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July 1999 Vol. 20 No. 7

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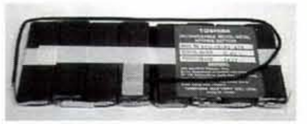

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- Uses 9V battery or AC Adapter (neither included)

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- 7" x 2.25" x 11" overall size
- 50-pin SCSI connectors, RCA Audio connectors
- SCSI ID switch, termination switch
- *Tiny* 12W Power Supply (5VDC @ 1.4A, 12VDC @ .4A, probably only good for CD-ROM's)
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The Computer Controlled World: RS-232 Network Control Methods and Applications

VF Displays: Bright, Brilliant, and So Easy to Use

by Ryan Sheldon, National Control Devices (404) 244-2432 http://members.aol.com/ncdcat

One of the Finest Display Technologies Available is Now Easy to Use with ANY Device Capable of Sending RS-232 Characters.

Walk into a room with a Noritake vacuum florescent display and your eyes will automatically be drawn to its brilliant glow. VF (Vacuum Florescent) displays are among the most brilliant display technologies available, boasting high brightness and a wide viewing angle, captivating the unsuspecting on-looker with a unique and uncommonly beautiful presentation.

"Beauty and the Beast" more accurately describes these technical marvels. Traditionally, they have been difficult to control for novice users, keeping them at a safe distance from many potential consumers. Fortunately, the burden of controlling these

Figure 1. Title VFD Screen

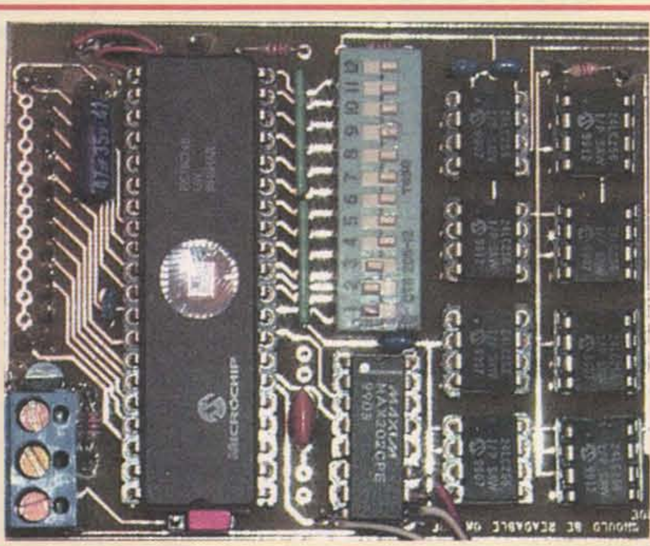


Figure 2. Picture of Controller

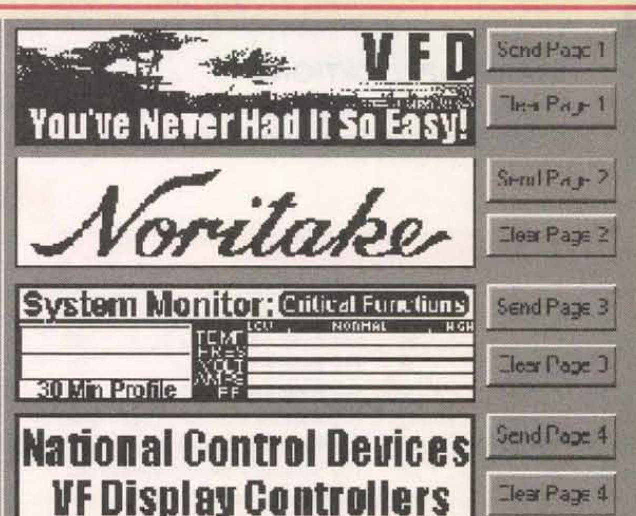
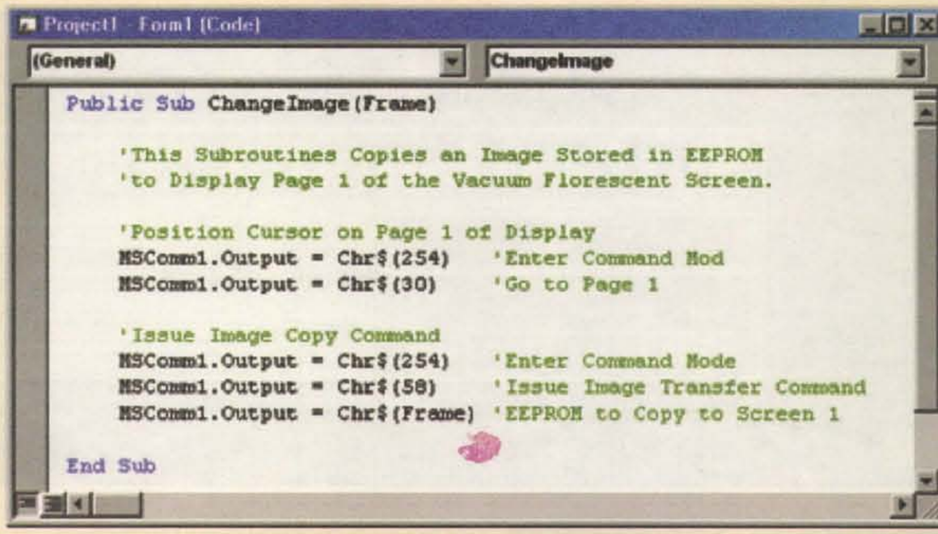


Figure 3. GUI Screen with Four Pictures

Figure 4. Change Image Command Screen



displays is finally over.

Gone are the days of hardware coding, bit-banging, parallel loading, and shifting. I have drawn on my experience of designing and building display controllers to integrate the features you have been asking for into the first of my series of Noritake VF display controllers. And I will confidently boast that you will not find a finer display or controller in this category.

This VFD display controller is the first in my line of devices to offer a simple ASCII-based command set. If you can send ASCII characters from your computer or micro-controller, then you can control this VF Display. Without exception, there is no easier way to control a vacuum florescent display. BASIC Stamp users will have no problems writing simple BASIC control programs.

Figure 5. Noritake VFD Screen with Clock

Forty-eight integrated commands allow you to plot pixels on the screen, copy images from memory to the screen, draw icons, scroll between images, write text, control the brightness, and much more. The VFD display controller holds 15 full-screen images (user-expandable to 127) in non-volatile EEPROM.

The controller shown here serves as a host for version 1.0 VF display control firmware. Using a PIC16C74 running at 20 MHz, a complex tangle of firmware plays host to your every desire, executing thousands of lines of code per second to hide the complexities of the display from the user. A set of 12 dip switches is used to set three start-up parameters. Three dip switches select baud rates of 1200 to 115.2K baud, one dip switch is reserved for future expansion, and the last eight set a device number. The device num-

