWrite)
Out PortAddress, ByteToWrite
End Sub

Private Sub Form_Load()
'Initial settings.
optNumberBase(1).Value = True
txtPortAddress.Text = 378
End Sub

Private Sub optNumberBase_Click(Index As Integer)
'The user may read and display values as decimal or hexadecimal numbers.
'When the number-base selection changes, change the display to match.
If optNumberBase(1) = True Then
   Hexadecimal = True
   txtPortAddress.Text = fncDecimalToHex(PortAddressAsText)
   txtWriteToPort.Text = fncDecimalToHex(ValueToWrite)
   txtReadPort.Text = fncDecimalToHex(ValueRead)
Else
   Hexadecimal = False
   txtPortAddress.Text = fncHexToDecimal(PortAddressAsText)
   txtWriteToPort.Text = fncHexToDecimal(ValueToWrite)
   txtReadPort.Text = fncHexToDecimal(ValueRead)
End If
End Sub

Private Sub txtPortAddress_Change()
'Get the value of the port address in the text box.
PortAddressAsText = txtPortAddress.Text
PortAddress = fncGetValueOfString(PortAddressAsText)
End Sub

Private Sub txtReadPort_Change()
'Store the contents of the text box in ValueRead.
ValueRead = txtReadPort.Text
End Sub

Private Sub txtWriteToPort_Change()
'Store the contents of the text box in ValueToWrite.
ValueToWrite = txtWriteToPort.Text
End Sub
```

Parallel Port Experiments

For a simple test of the example program, you can enter the base address of your parallel port, write a value, then read it back. The value shown should match logic levels of the Data bits (D0-D7) on the connector. Figure 2 shows the pin locations for each of the parallel port's signals.

All parallel ports use at least three port addresses. In addition to reading and writing to the port's base address, or Data port, you can read the Status port at base address + 1. (For example, with a base address of 378h, the Status port is at 379h.) Bits 3 through 7 of the Status register (S3-S7) are inputs. Bit 7 reads the inverse of the logic state at the connector. So if you read 78h, all five inputs are high at the connector. Bits 0-2 are usually

Another Way to Access Ports

Both Windows 3.x and Windows 95 allow software to read and write directly to ports. However, unlike DOS, Windows is a multi-tasking operating system, which means that a user may run multiple applications at once. If two programs try to access the same port at the same time, for different purposes, the result can be a mess!

For this reason, Windows makes it possible to manage accesses to a port from any application. A virtual device driver, or VxD, contains code that can read and write to a port. The VxD also can register the port with the operating system and specify whether or not it will share the port with other applications. If another program or driver attempts to access the port, the operating system will know whether to allow access or to inform the requesting software that access is blocked.

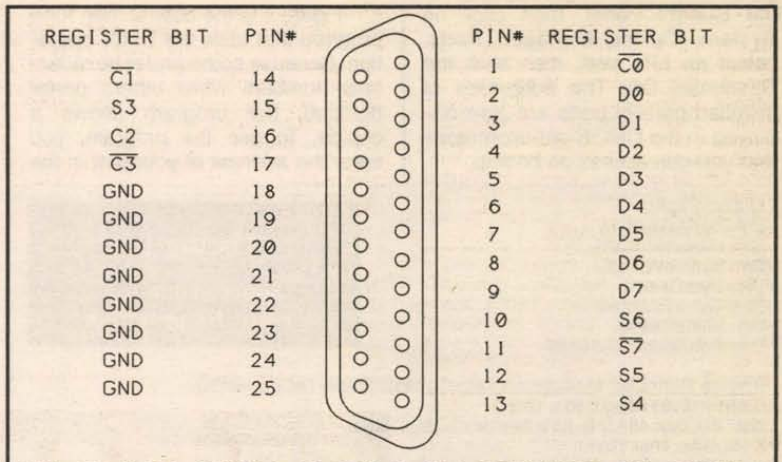
Sounds great, right? However, writing VxDs isn't for everyone. It requires an extensive knowledge of system hardware and Windows programming, plus expertise in assembly-language or C programming. Most device-driver writers use a variety of special tools, including Microsoft's Device Driver's Kit. There's no way to write a VxD in Visual Basic.

If your program communicates with a port that other applications have no reason to access, and if you're running Windows 3.x or Windows 95, direct port I/O is a simple and safe enough way to access the port. If you want to use a VxD to access a port, a quick solution is to buy one of the OCX's designed for this purpose. (See Sources for vendors.) These are also a solution if you're running Windows NT, which prohibits direct port accesses, or if you want to use the parallel port's hardware interrupt.

Using the OCX in a program is straightforward. You install the OCX on your system, place the OCX on a form in your Visual-Basic program, and configure it with a range of port addresses and other optional information. You can then use Visual Basic statements to read and write to the ports. When the program runs, the port accesses are handled by the OCX, which communicates with a VxD (Windows 95) or a kernel-mode driver (Windows NT).

```
'Declarations for Inp and Out routines for port I/O

'There are two sets of declarations,
'one for 32-bit programs and the other for 16-bit programs.

'The appropriate DLL (inpout32.dll or inpout16.dll)
'must be stored in one of the following directories
'on the user's system: \Windows, \Windows\System,
'or the current working directory.

#If Win32 Then
Public Declare Function Inp Lib "inpout32.dll" _
Alias "Inp32" (ByVal PortAddress As Integer) As Integer
Public Declare Sub Out Lib "inpout32.dll" _
Alias "Out32" (ByVal PortAddress As Integer, ByVal Value As Integer)

#Else
Public Declare Function Inp Lib "inpout16.Dll" _
Alias "Inp16" (ByVal PortAddress As Integer) As Integer
Public Declare Sub Out Lib "inpout16.Dll" _
Alias "Out16" (ByVal PortAddress As Integer, ByVal Value As Integer)
#End If
```

Listing 2. Include these declarations in any Visual-Basic project that uses an Inpout DLL.



THE PARALLEL PORT'S 25-PIN D-SUB CONNECTOR AND SIGNALS

Figure 2. Locations of the 17 signals on the parallel port's D-sub connector, including Data bits D0-D7, Status bits S3-S7, and Control bits C0-C3. An overbar indicates a signal that is the complement, or inverse, of the corresponding bit in the PC's port register.

unused and read as 0s. Writes to the Status port are ignored.

You can also read and write to the Control port, at base address + 2. (For a base address of 378h, the Control port is at 37Ah.) Bits 0 through 3 of the Control register (C0-C3) are outputs. Bits 0, 1, and 3 in the Control register are the inverse of the logic states at the connector. If you read 04h, all four bits are high at the connector. If you read 0Bh, all four bits are low. On some ports, the Control bits are open-collector-type outputs with pull-up resistors. These can be used to read external signals if you first write 4 to the Control port to pull the outputs high.

Two other bits on the Control port don't appear on the connector, but can affect port operation. On bidirectional ports, bit 5 determines the direction of the Data port. If you have a bidirectional port, be careful with this bit! The default is 0, which configures the Data bits as outputs. Setting the bit to 1 disables the Data outputs and allows you to use the port to read external signals. (In rare cases, bit 7 performs this function.)

Bit 4 determines whether or not hardware interrupt signals (from Status port bit 6) are passed on to the interrupt controller. The default is 0, disabled. Just setting the bit to 1 usually has no effect, however, because the interrupt must also be enabled at the system's interrupt controller. But it's best to keep this bit at 0, just to be safe, unless you intend to use the hardware interrupt.

In short, you can write values from 0 to Fh (15 in decimal) to the Control port, and the corresponding outputs will change, while the upper bits remain zeros.

To find out if you have a bidirectional Data port, write 20h to the Control port to bring bit 5 high. Then write a couple of values to the Data port and read each back. If the values don't match what you wrote, the Data outputs are disabled and you should be able to read external logic signals on the Data lines. If the values do match what you wrote, the Data outputs are still enabled and you can't use the port to read external signals.

No matter what changes you make to a port's registers, rebooting restores the original configuration.

Accessing Other Ports

You can also use the Inpout DLLs to access ports on I/O cards that have custom ports. These are available from many vendors, in many configurations. Advantages are that you usually get more than the parallel port's 17 bits, and you don't have the hassle of dealing with the standard port's inverted bits. Some cards have analog inputs or outputs, with the converter circuits on-board, or features such as isolated outputs or relay-driver circuits. A card with built-in features like these can simplify your design work.

Custom I/O cards may use any unused port addresses in your system. Address ranges that are free for use in many systems include 250-277h, 280-2AFh, 300-377h, and 390-39Fh.

Developing Your Application

Once you have the DLL tested and working on your port, whether it's the standard port or a custom one, you're ready to design circuits to connect to the port, and the software to control them. The Sources box includes resources to get you started. **NV**

Jan Axelson is the author of *Parallel Port Complete: Programming, Interfacing, and Using the PC's Parallel Printer Port* (ISBN 0-9650819-1-5). You can contact her by E-Mail at **jaxelson@lvr.com** — To download the Inpout DLLs and source code for the example program in this article, visit http://www.lvr.com on the Web.

For Delphi Fans

If Borland's Delphi is your programming language of choice, you can access ports without using a DLL. In Delphi 1.0, which creates 16-bit programs, use Port to read and write to ports.

Delphi 2.0, for creating 32-bit programs, has no port functions builtin, but you can access ports using in-line assembly code in your programs.

This code writes the value 55h to a port at 378h:

```
var
  ByteToWrite:byte;
  PortAddress:word;
begin
  PortAddress:=$378;
  ByteToWrite:=$55;
  asm
    push al
    push dx
    mov dx,PortAddress
    mov al,ByteToWrite
    out dx,al
    pop dx
    pop al
  end;
end;
```

This code reads the value of a port at 379h into the variable ByteRead:

```
var
  ByteRead:byte;
  PortAddress:word;
begin
  PortAddress:=$379;
  asm
    push al
    push dx
    mov dx, PortAddress
    in al,dx
    mov ByteRead, al
    pop dx
    pop al
  end;
end;
```

You can use this same technique with any programming language that supports in-line assembly code. Delphi programmers can also use the OCXs described in "Other Ways to Access Ports" in this article.

Sources

If you want to learn more about how to use the parallel port and custom I/O ports in your own projects, here are some resources that will get you started.

On the Internet, visit Parallel Port Central (http://www.lvr.com) for tutorials, program code, and links to resources of all kinds.

"PC Parallel Port Interface" by Dave Dage, *Nuts & Volts*, Oct. '96. An introduction to the PC's parallel port, including the pinout and simple test circuits.

Sources for OCX's for port access under Windows 95 and NT:

Driver X ($249.00)
Tetradyne Software, Inc.
2542 S. Bascom Ave., Suite #206
Campbell, CA 95008
Phone: **408-377-6367**
Fax: **408-377-6258**
E-Mail: sales@tetradyne.com
Web: http://www.tetradyne.com

WinRT OCX ($295.00)
BlueWater Systems, Inc.
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Edmonds, WA 98020
Toll free: **800-962-2114**
Phone: **206-771-3610**
Fax: **206-771-2742**
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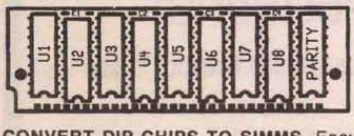

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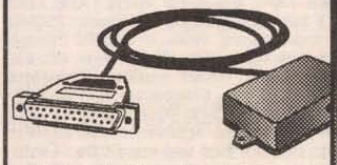

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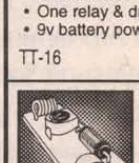

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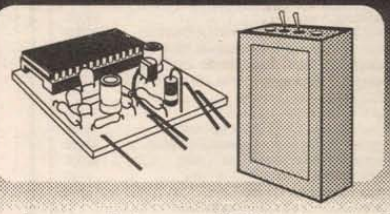

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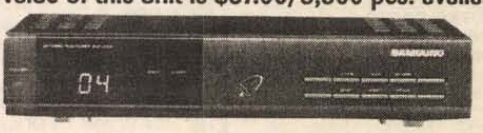

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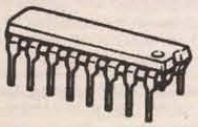

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ELECTRONICS Q & A

With TJ Byers

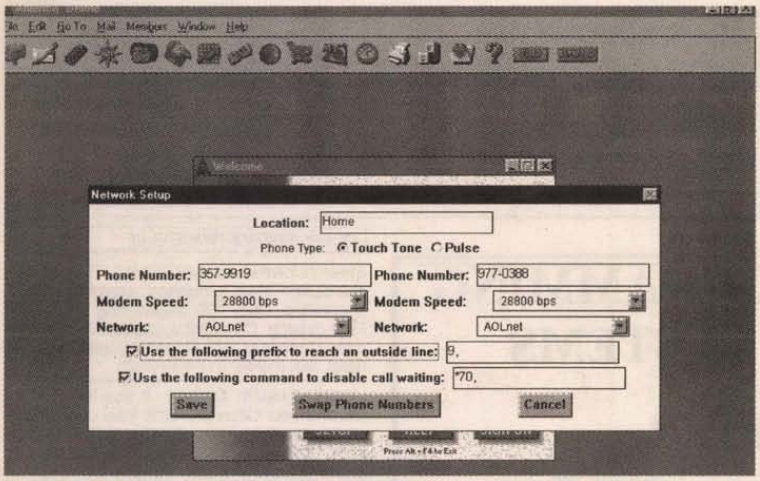
In this column, I answer questions about all aspects of electronics, including computer hardware and software. This column doesn't replace the Tech Forum that you've grown to love and support. Instead, it will supplement it, so feel free to participate as always with your questions and answers. You can reach me on America Online at TJBYERS, on the Internet at TJBYERS@aol.com, or by snail mail at *Nuts & Volts Magazine*, 430 Princeland Ct., Corona, CA 91719.

Motels & Modems

Q. You are my last hope (kinda funny that no one – not even my dealer or Radio Shack – can answer a question that I know must have been asked a hundred times). I have a laptop Toshiba 115 Satellite Pentium with Windows 95. It works great, and even does faxes. But when I have to go out of town I can't get it to send E-Mail because of the extra numbers, such as the "9" in the motel room, even though I add the extra numbers to the telephone number. I'll bet there are a million people who would like to know this answer!

Dick Rodgers
via Internet

A. *A million people? Hmm ... Actually, the answer is quite simple. What's happening is that it takes about a second or two for the "9" prefix to kick in and provide the second dial tone. When you put a "9" at the beginning of your dialing sequence, the software doesn't know that it has to pause between the "9" and the phone number. That's your problem. Back in the days of old, we used an "AT" code with commas to insert the wait period (the actual code went something like ATD 9,,714-555-1212). Fortunately, most communication programs nowadays will do this for you. Look under the set-up or preference settings. Here's how it's done in America Online.*



If your software doesn't have this capability, you can do it manually by dialing "9" or whatever, then wait for the second dial tone before starting your software.

MIME For The Mac

Q. I'm a lifetime subscriber to *N & V*, and I'm looking for a MIME translator for my Macintosh.

Tall Henning
via Internet

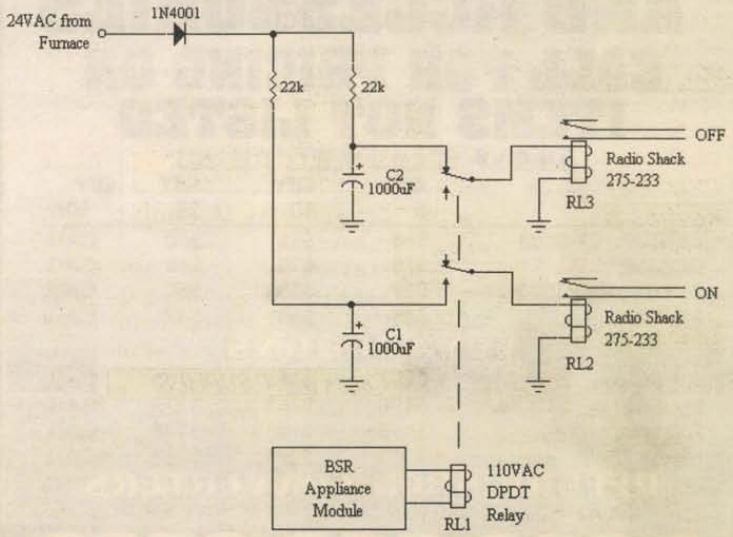
A. *Most Mac users prefer BINHEX for sending binary files over the Internet, but MIME is used, too. You'll find a MIME decoder for the Mac on our Web site under the name YA-BASE64-129.HQX. You'll also find a BINHEX file converter for the Macintosh under the name BINHEX50.SIT.*

X-10 Toggle ON-OFF Remote

Q. I have a gas fireplace that I control with a latching relay which I activate from several locations. Basically, one momentary push button supplies 24 VAC to the ON coil which turns on the fireplace; another momentary push button provides 24 VAC to the OFF coil to turn the fireplace off. Alternatively, I'd like to use a wireless X-10 (BSR) system to turn it on and off, too. I could, of course, use two Universal Modules – one for the ON function and one for the OFF – but I prefer to build a steering circuit that runs off a single module. What is the simplest way to do this?

Occupant
St. Louis, MO

A. *Here's a very low-tech solution that was popularly used in the 50s.*



The core of the circuit is built around three relays and a couple of capacitors. RL1 drives RL2 and RL3 alternately to trigger your latching relay on and off. When the BSR module is activated, RL1 pulls in, which causes capacitor C1 to discharge through RL2, and momentarily close its contacts. When the BSR module turns off, RL1 drops out, and C2 discharges through RL3 to momentarily activate it. Capacitors are charged via their separate 22K resistors. The values have been selected so that the Radio Shack relays (with a coil resistance of 1K) close for about one second, then drop out. The capacitor take about 30 seconds to recharge after RL1 toggles. Relays RL2 and RL3 can probably be eliminated and replaced by the ON and OFF coils of your latching relay. What you need to do is measure the resistance of the latching coils using a VOM, then calculate the value of the capacitors using the formula

$$C = \frac{1}{\text{coil resistance}}$$

Don't worry that it's not AC voltage. Most AC relays will work on DC voltage, particularly the latching type. If you have trouble with RL1 engaging, plug a night light into the X-10 module. For more information on the X-10 system, check out http://www.techmall.com/smarthome/x10tech.html on the Internet.

PC Memory Primer

Q. I am trying to learn how the 8086 uses 16-bit registers to address up to 1 MB of memory. I have read explanations in several publications, each which allocates only about a page or so as to how this is accomplished. None go into enough detail for me to gain a complete understanding of how this memory segmentation is accomplished. Can you recommend a publication or book that goes into a detailed step-by-step explanation?

M. Meyers
Bothell, WA

A. *I'll give our readers a quick rundown of the concept here, but what you need for step-by-step is a good book on assembly language programming. Try Stacey's Professional Bookstore (http://www.staceys.com) in San Francisco (and other locations) or Amazon.com, Inc. (http://www.amazon.com) on the Internet. Both stock in depth. Now the details. Think of the computer's RAM as a city, where you have boulevards, avenues, and streets. Along the way there are homes. Each house represents a pigeonhole for data. Just as you find a person's house by its*

Continued on page 111

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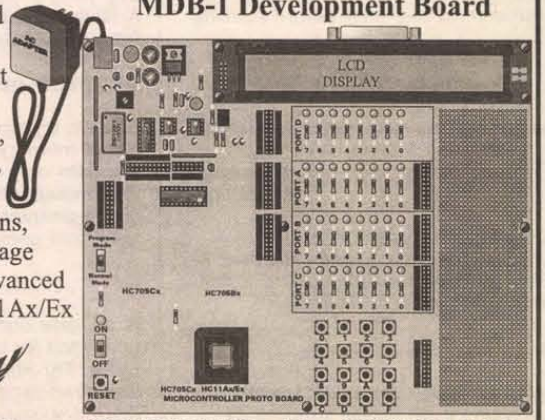

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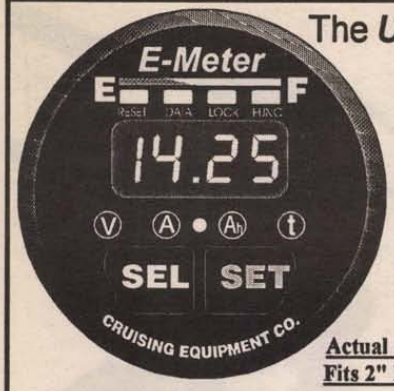

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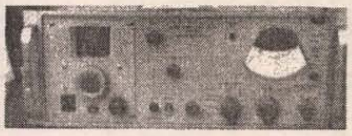

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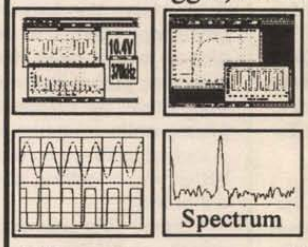

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NO HOLES IN *MY* VEHICLE!

by Gordon West

As you and your better half look over your new vehicle, one statement is always going to be made before this new unit gets off of the car lot: "You are not going to drill any holes in our new vehicle for any antenna!"

Sound familiar?

As a radio hobbyist, the need for external antennas on your vehicle is paramount for good reception. The lower the frequency, the longer the antenna or its necessary loading coil. On cellular phone frequencies, on-glass antennas may work adequately well. But on lower frequencies, you will want to squeeze out every last drop of dB gain that the antenna may offer, and a direct coax connection between your radio and the antenna will lead to the lowest loss, plus capabilities of driving the antenna with higher power output levels.

You will still see through-the-body hole mounts available at local communications dealers:

Larsen, NMO series
Motorola, 3/4" series
Larsen, LM and PO series
Hustler, four-hole ball mount

Magnetic mounts are fine for temporary installations, but for permanent installs, the mag mount may scratch or bubble your new paint job and that coax running in through the window looks anything but professional.

On-the-glass mounts are an adequate way to feed a small stinger, but the mount requires precise SWR adjustments and may be influenced by the tinting within your vehicle's windows. I have also found that car washes can sometimes wipe them out, and on a hot day the inside pick-up box unglues itself from the window. While there are probably thousands of radio enthusiasts who swear by on-glass mounts, their popularity among radio amateurs and hobby radio enthusiasts — including CB radio operators — has fallen off to a better way of getting an antenna on a vehicle without holes.

Japan first introduced gutter-mounts and lip-mounts about 15 years ago. The first generation of mounts was designed for temporary installations. But after a few years of use and constant feedback by stateside radio operators, Japan perfected their trunk-lip and gutter-mounts into a permanent system of hanging almost any type of whip antenna on almost any type of vehicle.

The big players in lip-mounts without holes are the following: Comet, NCG Company, Anaheim, CA, 714-630-4541; Diamond, RF Parts Company, San Marcos, CA, 619-744-0750; Maldol Corporation, Seattle, WA, 206-525-1896.

While I have seen other lip-mounts which look similar to Comet, Diamond, and Maldol, I have not worked with them to test their strength, and everyone who runs external antennas from gutter-mounts and lip-mounts all indicate Comet and Diamond as the two most popular brands.

Gutter-mounts hang onto the rain gutter of vehicles by a compression fit that gets tightened up with a minimum of two Allen screws. If your vehicle has a rain gutter, the gutter-mount is a great way to get your VHF or UHF antenna up nice and high.

Early versions of the gutter-mount offered all adjustments via the supplied pair of Allen wrenches. The small Allen wrench would adjust the tightness of the gutter-clamping assembly, and the bigger Allen wrench would adjust the side-to-side positioning for the vertical antenna. That has been improved by a ratchet-style thumb adjustment that allows you to lower the antenna in order to get under low clearance heights.

The Comet RS-500 and RS-2 both offer the ratchet-style lock. I am presently running the Comet RS-500 on my communications van (see photos), and the whip is held securely in place and has even survived several encounters with tree branches.

Comet has also developed better Allen screws that won't easily strip out, and they also have a powerful locking mechanism that will keep the mount from breaking its little teeth when accidental stress (from a tree) torques it from side to side.

If your vehicle has no gutter, you are all set with Comet, Diamond, and Maldol lip-mounts. The lip-mount works on hatches, doors, trunk lids, or just about anywhere else on the vehicle that has some thin lip for it to grab. The mount slides over the lip, and a minimum of two — preferably four — Allen screws tighten in on the lip, securely holding the mount on your vehicle. You then use a bigger Allen wrench for vertical adjustments, and there are so many things that you can adjust for vertical, you can mount the lip in almost any position and always manage to get the antenna standing absolutely straight up.

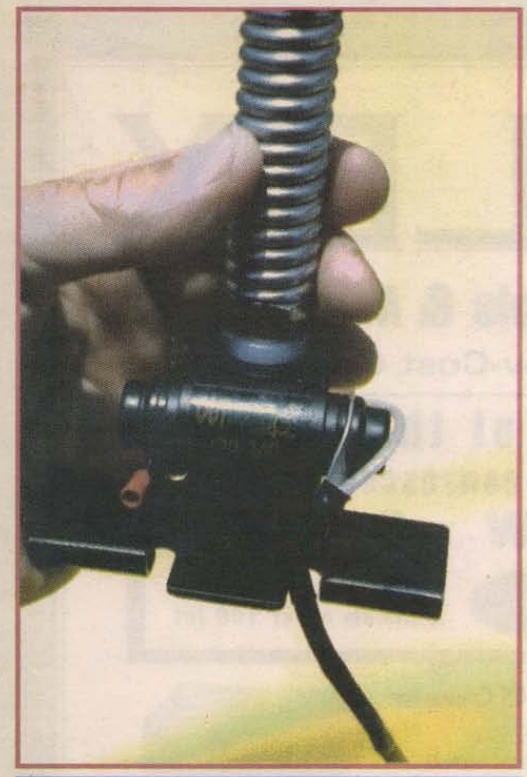
Comet also offers the lip ratchet-mount that allows you to lay the antenna down when going under low obstacles. Comet includes a rubber-coated base so you won't mar the outside finish of your vehicle.

However, a word of caution. Some lip-mounts may offer an additional extrusion to help anchor the mount in place when the hatch or door is closed. You must make absolutely sure that your door is flush with the rest of the vehicle before attempting to test your new set-up. If your door is slightly recessed, closing the door may cause this extrusion to bite into your finish, taking a big chip out of your paint job. Your better half definitely won't be happy on this thought! So carefully check out your new lip-mount to make absolutely sure nothing digs in when you close the hatch or slam the door.

Diamond offers several lip-mounts, and they also have a unique hide-away antenna mount which allows you to open your trunk, fold the antenna safely into the trunk, and then close the trunk with-

Small-to-big coaxial cable transition.

Big ham "outbacker" high-frequency whip on lip-mount on Gordon West's new communications unit.



This lip-mount holds a big outbacker antenna in place with no problems after 3,000 miles on Gordon's new communications van.

out anything showing. This is a clever arrangement; I have tried one of these and I like it very much on my smaller single-band and dual-band amateur antennas.

Maldol and, most recently, Diamond have gone one step further — their lip-mount features a small motor that can remotely power-up or power-down your antenna system. The antenna does not telescope in or out, but rather goes from lay-down position to vertical at the flip of a switch. I have this on my communications vehicle, and it works great as long as I remember to power it horizontal under low bridges. There is a slip-clutch assembly just in case I forget.

You are probably thinking that your new vehicle door or trunk lip won't have enough stamina to take the compression of set screws and the mount on the other side. If you look carefully at your lip, you will see that most vehicles fold back the metal, giving it double strength right at the edge. This is where the set screws can bite in if you're looking for a well-grounded mount. If you are running a halfwave shunt-fed antenna that does not necessarily need a good ground at the feedpoint, you can also insert a metal plate that will keep the set screws from taking an inside bite at the inside paint job that no one will probably ever see. The worst you might have is four little tiny bare spots from where the set screws have dug in. Nothing shows from the outside.

Once your mount is in place, your next job is to route the cable. The cable usually comes extra.

Your first choice is whether or not you want your mount to accept a cable with an N-type connector for UHF antennas, or the more common UHF connector for most VHF antennas. Take a look at the antenna you plan to mount on the lip-mount or gutter-mount; does it terminate to a low-loss N-connector, or does it terminate to a PL-259 type fitting?

The coax cable assemblies may come with about 12" of RG-188 Teflon coax that allows you to close the trunk, door, or hatch without crushing larger coax. This tiny coax then blends into larger low-loss coax, and this you route to your equipment. Almost all manufacturers allow for the radio connector on the end of the coax to be unscrewed, and this lets you get your cable through very small areas under the rug that you normally could not do with the connector already attached. Smart.

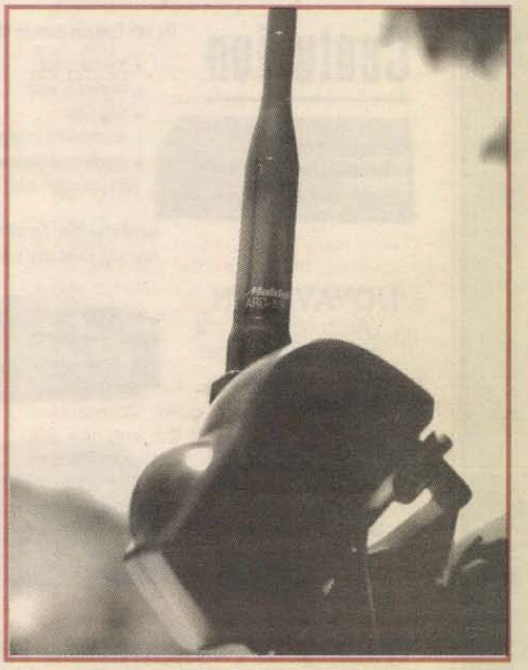
It's important to keep in mind that most mounts don't come from the coax attached — this will be extra. In fact, the coax cable assembly with the proper connectors may actually cost you more than the mount itself, but you go with the coaxial cable option specifically designed for the mount to prevent headaches when you go to install the set-up in your new vehicle.

Both Comet and Diamond make some excellent low-profile mounts for sports cars. The Diamond K600 mount is aerodynamic and is held on with four set screws. The Comet GR-5M is also low-profile, and even comes with a gold-plated UHF connector.

Comet also has the CQ-5M deluxe quick-disconnect trunk mount that easily disengages by the release of a lever if parking in a high crime area. Another great idea!

But what about big high-frequency ham antennas? Anyone make a mount that will keep them standing tall on a vehicle without stripping out the inside vertical-adjustment threads? I found that the Diamond special trunk mount for 3/8 x 24 thread antennas does a relatively good job in staying in place with lightweight whips such as Hamstik, Lakeview whips, ASA whips, and Valor lightweight whips. But if you try to hang a heavy Hustler or Outbacker antenna on it, it will only work if you mount this special trunk mount so that the wind action is on its side, rather than on its tilt-able face. The little teeth inside can't take this type of pressure, and it will ultimately strip out and fold back. But if you are careful on how you mount it, it may work okay. Or maybe you might need a little bit of monofilament so as not to overstress this mount.

So, take a look at the photos in this article, and see how I have used all of the different mounts for configuring antennas all over the new WB6NOA 21-foot van/RV. I have over 3,000 miles on the antenna systems, and they have worked well — including several encounters with tree branches. Take a look and see how your vehicle could very easily work with these very smart imported gutter- and trunk-lip mounts from Comet, Diamond, and Maldol. Stay with these three brand names as proven performers. NV



Maldol power-up and power-down lip-mount.

New ARC for WB6NOA

After 20 years of faithful emergency communications service, the Gordon West black station wagon will retire and NOA's ARC amateur radio communications vehicle will take over. Gordo indicates the new ARC unit will be used for both classroom demonstrations, as well as VHF/UHF/microwave DXpeditions.

"This new unit will be added to our water-grid arsenal, now allowing us the capabilities of attending regional ham shows, and have all of our microwave equipment onboard," comments Gordon West WB6NOA.

"It will also serve as an emergency communications vehicle for our local American Red Cross chapter, plus emergency communications to the city of Costa Mesa," adds West.

West's new communications vehicle is built around a Chevrolet 22' G30, one-ton, extended-van chassis with a 7.4 liter 454 CID EFI V8 gas engine. There will be a 4.5 KW generator installed beneath the rear radio operating area to provide plenty of power for all amateur radio equipment onboard.

The upper portion of the vehicle is built by Home & Park Motorhomes in Ontario, Canada, called "Roadtrek." The roof is all fiberglass, but will contain built-in copper screening for good RF shielding between the antennas and the passenger compartment.

"All of the antennas will feature lip-mount and gutter-mount technology from the leading antenna manufacturers like Diamond and Comet. We will also have a motorized antenna lay-down mount from Maldol," comments West.

His idea of "no holes" was to specifically test the new generation of antenna mounts that secure firmly to almost any ridge, lip, or metal edge. "We will even run a full-length, high-frequency whip off of the rear door tire mount, and again, we will go only with off-the-shelf antenna mounts available at all ham radio stores," adds West.

Built into the screen area separating the metal sides of the vehicle and the fiberglass roof will be an automatic high-frequency antenna coupler with a long-wire attachment. "This could allow us to string up a long wire, using the screen, as well as the chassis sides of the vehicle for a great ground plane system," adds West.

"This would allow us to put a strong signal on 75 meters, the coordination band for weak signal tropo and meteor scatter work," comments West.

Long-boom Yagi antennas will be carried on the inside of the vehicle. The booms would be separated so as not to exceed the length of the vehicle. The Yagis would operate either fixed direction or, for now, via "Armstrong" rotor system.

When it comes to the amateur radio equipment on the inside, West claims that every manufacturer of amateur radio equipment will be represented.

"We will have 160 meters through 10,000 MHz, and each and every manufacturer will have at least one operating unit in this communications vehicle," comments West. "This will allow students to enjoy 'hands on' exposure to every brand sold through dealers or direct, and this way our mobile classroom will support everyone in the industry equally," adds West.

Plans also call for large magnetic signs, indicating AMATEUR RADIO ON THE AIR so that the vehicle may also travel as an amateur radio information center. "We plan to make this unit very visible during amateur radio operating events like Field Day and Simulated Emergency Test. We will also carry amateur radio information packages, including amateur radio magazines, ARRL information sheets, ham publications, along with manufacturer frequency charts and 'Welcome to Ham Radio' guides," finalizes West.

There will be three operating positions inside the vehicle — the front for high-frequency, mid-section for VHF and UHF, and the rear area that will carry satellite and data equipment.

"I look forward to working many stations on the air from NOA's ARC," smiles West.

Plans call for a West Coast "shakedown," and then looking into other engagements throughout the rest of the country. Gordon West's wife, Suzy West N6GLF, looks forward to driving while "Gordo" scurries around inside keeping everything on the air "ARC Mobile."

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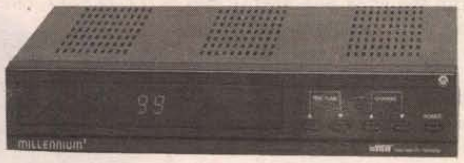

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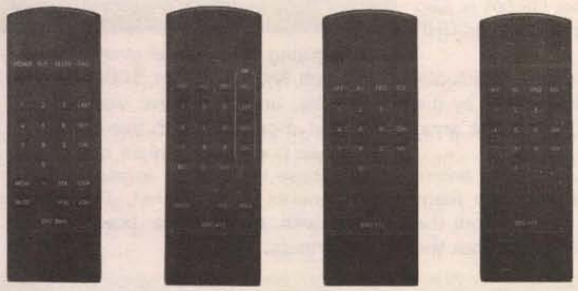

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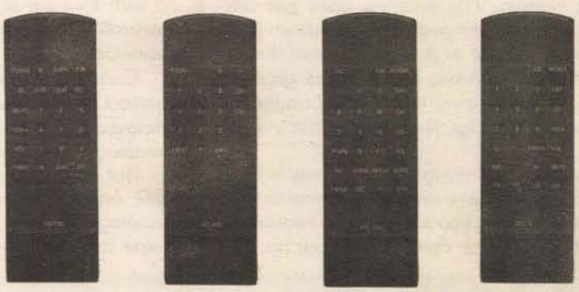

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by Jeff Stefan

Fractals Unraveled

This article explains the concepts of fractal geometry and provides you with a simple program that helps you to generate your own fractal images. When I first saw fractal images, I was struck by their jagged, colorful electric forms. The images appeared to be terribly complicated, but really only required a few lines of code to produce. I had an executable file (with no source code) that generated fractal images, but I never took the time to really understand how they were created and the underlying mathematical concepts behind them. Unraveling fractals comes down to understanding two concepts: iterative functions and complex arithmetic.

What are fractals?

We experience life in four dimensions: length, width, height, and time. Our senses tell us this. The irreversibility of events gives us our intuition of time. Euclidean and analytic geometry provide the mechanisms to model spatial relationships in the real world. It allows us to create useful abstractions of reality, but clean right angles and perfect arcs rarely occur in the natural world.

Objects in the natural world are contradictory, complex, and difficult to describe (especially mathematically), yet appear to be governed by a recurring set of simple underlying principles.

Tree bark looks the same from a distance, but each individual piece is somewhat different. Every ocean wave breaking against a rocky shore is a little different, even if it contains the same volume of water and travels at the same velocity. Look at the clouds and they all have similar shapes, but all are a little bit different, especially around the edges.

This is called self-similarity, a phrase coined by Benoit Mandelbrot, the father of the Mandelbrot Set. A fractal object looks almost the same from a great distance or on a microscopic scale. Fractal objects appear to be similar on all scales, but not exactly alike.

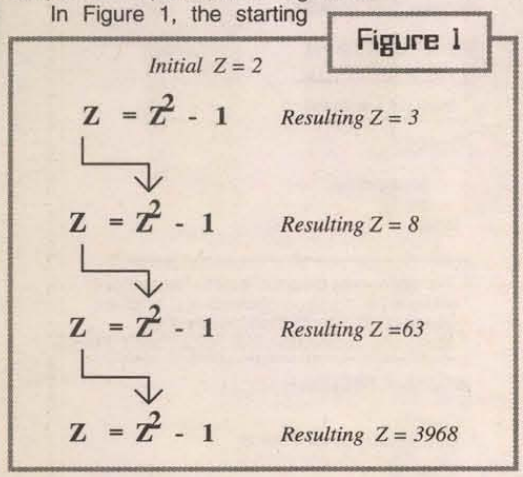
Furthermore, the dimensions of these objects do not clearly seem to be separated into one, two, or three dimensions, but somewhere in between. Hence, the word fractal for fractional dimension (also coined by Mandelbrot).

Iterative Functions

To begin learning how to generate fractal images, we first start with iterative functions. An iterative function calculates a value, then uses the value as the basis to calculate the next value. This process is repeated indefinitely. An iterative function, $Z = Z^2 - 1$, is shown in Figure 1.

In Figure 1, the starting value of Z is two. Notice how quickly the resulting Z values grow in magnitude. We can safely assume that Z will continue to grow toward infinity.

Figure 1



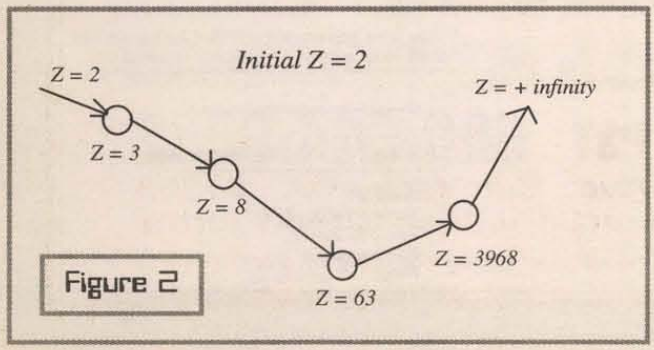
We can track the progress of each step in the equation graphically, and can consider each iteration of the equation as a new state. The transitions between these new states are depicted by arrows drawn between the nodes, with the arrowhead indicating the progress of the numbers as they iterate through the equation.

This is called a state machine. Figure 2 interprets each new number generated as a new state in a state machine. This state machine knows no bound and heads straight for positive infinity when the initial value of two is used.

For the starting value of two, this equation has infinity as an attractor. If we use the same equation with a starting value of Z less than zero, the resulting numbers rapidly shrink toward zero, as illustrated in Figure 3. For a starting value of one or less, the equation oscillates between attractors of zero and negative one.

Figure 4 shows the state machines for the equation $Z = Z^2 - 1$ for the starting value of Z = .9.

For the initial value of one, Z immediately orbits around negative one and zero. If the starting value is reduced to .9, then it takes a little longer for Z to settle down to and orbit around negative one and zero. It's easy to see by the state machine that the numbers rapidly start approaching negative one and zero with each iteration of the equation.



This may seem dull and obvious for real numbers, but it explodes in chaotic complexity and detail when complex numbers are used instead. The key points of understanding here are orbits and attractors.

Complex Numbers: A Quick Review

The hurdle in generating fractals is understanding complex numbers. Complex numbers are composed of two parts: a real part and an imaginary part. The imaginary part is defined as the square root of negative one. The square root of negative one is given the universal symbol *i*. By definition, i^2 is equal to negative one.

Any real number can be expressed as a complex number. For example, the number 2 can be expressed as 2 + 0 *i*. Zero times *i* is of course, zero.

Complex addition is simple, as shown in Figure 5. You just add like terms.

Complex multiplication is slightly more complicated, as shown in Figure 6. The trick is to pay attention to the fact that i^2 is equal to negative one.

When graphing a complex equation, the real part of the expression is plotted along the X axis, and the complex part is plotted along the Y axis.

The equation we're interested in is $Z = Z^2 + C$. Figure 7 shows this equation when complex numbers are used instead of real numbers.

The concepts behind fractals have been around since the beginning of the 20th century. In 1905, the year Jules Verne died, a French mathematician name Pierre Fatou studied the simple equation $Z = Z^2 + C$, varying the value of Z while keeping C constant. This is trivial and unproductive for real numbers, but Fatou used complex numbers for Z and C.

He soon discovered that infinity is the equation attractor if the absolute value of Z ever grows larger than two. This is the equation used to generate the Mandelbrot set, which our program generates.

The Mandelbrot Set is generated by varying the value of C and keeping Z constant. The Mandelbrot Set is the set of numbers that do not exceed +2 or -2 when varying C in $Z = Z^2 + C$.

Mandelbrot, a contemporary mathematician, built on Fatou's work, studying the profound differences between analytic/Euclidean geometry and the shape of things in the real world. In 1975, he coined the word fractal, which appeared in the title of his 1977 book, *The Fractal Geometry of Nature.* The key value of the Mandelbrot Set, and fractals

in general, is that tremendously complicated systems like those found in nature can be created from very simple rules.

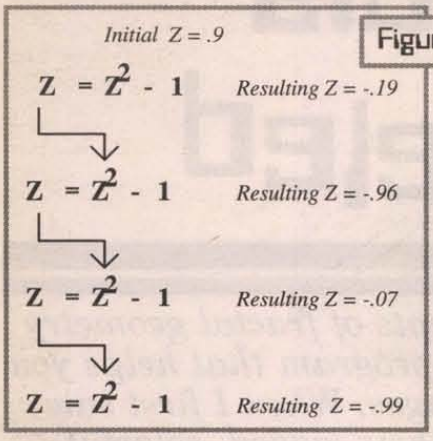
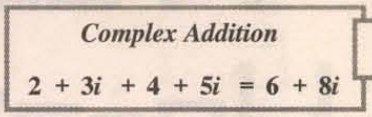
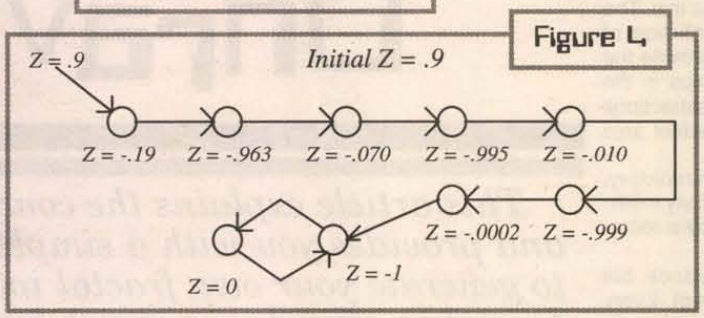
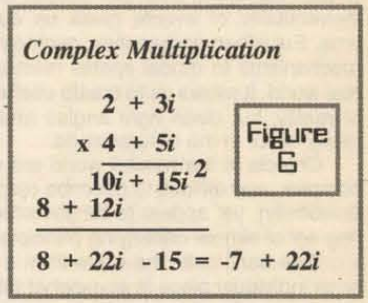


Figure 8 illustrates the full Mandelbrot Set generated from our program.

Figure 9 shows the wild effects of slight magnification and slightly different starting values.







Code Description

The program to generate the Mandelbrot Set is called mbs.c. It's written in Turbo C/C++ Version 3.0 and uses the Borland Graphics Interface (BGI) for graphics support. The file egavga.bgi must be in the same directory as mbs.exe or the program

```
/*************************************************************************
* Filename: mbs.c
* Description: Mandelbrot Set Generator
*          This program is written using Borland C/C++ ver. 3.1
*          or Turbo C/C++ ver. 3.0 utilizing the default BGI
*          interface. The graphics runtime module egavga.bgi is
*          required to be in the same directory as this executable.
*
*  Application Notes:
*
*    1) The screen width and aspect ratio can be altered by
*       changing
*       the values of X_PIXELS and Y_PIXELS. The count limit
*       can be altered by changing MAX_COUNT. The display
*       centering can be adjusted by changing X_ADJUST and
*       Y_ADJUST.
*
*    2) The switch statement in GetColor() can be expanded and
*       enhanced to change pixel color and color resolution
*       depending on the value of the count.
*
*    3) The program can be terminated at any time by pressing a
*       key.
*
*  (c) 1997 Jeff Stefan
*
*************************************************************************/
#include <stdio.h>
#include <stdlib.h>
#include <graphics.h>
#include <conio.h>

/*************************
* Define display parameters
*************************/
#define MAX_COUNT 50
#define X_PIXELS  450
#define Y_PIXELS  350
#define X_ADJUST  25
#define Y_ADJUST  75

/*********************
* Input file pointer
*********************/
FILE *fp;

/***********************
* Variable declarations
***********************/
int FromFile;
char TextBuffer[512];
int Count,Color,i;
int MaxCount = 0;

/***********************
* Function prototypes
***********************/
int GetColor(void);

#define DEBUG

main()
{
int j,k;
double XStart,YStart,Ca,Cb,Zx,Zy,Xtemp,Size,Result;
int gdriver = DETECT, gmode, errorcode;
int Done = 0;
int InChar;

  clrscr();
  printf("Read data from File or Keyboard?\n1 File  2 Keyboard\n");
  scanf("%d",&FromFile);

  /*************************/
  /* graphics initialization */
  /*************************/
  initgraph(&gdriver, &gmode, "");
  errorcode = graphresult();
  if(errorcode != grOk)
  {
    printf("Graphics error: %s\n", grapherrormsg(errorcode));
    printf("Press any key to halt:");
    getch();
    exit(1);
  }

  /***********************
  * initialize variables
  ***********************/
  Ca = Cb = XStart = YStart = Xtemp = 0.0;

  /*********************************
  * Get data from file or keyboard
  *********************************/
  switch(FromFile)
  {
  case 0:
  case 1:
    fp = fopen("mbs.dat","r");
    if(fp == NULL)
      exit(0);
    break;

  default:
    break;
  }

  while(!Done)
  {
    /*************************************
    * Re-init graphics to refresh screen
    *************************************/
    initgraph(&gdriver, &gmode, "");
    errorcode = graphresult();
    if(errorcode != grOk)
    {
      printf("Graphics error: %s\n", grapherrormsg(errorcode));
      printf("Press any key to halt:");
      getch();
      exit(1);
    }

    /*************************/
    /* get input parameters */
    /*************************/
    switch(FromFile)
    {
    case 0:
    case 1:

      if(fp!=NULL)
      {
        fscanf(fp,"%lf %lf %lf
%d",&XStart,&YStart,&Size,&MaxCount);
      }
      break;

    /*****************************
    * Get input data from keyboard
    *****************************/
    case 2:
    default:
      ClearPrompt();
      printf("Enter XStart : ");
      scanf("%lf",&XStart);
      ClearPrompt();
      printf("Enter YStart : ");
      scanf("%lf",&YStart);
      ClearPrompt();
      printf("Enter size : ");
      scanf("%lf",&Size);
      ClearPrompt();
      printf("Enter Max Iterations: ");
      scanf("%d",&MaxCount);
      break;
    }
    /*************************************************
    * Default to 100 if count is entered incorrectly
    *************************************************/
    if(MaxCount <= 0)
    {
      MaxCount = 100;
    }

    /*************************/
    /* Create Mandelbrot Set */
    /*************************/
    sprintf(TextBuffer,"XStart = %2.3lf YStart = %2.3lf Size = %2.3lf
          MaxCount = %d",XStart,YStart,Size,MaxCount);
    outtextxy(20,50,TextBuffer);

    for(j=1;j<X_PIXELS;j++)
    {
      /*****************************
      * break out if keyboard hit
      *****************************/
      if(kbhit())
        {
          closegraph();
          exit(1);
      break;
        }
      /*****************************************************
      * This section does the actual work by first assigning
      * values to the complex components of C, which are
      * Ca and Cb. In order to adjust the size of the
      * display, change the values of X_PIXELS and Y_PIXELS.
      *****************************************************/
      for(k=1;k<Y_PIXELS;k++)
      {
        Count=0;
        Ca = XStart+j*Size/X_PIXELS;
        Cb = YStart+k*Size/Y_PIXELS;
        Zx=Zy=0;
        /*****************************************************
        *  Stay in the loop and test until MaxCount is reached
        * or the result exceeds 4.0 (definitely not in the set).
        *****************************************************/
        do {
          /*****************************************
          *          2
          * Evaluate Z = Z + C in the complex plane
          *****************************************/
            Count+=1;
            Xtemp = Zx*Zx - Zy*Zy;
            Zy = 2*Zx*Zy+Cb;
            Zx = Xtemp+Ca;
            Result = Zx*Zx + Zy*Zy;
        } while ((Count<=MaxCount) && (Result <= 4.0));
```

$$z = z^2 + c$$

$z = x + yi$ *Complex substitition for z*

$z^2 = (x + yi)^2$ *Complex substitution for* z^2

$c = a + bi$ *Complex substitution for c*

$z = (x + yi)^2 + a + bi$ *Resulting experssion with*

$(x + yi)^2 = x^2 + 2xyi - y^2$

Final expanded expression

$z = x^2 - y^2 + 2xyi + a + bi$

Figure 7

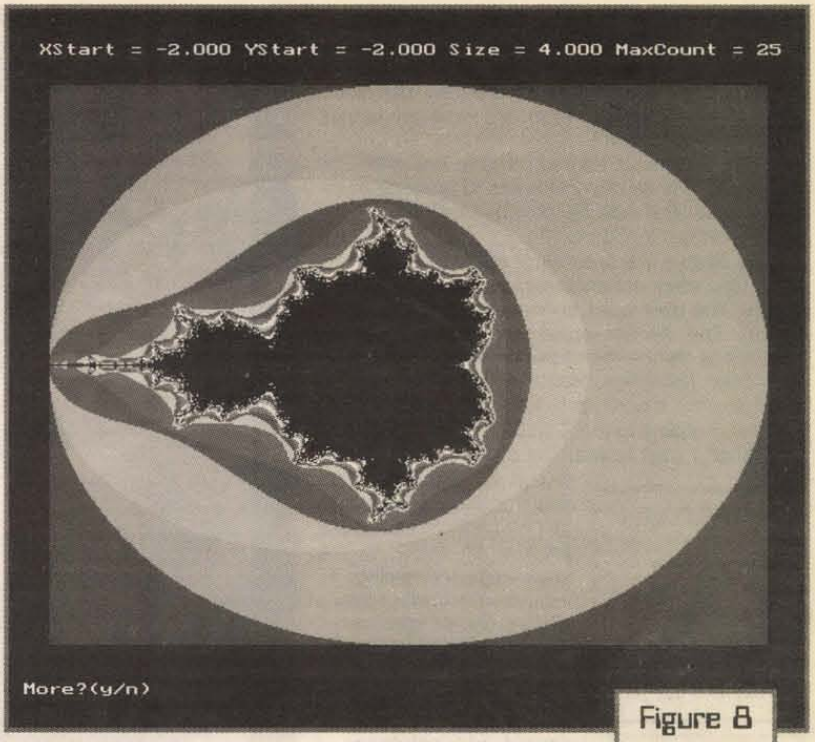


Figure 8

won't run.

You can enter set generation coordinates from a file, called mbs.dat, or directly from the keyboard. The parameters entered are the starting X and starting Y coordinates, the size or magnification of the image, and the number of iterations to determine whether a pixel is within the set or not in the set. We need to put a cap on the number of iterations, otherwise it could take a very long time for a decision to be made for each pixel.

The screen width and aspect ratio can be altered by changing the values of X_PIXELS and Y_PIXELS. The count limit can be altered by changing MAX_COUNT, and the display centering can be adjusted by changing X_ADJUST and Y_ADJUST.

Here's the loop for the set generator equation $Z = Z^2 + C$. This section of the program does the actual work by first assigning values to the complex components of C, which are Ca and Cb.

In order to adjust the size of the display, change the values of X_PIXELS and Y_PIXELS.

```
Count = 0;
Ca = Xstart + j *
Size/X_PIXELS;
Cb = Ystart + k *
Size/Y_PIXELS;
Zx = Zy = 0;
```

Now we need to stay in the loop until +2 or -2 is encountered, or we hit the MAX_COUNT limit value.

```
do {
    Count+=1;
    Xtemp = Zx*Zx - Zy*Zy;
    Zy = 2*Zx*Zy+Cb;
    Zx = Xtemp+Ca;
    Result = Zx*Zx + Zy*Zy;
} while ((Count<=MaxCount) && (Result <= 4.0));
```

Once we're out of the loop, we determine the color and plot it on the display:

```
    /*************************************/
    /* determine pixel color and display */
    /*************************************/
    Color = GetColor();
    putpixel(j+X_ADJUST,k+Y_ADJUST,Color);
   }
  }
  /*******************************
   * Terminate program if desired
   *******************************/
  InChar = NULL;
  outtextxy(10,450,"More?(y/n)");
  InChar = getch();
  if(InChar != 'y')
  {
   Done = 1;
   if(fp)
    close(fp);
  }
 }
 /*****************************
  * Restore original screen mode
  *****************************/
 closegraph();
 return(0);
}
/*************************************************/
/* GetColor: determines the pixel Color depending */
/*         on the value of count.                */
/*************************************************/
int GetColor()
{
 switch(Count)
 {
  case 1: Color = BLUE;
  break;
  case 2: Color = GREEN;
  break;
  case 3: Color = CYAN;
  break;
  case 4: Color = RED;
  break;
  case 5: Color = MAGENTA;
  break;

  case 6: Color = BROWN;
  break;
  case 7: Color = LIGHTGRAY;
  break;
  case 8: Color = DARKGRAY;
  break;
  case 9: Color = LIGHTBLUE;
  break;
  case 10: Color = LIGHTGREEN;
  break;

  case 11: Color = CYAN;
   break;
  case 12: Color = RED;
   break;
  case 13: Color = MAGENTA;
   break;
  case 14: Color = YELLOW;
   break;
  case 15: Color = WHITE;
   break;

  case 21:  Color = BLUE;
   break;
  case 22:  Color = GREEN;
   break;
  case 23:  Color = LIGHTCYAN;
   break;
  case 24:  Color = BROWN;
   break;
  case 25:  Color = LIGHTMAGENTA;
   break;

  case 31:  Color =  RED;
   break;
  case 32:  Color = GREEN;
   break;
  case 33:  Color = BLUE;
   break;
  case 34:  Color = CYAN;
   break;
  case 35:  Color = BROWN;
   break;

  case 41:  Color = LIGHTCYAN;
   break;
  case 42:  Color = LIGHTRED;
   break;
  case 50:  Color = CYAN;

  case 51:
  case 100: Color = RED;
  break;

  case 101:
  case 125: Color = MAGENTA;
  break;

  case 150:
  case 165: Color = BROWN;
  break;

  case 166:
  case 199: Color = LIGHTGRAY;
  break;

  case 200 :
  case 225 : Color = DARKGRAY;
  break;

  case 226:
  case 250: Color = LIGHTBLUE;
  break;

  case 251:
  case 275: Color = LIGHTCYAN;
  break;

  case 276:
  case 300: Color = LIGHTRED;
  break;

  default : Color = BLACK;
  break;
 }
 return(Color);
}

/*************************************
* ClearPrompt: clears text entry area
*************************************/
int ClearPrompt()
{
 gotoxy(30,15);
 printf("                ");
 gotoxy(30,15);
 return(0);
}
```

```
Color = GetColor();
putpixel(j+X_ADJUST,k+Y_ADJUST,Color);
```

That's the real meat of the program. The rest is just support for file and keyboard input and output, and graphics support.

The data file is named mbs.dat and can contain multiple lines of parameters to produce multiple images. The data file provided with the source code is shown in Figure 10.

As always, the program is yours to experiment with. One easy enhancement is to tinker with the colors. The pixel color is determined by the count value. The switch statement in the function GetColor() can be expanded to change pixel color and color resolution. You can plot Julia sets by changing the algorithm to keep the C value constant and changing the Z value.

When I want to examine a new area, I usually give it 25 iterations. That way it produces the image fast and with a reasonable amount of detail. If the area looks interesting, I'll increase the level of detail.

This program relies heavily on floating point operations, which tax the computer's horsepower. This also gives the program a degree of usefulness. I use it as a benchmark when testing a new machine's speed and performance.

MBS.DAT

```
-2.0 -2.0 4 125
-.33 .34 1 125
-.7 -.7 .7 350
-1.5 -.15 .6 425
-.744 .097 .5 100
-.744 .097 .05 100
```

Figure 10

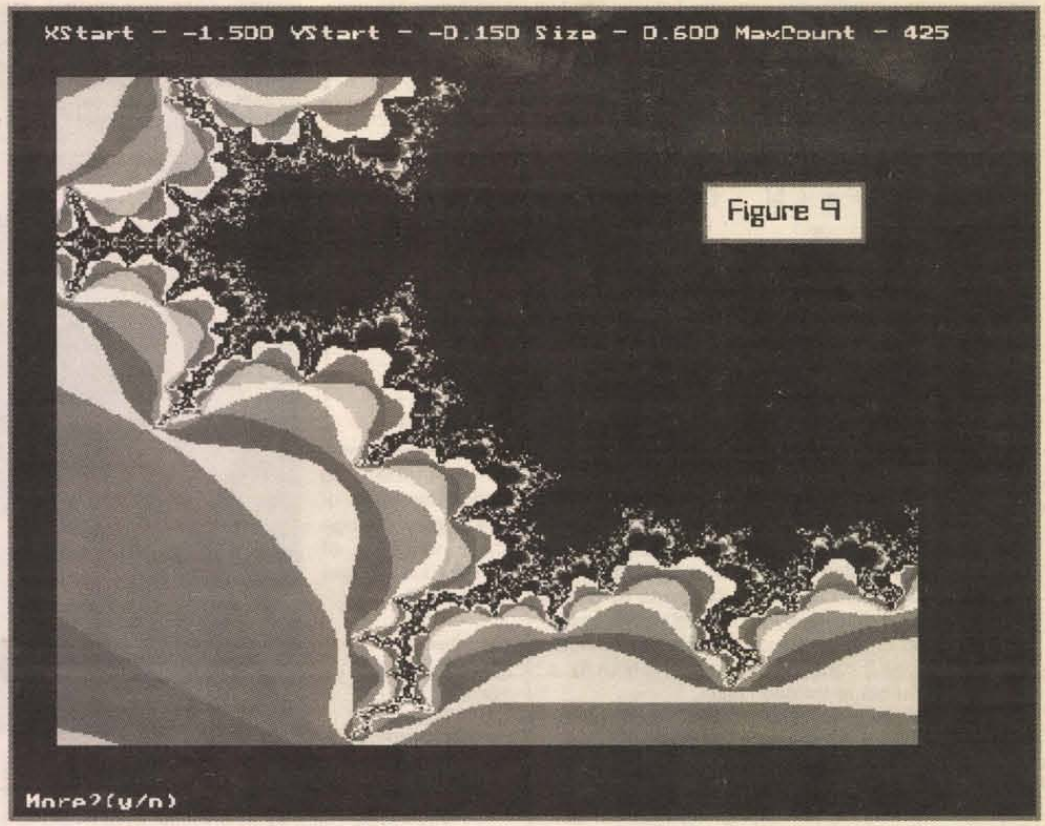


Figure 9

The program runs exceedingly slow on a 386, reasonably well on a 486, and cruises on a Pentium. You'll get a feel for it after you run it a while on different machines. You'll be surprised at the range of performance between seemingly identical machines from different computer manufacturers. I've learned to trust it as a reliable benchmarking tool.

It's amazing that a few lines of fractal code and a personal computer are all a person needs in order to do serious mathematical research, if so inclined. Like amateur astronomy, fractal geometry opens the door for an amateur to make real and outstanding contributions to human knowledge.

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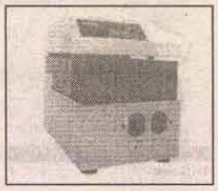

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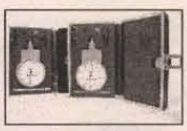

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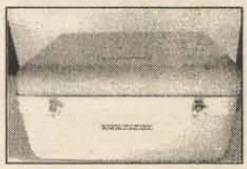

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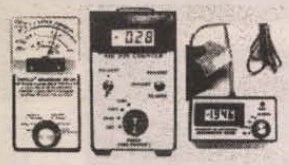

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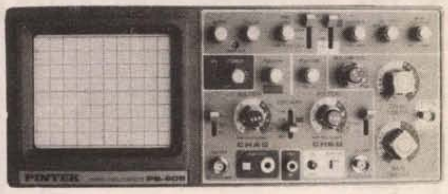

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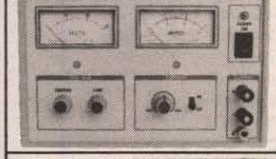

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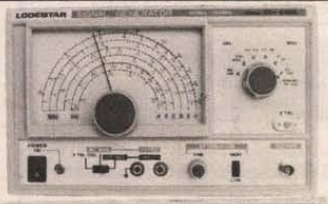

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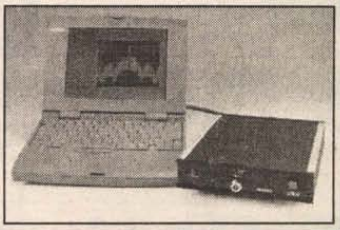

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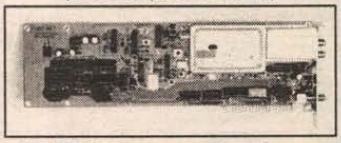

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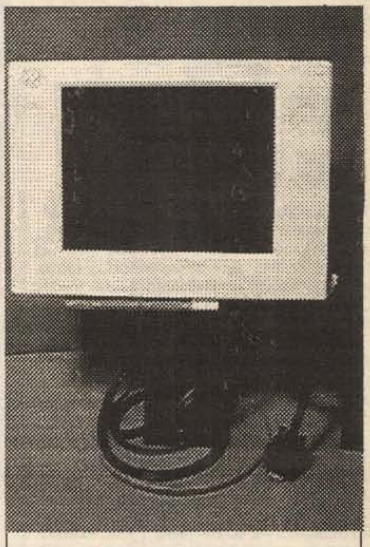

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HP 8557A/182T Spectrum Analyzer, 0.01-350 kHz, 1 kHz res., w/display $1,650.00
HP 8565A Spectrum Analyzer, 10 MHz-22 GHz, 1 kHz min.res.bw. $5,000.00
HP 8565A-100 Spectrum Analyzer, 10 MHz-22 GHz, 100 Hz min.res.bw. $5,500.00
HP 8569B Spectrum Analyzer, 10 MHz-22 GHz, 100 Hz min.res.bw. $9,000.00
TEK 7L13/7623A Spectrum Analyzer, 1 kHz-1.8 GHz, 30 Hz min.res.,w/frame $2,250.00
TEK TR503 Tracking Generator, 0.1-1800 MHz, for 492/4/5/6 ..... $1,375.00
TEK WM782V WR15 Harmonic Mixer, 50-75 GHz $2,000.00

NETWORK ANALYZERS

HP 11589A Bias Network, 0.1-3.0 GHz, N(f/f) $350.00
HP 11590A-001 Bias Network, 1.0-18.0 GHz, APC7 ..... $450.00
HP 11664C Detector Adapter, for 8755/6/7 ..... $200.00
HP 11665B Modulator, 0.15-18.0 GHz, for use with 8755/6/7 ..... $375.00
HP 3577A Network Analyzer, 5 Hz-200 MHz $15,000.00
HP 8505A-005/85 Network An., 0.5-1300 MHz, w/S-Parameter & phase lock $5,000.00
HP 8755C/(3)116 Scalar Network An. w/3 detectors, 10 MHz-18 GHz & frame $1,750.00
HP 8756A/(3)116 Scalar Network Analyzer, w/(3) detectors, 0.01-18 GHz $3,750.00
WAVETEK 1038D14A/H12 Scalar Network An,w/(3)15882 WR28 detectors,26.5-40 GHz $2,200.00

SIGNAL GENERATORS

FLUKE 6060A/AN Synthesized Signal Gen., 10 kHz-520 MHz, 10 Hz res,GPIB $2,000.00
GIGATRONICS 600/10-18 Synthesized Source, 10-18 GHz, 1 MHz res., GPIB $2,600.00
GIGATRONICS 605/10-18 Synthesized Source, 10-18 GHz, 1 kHz res., GPIB $3,000.00
GIGATRONICS 840-01 Freq. Doubler, 26.5-40 GHz (WR28) out, 13-20 GHz in $2,000.00
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 $5,000.00
GIGATRONICS 910/12-18,op Synthesized Source/Sweeper, 12-18 GHz, 1 Hz res., OCXO $3,500.00
HP 85100V Frequency Mult., 10-15 GHz in / 50-75 GHz out >0 dBm $4,250.00
HP 8640B-001,00 Signal Gen., 0.5-1024 MHz, AM, FM, var. audio osc. $2,500.00
HP 8654A Signal Generator, 10-520 MHz, calibrated AM & uncal. FM $550.00
HP 8656A Signal Generator, 0.1-990 MHz, 100 Hz res, AM, FM, HPIB $2,900.00
HP 8660C/86602B Synthesized Signal Gen., 1-1300 MHz, 1 Hz res., AM, FM $2,750.00
HP 8660D/86603A Synthesized Signal Generator, 1-2600 MHz $7,000.00
HP 8671A-005 Synthesized CW Generator, 2.0-6.2 GHz, 1 kHz res., HPIB $6,000.00
ROHDE & SCHWARTZ SMGU Synthesized Signal Generator, 0.1-2160 MHz, 0.1 Hz res. $12,000.00
WILTRON 6742A Synth. Signal/Sweep Gen., 18.0-26.5 & 26.5-40.0 GHz $8,750.00

SWEEP GENERATORS

HP 11869A Plug-in Adapter $450.00
HP 8600A Digital Marker, for HP 8601A $400.00
HP 8601A Generator/Sweeper, 0.1-110 MHz, +20 dBm levelled $400.00
HP 8620C Sweep Oscillator Frame $550.00
HP 8620C-011 Sweep Oscillator Frame, HPIB programmable $675.00
HP 86222A-002 RF Plug-in, 10-2400 MHz, +13 dBm levelled, 70 dB atten. $1,600.00
HP 86230B RF Plug-in, 1.8-4.2 GHz, +10 dBm unlevelled $675.00
HP 86240A-002 RF Plug-in, 2.0-8.4 GHz, +14 dBm lvld., 70 dB step att. $1,200.00
HP 86241A-001 RF Plug-in, 3.2-6.5 GHz, +8 dBm levelled $500.00
HP 86242D-004,0 RF Plug-In, 5.9-9.0 GHz, +10 dBm levelled $500.00
HP 86245A RF Plug-in, 5.9-12.4 GHz, +16 dBm levelled $1,100.00
HP 86250D RF Plug-in, 8.0-12.4 GHz, +10 dBm levelled $675.00
HP 86260A RF Plug-in, 12.0-18.0 GHz, +10 dBm unlevelled $800.00
HP 86260A-H04 RF Plug-in, 10.0-15.0 GHz, +10 dBm unlevelled $800.00
HP 86290A RF Plug-in, 2.0-18.0 GHz, +7 dBm levelled $1,750.00
HP 86290C RF Plug-in, 2.0-18.6 GHz, +13 dBm levelled $2,500.00
WAVETEK 962 Sweep Generator, 1.0-4.0 GHz, markers, +12 dBm unlvld. $1,750.00

POWER METERS

ANRITSU MP-81B/ML-83 Power Meter, 75-110 GHz (WR10), -20 to +20 dBm $2,500.00
ANRITSU MP-82B/ML-83 Power Meter, 90-140 GHz (WR8), -20 to +20 dBm $3,250.00
BOONTON 4200-01A,03/ Dual Channel Microwattmeter, w/(2) 1 MHz-7 GHz sensors $1,500.00
BOONTON 42B/41-4B Analog Power Meter, with 1 MHz-12 GHz sensor $375.00
BOONTON 42B/41-4E Analog Power Meter, with 1 MHz-18 GHz sensor $500.00
GENERAL MICROWAVE 476/4240A Power Meter & Sensor, 0.01-18 GHz, -35 to +10 dBm $375.00
HP 435A/8481A Power Meter, 10 MHz-18 GHz, -30 to +20 dBm $1,000.00
HP 435A/8482A Power Meter, 100 kHz-4.2 GHz, -30 to +20 dBm $1,000.00
HP 435A/8482H Power Meter, 0.1-4200 MHz, -15 to +34 dBm $1,150.00
HP K486A WR42 Thermistor Mount, 18.0-26.5 GHz, for 432 series $350.00
HP Q8486A Power Sensor, 33.0-50.0 GHz, WR22, for 435/6/7/8 ..... $1,500.00
HP R486A WR28 Thermistor Mount, 26.5-40.0 GHz, for 432 series $350.00

RF MILLIVOLTMETERS

RACAL 9303 TRMS Level Meter, 10 kHz-2 GHz, -77 to +23 dBm, GPIB $875.00

AMPLIFIERS, MISCELLANEOUS

HP 8447A-001 Dual Amplifier, 0.1-400 MHz $450.00
HP 8901A-002,01 Modulation Analyzer, 150 kHz-1300 MHz, OCXO, int. cal. $5,500.00
HP 8901B-001 Modulation Analyzer, 150 kHz-1300 MHz, rear panel input $8,500.00
HUGHES 1177H01F000 TWT Amplifier, 20 Watts output, 1.4-2.4 GHz $1,750.00
M.P.D. LAB2-1020-2A Amplifier, 34 dB, 1.0-2.0 GHz, 2 Watts $800.00
M.P.D. LAB2-714-3A Amplifier, 34 dB, 0.7-1.4 GHz, 3 Watts $800.00
MARCONI TF2304 AM/FM Modulation Meter, 18-1000 MHz, FM dev.1.5-150 kHz $500.00
MICROWAVE SEMI. CORP. MC5112 Noise Source, 25.5 dB ENR, 1.0-12.4 GHz, N(m), +28 VDC $325.00

COAXIAL & WAVEGUIDE

AMERICAN NUCLEONICS AM-432 Cavity Backed Spiral Antenna,LHC, 2-18 GHz,TNC(f) *NEW* $95.00
CONTINENTAL MW. & TOOL PLPT42 WR42 Low Power Termination, 18-26.5 GHz, 1 Watt $90.00
FXR/MICROLAB S3-02N Triple Stub Tuner, 200-1000 MHz, 100 Watts max., N(m/f) $125.00
GR 874-LTL Constant Impedance Trombone Line, 0-44 cm, DC-2 GHz $450.00
GR 900-Q GR900 14mm Interseries Adapters $125.00
HP 11691D Directional Coupler, 22 dB, 2-18 GHz $450.00
HP 11692D Dual Directional Coupler, 22 dB, 2-18 GHz $800.00
HP 33330B Crystal Detector, 0.01-18 GHz, neg. pol., SMA(m)/SMC(f) $135.00
HP 774D Dual Directional Coupler, 20 dB, 215-450 MHz $275.00
HP 777D Dual Directional Coupler, 20 dB, 1.9-4.1 GHz $275.00
HP 778D-011 Dual Directional Coupler, 20 dB, 100-2000 MHz, APC7/Nf $400.00
HP 8470B-012 Crystal Detector, 10 MHz-18 GHz, neg. pol., N(m) $250.00
HP K422A WR42 Flat Broadband Detector, 18.0-26.5 GHz $350.00
HP K532A WR42 Frequency Meter, 18.0-26.5 GHz $500.00
HP K870A WR42 Slide Screw Tuner, 18.0-26.5 GHz $275.00
HP K914B WR42 Moving Load, 18.0-26.5 GHz $425.00
HP Q752D WR22 Directional Coupler, 20 dB, 33-50 GHz $650.00
HP R375A WR28 Variable Attenuator, 0-20 dB, 26.5-40 GHz $375.00
HP R422A WR28 Flat Broadband Detector, 26.5-40 GHz $400.00
HP R532A WR28 Frequency Meter, 26.5-40.0 GHz $500.00
HP R914B WR28 Moving Load, 26.5-40 GHz $300.00
HP V365A WR15 Isolator, 25 dB, 50-75 GHz $900.00
HP V752D WR15 Directional Coupler, 20 dB, 50-75 GHz $650.00
HP X870A WR90 Slide Screw Tuner $150.00
HUGHES 45111H-2000 WR28 Isolator, 25 dB, 26.5-40 GHz $450.00
HUGHES 45113H-1000 WR19 Isolator, 25 dB, 40-60 GHz $650.00
HUGHES 45521H-2000 WR28 Manual 4-Position Switch $750.00
HUGHES 45711H-2000 WR28 Frequency Meter, 26.5-40 GHz $600.00
HUGHES 47316H-1111 WR10 Tuneable Detector, 75-110 GHz, positive polarity $750.00
HUGHES 47323H-1211 WR19 Flat Broadband Detector, negative, 40-60 GHz $650.00
HUGHES 47974H-1000 WR15 SPST PIN Switch, 250 MHz speed, 60-62 GHz response $375.00
KAY 442D Step Attenuator, 0-101 dB, 75 ohms, BNC $100.00
KRYTAR 1818 Directional Coupler, 16 dB, 2-18 GHz, SMA(f) $200.00
M/A-COM 3-19-300/10 WR19 Directional Coupler, 10 dB, 40-60 GHz $450.00
MINI-CIRCUITS ZFDC-20-4 Directional Coupler, 19.5 dB, 1-1000 MHz, SMA(f) $25.00
NARDA 25171 Level Set Attenuator, 0-17 dB, 2-8 GHz, SMA(f) $100.00
NARDA 26298 20 dB Attenuator, 150 Watts, DC-1 GHz, N(f/f) $200.00
NARDA 3000-SERIES Directional Couplers $150.00
NARDA 3024 Bi-Directional Coupler, 20 dB, 4-8 GHz $300.00
NARDA 3090-SERIES Precision High Directivity Couplers $225.00
NARDA 368NM Coaxial High Power Load, 500 Watts, 2.0-12.4 GHz, N(m) $400.00
NARDA 369BNF High Power Termination, 175 Watts, 0.7-18 GHz, N(f) $325.00
NARDA 3753B Coaxial Phase Shifter, 0-60 deg./GHz, 3.5-12.4 GHz $1,250.00
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 4245-10 Directional Coupler, 10 dB, 4-12 GHz, SMA(f) $100.00
NARDA 4246B-20 Directional Coupler, 20 dB, 6-18 GHz, SMA(f) $100.00
NARDA 4317-2 Power Divider, 18.0-26.5 GHz, 3.5mm $175.00
NARDA 4799 Level Set Attenuator, 0-15 dB, 4-18 GHz, SMA(f) $135.00
NARDA 5070-SERIES Precision Reflectometer Couplers $300.00
NARDA 765-20 20 dB Attenuator, 50 Watts, DC-5 GHz, N(m/f) $135.00
NARDA 766-10 10 dB Attenuator, 20 Watts, DC-4 GHz, N(m/f) $100.00
NARDA 768-20 20 dB Attenuator, 20 Watts, DC-11 GHz, N(m/f) $125.00
NARDA 792FF Variable Attenuator, 0-20 dB, 2.0-12.4 GHz $375.00
PAMTECH KYG1014 WR42 Junction Circulator, 18.0-26.5 GHz $250.00
SIERRA 662A-20 20 dB Attenuator, 100 Watts, N(f/f) $150.00
SONOMA SCIENTIFIC 21A3 WR42 Circulator, 20 dB, 20.6-24.8 GHz $125.00
SPACEK LABS DQ-1 WR22 Flat Broadband Detector, 33-50 GHz $550.00
TELONIC TTF-2250-5-5 Tunable Bandpass Filter, 1.5-3.0 GHz, 5% 3 dB BW, N(f) $350.00
TRG V510 WR15 Precision Rotary Vane Atten., 0-50 dB, 50-75 GHz $1,000.00
TRG V551 WR15 Frequency Meter, 50-75 GHz $600.00
TRG V559-10 WR15 Directional Coupler, 10 dB, 50-75 GHz $400.00
TRG W510 WR10 Precision Rotary Vane Atten., 0-50 dB, 75-110 GHz $1,000.00
WAVELINE 898-DR WR42 Frequency Meter, 18.0-26.5 GHz $350.00
WEINSCHEL 1515 Power Divider, 2-Way, DC-18 GHz, SMA(m/f/f) $125.00
WILTRON 26N50 Precision Termination, N(m), DC-18 GHz $250.00
WILTRON 4612K Programmable Step Attenuator, 0-70 dB, DC-40 GHz $800.00
WILTRON 4622K Programmable Step Attenuator, 0-110 dB, DC-40 GHz $1,000.00
WILTRON 60N50-opt.1 SWR Bridge, 5-2000 MHz, 46 dB directivity, N(m/f/f) $500.00
WILTRON 87A50 VSWR Bridge, 2-18 GHz, 35 dB dir., APC7 test port $600.00
WILTRON SP2369 SWR Autotester, 2-12 GHz, APC7 test port $400.00

LOGIC

FLUKE 9000A-series Microprocessor Pods: 6800; 6809; 8080; 8085; Z80 ..... $375.00
HP 10343B/10269 SCSI Bus Preprocessor, s w/probe intfc., for 1630 serie $300.00
HP 5005A Signature Multimeter $350.00
HP 8170A-002 Logic Pattern Generator, 2 MB/s, address driver option $1,200.00

COMMUNICATIONS

HP 59401A HPIB Bus Analyzer $700.00
TEK 1411R-opt.04 PAL Test Gen. w/SPG12,TSG11,TSP11,TSG13,TSG15,TSG16 ..... $2,750.00
TEK 147A NTSC Test Signal Generator, with noise test signal $800.00
TEK 148 PAL Insertion Test Signal Generator $800.00
TEK 1750 NTSC Waveform / Vector Monitor $2,750.00
TEK 520A NTSC Vectorscope $750.00
TEK 521A PAL Vectorscope $750.00

MISCELLANEOUS

P.A.R. 5205-94,95,9 Lock-In Amp, 20 Hz-20 kHz, int. osc., lin/log, GPIB $2,750.00
P.A.R. 5206 Two-Phase Lock-In Amplifier, 2 Hz-200 kHz $2,500.00
P.A.R. 5208-92,94,9 Two Phase Lock-In Amp., 5 Hz-20 kHz or 200 kHz, GPIB $3,250.00
TEK TM5006 5000-series 6-slot Programmable Power Module $600.00
TEK TM503 500-series 3-slot Power Module $175.00
TEK TM504 500-series 4-slot Power Module $175.00
TEK TM506 500-series 6-slot Power Module $250.00
TEK TM515 500-series 5-slot Traveller Power Module $275.00

Stamp Applications:

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

by Scott Edwards

My favorite Stamp projects are like magic tricks. Take a little science knowledge and some hardware-store items, add our favorite BASIC computer, and – presto! – a neat application.

This month's application combines magic with down-to-earth practicality to create a water-level sensor. The method can be scaled to work with any container from a bucket to an irrigation tank to a swimming pool.

Measure Water Level Without Getting Wet

Make a sensitive water sensor from hardware-store parts

Measuring Water Level

Water has quite a few properties that can be used to measure its quantity. Here's an (incomplete) list of possible measurement methods:

- Measure the position of a float on the surface of the water.
- Weigh the water and calculate the volume.
- Bounce a sonar or radar ping off the surface of the water and measure its echo timing to detemine the height of water.
- Thump the water tank and measure the frequency at which it rings. The higher the water level, the lower the pitch.
- Air is a better thermal insulator than water; use a self-heating sensor to locate the point at which air and water meet by the change in thermal response.
- Water cannot be compressed as air can. Use a sealed tank, a pressure sensor, and air supply to determine the proportion of air to water in the tank.
- Water is clear like air but has a different refractive index. (Light-bending characteristic: Look at a straw standing in a glass of water and it appears to be broken at the air-water junction.) Use an optical sensor to detect the point at which the air meets the water.
- Water (with common impurities) is a better electrical conductor than air. Use electrodes to measure this property.
- Measure the amount of water pumped into the tank and the amount pumped out, and balance the books to determine the amount remaining in the tank.
- The dielectric constant (an important factor in determining the capacitance of two conductors separated by an insulator) of water is very different from that of air. Measure the capacitance across the tank to determine the proportion of water to air and therefore the level of the water.

I'm sure that with a little time and imagination you could double the length of that list.

The thing I find interesting about the list is that the methods that are the easiest to understand can also be the hardest or most expensive to implement. Take the first two: a float sounds great. You can picture it immediately; rig a lever arm on a potentiometer shaft and fix a float to the end of the lever. Use the Stamp's built-in pot instruction to measure the pot setting, and convert that result to the appropriate volume of water.

Unless the tank is 10 feet high and 4 feet in diameter: Using trigonometry, you can calculate that the lever connected to the pot would also have to be about 10 feet long, if we assume that the float would work over an angle of say 75 degrees. (If it went a full 90 degrees, it could get stuck in the down position.)

So floats and lever arms might be better for broad, shallow tanks. But even then there's the problem of protecting the pot from the effects of a humid environment.

Okay, what about weight? Your choices here range from elegant but expensive (an electronic load cell and analog signal-conditioning circuitry, both designed specifically for the max weight and weight range of the tank), to cheap but cumbersome (a spring-plunger arrangement coupled to a linear-travel pot?).

The last item on the list — dielectric constant — sounds difficult, but turns out to be a piece of cake to implement. Figure 1 shows the general arrangement I used to test the idea, while Figure 2 is a schematic of the electronics.

I used aluminum foil tape to form the measuring-column capacitor. This tape is a common hardware-store item used to repair rain gutters and join sections of foil-faced insulation.

My first job was to apply it to the measuring column (a section of 1/4" drip-irrigation tubing) in two non-overlapping stripes. I found an easy way to do this. I got a piece of IC carrier tubing for skinny (0.3") ICs. There's a 1/4" trench that runs along the length of this tube. I stuffed the measuring tube into the trench, and taped it in place with the foil tape. Using a razor knife, I

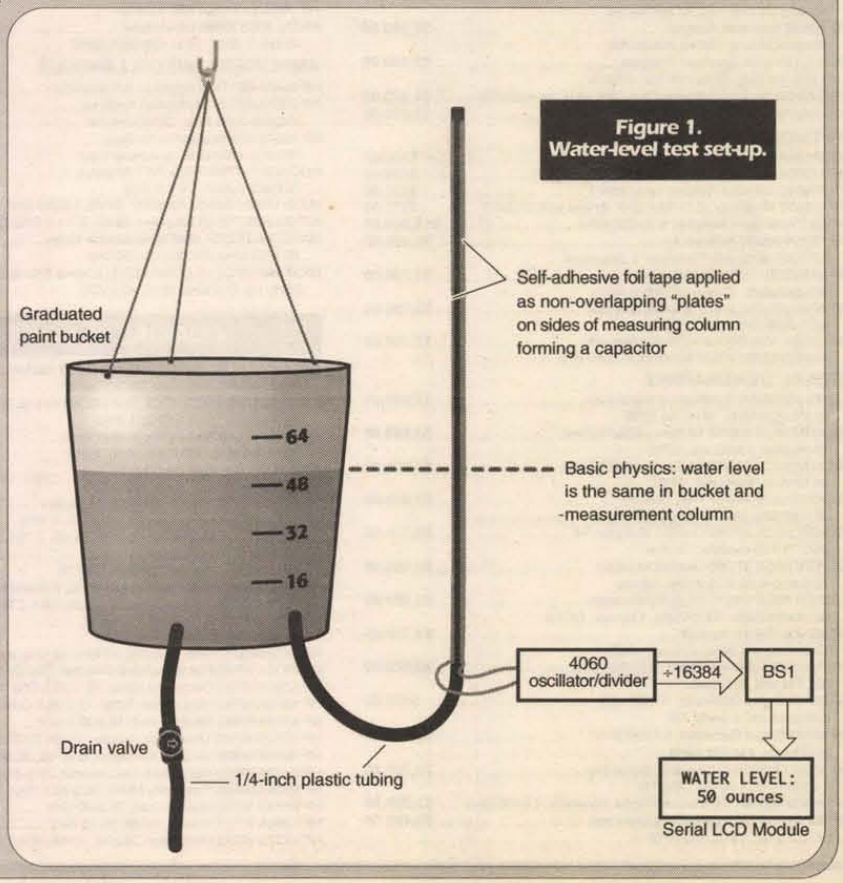


Figure 1. Water-level test set-up.

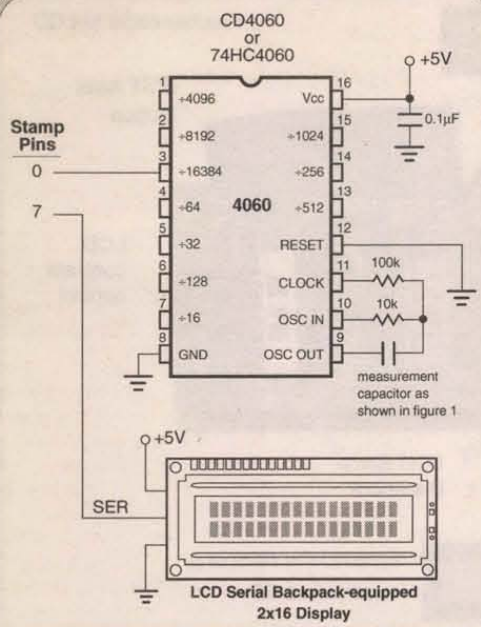


Figure 2. Schematic of H_2O-level test set-up.

trimmed the foil tape that held the measuring tube to the IC tube, and was left with a perfect stripe of foil tape. I rotated the measuring tube and repeated the process to get the second stripe.

The second task with the foil tape was hooking it up to my circuit. Aluminum tape is not the best stuff for this application, because it's difficult to make a reliable electrical connection to it. However, it had the huge advantage of being on hand the day that I had the urge to test this idea! And the hardware store also carries a conductive grease (trade name Ox-Gard) that prevents the oxidation that spoils aluminum-to-copper connections.

I smeared some Ox-Gard on the ends of the foil, stuffed them in to crimp-type butt connectors, put short wires to my 4060 circuit in the other ends of the connectors, and crimped hard.

If you plan to replicate this set-up, consider using self-adhesive copper-foil tape. Digi-Key **(1-800-344-4539)** carries it under part numbers 3M1181A-ND, 3M1181B-ND, and 3M1181C-ND (1/4", 1/2", and 1" widths by 18-yard lengths, respectively). The adhesive is conductive, so you can connect to a circuit by simply sticking it down.

Once I had my test set-up assembled, I connected a Counterfeit (my company's BS1 kit) to the 4060 to get a feel for the raw data. I took Pulsin measurements and got the following readings:

Water Level	Pulsin Result
16 oz.	3683
32 oz.	3743
48 oz.	3798
64 oz.	3848

I repeated the measurements several times, and to my amazement, they were rock-steady, and within one to two units of identical for each of the liquid levels. Things are not usually this easy in the world of homemade sensors. I dumped the numbers into a graph, and found that the relationship between water level and pulse width was darn near linear (Figure 3).

The slight deviation from a straight line predicts a one-ounce error in the middle of the range. And the final program (Listing 1) exhibits that minor quirk. But gosh, this is a talking dog — you don't correct his grammar!

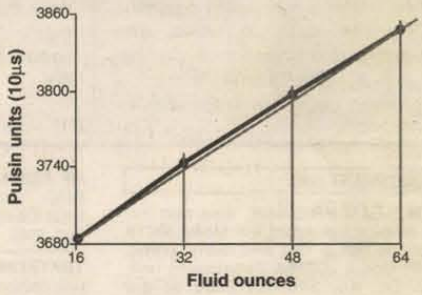


Figure 3. Graph of Pulsin versus water level.

Sources

For more information on the BASIC Stamp, contact:

Parallax, Inc.
3805 Atherton Road, #102, Rocklin, CA 95765
phone **(916) 624-8333**
Internet **http://www.parallaxinc.com**

The BS1/LCD kits are available from Scott Edwards Electronics for $59.00 (non-backlit) or $69.00 (LED-backlit) plus shipping. For a catalog of serial LCDs and Stamp-related products, contact:

Scott Edwards Electronics
P.O. Box 160, Sierra Vista, AZ 85636-0160
phone **520-459-4802**; fax **520-459-0623**
Internet at **ftp.nutsvolts.com** in **/pub/nutsvolts/scott**
E-Mail: **72037.2612@compuserve.com**

Listing 1. Water-level measurement

```
' Program: H2OLEVEL.BAS (Measure water level via variable capacitance)
' This program works with the circuit shown in the accompanying
' article to measure the water level in a plastic-tube measuring
' column. Since water 'seeks its own level,' such a measuring
' column can be used to measure water levels in containers from
' a bucket to a lake! The program is straightforward — most
' of the magic is in the circuit. An oscillator whose frequency
' depends in part on the capacitance of the measuring column
' is divided by 16,384 by a ripple counter. This program times
' the low-high-low (pulse) portion of the output and converts it
' to fluid ounces. The conversion is based on a series of manual
' measurements, and depends (obviously) on the characteristics of
' the measuring column and the size of the container being monitored.

'========Variables and Constants
SYMBOL level = w4          ' Water level measurement in Pulsin units.
SYMBOL oz = b6             ' Measurement converted to fluid ounces.
SYMBOL checks = b5         ' Number of out-of-range readings in a row.
SYMBOL lcd = 7             ' Serial LCD on pin 7.
SYMBOL I = 254             ' Instruction prefix for LCD.
SYMBOL clsLCD = 1          ' Clear-screen instruction for LCD.
SYMBOL line2 = 196         ' Location on 2nd line.

'========Main Program
' This code measures the incoming pulses and scales them to
' ounces based on previous manual measurements. It also keeps
' track of out-of-range readings and, if it gets 10 in a row,
' displays a message on the LCD. By waiting for more than
' one bad reading, the program is tolerant of glitches and noise
' that might otherwise cause occasional false readings.

setup:
 serout lcd,n2400,(I,clsLCD, "  WATER LEVEL:" )        ' Label LCD screen.
restart:
 checks = 0                                            ' Reset out-of-range counter.
again:
  if checks > 10 then handleError                      ' > 10 bad readings? Tell user.
  checks = checks + 1                                  ' Increment checks.
  pulsin 0,1,level                                     ' Take a raw reading.
  if level < 3683 then again                           ' Out of range (low)? Try again.
  if level > 3850 then again                           ' Out of range (high)? Try again.
  oz = level - 3683 * 16 / 55 + 16                     ' In range: Calc ounces.
 serout lcd,n2400,(I,line2,#oz," ounces") ' Display on LCD.
goto restart                                           ' Do it again.

'========Error Handler
' If 10 pulsin readings in a row are out of range, the bucket may be
' empty or overflowing, or the electronics are malfunctioning (wet?).
' These routines print appropriate messages on the LCD.