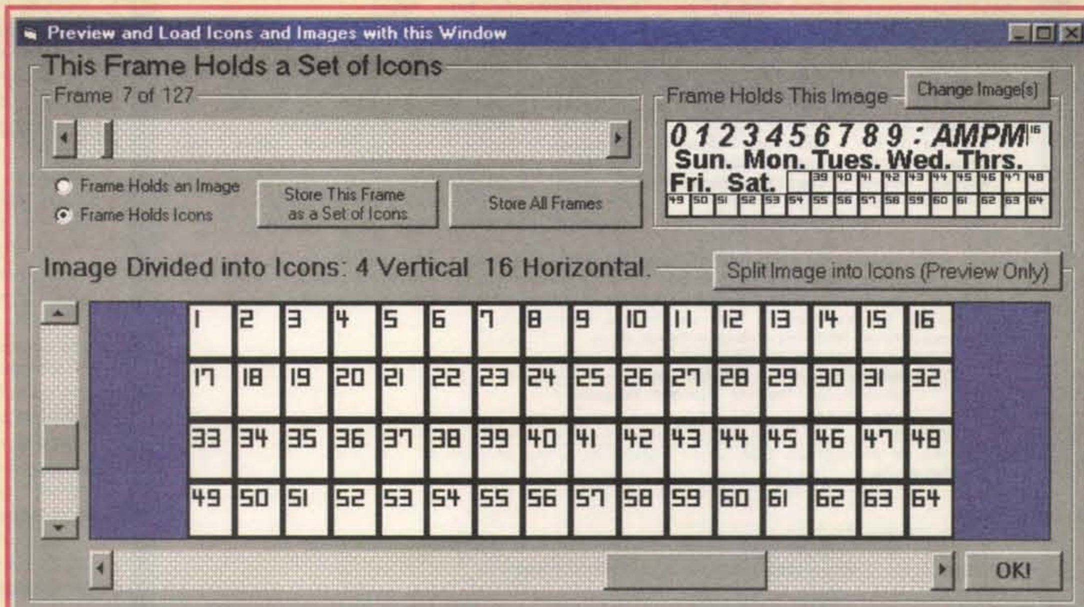


Figure 6. GUI of Numbers used in Clock and Icon Segmentation

THE COMPUTER CONTROLLED WORLD

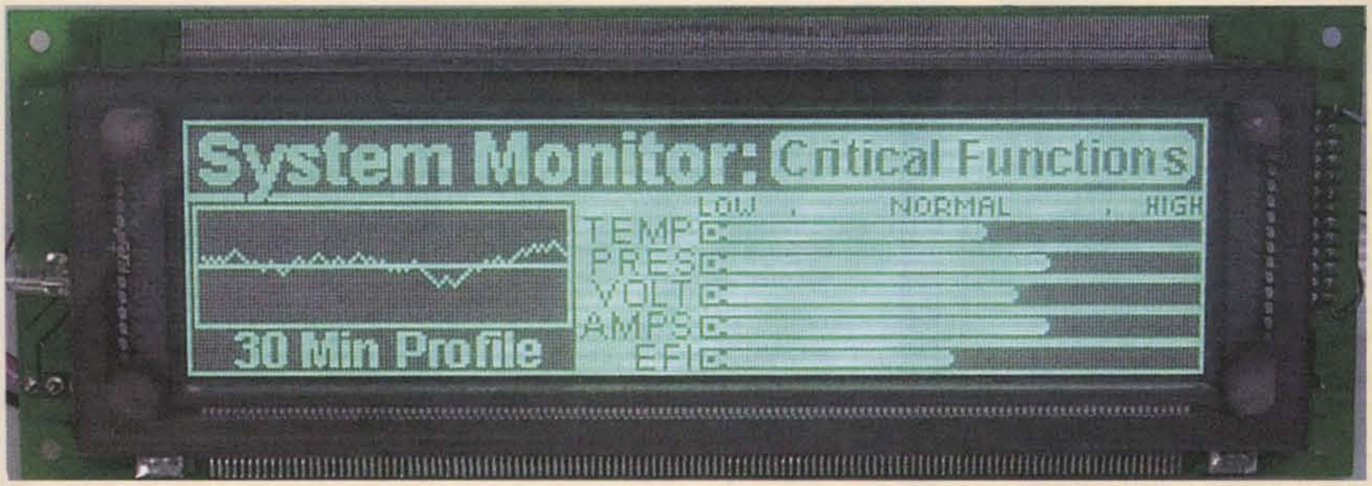


Figure 8. System Monitor VFD Screen

ber allows you to control 256 devices on a single serial port. Speak to each device individually or all devices simultaneously.

A MAX202 is used to provide a three-wire RS-232 serial interface to your computer or micro-controller. The photograph shows the controller fully loaded with 256K of EEPROM (24LC256), allowing you to store up to 127 full-screen images. The base configuration stores 15 images and is user-expandable by simply installing more EEPROMs.

A complete graphical user interface further simplifies batch-loading images into the controller from a Windows 98 system. The Noritake GU256x64-372 VF Display holds four images in its display memory. Figure 3 illustrates the GUI used to load images directly to display memory. Display memory may be scrolled using only six lines of code. Scrolling is smooth because of the high refresh rate of the VF Display. Unlike many LCD displays, the Noritake VF Displays instantly refresh, eliminating the ghosting effect as images are scrolled or changed.

The VF Display screen memory is typically filled with garbage when first powered up. The VF display controller automatically loads the first four EEPROM images directly to the screen on power-up so the user is never confronted with unintelligible images.

Once the display is powered up, you may want to copy your own preloaded images to the screen. Images may be used as menus or as templates to a more complex user interface as shown later in this article.

Upon power-up, the VF display controller is ready to accept data. Received data is sent directly to the screen. If ASCII 254 is received, the display controller is put in command mode. The next ASCII character defines a command, allowing you to scroll, copy images, control the brightness, plot pixels, or just about anything you can think of.

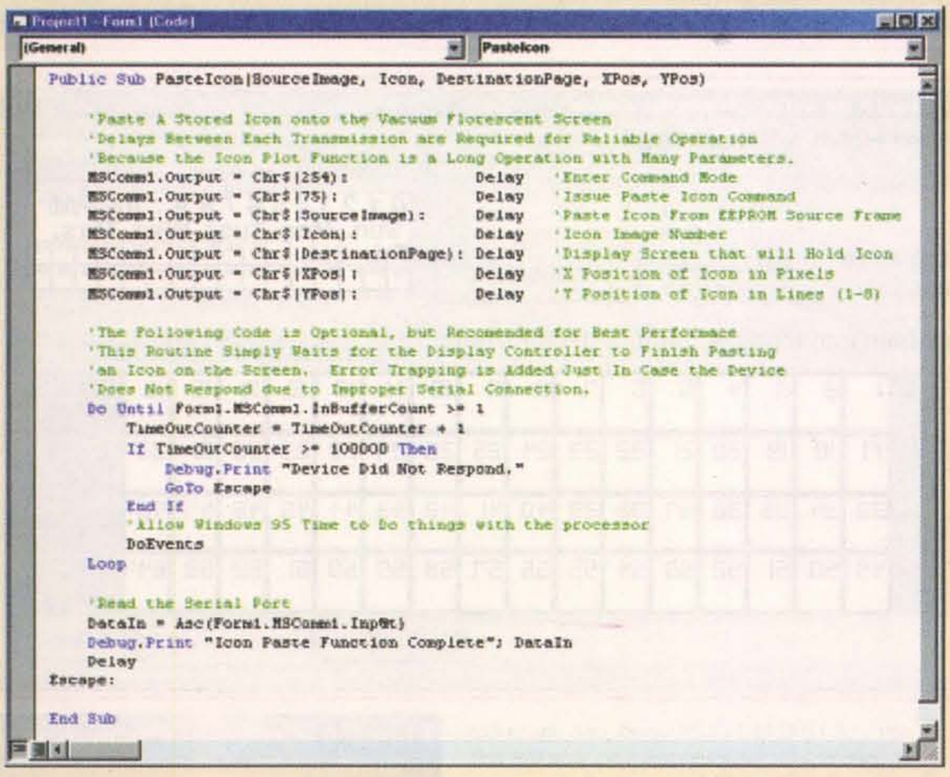
Figure 4 sends two commands to the display controller. The first command (30) tells the display to position the cursor on page 1. The second command (58) is used to copy an image stored in EEPROM to the display. The "Frame" identifies the image to copy to the screen. EEPROM memory is organized as frames, or full-screen images. The first EEPROM stores 15 frames. Each additional EEPROM adds 16 frames of storage to the controller.

One of the most powerful features of the VF Display controller is the ability to store icons. Icons can be used as Fonts in a limited capacity. Figure 5 illustrates the use of icons to display the current time and day of the week.

When loading images into the controller's memory, the user has the option of storing the image as a full-screen graphic or as a set of icons. The image shown in Figure 6 is loaded as a set of icons, allowing your program to reposition any portion of the image in just about any location on the display screen.

Figure 7 shows you how to use the paste icon command. This is the most CPU-intensive command, necessitating a few short delays between each ASCII character, giving the CPU time to perform the calculations necessary to position the graphic on the screen. Once this command is complete, ASCII character 85 will be sent to your computer or micro-controller signifying the completion of the icon paste command.