handleError:
 if level < 3683 then empty
 serout lcd,n2400,(I,line2, "OVERFLOW ")
 pause 1000
 goto restart
empty:
 serout lcd,n2400,(I,line2, "-EMPTY-  ")
 pause 1000
  goto restart
```

Stamp Applications:

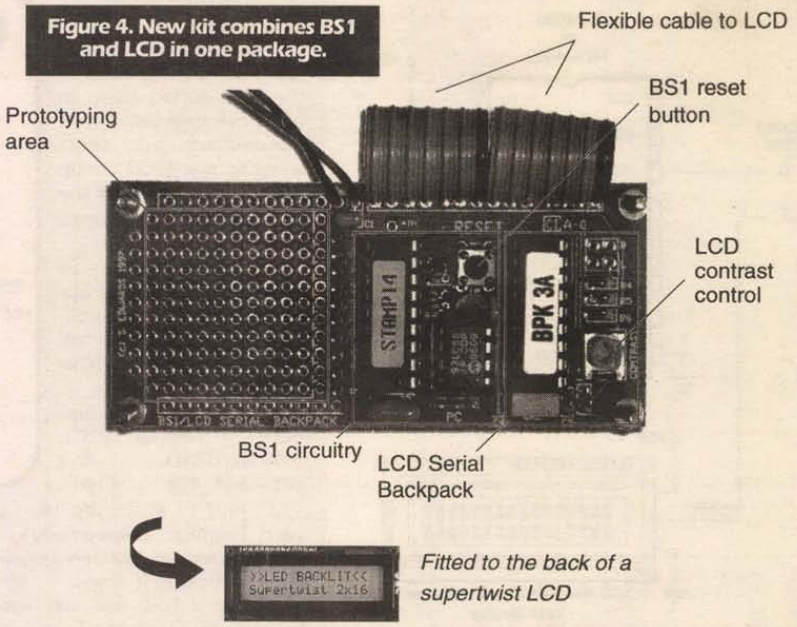
Summary

There are quite a few opportunities to experiment with this application. The calibration is likely to vary with temperature, since the measuring tube is likely to shrink and swell slightly, changing the plate spacing, and therefore the capacitance. In a practical application of this idea, you would also have to prevent people and objects from getting too close to the measuring column, as their proximity would also influence capacitance. This might mean simply enclosing the measuring column in another tube a couple of inches in diameter.

While I was working on this column, I was struck by how many Stamp applications follow this general pattern of reading a sensor, scaling the data to units, and presenting the units on a display. At about the same time, a customer called to ask whether I'd considered offering an all-in-one computer/display package based on the BS1. I take suggestions seriously, as you can see from Figure 4.

The new BS1/LCD kits *(see Sources)* are available with LED-backlit or non-backlit 2 x 16 LCDs. As the photo shows, there's a fair amount of prototyping area left over for custom circuitry. The 4060 used in this month's water-level application would fit with plenty of room to spare. And since the display takes only one of the BS1's eight I/O lines, there's room for expansion. **NV**

Figure 4. New kit combines BS1 and LCD in one package.



TEST EQUIPMENT *cont.*

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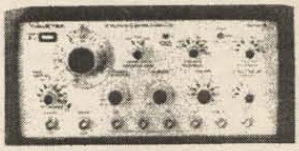

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FOR SALE: Tektronics oscilloscope, RM647, 100MHz, dual trace, w/all manuals $350. Bill 910-278-3912.

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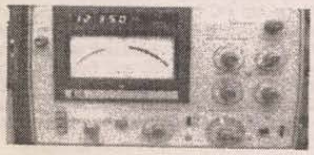

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EQUIPMENT MANUALS we have 1000's of service and operators manuals for all types of test and measurement equipment from 1950 to present. All test equipment manufacturers are represented. Call, write, or fax your want list. Please include mfg.'s manual P/N unit serial numbers if known. **Manuals Plus**, Box 549, TAD #601, Tooele, UT 84074. 801-882-7188, FAX 801-882-7195.

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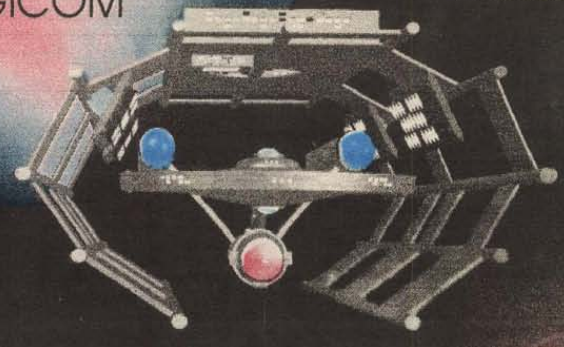

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RESOURCE BIN

number sixty four

The human side of the web.

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I'm now in the process of setting up my new *Guru's Lair* web site you will find at (where else?) www.tinaja.com

The Human Side of the Web

In past columns, we have looked at getting yourself web-literate, starting your own home page, finding favorite web sites, and doing online research. More details on these files are found on my *Webmastering Library Shelf* of my *www.tinaja.com*

But the web can be many things to many different people. So, this month, I'd thought we'd take a gander at the human side of the web. Those special interest places where folks one-on-one talk to each other or can get answers to really tough questions.

Three wildly different personal web services now include *newsgroups, chat rooms,* and *newsletters.*

A Warning

Let's start with this warning: The acronym "net" stands for *not entirely true.* Anyone on the human side of the web can say anything at any time for any reason. Regardless of their skills, motives, emotional stability, fervor, greed, or competence.

There's a tendency with E-Mail to impulsively "quickly say sumpthun," instead of thinking out a researched or carefully measured response.

Thus, any *E-Mail message largely and ruthlessly stomps out any and all creative thought* within a six-block radius.

Some people may genuinely try to help, but do not have the faintest clue what they are talking about. Often, they might cause lots more harm than good. Some may have an axe to grind. Others may be selling something you might not want or are perpetuating outright scams. Yet others may react violently to anything they consider a personal affront.

Thus, take everything you read on the net with several Bonnevilles of salt. *Always* get a second and even a third opinion. *Always* look before you leap. And *Never* flame, confront, or infuriate anyone. For they surely will return with a vengence.

Buyer beware.

Chat Rooms

Chat rooms are offered by most of the commercial online services. They are similar to a telephone party line or an open CB channel. Anyone can call in at any time. A lot of these users often do tend to be pathetic juvenile newby flamers. Org.

Who quickly drive all of the useful participants away.

More organized chats are known as *conferences.* They include a *moderator* that plays "Mother May I" and instills some sort of order. This is particularly useful whenever any guest speaker is present, fielding questions.

Pick your chat rooms with care. For the overwhelming majority are an utterly mind-rotting waste of time.

NEXT MONTH:
Don shows some unique resources for video game development.

Newsletters

A *newsletter* is an automated list of E-Mail recipients. Often with a tightly targeted special interest. Some person who feels strongly about this interest area elects to *maintain* the list and the mailings. Some lists will accept any posting from anyone. Others may be edited to one degree or another.

Newsletters can be either public or private. Your only real difference is whether the moderator decides to let you get on the distribution list.

Virtually anybody can join a public newsletter. All you'll need is a way to send and receive E-Mail. Your typical procedure is to put the word *subscribe* followed by the newsletter name into the body of your E-Mail message.

Which will start getting you great heaping quantities of E-Mail. Possibly hundreds a day. A scant few of which are genuinely useful. By hitting your browser's *reply* button, you'll answer any E-Mail sent you.

Or start a *thread* of your own.

You also might have the option of *subscribe digest.* In which you get one or two humongous mailings per day instead of hundreds of smaller ones. But these might be a royal pain to go through. It can be an even bigger pain to respond to a single message.

An *unsubscribe* message should get you off their list. But oftentimes might not do so on your first try.

While newsletters are easy for the host to set up and run, nearly *all of the hassles and inconveniences get placed on the end user.* Thus a typical newsletter is extremely *user vicious.* And often might have the *exact opposite* effect of what the provider intended. But these do have controlled distribution.

There is also that old "W. C. Fields" problem. In which you may not want to subscribe to a newsletter that will accept you as a subscriber.

There are 18,000 public newsletters. And probably three times that many private ones.

Newsgroups

A *newsgroup* is any special Internet service provided by a *news host server.* Sort of a syndication. Arrangements have been made by the group's host moderator for distribution. To read newsgroup postings, you will simply select the newsgroup from your news server. You then pick out only those messages of interest to you. And then only respond to those you wish to.

Thus, a newsgroup places most of the hassles on the provider. And very few on the user. Anyone can access a newsgroup. So long as they do have access to an ISP with a news server. Such access may cost a dollar or two a month extra with certain ISPs.

You don't have to be a newsgroup member or a subscriber. Because of open access, a newsgroup is poor for sensitive, proprietary, "gray," or any potentially litigious content. There are tens of thousands of newsgroups.

Let's look at a few newsletter and newsgroup resources ...

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alt.armourers
alt.art.pyrotechnics
alt.ascii-art.animation
alt.autos.antique
alt.aviation
alt.bad.clams
alt.bbs.doors
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alt.bigfoot.research
alt.binaries.clip-art
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alt.comics.dilbert
alt.comp.hardware.homebuilt
alt.comp.lang.yorick
alt.comp.shareware
alt.config.control-freaks
alt.consumers.free-stuff
alt.crackers
alt.crafts.professional
alt.culture.sardines
alt.current-events.kobe-beef
alt.cyberspace
alt.disasters
alt.disney.the-evil-empire
alt.drinks.kool-aid
alt.folklore.kooks
alt.duck.quack.quack
alt.dumpster
alt.energy.homepower
alt.energy.renewable
alt.fairs.renaissance
alt.fan.ceiling
alt.fan.lemurs
alt.fan.nancy-kerrigan.ouch
alt.fan.spinal-tap
alt.folklore.urban
alt.food.chocolate
alt.food.pez
alt.food.wine
alt.fractals.pictures
alt.fringeware
alt.galactic-guide
alt.games.tiddlywinks
alt.games.video.classic
alt.graffiti
alt.guinea.pig.conspiracy
alt.hash.house.harriers
alt.hemp.politics
alt.home-theater.marketplace
alt.housing.nontrad
alt.html.editors
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alt.tv.eek-the-cat
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alt.ufo.reports
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alt.wolves.hybrid
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rec.aviation.restoration
rec.aviation.rotorcraft
rec.backcountry
rec.bicycles.tech
rec.birds
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rec.crafts.rubberstamps
rec.crafts.textiles
rec.crafts.winemaking
rec.fitness
rec.food.chocolate
rec.food.sourdough
rec.food.veg.cooking
rec.games.design
rec.games.pinball
rec.games.video.marketplace
rec.ham-radio.swap
rec.humor
rec.models.railroad
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soc.genealogy.methods
soc.history.science
soc.history.war.world-war-ii
soc.support.depression
talk.politics.crypto
us.jobs.offered
vegas.food

News

To access most public newsgroups, first make sure your ISP offers one or more *news servers.* Then simply type *News:* into your browser. The listing of offered news services should pop up. When you know the name of your desired newsgroup, just enter it. For instance, one great *Adobe Acrobat 3.0* newsgroup is called *comp.text.pdf*

The last few day's of postings will show up in a browser window. Click on the ones you want to read. Right mouse click to post your reply. More clicks can save or flag a message.

The more dots in any newsgroup name, the more specific its content. To get a list of all newsgroups, just go to your browser's *options* box and click on *show all newsgroups.* You may also have options of viewing *active, new,* or *subscribed* newsgroups.

To keep the listing short, most are found in closed folders. For instance, you will find at least 2,500 newsgroups whose name starts with ".alt."

I've posted a NEWSLIST.HTML file to my *www.tinaja.com*

For this month's resource listing, I somewhat randomly chose a bunch of newsgroups you may find of interest. Note this is only a tiny sampling of what is really available.

Deja News

The oldest and finest newsgroup snooper is called *Deja News.* I have a link to it through my "search all sites" feature on the *Web Related Links* of my *www.tinaja.com* — You can also hit them directly at *www.dejanews.com* — Simply enter your subject phrase, and a list of all recent messages to all newsgroups pops up. There is also a historical archive.

Perhaps you need a schematic for a *Lambda* power supply. You punch in *Lambda power supply schematic* to see where it directs you. If you are lucky, you'll get *direct* hits that give you a useful answer.

If you aren't lucky, you enter *power supply schematic* and get the *indirect* list of all the newgroups where such questions are likely to be asked or answered. When that does not work, try *schematic wanted.*

Another neat feature of Deja News lets you find where *else* someone has been posting. This gives you a quick check on credibility and interests.

Alta Vista

Of all the major search services, I personally found *Alta Vista* the most useful. Link to it from my "search all sites" or *www.altavista.digital.com* — Note that there is a seldom noticed window on Alta Vista which lets you select *Web* or *Usenet.* When Web gets selected, you're searching home pages and similar content. When Usenet is chosen, you're searching for personal newsgroup postings.

If you do *not* put your keywords in quotes, Alta Vista will automatically pick the "best" places to go for your information. When you do quote your keywords, it searches for those words *only in exact sequence.* Without quotes "Don" will hit any time that the word "don't" appears in a message.

Thus, quotes are useful to restrict you to a very specific subject. But they also might miss a lot, may be slower, and may not report your best results first. Your best rule is to *quote names, but very little else.*

PAML

This great service is short for *Public Accessible Mailing Lists* and does to newsletters what Deja News does to newsgroups. This time, you'll find a direct button on *www.tinaja.com* — Their internet site link can now be found at *www.NeoSoft.com/internet/paml* — There are some 14,000 newsletters listed here. Accessible by your choice of name or subject. Do note that their subjects are set alphabetical by *rows,* rather than columns.

Ferinstance, to locate a newsletter which specializes in tan 1987 *Synchro* 4wd Vanagons having diff locks but non-Westy, start with *automotive,* then *vanagon.* Which should lead you on to *LISTSERV@lenti.med.unm.edu*

You can then E-Mail them by using *subscribe vanagon firstname lastname.* For the digest, use *subscribe vanagon digest firstname lastname.* And to get off the list, use *unsubscribe vanagon.*

The rules are sort of similar for any newsletter, but the details may vary. So, *always read the fine print.*

Stash a hard copy somewhere.

User Etiquette

Never jump into a newsgroup with both feet. Instead, *always* study the group for a few days. As a lurker. To soak up the vibes, competence, and their coverage levels.

Next, see if there is a FAQ area for *frequently asked questions.* Scan this backgrounder and see if you are up to speed. Then find out if there are any further tutorial background files.

Newsletters and newsgroups

work *only* when useful experts willingly participate. If they are flooded with stupid newby questions or any flames from epsilon minuses, they will surely leave. Every time.

Avoid committing what the French Veternarians call a *four paw.* Such as asking a caving newsletter where you can buy a large ball of string.

Or using words like *overunity* or *free energy* at a real science group.

Never flame! First and foremost, you always *wait 10 seconds* before hitting your *send* button. Always ask yourself "Is this what I really want to say?" Do remember that your message will be on the net for a long time.

The best way to avoid a tug-of-war is to not pick up your end of the rope. Avoid any second or higher response to a message. And remember that the other side *will* have the last word. The best strategy is to decide just when or where you will let them do so.

Never spam newsgroups! Send the tightly targeted query to *one* site only. Maybe two in a dire emergency.

Yes, it is permissible to post a brief commercial message. So long as it is a "more details" part of a posting with genuinely useful content. Your usual trick is to put your *short* hard sell into your signature file.

Always make sure your comments are relevant to the group's goals.

It is also considered poor form to send any long files to newsgroups or newsletters. Especially binary files or images. Keep your message short and to the point. Any time you have longer information to submit, give them a separate download link.

Respect your readers time!

Scams and Chain Letters

Sending a get-rich-quick scam or a chain letter to many newsgroups is not even dumb. First and foremost, because your response will be zero.

What happens instead is that more than a few of their readers will take *very* strong exception to your invasion of their privacy. A few are *certain* to find creative ways to get even. Such as trashing your web site. Or maybe requesting tons of junk mail for you. Or writing your local postmaster and your state's Attorney General.

Or, as has been suggested under current "shrinkwrap" laws: filing a $500.00 "proofreading" fee against you. And then taking you to small claims court in a place that costs you a lot more than $500.00 to get to. Since you did not show up to contest, the claim becomes valid and *will* be awarded. The claim is then given to a collection agency. Spamscam enough of these newsgroups, and you can end up owing millions of dollars.

Some more "etiquette enforcement" ideas are at *www.scambusters.com*

Two Horror Stories

I was repeatedly placed on a highly intrusive tech newsletter without my knowledge or consent. Lots of polite requests for my removal were ignored. Those that were not caused an ever increasing flow of ping tests.

Forever and ever.

Stronger removal techniques seem to have finally worked. Needless to say, I now am highly praising all their competitor's products whenever and wherever I get any chance. Their link also is banned from my website.

It turned out that *any* E-Mail contact with their company *automatically* and *permanently* placed you on the list for their newsletter.

But the absolute worst offender on removals are the yoyos at Yoyodyne. Especially with their Zonker scam. These epsilon minuses have ignored *hundreds* of removal requests from me over the last year.

Their usual response is to ask you for a nonexistent member's password. Or else they obtusely explain their 347-step procedure for your asking to be considered by the selection committee to get on the waiting list for a removal application request form. And then repeatedly E-Mail you back to say you forgot to say "Mother May I?"

The single time I did reach a real person, they assured me I would be removed from the list. Needless to say, the whole process started up all over again a week later.

And continues to this day.

So, I guess it is way beyond high time someone passed on these rules of web newsletter ...

Host Etiquette

If you are in charge of running a newsletter, the first and foremost step you can make for user friendliness is to *replace it with a newsgroup as soon as you possibly can!*

Once again, newsletters place all the hassles and all the mind-rotting inconvenience on the end user, while newsgroups put them on the host.

It is a good idea to provide some *archive* file area for previous traffic, a *Frequently Asked Questions* stash for any newbies and casual dropins, plus a *Tutorial Background* area for serious first-time visitors.

Never enter anyone without their knowledge and consent! Make sure their request is specific and valid.

Always *personally* read *all* postings at least *twice* a day. If *anyone* wants out, *personally* and *immediately* remove them. *By hand!*

Do *not,* under *any* circumstances, ask them to place specific words in certain message positions. And, above all, do not require a never-received or long forgotten password or member ID number for removal.

Always be sure to remove anyone *immediately* on their *first* request.

Always make sure your digests are timely and consistent.

Never use the newsletter E-Mail list for any other purpose. Unless you get *specific* permission ahead of time.

Show all subscribe and unsubscribe messages in plain English. Some of those UNIX stock message screens are totally undecipherable gibberish.

Do make sure the unsubscribe info appears in *every* message sent.

Always test your list once a month. Send a short E-Mail message advising that *any* response will delist. All any current subscriber has to do is ignore the test message.

And will welcome your concern.

This Month's Contest

As our contest this month, just send me a list of your favorite newsletters or newsgroups and tell me why you like them. Or tell me any funny or bizarre story involving these. Or tell me how to get off of that Yoyodyne Zonker scam mailing list.

There will be a largish pile of my new *Incredible Secret Money Machine II* books going to the dozen or so better entries, plus an all-expense-paid (FOB Thatcher, AZ) *tinaja quest* for two that will go to the very best of all.

Send all your *written* entries to me here at *Synergetics,* rather than to *Nuts & Volts* editorial.

Let's hear from you. **NV**

Microcomputer pioneer and guru Don Lancaster is the author of 33 books and countless tech articles. Don maintains his no-charge US tech helpline found at ***(520) 428-4073****, besides offering all of his own books, reprints, and consulting services. Don also offers a free catalog full of his resource secrets waiting for you. Your best calling times are 8-5 on weekdays, Mountain Standard Time.*

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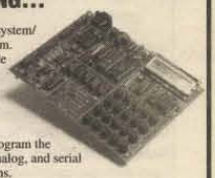

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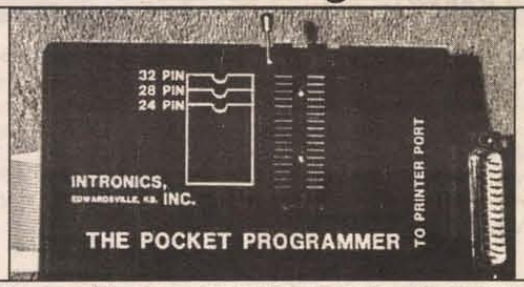

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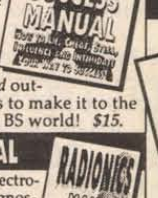

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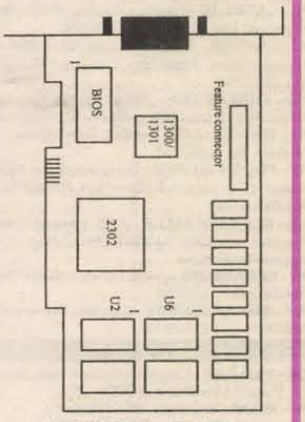

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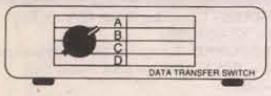


Many Data Switch Boxes available starting at $6.50!!
Best Selection

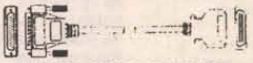
CD Jewel Case

Replacement for original case

#TM-CD1
$.40 each
10/$.33 100/$.25

I-EEE 1284 Printer Cable

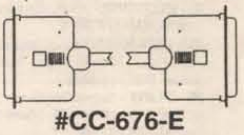
10' Bi-Directional
DB25 Male to Mini Centronic 36
A.K.A. type "A" - "C"



#CC-PR6-BIMIN
$4.50 each
Any quantity

SCSI 1 TO SCSI 1 Cable

50 pin Centronics male to male



#CC-676-E
6 foot **$2.00 each**
Close Out!

DB25 Null Modem Adaptor

for serial printer and plotters
male to female
#CA-134
$2.00 each
20/$1.60 50/$1.40

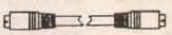
Printer Adaptors

DB25 male to 36 pin female Centronics

#CA-180
$1.00 each
Close out!

S-Video Cable

4ft cable
Oxygen-Free wire
4 pin mini
male to male



#VC-735-4
$1.00 each
50/$.75

Parallel Port

DB25 Female to 26 pin socket IDC

#CN-702
$.50 each
100/$.40

SVGA Shielded Extensions

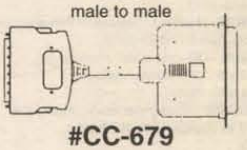
6 ft. male to female
#CC-VGA-4
$2.00 each

3.6 Volt 60 mAh Nickel-Metal Hydride Battery

Replacement for Motherboards
Solder Type 3-Pin
MFG. by Varta
#TM-3V/60H
$3.50 each
20/$3.00

SCSI 2 to SCSI 1

3 foot
male to male



#CC-679
$18.00 each
Close Out!

12" Gooseneck Microphone

Condenser style 3.5mm, Stereo plug
Fits any sound card or voice modem
#TM-MIC-3
$4.00 each
3/$10.00

12v DC Fan
#TM-FAN
$3.00 each
20/$2.50

3 1/8" ball Bearing type; Standard replacement fan for PC/AT mini-full towers

Heat Sink with Fan

For Pentium
Bi-Pin Connector

$2.00 each
100/$1.60 each

Miniature Mouse

2-Button, black
Great for small hands or laptop!
#TM-290-MINI
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California residents add 8.25% tax • eMail Sales@RogersSystems.com
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Events

MAY 1997

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
E-mail events@nutsvolts.com

MAY 2-3

CA - FRESNO - ARRL Hamfest. John Pritchett WA6JWK, 209-222-6793
LA - BATON ROUGE - ARRL Hamfest. Herb Ramey KB5AQ, 504-654-6087 or 1-800-256-FEST

MAY 2-3-4

WI - WAUSAU - Computer Show. Wausau/Marathon Co. Park. Blue Star Productions 612-788-1901

MAY 3

AZ - SIERRA VISTA - Hamfest. Ron Slominski KC7QXJ, 520-378-3018. E-Mail: slominsk@Tron.Cochise.cc.az.us
CA - OAKLAND - Computer Show. Oakland Convention Center, Broadway @ 10th St. 1-800-243-7041 http://www.robertaustin.com
CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
IN - INDIANAPOLIS - AGI Computer Fair. Indianapolis Events Center. 3655 E. Raymond St. 10am-4pm. 317-299-8827
IN - SOUTH BEND - Computer Show. Century Center. MarketPro 301-984-0880
KY - OWENSBORO - ARRL Hamfest. George Stokes KD4CKT, 502-926-4451
MD - NEW CARROLLTON - Computer Show. Ramada Conference & Exhibition Center. MarketPro 301-984-0880
MI - CADILLAC - Hamfest. Cadillac Middle School. 8am-2pm. Dan KE8KU 616-775-0998
MI - LANSING - Super Computer Sales. 904 Elmwood Plaza. 10am-3pm. Computers & You 313-283-1754
MO - KANSAS CITY - ARRL Hamfest. Bob Roske WA0CLR, 816-436-0069. E-Mail: wa0clr@juno.com
NY - OWEGO - ARRL Hamfest. Dick Wilson KB2LDY, 607-648-2748
NY - POUGHKEEPSIE - Computer Show. Mid-Hudson Civic Center. 9:30am-4pm. MarketPro 201-825-2229
OR - KLAMATH FALLS - ARRL Hamfest. Tom Hamilton WD6EAW, 541-883-2736. E-Mail: wjonesjr@cdsnet.net
WI - CEDARBURG - ARRL Hamfest. Gabe Chido N9QQA, 414-377-2784
WV - MIDDLEBOURNE - Hamfest. Ray Gorrell KA8GOH, 304-758-2832

MAY 3-4

CA - VALLEJO - Computer Show & Sale. Solano Co. Fgrds. MarketPro 415-456-6730
FL - MIAMI - Computer Show. Dade Co. Fairgrounds. MarketPro 301-984-0880
PA - HARRISBURG - Computer Show. Farm Show Complex, East Bldg. MarketPro 301-984-0880
TN - EAST RIDGE - Computer Show. Camp Jordan Arena. MarketPro 301-984-0880
TX - ABILENE - ARRL West TX Conv. & Hamfest. Abilene Civic Center. Sat: 8am-5pm, Sun: 9am-2pm. Peg Richard 915-672-8889
VA - NORFOLK - Computer Show. Norfolk Scope. MarketPro 301-984-0880

MAY 4

CA - LIVERMORE - Swapmeet. Las Positas College. Noel Anklam 510-447-3857
CA - SAN DIEGO - Computer Show & Sale. Scottish Rite Center. 10am-5pm. MarketPro 415-456-6730
IL - DECATUR - ARRL Hamfest. Doug Ellison N9ULL, 217-423-1013
IL - SANDWICH - Hamfest. Sandwich Fairgrounds. 8am-1pm. Bob Yurs 815-895-3219
IN - BLOOMINGTON - Hamfest. Monroe Co. Fairgrounds. 8am-3pm. John Anderson 812-332-3734 after 5pm
IN - FORT WAYNE - Computer Show. Memorial Coliseum, 1/2 of Exhibit Hall. MarketPro 301-984-0880
IN - NOBLESVILLE - AGI Computer Fair. Hamilton Co. 4-H Grounds (off Pleasant St. on SR-37).10am-3pm. 317-299-8827
MA - WEST SPRINGFIELD - Computer Show. Eastern States Exposition. 9:30am-4pm. MarketPro 201-825-2229
MD - FREDERICK - Computer Show. Frederick Fairgrounds, MarketPro 301-984-0880
MD - HAGERSTOWN - Hamfest & Computer Show. Hagerstown Junior College, Athletic, Recreation, & Community Center. ARA 301-791-3010
MI - SOUTHGATE - Super Computer Sales. Crystal Gardens, 16703 Fort St. 10am-4pm. Computers & You 313-283-1754
NH - PORTSMOUTH - Computer Show. Yoken's Conference Center. 10am-3:30pm. Northern Computer Shows 508-744-8440
NJ - FAIRFIELD - Computer Show. Fairfield Radisson. 9:30am-4pm. MarketPro 201-825-2229
NY - YONKERS - Electronic Flea Market. Lincoln High School. Otto 914-969-1053
PA - WRIGHTSTOWN - Hamfest. Middletown Grange Fairgrounds, Penns Park Rd. John D'Onofrio 215-675-9165
WV - RIPLEY - ARRL Hamfest. Joe Pickens N8UXE, 304-372-5648

MAY 9-10

NH - ROCHESTER - HOSSTRADERS Hamfest. Joe Demaso K1RQG, 207-469-3492. E-Mail: k1rqg@aol.com

MAY 9-10-11

IA - DES MOINES - Computer Show. State Fairgrounds. Blue Star Productions 612-788-1901

MAY 10

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School.
Bill 909-822-4138 eves
GA - STATESBORO - ARRL Hamfest. Ellie Waters WB4CJB, 912-653-4939. E-Mail: marshall@bulloch.com
ID - CALDWELL - ARRL Hamfest. Dan Gardner KB1WW, 208-893-4705. E-Mail: dgardner@micron.net
IL - PEOTONE - ARRL Hamfest. Willis Bowser K9IFO, 815-472-2079
MA - STURBRIDGE - Computer Show. Sturbridge Host Hotel. 10am-3:30pm. Northern Computer Shows 508-744-8440
MI - FLINT - Super Computer Sales. IMA Arena, S. of Exit #139 off of I-69. 10am-3pm. Computers & You 313-283-1754
OH - MEDINA - ARRL Hamfest. Clarence Miller WA8JLA, 330-725-4492
SC - ANDERSON - ARRL Hamfest. Anderson Co. Fairgrounds, E. of Anderson on Hwy 29. 8am-5pm. Gene WB4ZBZ, 864-476-2609
SD - HURON - Amateur Electronics Swapfest. National Guard Armory, State Fairgrounds. 8am-3pm. Lloyd Timperley 605-352-7896 eves
TN - KNOXVILLE - Amateur Radio, Computer & Electronics Show. Tennessee Valley Fairgrounds, Chilhowee Park. 8am-2pm. Carol Whetstone N4LFR 423-673-0475
WA - STANWOOD - ARRL Hamfest. Vic Henry N7KRE, 360-387-7705
WI - MANITOWOC - Hamfest & Computer Swapfest. County Expo Ctr., intersection of Hwys 42-151 & I-43 on Co. R. Red 414-684-9097 days, Glenn 414-684-7096 day or evening

MAY 10-11

FL - WEST PALM BEACH - Computer Show. South Florida Fairgrounds. MarketPro 301-984-0880
GA - KENNESAW - Computer Show. I-75 Exit 116, go W. on Barrett Pkwy. to Hwy. 41, turn right, go to 2nd traffic light; we're on the right next to "Cowboys." GA Mountain Productions 706-838-4827
MD - PIKESVILLE - Computer Show. Pikesville Armory. MarketPro 301-984-0880
NY - STONY BROOK - Computer Show. SUNY Stony Brook. 9:30am-4pm. MarketPro 201-825-2229
OH - CINCINNATI - Computer Show. Cincinnati Gardens. MarketPro 301-984-0880
TN - NASHVILLE - Computer Show. State Fairgrounds, Exhibition Bldg. MarketPro 301-984-0880
VA - CHANTILLY - Computer Show. Capital Expo Center. MarketPro 301-984-0880
VA - FLOYD - FAIRS Club Station N4USA, US5WE, BY1QH, 8R1WD & S21AM. Send QSL for certificate to FAIRS, POB 341, Floyd, VA 24091

MAY 11

MI - DEARBORN - Super Computer Sales. Dearborn Civic Center, 15801 Michigan Ave. 10am-4pm. Computers & You 313-283-1754

MAY 15-16-17

CA - BAKERSFIELD - San Joaquin Valley Section Convention. Ed Harlander KO6DY, 805-589-4163. E-Mail: eharlander@aol.com

MAY 16

OH - DAYTON - Quarter Century Wireless Assoc. Banquet. Alex's Continental Restaurant. Robert Dingle, 1117 Big Hill Rd., Kettering, OH 45429-1201

MAY 16-17-18

OH - DAYTON - Hamvention '97. Hara Arena, Intersection, Shadow Springs Creek & Wolf Rd. Fri: 8am-6pm, Sat: 7am-5pm, Sun: 7am-4pm. 937-276-6930. E-Mail: info@hamvention.org

MAY 17

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
CO - COLORADO SPRINGS - Hamfest & Electronics Show. Doherty High School, 4515 Barnes Rd. Carlos Caro KB0REI, 719-632-1569 ccaro@ccs.lmco.com
MA - TOPSFIELD - Computer Show. Topsfield Fairground. 10am-3:30pm. Northern Computer Shows 508-744-8440
NY - ROCHESTER - Computer Show. The Dome Center. 9:30am-4pm. MarketPro 201-825-2229
PA - EPHRATA - ARRL Hamfest. William Kirkner N3PZA, 717-484-2102. E-Mail: N3PZA@ptd.net
PA - GREENGATE - Computer Show. Greensburg Mall Expo Center. MarketPro 301-984-0880
RI - FORESTDALE - Spring Auction & Flea Market. VFW Post 6342, Main St. (N. Smithfield). 8am-3pm. Rick Fairweather K1KYI, 401-725-7595 7-8pm
VA - ANNANDALE - Computer Show. Northern Virginia Community College. MarketPro 301-984-0880
VA - RICHMOND - Computer Show. The Showplace. MarketPro 301-984-0880

MAY 17-18

FL - ORLANDO - Computer Show. Central Florida Fairgrounds, Bldg. D & E. MarketPro 301-984-0880
PA - ALLENTOWN - Computer Show. Allentown Fairgrounds. MarketPro 301-984-0880
WA - SELAH - Washington State Convention. Dick Umberger N7HHU, 509-248-3580.

MAY 18

CA - CARMICHAEL - Hamfest. Bob Naylor AC6HF, 916-966-3654. http://www.ns.net/~NHRC
IA - MASON CITY - Hamfest. Douglas J. McMannes KB0JBF, 515-423-5064. E-Mail: mcmannes@willowtree.com
MA - CAMBRIDGE - Flea Market. Kendall Square area. 9am-2pm. MIT. Nick Alternburnd 617-253-3776
MA - SWANSEA - Computer Show. Venus DeMilo. 10am-3:30pm. Northern Computer Shows 508-744-8440
MD - WEST FRIENDSHIP - Computer Show. Howard Co. Fairgrounds. MarketPro 301-984-0880
MI - MADISON HEIGHTS - Super Computer Sales. UFCW Hall, 876 Horace Brown Dr. 10am-4pm. Computers & You 313-283-1754
NY - BUFFALO - Computer Show. Hamburg Fairgrounds. 9:30am-4pm. MarketPro 201-825-2229
PA - ERIE - Computer Show. Erie Civic Center. MarketPro 301-984-0880
VA - ROANOKE - Computer Show. Roanoke Civic Center. MarketPro 301-984-0880

MAY 23-24

MS - PASCAGOULA - ARRL Hamfest. Pascagoula Civic Center, Jackson Co. Fairgrounds. Fri: 5pm-9pm, Sat: 8am-3pm. Charles F. Kimmerly 601-826-5811

MAY 24

CA - DALY CITY - Computer Show. Cow Palace, Gate #5, Geneva & Santos. Robert Austin Corp. 1-800-243-7041, http://www.robertaustin.com
CT - VERNON - Hamfest. Wayne Rychling N1GUS, 860-487-1921. E-Mail: warych@neca.com
FL - TAMPA - Computer Show. State Fairgrounds. MarketPro 301-984-0880
FL - FORT LAUDERDALE - Computer Show & Sale. Holiday Inn West, 5100 N. State Road 7. Narisaam 770-663-0983
IN - INDIANAPOLIS - AGI Computer Fair. Indianapolis Events Center. 3655 E. Raymond St. 10am-4pm. 317-299-8827
MI - LIVONIA - Super Computer Sales. Livonia Elks Lodge Hall, 31117 Plymouth Rd. 10am-3pm. Computers & You 313-283-1754
NC - DURHAM - Hamfest. South Square Mall. 8am-3pm. Rodney Draughon AE4JW 910-364-7420
NH - NASHUA - Computer Show. Sheraton Tara. Northern Computer Shows 508-744-8440
OH - NILES - Computer Show. Eastwood Expo Center. MarketPro 301-984-0880

MAY 24-25

DE - NEWARK - Computer Show. Univ. of DE. MarketPro 301-984-0880
FL - MELBOURNE - Computer Show. Melbourne Auditorium, 625 E. Hibiscus Blvd. Frank Cox 941-954-0202.
KY - LOUISVILLE - Computer Show. Kentucky Fair & Expo Center. MarketPro 301-984-0880
MD - GAITHERSBURG - Computer Show. Montgomery Co. Fairgrounds. MarketPro 301-984-0880
NJ - SOMERSET - Computer Show. Garden State Exhibit Center. 9:30am-4pm. MarketPro 201-825-2229
SC - GREENVILLE - Computer Show. Palmetto Expo Center. 9:30am-4pm. MarketPro 201-825-2229
VA - HAMPTON - Computer Show. Hampton Coliseum. MarketPro 301-984-0880
WY - CODY - ARRL Hamfest. Carol Jaussaud K7KD, 307-587-9764. http://www.wave.park.wy.us/cmarc/cmarc.htm

MAY 25

CANADA - QUEBEC - SOREL-TRACY - Hamfest. Jean Gadoury VE2UL, 514-587-2986
CA - SANTA ANA - Swapmeet. ACP parking lot. Mary Russo 714-558-8813
FL - CLEARWATER - Computer Show. Harborview Center. MarketPro 301-984-0880
FL - WEST PALM BEACH - Computer Show & Sale. Palm Beach Airport Hilton, 150 Australian Ave. Narisaam 770-663-0983
IL - CHICAGO - CARC Hamfest. DeVry Institute of Technology, 3300 N. Campbell. 8am-3pm. 773-545-3622
IL - GLEN ELLYN - Computer Show & Sale. College of DuPage. Main Arena of Phys Ed Bldg. Corner of Park Blvd. & College Rd. 9:30am-3pm. Computer Central Shows 847-940-7547
KY - LOUISVILLE - Computer Fair South. Executive West Hotel. 9:30am-3pm. Sammy L. Hastings 812-333-9300
MD - WEST FRIENDSHIP - MFMA Hamfest. Howard Co. Fairgrounds. Craig Rockenbauch 410-987-6042
MI - GRAND RAPIDS - Super Computer Sales. Crowne Plaza, 5700 28th St. S.E. 10am-4pm. Computers & You 313-283-1754
OH - COLUMBUS - Computer Show. Veterans Memorial. MarketPro 301-984-0880
OH - HILLIARD - Hamfest. Chris Lind, 614-267-7779

MAY 26

KY - LEXINGTON - Computer Show. Continental Inn. MarketPro 301-984-0880
NC - ASHEVILLE - Computer Show. Asheville Civic Center. 9:30am-4pm. MarketPro 201-825-2229

Events CALENDAR

NJ - PARSIPPANY - Computer Show. Parsippany Hilton. 9:30am-4pm. MarketPro 201-825-2229
OH - DAYTON - Computer Show. Montgomery Co. Fairgrounds. MarketPro 301-984-0880
PA - READING - Computer Show. Sheraton Berkshire. MarketPro 301-984-0880
VA - MANASSAS - Computer Show. Manassas Fairgrounds. MarketPro 301-984-0880

MAY 30-31-JUNE 1

NY - ROCHESTER - Hamfest & Computer Show. Monroe Co. Fairgrounds, Rte. 15A. Fri: 6am-6pm, Sat: 8:30am-5:30pm, Sun: 8:30am-1:30pm. 716-424-7184
WA - DRYDEN - ARRL Hamfest. Arlene Trotter KC7EW, 509-662-2344

MAY 31

CA - OAKLAND - Computer Show. Oakland Convention Center, Broadway @ 10th St. 1-800-243-7041 http://www.robertaustin.com
CO - DENVER - Metro Computer Show & Swap Meet. 2950 W. 72nd Ave., Westminster. Reputable Systems 303-444-2664
CO - LOVELAND - Superfest. Larimer Co. Fairgrounds, 700 Railroad Ave. 8am-3pm. Michael Robinson N7MR, 970-282-1167
IL - SPRINGFIELD - Hamfest. State Fairgrounds, 4-H building. 8am-1pm. Don Pitchford W9EBK, 217-789-4519
IN - INDIANAPOLIS - AGI Computer Fair. Indianapolis Events Center. 3655 E. Raymond St. 10am-4pm. 317-299-8827
ME - AUGUSTA - Computer Shows. Augusta Civic Center. Northern Computer Shows 508-744-8440
MI - TAYLOR - Super Computer Sales. Democratic Club Hall, 23400 Wick Rd. 10am-3pm. Computers & You 313-283-1754
NY - SYRACUSE - Computer Show. On Center. 9:30am-4pm. MarketPro 201-825-2229
TN - NASHVILLE - Hamfest. State Fairgrounds, Agriculture Bldg. 8am-5pm. Bill Pingley KT0C, 615-889-7376
VA - CHANTILLY - Computer Show. Capital Expo Center. MarketPro 301-984-0880

MAY 31-JUNE 1

FL - TALLAHASSEE - Computer Show. North Florida Fairgrounds. MarketPro 301-984-0880
NC - CONCORD - Hamfest & Computer Fair. Cabarrus Co. Fairgrounds, Hwy. 29 S. & Cabarrus Ave. Sat: 5pm-10pm, Sun: 8am-4pm. N4DUQ, 704-455-6484
NC - WINSTON-SALEM - Computer Show. Lawrence Joel Veterans Memorial. 9:30am-4pm. MarketPro 201-825-2229
NY - WHITE PLAINS - Computer Show. Westchester Co. Center. 9:30am-4pm. MarketPro 201-825-2229
PA - KING OF PRUSSIA - Computer Show. Holiday Inn. MarketPro 301-984-0880
PA - MONROEVILLE - Computer Show. Pittsburgh Expo Mart. MarketPro 301-984-0880
TN - KNOXVILLE - Computer Show. Tennessee Valley Fairgrounds. MarketPro 301-984-0880

JUNE 1997

JUNE 1

CANADA - QUEBEC - COTE ST. LUC - Hamfest. Gerald Philips VE2XGP, 514-683-6469
CA - LIVERMORE - Swapmeet. Las Positas College. Noel Anklam 510-447-3857
CT - NEWINGTON - Amateur Radio & Electronics Flea Market. Newington High School, Willard Ave. (Rte. 173). 9am-1pm. Ed Matthews KC1JV, 68 Wildmere Ave., Waterbury, CT 06705
IL - PRINCETON - Hamfest & Computer Show. Bureau Co. Fairgrounds. Bruce Burton KU9A 815-795-2201. E-Mail: brburton@mtco.com
IN - ANDERSON - AGI Computer Fair. Holiday Inn (just off I-69). 10am-3pm. 317-299-8827
MD - UPPER MARLBORO - Computer Show. The Show Place Arena. MarketPro 301-984-0880
MI - CHELSEA - CARC Swap & Shop. Chelsea Fairgrounds. K. Alan Robbins 313-878-0363
MI - LANSING - Super Computer Sales. Holiday Inn South Convention Center, 6820 S. Cedar St. 10am-4pm. Computers & You 313-283-1754
NH - SALEM - Computer Show. Rockingham Park Race Track. Northern Computer Shows 508-744-8440
NY - QUEENS - Hamfest. New York Hall of Science parking lot, Flushing Meadow Park, 47-01 111th St. Arnie Schiffman WB2YXB, 718-343-0172 eves.
NY - UTICA - Computer Show. Utica Memorial Coliseum. 9:30am-4pm. MarketPro 201-825-2229
PA - BUTLER - Hamfest & Computer Show. Butler Farm Showgrounds. 8am-4pm. George Artnak N3FXW, 412-854-5593. E-Mail: GEOART@USA.NET
VA - MANASSAS - Hamfest & Computer Show. Prince William Co. Fairgrounds, I66 W. to Rte. 234, S. on Rte. 234 to Fairgrounds. 8am-4pm. Mary Lu KB4EFP, 703-369-2877

JUNE 6-7-8

TX - ARLINGTON - Texas State Convention. Tom Gentry K5VOU, 972-442-1721

JUNE 6-7-8-9

NY - ELLENVILLE - Chaverim International Convention. Fallsview Hotel. Sonny Gutin WB2DXB, 609-853-7889. E-Mail: wb2dxb@juno.com

JUNE 7

CANADA - ONTARIO - KITCHENER - Hamfest. Bill Smith VE3WHS 519-821-6642
CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
MA - WEST SPRINGFIELD - Computer Show. Eastern States Expo. Center. 9:30am-4pm. MarketPro 201-825-2229
MI - GRAND RAPIDS - Hamfestival. Hudsonville Fairgrounds, 5 mi. W. of Grand Rapids off I-196 x-way. IRA 616-534-6803
MI - LIVONIA - Super Computer Sales. Livonia Elks Lodge Hall, 31117 Plymouth Rd. 10am-3pm. Computers & You 313-283-1754
MN - MINNEAPOLIS - ARRL Hamfest. Shep Shepardson N0NMZ, 612-633-8135
NH - LEMPSTER - Hamfest. Conrad Elkstrom WB1GXM 603-543-1389
NH - SEABROOK - Computer Show. Seabrook Greyhound Park. Northern Computer Shows 508-744-8440
NJ - TEANECK - ARRL Hamfest. Jim Joyce K2ZO, 201-664-6725
NY - PLATTSBURGH - ARRL Hamfest. Chuck Orem KD2AJ 518-563-6851
OH - TOLEDO - Computer Show. SeaGate Convention Centre. MarketPro 301-984-0880
PA - LANCASTER - Computer Show. Holiday Inn Lancaster Host. MarketPro 301-984-0880

JUNE 7-8

FL - JACKSONVILLE - Computer Show. Morroco Shrine Auditorium. MarketPro 301-984-0880
MD - TIMONIUM - Computer Show. Maryland State Fairgrounds. MarketPro 301-984-0880
NY - LAKE GROVE - Computer Show. Sports Plus. 9:30am-4pm. MarketPro 201-825-2229
TN - NASHVILLE - Computer Show. Tennessee State Fairgrounds. MarketPro 301-984-0880

JUNE 8

CANADA - BRITISH COLUMBIA - MAPLE RIDGE - Hamfest. Nick VE7FYT, 604-463-9476
IL - GRANITE CITY - Hamfest. Bill Dusenbery N9OQK, 618-398-1456
IL - WHEATON - Hamfest. DuPage Co. Fairgrounds, 2015 Manchester Rd. 708-442-4961
IN - FORT WAYNE - Computer Show. Memorial Coliseum. MarketPro 301-984-0880
IN - WABASH - ARRL Hamfest. Don Spangler W9HNO, 219-563-5564
KY - ERLANGER - Ham-O-Rama '97. Kentucky Lions' Park, 8 mi. S. of Cincinnati at the end of Sunset Ave. Robert N8JMV 513-797-7252 evenings
MA - TAUNTON - Computer Show. Holiday Inn. Northern Computer Shows 508-744-8440
MI - DEARBORN - Super Computer Sales. Dearborn Civic Center, 15801 Michigan Ave. 10am-4pm. Computers & You 313-283-1754
MI - FLINT - Computer Show. Holiday Inn, Gateway Centre, US 23 @ Hill Rd. Exit. Five Star Productions 810-890-0988
NC - CHARLOTTE - Hamfest & Computer Fair. Roll-A-Round Skate Center, 8830 E. Harris Blvd. 8am-4pm. Daryl Sampson KM4GO 704-522-4971 Ext. 3330
NY - BETHPAGE - ARRL Hamfest. Mark Nadel W2OT, 516-796-2366 E-Mail: hmn@i2000.com
NY - DARIEN CENTER - ARRL Hamfest. Charles Koester WD2AIK, 716-937-3592
NY - POUGHKEEPSIE - Computer Show. Mid-Hudson Civic Center. 9:30am-4pm. MarketPro 201-825-2229
OH - SUFFIELD - Family Picnic & Computer Fest. Goodyear's Wingfoot Lake Park, 10 mi. E. of Akron off State Route 43. 8am-4pm. Ken Phillips K8CHE, 330-733-5795. E-Mail: kenphillips@juno.com
PA - YORK - Computer Show. Holiday Inn Holidome & Conference. MarketPro 301-984-0880
RI - WEST WARWICK - Computer Show. West Warwick Civic Center. 9:30am-4pm. MarketPro 201-825-2229
WI - JUNCTION CITY - Hamfest. John Feltz WA9LWJ, 715-457-2506 E-Mail: jfwa91wj@tznet.com

JUNE 12-13-14

MD - LAUREL - Radioactivity '97. Best Western Maryland Inn, 15101 Switzer Lane. http://www.radiohistory.org/ra97.htm

JUNE 13-14-15

CANADA - ALBERTA - Hamfest. Bob King VE6BLD, 403-782-3438

JUNE 13-14

GA - ALBANY - Hamfest & Computer Fair. GA Section Convention. Arthur Shipley N4GPJ, 912-439-7055. E-Mail: n4gpj@isoa.net

JUNE 14

CA - DALY CITY - Computer Show. Cow Palace, Gate #5, Geneva & Santos. Robert Austin Corp. 1-800-243-7041, http://www.robertaustin.com
CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School.
Bill 909-822-4138 eves
FL - FORT MCCOY - Hamfest. Bob Dary K4VDX, 352-694-6160
KY - PADUCAH - "Dukefest." Executive Inn Convention Center. 9am-3pm. Craig Martindale WA4WBU, 502-444-6822 or 502-443-3860
ME - HERMON - Bangor Hamfest. Hermon High School. 8am-1pm. Roger W. Dole 207-848-3846
MI - FLINT - Super Computer Sales. IMA Arena, S. of Exit #139 off of I-69. 10am-3pm. Computers & You 313-283-1754
MI - MIDLAND - MARC Hamfest. Midland Co. Fairgrounds. 8am-1pm. 517-839-9371 eves.
NC - WINSTON-SALEM - Hamfest, Computer, & Electronics Fair. Dixie Classic Fairgrounds. Forsyth ARC, 910-723-7388. http://www.rdbc.com/~kq4lo/farc.htm
NY - BUFFALO - Computer Show. Hamburg Fairgrounds. 9:30am-4pm. MarketPro 201-825-2229
NY - CORTLAND - ARRL Hamfest. Andrew Slaugh KB2LUV, 607-753-0597
OH - DAYTON - Computer Show. Montgomery Co. Fairgrounds. MarketPro 301-984-0880
VA - ANNANDALE - Computer Show. Northern VA Community College. MarketPro 301-984-0880
VA - ROANOKE - Computer Show. Roanoke Civic Center. MarketPro 301-984-0880

JUNE 14-15

FL - ORLANDO - Computer Show. Central Florida Fairgrounds. MarketPro 301-984-0880
GA - KENNESAW - Computer Show. I-75 Exit 116, go W. on Barrett Pkwy. to Hwy. 41, turn right, go to 2nd traffic light; we're on the right next to "Cowboys." GA Mountain Productions 706-838-4827
KY - LOUISVILLE - Computer Show. Kentucky Fair & Expo Center. MarketPro 301-984-0880
MA - WILMINGTON - Computer Show. Shriner's Auditorium. 9:30am-4pm. MarketPro 201-825-2229
MT - WHITETAIL - Hamfest. Stacey Hanrahan E-Mail: 2aa7ya@3rivers.net
NH - MANCHESTER - Computer Show. Center of NH Complex. Northern Computer Shows 508-744-8440
OR - SEASIDE - SEA-PAC Northwest Div. Ham Convention. Seaside Convention Center. Brad N7NVC, 503-657-1781
PA - ALLENTOWN - Computer Show. Allentown Fairgrounds. MarketPro 301-984-0880
SC - CHARLOTTE - Computer Show. The Merchandise Mart. 9:30am-4pm. MarketPro 201-825-2229

JUNE 15

CA - ORCUTT - ARRL Hamfest. Eric Lemmon WB6FLY, 805-733-4416
IN - CROWN POINT - LCARC Hamfest. Lake Co. Fairgrounds. Malcom Lunsford WN9L, 219-769-3925. 72202.230@compuserve.com
MA - CAMBRIDGE - Flea Market. Kendall Square area. 9am-2pm. MIT. Nick Alternburnd 617-253-3776
MD - FREDERICK - Hamfest. Frederick Co. Fairgrounds. 8am-3pm. Sound Source 301-695-2633 Code: 6 393
MD - NEW CARROLLTON - Computer Show. Ramada Conference & Exhibition Center. MarketPro 301-984-0880
MI - MADISON HEIGHTS - Super Computer Sales. UF&CW Hall, 876 Horace Brown Dr. 10am-4pm. Computers & You 313-283-1754
MI - MONROE - Hamfest. Monroe Co. Fairgrounds, M-50 @ Raisinville Rd. 7:30am-1pm. Fred VanDaele 313-242-9487
NY - ROCHESTER - Computer Show. The Dome Center. 9:30am-4pm. MarketPro 201-825-2229
OH - COLUMBUS - Computer Show. Ohio Expo Center. MarketPro 301-984-0880
OH - MACEDONIA - ARRL Hamfest. Rich James N8FIL, 216-468-2035, http://www.cars.org/hamfest
VA - RICHMOND - Computer Show. The Showplace. MarketPro 301-984-0880
WV - BLUEFIELD - Hamfest. Brushfork Armory, on the border of VA & WV, 1-1/2 mi. N. on US 52. Don Williams WA4K, 540-326-3338, E-Mail wa4k@amsat.org Web: http://www.inetone.net/erarc/hamfest.html

JUNE 21

CANADA - ONTARIO - MARMORA - Hamfest. Pete VA3PGB, 613-473-1171

Continued on page 104

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SPECTRUM ANALYZERS: HP 8555A, 8552B, 141T (.01-18 GHz) $1,600. **Tek 7L5/L3,** 20Hz-5MHz $1,400; with tracking generator $1,900. **HP 3580A** 5Hz-50KHz, 1Hz RBW, adaptive sweep, tracking generator: $790 (mech), $1,250 (LED). Excellent condition, warranty. Pepper Systems, 214-353-0257. **We're Back!**

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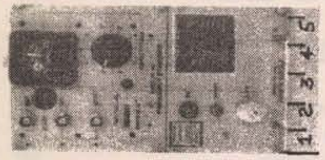

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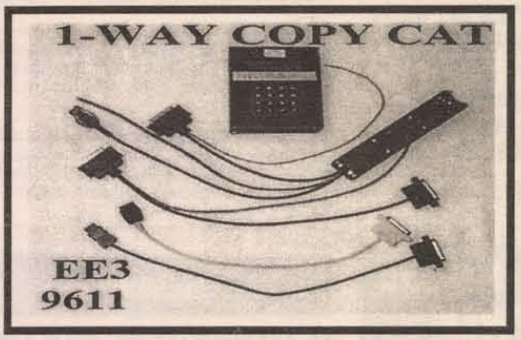

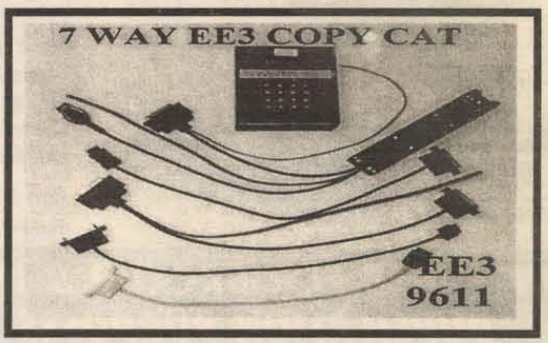

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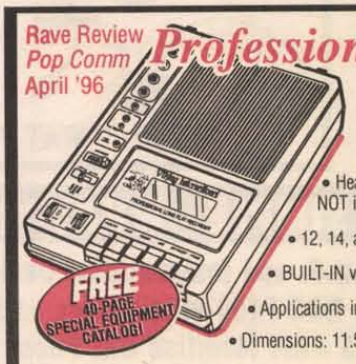

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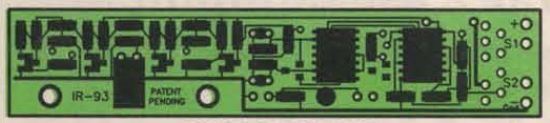

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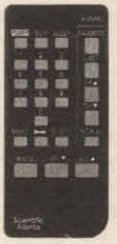

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Electrical Power All Over the Place ... and a Few Safety Notes

Open Channel

by Joseph J. Carr
K4IPV

Travel overseas can be an interesting and gratifying experience. You can send postcards to envious friends from exotic locations, pick up a few souvenirs, and take about a gozillion color pictures. Some places you can even get shot at ... which will make many of us feel right at home. All you need to do is get a passport from the State Department (takes from three to eight weeks, but one can be had on an urgent basis if you have a ticket to prove departure date), stop by a few consular offices to obtain visas (you really don't want to get arrested at the airport), pack some clothes, and take off. Right? Wellllll, maybe not.

There are a number of things that must be tended to before leaving.

If you are a ham radio operator and want to take along a rig to operate in an exotic DX location, then you need to do some investigations. Not every country is going to let you operate or, for that matter, bring radio gear into the country.

The American Radio Relay League (225 Main Street, Newington, CT 06111; E-Mail: hq@arrl.org) can advise you on reciprocal licensing and other issues (such as customs regulations) relating to hamming in various countries.

If you are a photographer or video camera fan, then there may be some special considerations. Not all countries welcome cameras and the like (most do, and you probably don't want to visit the other kind, anyway). But most countries have restrictions on how many cameras you can bring into the country without paying customs duty. One general rule is one still camera for every adult. That takes care of the tourist, but the professional might be asked to lay out $$$$ at the airport.

Some old hands could also tell you about the specifics of each country (bribes? never ... I think they're called "paperwork facilitation fees"). One chap told me that a certain Latin American country almost always imposed a huge import tax on radio and photographic gear brought into the country in the cargo hold of the aircraft, packed in factory boxes. On the other hand, if you carry the radio under your arm, and make it look a bit old, that seems to do the trick.

Be very wary of some countries. Nigeria has been in the news in the past few years because of their abusive customs officials. Requiring hundreds of dollars in bribes is commonplace according to one TV news report. Although the government of that country is reportedly taking steps to solve the problem, the shakedown seems to be a good reason to avoid the place.

Another major issue is the matter of AC power for your equipment. Some larger equipment is equipped with AC power mains selector switches on the back of the rig (or of the power supply if it is separate), especially if it was made overseas for use in many different countries. In other cases, there are taps on the internal AC power transformer for different voltages. For example, on one species of ham rig I saw had a 120/240-volt switch on the rear panel. But a service technician showed me something that was not hooked up. The schematic showed several additional primary taps that could accommodate primary voltages of 100 to 380 volts, depending on which was hooked up. It only makes sense. After all, why would the manufacturer make different AC power transformers for different countries when a few taps covers a lot of locations.

Many electrical devices you will take with you are battery powered, but if the battery is a rechargeable type then you will have to account for the difference in voltages in different countries. The ugly black "wall crawler" power supply used to charge the batteries is probably intended for use in 120-volt AC systems in the USA. Some of them will have a 220-VAC or 240-VAC switch, but most don't. If you plan to go overseas with the equipment, then you might want to check with the manufacturer to see if an overseas version of the power supply is available.

In some cases, you will need an external transformer adapter for the power supply. Don't rely on those little "travelers" transformers that run your electric shaver, however, unless you check the wattage and voltage ratings. The wattage will be expressed in terms of "volt-amperes" (1 V-A = 1 watt in resistive circuits). Those transformers are essentially a step-down transformer that converts the 240 VAC found in many countries to 120 VAC used in American appliances.

Isolation transformers come in 1:1 and 2:1 ratio, so can accommodate a variety of power situations. The most useful of those have a 120-volt AC outlet on one side, and a plug and voltage selector on the other. Transformers of that sort are not rated for power (i.e., watts), but rather are rated for volt-amperes (VA). VA is the same as watts, except for power factor. These transformers are available in V-A ratings from about 200 V-A to several thousand V-A. The problem is that the higher the rating, the heavier the transformer. I, for one, would not want to tote a 1,000 V-A 2:1 isolation transformer around in my luggage.

A friend of mine of many years standing lives in Ireland. Although he has been there many years, he still has a lot of American electrical thingees, including his ham rig. He has several rather beefy transformers to accommodate them. But then again, he shipped his household goods over in a sealed cargo container.

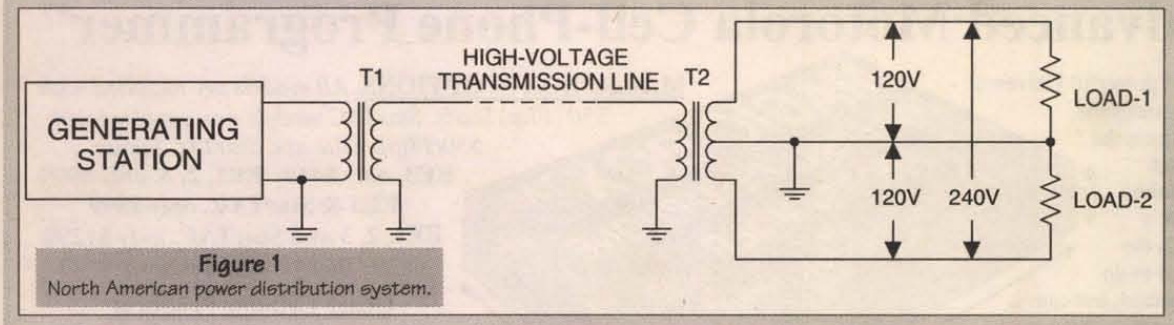

Figure 1
North American power distribution system.

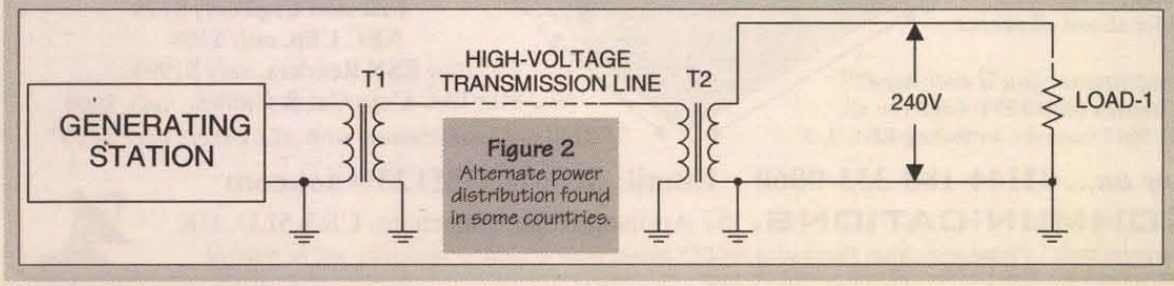

Figure 2
Alternate power distribution found in some countries.

Power Distribution Systems

Figure 1 shows the standard AC power distribution system in North America. The generating station produces high-voltage AC power. It is distributed at high voltage so that the current is reduced (for any given wattage), and that makes transmission through lossy transmission lines less of a headache. It will go through a number of step-down transformers, but I've shown only the one outside your house. It will have a high-voltage primary, and a 240-volt center-tapped secondary. The center-tap is grounded. If you want a 240-volt outlet, then you take the voltage across the two ends of the transformer. But if you want 120 volts, then you take the voltage from ground to either end. Two "circuits" can be served (shown as LOAD-1 and LOAD-2). Of course, in

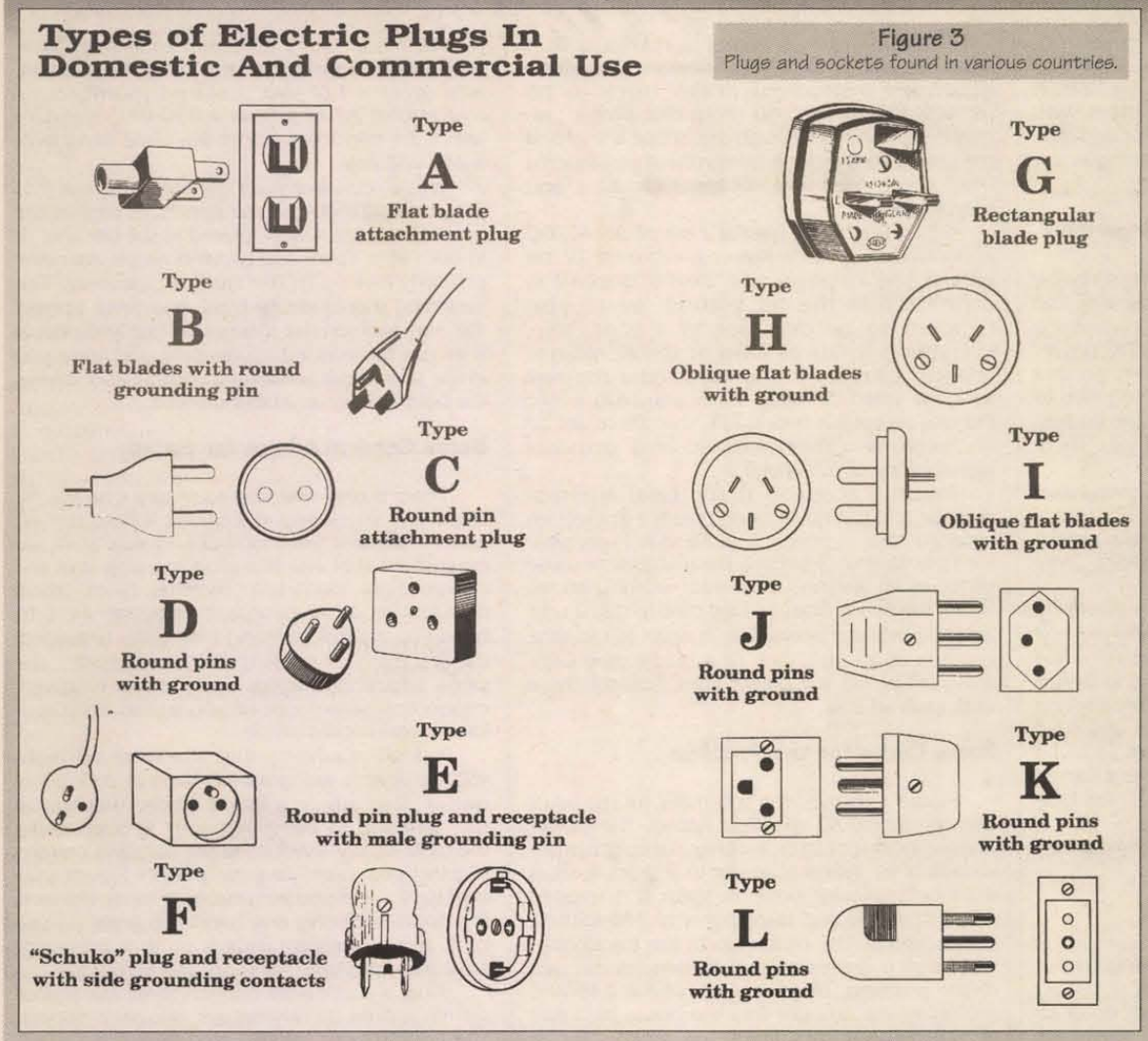

Figure 3
Plugs and sockets found in various countries.

a real system there are switches, fuses, circuit breakers, and a distribution box, as well as the transformer shown in Figure 1. [Note: This is a highly simplified version. It does not show intermediate transformers (where used), switching or fusing).]

Many overseas locations use the same type of distribution system, although the voltages may be different from those used in the United States and Canada. Other countries use a single wire secondary distribution system such as shown in Figure 2.

In two-wire systems, the voltages available will be listed in the form 120/240, or whatever voltages are actually present. This system is pretty much the same up to the primary of the transformer, but the secondary is not center-tapped. The voltage listed for those countries will be only one level.

Various plugs and sockets are found around the world. Figure 3 shows some of the different types of plugs that will be found. You will need to either buy adapters from our system to theirs, or buy new plugs when you arrive.

In one European country, until about a decade ago, they used seven different plugs on their household appliances. When you went to the store and bought, say, a video cassette recorder (VCR), the thing came out of the box with no plug. The store would ask you to point to the required plug on a chart, and then install it before you left the store. Standardization has its uses, doesn't it?

Another problem overseas is the frequency of the AC power. In the USA and Canada, 60 Hz is the standard AC frequency. In much of the rest of the world 60 Hz is also used. But many countries use 50 Hz rather than 60 Hz. For most cases, the difference is negligible. But if your appliance uses the AC line frequency for timing, then the problem will be profound. Your plug-in electric clock, for example, will run slow on 50 Hz electricity ... and that might make you miss your tour bus departure! Some appliances, such as tape recorders, can be fitted for 50 Hz use. Fortunately, most such products today use a different method that relies on DC from the normal power supply, so that is no longer the problem it once was.

For most appliances, the difference between 50 and 60 Hz is not a problem. But a few countries, or cities within countries, use a different system. Some smaller cities might use 25 Hz AC, which has not been standard since the turn of the century (1900!). Also, some places still use DC for normal power distribution. DON'T EVEN THINK ABOUT PLUGGING AN AC DEVICE INTO A DC LINE EVEN IF THE VOLTAGE IS CORRECT! Although devices are AC/DC in design, most are not ... and the results of plugging into a DC line can be disastrous.

The cities that use DC are usually those that have extensive streetcar or tram service, and an ancient infrastructure. When I was a young electronics technician just out of high school, I lived near Washington, DC. Several areas of the city were run on 125-volts DC because they bought their power from the old DC Transit Company. We had to be real careful about what we sold people in that part of the city, lest they burn it up when plugging it in. And that wasn't all that long ago ... the early 1960s was when they converted to an all-AC system in our nation's capital.

A Booklet for You

If you want detailed information about plugs, voltages, and so forth, the US Government can supply a little book for $9.95. Ask for Electric Current Abroad, publication number PB91-193383. Write to National Technical Information Service, US Department of Commerce, Springfield, VA 22161. Call 1-800-553-NTIS, or in the Washington, DC calling area, 703-487-4650.

Electrical Safety

When you work in electronics, especially on power supplies, you will probably (perhaps frequently) come into close proximity with voltage and current sources that are high enough to be dangerous — they can cause some damage to you, perhaps even your death.

How Much Current is Fatal?

Several years ago, the author worked in a hospital electronics laboratory. One day he overheard an intern claim that 120-volts AC from the wall socket is not dangerous because they told him in medical school that it's not the voltage that kills, but the current. A bystander asked him: "Doctor, have you ever heard of Ohm's law?" According to Ohm's law, the current is merely the quotient of voltage and resistance: I = E/R. Besides, a little statistic that the doctor apparently didn't know was that 120-volts AC from residential wall sockets is the most common cause of electrocution in the USA. In addition, medical studies reveal that the 50-60 Hz frequency used in AC power distribution almost worldwide is the most dangerous range of frequencies. Higher and lower AC frequencies are less dangerous (but not safe!) than 60-Hz AC.

According to medical experts who have studied electrical shock, the killing factor is current density in a certain section of the heart called the sinoatrial node. Any flow of current through the body that causes a high level of current to flow in that section of the heart can be fatal. In general, for limb-contact electrical shocks through intact skin, the following rules of thumb are accepted:

1-5 mA	Level of perception
10 mA	Level of pain
100 mA	Severe muscular contraction
100-300 mA	Electrocution

Keep in mind that these figures are approximate, and are not to be taken as guidelines to approximate "assumed risk." Death can occur under certain circumstances with considerably lower levels of current. For example, when you are sweating, and are standing in salt water, then risks escalate tremendously.

Is High Current, Low Voltage Dangerous?

The author once attended a design review meeting for a high-power mobile transmitter. The specification called for insulation of low-voltage (28 VDC), high-current (50-amperes) DC power supply terminals. One of the engineers present sneered that was something like asking him to insulate the battery terminals of his car; implied was that low current can never hurt you. There are two false premises to that opinion.

First, although low-voltage, high-current points rarely cause electrical shock, it is possible for dangerous shock to occur when the person has a very low electrical skin resistance (very sweaty), or has an open wound.

Second, the high current is extremely dangerous if you happen to be wearing jewelry! A two-way radio shop used 12-volt batteries and battery chargers for the troubleshooting bench supply for mobile service. A technician working on the battery rack dropped a wrench, and it fell onto the battery making contact from (-) to (+) through his watchband. The large current turned the watchband red hot, and gave him one serious second and third degree burns.

Don't assume that low-voltage, high-current power supplies are harmless!

Mechanisms of Electrical Shock

In order to raise our consciousness about how shock can occur, let's take a look at certain scenarios of electrical shock that might occur to electronics technicians. First, there is the direct approach to fatal electrical shock. You are grounded through conductive (wet leather?) shoes and touch a hot point. You need not be outdoors to be affected by this scenario. A concrete garage, shop or basement floor is a reasonably good conductor, as are wet leather and some forms of rubber shoe.

There is also an indirect scenario that especially affects electronics workers. Consider a grounded instrument probe (such as an oscilloscope). When you grasp that probe, you may be grounded through the 'scope shield and the power cord ground conductor. If you touch a "hot" point, then you will get shocked ... and maybe killed.

Or consider the special case of an AC/DC appliance, such as a low-cost radio or TV set where the oscilloscope probe ground is connected to the set ground, which also happens to be one side of the AC line. Everything is fine as long as the AC plug is oriented correctly in the wall, and if the wall socket is wired correctly. But if you plug it into the wall receptacle backwards, then there will be an explosive short circuit and possible electrocution of the operator.

Another scenario is the fatal antenna erection job. It is never good practice to erect an antenna near a power line! NEVER. Every year we hear stories of people electrocuted because either: a) an antenna they were working on fell across the power lines; b) they tried to toss a wire antenna over the power line in order to raise the antenna above the lines; or a ladder they were using fell across the power lines. Foolish! These tactics will kill you.

Some Cures for the Problem

Figure 1 showed the schematic for the usual USA residential AC electrical system. The power company distributes energy through high-voltage lines. When it arrives to a point a short distance from your home or shop, it is stepped down in a "pole pig" transformer to 240-volts AC center-tapped. The center-tap of the transformer secondary is grounded, and therein lies the root of the problem. The two ends of the 240-VAC secondary are brought into the house as a pair of 120-VAC hot lines. If you tap across the two lines, then you have a 240-VAC outlet; if you tap from the ground line to either hot line, then you have a 120-VAC outlet.

The problem is that the electrical system in your home or shop is ground referenced. The solution is to make the little local electrical system on your workbench non-ground referenced. My workbench in "Joe's Basement Laboratory" uses an isolation transformer. It is a 1:1 transformer, and gives a 120-VAC isolated (non-ground referenced) AC line from a 120-VAC standard line; a 2:1 transformer does the same thing from a 240-VAC line.

The circuit breakers or fuses are used to protect equipment on the bench, as well as the transformer. It is always placed in the hot line, or in both lines. Fuses and circuit breakers are never properly placed in the neutral line only. The switching should ideally break both lines. I prefer this approach on the theory that hot and neutral lines can be reversed accidentally, and leave you in the position of breaking a neutral, and leaving the hot line alive as a hissing cobra.

Some General Advice for Safety

There is only one way to ensure that the AC line won't shock you: disconnect it from the AC power. Make it your practice to not work on equipment that has the plug inserted into the power outlet. Don't trust switches, fuses, circuit breakers, or other people. If someone were to hand you a pistol, claiming that it was unloaded, the first thing you'd do is check it yourself ... the same advice also holds true for the electrical connection (which can kill you just as dead as a loaded and cocked pistol).

It is often advised that you work on high-voltage devices with your left hand in your pants pocket. That advice is based on the theory that the "lefthand to either leg path" is supposedly the most deadly. Even if the physiology is correct, placing one hand in your pocket leaves you awkward ... and you are unable to safely work on the circuit with only one hand. It is better to use both hands, and arrange it so that the work environment is safe ... and use safe technique.

What is a safe work environment? The power system should be isolated (as discussed above). The floor should be insulated by a dry carpet, treated masonite with a plastic cover, a rubber mat, wooden planking or some other material; the floor should always be well-insulated and kept dry.

When working on high-voltage DC circuits, keep in mind that capacitors store energy. All filter capacitors must be discharged manually after the power is turned off. Also, the capacitor must be discharged multiple times. Even when a short circuit is placed across the capacitor terminals, not all of the energy is removed the first time. Some energy is stored in the dielectric even after the main charge is discharged.

Conclusion

Electrical shock can be fatal, and is always painful. Even if you aren't killed, substantial injury could occur. But adequate attention to a safe environment and use of safe work practices, will greatly reduce the chances of your encountering what Workman's Compensation insurance instructions call an "untoward event." **NV**

What To Do For An Electrical Shock Victim

The usual mechanism of death for electrical shock victims is a phenomena called ventricular fibrillation (V. Fib.). This is an arrhythmic "heartbeat" in which the heart merely quivers, instead of beating. Unfortunately, V. Fib. is incapable of sustaining blood pumping effectiveness, so the victim dies within a few minutes unless someone trained in cardiopulmonary resuscitation (CPR) is nearby and can support the patient until qualified medical help arrives.

Before you can aid the victim of electrical shock you must be sure that either the victim is away from the current, or the current is turned off! Otherwise, when you touch the victim in order to help him or her, you also will become a victim.

As soon as the victim is clear of the electrical current, call 911 (or your local emergency number), and then initiate cardiopulmonary resuscitation (CPR). CPR will not bring the victim out of V. Fib. Its function is to provide life support until properly equipped and trained medical personnel can be summoned. They will use an electrical device called a "defibrillator" to shock the victim's heart back into correct rhythm. They will also use drugs and intravenous (IV) solutions in order to re-establish the body's balance.

None of these actions can be performed by the untrained person. In fact, even ordinary CPR cannot be effectively performed by the untrained person. Everyone who works near, on, or around electrical or electronic equipment should learn (and stay current in) CPR. In addition, teenage and adult family members should also learn CPR; after all, who is going to save you when the electrical accident occurs at home? The local Red Cross, the Heart Association, some community colleges, and most local hospitals can direct you to certified CPR courses. It is impossible for you to learn CPR from watching medical shows on TV, so get trained by a knowledgeable instructor!

Connections ...
I can be reached via snail mail at P.O. Box 1099, Falls Church, VA 22041, or via Internet E-Mail at carrjj@aol.com

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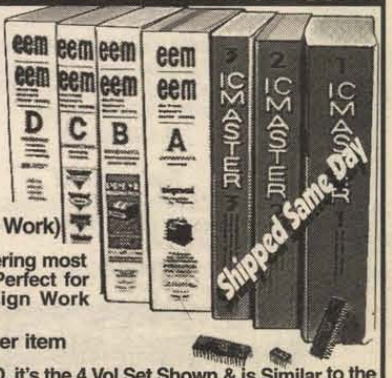

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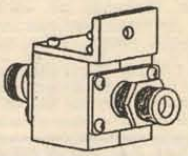

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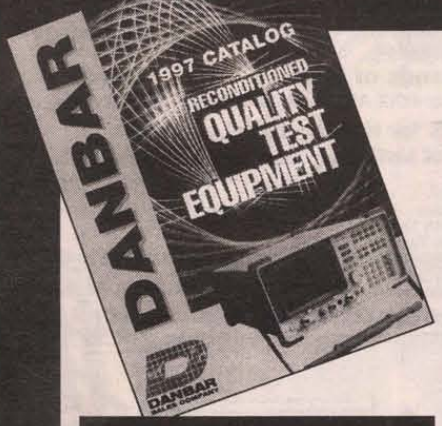

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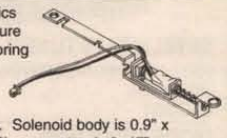

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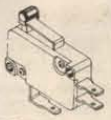
CHERRY D43 SNAP-ACTION SWITCH



S.P.D.T. snap-action switch with roller positioned above switch actuator. Rated 5 amps @ 125/250 vac. Switch body: 1.1" x 0.63" x 0.375". Solder or qc terminals. UL and CSA listed.

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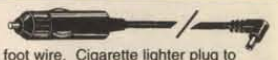

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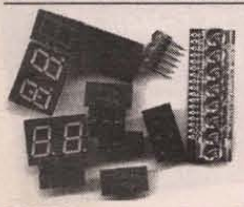

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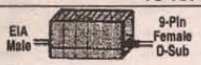

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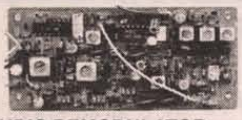

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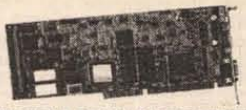

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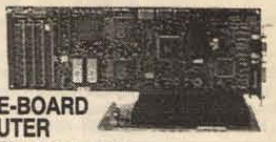

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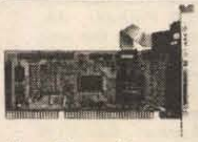

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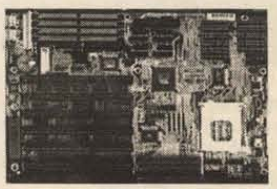

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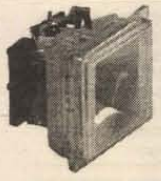

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USER'S GUIDE TO SPECIAL AUDIO PROCESSING ICs

by Ray Marston

Ray looks at practical ways of using three special types of audio processing ICs in this opening episode of a new three-part series.

Modern audio systems and hi-fi units are built mainly around simple analogue ICs such as pre-amp and power amplifier types, but often also make use of various special types of audio signal processing circuitry such as filters and tone controls, electronic channel selectors, or dynamic range manipulation, or noise-reduction systems, etc. Sometimes, these 'special' circuits are built around general-purpose devices such as standard op-amp or operational transconductance amplifier (OTA) ICs, but often they are built around special, dedicated types of audio processing ICs.

This new three-part series of articles explains the basic theory and practical working details of some of these dedicated audio signal processing ICs, including the MC3340P electronic attenuator IC, the NE570/571 dual 'compander' ICs, several multi-way 'analogue switching' and voltage- or digitally-controlled 'gain' and 'tone-control' ICs, and the ever-popular MF10C universal dual switched-capacitor filter IC.

THE MC3340P

The Motorola MC3340P is an old, but very popular dedicated 'electronic attenuator' IC. Figure 1 shows the outline, pin notations, and basic details of the device, which is housed in an eight-pin DIL package; only six of these pins perform useful functions, and two of these are used for power supply connections. Of the remainder, pins 1 and 7 provide input and output signal connections, pin 6 controls roll-off of the device's frequency response, and pin 2 is the device's gain-control terminal.

The MC3340P is really a simple operational transconductance amplifier (OTA), but is configured as a voltage-controlled amplifier. Its basic action is such that it acts as a linear voltage amplifier with 13 dB of signal gain when its pin 2 CONTROL terminal is tied to ground via a 4K0 resistance or is connected to a DC potential of 3.5V. This gain decreases if the control resistance/voltage is increased above these values, falling by 90 dB (to -77 dB) when the values are increased to 32K or 6V. The device's attenuation (or gain) can thus be controlled over a wide range via either a resistance or a voltage.

Figure 2 shows a practical example of a voltage-controlled MC3340P electronic attenuator, together with its performance graph, and Figure 3 shows a resistance-controlled version of the device.

In each of these circuits, C2 is wired to the control terminal to eliminate control noise and transients, thus giving a 'noiseless' form of gain control and enabling the control resistance/voltage to be remotely located, and 680 pF capacitor C3 is wired to pin 6 of the IC and limits the upper frequency response of the circuit to the high-audio range.

Without C3, the response extends to several MHz, but the circuit tends to be unstable. Note that this IC gives only slight signal distortion at low attenuation levels, but that the distortion rises to about 3% at maximum attenuation values.

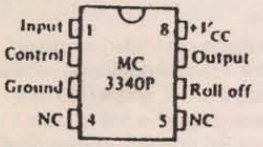
THE NE570/571 IC

The Signetics NE570 is known as a dual 'compandor' (compressor-expander) IC, but is really a rather sophisticated dual VCA (voltage-controlled amplifier). Each half (channel) of the IC contains an identical circuit, comprising a current-controlled variable gain cell (actually a high-quality OTA), an electronic rectifier that converts an AC input signal voltage into an OTA gain-control current, an op-amp, a precision 1.8V reference, and a resistor network.

These elements can be externally configured so that each channel acts as either a normal VCA, as a constant-volume or VOGAD (voice-operated-gain audio device) amplifier, as a disco voice-over or 'ducking' unit, or as a precision dynamic range com-pressor or expander.

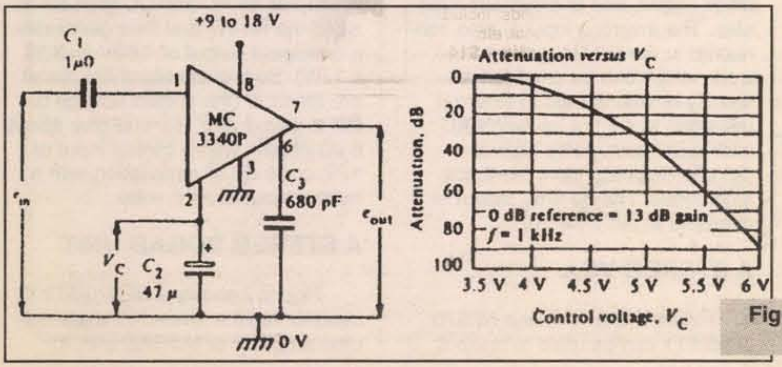
The Signetics NE571 is identical to the NE570, but has a slightly relaxed specification. Figure 4 lists the basic characteristics of the two ICs. Each IC is housed in a 16-pin DIL package, as shown in Figure 5, which also shows the block diagram of one IC channel.

Note in the block diagram (and in all following NE570/571 circuits) that pin numbers relating to the left-hand channel of the IC are shown in plain numbers, and those relating to the right-hand half are shown in bracketed numbers.



Parameter	Min.	Typ.	Max.
Supply volts	+9 V		+18 V
Control pin sink current			2 mA
Input voltage, rms			0.5 V
Voltage gain		13 dB	
Attenuation range		90 dB	
Total harmonic distortion		0.6%	

Figure 1. Outline and main characteristics of the MC3340P IC.



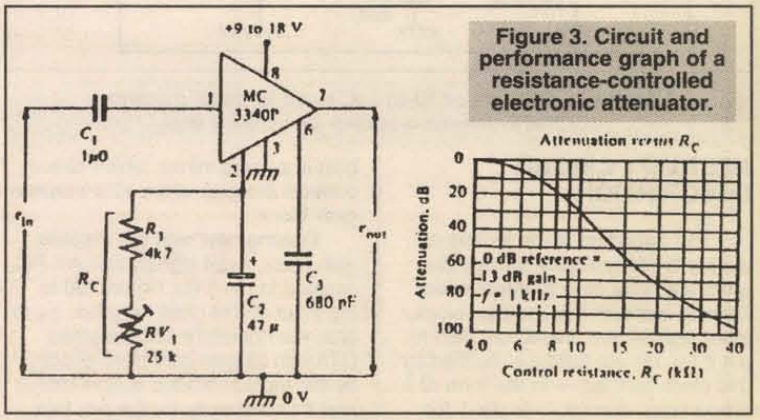


Figure 3. Circuit and performance graph of a resistance-controlled electronic attenuator.

Figure 2. Circuit and performance graph of a voltage-controlled electronic attenuator.

Parameter	NE570	NE571
Supply voltage range	6 V to 24 V	6 v to 18 V
Supply current	3.2 mA	3.2 mA
Output current capability	±20 mA	±20 mA
Output slew rate	0.5 V/μS	0.5 V/μS
Gain block distortion:		
Untrimmed	0.3%	0.5%
Trimmed	0.05%	0.1%
Internal reference voltage	1.8 V	1.8 V
Output DC shift	±20 mV	±30 mV
Expander output noise	20 μV	20 μV

Figure 4. Basic characteristics of the NE570 and NE571 compander ICs.

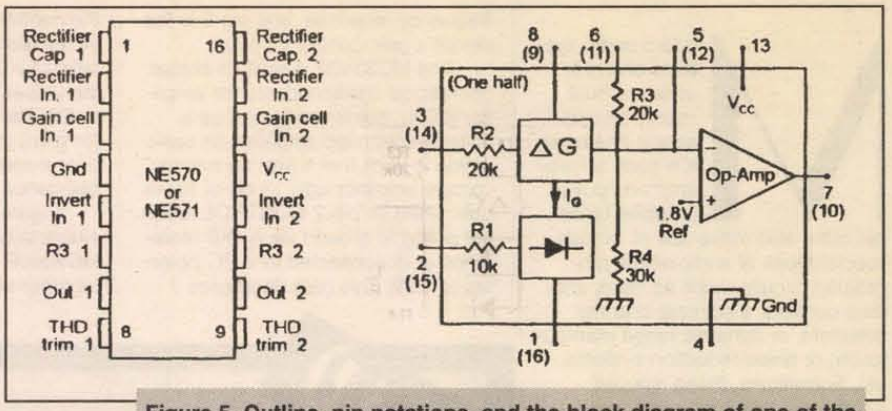


Figure 5. Outline, pin notations, and the block diagram of one of the two identical channels of the NE570/571 dual compander IC.

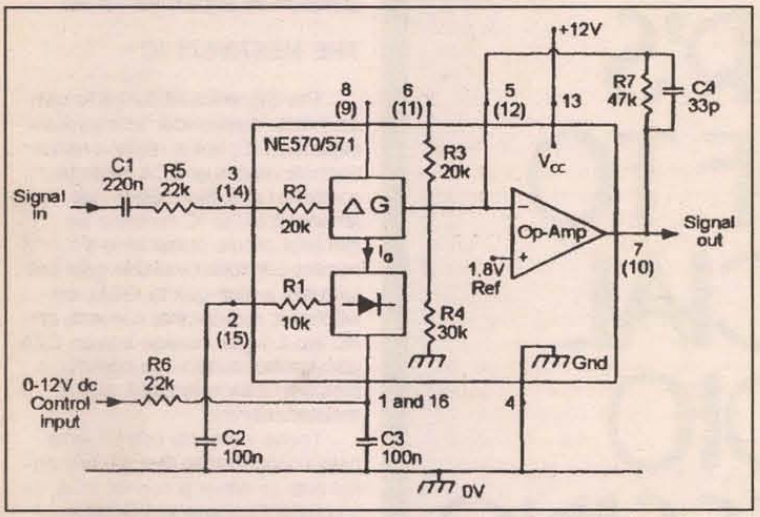


Figure 6. NE570/571 stereo voltage-controlled amplifier/attenuator (only one channel shown).

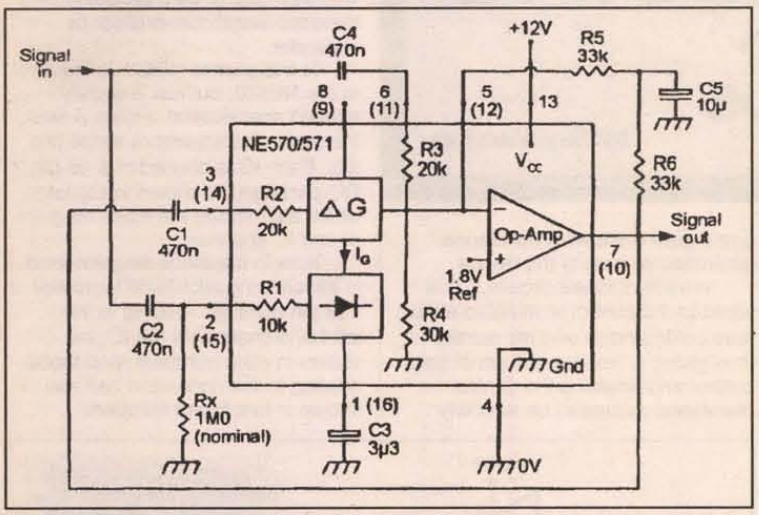


Figure 7. A NE570 or NE571 IC used to make a stereo constant-volume amplifier or VOGAD unit.

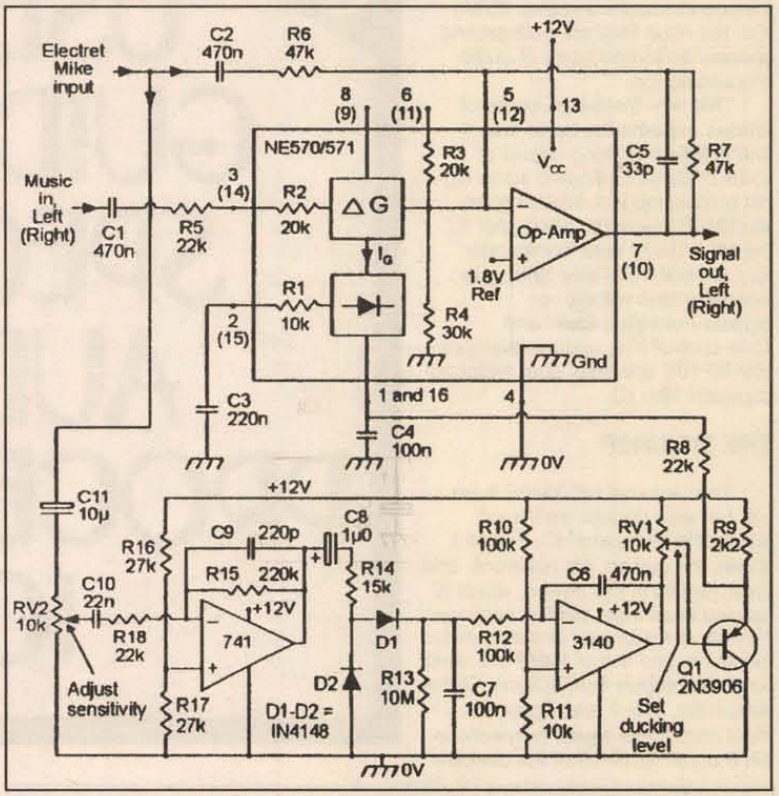


Figure 8. Basic circuit of an NE570/571 disco voice-over or ducking unit.

NE570/571 CIRCUIT DESCRIPTION

The operation of the individual elements of the Figure 5 block diagram are fairly easy to understand. Dealing first with the 'rectifier' block, input signals that are AC coupled to pin 2 (or 15) are fullwave rectified by this block and fed — in the form of a proportional current — to pin 1 (or 16), where they can be smoothed by an external capacitor. The resulting DC current is then applied to a built-in current mirror, which directly controls the gain of the IC's 'variable gain' block.

Dealing next with the variable gain block, input signals that are AC coupled to pin 3 (or 14) are fed to the input of this block, which is a precision temperature-compensated OTA with its gain controlled directly by the rectifier block's current mirror, and thus indirectly via the pin 1 (or 16) voltage; the gain block's output takes the form of a current, but is converted into a proportional output voltage via the IC's op-amp stage. The gain block's signal distortion is quite low, and can be minimized by feeding a 'trim' voltage to pin 8 (or 9).

The channel's op-amp is internally compensated and has its non-inverting input tied to a 1.8V precision band-gap reference; the inverting input is connected to the gain block output, and is externally available. The inverting input is also connected to the R3-R4 resistor network, which can be used (either directly or with the aid of external resistors) to set the op-amp's AC and/or DC gain, using normal op-amp output-to-input feedback techniques. The op-amp output is available at pin 7 (or 10).

A STEREO VCA

Figure 6 shows how a NE570 or NE571 can be used to make a stereo voltage controlled amplifier/attenuator. Here, the internal rectifier is disabled via C2, and a 0 to 12V DC control voltage is fed to pins 1 and 16 via R6 and C3, to give direct control of the rectifier's internal current mirror and thus of the variable gain block.

The output of the gain block is fed to pin 7 (or 10) via the op-amp, which has its AC and DC gain set at x2.56 via R4-R7 and thus generates a quiescent output of 4.62V (= 2.56 x 1.8V). Both channels of the circuit are identical (the control voltage is fed to pins 1 and 16), and give about 6 dB of gain with a control input of 12V, or 80 dB of attenuation with a control input of zero volts.

A STEREO VOGAD UNIT

Figure 7 shows a NE570/571 IC used to make a stereo constant-volume amplifier or VOGAD unit, in

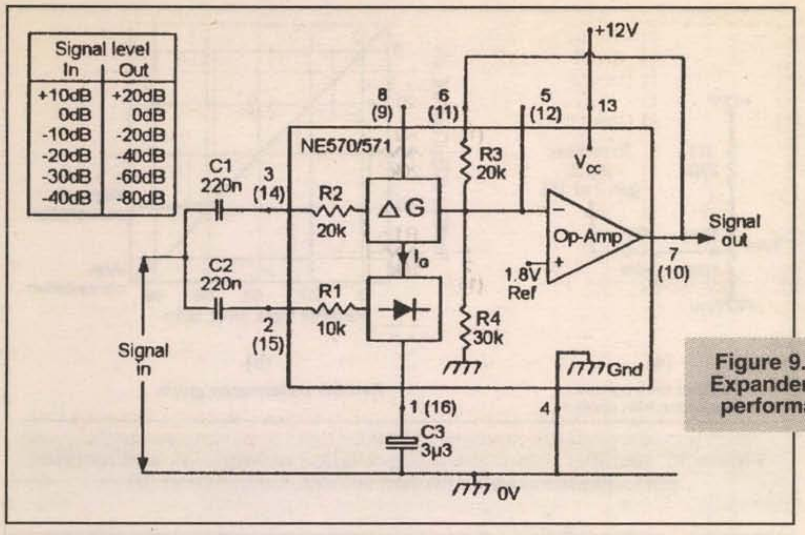


Figure 9. NE570/571 Expander circuit and performance table.

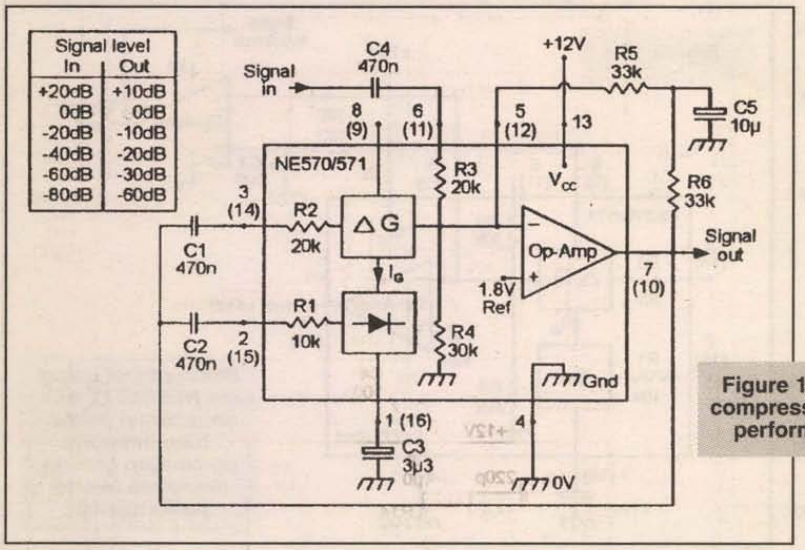


Figure 10. NE570/571 compressor circuit and performance table.

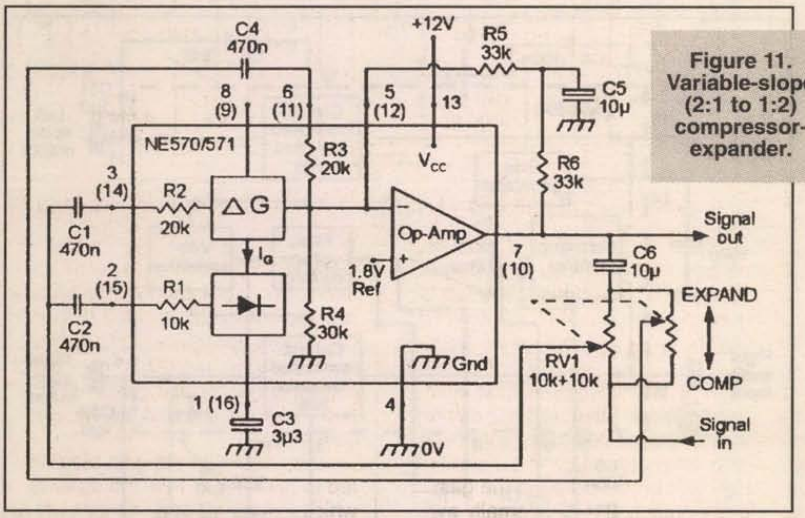


Figure 11. Variable-slope (2:1 to 1:2) compressor-expander.

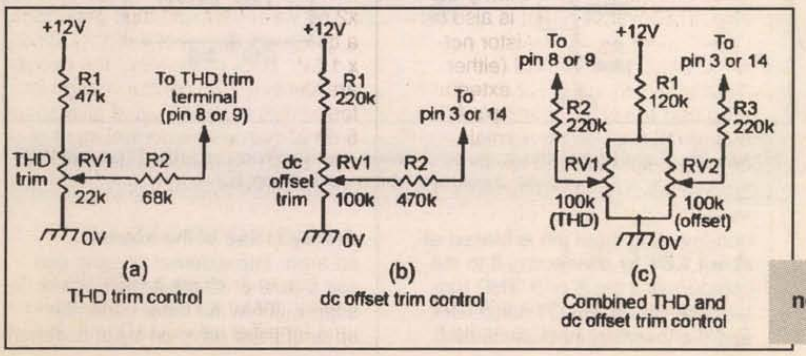


Figure 12. NE570/571 trimmer networks for minimizing THD and DC offset shifts.

which the mean audio output amplitude varies by only ±1 dB when the input signal amplitude is varied over the range +14 dB to -43 dB (the '0 dB' reference value is 0.9Vrms). This type of circuit is often used to feed amplified microphone signals to the inputs of telephonic (wire or radio) communication units or sound distribution or recording systems, and eliminates the need to fiddle with amplitude-level controls.

The circuit operation is quite simple. The pre-amplified input signal is AC-coupled directly to the input of the internal rectifier, and to the op-amp's inverting input via pin 6 (or 11) of the IC, but the gain block is wired in series with the op-amp's output-to-input negative feedback loop, thus making the overall gain inversely proportional to the input level.

Consequently, an 'x' dB fall in input level causes an identical dB increase in gain, thus giving zero change in the circuit's mean output amplitude. Resistor Rx is used to limit the unit's maximum gain, so that the unit does not generate an excessive noise output in the absence of a useful input signal. The Rx value can vary between 100K and 10M, the 'ideal' value (usually about 1M0) being found by trial-and-error.

A VOICE-OVER (DUCKING) UNIT

Figure 8 shows the basic circuit of a NE570/571 disco voice-over or 'ducking' unit that automatically fades the music down when the DJ talks into his microphone and gently restores the music again when the chatting is finished. In this design, each channel's op-amp is used as a two-input audio mixer that has one input taken directly from the microphone input signal and the other taken from the music input signal via the channel's gain cell.

Note that each channel's rectifier unit is disabled via C3, and the gain cell is controlled via transistor Q1, which is used as a simple electronic switch that is activated via the microphone input signal. In the absence of a strong microphone signal, Q1 is cut off and the gain cell is driven fully on via R8-R9, giving maximum amplification to the music signal, which appears at full volume at the pin 7 (10) output terminals.

In the presence of a strong microphone signal, however, Q1 is driven on, and the gain cell attenuates the music signal, causing the microphone signal to dominate the pin 7 (10) output.

In practice, the actual ducking or music-attenuation level of the circuit can be fully controlled — from near-zero to -80 dB — via RV1, enabling the 'ducked' music and the microphone signal amplitudes to be mixed in any desired ratio, and the microphone-derived gain-control signals are designed to give a smooth fade-over, rather than a sharp switching action.

These signals are derived from the microphone input via RV2, are given 20 dB of gain via the 741 speech-band (350Hz-3.5KHz) amplifier, are then peak-rectified and filtered via the D1-D2 network, and are used to activate the 3140 voltage comparator, which has a 1.1V reference applied to its non-inverting terminal and is given a 'slow swing' output action via its C6-R12 integrating network.

The output of the 3140 op-amp is normally high (and Q1 is thus cut off), but swings low in the presence of a strong microphone signal, thus pulling Q1 emitter down (thus attenuating the music signal) by an amount determined by the RV1 control setting.

COMPANDER THEORY

The NE570/571 is designed primarily to control the dynamic ranges of various circuits. In acoustics, the term 'dynamic range' can be simply described as the difference between the loudest and the quietest sound levels that can be perceived or recorded. Typically, a healthy human adult has a useful dynamic 'hearing' (acoustic perception) range of about 90 dB (= 50000:1). This range greatly exceeds that of most recording systems.

All practical recording systems generate inherent noise, which limits the minimum strength of signals that can be usefully recorded, and this factor (in conjunction with practical limits on maximum signal strength) places a limit on the useful dynamic range of the recording system.

Thus, if a recording medium can handle maximum signal amplitudes of 1V rms, but produces a 'noise' output of 1mV rms in the absence of a recorded signal, the system is said to have a signal-to-noise ratio or maximum dynamic range of 1000:1, or 60 dB.

Simple tape recorders typically have a useful dynamic range of less than 50 dB, and thus cannot directly record and replay high-quality music or other analog signals (these restrictions do not, of course, apply to digitally encoded signals).

One way around this problem is to use a compander system to compress the 90 dB dynamic range of the analog input signal down to 45 dB when recording it (thus giving a 2:1 compression ratio), and then use

a matching 1:2 expander to restore its dynamic range to 90 dB when replaying the signals.

This same basic technique can be used to improve the quality of many types of analogue audio signal, and the NE570/571 ICs were originally designed specifically for use in low-fi and medium-fi versions of such systems.

AN EXPANDER CIRCUIT

Figure 9 shows a practical NE570/571 'expander' circuit and its performance table. Here, the input signal is fed to both the rectifier and the variable gain block, and their action is such that circuit gain is directly proportional to the average value of the input. Thus, if the input rises (or falls) by 6 dB, the gain also rises (or falls) by 6 dB, so the output rises (or falls) by 12 dB, giving a 1:2 expansion ratio.

Note in this circuit that (because of the R3 and R4 ratios) the op-amp output takes up a quiescent value of 3V, and can thus supply only modest peak output signals. If desired, the output can be raised to 6V (giving a corresponding increase in peak output levels) by wiring a 12K resistor in parallel with R4 via pins 5 (or 12) and 4, or a 51K one in series with R3 via pin 6 or (11).

A COMPRESSOR CIRCUIT

Figure 10 shows a practical NE570/571 'compressor' circuit and its performance table. Here, the input signal is fed to the op-amp's inverting input via C4 and R3, but the variable gain block and rectifier circuitry are connected in exactly the same way as in the above expander design and are AC coupled into the op-amp's output-to-input negative feedback loop, and the circuit consequently gives a performance that is the exact inverse of the expander, i.e., it gives a 2:1 compression ratio.

R5 and R6 form a DC feedback loop (AC decoupled via C5) that biases the op-amp output at a quiescent value of about 6 volts.

COMPANDER CIRCUIT VARIATIONS

Simple compander systems suffer from a number of practical limitations and defects. They usually generate rather high levels of noise, THD, tracking distortion, DC-tracking shifts, and form a rather annoying phenomena known as 'breathing' or 'pumping.' These problems may reach intolerably high levels if the system's 'compression' or slope ratio is raised significantly above the basic 2:1 ratio, but can be greatly reducing by using slope ratios of less than 2:1.

Anyone wishing to experiment with high-slope compander systems can do so by simply cascading NE570/571 compression or expander circuits. Each IC contains the basics of two of these circuits, and can thus provide an overall 4:1 compression ratio or 1:4 expansion ratio and can, for example, thus compress an 80 dB (10,000:1) range of input signals into a 20 dB (10:1) output range.

Figure 11 shows how one half of an NE570/571 IC can be used to make a variable-slope compressor-expander in which the slope is fully variable from 2:1 compression to 1:2 expansion via dual-gang 10K pot RV1, which has its two sections wired in anti-phase. When the pot is in its central position, the circuit has a 1:1 slope, and acts as a simple amplifier that gives neither compression or expansion.

The circuits shown in Figures 6 to 11 are simple designs which can all be improved with the addition of various trim controls, such as those shown in Figure 12. The THD trimmer networks shown in (a) or (c) can be used to minimize an NE570/571 circuit's total harmonic distortion figures.

To use this trimmer, feed a fairly strong 1 KHz sinewave to the input of the main circuit, and then adjust RV1 for minimum output distortion. Note that if the THD trim facility is not used, pins 8 and 9 of the IC should be decoupled to ground via 220 pF capacitors, to eliminate HF instability.

The DC offset trimmer networks shown in Figure 12 (b) or (c) can be used to minimize any DC output voltage shifts that occur when a circuit's input signal voltages are varied between their maximum and minimum values.

The NE570/571 IC's rectifier elements each consume input bias currents of about 100 nA. In the simple Figure 6 to 11 circuits this current is derived from the rectifier's input signal, thus limiting the actual dynamic range of the rectifier (and also the IC's gain cells) to about 60 dB.

This snag can be overcome, thus expanding the rectifier's actual dynamic range to its full 80 dB+ value, with the help of the rectifier bias current cancellation network shown in Figure 13, which also shows the rectifier's basic performance graph with and without cancellation.

Finally, before leaving the NE570/571, note that this IC's greatest weakness lays in its internal op-amp, which is a very simple and rather noisy mid-fi design. If you wish to use a compander IC in a hi-fi application, therefore, you can either use a rather expensive dedicated hi-fi compander IC such as the SSM2120 (available from Analog Devices) or can simply ignore the NE570/571 IC's internal op-amp and use an external high-performance op-amp instead, using the basic connections shown in Figure 14.

Here, the external op-amp's non-inverting input pin is biased at about 1.8V by connecting it to the compander's pin 8 or 9 'THD trim' terminal via the R5-C1 noise filter, and the inverting input pin is tied directly to that of the internal op-amp. The external op-amp can use a dual or single-ended power supply, but in the latter case, the op-amp must have an input common

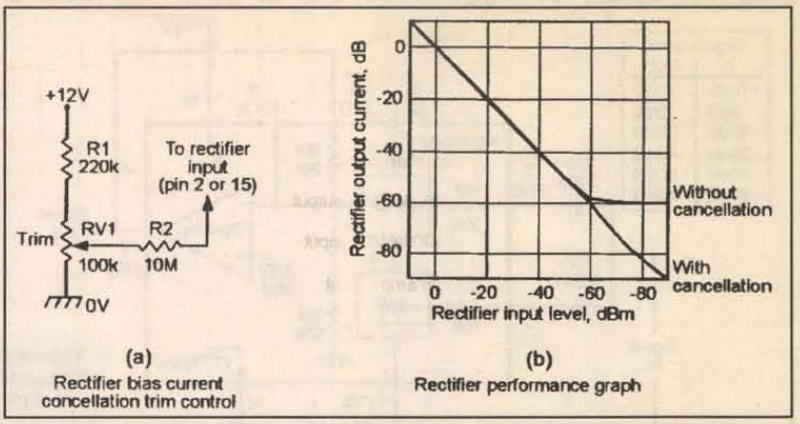
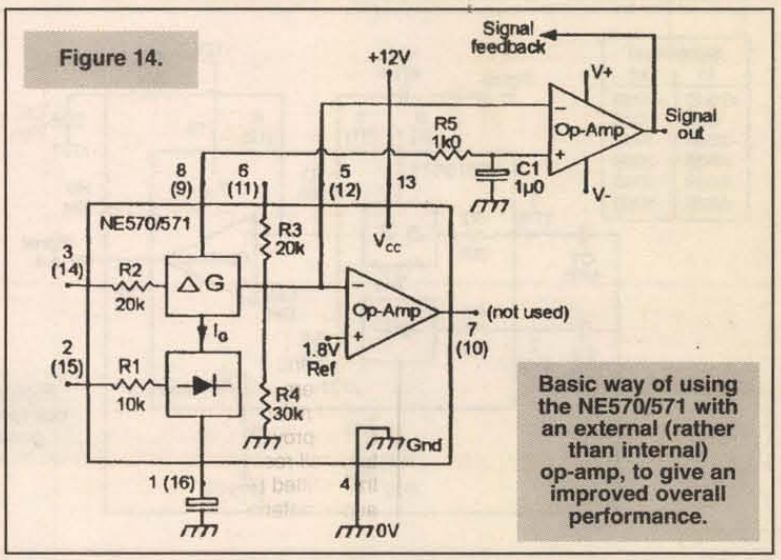


Figure 13. Rectifier bias current cancellation network (a), and rectifier performance graph with and without cancellation (b).



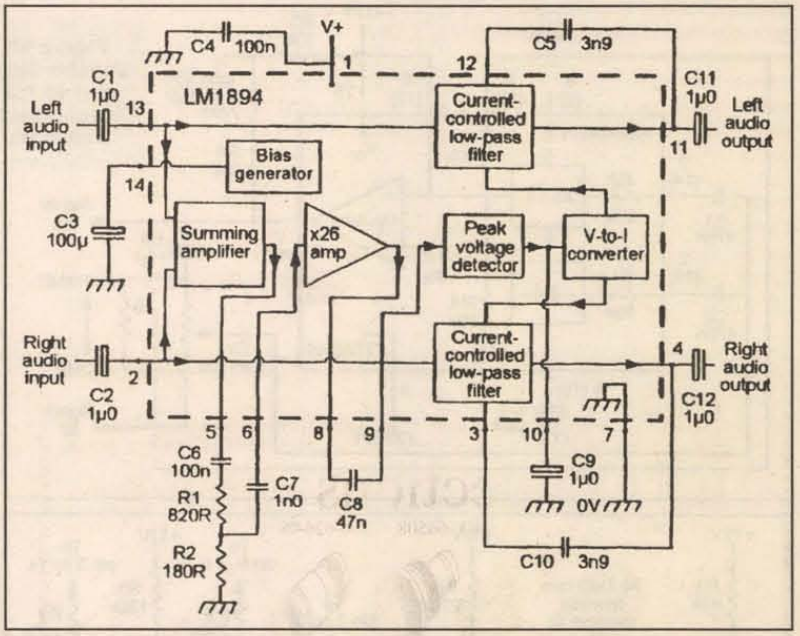


Figure 15. Functional diagram and basic application circuit of the LM1894 stereo dynamic noise reduction IC.

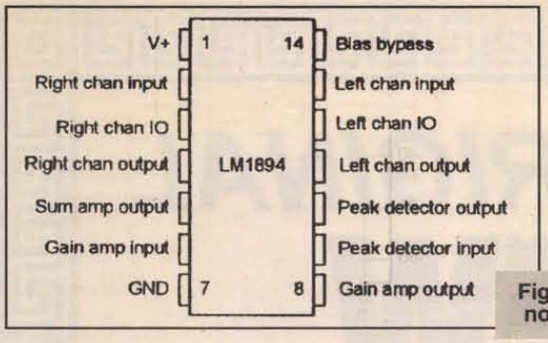


Figure 16. Outline and pin notations of the LM1894.

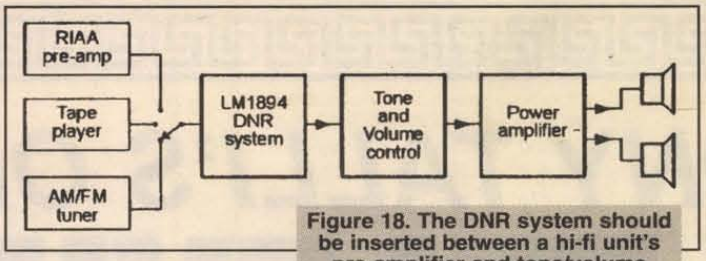


Figure 18. The DNR system should be inserted between a hi-fi unit's pre-amplifier and tone/volume control sections.

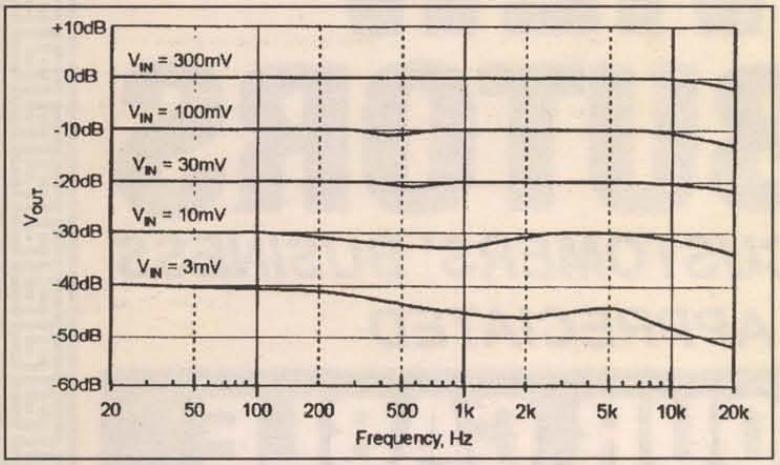


Figure 17. Frequency response graph of the LM1894 DNR system.

mode range that extends down to less than 1.8V.

DYNAMIC NOISE REDUCTION PRINCIPLES

The NE570/571 is just one of many dynamic range manipulation ICs that are designed for use in systems that aim to improve the acoustic reproduction quality of material that is recorded on — or transmitted via — inherently noisy media. Most such systems (including dBx, ANRS, and Dolby) are double-ended and achieve this noise-reduction aim by encoding the material — using dynamic range compression and/or pre-emphasis techniques — at the input end of the system, and using matching decoding (dynamic range expansion and/or de-emphasis) circuits at the output end of the system.

There are, however, two single-ended noise reduction systems that can improve the sound quality of virtually all recorded (tape or disc) or transmitted (AM or FM) non-coded audio material. The two systems in question are the Philips DNL (dynamic noise limiter) system and the National Semiconductor DNR (dynamic noise reduction) system ('DNR' is a trademark of National Semiconductor Corporation).

The DNL and DNR systems both work by using psychoacoustic techniques that automatically adjust the system's bandwidth and gain to match the instantaneous characteristics of the audio signals that are being processed. The DNR system is of special interest, and is described in detail in the next section of this article, together with application details of a special IC — the LM1894 — that is designed to implement the system. Note, however, that this is a custom IC, and is available only to approved professional 'bulk purchase' consumers.

DNR AND THE LM1894

The DNR system makes use of two simple psychoacoustic facts. The first is that the audibility of white noise (the dominant type of system noise) is proportional to the mean energy level of the noise, which, in turn, is proportional to the bandwidth of the system. Noise audibility can thus be reduced by reducing the system bandwidth.

The second psychoacoustic fact is that, if a simple tone signal and a white noise signal are present at the same time, the tone signal will mask (swamp) the noise signal if the tone's power level is significantly greater than that of the noise signal. Thus, if a low-frequency tone signal is masked by noise in an audio system it can — if the two signals have similar power levels — usually be unmasked by simply reducing the system's bandwidth.

In National Semiconductor's DNR system, these two sets of facts are utilized by feeding normal audio signals through a filter-amplifier unit that dynamically self-adjusts its bandwidth and gain in sympathy with the instantaneous mean frequency and amplitude of the input signal, thus effectively reducing noise levels by an average of about 10 dB, i.e., by a factor of three.

All of the active components of a stereo version of this system are contained in the LM1894 IC, and Figure 15 shows the full functional diagram of this device, together with its basic application circuit, and Figure 16 shows the outline and pin notations of the IC. The system functions as follows:

On entering the IC, the stereo audio channel signals are each passed from input to output via a current-controlled low-pass filter that has its gain controlled via an input-driven bandwidth-control generator circuit.

In the latter circuit, the two input signals are added together and then attenuated and filtered via the C6-R1-R2-C7 network; the resulting signal is then amplified, filtered via C8, peak-amplitude detected (rectified), filtered (smoothed) via C9, and finally converted into a proportional current that is used to control the gains of the IC's two current- controlled low-pass filters.

Each of the filters, in fact, consist of an OTA gain cell (of the type used in the NE570/571) plus an op-amp output stage that has its frequency response tailored via C5 or C10.

The net result of all this is that each stereo channel exhibits the input-to-output frequency response shown in Figure 17.

Note in Figure 17 that the frequency response is almost linear when input signals have amplitudes greater than 30 mV (and can thus easily swamp system noise), but is subject to fairly heavy noise-attenuating top cut when the input signal amplitudes are less than 10 mV.

Finally, note that the LM1890 DNL system is intended to be inserted in the middle section of a hi-fi system, between its pre-amplifier and tone/volume control sections, as indicated in Figure 18, where it will be driven by reasonably strong input

Next month's episode of this three-part 'how to use it' series will look at a selection of hi-fi electronic selector switch ICs.

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by TJ Byers

THE NUTS & VOLTS SOLAR WORKSHOP

Welcome to The N&V Solar Workshop ...

How To Go From 12-Volts DC To 110 VAC

Despite the low-tech appeal of a 12-volt photovoltaic system, it's a costly investment. As we discovered a couple months ago, the wire losses alone are substantial, which means you have to pay top dollar for heavy-gauge wire. Moreover, it's next to impossible to find a 12-volt microwave oven, and the few 12-volt appliances which are available cost considerably more that their 110-volt counterparts.

In this installment of *The Nuts & Volts Solar Workshop*, I'll show you how to turn the output of your 12-volt battery into 110-volts AC. In fact, I see Raj putting the finishing touches on a 50-watt DIY inverter that you can make for about $20.00. "Ah ... Raj, what's burning? Oh, toast. Yeah, be with you in a minute."

While Raj's inverter is perfectly capable of powering a fluorescent lamp, sensitive appliances like CD-ROM players and many TVs don't take kindly to its squared waveform. That's the topic we take up in the Classroom, and a session you don't dare miss if you want to go "conventional." Here's where I'll tell you why Trace Engineering's inverters command their asking price.

Umm ... smells like the coffee is ready, so let's join Raj in the Workshop and see what's cooking.

The Workshop

Build A 50-Watt Inverter

"Good morning, Raj. How goes the battle?"

"Oh my goodness, it is not a battle. It is just a trade-off of cost and efficiency. My goal is to create a small inverter that won't break your TV set or piggy bank. The problem, if you can call it that, is to make a squarewave behave like a sinewave. Sinewaves are what you get from the power company, and a squarewave is what you get from a 'cheap' inverter."

"I'll take up that topic in the Classroom. Meanwhile, tell us what you've built. It obviously works, because the coffee is good and hot. Can all coffee pots run off your inverter?"

"Some can, but many can't."

"Why not?"

"Because this is only a 50-watt inverter. If I were to trade the IRF510 transistors for IRF520s, I could up the power to 100 watts, but more on that later. What I have here is a simple squarewave inverter that changes 12-volts DC into 110-volts AC. It took me a while to come up with this design because of price and parts availability. Most of your commercial inverters use special transformers. Unfortunately, none of the inverter companies I queried were willing to sell me the transformer only. So, I went to the library in search of a circuit that uses off-the-shelf parts that you can buy from Digi-Key or Radio Shack. Here's what I discovered."

Efficiency Versus Simplicity

"Nearly all of the circuits use a pair of transistors in a push-pull configuration. The simpler designs have just five parts: two transistors, two resistors, and a transformer, as shown in Figure 1. While cheap and easy to build, this design has two major drawbacks.

First, the bias circuit consumes a fair amount of power — about 10 watts — and the transistors spend far too much time in the active region, which wastes even more power. Typically, this inverter is only 70 percent efficient.

More annoying, though, is that the transformer is actually part of the resonant circuit, which means the oscillating frequency changes as the AC load changes. For resistive loads like incandescent lamps and toasters, this isn't a problem. Stereos and TVs, though, don't like it and can actually be damaged if the frequency drops below 50 Hz.

"Replacing the 2N3055 bipolar transistors with Hexfets (Figure 2) improves the efficiency considerably."

"What's a Hexfet?"

"It's a special type of field-effect transistor from International Rectifier that can pass large amounts of current through the semiconductor with very little loss. Moreover, it's voltage-controlled, not current driven, so there are virtually no bias current losses."

Raj Explains How The Inverter Works

"Unfortunately, the oscillating frequency still fluctuates with the load. The way to overcome this problem is to drive the switching transistors with a separate oscillator, like I've done in Figure 3. The oscillator is built around a pair of CMOS NAND gates, IC1a and IC1b, configured as inverters. IC1c buffers the squarewave output, where it drives Q1 through R2 and is inverted by IC1d to drive Q2 via R3.

"This phase reversal is the key to the inverter's operation. When Q1's gate is high, Q2's gate is low. This shifts the current flow between Q1 and Q2 on alternate cycles, which is why this is called a push-pull circuit. Q1 pushes current through the transformer, and Q2 pulls it through."

"So what you're saying is that only half of the primary winding conducts at any time."

"Exactly. And it's this see-saw action that causes a reversal of the magnetic polarity in T1's secondary winding, which generates an AC voltage. Of course, the waveform is squared rather than sinusoidal, but most appliances can tolerate the distortion. Capacitors C2 through C5 remove many high-frequency components and the back EMF (electromotive force) spikes commonly associated with inductive circuits. If we want to filter the signal further, we could hang a low-pass filter on the secondary, but that adds extra cost."

"Would a surge protector, like the kind used with PCs, help the waveform any?"

"Not really, but the addition of an RFI line filter commonly found in computers would take some of the edge off the waveform. And they can be salvaged from an old PC."

Construction

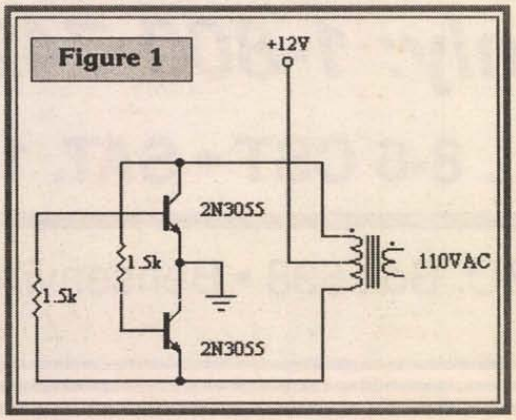
"My version of the inverter uses a pair of IRF510 Hexfets, which you can buy at Radio Shack for $2.00 each. When combined with their model 273-1512 power transformer ($10.00), this circuit can deliver about 50 watts of AC power — more than enough power for an electric razor, portable computer, or a fluorescent shop light.

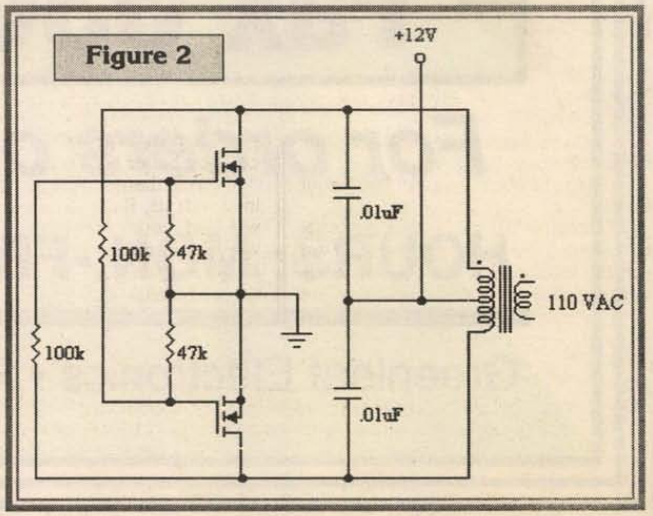
"The first thing I did was to locate a suitable enclosure, one large enough to house the transformer and transistors. I chose a ventilated, all metal cabinet (see Parts List) from Radio Shack ($7.00) that cradles easily in the palm of my hand. Not only is the aluminum bottom easily drilled, its thermal properties serve double duty as a heatsink for Q1 and Q2.

"If you want to duplicate my efforts, I suggest that the first thing you do is to plan the location of your big parts and drill the holes for them (I didn't plan ahead for this 'work in progress' project, and it shows). All the electronic parts, including the power switch and binding posts, are mounted on the bottom plate. The AC outlet mounts in the ventilated top shell. I used a standard duplex wall outlet, which requires two large keyed holes that I hacked out with a drill and small file. I used a standard cover plate to scribe out the shape of the holes and their location. If you don't have the tools or skills to do this, you can use an extension cord fed through a rubber grommet, instead.

"Because the part count is very low, I decided to use a general-purpose perfboard rather than spend the time and money on developing a custom printed circuit board. Figure 4 shows how I placed the parts on the board, but feel free to arrange them any way you like.

"You'll notice that I used Q1 and Q2 to anchor the perfboard to the chassis. Before you do this, though, you have to electronically isolate the transistor's metal tab from the chassis using a TO-220 hardware mounting kit. If you buy this kit from Radio Shack or Digi-Key, the kit comes with mica insulators, screws, and washers





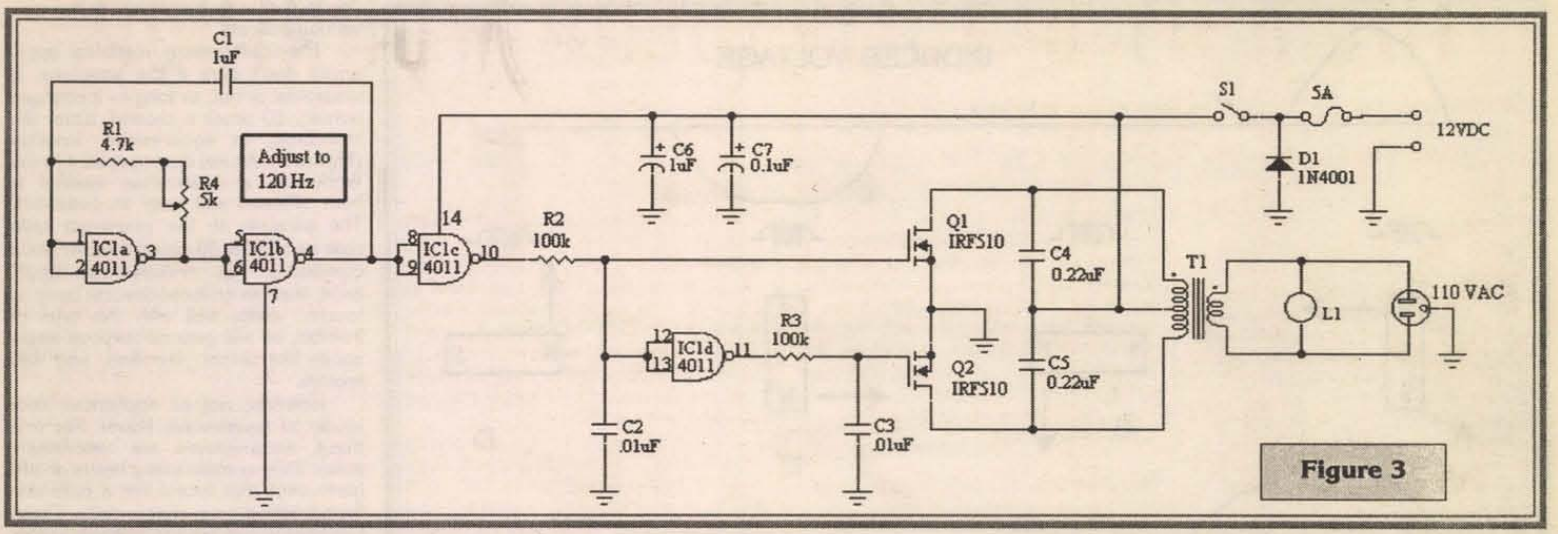


Figure 3

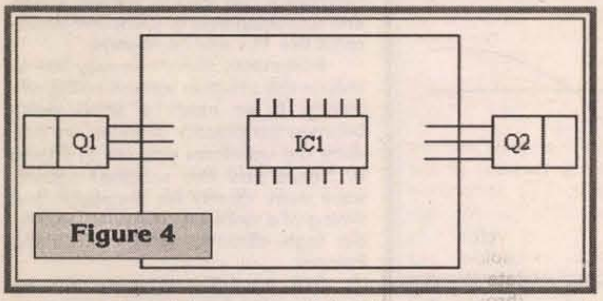


Figure 4

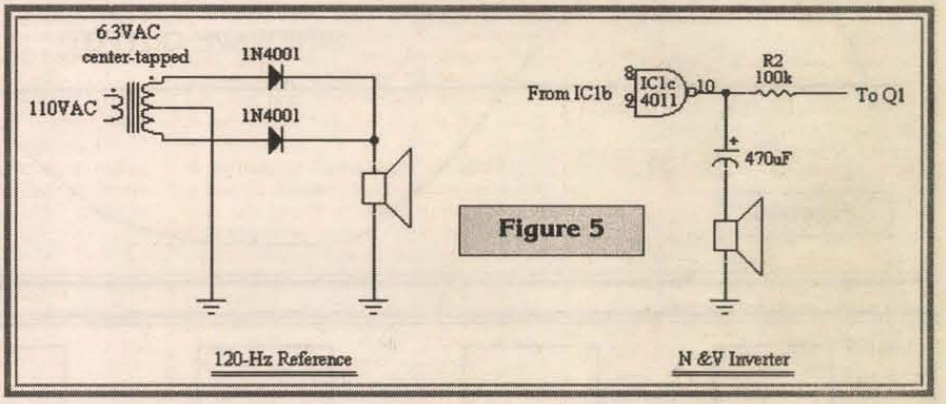


Figure 5

– but not heatsink grease, which I strongly recommend. I also suggest to put a layer of electrical tape on the bottom of the perfboard just to be on the safe side.

"Speaking of safety, take note of the unique reverse polarity circuit I devised. Rather than put the diode in series with the 12-volt line, I put it in the reverse-bias orientation behind a fuse. If the battery is connected backwards, the fuse blows. If there's an over-correct in the inverter, the fuse blows. Either way, you're protected. I did this to, number one, force any inverter malfunction to completely and totally disconnect the battery from the inverter. And, number two, it eliminates the voltage drop and power loss incurred by having the diode in series with the power input. I think it is a safer and more efficient design."

Final Touches

"It sounds like you've thought of everything. Is there anything else we should know?"

"Yes, we need to adjust the oscillator's frequency to 120 Hz."

"Why 120 Hz? Isn't the line power 60 Hz?"

"Because the push-pull configuration divides the frequency in half. If we run the oscillator at 60 Hz, the resultant output is 110 VAC at 30 Hz. The way I adjust the frequency is to listen to it using a small speaker in series with a 470-uF capacitor connected to pin 10 of IC1c. How do I know when it's 120 Hz? When it has the same pitch as the reference tone (Figure 5), which I created using a small transformer and a couple of diodes. A pair of stereo headphones lets you compare both tones at the same time."

"I think we should tell our readers that your reference circuit uses a center-tapped transformer with a fullwave rectifier to generate the 120-Hz tone."

"Yes, it's exactly the opposite of what we are doing inside the inverter, and a good example of how center-tapped transformers are often used as frequency converters. To expound on something we touched on earlier, you can increase the power output of the inverter to 100 watts by substituting an IRF520 for Q1 and Q2, and replacing T1 with a 25.2-volt, four-amp transformer. In fact, there's no limit to which you can take this design, but I wouldn't push it past 200 watts. By then, you can buy better for cheaper.

"Well, thanks for sharing your findings with us, Raj. I'm sure our readers will find your project useful. By the way, how did your 50-watt inverter manage to burn a piece of bread? I thought toasters used over 1000 watts of power."

"They do. That's why I used this metal reflector and a fresenel lens aimed at the sun to do the cooking. Would you like a piece of toast?"

The Classroom

An AC Power Inverter Primer

Thanks, Raj. That was a great intro into today's Classroom topic, which, of course, is all about inverters.

Let's begin with a description of how the utility companies make electricity. They begin with a spinning magnet and a coil, as shown in Figure 6. (Give me a break! This is the Solar Classroom, not Electrical Engineering 101.) When a magnetic field cuts across the grain of a coil (Figure 6a), a voltage is generated. As the magnet rotates, the magnet and the magnetic field align themselves parallel to the coil (Figure 6b).

In this position, no magnetic lines are broken, and no voltage is generated. A half-turn later (Figure 6c), the south pole of the magnet is sweeping the coil with its magnetic field, which again produces an output voltage – but in the opposite polarity! Ninety degrees later (Figure 6d), the magnet is again parallel to the coil, and no voltage is generated. Finally, the magnet rotates to square one (Figure 6a) and the process starts all over again.

The amplitude of the voltage generated is proportional to the number of magnetic lines crossed and the speed at which they are cut. When the magnetic pole is perpendicular to the coil, the concentration of lines is at its greatest. When the magnetic is parallel to the coil, the magnetic field is at its weakest. Between these two extremes, the number of magnetic lines changes according to the angle of the magnet. This sweeping action produces the sinusoidal waveform you see in Figure 6. This is the waveform the inverter tries to imitate.

Unfortunately, this is easier said than done. Sure, you can construct a sinewave generator and amplify its output with an audio amplifier, like a 200-watt stereo, but it's a costly proposition. No, I'm not talking dollars; I'm talking watts. At its best, this arrangement wastes 50 percent of the power you put in. In other words, half of your

PARTS LIST

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R4 - 5K trimmer

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C2, C3 - 0.01 uF
C4, C5 - 0.22 uF
C7 - 0.1 uF tantalum

Semiconductors
D1 - 1N4001
IC1 - 4011 NAND gate, or 4001 NOR gate
Q1, Q2 - IRF510

Misc.
5A fuse
AC outlet (see text)
Binding posts - Radio Shack 274-662 or equivalent
L1 - 120-volt neon lamp indicator, Radio Shack 272-712 or equivalent (optional)
S1 - SPST toggle switch
T1 - 25.2 CT, 2A power transformer, Radio Shack 273-1512 or equivalent
TO-220 mounting hardware - Radio Shack 276-1373
Perfboard - Radio Shack 276-148
Metal cabinet - Radio Shack 270-283

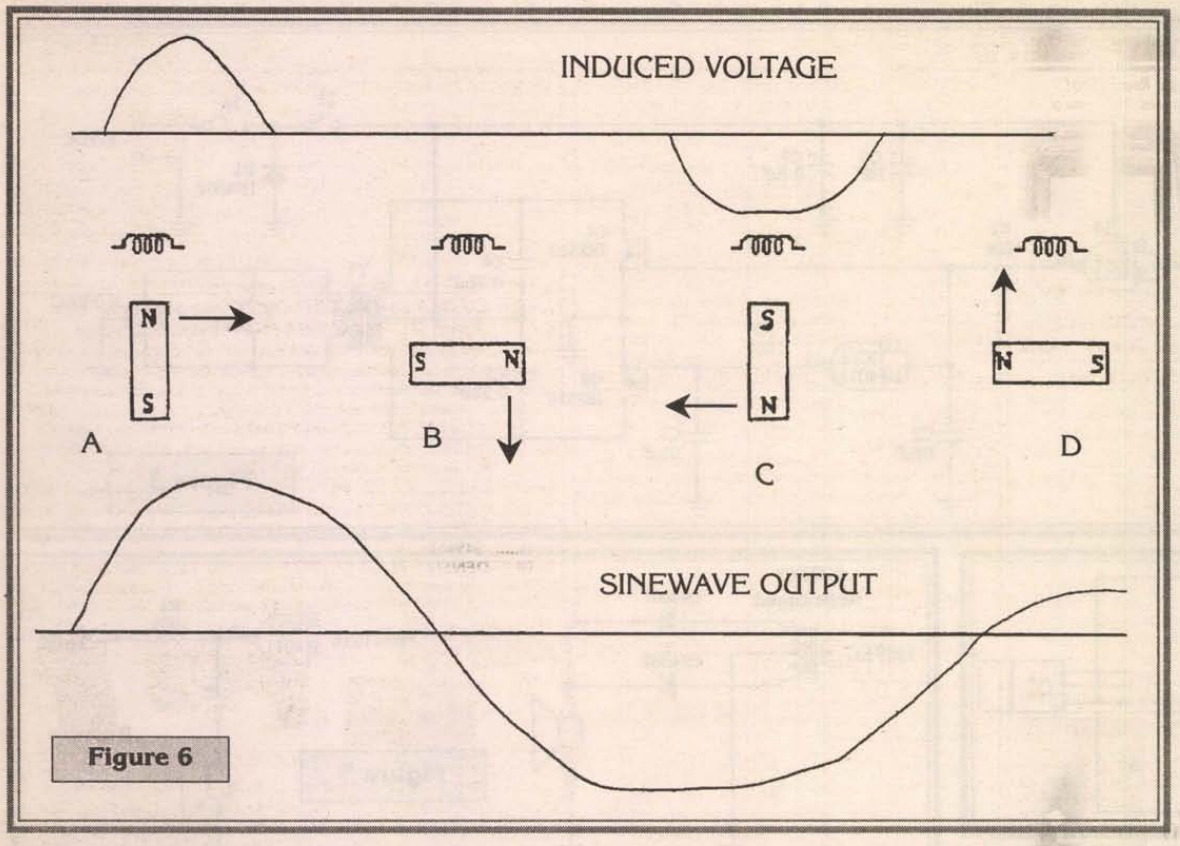

Figure 6

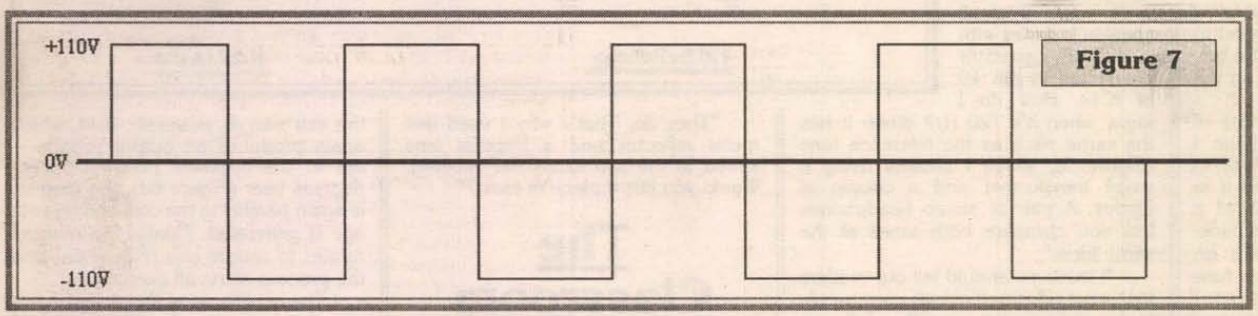

Figure 7

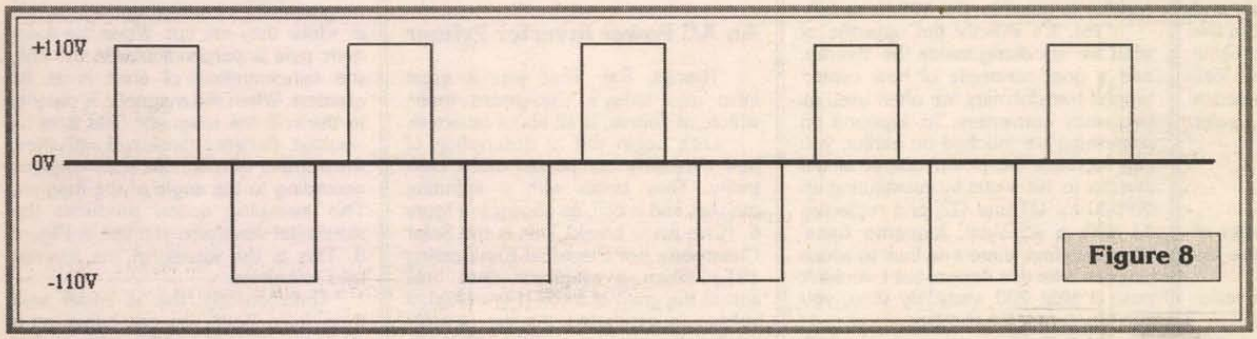

Figure 8

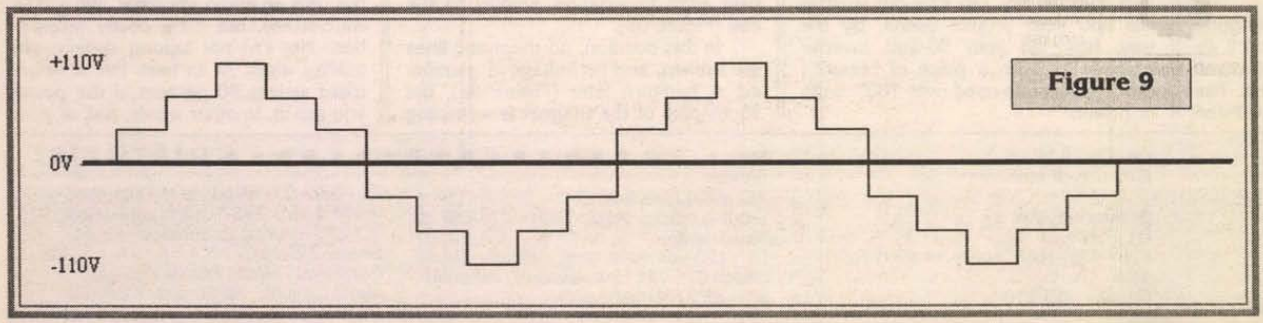

Figure 9

precious solar power is lost in the conversion process.

Thankfully, many electrical appliances don't care if the waveform is sinusoidal or not, as long as it changes polarity 60 times a second. Enter the switching, or squarewave, inverter (Figure 7). As Raj demonstrated in the Workshop, a squarewave inverter is both efficient and easy to construct. The power-in to the power-out ratio runs as high as 96 percent under good conditions. Any resistive-type appliance, such as an incandescent lamp or toaster, works well with this type of inverter, as will general-purpose appliances like razors, blenders, and drill motors.

However, not all appliances take kindly to squarewave power. For one thing, squarewaves are notoriously noisy. They contain many layers of odd harmonics that sound like a buzz saw broadcasting on a cheap radio. These harmonics can lead to voltage spikes and unwanted heat in electronic equipment like TVs and computers.

Fortunately, there's an easy way to reduce this irritation without losing efficiency. If we insert a small delay between the polarity changes, we produce the waveform you see in Figure 8. Notice how this modified squarewave more closely fits the shape and timing of a sinewave while maintaining the high efficiency of the switching inverter.

Still, it's not a sinewave. But we can get closer to our goal using a technique called step switching. Everyone knows what a staircase looks like. It's a structure of platforms that take you from one level to another. If we were to construct a staircase within the confines of a sinewave shape using switching transistors, we could still maintain high efficiency and get a good approximation of a sinewave. Figure 9 shows a simple six-step staircase inverter that until recently was considered as close as you needed to get for all practical purposes.

Improvements in semiconductor technology, however, have made the six-step staircase inverter all but obsolete. Inverters from Trace Engineering, for example, use a 52-step staircase. This resolution produces a waveform so close to the original that the inverter manufacturers actually call it a "true" sinewave inverter, rather than a modified squarewave inverter. So close, in fact, that your TV or computer can't tell them apart.

While there's a lot more to be said about inverters, we've covered enough ground for one day. In our next Classroom session, we'll discuss the different types of inverters, synchronous and so forth, and which to choose for any particular application. So go now, and have a good weekend. Class dismissed. **NV**

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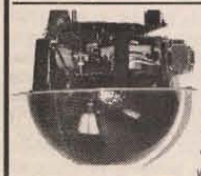

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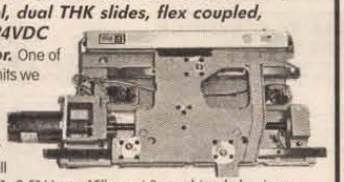

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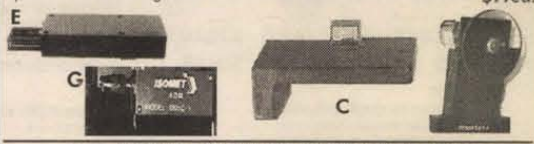

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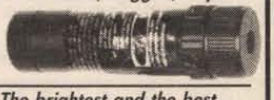

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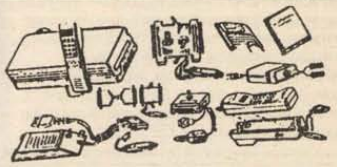

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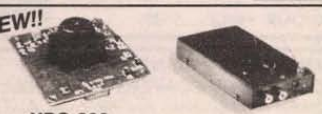

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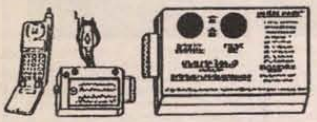

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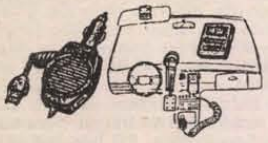

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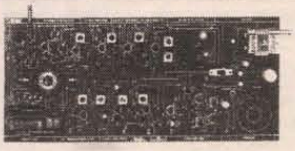

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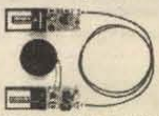

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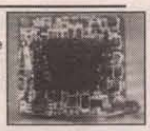

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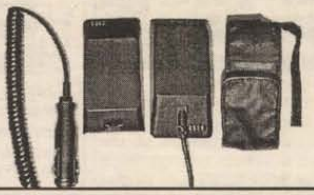

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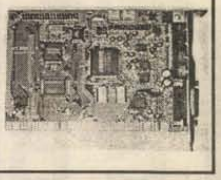

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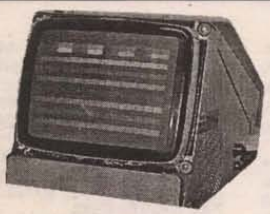

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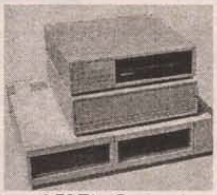

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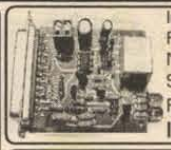

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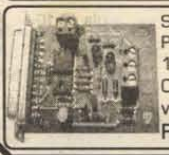

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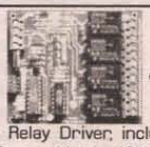

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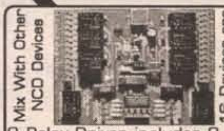

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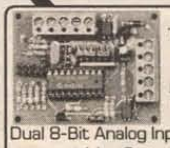

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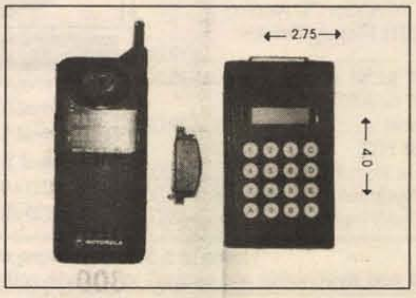

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AMATEUR ROBOTICS

Last month, I took you through the design of a simple robopet frame, suitable for a beginner's robot. This month, I'll finish the robot by taking you through the steps needed to develop software and install it in your microcontroller (MCU) board.

Begin by building up one of Marvin Green's BOTBoards, a small 68hc11-based MCU board. This printed circuit board (PCB) measures just 3 x 2 inches, but holds a 68hc11 MCU, serial communications connector, four servo motor ports, and a small prototyping area. You can buy the BOTBoard several places, including Mondotronics **(www.robotstore.com).** Be sure to get a 68hc811e2 chip for your BOTBoard. This device contains 2K bytes of EEPROM, enough room for some fairly strong robot code. The rest of this article assumes your board contains such a chip.

Carefully wire up the BOTBoard, following the instructions included. If you've never soldered any electronics before, hold off long enough to make a quick trip to the local Radio Shack and pick up Forrest Mims' excellent book on getting started in electronics. You will need information on how to read resistor codes, how to recognize different devices, and how to tell the polarity of components, such as diodes and capacitors.

While you're out, pick up any tools you might need to round out your set. Ideally, you should have a 20- to 40-watt soldering iron with a grounded tip. You can get a fancy, temperature-controlled unit from Weller, the WCC-100, from most large electronics supply houses. This 60-watt unit has a dial for setting the tip temperature and comes with a wire cage for holding the iron safe from accidental contact. The rest of your tools list should include high-quality wire cutters (called "dikes"), needle-nose pliers, and a set each of Phillips- and standard-blade jeweler's screwdrivers.

Another real handy tool to have is a logic probe. This tool looks like a fat pencil with a thin cable coming out of the top. You hook these leads to ground and +5 VDC somewhere in your circuit. Now, if you touch the probe's tip to a point on your circuit board, one of several LEDs will light to indicate the state of that point. Typically, a cheap probe will show logic high, logic low, changes between high and low, and a crude indication of frequency of change. Spend the 10 bucks or so to get a basic logic probe; you'll be amazed at how often you rely on it.

Back at your workbench, finish wiring up the BOTBoard. Add a two-pin male MTA connector for hooking up your four AA alkaline batteries, as indicated in the instructions. You will also need to add the matching female connector to the end of the battery leads on your four-cell AA battery holder. Be sure to get the polarity on both connectors correct; double-check the alignment of the red (positive) wire on the female connector with the corresponding pin of the male connector.

Also, add the mod in the instructions for setting the mode of the 68hc11 on reset. This mod involves cutting a trace on the underside of the PCB and adding a couple of wires and a resistor. Work carefully when making the mod, and verify your work with a magnifying glass, if necessary. While you're at it, read over the theory of the mod so you understand what is happening in each of the two cases the mod supports.

At this point, you will likely have many questions on how the 68hc11 works. I can only refer you to the Mobile Robots book mentioned last month, and to the assorted 68hc11 manuals available free from your local Motorola representative. The 68hc11 is far too complex to cover here, though I might devote a column or two to it another time. I realize that this can leave you hanging, since you may not know how to correct a problem that arises if you leave out a subtle but critical step. All I can say is you will have to do some digging on your own, use the Internet and Web resources, read the books, and ask questions. This phase is the hardest part of the hobby for most people, but (to me) is also the most rewarding. Making that slab of silicon wake up and do your bidding takes a lot of work, but the results can be way cool.

After you have wired up your BOTBoard, position it on the upper surface of your four-inch frame. Also, place the battery holder where you think it fits the best. Play around with the placement of both pieces until you get an arrangement that you like. Remember to check for wire lengths and how you will run the cables from one element to another. The servo cables aren't normally a problem, given their length, but you want to place the battery holder so you don't need to lengthen its wires to reach the proper terminals on the BOTBoard.

Mark the final positions of the battery holder and the BOTBoard. Then use two pieces of double-sided foam tape to stick the battery holder in place. Add a dab of hot glue to two opposite corners of the BOTBoard to hold it in place.

If you haven't done so already, you need to make or buy a serial cable to connect between the BOTBoard and your PC. The BOTBoard docs include a schematic and parts list for building such a cable. If you can, you should build the MAX232 or MAX233 circuitry into a plastic DB-25 or DB-9 shell. This yields a compact, portable tool that you can use on several different robots as you get them built. Plus, you don't waste valuable board space and wiring to support the same circuitry on each robot; just plug in the serial cable and go.

Now is the time to install pcbug11 on your PC. You can pick up this valuable 68hc11 development tool from several places. Many vendors who sell BOTBoards also sell or give away a floppy disc containing pcbug11 and other 68hc11 tools. You can also find pcbug11 on the Internet, by browsing Motorola's FREEWARE web site **(http://www.mcu.motsps.com:80/freeweb/)**. Note that the file you want is named pcbug342.zip.

Move the pcbug342.zip file into a suitable directory, such as c:\68hc11, and unzip it. You will now have a set of files including pcbug11.exe. pcbug11 uses a serial connection to your PC's comm port to exchange information with a tiny program — called a talker — that resides in the 68hc11. pcbug11 automatically downloads the proper talker program following invocation, provided you use the correct command line options and reset your 68hc11 so it comes up in special bootstrap mode.

Now you're ready to try starting up your BOTBoard. Connect the serial cable between the BOTBoard and the PC; I'll assume here that you are using COM1, though pcbug11 also works from COM2. Strap the BOTBoard for special bootstrap mode, then connect the battery pack and press the reset switch. The 68hc11 should now be sitting in a communications loop, waiting for instructions from the PC.

Now execute pcbug11 from a DOS prompt. Assuming you are using a 68hc811e2 in your BOTBoard and that your serial cable is hooked to COM1, use the command line:

pcbug11 -a

If everything works properly, you should see a bright blue screen with a command prompt at the bottom. If so, you have cleared the first big hurdle in amateur robotics; you have a working MCU board.

If you got a blue screen with an error splat on it, start pressing the ESC or Enter key until you see the command prompt, then enter **quit y**. This kicks you completely out of pcbug11. Remove power from your BOTBoard, double-check the wiring of your serial cable, and try the above sequence again. The most common cause for this failure is a miswired serial cable; typically, the wires to pins 2 and 3 of the PC's connector are swapped.

If you are running Windows 95 and pcbug11 errors out to a black screen with a message about hardware failure, you may have to reboot your machine to DOS mode and try again. This happens on quite a few machines, and I haven't yet heard a good explanation for why it happens or how to get around it. My laptop, running Win95, cannot run pcbug11, though my main 486 can.

After you get a working connection to the BOTBoard, you can begin doing some serious playing. Enter the commands:

control base hex
md 1000 103f

The control command tells pcbug11 to assume any number you type is in hexadecimal, rather than decimal. The **md** command displays the 64

SBasic program to blink an LED slowly