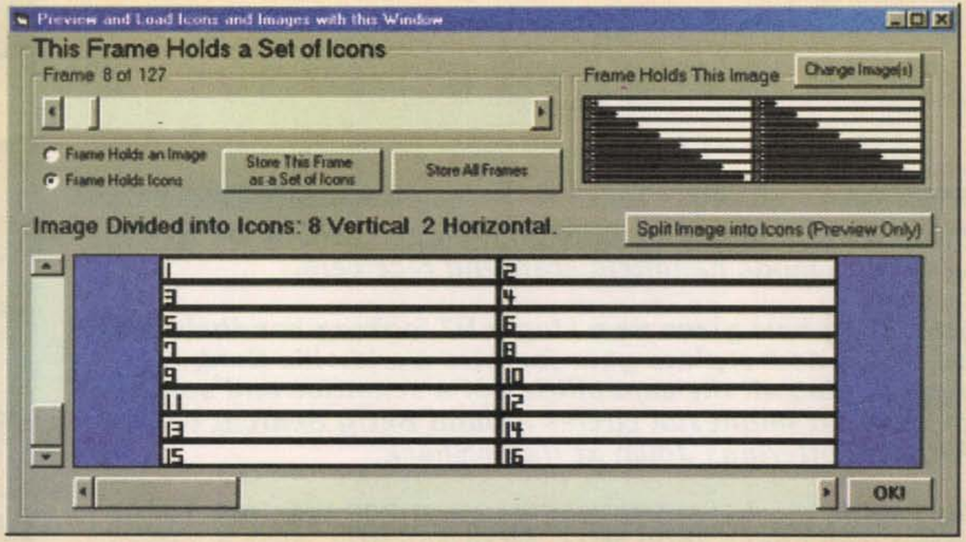
Figure 8 demonstrates the use of a complex user interface consisting of a template image (shown in the third image




```
Public Sub PasteIcon(SourceImage, Icon, DestinationPage, XPos, YPos)

    'Paste A Stored Icon onto the Vacuum Florescent Screen
    'Delays Between Each Transmission are Required for Reliable Operation
    'Because the Icon Plot Function is a Long Operation with Many Parameters.
    MSComm1.Output = Chr$(254):             Delay   'Enter Command Mode
    MSComm1.Output = Chr$(75):              Delay   'Issue Paste Icon Command
    MSComm1.Output = Chr$(SourceImage):     Delay   'Paste Icon From EEPROM Source Frame
    MSComm1.Output = Chr$(Icon):            Delay   'Icon Image Number
    MSComm1.Output = Chr$(DestinationPage): Delay   'Display Screen that will Hold Icon
    MSComm1.Output = Chr$(XPos):            Delay   'X Position of Icon in Pixels
    MSComm1.Output = Chr$(YPos):            Delay   'Y Position of Icon in Lines (1-8)

    'The Following Code is Optional, but Recomended for Best Performace
    'This Routine Simply Waits for the Display Controller to Finish Pasting
    'an Icon on the Screen.  Error Trapping is Added Just In Case the Device
    'Does Not Respond due to Improper Serial Connection.
    Do Until Form1.MSComm1.InBufferCount >= 1
        TimeOutCounter = TimeOutCounter + 1
        If TimeOutCounter >= 100000 Then
            Debug.Print "Device Did Not Respond."
            GoTo Escape
        End If
        'Allow Windows 95 Time to Do things with the processor
        DoEvents
    Loop

    'Read the Serial Port
    DataIn = Asc(Form1.MSComm1.Input)
    Debug.Print "Icon Paste Function Complete"; DataIn
    Delay
Escape:

End Sub
```

Figure 7. Paste Icon Source Code

Figure 9. GUI Level Meter Bars Icon Screen



of Figure 3) used as the background. Level meters are pasted into the interface for a graphical representation of analog values. These level meters were drawn in Photoshop 5 and loaded as icons, shown in Figure 9.

The graph on the left side in Figure 8 was drawn using the VFPLOT command, allowing you to draw pixels anywhere on the screen. The VFPLOT command is very easy to use. Figure 10 illustrates how to plot pixels on the screen.

Again, ASCII character 254 is used to put the controller in command mode. ASCII 62 is used to access the plot function; X and Y represent the location of the pixel that is to be turned on.

VF Displays may be used in just about any indoor application. Unlike LCDs, VFDs are not suitable in sun-lit environments. The Noritake GU256x64-372 requires a five-volt power supply capable of delivering two amps. Because of the high power consumption, VFDs are not typically used in battery-operated devices.

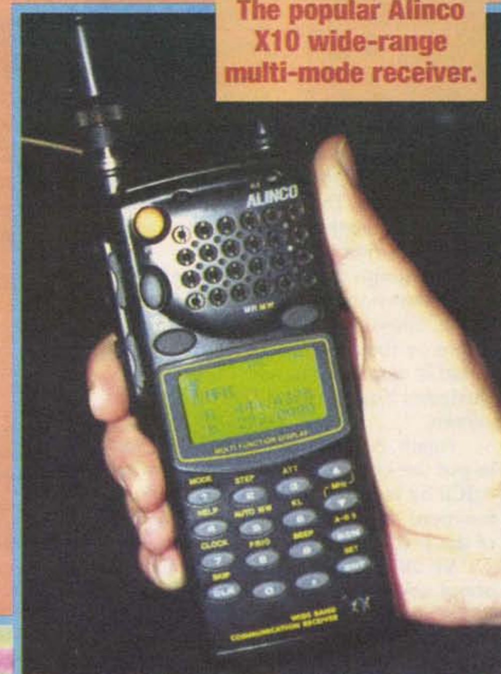
I hope you have enjoyed learning some of the basics of Vacuum Florescent displays; they are a truly remarkable technology with many applications. Future articles will explore this technology further from a more technical standpoint.

The VFD display controller shown in this article is currently in production and is due to ship by mid-August to early September at the latest. The controller and display will sell for $399.00; ***Nuts & Volts* readers with a current paid subscriber number and expiration date may purchase an evaluation unit at the 10-piece price of $349.00.** An additional $25.00 discount is offered for prepaid backorders. **NV**

```
Project1 - Form1 (Code)
(General)                    VFPLOT

Public Sub VFPLOT(X, Y)

    'Plot a Pixel on the Vacuum Florescent Display
    MSComm1.Output = Chr$(254)  'Enter Command Mode
    MSComm1.Output = Chr$(62)   'Send Plot Command
    MSComm1.Output = Chr$(X)    'Send X Position
    MSComm1.Output = Chr$(Y)    'Send Y Position

    'Wait for Controller to Finish Plot Command
    Do Until MSComm1.InBufferCount >= 1
        DoEvents
    Loop

    'Read the Serial Port
    DataIn = Asc(MSComm1.Input)
    Debug.Print "Plot Command Complete."; DataIn

End Sub
```

Figure 10. VF Plot Function Source Code

USING THOSE WIDE-RANGE, ALL-MODE HANDHELD RECEIVERS



The popular Alinco X10 wide-range multi-mode receiver.

***Competition** heats up among manufacturers of DC to daylight all-mode handheld scanning receivers.*

***Technology** now gives us a single HT-looking handheld radio that might now replace your favorite worldwide Sony and Grundig, plus all the capabilities of a sensitive and selective scanner that might run circles around Betty Bearcat or the VHF/UHF offerings down at RadioShack.*

Multi-mode receive starts way down at 200 kHz, and could extend well above 1500 MHz. All in one nice, neat package priced from $379-$600+.

by Gordon West

When you look at the technical spec sheets on these scanning shortwave and VHF/UHF receivers, it's really hard to tell how they stack up against dedicated VHF/UHF scanners and dedicated high-frequency shortwave equipment. Is there a trade-off when you take a dictionary-sized shortwave receiver, and shrink it down to a handheld-sized, all-mode scanning receiver with built-in VHF and UHF capabilities? I wondered this myself, so I have tried each of the four units over the past six months, and found that they are all admirable performers, but all share some of the same limitations down on the worldwide bands, plus some limitations in the traditional VHF bands.

ICOM America showing plenty of receivers, scanners, and ham equipment capable of wide-band receiving.


The AOR top-of-the-line receiver, the AR7000.

Each set looks much like a two-way ham or business band transceiver. Battery down on the bottom, speaker in the middle, and the keypad with an LCD display. Volume and squelch controls like a regular two-way radio, but no push-to-talk because these are receivers, not transceivers — except for the unique new Yaesu VX5 which is more like a ham transceiver with wide-band VHF/UHF coverage and AM-only modes down below 30 MHz.

Common to all four handheld scanning receivers, down on the shortwave bands, skywave reception with decent signal levels is pretty tough with the supplied little rubber-duck antenna. But since this equipment has a BNC jack, it's relatively easy to substitute a telescopic whip that makes a fairly positive difference, or a longwire antenna that makes a huge difference.

The AOR 8200 has a unique plug-in ferrite AM broadcast band antenna bar that kicks the receiver into overdrive when pulling in weak nighttime AM broadcast radio skip signals.

Is there a trade-off when you take a dictionary-sized shortwave receiver, and shrink it down to a handheld-sized, all-mode scanning receiver with built-in VHF and UHF capabilities?

The little plug-in ferrite antenna is so compact that I'm surprised they couldn't have figured out a way to build it inside the chassis — but nonetheless, if you want a hot AM radio for broadcast band reception, just plug in the little AM broadcast band ferrite bar.

On high-frequency shortwave, the ICOM, AOR, and Alinco all offer hot multi-mode reception coming out of that very small speaker. A set of stereo headphones really pulls in

Author West tunes in UHF business band calls in London.

the great audio capabilities but, of course, you won't get stereo — even on the FM music band.