```
'
' blinky.bas     a program to blink an LED slowly
'

include "regs11.lib"

declare n

main:
do
        n = peekb(portb)                ' get current port B
        n = n xor $ff                   ' reverse all bits
        pokeb portb, n                  ' change port B

        for n = 0 to $7ffe              ' software delay
        next

loop

end
```

memory locations, starting at address $1000. If you check your 68hc11 reference manual (the "pink book") you will see that these addresses are actually the 68hc11's I/O ports. The 68hc11 places all of its I/O ports in addresses in the memory map, and you can use any machine language instruction that references memory to reference I/O ports as well.

Take a few moments to examine some of these addresses and compare the values in them to the technical information in the pink book. Note, for example, the contents of address $1004. In the manual, this is called PORTB and it is an output-only port. This means that whatever bit pattern your software writes to $1004 automatically appears directly on the port B output lines on the 68hc11.

The 68hc11 comes out of reset with PORTB holding a 0; thus, all output lines for port B should show a logic 0. You can verify this with your logic probe. Next, enter the pcbug11 command:

ms 1004 ff

This **ms** (memory set) command writes all 1s to PORTB, which, in turn, brings all port B output lines to logic 1. Again, verify this with your logic probe.

Now you're ready for your first 68hc11 program. Rather than jump right into a major assembler program, we'll start with the pcbug11 in-line assembler. First, we need to choose a location in memory to hold our program. The 68hc811e2 contains 256 bytes of RAM from address $0000 to $00ff. pcbug11 uses all of this memory for its talker, so it is off-limits for your testing. Note that if you try to modify any of this RAM, pcbug11 will immediately crash.

SBasic program that prints debug info

```
'
'  prtest.bas     a program to print debug info
'

include  "regs11.lib"

declare  n
declare  j

main:
pokeb baud, $30                    ' 9600 baud
pokeb sccr2, $0c                   ' enable SCI xmtr & rcvr

print "prtest.bas"                  ' here we are

j = 0
do
        for n = 0 to $7ffe         ' wait a bit
        next

        print "Loop "; j; "is done!"
        j = j + 1                  ' count this loop
loop

end
```

The '811e2 also has 2K bytes of EEPROM from address $f800 to $ffff. This memory differs from RAM in two important ways. First, it is non-volatile; if you write something to EEPROM, it stays there forever until you erase or overwrite it. Second, you must use a special sequence to modify EEPROM; you just don't write to it as if it were RAM and expect the data to stay.

Fortunately, pcbug11 can help you in dealing with EEPROM. Enter the commands:

eeprom f800 ffff
ms 1035 10

The **eeprom** command tells pcbug11 to treat addresses from $f800 to $ffff as EEPROM rather than as RAM. Now any time you change an address in this range, pcbug11 automatically uses the proper ritual for changing EEPROM. The **ms** command changes a set of block-protection bits in the 68hc811e2. If you don't change the four low bits of $1035 to 0s, you won't be able to change EEPROM at all. (Actually, this isn't exactly true. Check the E-series pink book for full details on the functions of these low four bits.)

Now that you have set up pcbug11 so it will properly modify addresses in the EEPROM area, you can use the in-line assembler to write your first 68hc11 program. Enter the command:

asm ff80

This starts the in-line assembler, which will disassemble the contents of $ff80 and present it to you as a line of assembly-language source. You can then enter a new source line to overwrite the original. For example, assume pcbug11 gives you back the following response:

FF80 FFFFFF > STX >$FFFF

This tells you that addresses $ff80 to $ff82 contain $ffffff, which disassembles to a STX instruction. Finally, pcbug11's cursor sits at the command prompt just before the STX, ready for your input. Anything you type now will overwrite the original text, and form your assembler source line. Enter the text:

ldaa $1004

Note that you MUST include a leading space before the **ldaa**, or pcbug11 will treat your **ldaa** as a label and the assembler will fail. Note also that you must overwrite all original text with either spaces or your own assembler source; any leftover original text will likely cause an assembler error. If you got it right, pcbug11 will open the next address for you, and display something like:

FF83 FFFFFF > STX >$FFFF

Continue with the rest of the program:

eora #$ff
staa $1004
jmp $ff80

After you've entered the **jmp** instruction, press the ESC key to leave the in-line assembler. Verify that your program is correct with the following disassemble command:

dasm ff80 ff8b

You should see your new four-line program echoed back to you correctly. Now you are ready to run it. Enter the command:

g ff80

pcbug11 won't appear to change much, but your program actually is running on the 68hc11. You can verify this by putting your logic probe on any port B output line. The probe will show a very high frequency signal on all port B output lines, with a duty cycle of 50%. You can stop your program by entering the command:

s

The program you entered creates a very tight loop that reads the value of PORTB, inverts all the bits, stores the new value back to PORTB, and starts over again. This causes all bits of PORTB to change from 0 to 1 and back again at a uniform and very fast rate.. Take some time to go through the pink book to understand exactly how this routine works. Though it is only four lines long, it uses some of the most common elements of hobby robotics software.

This idea of "change an output line" lets your robot begin to control its nearby environment. The simplest output device that works on this principle is an LED. Pick up a bright LED (rated at 20 mcd or more) and a resistor somewhere between 180 and 330 ohms. Wire one lead of the resistor to the LED's cathode, which is usually the lead next to the flat spot on the LED body. Wire the other lead of the LED (the anode) to line 0 of port B (PB0). Finally, wire the other end of the resistor to ground.

Now if you force PB0 high, the LED lights. Force the line low and the LED goes dark. Translated into pcbug11, this becomes:

ms 1004 01 to turn LED on
ms 1004 00 to turn LED off

If you run the little program we entered above, the LED will blink on and off so fast it will light at half-brightness.

But you can't keep typing your programs into pcbug11's one-line assembler; besides being error-prone, you have no way to easily maintain or change your programs. You really need to use a text-editor and a stronger software tool such as an assembler or compiler. Armed with these tools, you can quickly go from your ideas for a program to an S19 object file, which you can then load into your 68hc11 via pcbug11. The S19 object file contains only the information the 68hc11 needs; that is, what opcodes get burned where in memory and how the program starts up following reset.

The best way to learn how an MCU really works inside is by learning how to write assembly language software for the chip. To make assembly language programs work, you have to know how the registers operate, what type of opcodes the MCU supports, and how the stacks and addressing modes behave. Learning 68hc11 assembly, however, is beyond the scope of this article, though I will point you to some helpful tools to get you started. The Motorola FREEWARE site contains two assemblers available for downloading. Their user interfaces are both fairly user-hostile, unfortunately, so you might have to dig a little and ask some questions on the net if you get stuck using them.

Another option for you is to use a compiler. This software tool takes a source file written in a high-level language, such as C, and translates it into assembly language for you. The compiler usually comes with other tools, such as a matching assembler, that completes the compilation job and leaves behind the S19 object file. A good compiler can really ease the task of writing robot software. You can focus on the larger picture of what you want your robot to do, and not get bogged down in the details of what value is in what register when.

Perhaps the friendliest compiler to start with is my SBasic compiler, available on my web site **(http://www.seanet.com/~karllunt)**. SBasic lets you write programs in a simple dialect of Basic, then compile the source file down to an assembly language file. You then use the included asmhc11 assembler to assemble that file into the final S19 object file. To help you with SBasic, the distribution file includes a 60+ page manual on setting up and using the compiler. The rest of this article will use example code written in SBasic.

Let's go back to our LED and the program that blinks the LED too fast. One way to slow down the LED is to stick a software delay — called a timing loop or a delay loop — into the instruction flow. I'll rewrite this program in SBasic and stick in the delay loop. See the accompanying listing for details.

SBasic program that controls servo motors

```
'
' myservo.bas    a program to test servo motors
'

include "regs11.lib"
include "servos.bas"