In a recent test of the AOR handheld receiver in London, I was impressed that they made shortwave reception automatically mode selected. When you punch in 15 MHz or 10 MHz for the WWV time signals, it goes to AM. Punch in BBC or VOA frequencies, and the radio is on AM, again. But punch in a ham 40-meter frequency — such as 7285 kHz — and presto, the automatic mode selector switches it over to lower sideband. Go to 20 meters, 14285 kHz, and presto, it comes up upper sideband.

We found that each handheld scanner did a decent job for both sensitivity and selectivity on the high-frequency bands, but all equipment seemed to be operating with fast automatic gain control (AGC). If you're an avid shortwave or ham radio listener, fast AGC is not as pleasant or as smooth to listen to as slow AGC. With fast AGC, background band noise rushes up after each syllable or dot and dash, and this makes for slightly noisier reception than tuning in a relatively strong signal on a regular shortwave receiver, and having the background noise hushed by the slow AGC action on strong voice syllables. When copying Morse Code, expert hams like fast AGC, but if the code is relatively strong, I prefer slow AGC.

When you find a station you want to store in memory, all of the receivers offer memory capabilities, along with name calling. This means you can enter some letters or numbers to come up on the screen each time you recall that specific shortwave or VHF/UHF frequency. With 1,000 memories, this sure beats bringing along a little cheat sheet that tells you what is where!

But with so many memories, all of these little handhelds really require diligent reading of the instruction book. In fact, unlike a simple shortwave set or simple scanner with just a couple of buttons, each of these handheld receivers are NOT ones that you can just turn on, start punching some buttons, and quickly

- **ALINCO DJ-X10T**, all mode, 100 kHz to 2000 MHz, 1,200 memories, eight-character alphanumerics, triple conversion receiver; $389.00.
- **AOR AR8200**, all mode, 530 kHz to 2040 MHz, 1,000 memories, eight-character alphanumerics, triple conversion receiver, computer-controllable; $569.00.
- **ICOM IC-R10**, all mode, 500 kHz to 1300 MHz, 1,000 memories, eight-character alphanumerics, triple conversion receiver; around $400.00.
- **Yaesu VX5**, tri-band ham transceiver, AM mode for shortwave, 500 kHz to 16 MHz, FM wide and narrow modes for 47 MHz to 999 MHz. Keep in mind two-meter, six-meter, and 440 MHz ham transceive capabilities, too. No sideband mode for shortwave, 220 memories, computer-controllable. Price around $500.00+.

Taka and John testing a new shipment of wide-band AOR receivers.

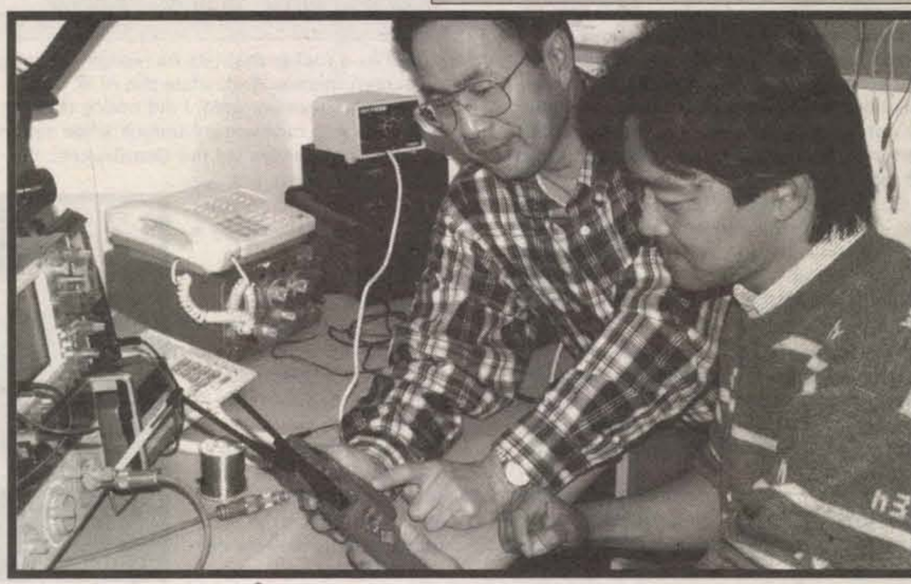


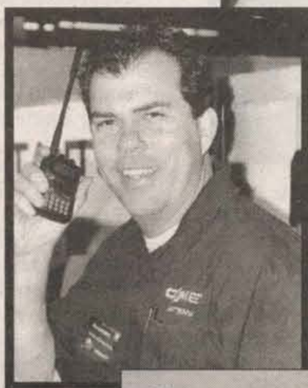
figure out what goes where in a matter of minutes. It's going to take you days, if not weeks, to master all of the many functions and options they have behind many of the on-screen menus.

The AOR AR8200 has an optional computer connection kit that includes cable and software for your Windows-based computer running from a CD-ROM. AOR is presently working on a software package that will be made available as an Internet free download from the AOR web site, www.aorja.com. The side-mounted AOR specific connector also supports cloning of memory data between two AR8200s, plus capabilities for tape recorder output, detector output, mute, and they say automatic gain control.

AOR goes one step further with a trap door on the bottom of the unit to accept optional slot cards. One memory slot card could increase storage of up to 4,000 memories, with 160 search banks. Another slot card could give you full encode and decode CTCSS squelch. Another interesting card is a 20-second voice recorder playback system, allowing you to repeat specific messages that you captured onto the digital voice recorder card. They have another card that is specifically designed to eliminate specific idle tones that will sometimes hang up scanners. But one card they say they cannot bring into the USA is the voice inverter card, designed to decode light-scrambled radio calls.

But since the AOR also does upper and lower sideband true carrier re-insertion, I suppose if you wanted to play around with this mode on certain signals you very well could pull in some intelligibility without the band voice inverter card.

I liked the AOR side-mounted tuning thumbwheel. This could allow me to hold the equipment in one hand, and do all of the tuning without needing to use my other hand. There is also a side four arrow keypad that works as a rocker that lets us navigate through on-screen menus. And, while the AOR had exceptional receiver gain, I did notice that the PLL goes into momentary unlock while zipping through frequencies via the thumbwheel. On scan, no problem, but keep this in mind so you don't accidentally zip by a frequency that may be occupied but you missed because you were going so fast, the PLL was still trying to achieve lock.



The very small Yaesu VX-5 wide-band scanning three-band transceiver.

So which one is best for you? Alinco? ICOM? AOR? Yaesu?

The AOR also has a band scope that I really didn't think I could ever use. But when I was in London, I found the band scope very useful in telling me where the major activity was for certain VHF and UHF calls, like marine radio, air radio, THEIR business band frequencies, and THEIR public safety channels. The band scope mutes the receiver on search, but about 30 seconds later, you've got a great 10 MHz insight on what is around the center frequency you have initially dialed in.

A highlight in England was going to the zero meridian, and standing next to the Greenwich mean time (GMT) clock. I wondered whether or not we could hear USA WWV signals, and sure enough, there was faint reception to a long telescopic whip as long as I held it in just the right position near a big mass of ungrounded metal.

On the way back home, there was plenty of interesting AM aeronautical traffic at Heathrow Airport, JFK New York, and LAX in California. Again, the band scope on the AOR

The Alinco X10 in action at a shortwave listener's convention.

8200 proved helpful in identifying where to tune for the action.

Up on VHF and UHF, all four scanning receivers did well. AOR has again preset modes according to popular USA and foreign ham band operation. Down at the bottom of six meters, two meters, the 222 MHz band, and 430 MHz, the equipment would automatically come up in upper sideband. When I tuned in the satellite portion of the two-meter band at 145.80 to 146.00, sure enough, the AOR went from FM back to upper sideband for weak signal reception. As soon as I tuned to 146 MHz, it jumped back to narrow-band FM. The AOR also has some additional more-narrow filters for restricting AM, FM, and several other modes of reception to a tighter bandwidth.

But I did notice something with the AOR 8200 that also seemed to affect — to a lesser extent — some of the other receivers. The problem is overload from 152 MHz pagers when tuning ham band and marine band frequencies near 140 MHz-165 MHz. I had tuned in some weak national weather service frequencies on the little rubber antenna, and then switched over to the telescopic whip to see how much the distant stations would improve in signal strength. They improved a lot. I then plugged in a big 9 dB gain Shakespeare 476-1 VHF collinear antenna, and all of the weak weather stations mysteriously disappeared. In fact, so did our nearby strong weather station. And there was nothing wrong with my big outside antenna.

When I went to the band scope to see exactly what the problem was, I could instantly see a huge spike at 152 MHz. This was a local paging transmitter that is on the air almost continuously, except for a brief 10-second carrier drop right on the hour. And sure enough — as soon as their carrier would drop, the big antenna would instantly pull in the distant weather stations loud and clear. But as soon as the paging transmitter came back up on 152 MHz, it literally swamped the VHF section of the AOR 8200 handheld receiver, and I had to go back to a smaller antenna.

But, to some extent, this has happened with a lot of VHF handhelds on my test bench, and I have a nice little notch filter that can easily go in line to quiet the squawk from the 152 MHz paging transmitter just a couple of miles away.

These little handheld scanners on VHF and UHF offer almost non-stop coverage from your local 40 MHz state police frequencies all the way up to the GPS band at 1575 MHz. It probably won't be too long until they include a little card for GPS reception, too!

If you go to air shows, I found running the ICOM R10 in the scan-up mode around 300 MHz quickly seeks out the air-to-air and air-to-ground action. If you're running the Yaesu VX5, you can call your buddies on two meters, six meters, or 70 cm, and tell them where the action is. But few dual-band and tri-band ham transceivers offer hot 300 MHz military reception. The Yaesu and ICOM ham sets do!

The AOR did nicely on wide-band AM reception down at 137 MHz for NOAA satellite signals. I would feed them into a SSC weather FAX computer program, and voila, I could easily decode twice-a-day weather facsimile broadcasts coming in from polar-orbiting weather satellites. It takes wider than usual AM capabilities to get good satellite reception, and the AOR has an extra-wide setting for extra-wide AM data receive. It also gives some extra fidelity to tuning in BBC and VOA calls, too.

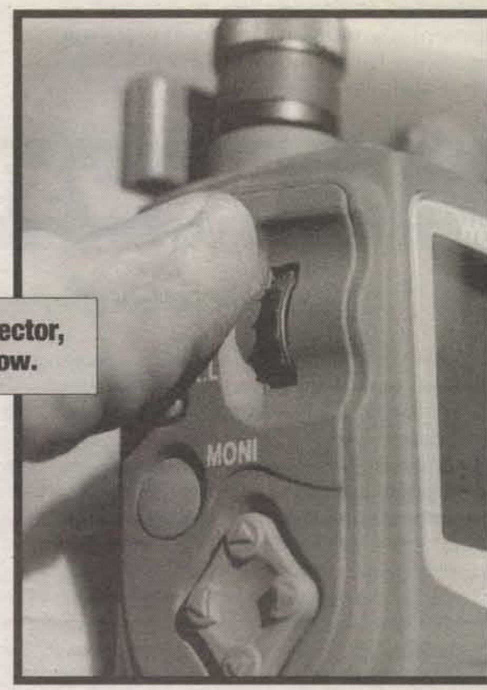
On all of the equipment, each manufacturer has blocked out the cellular segments of 800 and 900 MHz. I could still tune in my favorite 856.4625 MHz public safety calls, but a little above that the equipment jumps to the public safety bands above cell phone. By FCC order, there is no simple way to unlock cellular. But if you really get bored, try tuning FM just below 50 MHz, hold onto your earphones, and keep your lips sealed.

I have a repeater on 1282.400 MHz, and both the Alinco, as well as the AOR, picked up the signals best of all. In fact, I think these little receivers did a slightly better job than a little 1270 MHz two-way handheld I own. I was

The AM broadcast ferrite loop antenna.

impressed. But my handheld had a lot more audio output than the little scanners, so that is something else that you may wish to find out before you plunk down the dollars — what kind of speaker and how much audio can you really get out of this equipment when it is hanging on your belt?

Probably the best part of this kind of gear is its portability and capabilities of running on just four AA batteries for several days on end. Of course, the louder you play the volume, the more it's going to deplete the internal batteries. The AOR battery tray accepts either AA alkalines or AA rechargeables. They send along a Maha recharger for either nickel cadmium or nickel metal hydride cells, but you still need to go to the trouble of removing the batteries in order to give them a recharge. And, when we tried to plug in alkaline AA cells, I had to take out my handy fingernail file, and give the top of the AA positive contacts a

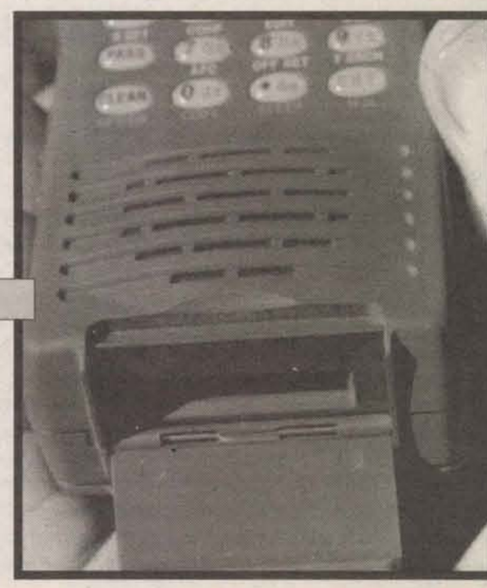


The AOR thumbwheel frequency selector, with the rocker selector seen below.

little file job in order to get them to finally fit in the very tight holder. But "Taka" at AOR tells me this is the way it's supposed to be in order to keep the batteries in nice and tight and free from loose connections. I guarantee on the AOR, they won't be loose!

So which one is best for you? Alinco? ICOM? AOR? Yaesu? Each seems to have its own style of operating, and your best bet is to get your hands on each brand of equipment, and play it for a few minutes down at the radio store in order to get the "feel" of how it operates.

On some equipment you will find the audio volume lacking dramatically. Yet on others, it's reasonably loud. Some have more base, and some seem a bit tinny. But it all depends on what you like to hear from a portable scanner, and what it sounds like through your own set of lightweight headphones — which means I won't try to tell you which set is going to be exactly the best one



The slot card trap door.

for you — all four performed well beyond their listed specs, and the AOR 8200 that went halfway around the world with me really pulled in some exciting calls and gave me the portability to keep it hanging on my hip and barely noticeable as a powerful shortwave and VHF/UHF scanning receiver. Check all of them out at your local radio dealer or their catalogs, and then choose the one that you seem to like best. **NV**

Reader FeedBack

Dear *Nuts & Volts:*

I wish to acknowledge all the letters of correction regarding my "Tech Forum" response published in the Mar. '99 issue (Question #3996: Non-Polarized Electrolytic Capacitor Replacement).

To all writers of those letters: I offer MY HEARTFELT AND SINCERE THANKS for correcting my errors AND "re-educating" me regarding capacitor behavior!

For the record: It WAS NOT my intention to provide erroneous and potentially dangerous information/suggestions to the individual I replied to. To that end, I'm ETERNALLY GRATEFUL to those who cared enough to correct my unintended misinformation.

To Mr. Broussard (original asker) and "anyone else" needing similar info: while the "concept" in my answer was basically valid, PLEASE heed the warnings and recommendations regarding voltage ratings for the capacitors! Your safety, as well as the safety of your equipment, isn't worth going "the cheap route."

I thank the readership of *Nuts & Volts* for being "on the ball" in quickly catching these kind of errors and summarily correcting them.

Ken Simmons
Auburn, WA

Newsbytes

Embedded Design Bulletin

The Embedded Design Bulletin is a free quarterly newsletter of interest to engineers, new product developers, design/manufacturing firms, and all else interested in electronic and microcontroller-based circuit design.

Containing the latest in new cost-saving components, professional hints and tips to aid in fine-tuning microcontroller designs, reader input on field-trials of various design techniques, and mini-tutorials on cutting-edge topics, it's an excellent way to stay on top in the fast-paced electronics design world!

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FCC Restores Non-Emergency Use On 462/467.675 Frequency

Action by the Federal Communications Commission June 10th has re-instated the original use of an important GMRS frequency pair.

Throughout the country, many licensees had been using 462/467.675 for personal communications. This was eliminated by the FCC on March 8th as part of Docket 98-20. Many letters were received in Washington protesting this action, which has now been reversed after three months.

Many REACT (Radio Emergency Associated Communications Team) monitor .675 for emergency and motorist assistance. It has been known as the unofficial channel for that purpose although not the only use that was allowed. The FCC action in March makes it exclusively for that kind of use. In the case of numerous teams that own .675 repeaters, this meant a REACTer's personal communications had to be on a different repeater frequency.