main:
gosub InstallServo, toc2
gosub InstallServo, toc3

toc2 = $f500
toc3 = $f700

end
```

Notice how the SBasic listing lets you look at the concepts behind the program, rather than the lowest-level details. For example, the program reads and writes **portb**, not the address **$1004**. In fact, the SBasic program even buries the connection between **portb**, which is how you want to refer to the I/O port, and the address **$1004**, which is how the assembler must refer to the I/O port. The connection between these two is hidden in the **include** statement at the beginning of the program. This statement causes the SBasic compiler to switch over and begin compiling the file **regs11.lib**, which contains many lines of bookkeeping information such as:

const portb = $1004

You don't need to add these **const** statements to each 68hc11 program you develop; just add the **include** statement and the compiler handles the rest.

I'll assume you have written the SBasic program into a file named **blinky.bas**. To compile this program, enter the command:

sbasic blinky /v0000 /s00ff /cf800 >blinky.asc

This command causes SBasic to compile the file **blinky.bas**, placing the SBasic variables at address **$0000**, the 68hc11 stack at **$00ff**, the code for this program at **$f800**, and the output assembler source file to file **blinky.asc**. The code and stack locations are specifically set up for the 68hc811e2; you might need to change these for other variants of the 68hc11.

Check the **blinky.asc** file to see if you got any errors from the compilation; there shouldn't be any. While you're looking at the file, compare the assembly language source for each SBasic instruction with the little program we used in pcbug11 above. You should notice several similarities.

To create the final S19 object file from **blinky.asc**, you need to run the asmhc11 assembler. Use the command:

asmhc11 blinky.asc

to perform the assembly. asmhc11 will leave behind a file named blinky.s19, which is the object file for your program. Remember that I said asmhc11 wasn't very user-friendly. You can run into a problem with the above statement if you did all of your work on the D: drive and try to assemble your blinky.asc file. asmhc11 wants to find your .asc file on the C: drive, and you will not be able to convince it to look into your working directory if that directory is not on C:. The simplest solution is to include a full path for the .asc file, as in:

asmhc11 d:\karl\68hc11\blinky.asc

This is awkward, I know, but asmhc11 is pretty old and in those days one hard drive was usually enough. A better solution is to build up a custom batch file for automating both the compile and assemble operations; you're on your own here.

Now that you have an S19 file for your blinky program, you need to move it into the BOTBoard so you can actually see it run. This gets us back to pcbug11. Restrap your BOTBoard for special bootstrap mode, then press the reset switch. At the pcbug11 command prompt, enter the command:

restart

This command causes pcbug11 to reload its talker into the 68hc11 and re-establish communications. This technique comes in handy when your 68hc11 program runs away and you have to reset everything to try again. Note that pcbug11 will still remember any previous **control** or **eeprom** commands you might have entered.

Now you are ready to load your S19 file into memory. Enter the command:

loads blinky

pcbug11 will open **blinky.s19** and burn the object file into the 68hc11's EEPROM at the proper addresses. When the operation is done, which will only take a second or so, you can then enter:

verf blinky

This causes pcbug11 to reopen **blinky.s19**, but only for comparing the object file with the current contents of the 68hc11's memory. If everything matches, your program is successfully burned and you are ready to go. Note that you can specify full paths on both the **loads** and **verf** commands, if necessary.

To run your program, restrap the BOTBoard for single-chip mode, then press the reset switch. You should see the LED begin blinking immediately. The length of time that the LED is on or off gives you a crude measure of how fast the 68hc11 is running. The program turns the LED on or off, then sits in an empty loop incrementing and testing variable **n** until **n** exceeds $7ffe. At this point, the program reverses the state of the LED and restarts the empty loop. Thus, the LED is on or off for the amount of time the 68hc11 takes to count to 32,767. As you can see, the MCU gets through the loop pretty quickly.

The blinky program is a long stretch from being a working robot program, but that isn't its purpose. I used it to show you how to go from a concept for a program to the SBasic source code to the final object file to burning the file into a 68hc11 and running the program. Everything else you ever write in SBasic will follow pretty much the same pattern, but the programs will be larger. blinky makes a good practice program to get you started.

Now that you know how to program your 68hc811e2 using SBasic and pcbug11, we can move onto more sophisticated ideas. One technique you will need to master fairly quickly uses SBasic's **print** statements to send debugging information over the serial port back to the host PC. Such debug info can be invaluable in pinning down errors in your program. Again, pcbug11 can help you in this. We'll start with the **prtest.bas** program shown nearby.

Like **blinky.bas**, this program starts with the **include** statement to preload all of the 68hc11 register equates. Next, the program declares two variables for later use. The code following statement **main** sets up the 68hc11's serial communications interface (SCI) for uses with SBasic's **print** statement. Your program must set up these two registers properly, or any subsequent **print** statements simply won't work. As shown, these two statements set the SCI so it talks to the host PC at 9600 baud; by default, it also uses eight data bits, one stop bit, and no parity bit.

The rest of the program consists of the same high-speed empty loop we used in **blinky.bas**, along with a debug **print** statement that prints the value of j at the end of each loop. Compile and assemble this program using commands similar to those above, then use pcbug11 to burn the object file into your 68hc11.

When the program is ready to run, restrap your BOTBoard for single-chip mode, but don't press reset yet. Instead, enter the pcbug11 command:

term

This puts pcbug11 into a special terminal mode, much like a modem comm program. By default, pcbug11's terminal mode matches the configuration we set up in **prtest.bas**, so we should see anything the 68hc11 sends us following reset. Finally, press the BOTBoard's reset switch. You should see a stream of statements moving up the screen. Each statement should contain a higher value of **j**. If you wait long enough, you will see **j** count up to 32,767, switch to negative numbers, then finally reach 0 and start over again.

This program shows the basics of sending debug info back to the host PC. You can spiff this routine up by using other features of SBasic. For example, using **printx** instead of **print** causes all numbers to appear in hexadecimal, which can come in handy when you want to know what is appearing on an input port or in an A/D register. You can also use the **inkey()** function to wait for a character from the host PC before proceeding. This lets you halt the program while you can examine the debug info, then press a key to continue.

We are still a long way from having a robot running, but you should begin to see how you can use SBasic and the 68hc11's I/O ports to get things done. I'll finish up with a final program for moving servo motors, which is how we got started down this path last month.

The 68hc11 can provide up to four low-speed PWM signals for controlling, among other things, hobby servo motors. The BOTBoard supports this feature with its four three-pin servo control ports; refer to the BOTBoard docs for details. All your program must do is configure the four corresponding timer channels, TOC2 through TOC5, so a signal of the proper duration appears at each servo control pin.

This set-up is fairly straightforward, once you understand how the 68hc11 timer subsystems work. If you're trying to build your first 'bot, however, you probably want to just get on with it and figure out the low-level stuff later. (I know I would, at any rate.) To that end, my distribution package contains an SBasic library file called **servos.bas**.

You can include this file in your SBasic program just as you include the **regs11.bas** file. When you do, your SBasic program can then simply invoke the new subroutine **InstallServo** to set up a timer channel for controlling a servo motor. See the accompanying listing of **myservo.bas**.

This program ties one servo to timer channel TOC2 and another to TOC3. It then writes a 16-bit value of $f500 to TOC2 and a value of $f700 to

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TOC3. The program then simply ends, which SBasic compiles into a single instruction that jumps to itself, effectively locking up the 68hc11.

The two timer values create two different servo control pulses; each affects its corresponding servo motor differently. The value you write to a TOC register determines the servo's position if you have not modified the servo, as described last month. If you did the mods, then the TOC register value determines both the servo's speed and direction of rotation. Thus, by doing nothing more than writing a value to a register, your software can change the robot's direction of travel and its speed.

I can simply "fall" into an **end** statement at the end of this SBasic program because the 68hc11 timer subsystem is so powerful that it generates the servo pulses without any software overhead at all. You don't need to write any interrupt code and your program doesn't have to monitor any input lines. Your code simply writes a value anytime you want the servos to do something different, then goes back about its business.

To watch this program work, download it into your BOTBoard and connect a pair of servos to the proper servo ports. Strap your BOTBoard for single-chip mode and press reset. You should see your servos turn round and round, or swing to position, whichever is appropriate. Experiment by using different values for the two timer registers to see what effects they have on the servo motors. Generally, you will be using values in the range $f400 to $f800, but the exact performance of each servo will vary.

If the servos don't move at all, make sure you have added the servo power jumper as called out in the BOTBoard docs. Without this jumper in place, the servos will not receive any power. If the servos move erratically or start to move and the 68hc11 seems to lock up, you might need to use fresh batteries, or move up to four C-cells. This runaway happens because the servos momentarily suck so much juice from the batteries that the 68hc11's supply voltage drops below the necessary minimum.

In extreme cases, you can pull the servo power jumper and hook a second set of batteries to the board solely for supplying voltage to the servos.

That does it for this month. This should be enough to get you over many of the initial hurdles in designing your first robot. From here on out, it's mostly getting used to the tools, figuring out what you want your machine to do, and then using the tools at hand properly to get the task done. If you have access to my previous columns, take a look at some earlier robots; you will see elements of what we've done here in many of them.

Build on those ideas, add your own innovations, and get that 'bot going. **NV**

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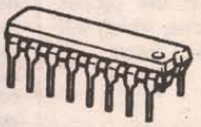

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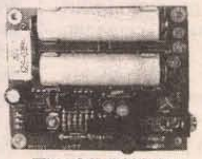

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New 2.88 Meg 3.5" floppy disk drive mfr. by Alps for IBM Thinkpads 755 Series computers. This drive replaces the 1.44 Meg drive by transferring it into the original mounting bracket (5 min.) and it will be auto-detected when the computer is started. Supports 720K/1.44Meg/2.88Meg standards.
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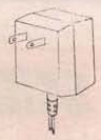

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New 512K PCMCIA SRAM card made by Fujitsu. Will work in most laptop, PDA, or handheld computers with PCMCIA socket and socket management software. HP100/200, OmniGo, Zaurus, Etc.
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Note: Battery not included.
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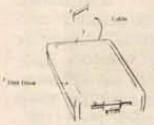

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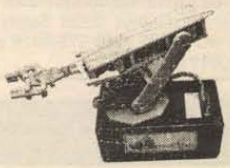

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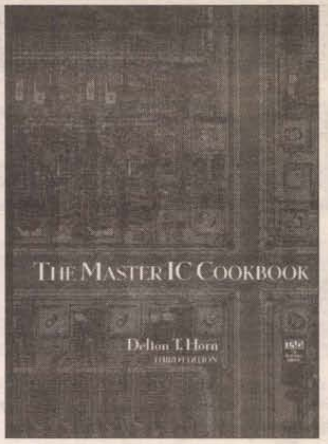

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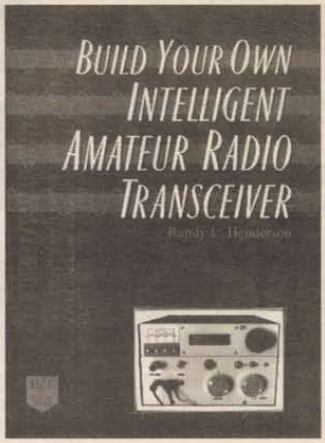

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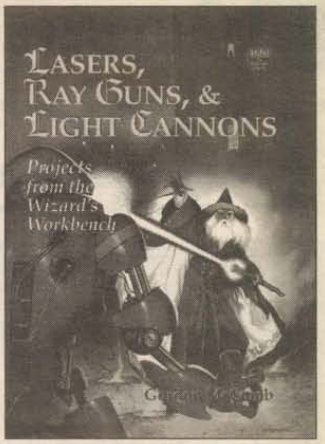

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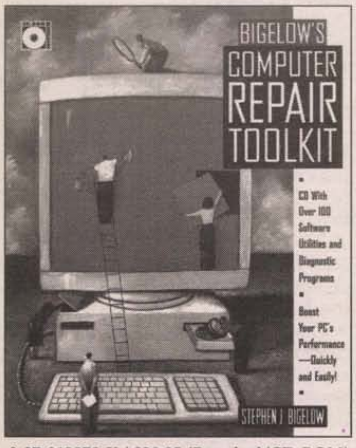

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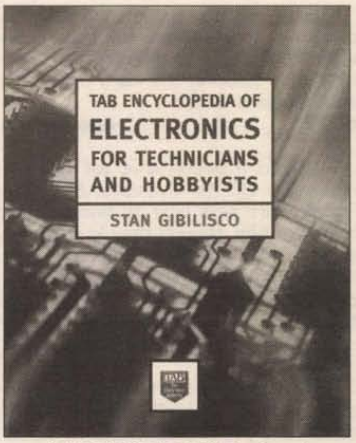

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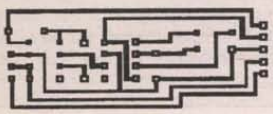

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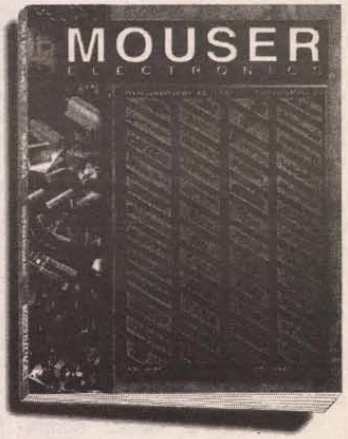

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TECH FORUM

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QUESTIONS

I need a circuit that senses a current draw over the range of 0.5 to 5 amps AC and provides a switch closure (e.g., relay) output. The loads consist of a solenoid coil (11 watts) followed by a 1/3 to 1/2 HP motor.

I used the circuit provided on page 84 of your Feb. '97 issue. The circuit appeared in the Tech Forum section and was provided by Chris Smith of Bieber, CA as an answer to #1974 (Jan. '97). Unfortunately for my application — probably due to the low current that I need to detect — the circuit didn't work. I could not detect a magnetic field from the coil.

Any suggestion as to a current-sensing circuit for my application would be most appreciated.

5971 **Robert A. Shaffer**
Southampton, PA

I recently purchased a device from a flea market that appears to be a word processor and answering machine. I would like to find out any information possible about this device that any reader might know, due to the fact that the company no longer seems to exist. According to the power-up prompt, it needs some sort of re-coding in order to operate. The device is a Unity 100 made by Integrated Office Systems of Cupertino, CA.

5972 **Chris**
Beiber, CA

I have several electronic components that I believe are diodes. They have an 1H6284-A number. Any specs would be helpful.

5973 **Joseph Finn, Jr.**
North Aurora, IL

I have a Crown color TV Model CTV-L13 which has a burned out RT801 PC board identification. Can anyone tell me what a RT801 is and where I can buy the part?

5974 **Hugo Castro**
Paterson, NJ

I need to know where I can get a plan, kit, or schematic or even purchase a video amplifier, low gain 2-6 decibel (dB) range with an inverted output. I want that, not an RF amplifier.

5975 **Donald Herring**
Knightdale, NC

My recently acquired Radio Shack DWP 210 — which is in pristine condition — prints perfectly in self-test. However, when the Tandy 1000SX is set to single spacing, the DWP 210 prints in double spacing, and when the Tandy is set to double spacing, the printer prints in quadruple spacing. What's wrong? My DWP 230 works fine with the Tandy in either setting.

5976 **David R. Brager**
Hawthorne, CA

How can you get an old IBM XT computer to recognize the hard drive after replacing the internal disk battery and replacing the hard drive with another hard drive?

5977 **Anonymous**

I need a circuit that will convert nine-volts DC to five-volts DC. The Robot Store sells nine- to five-volt mini regulator kits, though they look simple enough, they cost $20.00 each. Does anyone have a schematic for this device?

5978 **M. D. Caigoy**
Los Angeles, CA

On my Christmas treetop, I use an angel that opens and closes its wings continually (117 VAC motor). I would like to put in a time delay that would let the wings open every one to five minutes. Any help would be appreciated.

5979 **Norman R. Stokosa**
Presque Isle, MI

I have a TR-7 Drake Model 1337. Where would I get a schematic and information on the programming (P57) port, and where would I obtain accessories? Also, I have an old Navy AN/SRR-13A Serial #336. I would like any information besides the fact that it is a shortwave receiver.

59710 **Stephen Reynolds**
Port Wentworth, GA

I am trying to design an antenna that will fit inside a hollow fiberglass wing off of an 1989 Pontiac Sunbird. This antenna needs to be able to receive TV and radio broadcasts, as well as transmit to an alarm pager. Using multiple antennae is okay if necessary to obtain the best reception and transmissions, as long as they will fit into the wing, since I know very little about antennae, all help would be appreciated.

59711 **R. Fulk**
Greenville, MI
E-Mail: elixir@pathwaynet.com

I need an inverter to power a military altitude indicator gyro. Input 14 VDC, output 26 VAC, three phase. Does anyone know of a source or a circuit design for this item?

59712 **Bob Surdam**
Los Angeles, CA

We have an AM station that can be heard over any breadboarded audio project. I recently built such a project, which consisted of three ICs: an LF412, an LM311, and a CD4013. I put a 10-ohm resistor with a ferrite bead on each power pin. I bypassed with .01 ceramic caps. I placed the breadboarded circuit in a steel box. Line power to the ±15-volt supply is RFI filtered, and the box is grounded.

The station still comes in loud and clear. I tried floating and earthing the power supply ground. I even tried using an LH4001 as a ground driver. Apparently, the RFI is common-mode, everywhere except across my headphones! What gives?

59713 **Daniel Gates**
Wichita, KS

I have been trying since last November to repair a Perimitron Wireless Home Alarm System, Model PT-1000-R. This was made by Universal Security of Baltimore, MD (under new management). The original company had a fire and the new company insists that they cannot supply a schematic or any information on this device.

I need a schematic for this, or possibly a service manual, or advice from someone familiar with these devices. I have all new parts for this, including seven new ICs, the largest of which is a microprocessor #INS-8049 40-pin unit made by National Semiconductor. The other ICs are two quad op-amps, one quad comparator, one hex inverter, one flip-flop, and one addressable eight-bit latch. I also have all new capacitors, and several new transistors, and a new crystal, 4.19 frequency.

The console has a 20-key keypad, six indicator LEDs. It is powered by a nine-volt AC supply, with a battery back-up system. With all new parts installed, it draws about 160 mA, but the keys have no effect, and the lamps do not operate. Something must be shorted or open, but up to now, I cannot find it. I have a scope, logic probe, Fluke meter, etc., but without a schematic, I am at a loss.

If someone could supply a schematic or other data on this, it will be greatly appreciated.

Although this device may be obsolete — about 11 years old — I would like to salvage it, as I have a large external horn and five door transmitters, all in perfect shape. The internal horn is also good, and the device seems well made.

59714 **Howard W. Megee**
Shelton, CT

I am building an optical crank trigger ignition system for a V8 engine. Already completed are four CD ignition amplifiers to be used with four dual output coils

I need some direction on what approach to take for the ignition timing black box. I want to use the trigger pulses for RPM input, and a pressure transducer for the vacuum input. Can this be done with an analog circuit? If so, will I be using "bucket brigade" technology for retard or facilitating advance functions? Or will this have to be done in the digital domain? Is there any existing circuitry out there that can be used as an example?

Any information will be greatly appreciated.

59715 **Joe Riedi**
Renton, WA

I am trying to find a source and the rating of what I think is a DC transient

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TECH FORUM

protector. It is a flat disk about 3/4" in diameter with two radial leads coming out, similar to a MOV. The part is stamped with the following number: SG-307.

I believe the two devices in the drive protect against transient as the transistor module switches the DC bus on and off to create the variable frequency three-phase AC. Just finding the manufacturer would be immensely helpful.

59716 **Dean Schrickel**
Englewood, OH

I inadvertently hit the "format" button for two to three seconds on a 3-1/2" diskette that was loaded with data. The power was killed in two seconds. Formatting takes about 15-20 seconds with this Smith Corona PWP 4400 Word Processor. The disk will not read, but information has to be still there. Possibly only a portion of the disk's directory was destroyed. Does anyone have any ideas?

59717 **Lee Lipsky**
Garden Grove, CA

Does anyone have a "quick-and-dirty" circuit for a DTMF encoder which will work with all 16 tone pairs?

59718 **Ed Rubin N6RMG**
San Diego, CA
edrubin@connectnet.com

I am looking for a circuit which will measure very small values of capacitance.

59719 **E. Ciccone**
Chicago, IL

Most light dimmers are not designed for inductive loads. Though a few very expensive ones are available for cords like transformer driven halogen lights. They seem to contain pretty much the same components. What's the difference? Can an inexpensive dimmer be enhanced to drive transformer/halogen set-ups?

59720 **David D. Speck**
Auburn, NY

How are through-plated holes and gold plating on PCBs done?

59721 **Rune Lindholm**
British Columbia,Canada

I am trying to design a schematic that would convert my television channel 13 (210-216 MHz) to the lower frequency of channel 3 (60-66 MHz) with low dB loss. Can anyone help?

59722 **Jason Chester**
Eatonville, WA

I would like detailed technical information on how the new slot machines with the random number generator (RNG) work — from the actual electronics to the programming software. I would also like to know what combinations of non-paying vs. paying are reflected over a period of one million pulls of the handle.

59723 **kahuna13@ix.netcom.com**

I would like to add a large back-up type capacitor or possibly a battery back-up to my old Heath GD-1197 digital chime clock. It has the annoying habit of needing to be reset after even the tiniest power blip and there is plenty of room in the case to add one of the above.

I need at least a general idea of where the best place in the circuit would be to add this. It doesn't need to keep time for an extended period.

I have the schematic and will be happy to provide a copy to anyone with a possible answer. Also the clock is run by 18 volts with a separate five-volt lamp circuit from regular 120 VAC.

59724 **Richard Flaws**
Oswego, IL

I would like some information on putting together a crystal-controlled frequency synthesizer that I can use to replace a crystal in a pager. Any help would be greatly appreciated.

59725 **Leonard**
Via Internet

I am building a very low-frequency receiver, .001 Hz to 5000 Hz primary frequencies. How can I make this receiver tunable to the various discrete primary frequencies over this range?

59726 **Robert Olson**
Canadian, TX

I have a telescope project in process (an 18" Newton reflector) that, once completed, will be moved about the sky on a mount driven by 6-wire stepper motors. I have a commercial controller that's complete with 40-oz/in steppers, one for each axis. However, I'd like to replace them with larger steppers of approximately 100-oz/in. Is there a circuit that I can make, maybe with darlington transistors or optoisolators with a new, heftier power source to power the bigger stepper motors.

59727 **Nicholas Oshana**
Bristol, CT

How can I generate a fast-rising pulse from an I.R. remote control? The master pulse seems to be about 1 ms wide; the rest of the PWM word or BCW pulses are one-third as wide. I don't have a memory scope or a strip chart recorder. The trigger pulse will be used to EXT. trigger my scope to read the BCD word.

59728 **Gabriel Silva**
t20sil@webtv.net

My brother is working with a large network server. One tower contains 4 dual SCSI cards, 56 CD changers @ 4 disks each for a grand total of 224 CD's. A "background feature" is making this setup a dog. It seems that Windows (95 or NT4.0) wants to "poll all drives" at random, which in this case takes 16 minutes! This cycle happens about 3 times every 2 hours. Is there any way to turn off this function?

59729 **Don Edwards**
Electromec@worldnet.att.net

In the quest to obtain a 12-volt Stereo VCR, I found that only $1,000.00+ units were available. I picked up a SONY 110V unit. When I took it apart, I saw it needed -10V, 35V, 13V, and ground. Obviously, I can handle the 13V and ground. How do I take 12V from a car and make 35V and -10V?

59730 **Jason**
http://www.mirage1.com
mirage1@mirage1.com

ANSWERS

ANSWER TO #3979 - MARCH 1997

For an excellent explanation of bi-directional communication with an external device via a PC's parallel port, check out an article by Jeff Stefan in the Sept. '96 issue of *Nuts & Volts* called "Home Security with PCM and the Parallel Port." Although Mr. Stefan uses the C language for his project, his detailed and easily understood explanation for using a PC's parallel port addresses and registers to communicate with his simple hardware I/O circuitry should be enough to enable you to write basic software and build your own I/O interface.

John McMichael
Laramie, WY

ANSWER TO #39720 - MARCH 1997

The part you want to replace DN838 is directly replaceable by Phillips ECG9402 which is available from MCM Parts Co., an advertiser in *Nuts & Volts*. MCM Electronics **1-800-543-4330**.

Leo D. Barrette
Mineral Point, WI

ANSWER TO #3978 - MARCH 1997

By far, the best place to find information regarding construction of linear amplifiers for ham applications is any recent edition of the comprehensive *Amateur Radio Handbook* put out annually by the ARRL. These books will have not only the schematics, but also sources for the parts needed and, in the more recent editions, printed circuit layouts for many of the projects. Both solid-state and tube circuits are presented, so the reader has many options.

Of course, any hamfest can be a source of parts for those who like to scrounge creatively, but the reader lives sufficiently close to one of your central Florida advertisers — Skycraft Parts and Surplus in Orlando (ad on page 25 in the Mar. '97 issue) — to merit at least one trip. I haunt the place myself, and have found many solutions to my project problems there.

The ARRL Antenna Handbook would be an excellent place to find plans for beam antennas such as the reader seeks, although an 80-meter beam would be a monster. However, there are articles on helically-wound projects which might be adapted for the reader's use (and pocketbook). Bandwidth will, of course, be quite narrow in 80, 40, and 20 meters, especially if traps are incorporated in the design. To that end, the reader should consider building, if he has not already done so, a matching system such as

Continued on page 115

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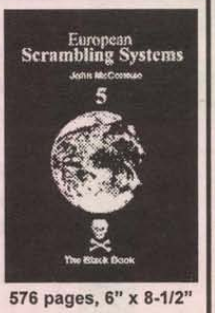

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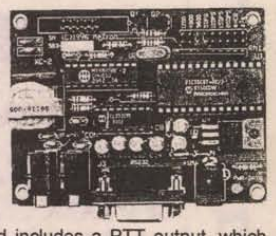

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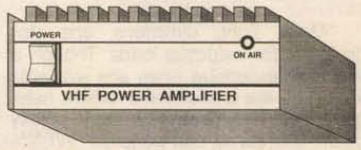

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FM-25, Synthesized FM Stereo Transmitter Kit $129.95

Tunable FM Stereo Transmitter

A lower cost alternative to our high performance transmitters. Offers great value, tunable over the 88-108 MHz FM broadcast band, plenty of power and our manual goes into great detail outlining aspects of antennas, transmitting range and the FCC rules and regulations. Connects to any cassette deck, CD player or mixer and you're on-the-air, you'll be amazed at the exceptional audio quality! Runs on internal 9V battery or external power from 5 to 15 VDC, or optional 120 VAC adapter. Add our matching case and whip antenna set for a nice finished look.

FM-10A, Tunable FM Stereo Transmitter Kit $34.95
CFM, Matching Case and Antenna Set. $14.95

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LPA-1, Power Booster Amplifier Kit $39.95
CLPA, Matching Case Set for LPA-1 Kit. $14.95
LPA-1WT, Fully Wired LPA-1 with Case $99.95

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World's smallest FM transmitter. Size of a sugar cube! Uses SMT (Surface Mount Technology) devices and mini electret condenser microphone, even the battery is included. We give you two complete sets of SMT parts to allow for any errors or mishaps-build it carefully and you've got extra SMT parts to build another! Audio quality and pick-up is unbelievable, transmission range up to 300 feet, tunable to anywhere in standard FM band 88 to108 MHz. 7/8"w x 3/8"h x 3/4"h.

FM-5 Micro FM Wireless Mike Kit $19.95

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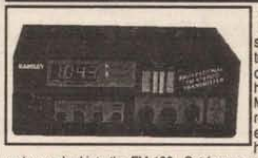

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FM-100WT, Fully Wired High Power FM-100. ..... $429.95

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SS-70AWT, Fully Wired SS-70A with Case $79.95
AC12-5, 12 Volt DC Wall Plug Adapter $9.95

Tone-Grabber Touch Tone Decoder / Reader

Dialed phone numbers, repeater codes, control codes, anywhere touch-tones are used, your TG-1 will decode and store any number it hears. A simple hook-up to any radio speaker or phone line is all that is required, and since the TG-1 uses a central office quality decoder and microprocessor, it will decode digits at virtually any speed! A 256 digit non-volatile memory stores numbers for 100 years - even with the power turned off, and an 8 digit LED display allows you to scroll through anywhere in memory. To make it easy to pick out numbers and codes, a dash is inserted between any group or set of numbers that were decoded more than 2 seconds apart. The TG-1 runs from any 7 to 15 volt DC power source and is both voltage regulated and crystal controlled for the ultimate in stability. For stand-alone use add our matching case set for a clean, professionally finished project. We have a TG-1 connected up here at the Ramsey factory on the FM radio. It's fun to see the phone numbers that are dialed on the morning radio show! Although the TG-1 requires less than an evening to assemble (and is fun to build, too!), we offer the TG-1 fully wired and tested in matching case for a special price.

TG-1, Tone Grabber Kit $99.95
CTG, Matching Case Set for TG-1 Kit. $14.95
TG-1WT, Fully Wired Tone Grabber with Case $149.95
AC12-5, 12 Volt DC Wall Plug Adapter $9.95

Mini-Peeper Micro Video Camera

Super small, high quality fully assembled B & W CCD TV camera the size of an ice cube! Provides excellent pictures in low light (2 lux), or use our IR-1 Infra-Red light source to invisibly illuminate an entire room on a pitch black night! Imagine the possibilities... build it into a smoke detector, wall clock, lamp, book, radio. Exact same camera that's in big buck detective catalogues and stores. Kit includes: fully assembled CCD camera module, connectors, interface PC board kit with proper voltage regulation and filtering, hook-up details, even a mini microphone for sensitive sound! Two models available: Wide Angle Lens 3.6mm/f2, adjustable focus lens, 92 degree view; Pinhole Lens 5.5mm/f4.5, 60 degree view. The Pinhole Lens is physically much flatter and provides even greater depth of focus. The camera itself is 1.2" square. The Wide Angle Lens is about 1" long, Pinhole Lens about 1/2", interface PC board is 1" x 2" and uses RCA jacks for easy hook-up to VCRs, TVs or cable runs. Power required is 9 to 14 VDC @ 150 mA. Resolution: 380 x 350 lines. Instruction manual contains ideas on mounting and disguising the Mini-Peeper along with info on adding one of our TV Transmitter kits (such as the MTV-7 unit below) for wireless transmission!

MP-1, Wide Angle Lens CCD TV Camera Outfit $169.95
MP-1PH, Pin-Hole Lens CCD TV Camera Outfit $189.95

MicroStation Synthesized UHF TV Transmitter

Now you can be in the same league as James Bond. This transmitter is so small that it can fit into a pack of cigarettes - even including a CCD TV camera and battery! Model airplane enthusiasts put the MTV-7A into airplanes for a dynamite view from the cockpit, and the MTV-7A is the transmitter of choice for balloon launches. Transmitter features synthesized, crystal controlled operation for drift-free transmission of both audio and video on your choice of frequencies: Standard UHF TV Channel 52 (which should only be used outside of the USA to avoid violating FCC rules), and 439.25 MHz or 911.25 MHz which are in the amateur ham bands. The 439.25 MHz unit has the nifty advantage of being able to be received on a regular 'cable-ready' TV set tuned to Cable channel 68, or use our ATV-74 converter and receive it on regular TV channel 3. The 911.25 MHz unit is suited for applications where reception on a regular TV is not desired, an ATV-79 must be used for operation. The MTV-7A's output power is almost 100 mW, so transmitting range is pretty much 'line-of-sight' which can mean many miles! The MTV-7A accepts standard black and white or color video and has its own, on-board, sensitive electret micorphone. The MTV-7A is available in kit form or fully wired and tested. Since the latest in SMT (Surface Mount Technology) is used to provide for the smallest possible size, the kit version is recommended for experienced builders only. Runs on 12 VDC @ 150 mA and includes a regulated power source for a CCD camera.

MTV-7A, UHF TV Channel 52 Transmitter Kit $159.95
MTV-7AWT, Fully Wired Channel 52 Transmitter $249.95
MTV-7A4, 439.25 MHz TV Transmitter Kit $159.95
MTV-7A4WT, Fully Wired 439.25 MHz Transmitter $249.95
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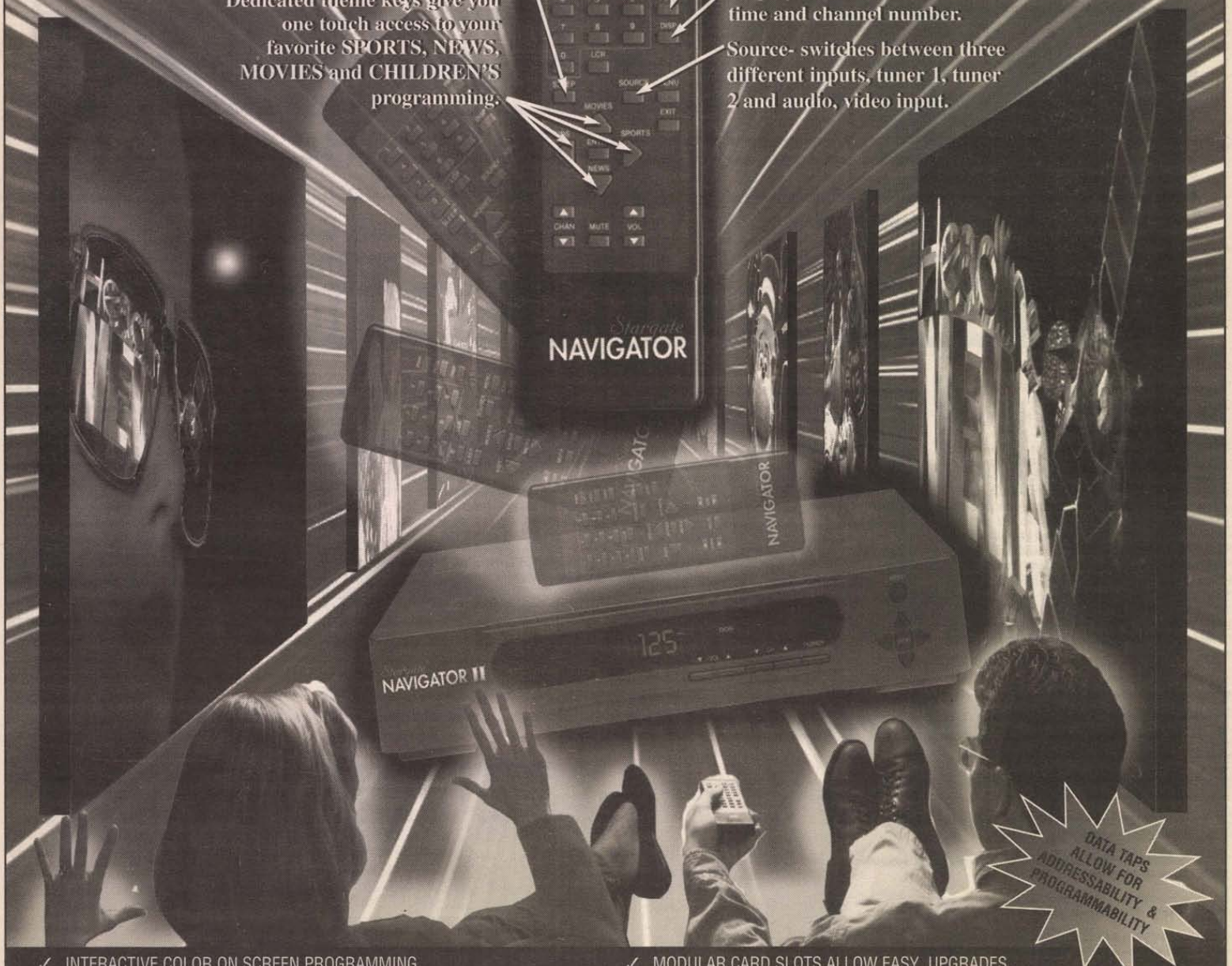

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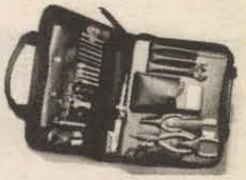

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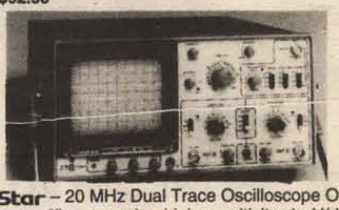

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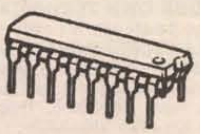

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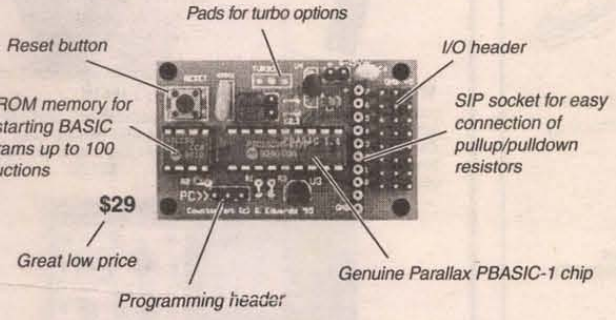

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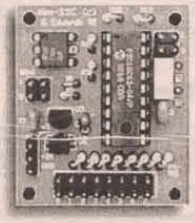

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PO2K	2K Ω	.69	.66	.59
PO5K	5K Ω	.69	.66	.59
PO10K	10K Ω	.69	.66	.59
PO20K	20K Ω	.69	.66	.59
PO50K	50K Ω	.69	.66	.59
PO100K	100K Ω	.69	.66	.59
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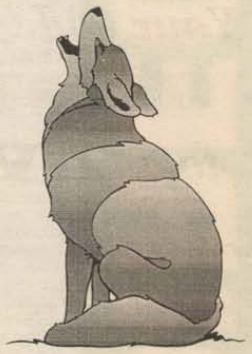

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RS-232 Analog Input

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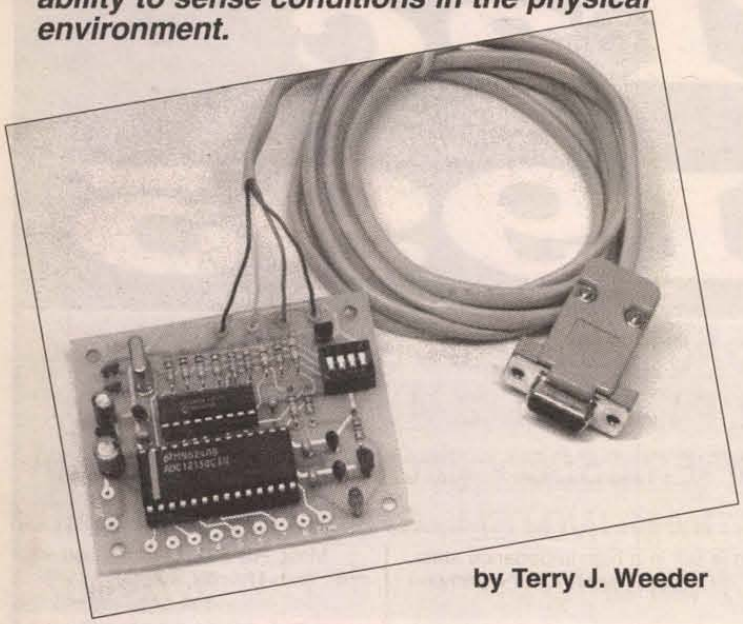


by Terry J. Weeder

We obtain information regarding temperature and pressure via the nerve endings under our skin, light with our eyes, sounds with our ears, smells, etc. Regardless of the computing power of our brain, life's management would be very difficult, to say the least, if not for the data provided by these human sensors.

In the same respect, there are many computer-related applications which are absolutely dependent upon data input reflecting this same physical environment. Albeit, data acquisition, or various forms of closed-loop controlling systems.

Many component-level electronic sensors are available which meet these needs. Discreet devices that measure temperature, pressure and, of course, mechanical position such as a potentiometer, are among a few. Unfortunately, the data output from most of these sensors is in the form of an analog voltage which is not compatible with the binary "1s" and "0s" used in the computer world.

To pass analog voltage data to a digital environment such as a PC, some form of conversion is necessary. The RS-232 analog input kit, described here, uses a self-calibrating, 12-bit plus sign A/D converter which measures the voltage levels at its input pins and converts them to a number in the range of 0 to 4095, represented in 1 mV steps.

Eight input pins are available and can be set up for either single-ended conversion (read the voltage potential between each pin and a common return), or differential conversion (read the difference in voltage between pin pairs).

Because the result is scaled to 1 mV steps, further adjustments or math calculations are not required to yield the direct voltage measured at an input pin. For instance, a 2.499-volt input will be converted to the number 2499.

A powerful feature of this circuit is its ability to store alarm trip-point levels for each of its eight inputs. Even during times when the host computer is not requesting conversions, the RS-232 analog input module is continually scanning its input pins and reports if any pass over their user-defined trip points. These trip points can be changed on the fly by the host. This is ideally suited for applications where 100 or so sensors need to be monitored for over-range conditions without tying up the communications line/port.

Due to the special design of the RS-232 interface being used, the module can share the same port with others of its kind. A DIP switch setting on board allocates its own unique address, and allows up to 16 units to be stacked together to provide a total of 128 single-ended inputs, or 64 differential inputs.

The set of commands which can be sent from your PC's com port to initiate a conversion or set an alarm trip point is shown in Listing 1. For versatility, each input pin can be read individually in either single-ended or differential mode, or all pins can be read as a group. The latter being convenient for continuous data acquisition applications. There is also a command which will instruct the A/D converter to initiate its auto-zero function. This is useful when the RS-232 analog input kit is located in an environment subject to broad ambient temperature changes which may cause an offset error.

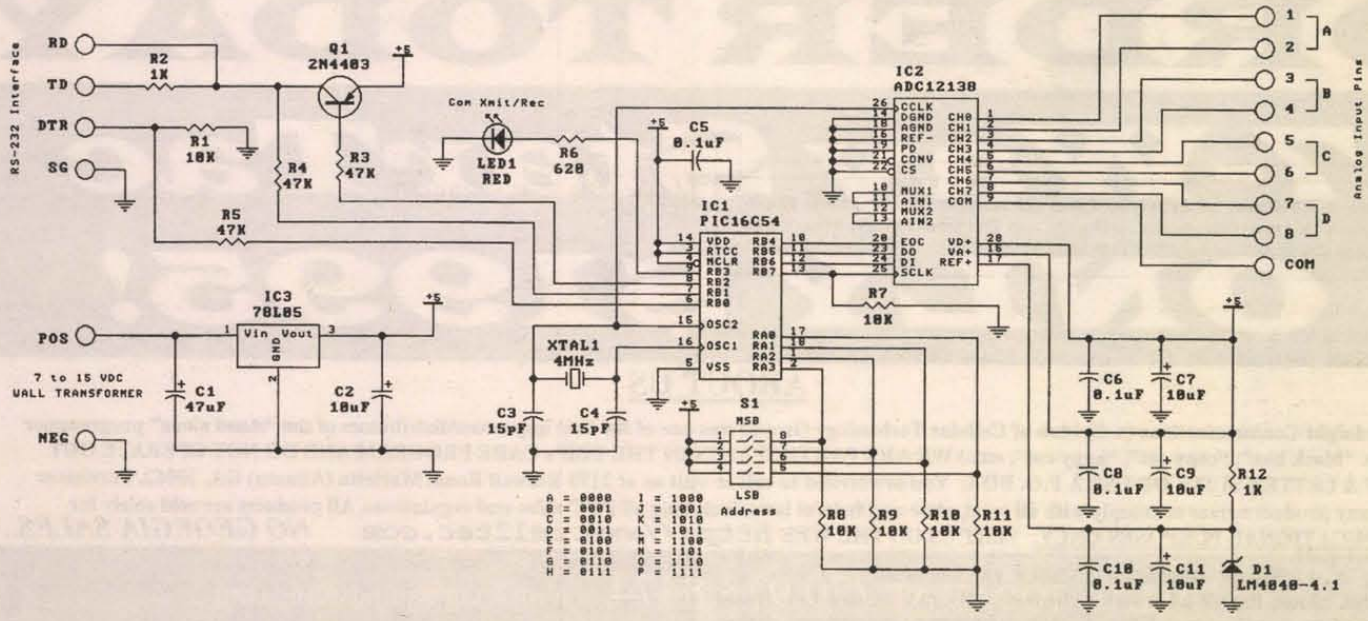
Circuit Theory

Refer to the schematic diagram

RS-232 ANALOG INPUT

WTADC

Figure 1 - The key component in this circuit is IC2, a self-calibrating, 12-bit plus sign, analog-to-digital converter with eight-channel multiplexer.



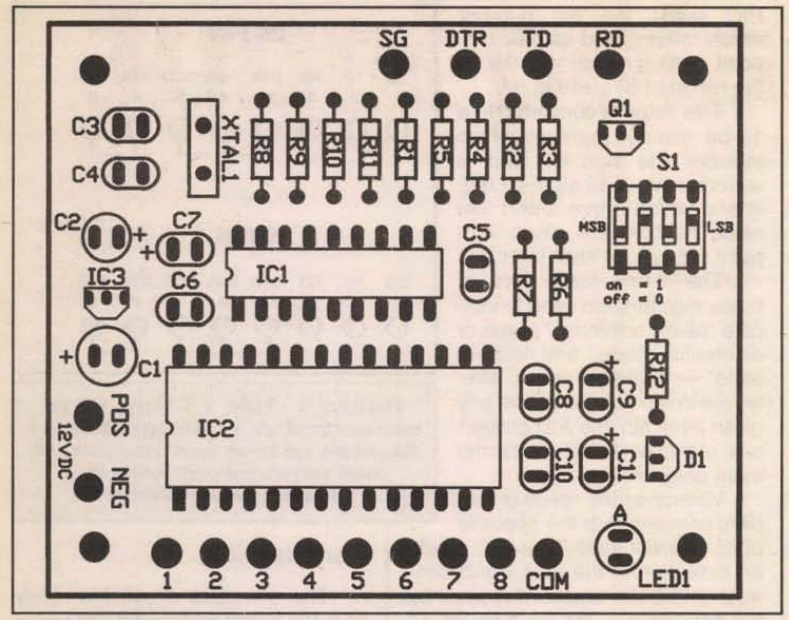


Figure 2 - Use this parts placement diagram when soldering components onto the PC board.

shown in Figure 1. The key component is the ADC12138 (IC2), a self-calibrating 12-bit plus sign A/D converter manufactured by National Semiconductor. This ADC features an eight-channel multiplexer and can be configured to operate in various combinations of single-ended, differential, or pseudo-differential modes.

Control is accomplished via a three-wire serial I/O interface which makes it ideal for a microcontroller-based project such as this. Of the three wires there is a digital out (DO), a digital in (DI) and a serial clock pin (SCLK). The end of conversion pin (EOC) is used to indicate when the ADC is ready to receive another command. IC2 uses a precision voltage reference set by an LM4040-4.1 (D1).

Using a 4.096-volt reference such as this allows the 12-bit result to be scaled to 1 mV steps. Filter capacitors C6 through C11 provide bypassing of noise spikes on the power supply and reference pins.

The intelligence in the circuit is provided by a PIC16C54 (IC1), an EPROM-based eight-bit CMOS microcontroller manufactured by Microchip. The crystal (XTAL1) sets the microcontroller's internal oscillator at 4 MHz, which is also used to supply the conversion clock (CCLK) required by IC2. IC1 has the responsibility of communicating with the A/D converter — instructing it to begin a conversion on a specified input pin then reading the result, or telling it to perform a function such as auto-calibrate or auto-zero.

This is initiated with a set of commands transferred via the three-wire interface mentioned above. Resistor R7 is required to hold the SCLK pin low during the microcontroller's 18 ms Power-On Reset delay when its corresponding driving pin is still in a high impedance state.

IC1 also handles the communications to and from the RS-232 serial port of the host computer. The voltage levels defined for serial communications on an RS-232 interface are +3 volts to +25 volts for a logic 0, and -3 volts to -25 volts for a logic 1.

Most RS-232 devices use +12 volts and -12 volts, respectively. Bit 2 of port B is used to send data to the serial port. A logic 1 is generated by placing bit 2 at a high level which turns off Q1, thus allowing the -12 volts from the TD (Transmit Data) pin to be applied to the RD (Receive

Listing 1 - Send these commands out your computer's com port to set-up and control the analog input module.

TITLE	COMMAND	DESCRIPTION
READ	R pin	Perform conversion on a single input pin. (pin = 1-8 or A-D). Returns -4095 to 4095.
SINGLE-ENDED	S	Perform single-ended conversion on input pins 1-8. Returns "result1 result2 result3 result4 result5 result6 result7 result8" (resultX = -4095 to 4095).
DIFFERENTIAL	D	Perform differential conversion on input pins A-D. Returns "resultB resultC resultD" (resultX = -4095 to 4095).
ALARM	A pin {-} value	Set alarm trip-point on an input pin. (pin = 1-8 or A-D, value = 0 to 4095). Returns "pinH" or "pinL" when transition of trip-point.
AUTO-ZERO	Z	Perform Auto-Zero function on ADC.

Note, all commands must be preceeded by the WTADC header character A, and address character A-P. All responses from the WTADC will also contain this preface.

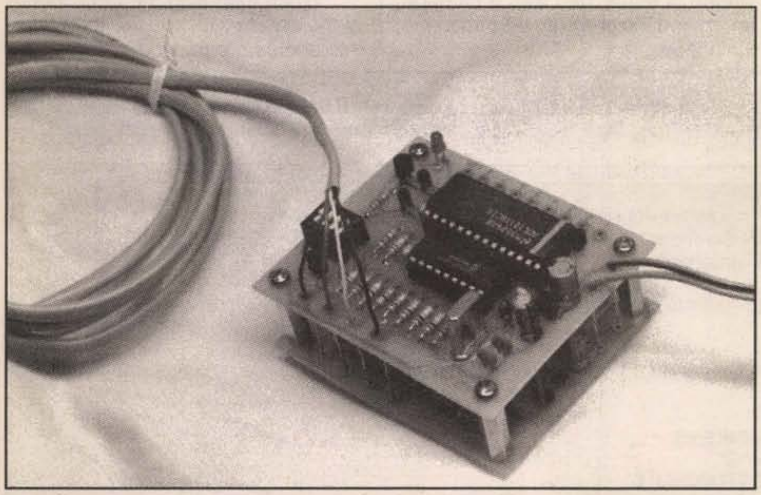
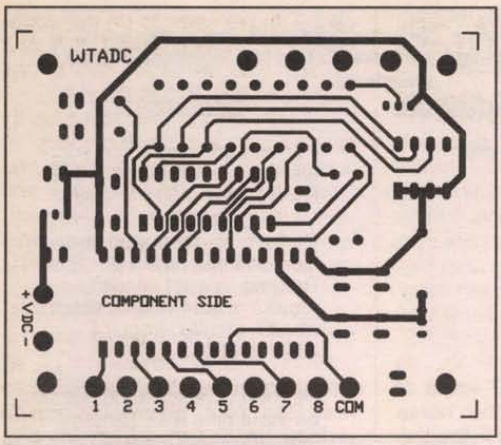


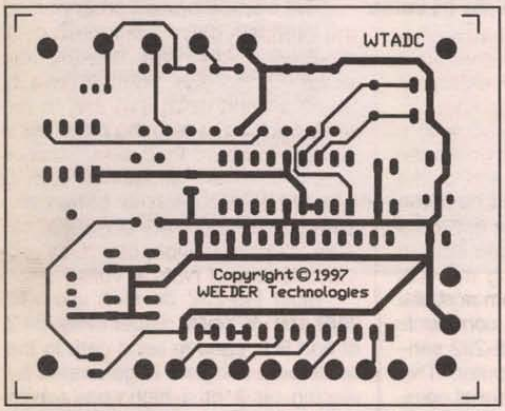
Photo 1 - When stacking two or more units, the RS-232 and power supply wires can be fed from the top board down through the bottom board as shown.

Listing 2 - This simple QBASIC program will allow you to manually send commands to the analog input module, and see any data being returned.

```
'This QBASIC program will test out the RS-232 analog input kit.
'Set the WTADC address to "A." Start the program then hit "C" on the
'keyboard. Type in any command shown in Listing 1 that you wish to send to
'the WTADC then press enter. The WTADC will respond to the command and
'return any data (if applicable) which will be displayed on the monitor.

'Hit "ESC" to exit the program.


CLS
OPEN "COM2:1200,N,8,1" FOR RANDOM AS #1
ON COM(2) GOSUB RECEIVE
COM(2) ON

DO
    KEY$ = INKEY$
    IF UCASE$(KEY$) = "C" THEN
        INPUT "Enter Command ", OUT$
        GOSUB TRANSMIT
    END IF
LOOP UNTIL KEY$ = CHR$(27)
CLOSE #1
END

RECEIVE:
    COM(2) OFF                          'disable event trapping
    IF INPUT$(2, #1) = "AA" THEN        'test for WTADC header and address characters
        LINE INPUT #1, IN$              'get response from WTADC board
        PRINT IN$                       'print response to screen
    ELSE LINE INPUT #1, DISCARD$        'discard data using different header
    END IF
    COM(2) ON                           'enable event trapping
    RETURN

TRANSMIT:
    COM(2) OFF                          'disable event trapping
    OUT$ = "AA" + OUT$                  'append header and address characters
    PRINT #1, OUT$                      'send string to WTADC
    LINE INPUT #1, DISCARD$             'discard echo
    COM(2) ON                           'enable event trapping
    RETURN
```



TOP SIDE 1:1



BOTTOM SIDE 1:1

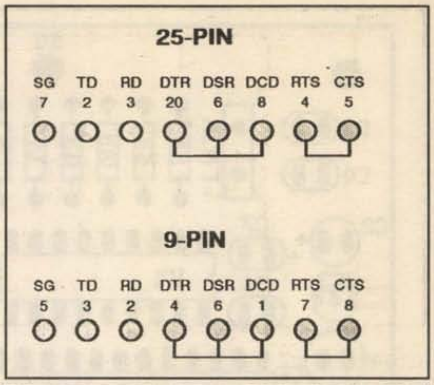


Figure 3 - Use 15-turn POTs connected in a voltage divider fashion to test out the circuit and experiment with the alarm trip-points.

Data) pin through R2. Bit 2 is sent low to produce a logic 0 which turns on Q1, pulling the RD pin to +5 volts.

Because the TD pin of an RS-232 port is normally at a marking level (-12 volts), it is possible to "steal" from it the negative voltage needed for communications at RS-232 levels and a separate supply or negative charge pump is not required. Bit 0 of port-B is tied to the DTR (Data Terminal Ready) pin through R5 and determines when the unit is plugged into an active RS-232 port.

Bit 1 of port B is tied to the RD pin through R4 and is used to verify an idle RS-232 state prior to sending any serial data. This will avoid a collision with the data sent from any other projects which are sharing the same RS-232 port.

LED1 is used to indicate communications activity with the com port. The DIP switch (S1) together with the pull-down resistors R8 through R11 set the address of the RS-232 analog input board. Power for the circuit is supplied from a standard wall transformer with an output in the range of 7 to 15 VDC. IC3, a 78L05 voltage regulator, drops this voltage to the five volts required by the rest of the circuit. C1 and C2 stabilize the operation of the regulator and provide filtering.

The PIC Firmware

The PIC16C54 must be programmed with the "RS-232 analog input" firmware before installing. A pre-programmed PIC is available from the supplier mentioned in the parts list. The source and object code files have been placed on the *Nuts & Volts* web site for those who have the proper equipment to program their own, or simply wish to explore the program line for line.

Upon power-up, the PIC sends a series of commands to the ADC to set its acquisition time, perform auto-calibrate, and auto-zero. It then enters the main program loop which monitors the "TD" pin of the com port looking for a start bit.

If a start bit is detected, the program jumps to a routine which gets the first character from the com port and checks to see if it is the RS-232 analog input header character "A." This will determine if the data to follow is meant for this kit or some other kit sharing the same port.

Immediately following this header character is the address character (A-P). The PIC reads the DIP switch setting to determine if there is an address match and, in turn, either fetches or discards the remainder of the data stream.

The next character received is the "command" character and will indicate to the PIC the action being requested by the host. For a single-ended or differential conversion, the PIC sends the appropriate multiplexer addressing data to the ADC instructing it to initiate a conversion on the desired input pin. The result is returned to the PIC in the form of a 12-bit plus sign binary number. This number is converted to a decimal format represented in ASCII characters, then transmitted to the host via the RS-232 interface.

If the request was to read "all" input pins, the PIC repeats this conversion process for each pin, transmitting a "space" character between results.

If the "Alarm" command is received, the PIC reads the pin number which follows, and its new trip-point setting which can be in the range of 0 to ±4095 mV.

This value is converted to a 13-bit binary number which includes the sign bit, and is stored in two of 16 eight-bit registers which have been set aside to hold the alarm trip-point settings for each input pin.

The extra three bits in these registers are used to indicate "alarm activem," "single or differential mode," and "current state" — above or below. After an alarm trip-point is set on any given input pin, the A/D conversion of that pin is included in the main program loop.

Whenever the result of that pin's conversion is the opposite of its "current state," the PIC sends an indication to the host which consists of the pin number followed by the new state — "H" for high, or "L" for low. There is a built-in 10 mV hysteresis used with these alarm trip-points to prevent constant reporting when the voltage at an input pin is residing at the threshold.

When data is to be returned to the host — whether reporting an alarm trip or conversion result — the PIC first listens to the communications line to determine its availability.

If or when it becomes idle, the header and address characters are sent followed by the response in the format shown in Listing 1. This data stream is terminated with a carriage return and the program returns to the main loop.

Construction

The complete circuit fits nicely on a PC board measuring just under 3" x 2.5". The artwork is provided here for those who wish to etch their own PCB, or a pre-etched and drilled board can be purchased from the source mentioned in the parts list.

Refer to the parts placement diagram shown in Figure 2; identify the component side of the PC board which is marked, and begin by soldering in the two IC sockets. Next, solder in the resistors and capacitors paying particular attention to the orientation of the polarized caps C1, C2, C7, C9, and C11.

When mounting the LED, identify the anode which is the long lead; this should correspond with the pad

Listing 3 - Use this QBASIC program for continuous data acquisition, monitoring the voltage present on all analog input pins.

```
'This QBASIC program will use the RS-232 analog input kit for continuous
'data acquisition on all inputs (1 through 8) in single-ended conversion mode.
'To monitor inputs A through D in differential mode, change the "S" in the OUT$
'statement in the main loop to "D," and use only four variables in the PRINT
'and INPUT statements.

'Hit "ESC" to exit the program.

CLS
OPEN "COM2:1200,N,8,1" FOR RANDOM AS #1

DO
    KEY$ = INKEY$
    OUT$ = "S"
    GOSUB TRANSMIT
    GOSUB RECEIVE
    LOCATE 5, 1
    PRINT A%, B%, C%, D%, E%, F%, G%, H%
LOOP UNTIL KEY$ = CHR$(27)
CLOSE #1
END

RECEIVE:
    IF INPUT$(2, #1) = "AA" THEN      'test for WTADC header and address charac-
ters
    INPUT #1, A%, B%, C%, D%, E%, F%, G%, H%
    ELSE LINE INPUT #1, DISCARD$ 'discard data using different header
    END IF
    RETURN