Since REACT is a non-profit volunteer organization with limited funds, it would have been a financial hardship to maintain two repeaters — one for each purpose. According to W. Robert Stone, REACT Chairman of the Board, some teams were planning to move their repeaters off the .675 frequency for not being able to support two separate ones. This would have left .675 with less chance — not more — of an answer for emergencies and assistance.

One aspect of Docket 98-20 was not revised, and is still in effect. Licensees of any GMRS frequency can use any other GMRS frequency. At this time, it is unknown how owners might react when unknown users start to appear on their repeater.

REACT was founded in 1962 and is the recipient of the President's Volunteer Action Award. Although first use involved CB radio — which still exists — most teams now also use the GMRS. There is an extensive network of GMRS repeaters throughout the country.

In a typical year, members may monitor CB, GMRS, Amateur, VHF, and Marine frequencies over three-million total hours. Approximately 170,000 calls will be taken and 39 million dollars will be saved by taxpayers because of this work.

Many areas of the country still need REACTers even though it only takes three people to start a team. Information may be found on the Website: www.reactintl.org

Hall Duncan, Fred Lanshe — Directors of Community and Public Relations
Bob Leef, Ron McCracken — Public Relations Committee Co-Chairs

Ninth Annual Shareware Industry Conference To Be Held July 22-24 in Tampa

TAMPA, FLORIDA — The Shareware Industry Conference (SIC), an international meeting of software programmers, developers, and distributors, will hold its ninth annual gathering from July 22-24 at the Wyndham Harbour Island Hotel in Tampa, Florida.

One of the most important segments of the fast-growing software industry, shareware is a marketing channel where users are able to evaluate programs before making a final purchase. The "try it before you buy it" software market accounts for nearly $650 million in annual sales, and has been influential in the premiere of new technologies including Internet browsers, anti-virus products, e-mail programs, and Windows utilities. Most shareware sales occur online, making it one of the most significant examples of electronic commerce.

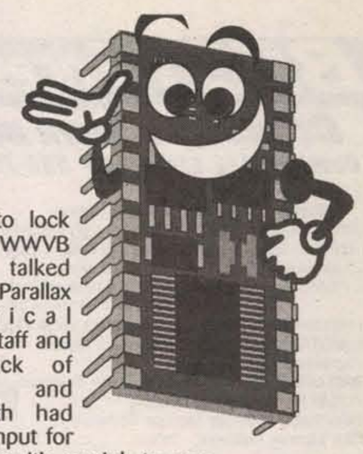
The SIC 99 conference will feature the Shareware Industry Awards, the most prestigious honors bestowed upon shareware programs, and will also include the latest round of inductions into the Shareware Hall of Fame, a special pantheon celebrating the pioneering individuals and groundbreaking products which have propelled this industry segment since its debut in 1983.

SIC 99's breakout sessions will feature a lively mix of technology-related subjects as well as focus groups dealing with marketing, sales and business management. Registrations for SIC 99 can be processed online at the conference's web site at http://www.sic.org. The web site also includes information on discount airfare, hotel accommodations, conference exhibit booths, and sponsorship. Registrations can also be accepted by telephone at (800) 218-8294. SIC 99 is sponsored by the Shareware Industry Awards Foundation.

Contact: Michael E. Callahan — mike@drff.com

STAMP APPLICATIONS

by Lon Glazner



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

WWVB Clock Interface

Somewhere up in the misty mountains of Colorado (or a little to the east, I'm told) lies a magical place. An ethereal signal sweeps across America, and keeps the whole country moving at the same tempo. No, it's not the 24-hour Grateful Dead concert station, it's the National Institute of Standards and Technology (NIST) radio station WWVB.

Overview

The WWVB is located near Fort Collins, CO and continually broadcasts highly accurate time signals. These time signals are used throughout the United States to synchronize time-sensitive applications. The binary coded decimal (BCD) time code can be received and utilized with an accuracy in the 0.1ms range.

The time code sent includes information such as Daylight Savings Time (DST), leap second, and leap year indicators, as well as the time, year, and day of the year information. All of this is broadcast at 60kHz with 30kW of power.

I think it's safe to say that the government spent a pretty penny putting together this system. And, as a taxpayer, I would be remiss in not making adequate use of it, and so would you. So here it goes.

Defining the Design

I guess there's three ways that we could go about accessing the WWVB time signal. The first is to design from scratch a receiver and decoder unit. No thanks! This is, after all, a BASIC Stamp article. The second method would be to hack one of the WWVB clocks that are available through retail stores. Again, I'm afraid the resulting information would be of little use to those of you that might like to build a product based on WWVB timing information. The third way – and my preferred method – is to use the highly versatile Atomic Time Clock Interface manufactured by Ultralink (hereafter referred to as the Ultralink module).

The Ultralink module operates with a simple serial interface that can be accessed with the BASIC Stamp SERIN and SEROUT commands. One nice feature of the Ultralink module is that it can be separated into two modules: the receiver module which has the antenna, and the decoder module which your BASIC Stamp communicates with. This allows you to place the antenna in a location away from the noise generated by many of the electronic devices in the home or office.

My goal for this article was simple. I wanted to simply display the WWVB time data via the DEBUG command.

Connecting the Parts

The schematic for this design is incredibly simple, but there are a couple of things I should mention to avoid any confusion for those of you that build this system.

The pin designations on the Ultralink module are defined relative to the module itself. For example, the Rxd pin is the data input for the Ultralink module. Therefore, it is connected to the Txpin in my BASIC Stamp2 (BS2) code. Likewise, the Txd pin of the Ultralink module is connected to the Rxpin in my BS2 code.

Early on in testing the Ultralink module, I was having a hard time getting the receiver to lock on to the WWVB signal. I talked with the Parallax Technical Support staff and Rod Mack of Ultralink, and they both had valuable input for me. I figure it's my job to pass this information on. The Ultralink module is shipped with the receiver connected to the decoder via a short three-pin connector. This three-pin connector is secured to each of the boards (receiver and decoder) by a screw terminal. I replaced this connector with about 10 feet of wire. This allowed me to place the receiver further from all of the test equipment around the office.

As it turned out, antenna placement was paramount to successful reception of the WWVB signal. It was also recommended to me that I place indicator LEDs on the test board, and run the BS2 and Ultralink module off of a battery. In this way, I could take the test board outside and get a lock on the WWVB signal. Since I'm in a metal building, surrounded by metal buildings, this proved necessary.

With the LED indicators and a mobile test

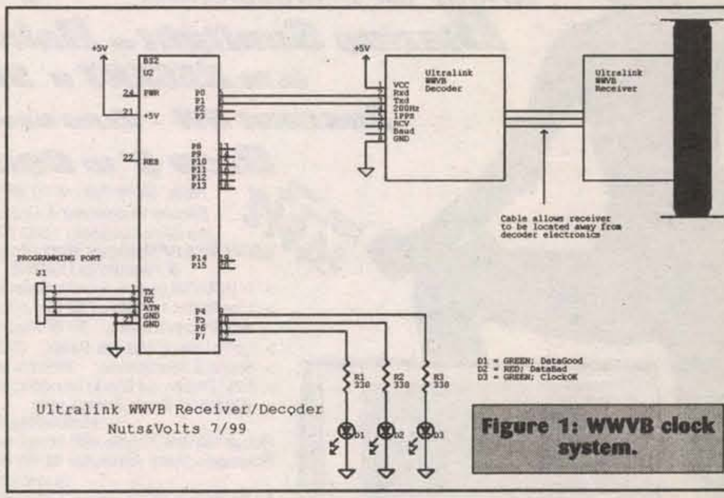


Figure 1: WWVB clock system.

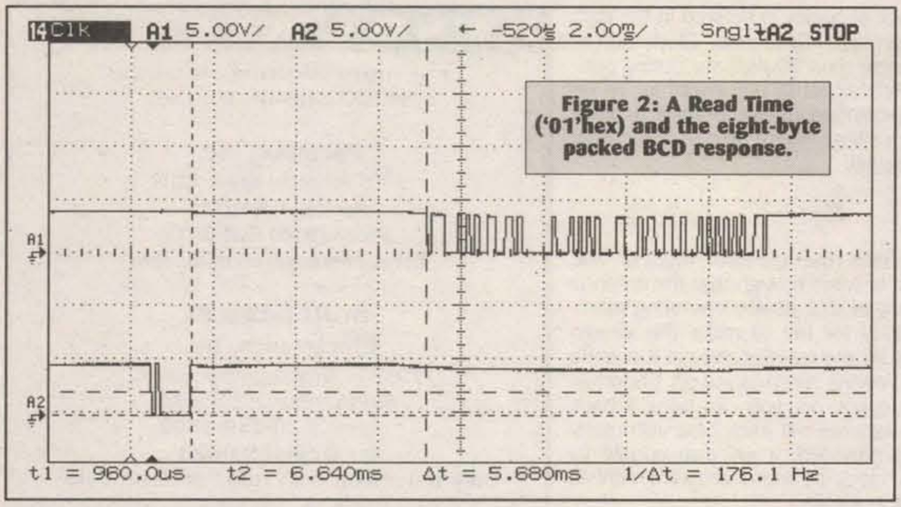


Figure 2: A Read Time ('01'hex) and the eight-byte packed BCD response.

board, I was locked on to the signal in under two minutes. The schematic in Figure 1 shows the connectivity used for this WWVB clock system.

Writing the Code

There are a few things about how this code works that require some explanation. There are quite a few features built into the Ultralink module. I didn't use all of them and, in fact, kept the code as basic as I could. The Ultralink module has both an ASCII and a packed BCD interface built into it. I opted for the packed BCD interface which required less variable space and was easier to manipulate for display with the DEBUG command. Binary coded decimal, or BCD, is simply using binary nibbles (four bits, or half a byte) to store values that range from 0-9. Packed BCD uses both the high and low nibble of a byte to store BCD values. For instance, a packed BCD '95'hex, is the same as a '10010101'binary, or 149 in decimal.

This leads to some interesting conversion needs in the code. For example, the RAW_DAY register can only return a value from 00 to 99 in packed BCD. Yet there are 365 days in a non-leap year. So where do you get the DAY value when you reach 100+ days? This information is held in the lowest two bits of the LT register (see NV_JUL99.BS2 code listing). The binary value in these bits is the number of 100s that you must add to the DAY register for the actual day of the year. So, if it was day 254, the RAW_DAY register would contain '54'hex, and the LT register would read 'xxxxxx10'binary (where x is not used). This is handled in the code by first determining the value in the lowest two bits of the LT register by ANDing that register with a value that masks all of the bits except for the lowest two. The lowest two bits are then multiplied by '100'hex, which is a BCD representation of 100. The RAW_DAY register is then added to this value and stored in the word variable DAY.

A similar operation is required to determine the century. Bit 4 of the LT register designates whether the century value is 1900 or 2000. The RAW_YEAR value can then be added to the BCD representation of the century and stored in the word variable YEAR.

There are five commands that the Ultralink module will accept. They include ...

- '01'hex "A" ASCII Read Time: returns date and time string
- '02'hex "B" ASCII Diagnostic Receive: returns a status byte each second
- '03'hex "C" ASCII Force Update: initiates a receive update cycle
- '04'hex "D" ASCII Read UT1 Correction: returns a two nibble time correction
- '05'hex "E" ASCII Read Firmware Rev.: returns current firmware revision

The source code that I generated only makes use of the first two commands, and uses the BCD communication method. The code listing NV_JUL99.BS2 waits three seconds after power-up for the Ultralink module to complete its reset cycle. Then the BS2 places the Ultralink module into its diagnostic mode (command '02'hex) and begins receiving status bytes from the Ultralink module at a rate of one every second. These bytes can represent a Zero ('00'hex), a One ('01'hex), a Mark ('10'hex), or an unknown or bad byte ('11'hex). In this code, the BS2 must receive 60 consecutive bytes that are not a '11'hex in order for the BS2 to start reading and displaying the WWVB time. Indicator LEDs are set or cleared based on the number of good bytes read.

Finally, the WWVB time is in UTC which is a French acronym for "Universal Coordinated Time," which is the same as Greenwich Mean Time (GMT). I didn't further modify the time from GMT, but you'll probably want to for your own design.

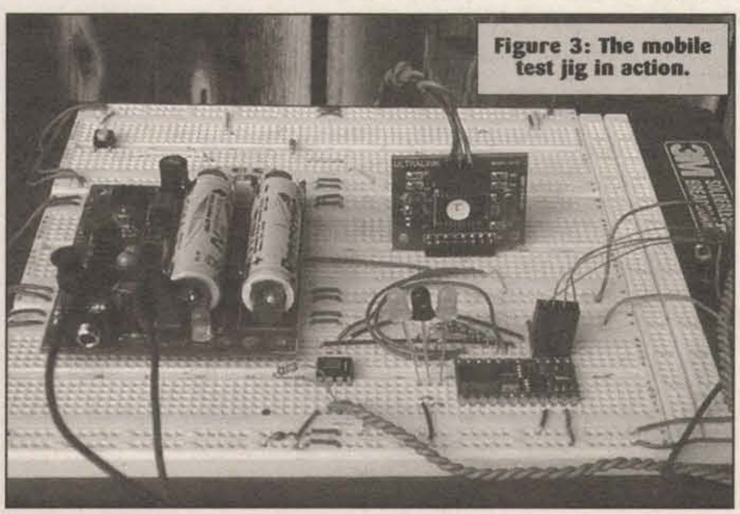


Figure 3: The mobile test jig in action.

Serial Communication and Time Accuracy

The serial communication format for the Ultralink module can be selected for either 2400bps or 9600bps. The 2400bps mode is ideal for interfacing to a BASIC Stamp 1 (BS1). An example of the serial communication for a Read Time ('01'hex) command can be seen in Figure 2. The time delay from sending a Read Time command until a response is initiated is specified as at least 5ms. This allows a BASIC Stamp enough time to prepare for the incoming data.

The Ultralink module provides time base values down to the 10s of milli-seconds. Clock accuracy is defined in the data sheet as ±20ms upon synchronization. Clock drift is expected to be no larger than 20ms/hour during periods where the WWVB signal is not available. To be sure, the best way to maintain time accuracy is to place the antenna in a position where it can effectively receive the WWVB signal.

In Closing

Communicating with the Ultralink module was smooth sailing. Keep in mind though that the antenna position is paramount to this device operating effectively. It was necessary for me to make this design mobile (see Figure 3 for the test jig) and get it outside of my office for the WWVB reception to go smoothly. Once the device is locked on, you can bring it back inside. The Ultralink module will track time accurately as long as power is provided. It will also update its internally generated clock as more accurate WWVB time stamps become available.

It's important to understand that while I moved my Ultralink module in and out of my building to receive time updates, for serious applications, the antenna should be positioned so that it can effectively receive the WWVB signals. I have also been informed from a reliable source at Ultralink (thanks Rod) that a cable used between the receiver and decoder parts of the module can be very long. The data sheet specifies 200 feet, but much longer cable (up to 1000 feet) has been used successfully with this module. **NV**

RESOURCES

For more information on the BASIC Stamp, contact:

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

Scott Edwards Electronics, Inc.
1939 S. Frontage Rd. Ste. F
Sierra Vista, AZ 85635
phone **520-459-4802**
fax **520-459-0623**
www.seetron.com info@seetron.com

Solutions Cubed
Lon Glazner
3029 Esplanade Suite F
Chico, CA 95973
E-Mail: **lon@solutions-cubed.com**
www.solutions-cubed.com
Phone: **530-891-8045**
Fax: **530-891-1643**

For more information on the Ultralink atomic time clock interface:

Ultralink was founded in 1984, and has completed designs ranging from ISA bus links to the STD, VME, and Multi Bus systems, to WWVB based time code receivers.