TRANSMIT:
    OUT$ = "AA" + OUT$                'append header and address characters
    PRINT #1, OUT$                    'send string to WTADC
    LINE INPUT #1, DISCARD$           'discard echo
    RETURN
```

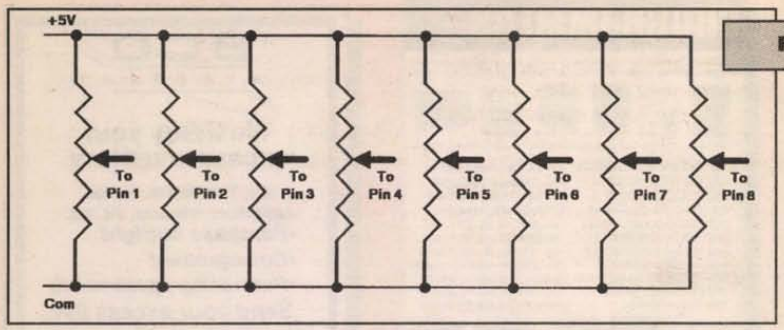


Figure 4

labeled "A" on the parts placement diagram.

Care should be taken when soldering in the transistor (Q1), the regulator (IC3), and the voltage reference (D1) to avoid a solder bridge between the closely spaced pads. The crystal (XTAL1) should be mounted leaving a small gap between the bottom of its case and the PC board to avoid the chance of its metal case shorting the two pads together. Finish by mounting the DIP switch (S1).

Obtain a piece of four-conductor telephone cord to be used as your RS-232 cable, and the appropriate connector to mate with your computer's serial port. Figure 3 shows the hook-up diagram for both a 9-pin and 25-pin RS-232 connector.

Match the "SG," "DTR," "TD," and "RD" connections on the PC board with their corresponding pins on the connector you are using, as shown in the diagram. Solder a jumper wire on the RS-232 connector between pins "RTS" and "CTS," and between pins "DTR," "DSR," and "DCD" as shown.

Use a DC wall transformer with an output in the range of 7 to 15 VDC. Cut off the connector at the end of the wires, use a voltmeter to determine positive and negative, and solder those wires to the "POS" and "NEG" connections on the PC board.

After all components and wires have been soldered, closely examine both sides of the PC board for solder bridges and/or cold solder joints and re-solder, if necessary. Carefully plug IC1 and IC2 into their sockets using the orientation as shown in the parts placement diagram.

Operation

The RS-232 analog input kit can share the same serial port as other kits of its kind simply by wiring each kit in parallel on the same RS-232 cable as shown in Photo 1. You must, however, remove R1 and R2 on any subsequent kit (i.e., of all the kits paralleled on the same line, only one kit should have R1 and R2 installed).

Doing this will allow you to piggyback up to 16 analog input modules and use them on the same port which currently supports the RS-232 digital input/output kit as described in the Jan. '97 issue of *Nuts & Volts,* and/or the home automation kits described in the Jul. and Aug. '96 issues.

Because of the relaxed communications speed required by these RS-232 modules (1200 baud), it is possible to string out the communications cable over hundreds of feet and use as a multiple drop line.

To test out the circuit, hook up a 15-turn 1K potentiometer (available from Radio Shack) to each of the eight analog inputs in a voltage divider scheme as shown in Figure 4. Plug the wall transformer into an electrical outlet, then plug the RS-232 connector into the com port of a PC. Note: *Always apply power to the analog input kit prior to plugging it into an active com port.*

Use the simple QBASIC program shown in Listing 2 to read the voltages contrived by the POT settings. Start the program, then hit "C" on the keyboard. A prompt will appear asking you to type in a command. Type "R1" — using caps — then hit enter.

The voltage seen at analog input pin 1 will be read and displayed on the computer monitor in millivolts. Typing in "R2," "R3," "R4," etc., in the same manner as above, will read the voltages at each of the other input pins.

Use pin numbers A through D to read the "difference" in voltage potential between pin pairs as allocated in the schematic diagram.

Depending on which pin of a pair is more positive than the other, will stipulate whether the result is returned as a positive or negative number.

To set an alarm trip point on an input pin, type in "A," the pin number, followed by the setting value in millivolts, then hit enter. To use a negative number, simply include the negative sign. Experiment by setting alarm trip points on various pins or pin pairs, then adjusting the POTs to transcend those points.

When the voltage at an input pin exceeds its alarm trip point, the pin number along with the letter "H" is echoed on the monitor.

After the voltage returns to a level 10 mV less than the trip-point — used for hysteresis — the pin number along with the letter "L" is echoed.

Keep in mind that setting trip points on pin pairs A through D will cancel those settings on the corresponding individual pins 1, 3, 5, or 7 — and vice versa — due to the sharing of registers in the PIC.

If you wish to use two broadly spaced high and low trip points on one sensor, simply connect two input pins to the same sensor and set their trip points to the high and low extremes. Remember to take into account the 10 mV hysteresis when defining the low trip point.

Listing 3 shows a simple QBASIC program which can be used for continuous data acquisition on all single-ended inputs at one time. To read the four differential inputs instead, change the "S" in line 5 to "D" and use four variables in lines 9 and 15.

This mode of operation ties up the communications line/port, so if there are other kits sharing the same RS-232 line, you will have to insert a short delay (10 ms) in the program loop to give the other kits a chance to report their data; such as alarm trips on additional analog input boards, switch or button closures on a digital I/O board, DTMF data, X-10 reception, etc. (See previous issues of *Nuts & Volts.*)

Creating Your Own Program

The RS-232 analog input module communicates at 1200 baud, no parity, eight data bits, and one stop bit. Your program should contain the line OPEN "COM1:1200,N,8,1" FOR RANDOM AS #1, or similar. Also the ON COM GOSUB statement should be used as shown in the sample programs to handle branching to a subroutine when data is received from the module.

All data sent by the analog input module to the serial port is preceded by the header character (A) and the board address character (A-P), then ending with a carriage return. All commands sent by the PC to the analog input module must also be preceded by these same header and address characters.

Two important notes here: Because of the structure of the RS-232 interface used by the analog input module, all characters that are sent to the module are also echoed back to the PC. Therefore, your program must use the COM(1) OFF statement prior to using the PRINT #1, and then a LINE INPUT #1 statement to dump all echoed characters in the buffer before issuing a COM(1) ON statement.

Also, always use the COM(1) OFF statement at the beginning of your subroutine branched to by the ON COM GOSUB statement, then a COM(1) ON statement at the end after all characters have been received.

Failure to turn off event trapping as mentioned above will cause communications errors between the PC and the analog input module. **NV**

Parts List

Resistors (All are 1/4-watt, 10% units)
R1, R7, R8, R9, R10, R11 — 10,000 ohm
R2, R12 — 1,000 ohm
R3, R4, R5 — 47,000 ohm
R6 — 620 ohm

Capacitors
C1 — 47 uF, 35-WVDC, electrolytic
C2 — 10 uF, 35-WVDC, electrolytic
C3, C4 — 15 pF, ceramic disc
C5, C6, C8, C10 — 0.1 uF monolithic ceramic
C7, C9, C11 — 10 uF, 10-WVDC, tantalum

Semiconductors
D1 — LM4040-4.1 precision 4.096-volt reference (National Semiconductor)
IC1 — PIC16C54-XT/P (pre-programmed) eight-bit microcontroller (Microchip)
IC2 — ADC12138CIN self-calibrating, 12-bit plus sign, A/D converter with eight-channel multiplexer (National Semiconductor)
IC3 — 78L05 low power five-volt regulator
LED1 — light emitting diode, red
Q1 — 2N4403, general-purpose PNP silicon transistor

Other Components
S1 — DIP switch, four-pole
XTAL1 — 4 MHz crystal

Miscellaneous: PC board, IC sockets, DC wall transformer, RS-232 connector and cable, analog sensors, solder, etc.

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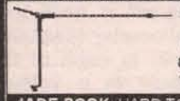

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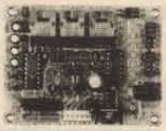

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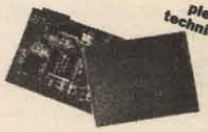

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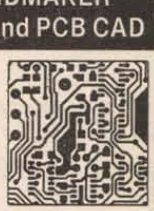

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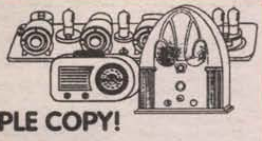

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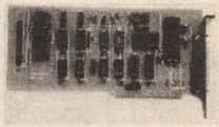

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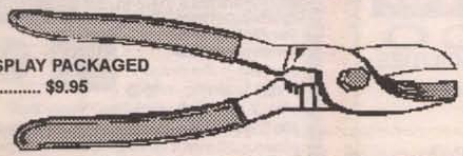

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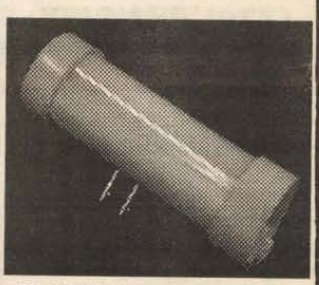

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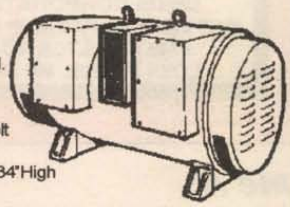

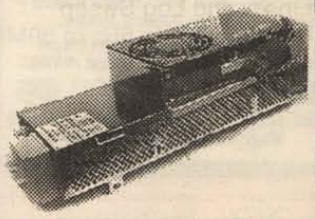

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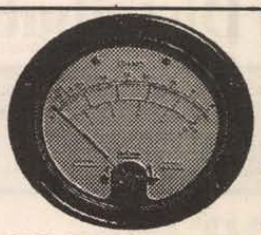

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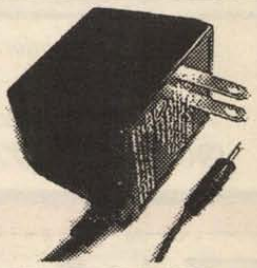

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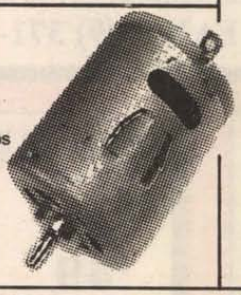

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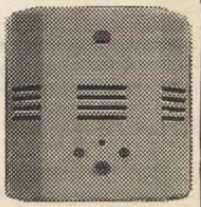

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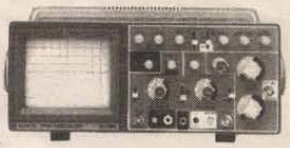

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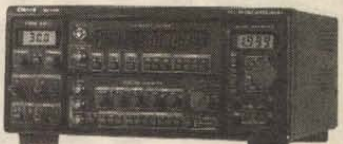

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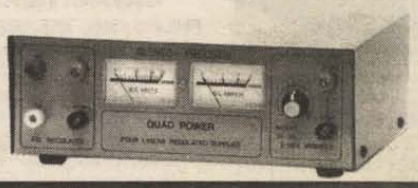

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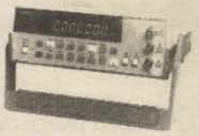

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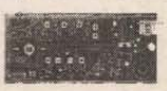

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Software Wizardry

by Harry Helms

When you think of sexy, high-tech PC stuff, you probably don't think of buses.

If the Internet is the information superhighway, then the buses in your PC are your neighborhood streets. Think of your home as the microprocessor in your PC. You need some way to get to your job, the grocery store, the doctor's office, the video rental emporium, etc., in order to survive. Now think of your job, the grocery store, etc., as the peripherals and plug-in cards of your PC. Your microprocessor needs some way to get data to and from them to do anything useful. And that's where data buses come in. You need streets to get to and from the grocery store; a microprocessor needs a data bus to read from or write to a peripheral device.

But a bus is more than a collection of wires between the microprocessor and peripherals in your PC. Think how chaotic – not to mention dangerous! – it would be if there were no traffic signs, signals, or even commonly understood "rules of the road" on your neighborhood streets. For example, suppose some drivers drove on the right side of the road ... and others drove on the left! Suppose there were no speed limits ... no stop signs ... you'd probably think long and hard about how badly you really wanted to see a certain movie before driving down to the video rental emporium!

Your PC faces its own traffic management problems. Stop and think about the multitude of signals zipping around inside a PC at any given moment. The various circuits and plug-in cards of your PC are all demanding the attention of the microprocessor, and the microprocessor has to have some way of recognizing those signals and communicating back. Without some way of managing the signal flow along the bus, your PC would soon suffer the digital equivalent of multiple head-on collisions and grind to a halt.

If you've been around personal computing for a while, you probably remember such "classic" buses as the S-100, which was used in numerous early machines built around the Z80 microprocessor. However, it wasn't until the introduction of the first IBM PC in 1981 that a bus was used widely enough to become a de facto standard. That original bus has given rise to other buses known by such acronyms as VESA, PCI, and PCMIA. Many PCs today now come with two bus systems installed.

Even if you consider yourself to be a 100% software type, you need to be familiar with the basics of today's most widely used buses. All software involves a lot of communication between the microprocessor and other system hardware, and the bus used by a PC has a big impact on how that communication takes place. A knowledge of buses is especially crucial if you write driver software for various peripherals and plug-in cards. And understanding buses is important for anyone who wants to knowledgeably buy a new PC: just what does it mean when a PC is advertised as having a "local VL bus?" Is that something you need and should pay extra for?

Functions of a Bus

Buses came about because it was impossible to integrate everything needed for a true functioning personal computer – like memory – onto a single slice of silicon. However, all system hardware has to function as if it were all integrated onto a single chip (a "macroprocessor"?). The key design goal of any bus is to get the entire PC hardware to function as one monolithic unit instead of a collection of hundreds of discrete components.

Physically, a bus is simple. The various signals going into and out of a microprocessor are connected to other system hardware through buffering circuits. Electrically, all the PC components are, in effect, a single device.

Let's return to the street analogy. There are certain rules of the road that are implicitly understood even without traffic signs or signals, such as always driving on the right-hand side in North America. Buses have their own implicit rules, such as where electrical power will be supplied and where control signals will be received or data sent. All of the plug-in cards added to a PC's bus must follow these rules or they will be inoperative. Bus standards also determine the size and type of connectors used to add plug-in cards and other peripherals to the PC. In effect, the bus "lays down the law" on how external circuits can be connected to the PC and imposes discipline on designers and manufacturers.

Getting Aboard The Right Bus

An "open architecture" is a bus that allows anyone to build a card or other peripheral to its standards, and the card can be connected to the bus and it will work. This allows PC users to configure their machines for their specific needs and choose among competing cards and peripherals for the performance and price they feel is best. One of the key advantages of the Apple II over competitors like Radio Shack's TRS-80 line was its open architecture. An entire industry providing third-party cards for the Apple II developed in the late 1970s; in fact, one of Microsoft's early successes was a plug-in card for the Apple II that enabled it to run the then-popular CP/M operating system!

IBM wisely made the bus for its original PC an open architecture. Surprisingly, Apple decided to use a largely closed architecture that did not permit plug-in cards for its original Macintosh. It wasn't until 1987 that this was rectified with the introduction of the Macintosh II. In retrospect, it seems the lack of an open architecture and available third-party cards was a big factor in the slow acceptance of the Macintosh in businesses.

Like streets, buses have certain restrictions due to their design. Buses have a maximum "speed limit" at which events – like data transfer – can happen. This limit is the bus's maximum clocking speed. This is because events can only take place when a clocking signal is present on the bus. For example, the original IBM PC bus had a maximum clocking speed of 4.77 MHz, which happened to be the clock speed of the 8088 microprocessor used in the first IBM PC. There's no way to put data and signals on a bus, or read data and signals from a bus, at a rate faster than the clock speed. Buses are also constrained by the maximum number of data bits they can carry. Again, the original IBM PC bus was a real clunker in this regard, as its "width" was just eight bits. By contrast, modern bus designs are 64 bits wide.

By the way, there are real advantages to using a 64-bit data bus with 32-bit microprocessors (or a 32-bit bus with 16-bit microprocessors). In this case, the microprocessor can load the contents of two registers to or from the bus during a single clock cycle. If the bus and microprocessor are equally "bit wide," like a 32-bit bus and a 32-bit microprocessor, then only one register can be loaded during a clock cycle. The performance improvement in being able to load two registers instead of one during a clock cycle is usually dramatic.

Perhaps the most single important function of a bus is addressing. A bus must be able to access all locations in a PC's memory and also provide access to the system's I/O ports. In addition, the bus must provide a standard address for key system hardware like disk drives, video cards, modems, etc. A bus standard must also include methods for signaling interrupts to the microprocessor, directly accessing system memory, and resolving conflicts between cards and/or peripherals that are attempting to signal interrupts or directly accessing memory locations.

Two terms used to describe different bus types are local bus and arbitrated bus. A local bus acts like a part of the microprocessor itself; the devices and functions on the local bus behave as though they are integrated on the same chunk of silicon as the microprocessor. In contrast, an arbitrated bus and the circuits connected to it are associated with the microprocessor but are independent of it.

Being more independent means a card in an arbitrated bus makes fewer demands on the microprocessor and, as a result, the microprocessor can handle other tasks. A local bus is like driving your car to the airport, while an arbitrated bus is like taking a taxi. Both accomplish the same objective, but driving your car means you have to devote most of your attention to the road and traffic. But if you take a taxi (the "arbitrated" way to go!), you can read, use your notebook PC, or even take a nap. That's the kind of freedom an arbitrated bus design gives a microprocessor.

Let's now look at the most widely used bus designs in Intel-based PCs. There are other bus standards used with the Macintosh and for specialized purposes, and these are discussed in the accompanying sidebar.

The Original PC/XT Bus

The PC/XT bus was introduced in 1981 by IBM when they introduced their first PC. It was continued in late 1982 when IBM introduced their XT, which was the original PC with a hard drive added (a walloping 10 meg hard drive, I should point out).

The PC/XT was a local bus and little more than an extension of the internal connections of the 8088 microprocessor used by the first IBM PC. It was an eight-bit bus with a maximum clock speed of 4.77 MHz (the 8088's limit). The performance limitations of this design were so quickly apparent that it was essentially abandoned with the introduction of the ISA (industry standard architecture) bus in 1984. However, the PC/XT bus is important because many of its concepts are still used today. For example, the arrangement of pins for power, control signals, and

data transfer on most of today's plug-in cards still follow the same basic pattern established by the PC/XT bus. For better or worse, the majority of PC users today are still living with the decisions made by the PC/XT bus designers back in 1980 and 1981!

Industry Standard Architecture (ISA) Bus

The ISA is widely known as the "AT" bus because it was first used in the IBM AT (advanced technology) PC in 1984. The AT used the 80286 microprocessor, a 16-bit chip, and IBM expanded the capabilities of the PC/XT to take advantage of it. The bus width was expanded to 16 bits, and additional addressing lines were added to access up to 16 megs of RAM. The clock speed was upgraded to 8 MHz, matching the clock speed of the first 80286 processors. It was a local bus design, like the PC/XT bus.

One interesting design quirk of ISA was that all operations reading to or writing from the bus required two clock signals. Suppose an operation calls for some data to be transferred from a 80286 register to RAM. On one clock cycle, the memory address would be loaded to the bus. On the next clock cycle, the data itself would be loaded from the register to the bus. This means that the effective data transfer rate of the ISA bus is substantially slower than its clocking rate. While faster microprocessors like the 80386 were eventually used with the ISA bus at clock speeds up to 16 MHz, the maximum improvement in data transfer over the original PC/XT bus was a modest 66%.

However, IBM made a crucial decision to make the ISA bus backwards compatible with cards designed for the PC/XT bus. This meant users could pull modem, printer, and memory expansion cards out of their old PC or XT and plug them into their new AT. While this was very popular with customers, it meant that many of the design shortcomings of the original PC/XT bus were also carried forward.

From IBM's viewpoint, however, the ISA bus had an even more fundamental problem. The ISA bus was completely "open" and not covered by any IBM patents. This was originally intended to spur development of plug-in cards by third parties in support of IBM PCs. Unfortunately for IBM, it also spurred development of compatible PCs directly competing with IBM, such as the models from Compaq. IBM's efforts to change this situation with something called the MCA bus resulted in one of the biggest fiascoes in the history of the PC industry.

The MicroChannel Architecture Bus (MCA)

The MicroChannel Architecture (MCA) bus began as an attempt by IBM engineers to reduce radio frequency emissions from their PCs in order to comply with new FCC regulations. Plug-in cards were a big source of these stray emissions. Other PC makers met the FCC standards by better shielding and circuit isolation of the cards, but IBM's engineers opted to redesign the card connectors to reduce signal "leakage." The result was indeed reduced emissions from each card, but the cards would no longer fit into the connectors used by the ISA bus. Thus "freed" from the problem of maintaining backwards compatibility, IBM's engineers went on to design a true state-of-the-art bus that still remains technically impressive 10 years later.

The MCA was an arbitrated 32-bit bus capable of addressing up to four gigabytes of RAM. Cards designed for the MCA handled their own "housekeeping" and administrative functions, freeing the microprocessor for other tasks; 16-bit and 8-bit "subsets" were designed in since 32-bit microprocessors were still in the prototype stage when the MCA was developed. As explained earlier in this column, 16-bit chips like the 80286 performed significantly better with the 32-bit MCA. The initial clock speed of the MCA was 10 MHz, although it was designed to eventually handle 20 MHz clocking. The MCA was a very forward-looking design, since its capabilities were far in excess of the capabilities of the microprocessors, hardware, and software in use at the time of its introduction in 1987. In fact, its capabilities were far greater than customer needs in 1987.

The MCA bus was introduced in April, 1987 with the introduction of the first PS/2 PCs. IBM secured patents on key aspects of the MCA, and announced stiff licensing fees for any manufacturer desiring to produce PCs using the MCA bus or MCA plug-in cards. To show how serious they were about making MCA the new standard for PCs, IBM discontinued their IBM AT, which at the time was the biggest selling unit in the entire US PC industry, and abandoned their support for the ISA bus.

Unfortunately for IBM, the demand for PCs using the MCA never materialized. Other makers of PCs and plug-in cards were put off by the IBM licensing fees and waited to see if there would be sufficient consumer demand for MCA PCs. Consumers didn't like the idea of having to junk their old plug-in cards and buy new (and expensive) ones from IBM. The PS/2 PCs shipped with the original command-line version of OS/2, which was a memory hog that forced MS-DOS users to learn a new set of commands. The PS/2 also used 3.5-inch floppies instead of the then-standard 5.25-inch units, and potential customers didn't like the idea of being forced to transfer their data and software to the new format.

But the key problem with MCA-based PCs was that the MCA was too far ahead of its time. While its potential was great, the first MCA PCs did not offer any significant performance gains over ISA-based PCs. In fact, the first PS/2 PCs used the same 80286 microprocessor as the discontinued AT. Most PC users concluded that MCA-based PCs offered no measurable performance gains over their ISA-based systems, but the MCA units cost a lot more. Customers didn't demand PCs using the MCA, and as a result only a few companies (like Tandy and Compaq) bothered to license the MCA from IBM. Those sold poorly, and by early 1988 it was apparent that the MCA bus was not being accepted as an industry standard the way the ISA had.

The Extended Industry Standard Architecture (EISA) Bus

Other PC manufacturers saw the MCA bus as an attempt by IBM to wrest control of the PC market from upstart companies like Compaq. While this was indeed true, the need for an improved bus design was real. However, engineers at IBM's competitors realized the ISA bus could be easily extended for improved performance. In 1988, companies such as Hewlett-Packard, Tandy, Compaq, AST Research, and NEC released the specifications of the extended industry standard architecture (EISA) bus. Unlike MCA, anyone could design a PC using EISA without any patent problems or licensing fees.

Like MCA, EISA was also a 32-bit arbitrated bus. However, it was fully backwards compatible with ISA plug-in cards thanks to identical pin arrangement specifications and 8- and 16-bit subsets. This meant that the maximum clocking speed under EISA was limited to 8 MHz. However, through the use of 32-bit data width and reduced loads on the microprocessor by arbitrated cards, the maximum data transfer rate using EISA was over 15 times greater than the ISA transfer rate.

The EISA bus was clearly technically inferior to the MCA bus and had lower ultimate performance. But EISA was much closer to the actual needs of users and ultimate capabilities of existing hardware and software in 1988 than was MCA, and EISA systems were less expensive than MCA systems. As a result, EISA-based PCs did much better in the marketplace than MCA-based systems.

However, most PCs sold continued to be based on the ISA bus until the early 1990s. This was because most PCs used character-based operating systems and applications. For such purposes, the ISA bus and supporting plug-in cards were adequate and inexpensive. This remained true until the release of Windows 3.0 in May, 1990 and the later release of the multimedia extensions for Windows. Windows 3.0 (and 3.1 in late 1992) put new demands on PCs, such as the ability to handle enhanced graphics, video, and sound. The ability to rapidly move data around is mandatory for such purposes, and they finally were forced to move beyond the constraints of the original ISA bus. We'll discuss those efforts in the rest of this month's column.

Despite their limitations, most PCs used today include either the ISA or EISA bus (sometimes used in conjunction with a more advanced local bus design). The installed base for these two designs and their plug-in cards means they will be around for several more years.

The VESA Bus

The Video Electronics Standards Association (VESA) bus was introduced in mid-1992. (This bus is also known as the VL bus.) This was not an attempt to replace the ISA/VESA or MCA bus designs, but was rather intended as a supplementary local bus for multimedia PCs using one of those buses.

The VESA bus was designed as an extension for the 80486DX microprocessor that was then the standard chip for multimedia PCs. Version 2.0 of the VESA is designed as an extension of the Pentium processor. The original version was a 32-bit bus and version 2.0 is a 64-bit bus; the original's clocking speed was 33 MHz and version 2.0 checks in at 66 MHz. But what really set VESA apart from previous PC bus design was something called "burst mode."

Previous PC buses had required that all data units placed on the bus had to be individually addressed, even if all addresses were identical. VESA allows up to four consecutive data transfers to the same address for each addressing operation. The same data transfer operations that would take 10-clock cycles on the EISA or MCA buses could be accomplished in five-clock cycles using the VESA bus. The maximum data transfer possible with the VESA bus is about twice the maximum of the EISA bus.

The VESA bus has found its biggest applications in such areas as computer video and graphics, in which large amounts of data must be rapidly moved around. However, the growth of the VESA bus has been stunted by a competitor that may well become the new standard for PC buses – the PCI bus.

Is PCI the Future Bus Standard?

The VESA was designed around Intel's microprocessors. That's why it's a little surprising that the peripheral component interface (PCI) was designed by Intel, yet is independent of any particular microprocessors! The PCI works fine with the Pentium, but it works just as well with DEC's Alpha microprocessor.

Intel released the current PCI bus specifications in 1993, with both 32-bit and 64-bit implementations supported. Its clock speed and data transfer rates are approximately equal to the VESA bus. However, there are substantial differences between the two buses and they are incompatible with each other.

One key difference is in how they access the microprocessor. The VESA bus is a direct extension of an Intel processor, while the PCI bus "virtualizes" the microprocessor. To the PCI bus, all microprocessors look and act the same. Another difference is in the burst mode operations of the buses. In many cases, the PCI bus can do a dozen or more consecutive data transfers to the same address for a single addressing operation.

Perhaps the biggest difference is in their basic design philosophies. The VESA bus was intended as

a local bus supplementing the EISA or MCA buses. By contrast, the PCI bus is an arbitrated bus intended to replace earlier bus designs. (However, it is possible to use a PCI bus to augment earlier bus designs.) The PCI was introduced at a good time for a transition to an entirely new bus. The introduction of Pentium-based PCs running Windows95/NT caused many buyers to buy new plug-in cards rather than attempt to migrate older cards that would not allow them to get maximum performance from their new machines. In addition, many of the cards that users once had to add themselves -- like those for modems, video, CD-ROM controllers, etc. -- now were installed in a new PC at the factory.

As a result of such factors, the PCI bus has now passed the VESA bus in usage and is the "bus of choice" for new desktop PCs. In fact, it would be tempting to say the bus wars are over and that the future belongs to PCI ... except for this thing known as PCMCIA.

Taking It On the Road: The PCMCIA Standard

One of the real frustrations of early laptop PCs was how difficult it was to expand them. It was rare that you had enough room for a couple of ISA/EISA cards, and portable PCs that could accommodate a couple of cards were more "luggable" than "portable." With notebook PCs on the drawing boards, something had to be done to shrink the size of plug-in cards. The Personal Computer Memory Card International Association (PCMCIA) released its specifications for "credit card" size expansion cards and their supporting bus in September, 1991. The PCMCIA bus is an arbitrated bus with performance specifications equivalent to the EISA bus.

PCMCIA cards come in three different sizes, known as "types." A Type I card is about 3.5 millimeters (mm) thick and is used mainly for memory upgrades. The Type II card is about 5 mm thick and is the most commonly used size. Most of the modems used in notebook PCs are Type II cards. Type III cards are the thickest (10 to 15 mm) and are used mainly for hard drives and SCSI adapters.

Two Other Buses

There are several more bus designs that have been used in personal computers. Here are two of the more common ones that you have probably run across.

• Small Computer System Interface (SCSI) Bus

Many PCs come equipped with a "scuzzy" port. SCSI was originally a minicomputer bus, but has now become popular for connecting peripherals where a high rate of data transfer is important. SCSI is an arbitrated bus based around identification numbers. Each device on a SCSI bus has a unique identification number, and this number is set on the device itself (usually with a "spinner" thumbwheel or other device). Devices on a SCSI bus are connected in series with each other, and the last device on the bus must be terminated with a special connector. Most SCSI buses can support up to seven different devices. If you've ever used a SCSI bus, you know that it is prone to sometimes mystifying behavior. Some devices will work only with a certain identification number or at a certain position on the bus. An inoperative device on a SCSI bus can sometimes be miraculously restored to proper operation just by changing its identification number or switching its position on the bus with another device! The big advantage of SCSI is that it doesn't care if a PC is running the Macintosh, Windows, or OS/2 operating system or is powered by a Pentium, PowerPC, or Alpha processor; to a device connected to a SCSI bus, they're all the same thing.

• The IEEE-4888/General-Purpose Instrumentation Bus (GPIB)

This bus was a lot more common in the early days of PCs than it is now, although cards supporting it are widely available. It was originally developed by Hewlett-Packard for use with laboratory instruments controlled by a computer. Some instruments are known as "talkers" (they send data back to the PC), some are "listeners" (they receive control commands from the PC), and others are both. The PC itself is known as the "dictator!" Up to 20 instruments can be connected to a single GPIB bus cable up to 20 meters long. Like SCSI, the devices connected to the GPIB couldn't care less which microprocessor or operating system the host PC is using.

Unlike the other buses discussed so far, the PCMCIA bus was intended for use with devices other than PCs. Music synthesizers, data acquisition and logging equipment, controllers, and other devices have been built around the PCMCIA bus. In this respect, the PCMCIA bus is more like the IEEE-488 or similar general purpose bus than it is a PC-only bus like EISA or PCI. The PCMCIA standard specifies such things as data formats, methods by which the card can be accessed by other devices, and a software communication protocol, independent of any PC operating system, for linking PCMCIA cards to their host devices. These specifications are intended to make PCMCIA cards useful in any host device that supports them. For example, you could theoretically take a PCMCIA memory card out of your notebook PC and plug it directly into a music synthesizer that needs additional memory. Or you could take a hard drive card used to store data out of a data acquisition device and add it to your notebook PC. Of course, this interchangeability hasn't worked quite so smoothly in the real world, but it holds real promise for the future.

PCMCIA buses are showing up increasingly in small desktop PCs, as well as notebooks. A popular combination for many newer PCs is to use the PCI bus for functions where speed is all important, such as video, and use PCMCIA for functions where rapid data transfer is not that essential.

My feeling is that the PCI and PCMCIA buses will co-exist nicely over the next several years, with the PCMCIA bus and cards becoming increasing used in non-PC applications. If the forecast convergence between PC and TV technologies indeed takes place, then it seems like that PCMCIA will be the bus that will make it happen (this is especially true with digital high definition television on the way). In a few years, you might be swiping a memory card out of your TV to use in your notebook PC ... or maybe even your car! **NV**

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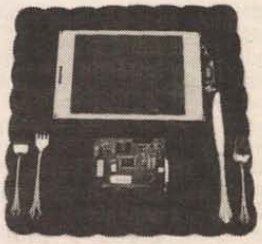

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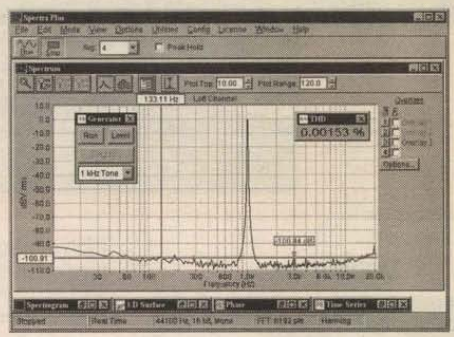

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Randy L. Henderson is a complete guide to the entire process of building, using, and enjoying a sophisticated radio transceiver (McGraw-Hill; 355 pages; $39.95, hardcover; $29.95, paperback).

The author thoroughly explains how to build a multiband, multimode HF transceiver, providing easy-to-follow descriptions of how it works and telling where to get parts. He also discusses projects for smaller devices, such as a simple frequency synthesizer and a spectrum analyzer.

Emphasizing the how and why of frequency synthesis, the guide covers everything from interfacing digital and analog circuitry to keeping digital switching noise out of sensitive analog circuits, from anticipating the real-world behavior of RF circuits to interfacing a microcontroller to various input/output devices, and from mastering the intricacies of circuit-board fabrication to performing assembly programming of the Intel 80C31 microcontroller.

For more information, contact:

MCGRAW HILL
11 W. 19TH ST., DEPT. NV
NEW YORK, NY 10011
212-337-5951 FAX: 212-337-4092

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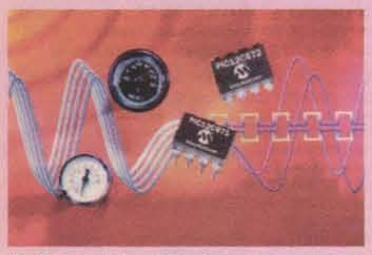

Microchip Technology, Inc., announces it has integrated analog-to-digital converter technology into its revolutionary eight-pin microcontroller family. The PIC12C671 and PIC12C672 eight-bit one-time-programmable (OTP) microcontrollers provide intelligence, data acquisition, and mixed-signal capability to new applications.

These eight-pin microcontrollers allow easy integration of first-time intelligent features into electromechanical designs and will compete directly with four-bit microcontroller products while providing significantly enhanced performance. The advanced analog features include an on-chip analog-to-digital converter and four analog channels, which are ideally suited to measure environmental conditions, such as temperature, pressure, motion, and voltage.

For more information, contact:

MICROCHIP TECHNOLOGY, INC.
2355 W. CHANDLER BLVD.
DEPARTMENT NV
CHANDLER, AZ 85224-6199
602-786-7200 FAX: 602-899-9210
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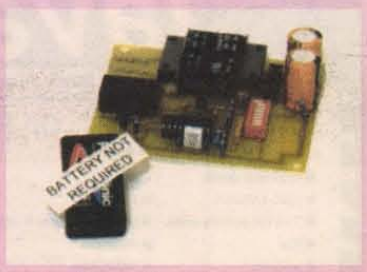

The "Smart" protector type 12 (SPPC-12) PC board from TDL Electronics has an on-card mechanical relay to control an off-card power relay or contactor. The on-card relay has SPDT contacts so the off-card relay may be either opened or closed if the power line voltage goes outside the programmed limits. The nominal line voltage is set with an on-card DIP switch. The voltage limits are also user programmable to four different "widths" with the DIP switch. The on-card relay contacts are rated 24 VDC at 3 amps or 240 VAC at 2 amps which is adequate to control a heavy-duty mechanical relay.

For more information, contact:

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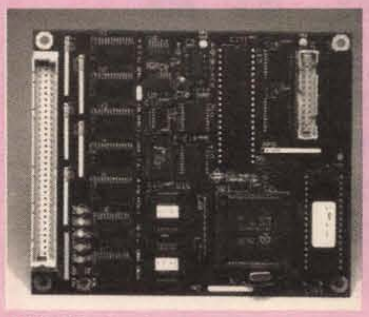
5260 COCHISE TRAIL, DEPT. NV
LAS CRUCES, NM 88012-9736
505-382-8175 FAX: 505-382-8810
E-MAIL: rtipton@zianet.com

GPIB CONTROLLED DIGITAL INTERFACE



ICS Electronics announces a new GPIB controlled digital interface board that combines digital I/O and monitoring capabilities in one card for OEM applications. The Model 4803 GPIB-to-parallel interface board is designed as a configurable IEEE-488.2 interface for adapting instruments or other devices with parallel digital signals to the GPIB bus. The Model 4803 replaces ICS's older, 488.1 GPIB-to-parallel interface boards.

The Model 4803 is an IEEE-488.2 compatible device and uses industry standard SCPI commands and ICS's short commands to configure the unit, to set the user's IDN message and to transfer data. Once set, the 4803's configuration is saved in E^2ROM and is automatically recalled at power turn-on. OEM specific parameters can be locked to prevent accidental change by the end user.

For additional information, contact:

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

WSS-300 2.4GHz WIRELESS COLOR SURVEILLANCE SYSTEM

The WSS-300 wireless color surveillance system is the solution for the person or business that needs to have their eyes in two places at once. This ordinary looking AM/FM cassette radio incorporates a high-resolution color camera (380 (H) TVL resolution), and FCC approved transmitter that delivers consistently sharp video images to its designated receiver. The color camera has a super low two lux sensitivity with built-in backlight compensation. In addition, the use of state-of-the-art circular polarized directional transmitting and receiving antennas maximizes the signal range and minimizes interference from unwanted signals. Capable of penetrating through walls, floors, and ceilings, the WSS-300 has an effective range of up to 300 ft.

The WSS-300 comes complete with AM/FM radio (color camera, FCC approved transmitter), four-channel FCC approved receiver, video cable (connects receiver to your video on your VCR or monitor) one A/B switch (allows selection between receiver and cable/antenna reception), one coaxial cable (connects A/B switch to receiver), one power adapter (provides 12 VDC power to receiver), and lastly, the easiest to follow set of instructions.

The special introductory price for this complete color wireless surveillance system is only $895.00.

For more information, contact:

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For more information, contact:

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171 S. MAIN ST., DEPT. NV
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E-MAIL: electsp@aol.com

Continued on page113

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Surplus Sales of Nebraska

Events CALENDAR

Continued from page 42

CA - OAKLAND - Computer Show. Oakland Convention Center, Broadway @ 10th St. 1-800-243-7041 http://www.robertaustin.com
CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
CT - GOSHEN - ARRL Hamfest. Bob Schoenfeld KA1ARR, 413-229-8695 E-Mail: collins@li.com
GA - NORCROSS - Computer Show. North Atlanta Trade Center. MarketPro 301-984-0880
IN - INDIANAPOLIS - AGI Computer Fair. Indianapolis Events Center. 3655 E. Raymond St. 10am-4pm. 317-299-8827
LA - SLIDELL - ARRL Hamfest. Ronald Riviere WB5CXJ, 504-882-5067
NJ - DUNELLEN - Hamfest. Columbia Park, near intersection of Rte. 529 & 28. 8am-2pm. Bob Pearson WB2CVL, 908-846-2056
OH - MILFORD - ARRL Hamfest. Chris Reinfelder KB8SNH, 513-753-5066
OH - NILES - Computer Show. Eastwood Expo Center. MarketPro 301-984-0880
PA - HANOVER - Hamfest & Computer Show. Pleasant Hill Fire Co., Carnival grounds. 8am-1pm. Wayne Leister N3MTR, 410-857-9689
VA - NORFOLK - Computer Show. Norfolk Scope. MarketPro 301-984-0880

JUNE 21-22

FL - FORT LAUDERDALE - Computer Show. War Memorial Auditorium. MarketPro 301-984-0880
GA - ATLANTA - HamFestival. City Hall East, Exhibition Center, 675 Ponce de Leon Ave. Atlanta HamFestival, POB 942150, Atlanta, GA 31141-2150. http://www.saf.com/arc E-Mail: dickb@akorn.net
IN - INDIANAPOLIS - Computer Show. Indiana State Fairgrounds. MarketPro 301-984-0880
MD - GAITHERSBURG - Computer Show. Montgomery Co. Fairgrounds. MarketPro 301-984-0880
NJ - SECAUCUS - Computer Show. Meadowlands Expo. Center. 9:30am-4pm. MarketPro 201-825-2229
PA - HARRISBURG - Computer Show. Farm Show Complex. MarketPro 301-984-0880

JUNE 22

GA - MARIETTA - Computer Show. Cobb Co. Civic Center. MarketPro 301-984-0880
KY - LOUISVILLE - Computer Fair South. Executive West Hotel. 9:30am-3pm. Sammy L. Hastings 812-333-9300
ME - PORTLAND - Computer Show. Verillo's Convention Center. Northern Computer Shows 508-744-8440
OH - YOUNGSTOWN - Computer Show. Canfield Fairgrounds. MarketPro 301-984-0880
VA - VIRGINIA BEACH - Computer Show. Virginia Beach Pavillion. MarketPro 301-984-0880

JUNE 27-28-29

OR - VERONIA - Hamfest. Sandy Mikalow 503-429-2430 E-Mail: smikalow@ardvark.com

JUNE 28

CO - DENVER - Metro Computer Show & Swap Meet. 2950 W. 72nd Ave., Westminster. Reputable Systems 303-444-2664
DE - NEWARK - Computer Show. University of Delaware. MarketPro 301-984-0880
SC - CHARLESTON - Computer Show. South Carolina State Port. 9:30am-4pm. MarketPro 201-825-2229
VA - CHANTILLY - Computer Show. Capital Expo Center. MarketPro 301-984-0880

JUNE 28-29

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Events CALENDAR

FL - WEST PALM BEACH - Computer Show. South Florida Fairgrounds. MarketPro 301-984-0880
IN - SOUTH BEND - Computer Show. St. Joseph Co: 4H Fairgrounds. MarketPro 301-984-0880
NY - WHITE PLAINS - Computer Show. Westchester Co. Center. 9:30am-4pm. MarketPro 201-825-2229
PA - KING OF PRUSSIA - Computer Show. Valley Forge Convention Center. MarketPro 301-984-0880
PA - MONROEVILLE - Computer Show. Pittsburgh Expo Mart. MarketPro 301-984-0880
TN - KNOXVILLE - Computer Show. Tennessee Valley Fairgrounds. MarketPro 301-984-0880

JUNE 29

IL - GLEN ELLYN - Computer Show & Sale. College of DuPage. Main Arena of Phys Ed Bldg. Corner of Park Blvd. & College Rd. 9:30am-3pm. Computer Central Shows 847-940-7547
MD - UPPER MARLBORO - Computer Show. The Show Place Arena. MarketPro 301-984-0880
PA - DICKSON CITY - Computer Show. Genetti Manor. MarketPro 301-984-0880
SC - FLORENCE - Computer Show. Florence Civic Center. 9:30am-4pm. MarketPro 201-825-2229

JULY 1997

JULY 5

CA - DALY CITY - Computer Show. Cow Palace, Gate #5, Geneva & Santos. Robert Austin Corp. 1-800-243-7041, http://www.robertaustin.com
CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
MA - WEST SPRINGFIELD - Computer Show. Eastern States Expo. Center. 9:30am-4pm. MarketPro 201-825-2229
NC - SALISBURY - Firecracker Hamfest. Salisbury Civic Center. 8am-1pm. Walter Bastow N4KVF 704-279-3391
OH - COLUMBUS - Computer Show. Ohio Expo Center. MarketPro 301-984-0880

JULY 5-6

FL - MELBOURNE - Computer Show. Melbourne Auditorium. MarketPro 301-984-0880
NY - WHITE PLAINS - Computer Fair. Westchester Co. Center. 9:30am-4pm. MarketPro 201-825-2229
MD - TIMONIUM - Computer Show. MD State Fairgrounds. MarketPro 301-984-0880
VA - HAMPTON - Computer Show. Hampton Coliseum. MarketPro 301-984-0880

JULY 6

NY - POUGHKEEPSIE - Computer Show. Mid-Hudson Civic Center. 9:30am-4pm. MarketPro 201-825-2229
OH - DAYTON - Computer Show. Montgomery Co. Fairgrounds. MarketPro 301-984-0880
PA - LEHMAN - Hamfest & Computerfest. Luzerne Co. Fairgrounds, Rte. 118. Bob WB3FAA, 717-288-3532

JULY 11-12-13

NV - LAS VEGAS - DEF CON V Convention. Aladdin Hotel & Casino. 206-790-3628

JULY 12

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves
CA - OAKLAND - Computer Show. Oakland Convention Center, Broadway @ 10th St. 1-800-243-7041 http://www.robertaustin.com
NY - BUFFALO - Computer Show. Hamburg Fairgrounds. 9:30am-4pm. MarketPro 201-825-2229
NY - OLD WESTBURY - Computer Show. SUNY Old Westbury. 9:30am-4pm. MarketPro 201-825-2229

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Almost all surge protection devices use MOV's (metal oxide varistors) as their active element. MOV's are sacrificial/wear/limited life components. Surge suppressors based on this technology are doomed to failure. These surge "suppressors" also don't suppress a thing. They divert powerline surges equally to the ground and neutral wire. When you put current on the common ground wire of interconnected equipment some of that current will flow (through the inherent ground loops) to the data lines. This is a major cause of lock-ups and misoperations that plague today's computer environments. Another fact; all modern computers use switch mode power supplies. During surges the power supply capacitors must charge to the clamping level of the MOV before the MOV turns on. A recent study has shown that it takes a 3000A surge 15 microseconds (15,000 nanoseconds) to charge the typical capacitors of these power supplies to that level. The surge is virtually over before the MOV reacts. ***(See five things you probably don't know about your surge suppressor at www.fivethings.com.)***

THE POINT: Standard surge suppressors allow too much current to hit the computer. Standard surge suppressors divert surge current to the ground wire and disrupt data transfer. Standard surge suppressors eventually fail without warning. Modern computers have logic voltage levels (the signals that transmit the data) and power supply voltages that are dramatically lower than that of their recent predecessors. Modern computers use integrated circuits with transistors of ever decreasing physical geometries. Modern computers are virtually always interconnected to other computers or peripheral equipment. The bottom line; ***modern computers are much more sensitive and susceptible to powerline anomalies.***

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A Brick Wall 1) Utilizes *NO MOV'S* or Any Other Sacrificial Components (a two pound inductor and nine capacitors are the heart of the unit) 2) Has No Joule Rating or Surge Current Limitations *3) HAS BEEN TESTED AND CERTIFIED BY UL TO THE MOST DEMANDING CLASSIFICATION OF A NEW GOVERNMENT SPECIFICATION; CLASS I, GRADE A. Which Means: UL PUT ONE THOUSAND 3OOOA, 6000V SURGES (this is the largest surge an interior environment can experience) THROUGH A UNIT (at 60 second intervals) AND DOCUMENTED NO FAILURE OR PERFORMANCE DEGRADATION OF ANY KIND WHATSOEVER..*

i.e.: A Brick Wall Will Not Fail.

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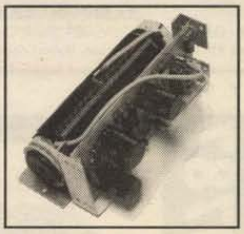

A Brick Wall is a current activated *Series Mode* device. *Since it is not wired in parallel, nor voltage activated, it does not have to wait for the capacitors of the power supply to charge before it becomes effective. YOUR EQUIPMENT IS PROTECTED INSTANTANEOUSLY (and indefinitely).*

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Events CALENDAR

JULY 19

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
GA - MARIETTA - Computer Show. Cobb Co. Civic Center. MarketPro 301-984-0880
MA - HYANNIS - Computer Show. Tara Hyannis Hotel. Northern Computer Shows 508-744-8440
NH - NASHUA - Electronic Fleamart. Res. Ctr. Church. 617-923-2665
OH - TOLEDO - Computer Show. SeaGate Convention Center. MarketPro 301-984-0880
VA - ANNANDALE - Computer Show. Northern Virginia Community College. MarketPro 301-984-0880
VA - RICHMOND - Computer Show. The Showplace. MarketPro 301-984-0880

JULY 19-20

FL - WEST PALM BEACH - Computer Show. South Florida Fairgrounds. MarketPro 301-984-0880
NC - CHARLOTTE - Computer Show. The Merchandise Mart. 9:30am-4pm. MarketPro 201-825-2229
NY - STONY BROOK - Computer Show. SUNY Stony Brook. 9:30am-4pm. MarketPro 201-825-2229
PA - HARRISBURG - Computer Show. Farm Show Complex. MarketPro 301-984-0880
TN - NASHVILLE - Computer Show. Tennessee State Fairgrounds. MarketPro 301-984-0880

JULY 20

GA - NORCROSS - Computer Show. North Atlanta Trade Center. MarketPro 301-984-0880
IN - FORT WAYNE - Computer Show. Memorial Coliseum. MarketPro 301-984-0880
MA - CAMBRIDGE - Flea Market. Kendall Square area. 9am-2pm. MIT. Nick Alternburnd 617-253-3776
MD - BRUNSWICK - Sweatfest '97. MARC Train Station. 301-416-8447 Box #109, Web: http://members.aol.com/madraclub
MD - FREDERICK - Computer Show. Frederick Fairgrounds. MarketPro 301-984-0880
MI - FLINT - Computer Show. Holiday Inn, Gateway Centre, US 23 @ Hill Rd. Exit. Five Star Productions 810-890-0988
NJ - AUGUSTA - Hamfest. Sussex Co. Fairgrounds, Plains Rd. off Rte. 206. Dan Carter N2ERH, 201-948-6999. http://www.planet.net/scarc/fest
OH - VAN WERT - Hamfest. Van Wert Co. Fairgrounds, US 127 South. Bob Barnes WD8LPY 419-238-1877
PA - INDIANA - ARC Summerfest, Computer, & Ham Radio Fair. Red Barn Sportsman Club near Homer City. 8am-3pm. Aaron J. LaMantia N3NHN, 412-354-3978
VA - ROANOKE - Computer Show. Roanoke Civic Center. MarketPro 301-984-0880

JULY 25-26

OK - OKLAHOMA CITY - Ham Holidays '97. Oklahoma State Fair Park, Hobbies, Arts & Crafts Bldg., intersection I-40 & I-44. Fri: 5pm-8pm, Sat: 8am-5pm. CORA Web site: www.geocities.com/heartland/7332 E-Mail: n1lpn@swbell.net

JULY 26

CA - DALY CITY - Computer Show. Cow Palace, Gate #5, Geneva & Santos. Robert Austin Corp. 1-800-243-7041, http://www.robertaustin.com
IN - INDIANAPOLIS - AGI Computer Fair. Indianapolis Events Center. 3655 E. Raymond St. 10am-4pm. 317-299-8827
MD - NEW CARROLLTON - Computer Show. Ramada Conference & Exhibition Center. MarketPro 301-984-0880
NC - WAYNESVILLE - Hamfest. Haywood County Fairgrounds, off Exit 24 on I-40. 8am-4pm. Tommy Queen K4BNP, 704-258-2639

JULY 26-27

FL - ORLANDO - Computer Show. Central Florida Fairgrounds. MarketPro 301-984-0880
NJ - SOMERSET - Computer Show. Garden State Exhibit Center. 9:30am-4pm. MarketPro 201-825-2229
PA - ALLENTOWN - Computer Show. Allentown Fairgrounds. MarketPro 301-984-0880
PA - KING OF PRUSSIA - Computer Show. Valley Forge Convention Center. MarketPro 301-984-0880
PA - MONROEVILLE - Computer Show. Pittsburgh Expo Mart. MarketPro 301-984-0880
SC - GREENVILLE - Computer Show. Palmetto Expo. Center. 9:30am-4pm. MarketPro 201-825-2229
TN - MEMPHIS - Computer Show. Mid-South Fairgrounds Complex. MarketPro 301-984-0880
WV - CHARLESTON - Computer Show. Charleston Civic Center. MarketPro 301-984-0880

JULY 27

CA - SANTA ANA - Swapmeet. ACP parking lot. Mary Russo 714-558-8813
IL - GLEN ELLYN - Computer Show & Sale. College of DuPage. Main Arena of Phys Ed Bldg. Corner of Park Blvd. & College Rd. 9:30am-3pm. Computer Central Shows 847-940-7547
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AUGUST 1997

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NC - HIGH POINT - Hamfest. National Guard Armory. 8am-3pm. 910-887-3039.

AUGUST 2-3

CA - EUREKA - Hamfest. Redwood Acres Fairgrounds. Sat: 9am-5pm, Sun: 9am-3pm. Wayne Carlson KF6AAP 707-668-4396
FL - JACKSONVILLE - ARRL National Convention/Amateur Radio & Computer Show. Prime Osborn Convention Center. Karl Hassler 904-268-2302

AUGUST 3

IL - PEOTONE - Hamfest. Will Co. Fairgrounds. 6am-3pm. Dave Brasel NF9N 708-448-0580
PA - NORTH WASHINGTON - Hamfest. Washington Twp. Firehall. Bob Reihms N3NOS, 412-727-2194 after 6pm EST

AUGUST 9

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AUGUST 9-10

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AUGUST 10

OH - PAULDING - Hamfest. Paulding Co. Fairgrounds, Fairgrounds Rd. Jerry KB8MAF, 419-399-4507 or E-Mail: jlrhod@Bright.net

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AUGUST 16-17

AL - HUNTSVILLE - Hamfest. Von Braun Civic Center. Art Davis WB4KKA, 205-883-0477
PA - YORK - Hamfest & Computer Show. York Interstate Fairgrounds. 8am-4pm. 717-764-8193

AUGUST 17

MA - CAMBRIDGE - Flea Market. Kendall Square area. 9am-2pm. MIT. Nick Alternburnd 617-253-3776
MI - FLINT - Computer Show. Holiday Inn, Gateway Centre, US 23 @ Hill Rd. Exit. Five Star Productions 810-890-0988

AUGUST 23

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AUGUST 23-24

CO - WOODLAND PARK - Hamfest. Colorado Lions campgrounds. Don AA0NW, 719-687-3692

AUGUST 30

KY - LOUISVILLE - Computer Fair South. Executive West Hotel. 9:30am-3pm. Sammy L. Hastings 812-333-9300

SEPTEMBER 1997

SEPTEMBER 6

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KY - LOUISVILLE - Computer Fair South. Executive West Hotel. 9:30am-3pm. Sammy L. Hastings 812-333-9300

OCTOBER 1997

OCTOBER 4

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OCTOBER 11

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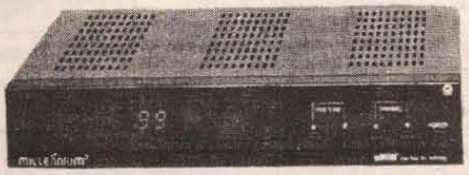

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OCTOBER 26

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NOVEMBER 1997

NOVEMBER 1

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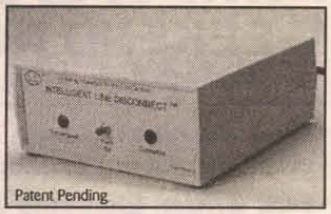

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by Dave Sweeney

Amplitude Modulation or Single Sideband: What's the Difference?

How is it that single sideband outperforms amplitude modulation by eliminating two thirds of the transmitted signal? Intuitively, less signal should mean less range, but that's not the case. With ordinary amplitude modulation — or AM — radio conversation stops when the audio fades from the carrier wave, at the limit of AM transmission. Yet, the same operators could still be talking if they used single sideband. For the same transmitter power, antenna efficiency, and atmospheric conditions, SSB reaches across the earth much farther than amplitude modulation. For a given set of conditions, an SSB system can exhibit four times the performance of an AM system with the same transmitter power.

Single sideband communications appeared as far back as 1915 when John R. Carson filed his patent application. At that time, most scientists comprehended only the time-based picture of AM transmission — a high-frequency sinewave (the carrier) modulated with a low-frequency intelligence (usually audio). Few technical people in those early days knew of additional frequencies called side frequencies.

Carson and other scientists discovered the bands of side frequencies in a mathematical analysis of AM. Arithmetic terms identified the side frequencies as separate from the carrier, yet necessary to maintain the modulated wave shape. Although scientists put the side frequencies to work and demonstrated the advantages of SSB, the extra cost for transmitter filters and precision low-frequency oscillator crystals delayed large scale development of the technology. However, things have changed.

Thanks to constant research and development, most amateurs, as well as the general public, can now afford single sideband equipment, and ham radio operators routinely use SSB for long-range voice communications on licensed frequencies.

You need not be a ham to use SSB. Citizen Band transceivers with SSB have been around for years. The special capabilities from SSB have attracted citizens with an active interest in communications with the result that, throughout the world, CB/SSB users have formed clubs — including the SSB "Network" — which publishes newsletters. The members are having a lot of fun with their SSB units and often perform a public service.

Besides longer range, SSB provides a bit of privacy. Without SSB, users hear a garbled "duck talk" when they tune in a "sidebander." That garbled audio demonstrates the first principle of single sideband: an SSB transmitter requires an SSB receiver. The SSB receiver generates its own carrier signal, and uses peculiar detector circuits to demodulate the SSB signal.

If you could see the antenna radiation, the SSB signal would appear as a complex waveform similar to AM in that it contains amplitude variations. However, there are major differences between AM and SSB.

With SSB, radio-frequency transmission occurs when there is some audio and, when there is no audio, a carrier frequency is not transmitted. Besides these differences, SSB control panels contain some unique controls. Among these are an upper/lower sideband switch, a clarifier control, and the SSB/AM switch. As we look at SSB and how the propagated signal differs from AM, we'll see what these controls do.

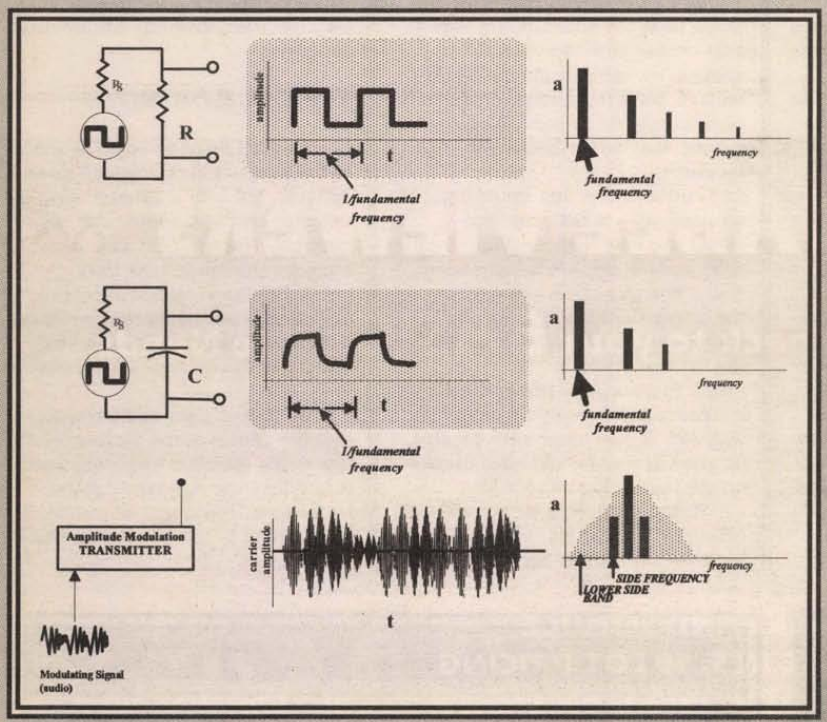

Figure 1: Waveforms related to frequency content.

WHAT'S A COMPONENT FREQUENCY?

The scientists who describe how equipment must pass a minimum band of side frequencies for successful communications derive their theories from mathematical expressions. While electronics analysis often requires math, an intuitive analysis of SSB can be more fun.

First, let's take an intuitive look at frequency components in time variant signals. One of the circuits shown in Figure 1 shows a squarewave applied to two resistors in series. In the other circuit, the squarewave is applied to a resistor in series with a capacitor.

At the resistor output, the expected squarewave exists as the signal alternately goes positive and negative. At the capacitor, the waveform looks quite different. The capacitor's charge and discharge rounds the edges of the output wave. At the edges of the input squarewave, the voltage changes quickly with respect to the time — a high-frequency characteristic.

In the flat region of the squarewave, the rate of change is zero. That's a low-frequency characteristic. The capacitor rounds the edges of the squarewave as the higher frequencies find a lower impedance to the circuit return. The capacitor can be said to "filter out" the high-frequency components of a waveform.

Just as subtracting frequencies with the capacitor changed the shape of the waveform, adding frequencies can restore the squarewave. A squarewave could be built using sinewaves. The signals from a number of sinewave oscillators will add up to a squarewave, provided that each oscillator generates the correct harmonic frequency at the correct amplitude.

Figure 1 contains a plot of amplitude for each frequency and illustrates the frequency spectrum for the signal. Notice that, for the capacitor, some of the high frequencies are missing.

WHAT'S A SIDEBAND?

For any signal — just as for the squarewave — maintaining the wave shape requires a transmission system that does not filter component frequencies. For an AM signal, those component frequencies result from the audio modulating the carrier, and those components change just as the audio changes. The range of components is called a frequency

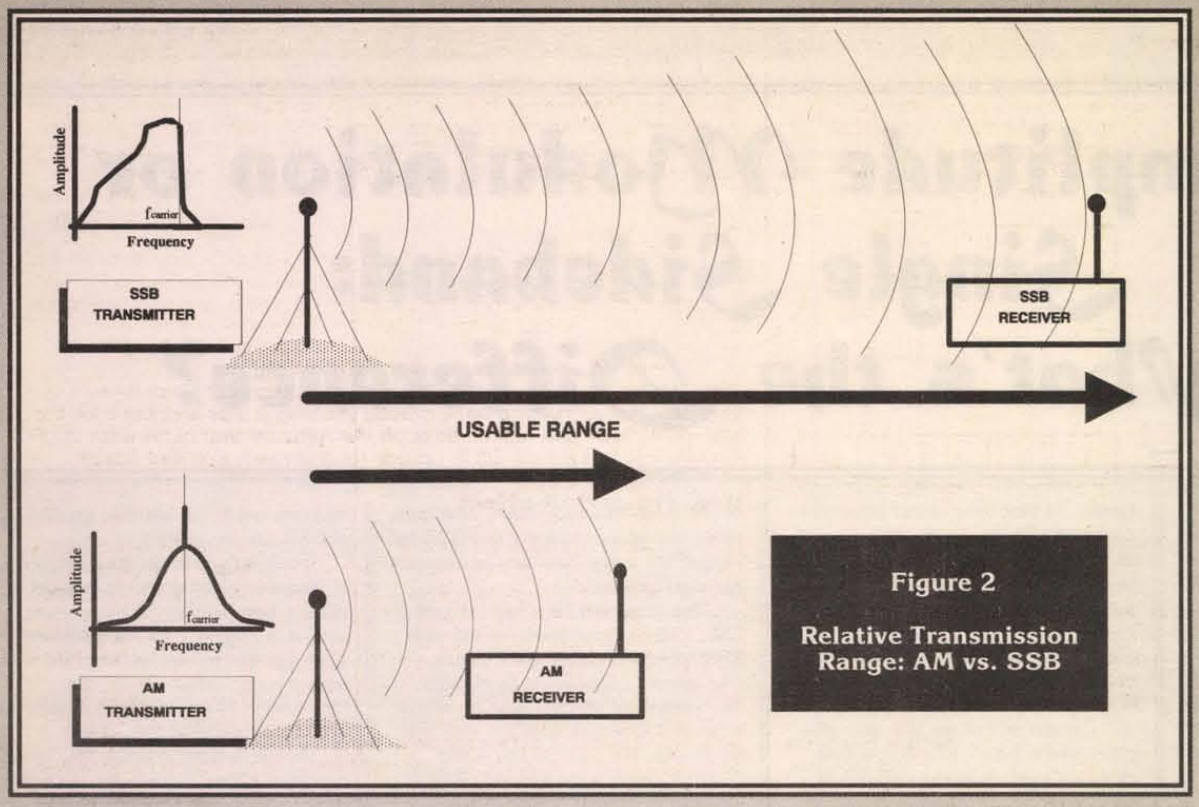

Figure 2

Relative Transmission Range: AM vs. SSB

band.

To simplify things, let's look at a single audio tone — say 1000 Hz — modulating a carrier. With a steady audio frequency, only three component frequencies establish the shape of the signal — the carrier and two side frequencies.

The difference between the carrier and the audio frequencies, (Fc-Fa) turns out to be the lower side frequency; the sum of the carrier and the audio (Fc+Fa) equals the upper side frequency.

Figure 1 shows what happens with varying audio frequencies instead of the fixed frequency of 1000 Hz. All the frequencies spanned by the AM carrier with the audio modulation are necessary to keep the original wave shape.

If you filter out most of the carrier and either the upper or lower sideband, you will change the shape of the wave, but you will transmit single sideband.

WHY SINGLE SIDEBAND?

To maintain the original wave shape, AM communications requires sending and receiving all of the frequencies at the correct relative power level as shown in Figure 1. As the receiver travels farther from the transmitter, the receiver may sense the carrier, but the side frequencies — since they are at a lower power level — may become weak.

As that happens, the wave shape is not maintained and the receiver amplifies an unmodulated carrier. You can hear this phenomenon especially at night, listening to distant AM stations with audio that varies between fading and distortion.

Single sideband transmission takes advantage of the difference in amplitudes between the carrier and the side frequencies. Since the transmitter special circuits remove the carrier and one of the sidebands before transmission, the resultant transmitted signal contains only one sideband of frequencies.

Since the sideband frequencies result from the audio, no transmission occurs until the operator speaks. (In some commercial systems, a low-level residual carrier is often continued to provide some degree of synchronization for receivers.)

Furthermore, this single band of frequencies — if not amplified — would use only half the power originally used in the AM transmission. But — and this is the key concept — the single sideband of frequencies can be amplified, then transmitted at the full transmitter power. As a result, the sideband power output increases to twice what it would be with AM. If the carrier were present, its amplification would have exceeded the transmitter's capability.

At the receiver, a local oscillator generates the carrier frequency. This high-level, noise-free local carrier, added to the received SSB signal, produces a detector signal.

Since the carrier plus the audio yields the upper sideband (Fc + Fa = Fssb), the detector finds the difference between the received SSB signal and the carrier to restore the original audio (Fc - Fssb = -Fa).

Notice that only one sideband is needed. The other sideband is then available for another pair of users. By locally generating the carrier, the effective signal strength at the detector exceeds that of an AM signal transmitted under the same conditions. This phenomenon is easily seen in the frequency spectrum diagrams in Figure 2, which relate the AM signal levels to single sideband levels.

Besides the amplification factor, there are some other benefits from single sideband. For example, a transmitter antenna tuning over a narrow band is sharper so that antenna efficiency improves for a given transmitter power. At the receiver, noise filtering produces improved signal-to-noise ratio since tighter filters can be used. Also, audio distortion from frequency sensitivity to atmospheric conditions is less likely. And, of course, SSB allows more operators in the same frequency range because the sidebands can be used separately.

TYPICAL CONTROLS

An SSB receiver contains many of the same kinds of circuits as an AM unit, but with a different kind of detector and with some additional controls. The AM/SSB switch changes the mode. The Upper/Lower Sideband switch selects the sideband — both operators must use the same sideband. The Clarifier fine-tunes the receiver's local oscillator.

Obtaining clear audio requires that the carrier at the receiver oscillate at the identical frequency used to produce the sidebands at the transmitter. The operator can diddle the Clarifier to minimize distortion. **NV**

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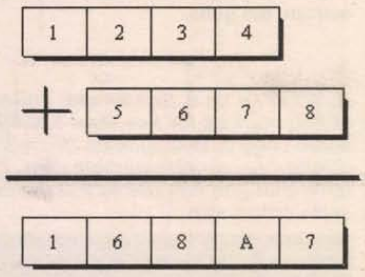
street address, the CPU accesses memory by means of a memory address. In a 16-bit CPU, the largest value that can be used for an address is 64K. These addresses are stored in a register, which is the equivalent of four city blocks (16K per block), for a total of 64K per register. So how do you get 1 MB from 64K? By adding more blocks rather than making the street longer. Here's how it works. The first register (Main Street) is called the segment. The addresses in the second register (1st Ave., 2nd, 3rd Ave., and 4th Ave.) is the offset to the segment. It, too, consists of four 16K blocks. As you can see, we now have addresses like 233 1st Ave., 233 2nd Ave., 233 3rd Ave., and so forth. Although the house numbers are the same, the streets are different. The offset register tells the computer which house and on which block in the segment to access. Sixteen segments of 64K each equals 1MB of memory.



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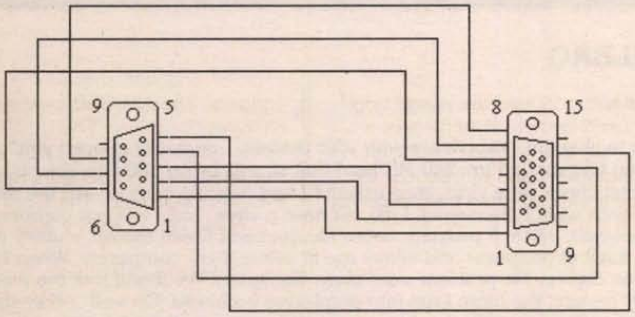
Arthur Hazboun
via Internet

A. *This is a 14-inch VGA monitor made about 10 years ago, when the industry was in the process of converting from the 9-pin to 15-pin video connector that's standard on today's monitors. You're lucky to have run across on old ATI board that supports both connector types. Unfortunately, the VIP video board contains only 256K of RAM, so you're limited to just 64 colors. It's easy enough to bring this monitor up to date by buying a SVGA video card that can provide up to 16.7 million colors (about $50.00). You'll need to make a 9-pin to 15-pin adapter, though. Here's how it's wired.*



15-Pin	*9-Pin*	*Description*
1	1	Red gun
2	2	Green gun
3	3	Blue gun
4	–	Monitor ID bit 2
5	–	no connection
6	6	GND (red return)
7	7	GND (green return)
8	8	GND (blue return)
9	–	no connection
10	–	GND
11	–	Monitor ID bit 0
12	–	Monitor ID bit 1
13	4	Horizontal sync
14	5	Vertical sync
15	–	no connection

Because of its age, I couldn't find any specs for this monitor on the Internet (my guess is 0.31mm dot pitch), but I was able to locate a couple of interesting Web sites that list specs for newer monitors. Check them out.

http://www.interlog.com/~gscott/TBOML/MAIN.html
http://www.cviog.uga.edu/Misc/monitors/index.html

PC Alzheimer's

Q. I have an old 486DX notebook which has been rendered useless due to a lost password. The computer won't boot without the password and I find no battery that I can remove to reset this BIOS. As expected, the manufacturer is long out of business, and the computer repair shops I've taken it to simply shake their heads. It appears the PC has a flash BIOS, if that helps any. If you know of a way of getting around this problem I'd greatly appreciate it.

Kamata Ng'andwe
Brighton, MA

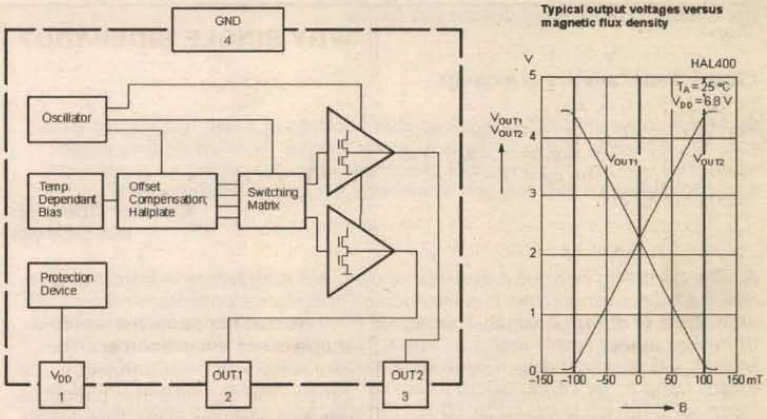
A. *Password protection is both a boon and a bane. On one hand, it protects your privacy. On the other, forget the password and your PC becomes the equivalent of a boat anchor. My first recommendation is to disconnect the backup battery. If you don't see a battery, look for a jumper that will let you reset the password. Still no luck. huh? Then locate all the jumpers in the system, map out their positions, and remove them all. Toggle DIP switches, too, if your motherboard has them. The next day, put everything back exactly the way it was and hope for the best. BTW, have you looked through the software that came with the PC? It might contain a flash BIOS update routine (well, you can hope).*

HAL Does Hall-effect

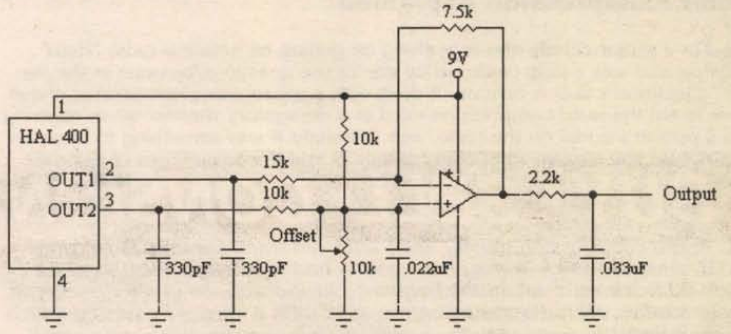
Q. I can't locate a source for the UGN3501M linear differential amplifier Hall-effect sensor. The package includes a Hall cell, a differential amplifier, an emitter follower, and a voltage regulator. Perhaps you can advise me as to where I might purchase this item.

Bob Shaffer
via Internet

A. *As far as I can determine, the UGN3501M is no longer available. The only Hall-effect devices Allegro MicroSystems now makes are ratiometric sensors. However, I did locate an acceptable substitute from ITT Semiconductor (http://www.itt-sc.de/itthome.html) called the HAL400.*



This linear CMOS Hall sensor has a differential output voltage that's proportional to the magnetic flux density. It works over a voltage range of 5 to 12 volts, and has a flux sensitivity of 40 mV per mT (milliTesla) at 6.8 volts. Here's a circuit to convert the differential output to single-ended output.



You can buy the HAL400 from Diodes Incorporated, 3050 East Hillcrest Dr., Westlake Village, CA 91362 (805-446-4800). If you can use a switched output, Siemens (http://www.siemens.de/components/LAST.HTM) makes two fully-integrated linear differential amplifier Hall-effect sensors, the TLE 4921-3 and TLE 4974. They both have all the features of the UGN3501, plus better sensitivity. Contact Siemens at Siemens Components, Inc., Integrated Circuit Division, 10950 North Tantau Avenue, Cupertino, CA 95014 (408-777-4500) for your nearest distributor.

Hold That Charge!

Q. I'm searching for a good reference on how to match the right type of capacitor (mylar, disc, electrolytic, etc.) with the application. Is there such a

book or catalog you can recommend?

Thomas Ng
San Jose, CA

A. *I sure can! Check out Ronald A. Reis' article "Hold That Charge!" on page 83 of the Aug. '96 issue of Nuts & Volts Magazine. In this article Mr. Reis talks about everything from fixed to variable to electrolytic capacitors. There's also a good discussion of capacitor theory, and parallel/series capacitors. You can order this issue from our Web site at http://www.nutsvolts.com or by snail mail at the address above. The cost is $5.00 each prepaid and includes postage for delivery inside the US.*

Audio-To-Digital Solutions

Q. I'm building an audio project and need to sample the signal and feed the data to a processor in a serial stream at 1 MHz. So the question is how do I convert audio into an eight-bit sample and send the samples out in a constant serial stream of data at 1 MHz? I can't find any help on this matter at the library.

Dan
via Internet

A. *Use the ADC08031B analog-to-digital converter from National Semiconductor. It's an eight-bit successive approximation A/D converter with serial I/O and configurable input. Allied Electronics (800-433-5700) stocks them at $2.52 each. You'll find data on this device and related ADC chips at the following Web sites.*

http://www.national.com/catalog/Analog_Data_A.html
http://www.national.com/pf/AD/ADC08031.html

I also recommend that you read my article on analog-to-digital converters (ADC) in the May '96 and June '96 issues. They contain lots of tips and tricks that'll make your design job easier.

Old Electronics Jargon

Q. I have some old QST magazines that I bought at a flea market last summer. What I would like to know is what an "exciter" is, what do they mean when they use the micro symbol two times when describing a capacitance, and could you possibly suggest somebody who sells vacuum tubes?

Charles Oblender
via Internet

A. *You certainly bought a handful of very old magazines – from the mid-50s, I'd guess. An exciter is a low-power, fully-functional transmitter with an output of about 2 watts. The signal from the exciter is then amplified to higher power levels using a "linear" for output to the antenna. The term is still in use today. The double micro capacitance symbol (uuf), which used to be called micro-micro or "Mickey-mike," is now the pico-farad (pF), which is equal to 10-12. Finally, you can find jobbers of vacuum tubes in the Classifieds of Nuts & Volts Magazine, beginning on page TK. There's also a wealth of information on vacuum tubes and related QST subjects on "Bill's New Ham Radio WWW Server" Web site at http://linux.cec.army.mil/Welcome.html*

Mike Compression Explained

Q. I'm a senior citizen who is working on getting an amateur radio "Ham" license and was a little confused by one of the questions/answers in the Mar. '97 Electronics Q & A column. It dealt with a microphone compressor circuit. I've heard the word compression used in a derogatory manner when referring to a person's audio on the radio, and I thought it was something to be avoided. Could you explain what compression is and the advantages of using it?

Robert Olson
Hemet, CA

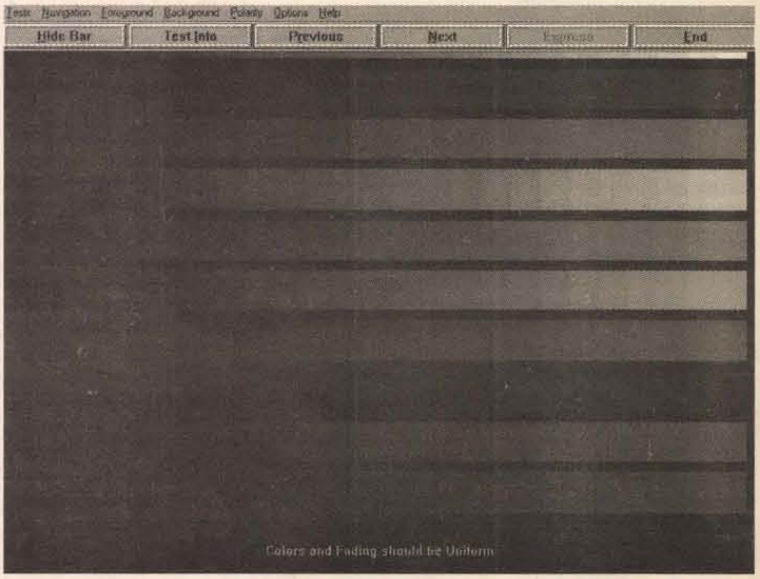
A. *Audio compression mostly deals with AM transmissions (including SSB, which is where it may have got its bad reputation because of its Donald Duck voice when the frequency lock drifts). As you'll discover in your studies, all radio transmissions start with a carrier frequency which is modulated in some way to encode the information. When you amplitude modulate (AM) this carrier, the RF power of the carrier increases and decreases according to the audio signal (this is really simplified, so bear with me). Since you want to be transmitting at peak power for maximum range, you don't want low-level audio to pull your output power too far down. Enter the mike compressor. Essentially, it's an automatic volume control (AVC) that listens to the sounds you're making and adjusts the gain of the microphone amplifier accordingly. Whisper into the microphone, and the AVC cranks the gain louder; shout in the mike, and the AVC turns down the volume control. In the end, they both have the same effective power level, which gives you maximum RF output from your AM or SSB transmitter. Why don't you see a lot of compression circuits, or mention of them, nowadays? Because the function is normally built into today's transceivers. If you have an older or vintage set, though, you'll probably gain range with an audio compressor between the microphone and the rig.*

Doctor My Eyes

Q. I'd like to have a simple circuit for a jig that would do a basic test on a video monitor – something you could plug the computer monitor into just to activate the guns.

Keith Worrell
via America Online

A. *What I'd do is find an old, 286-based PC computer, which you can buy at flea markets for less than $20.00 (sans monitor). Then I'd download a demo copy of DisplayMate (there's both a DOS and a Windows version) at http://www.displaymate.com. This demo contains several screen patterns that you can use to test the color guns and adjust the horizontal and vertical size.*



MAILBAG

Dear TJ:

I'd like to share my experience with your readers. I originally queried you, asking why Win 95 reported my 540 MB hard disk size as being 800 MB. You suggested to first check for a virus, then asked if I had recently compressed the drive. Well, here's what I discovered. I did not have a virus, and I was not compressed. I did however, delete a program called Quarterback Clean Sweep, a utility that keeps track of programs and allows me to delete them completely. When I deleted Clean Sweep, the problem went away. Go figure? I've found that the more I use my system, the more I run into perplexing problems. Oh well ... If anybody writes you about a similar problem maybe it's just a matter of getting rid of a program that might be screwing things up. (Of course, it was just pure luck this worked. I was cleaning house and it just happened.)

Dan Thompson
Minot (Brrrrrrrr), ND

Reply:
Well said! Suspect the software first. Undelete programs sometimes corrupt the byte count because they maintain links to various folders (subdirectories) and files on the drive. Although these links contain 1K of data, they occupy 8K of disk space. Put enough of them together, and the disk appears larger than it actually is. Thanks for the feedback!

TJ Byers
Q & A Editor

Dear TJ:

Just dropping you a note to say that I really like the new solar energy column in *Nuts & Volts Magazine*. We have been in the solar energy business since 1989 and our web site is located at http://members.aol.com/Quadenergy/index.htm.

Doug Atkins
Quad Energy

Dear TJ:
I saw your answer to Charles Oblender in the Apr. '97 issue about the Atari to IBM problem. I still use my Atari XL for most of my telecommunications stuff using BobTerm.

Rick Detlefsen
via CompuServe

Continued from page 103

New Product News

AMERITRON ARB-700

Ameritron's ARB-700 interface box protects your expensive radio from keying line voltage or current related damage. This completely solid-state interface unit is designed to replace conventional reed relay buffer systems and has no moving parts to wear out.

Ameritron's ARB-700 can be used with any amplifier relay voltage up to 200 volts positive, while handling amplifier relay control currents up to 200 mA. The ARB-700 requires the radio to sink only 2 mA of current, and limits voltage applied to the transceiver to values as low as three volts.

The Ameritron ARB-700, priced at $29.95, comes with a standard one-year warranty.

For more information, contact:

AMERITRON
116 WILLOW RD., DEPT. NV
STARKVILLE, MS 39759
601-323-8211 FAX: 601-323-6551
http://www.ameritron.com

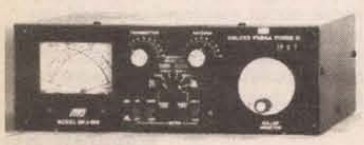
ISLAND KEYER KIT

Milestone Technologies offers Chuck Olson's WB9KZY board kit for a new iambic memory keyer. The "island" has four separate memories for a total of 500 characters; it's physically tiny (1.5" x 2"), and it can be configured to use less than a microamp of current when idling. It has a straight-key input, a side-tone oscillator with selectable audio pitch, and speeds from 7-48 WPM. It will even tell you (in Morse) what speed is currently set.

For more information, contact:

MILESTONE TECHNOLOGIES
3140 S. PEORIA ST., UNIT K
DEPARTMENT NV
AURORA, CO 80014-3155
http://www.mtechnologies.com/mthome

AIRCORE™ ROLLER INDUCTOR



MFJ presents the 300 watt AirCore™ roller inductor antenna tuner, featuring the widest matching range of any full-featured antenna tuner for $179.95.

Match any antenna with the MFJ-969. Match dipoles, verticals, inverted vees, random wires, beams, mobile whips, etc. You can use coax cable or balanced feedlines. MFJ-969's continuous 6 meter through 160 meters coverage covers all frequencies, including the "magic band."

For more information, contact:

MFJ ENTERPRISES, INC.
300 INDUSTRIAL PARK RD.
DEPARTMENT NV
MISSISSIPPI STATE, MS 39762
601-323-5869 FAX: 601-323-6551
1-800-647-1800
http://mfjenterprises.com

LASER POINTERS

Da-Lite Screen Company, Inc. extends its line of laser pointers with two new models: the blinking mode laser pointer and the jumbo laser pointer.

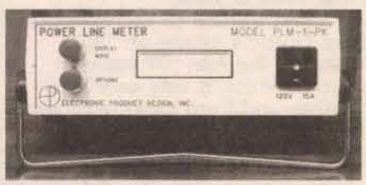
The blinking mode model is matte black and has dual button activation — one to operate the beam and one to operate the pulse beam. It has <5 MW brightness and includes a case.

The jumbo model is 10" in length and has a matte black finish. It has <5 MW brightness and comes complete with a padded carrying case.

For more information, contact:

DA-LITE SCREEN
COMPANY, INC.
3100 N., DETROIT ST.
P.O. BOX 137, DEPT. NV
WARSAW, IN 46581-0137
219-267-8101 FAX: 219-267-7804
1-800-622-3737
http://www.da-lite.com
E-MAIL: info@da-lite.com

PLM-1-PK POWER METER



The PLM-1-PK power meter is an electronic instrument used to measure parameters associated with power consumption by an electrical load that is normally operated from a 60-hertz, 120-volt power line. The PLM-1-PK power meter measures: true RMS voltage and current; true power; and peak voltage, current, and power. This meter also calculates volt-amps and power-factor, and measures time and watt-hours.

A liquid crystal display provides a visual output to the operator. Two front-panel pushbuttons allow sequencing through the different displays of values. All measurements and calculations are updated at .5-second intervals. An RS232 option is available which outputs all the measurements and calculations, simultaneously, as an ASCII string for subsequent logging into a computer serial port.

The PLM-1-PK power meter is a new product and the price is $886.00.

For more information, contact:

ELECTRONIC PRODUCT
DESIGN, INC.
2145 DEBRA DR., DEPT. NV
SPRINGFIELD, OR 97477
1-800-616-5521
HTTP://WWW.EPD.COM

MORSE CODE TUTOR™

MFJ announces the MFJ-418 pocket size Morse Code Tutor™ with custom character sets, proven beginner's course based on the ARRL method, Work Recognition Mode™, and much, much more!

You learn individual letters, numbers, and prosign sets first. If you have trouble with certain characters, you can custom build and save a set of problem characters for extra practice.

You can change speed while you're practicing. If you have your practice that you want, but find the speed a bit too fast, change it while the session is playing. No more resetting every time you want to move up or down a speed. You can adjust the speed of the Morse Code Tutor from 3 to 55 words-per-minute. You won't need an instruction manual with this simple three-button menu operation. You just choose your options from easy-to-use menus on the LCD display.

You can use earphones for private listening or built-in speaker for fun group practice. Loud, powerful audio amplifier is volume adjustable, pitch is 300 to 1000 Hz. The MFJ-418 weighs less than five ounces and uses a nine-volt battery (not included).

The Morse Code Tutor is priced at $79.95.

For more information, contact:

MFJ ENTERPRISES, INC.
300 INDUSTRIAL PARK RD.
DEPARTMENT NV
MISSISSIPPI STATE, MS 39762
601-323-5869 FAX: 601-323-6551
1-800-647-1800
http://mfjenterprises.com

WELLER MT1500 MICROTOUCH SOLDERING STATION

The Weller MT1500 is the ideal tool for soldering applications. The unique Microtouch technology stops the tip from heating when it is put down. This allows for quick tip changes, plus it prolongs the life of valuable solder tips. The tip is reheated two seconds after the operator picks it up.

The digital display accurately shows tip temperature, and with the optional supervisor lockout, can be set to operate at a predetermined temperature.

Additional features includes a minimal tip-to-grip ratio for better hand control, it's ESD safe, and meets all MIL standards.

For more information, contact:

WASSCO
12778 BROOKPRINTER PL.
DEPARTMENT NV
POWAY, CA 92064-6810
619-679-8787 1-800-4WASSCO
WEBSITE: www.wassco.com

SG-100A SIGNAL GENERATOR

Telulex, Inc. introduces its Model SG-100A; synthesized function, pulse, arbitrary waveform generator.

Based on direct digital synthesis (DDS) technology, Telulex, Inc. Model SG-100A signal generators produce DC to 20 MHz modulated and swept sinewaves and arbitrary waveforms with a 40 MSample/second update rate. All frequencies are adjustable with .1 Hz resolution and are accurate to .001%. Also included with the SG-100A is a versatile function generator and pulse generator.

The SG-100A is priced at $995.00 in single quantities and is available for immediate delivery.

For more information, contact:

TELULEX, INC.
2455 OLD MIDDLEFIELD WAY S.
DEPARTMENT NV
MOUNTAIN VIEW, CA 94043
415-938-0240 FAX: 415-938-0241
http://www.telulex.com

reader FeedBack

Continued from page 5

designed to move at 20 or 30 Hz only, and will NOT ring properly from 60 Hz power.

You may want to publish this revision, in case some of your readers are trying to use older phones with bell-type ringers.

Greg Miller
State College, PA
a.v.guru@juno.com

Dear Nuts & Volts:

In the Mar. '97 Software Wizardry column, I couldn't help but notice there was no mention of the obsolete Amiga operating system which could certainly be called Windows 85. It WAS leaps and bounds ahead of all the competition.

Ed Barcik
ed.barcik@amcom.com

Dear Nuts & Volts:

Regarding Mr. Helms' article (Mar. '97):

One OS left totally unmentioned is the Amiga's. In 1985, when the Mac and PC had two-color displays and went "beep," the Amiga 1000 was introduced with 4,096 colors, easy video hook-up, and output (including overlay graphics and animation with an inexpensive genlock), stereo music, and voice synthesis.

The 32-bit OS had true pre-emptive multitasking, and the hardware included custom coprocessors for sound, video, and graphics. The whole OS could boot from ONE floppy (and still can). The Amiga was the inspiration for the Bebox, as its inventor will tell you.

Because of the low-overhead OS, a six-meg machine with no HD can do useful work.

Most older software will run on current machines, and vice versa. I know people who run the latest OS on the original a1000. Try running W95 on an XT!

The term "desktop video" was coined by the Amiga and the Video Toaster. Most cable stations and many video studios have them. In fact, the "program guide" on cable stations is usually run on an Amiga, as are many kiosk-touch screen applications.

Multiprocessing is already available for Amigas — in the form of 68060/PPC 604 cards — one of which I am about to purchase for my A4000.

Dave Leeds
via Internet

Dear Nuts & Volts:

In the Mar. '97 issue, on page 6, Mr. Noel Nyman concluded that because Tony Farrell's E-Mail address was "@ibm.net," Mr. Farrell was an IBM employee. While it is possible that Mr. Farrell does work for IBM, this cannot be inferred from his E-Mail address. IBM is one of the largest internet access providers in the world. All that is indicated by the "ibm.net" address is that Mr. Farrell uses IBM as his internet service provider, just as someone whose E-Mail address is at Compuserve.com or AOL.COM uses Compuserve or AOL as their internet provider, but does not necessarily — or even probably — work for Compuserve or AOL. I also use IBM as an ISP, and I am not an IBM employee.

Barry Watzman
Watzman@ibm.net

Dear Nuts & Volts:

In his article ("A High-Quality Desktop Linear Power Supply for Automotive Electronics," Jan. '97), William C. Hendry IV has done an admirable job of presenting some of the more complex computations involved in designing a high-quality linear power supply. I would like to add a couple of concerns for anyone who would like to build one.

First and foremost, NO high quality power supply would use rectifiers in parallel! At the very least, current equalizing resistors are required to prevent the diode with the least forward drop from becoming overloaded.

Secondly, an additional consideration is that the average power dissipation of the regulator is directly related to the average input voltage. By using such large filter capacitors, the average power is raised considerably.

Since the regulator contains error-correcting feedback — to the tune of 80 dB ripple rejection — the average input voltage could be lowered with no noticeable increase in output ripple, while saving considerably on the heating and heatsinking requirements.

Phillip Milks
via Internet

Dear Nuts & Volts:

Harry Helms ("Software Wizardry," page 113, Mar. '97) makes reference to: "The Macintosh was the first PC to attempt a form of multitasking," and "OS/2 was the first PC operating system to support multiprocessing ... but inept marketing prevented it from gaining widespread use."

The all-time award for Inept Marketing has to go to Commodore Intl., who went bankrupt in 1993. The same company that launched the Commodore 64 hatched a golden egg with the introduction of the Amiga computer in 1985, the world's first multiprocessing/multitasking computer, then neglected its offspring into oblivion. The Atari ST, c. 1985, also had a rudimentary form of multiprocessing.

There are at least three separate processors in an Amiga: for graphics, for sound, and for everything else.

Yes, I still use my Amiga 3000 with an 80 MEG HD and 6 megs of RAM . I can run a paint program, sound editor, text editor, and DTP program all at the same time. What's more, the other programs continue to run in the background while you are working on the first one. The HD and RAM requirements are small because the programs are typically 50-500K in size.

Recently, my boss had the requirement of transferring a database from one system to another. I loaded the ASCII version of this 2 meg file into WordPerfect and later, Word, but to make 200,000 changes to the file would take several days, because the O/S periodically saves the file and Windows only allows a few thousand changes at a time.

I zipped it and took it home to my Amiga, where I used a $30.00 shareware program — UEdit — to make all the changes in under 20 minutes.

My boss was pleased that I had done this so quickly, but I didn't explain to her how I did it because of the blank looks that I always get when I mention the Amiga, like I just stepped off a spaceship (yes, there is other intelligent life in the PC universe).

To me, using the PC is like telling a guy who's been driving a LEXUS that he should be thrilled riding a three-wheel bicycle. It's really frustrating to have to go to work everyday and deal with a cranky Pentium PC which crashes at least once every three hours, forces the programmer to be at the mercy of the hardware (instead of the master/slave relationship I had with my Amiga), uses 20 times as much hard disk space and memory as a real computer, can't run two programs at the same time, has to write everything continuously to the hard disk, regards the user as an imbecile, uses software that costs hundreds of dollars for just an upgrade, and which everyone else seems to think is the best thing since sliced bread.

At least I will never be behind the technology curve.

Harry's comments should apply only to MicroSoft: (which poo-pooed the concepts of a GUI (Graphical User Interface), Multimedia, and other hi-tech developments) "True multitasking ... a lot of time and effort has gone into achieving that goal, but the results to date have been disappointing."

Jim Fairbrother
Sterling, VA

Dear Nuts & Volts:

I just wanted to comment on Ron Tipton's article on "AC Volts" in the Apr. '97 issue of *Nuts & Volts*. It was very informative, and I am looking forward to seeing more of his articles.

Alexandra G. Jacinto
Philadelphia, PA

Dear Nuts & Volts:

A couple of errors crept into my article — "The DC Volt" in the Jan. '97 issue — in Figure 6 that I would like to correct.

IC4 is not a TC7652 opamp. It should be an OP-07 (not chopper-stabilized) or a Maxim MAX420 or MAX422 (chopper-stabilized) depending on your need for minimal DC offset voltage. Power supply voltages for this opamp are ±15 volts and not ±8 volts as shown. (You just can't get a 10-volt output from an 8-volt power supply!)

The TC7652 detail drawing in Figure 6 is correct for the TC7652Z version. For a "plain" TC7652, the two capacitors return to pin 4 (the negative supply) instead of pin 5. The capacitor leads or printed circuit traces must go directly to pin 4 and not to any other place on the negative supply line.

An updated schematic (and circuit board artwork if wanted) will be sent to anyone on request. A SASE will be greatly appreciated.

Ron Tipton
Las Cruces, NM

Dear Nuts & Volts:

The coding for resistor values and tolerances is very available. I can't find any similar information for capacitors. Just when I think I've got it figured, I buy a new one that doesn't conform. The electrolytics are usually clearly designated — it's the thousand other varieties! At least now I know that "M" = m not "m" on a package! I enjoy pulling components off discarded boards, so the inability to identify them is pretty inconvenient. Testing is not an answer.

J. Burgmann
Sarasota, FL

Dear Nuts & Volts:

I just wanted to let Mr. Helms know how much I appreciate his Software Wizardry column. While I am relatively experienced with C and LISP programming, I do not currently write object-oriented applications (nor am I likely to in the near future). His concise articles make it possible for me to at least get a glimpse of "what's happening."

Bruce Shapiro
http://home.iaxs.net/bshapiro

Dear Nuts & Volts:

Thanks for the solar series. I trust that you will ultimately include a schematic for an inverter 12/24 VDC to 115 AC.

James Denny
Eugene, OR

Dear Nuts & Volts:

I've been with *Nuts & Volts* for a long time and it has only gotten better. You do an excellent job of improving. A person who knows more about electronics would get lost in each issue until the next one comes out. Everytime I pick it back up, I find something else I missed that I get into.

Terry Crowe
Woodruff, SC

Dear Nuts & Volts:

This is an excellent magazine. It's the greatest source for electronic information I have found so far.

Gerald Green
Raybrook, NY

the SPC Transmatch described in current editions of the comprehensive handbook. I built mine on a foundation of aluminum rack panels joined together by aluminum angle stock procured at a local hardware outlet. These publications may be ordered directly from the ARRL; many *Nuts & Volts* advertisers also carry them. A local radio club may have some of the older editions which might be borrowed for reference or for copying.

If the reader has not attempted such a project in the past, I would offer the standard warning — the voltages associated with projects such as these can be lethal if not respected. Observe any special precautions taken by the authors that relate to safety; even with bleeder resistors, the power supply of a linear amplifier can present a hazard long after it is shut down. Some kind of reliable grounding stick (the proverbial well-insulated screwdriver) is a must.

Ronald J. Potaczala
Paisley, FL

ANSWER TO #39721 - MARCH 1997

There is a small simple one-piece alarm that Radio Shack sells (Cat #49-805 page 229 in the '97 Catalog) that connects to your battery and will trip it's own alarm when voltage drops, or use it to do whatever you want to activate. It even comes with a keychain remote. The whole device is very small and meant to be attached right on the battery.

Paul Patch
Wheeling, IL

ANSWER TO #39728 - MARCH 1997

This Mod for the ALINCO DJ-580T will give you the expanded RF that you wanted (410-475 MHz), as well as giving you aircraft band and 800 MHz band (receive only), and extended VHF 130-175 MHz.

1) Remove the battery and antenna. **2)** Remove the four screws on the bottom of the radio. **3)** Remove the battery slide plate (connected by two wires) or there might be enough room to get around the plate without removing it. **4)** Locate and CUT the BLUE wire. (This gives you expanded TX/RX). **5)** Locate and CUT the RED wire. (This gives you aircraft & 800 MHz RX). **6)** Put the radio back together. **7)** Press and hold the FUNCTION key while turning the radio on. (This resets the microprocessor.)

To select the aircraft band, press the FUNCTION & VHF keys at the same time. The letter "A" will appear on the display for AM mode. Press these keys again to select the two-meter band. To select the 800 MHz band, press the FUNCTION & UHF keys at the same time (repeat to select the 440 MHz band).

Now, although the above mod would make it possible for you to TRANSMIT, as well as receive on the GMRS frequencies, this would NOT be legal, even though you have a license to use GMRS frequencies! Use of amateur approved radios to transmit outside of the amateur band is illegal no matter what type of license you have. You are allowed, however, to modify a GMRS radio to operate on the ham bands. The reason for this is that the FCC has a relaxed set of rules for amateur equipment to help keep radios at a lower cost for hams, but these radios may not meet the standards for use in other bands. The good news is you can still enjoy the above mod to LISTEN to the GMRS band, and will now have aircraft and 800 MHz to listen to as well and you don't even have to do any soldering!

Paul Patch
Wheeling, IL

ANSWER TO #39730 - MARCH 1997

The easiest way to detect power lines below or above ground is with a line power detector similar to a stud finder, available from many sources such as Grangers. These devices, called voltage detectors and circuit tracers, are designed to do exactly what you require, but they only detect AC or DC power at short distances, usually ranging from several feet to perhaps a dozen feet or slightly more. They range in price from $100.00 to several hundred dollars, but if you're looking for more sensitive equipment, be prepared to spend a whole lot more. Oscilloscopes with sensitive probes, and frequency counters with antenna attachments can be found, but these set-ups are far more expensive.

Chris
Bieber, CA

ANSWER TO #4974 - APRIL 1997

A simple inverting amp with a gain of one in the composite video path will let him view a negative image in most cases. The few cases where it won't are when part of the system absolutely insists on a signal that is fully up to RS-170 specs with uninverted vertical and horizontal sync — such cases are rare.

A very good article on building a video inverter that is fully up to specs and would work not only with black and white, but also with color negatives, appeared in the July '95 issue of *Electronics Now* magazine on page 41. It is what I would recommend he build. I used three ICs, an LM359 Norton op-amp, an LM339 quad comparator, and a 78L05 five-volt regulator. It ran off a nine-volt battery and required no hard-to-find special parts.

Frank Nally
Louisville, KY

ANSWER TO #4971 - APRIL 1997

The pulse train from Gabriel's IR remote consists of a 0.1 mS logic 1 master pulse followed by a six-bit code word with a duration of 0.385 mS. The duration of a data bit is about 0.029 mS and a data bit is always followed by a logic 0 "space" period. The first data bit is also proceeded by a space interval. Figure 1 shows an example waveform where the six-bit code is binary 101010.

Gabriel wants to repeatedly trigger his scope when he detects the 0.1 mS master pulse so that he can observe the waveform of the six-bit code. The two-chip circuit shown in Figure 2 is one solution.

R1 = 621K (Use 680K)
C1 = 0.1 uF
Pulse Width = 0.7 X R1 X C1

The 74LS221 monostable multivibrator is triggered by every rising edge of the input waveform and is designed to have a pulse width of about 1.5 X 0.029 mS = .0435 mS. This pulse width was selected so that whenever the pulse is triggered by the rising edge of a logic 1 data bit, it rises in about the middle of the following logic 0 space interval. However, when it is triggered by the rising edge of the master pulse, its output rises while the input waveform is still high. The Q output of the 74LS74 D-flip-flop is clocked to a logic 1 only under this condition. The Q output of the 74LS74 is held low or cleared whenever the input waveform is a logic 0 resulting in a trigger pulse to the scope beginning about midway through the master pulse and lasting until the end of the master pulse. Figure 3 shows the resulting waveforms.

John Montalbano
Carmel, IN
jrmont@iquest.net

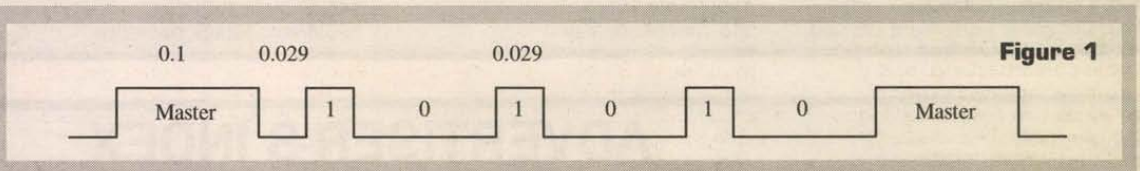


Figure 1

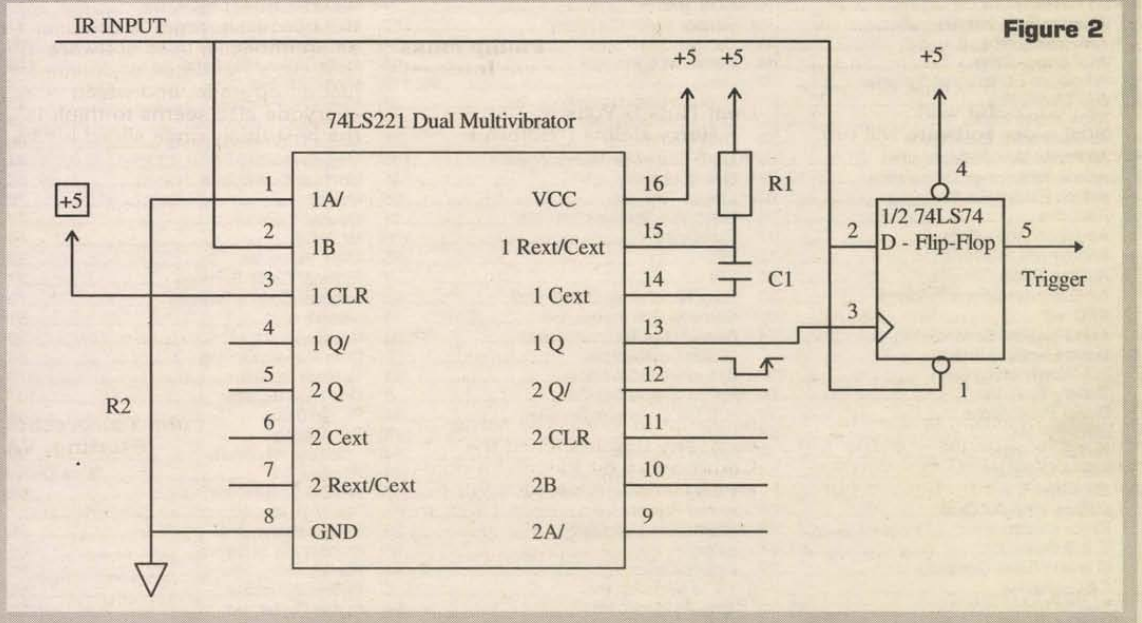


Figure 2

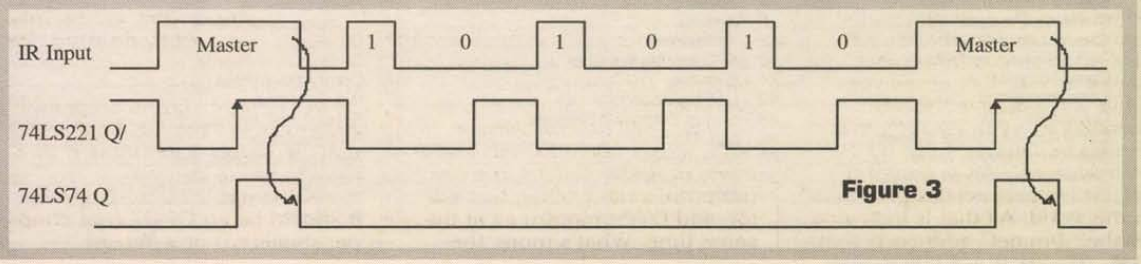


Figure 3

HOW TO PLACE A CLASSIFIED AD

TYPE or PRINT your **ELECTRONICALLY RELATED** ad copy **CLEARLY (not all caps)** on a separate piece of paper. Spell out words when submitting handwritten copy. Calculate the number of words and multiply it by the appropriate rate (see RATE PER WORD section). Include any charges for **bold** and/or CAPPED words, any artwork costs that would be applicable, and/or costs for boxing your ad (explained below). Choose the appropriate classification for your ad(s) to appear in (see below). If no classification is indicated, it will be placed in Misc. Electronics or wherever we deem most suitable. **Enclose your name, address, phone number, and *Nuts & Volts* account number from your mailing label** (if available) for identification purposes. Include full payment — **CLASSIFIEDS RUN ON A PRE-PAID BASIS ONLY** — and mail your completed order to:

NUTS & VOLTS MAGAZINE, 430 Princeland Ct., Corona, CA 91719.

RATE PER WORD

The ad rate for **current PAID subscribers** is **60¢** per word. All others pay **$1.20** per word. There is a **$9.00 minimum** charge per ad per insertion.

WORDS IN BOLD AND/OR ALL CAPS

Words to be set in **bold** or CAPS are each 10¢ extra PER WORD. **BOLD CAPS** are 20¢ extra per word. The first two words of each ad are bold capped at no charge. Indicate bold words by underlining. Words normally written in caps (e.g., IBM) and accepted abbreviations such as VAC or MHz are NOT charged as all cap words. Use a two-letter abbreviation for states.

PHOTOS, DRAWINGS, AND BOXES

A photo or drawing may be run at the top of your classified ad for an additional **$10.00** (1" depth max.) for camera-ready art. No wording is allowed in this area. Add a one-time charge of **$5.00** to enlarge, reduce, or duplicate line art, or **$8.00** for halftone of photographs. To **BOX** your ad, include an additional **$50.00** for copy-only ads, or **$75.00** for ads with art or photos.

FAXING IN AD COPY

You may fax in ad copy or changes before the closing date (5:00pm on the 10th) at 909-371-3052 using MasterCard or Visa. Include credit card expiration date, the name that appears on the card, a daytime phone number, and your *Nuts & Volts* account number. Ads without credit card information will not be listed as received until payment is received in full. **WE DO NOT CALL OR FAX BACK VERIFICATION OR QUOTES OF FAXED-IN ADS.** For verification of faxed-in ads, please call 909-371-8497.

DEADLINE

Prepaid ads received by 5:00pm on the closing date (10th of the month) will appear in the following month's issue. Ads postmarked through the 10th, but received after the closing date, will be placed in the next available issue. No cancellations or changes after the 10th. Cancellations and changes must be submitted in writing.

IMPORTANT INFORMATION

All classified ads are running copy only. No special positioning, centering, dot leaders, extra space, etc. is allowed. All advertising in *Nuts & Volts* is limited to **electronically related items ONLY**. All ads are subject to approval by the publisher. We reserve the right to reject or edit any ad submitted. We do not take ad copy or changes over the phone. We do not bill for classified ads. Repeat ads or ads run in multiple classifications within the same issue are allowed. Paid subscribers may run ads at the 60¢ rate only through their subscription expiration date. **NO REFUNDS**. Credit only. No credit for typesetting errors will be issued unless you *clearly* print or type your ad copy.

Choose a category for your ad from the classifications listed below.

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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
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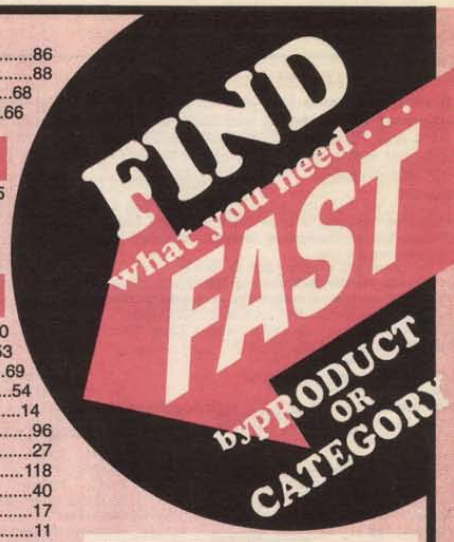

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Fantastic DMM Offer!!!

Don't let the price fool you. This meter is a digital multimeter designed for engineers and hobbyists. Equipped with 5 functions and 19 ranges. Each test position is quickly and easily selected with a simple turn of the FUNCTION/RANGE selector rotary switch.

Rubber Boot Included

Our Best Offer Ever on a High Quality Full Sized DMM

$19.00 any qty

General
Display: 3-1/2 Digit LCD, 21mm Figure Height with Automatic Polarity
Overrange Indication: 3 Least Significant Digits Blank
Temperature for Guaranteed Accuracy: 23°C±5°C RH<75%
Temperature Ranges:
Operating: 0°C to 40°C (32°F to 104°F)
Storage: -10°C to 50°C (14°F to 122°F)
Power: 9V Alkaline or Carbon-Zinc Battery(NEDA1604)
Low Battery Indication: BAT on Left of LCD Display
*Dimensions:*188mm long x 87mm wide x 33mm thick
Net Weight: 400g

DC Voltage (DCV)

Range:	*Resolution:*	*Accuracy:*
200mV	100µV	±(1%rdg+2dgts)
2000mV	1mV	
20V	10mV	
200V	100mV	
1000V	1V	

Maximum Allowable Input: 1000V DC or Peak AC.

DC Current (DCA)

Range:	*Resolution:*	*Accuracy:*
200µA	100nA	±(1.2%rdg+2dgts)
2000µA	1µA	
20mA	10µA	
200mA	100µA	
10A	10mA	±(1.2%rdg+2dgts)

Overload Protection: mA Input. 2A/250V fuse.

AC Voltage (ACV)

Range:	*Resolution:*	*Accuracy:*
200V	100mV	±(1.2%rdg+10dgts)
750V	1V	

Resistance (Ω)

Range:	*Resolution:*	*Accuracy:*
200Ω	100mΩ	±(1.2%rdg+2dgts)
2000Ω	1Ω	
20KΩ	10Ω	
200KΩ	100Ω	
2000KΩ	1KΩ	
20MΩ	10KΩ	±(2%rdg+10dgts)

Maximum Open Circuit Voltage: 2.8V

Diode Test
Measures forward voltage drop of a semiconductor junction in mV test current of 1.5mA Max.

ohFE Test
Measures transistor hFE.
Frequency Range: 45Hz-450Hz
Maximum Allowable Input: 750V rms
Response: Average Responding. Calibrated in rms of a Sine Wave.

CAT NO	DESCRIPTION	PRICE
9300G	Rugged High Quality DMM with Rubber Boot	$19.00

Switchable Scope Probe Sets

(Selectable X1/Ref/X10)
These high quality scope probe sets are for oscilloscopes up to 60MHz (model HP 9060) or 150MHz (model HP9150). Both sets include a handy storage pouch and include an IC test-hook adapter for the probe. The BNC connector rotates to avoid cable tangle or kink. Cable length is 1.4 meters.

CAT NO	DESCRIPTION	1	10	100
		PRICE EACH		
HP-9060	Scope Probe Set DC~60MHz	$16.49	$14.49	$11.58
HP-9150	Scope Probe Set DC~150MHz	24.95	21.95	18.62

CCD Camera - IR Responsive

As Low As $85!!

This black and white monochrome CCD Camera is totally contained on a PCB (70mm x 46mm). The lens is the tallest component on the board (27mm high from the back of the PCB) and it works with light as low as 0.1 lux. It is IR Responsive for use in total darkness. It comes with six IR LED's on board. It connects to any standard monitor, AUX or video input on a VCR or through a video modulator to a TV. Works with a REGULATED 12V power supply (11V-13V). Hooks up by connectiong three wires: red to 12V, black to ground (power & video) and brown to video signal output.

Power Supply Regulating Kit for CA-H34 This simple kit is designed to fit onto the back of the CA-H34 CCD camera. It resolves the problem of hooking up the camera to an UNREGULATED supply (which damages the camera) by providing safe regulated power from any 12V-14V DC supply. It also provides regulated 12V DC from a 12V AC source.

CAT NO	DESCRIPTION	1	5
		PRICE EACH	
CA-H34A	PCB Mounted IRCCD Camera	$99.00	$85.00
A34	Power Supply Regulating Kit	$6.95	----

PM-128: 3-1/2D LCD Digital Panel Meter; PM-129: 3-1/2D LED Digital Panel Meter

Features
- 200mV Full Scale Input Sensitivity
- PM-128 - Single 9VDC Operation
- PM-129 - Single 9VDC Operation
- Decimal Point Selectable
- PM-128 - 13mm Figure Height
- Automatic Polarity Indication
- Guaranteed Zero Reading for 0 Volt Input
- High Input Impedance (>100Mohm)

Specifications - PM-128/PM-129

Maximum Input	: 199.9mV DC
Maximum Display	: 1999 counts (3-1/2 Digits) w/Automatic Polarity Indication
Indication Method	: PM-128 - LCD Display PM-129 - LED Display
Measuring Method	: Dual-Slope Integration A/D Converter System *(cont.)*

(cont.)

Overrange Indication	: "1" Shown in the Display
Reading Rate Time	: 2-3 Readings per sec.
Input Impedance	: >100 Mohm
Accuracy	: +-0.5% (23+-5°C, <80% RH)
Power Dissipation	: PM-128 - 1mA DC PM-129 - 60mA DC
Decimal Point	: Selectable w/Wire Jumper
Supply Voltage	: PM-128 - 9V DC PM-129 - 9V DC
Size	: 67mm x 44mm

Applications Include:
- Voltmeter
- Thermometer
- pH Meter
- dB Meter
- Watt Meter
- Current Meter
- Capacitance Meter
- LUX Meter
- LCR Meter
- Other Industrial & Domestic Uses

Positive Photo Resist Pre-Sensitized Printed Circuit Boards

These pre-sensitized printed circuit boards are ideal for small production runs. They provide high resolution and excellent line width control. High sensitive positive resist coated on 1oz. copper foil allows you to go direct from your computer plot or art work layout. No need to reverse art.

Single-Sided, 1oz. Copper Foil on Paper Phenolic Substrate

CAT NO	DESCRIPTION	1	10	50
		PRICE EACH		
PP101	100mm x 150mm/3.91" x 5.91"	$2.55	$1.90	$1.70
PP114	114mm x 165mm/4.6" x 6.6"	2.98	2.45	1.98
PP152	150mm x 250mm/5.91" x 9.84"	5.40	3.98	3.60
PP153	150mm x 300mm/5.91" x 11.81"	6.15	4.48	4.10
PP1212	305mm x 305mm/12" x 12"	12.78	10.65	8.52

Single-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	1	10	50
		PRICE EACH		
GS101	100mm x 150mm/3.91" x 5.91"	$ 3.90	$2.98	$2.60
GS114	114mm x 165mm/4.6" x 6.6"	4.80	3.49	3.20
GS152	150mm x 250mm/5.91" x 9.84"	8.69	5.98	5.78
GS153	150mm x 300mm/5.91" x 11.81"	10.20	7.20	6.80
GS1212	305mm x 305mm/12" x 12"	18.88	15.73	12.59

Double-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	1	10	50
		PRICE EACH		
GD101	100mm x 150mm/3.91" x 5.91"	$ 5.07	$3.68	$3.38
GD114	114mm x 165mm/4.6" x 6.6"	5.95	4.29	3.99
GD152	150mm x 250mm/5.91" x 9.84"	10.47	7.39	6.98
GD153	150mm x 300mm/5.91" x 11.81"	11.95	8.69	8.30
GD1212	305mm x 305mm/12" x 12"	22.09	18.35	14.68

Developer

This product is used as the developer on our positive photo-resist printed circuit boards. Includes instructions. 50 gram package, mixes with water, makes 1 quart.

CAT NO	DESCRIPTION	1	10	25
		PRICE EACH		
POSDEV	Positive Developer	$ .95	$ .80	$ .50

Etching Tank

This handy etching system will handle PC boards up to 8" x 9", two at a time. Ideal for etching your PCB's! System includes an air pump for etchant agitation, a thermostatically controlled heater for keeping etchant at optimum temperature and a tank that holds 1.35 gallons of etchant. A tight fitting lid is also supplied to prevent evaporation when system is not being used. Typical etching time is reduced to 4 minutes on 1oz. copper board!

CAT NO	DESCRIPTION	PRICE
12-700	Etch Tank System	$37.95

REDUCES ETCHING TIME!

Etching Chemicals/Ferric Chloride

A dry concentrate that mixes with water to make 1 pint of etchant, enough to etch 400 sq. inches of 1oz board.

CAT NO	DESCRIPTION	1	5
		PRICE EACH	
ER-3	Makes 1 pint	$3.50	$2.75

Digital Panel Meters (LCD & LED)

3-1/2 Digit LCD 3-1/2 Digit LED 4-1/2 Digit LCD
PM-328: 4-1/2D LCD Digital Panel Meter

Don't let the prices fool you. These digital panel meters are not surplus, so even if you design them into an ongoing manufactured product, you can be assured of continued availability. These high quality digital panel meters are decimal point selectable with guaranteed zero reading at zero volts input.

Specifications - PM-328

Maximum Input	: 199.99mV DC
Maximum Display	: 19999 counts (4-1/2 Digits) w/Automatic Polarity Indication
Indication Method	: LCD Display
Overrange Indication	: "1" Shown in the Display
Input Impedance	: >100 Mohm
Accuracy	: +-0.05% (23+-5°C, <80% RH)
Power Dissipation	: 1mA DC
Decimal Point	: Selectable w/Wire Jumper
Supply Voltage	: 9V DC
Size	: 67mm x 44mm

Features:
- 200.00mV Full Scale Input Sensitivity
- Single 9V DC Operation
- Decimal Point Selectable
- 11mm LCD Figure Height
- Automatic Polarity Indication
- Low Battery Detection and Indication
- High Input Impedance (>100 Mohm)

CAT NO	DESCRIPTION	1	10	25	100	250
		PRICE EACH				
PM-128	3-1/2 Digit LCD Panel Meter	$ 9.90	$ 7.09	$ 6.40	$ 5.86	$ 5.25
PM-129	3-1/2 Digit LED Panel Meter	11.49	9.54	8.67	7.95	6.95
PM-328	4-1/2 Digit LCD Panel Meter	19.88	16.40	14.90	13.66	11.93

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Tiny computers run PBASIC™ programs

Little Green Men from Mars

Bjarne Bergheim, Ken Christian, William Jackson, and Ben Strayer worked on "the Flying Saucer Project" at the University of California, Irvine. Their project, which used two BASIC Stamp II modules, was a literal flying saucer. Although not as dramatic as Hollywood versions, their saucer did indeed fly! And fortunately, it didn't come on Independence Day.

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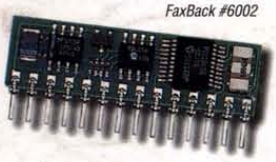

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BS1-IC™ Module $34

- 8 I/O lines
- 80 PBASIC instructions max.
- 2000 instructions/sec.
- 2400 baud serial I/O
- 14-pin SIP module

Familiar PBASIC language with I/O instructions for pushbuttons, EEPROM access, potentiometers, pulse measurement, PWM, serial I/O, sound, etc.

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BS2-IC™ Module $49

- 16 I/O lines
- 500 PBASIC™ instructions max.
- 4000 instructions/sec.
- 50k baud serial I/O
- 24-pin DIP module

Similar language as BS1, plus touch-tones, frequency generation, pulse counting, serial shift registers, X-10 powerline control, etc. I/O functions common to both modules have a higher resolution on the BS2-IC, due to its faster clock speed. With its rich feature set, the BS2-IC is the most popular BASIC Stamp we make.

New! 4-line Serial LCD $109

New 4-line serial LCD display is fun and useful for projects that require interaction with people. The display only takes one I/O line to operate, and can be controlled using simple SEROUT instructions in your BASIC Stamp programs.

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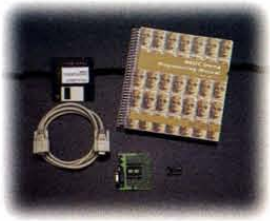

New! Basic Stamp® 2 Starter Kit $149

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Scanner hobbyists and communication professionals benefit from the ***Scout's*** unique functions. Whether you're searching for new frequencies in your neighborhood, or testing for interference, the ***Scout*** is the ultimate communications tool.

Armed with a 400 frequency memory register, the ***Scout*** does not record duplicate frequencies, instead it coordinates repeated frequencies into a hit register storing up to 255 hits per frequency. Attach it to your belt and begin your day, the ***Scout*** will alert you when a signal is received by its beeper or vibrator function.

You won't miss a thing with Reaction Tune. The ***Scout's*** CI-V compatible output allows it to interface to the AOR AR2700/AR8000, ICOM R7000, R7100, R8500, R9000 and now the new IC-R10 (shown oposite). The ***Scout*** captures the frequency, then sends the serial data to the receiver and tunes the scanner to the frequency for instant monitoring in less than one second. Recorded frequencies can be downloaded to a PC using the optional OptoLinx universal interface •

SPECIFICATIONS

- 10MHz - 1.4GHz frequency coverage
- Stores and records 400 frequencies in memory with 255 hits for each
- Interface to a PC for frequency download using optional OptoLinx PC interface
- Distinctive beeps indicate frequency hits, pager style vibrator for discreet recording
- Automatic EL backlight for night operation
- 16 segment RF signal strength bargraph
- Frequencies are automatically saved when unit is turned off
- Reaction Tune the ICOM R7000, R7100, R8500, R9000, IC-R10, and AOR AR2700, AR8000, and the Radio Shack Pro 2005/6 using the Optoelectronics OS456, Radio Shack Pro 2035/42 using the Optoelectronics OS535

Scout with ICOM IC-R10
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