Rod Mack — Ultralink
phone: 775-782-9758
E-Mail: rodmack@ulio.com

Code Listing: NV_JUL99.BS2

```
'NV_JUL99.BS2: This BS2 code interfaces to the Ultralink WWVB Receiver and
'decoder module that is available through Parallax, Inc. This code makes
'use of two of the features available in the module. The first feature
'is a diagnostic mode which returns a byte each second. The value of the
'returned byte is useful in determining whether or not your WWVB receiver
'has locked on to the signal coming out of Fort Collins, CO. The second
'feature displayed by this BS2 code is the reading of the WWVB time and date.
'The time is read in BCD format and displayed with the DEBUG command.

RXpin          CON  1          'serial data receive pin
TXpin          CON  0          'serial data transmit pin
DatGood        CON  6          'signal lock LED indicator
DatBad         CON  5          'signal not locked LED indicator
ClockOK        CON  4          'clock data OK LED indicator
BAUD           CON  84         '9600 bps, 8N1, true serial data
LT_CENT_MASK   CON  %00010000  'mask isolates the century bit
LT_DAYS_MASK   CON  %00000011  'mask isolates the hundreds of days bits

LOW      DatGood               'default LED status displays no signal
LOW      ClockOK               'condition
HIGH     DatBad

RX         VAR  BYTE   'receive status byte
YEAR       VAR  WORD   'year value storage word
RAW_YEAR   VAR  BYTE   'year value received from WWVB decoder
LT         VAR  BYTE   'leap year,century,DST,days modifier bits
RAW_DAY    VAR  BYTE   'days value received from WWVB decoder
DAY        VAR  WORD   'day value storage word
HOUR       VAR  BYTE   'hours value received from WWVB decoder
MINUTE     VAR  BYTE   'minutes value received from WWVB decoder
SEC        VAR  BYTE   'seconds value received from WWVB decoder
MSEC       VAR  BYTE   'milli-seconds value from WWVB decoder
DAT1       VAR  BYTE   'data received in diagnostic mode
TEMP_REG   VAR  BYTE   'counting/working register

PAUSE    3000                  'Allow > 2s for decoder reset cycle
GOSUB    DIAGNOSTIC_MODE       'verify reception of signal

START:
GOSUB    READ_WWVB             'read and display WWVB time each second
         PAUSE  1000
         GOTO   START

READ_WWVB:
SEROUT TXpin,BAUD,[$01]                 ''01'hex requests time from decoder
SERIN
RXpin,BAUD,500,no_response1,[RX,RAW_YEAR,LT,RAW_DAY,HOUR,MINUTE,SEC,MSE
C]
HIGH     ClockOK                 'light valid time LED
DEBUG    "RX BYTE ",BIN8 RX,CR   'display flag registers in binary
DEBUG    "LT BYTE ",BIN8 LT,CR   'display flag registers in binary
DEBUG    "TIME = ",hex2 HOUR,":",hex2 MINUTE,":",hex2 SEC,":",hex2
MSEC,CR
TEMP_REG = LT&LT_DAYS_MASK              'mask all but lowest two bits of LT
DAY = (TEMP_REG*$100)+RAW_DAY           'lowest 2 bits = #100's of days to add
'
YEAR = $1900+RAW_YEAR                   'Year = 1900 + raw year
TEMP_REG = LT&LT_CENT_MASK              'unless masked century value is '10'hex
IF TEMP_REG <> $10 THEN Display_Years
YEAR = $2000+RAW_YEAR                   'Year = 2000 + raw year
Display_Years:                          'display year and date
DEBUG    "YEAR = ",HEX4 YEAR," DAYS = ",HEX3 DAY,CR,CR

RETURN
no_response1:
DEBUG    "NO RESPONSE",CR
RETURN

DIAGNOSTIC_MODE:
SEROUT   TXpin,BAUD,[$02]        'execute diagnotic mode
TEMP_REG = 0                     'counting register is reset to zero
Read_Mode:
DEBUG    "COUNT = ",DEC TEMP_REG,CR           'display count
SERIN    RXpin,BAUD,2000,no_response2,[DAT1]
IF       DAT1 <> %00000011 THEN Increase_Count    'see if diagnostic
mode returns a '03'hex
TEMP_REG = 0                     'if a '03'hex is returned then reset counter
HIGH     DatBad                  'light no signal lock LED
LOW      DatGood                 'extinguish signal lock LED
GOTO     Read_Mode               'continue checking
Increase_Count:
TEMP_REG = TEMP_REG + 1          'increment count of "good" responses
If TEMP_REG < 60 THEN Read_Mode  'after a minute of "good" responses
HIGH     DatGood                 'consider the receiver locked
LOW      DatBad                  'set LEDs to display data as valid
RETURN
no_response2:
GOTO DIAGNOSTIC_MODE
END:
```

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- TEK 7904 500 MHz Oscilloscope, with 7A24, 7A26, 7B80, 7B85 ... $900.00
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- TEK SC503 10 MHz Dual Trace Storage Oscilloscope, TM500 series ... $375.00

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- HP 1122A Probe Power Supply ... $150.00
- TEK 1101A Accessory Power Supply, for FET probes ... $200.00
- TEK P6046 100 MHz Differential Probe ... $500.00
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CALIBRATION

- TEK SG503 Level Generator, 250 kHz-250 MHz, TM500 series ... $600.00

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- HP 3310B 5 MHz Function Generator, variable phase trigger ... $350.00
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- HP 8904A-001,002,004 Multifunction Synthesizer, DC-600 kHz ... $2,500.00
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- TEK PG508 50 MHz Pulse Generator, TM500 series ... $500.00
- WAVETEK 802 50 MHz Pulse Generator ... $300.00

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- HP 3478A 5-1/2 digit Multimeter, HPIB ... $600.00
- KEITHLEY 181 6-1/2 digit Nanovoltmeter, 10 nV sensitivity, GPIB ... $900.00
- SOLARTRON 7081 8-1/2 digit Voltmeter ... $3,250.00
- TEK DM5010 4-1/2 digit Multimeter, TM5000 series plug-in ... $300.00
- TEK DM501A 4-1/2 digit Multimeter, TM500 series plug-in ... $225.00

CALIBRATION

- FLUKE 510A AC Reference Standard, 10 VRMS, 0-10 mA ... $450.00
- FLUKE 515A Portable Calibrator, DC/AC/Ohms, line & battery power ... $900.00
- FLUKE 5220A Transconductance Amplifier, DC-5 kHz, 0-20 A ... $3,000.00
- FLUKE 731B DC Reference Standard ... $400.00
- VALHALLA 2703 AC Volt.Std.,0-120V/ 10 Hz-100 kHz;120-1200V/10 Hz-1 kHz ... $1,750.00

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- HP 6115A Precision Dual Range Power Supply, 50V 0.8A / 100V 0.4A ... $850.00
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- HP 4280A-001 1 MHz C Meter / C-V Plotter; 5-1/2 digit res. C ... $3,000.00

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- E.S.I. SR-1 Standard Resistor, various values ... $125.00
- E.S.I. SR1010 Resistance Transfer Standards, 1 Ohm-100 K/step ... $550.00
- E.S.I. SR1050-1M Resistance Transfer Standard, 1 Megohm/step ... $2,000.00
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- GR 1433-K 4-Decade Resistor, 0-1,110 Ohms, 0.1 Ohm resolution ... $150.00
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- VALHALLA 2724A Programmable Resistance Standard, 0-11 Gigaohms, GPIB ... $1,250.00

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- TEK 1503B-03,04 T.D.R., 0-50,000 ft., chart recorder & battery power ... $3,000.00
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- HP 6260B-027 0-10 V 0-100 A CV/CC Power Supply; 208 VAC line ... $675.00
- HP 6263B 0-20 V 0-10 A CV/CC Power Supply ... $400.00
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- ELGAR 501C/400SD AC Power Source, 45 Hz-5 kHz, 500 VA, 0-135 VAC ... $1,150.00
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- KEPCO BOP 50-2M Bipolar Op Amp/ Power Supply, to 50 V 2 A ... $400.00
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- TEK DC5010 350 MHz / 3.125 nS Universal Counter, TM5000 series ... $950.00
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- HP 5340A 18 GHz Frequency Counter ... $450.00
- HP 5343A-001 26.5 GHz Frequency Counter, OCXO reference ... $3,500.00
- HP 5345A/5355A/5356B 26.5 GHz CW/Pulse Frequency Counter ... $3,500.00
- TEK DP501 1.3 GHz Prescaler, divide by 16, TM500 series ... $225.00

STANDARDS

- HP 105B Quartz Oscillator, 0.1/ 1.0/ 5.0 MHz, battery power ... $1,500.00
- HP 5061A Cesium Frequency Standard, 0.1/1.0/5.0/10.0 MHz outputs ... $6,500.00
- HP 5065A-002 Rubidium Frequency Standard, 0.1/1.0/5.0/10.0 MHz out ... $3,500.00
- HP 5087A Distribution Amplifier, 12 outputs at 1 MHz ... $1,500.00
- HP 5087A-opt.032 Distribution Amplifier, 12 outputs at 5 MHz ... $1,750.00
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- TEK DA4084 Programmable Distortion Analyzer ... $750.00

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- FLUKE 8922A True RMS Voltmeter, 180 uV-700 V, 2 Hz-11 MHz ... $450.00

OSCILLATORS

- HP 3336C Synthesizer / Level Generator, 10 Hz-21 MHz ... $1,400.00
- TEK SG5010 Programmable Oscillator, 10 Hz-163.8 kHz ... $2,750.00
- TEK SG502 Sine/Square Osc., 5 Hz-500 kHz, 70 dB step atten.,TM500 ... $200.00

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KROHN-HITE 3342R Dual HP/LP Filter, ... $900.00
0.001 Hz-99.9 kHz, 48 dB/octave
KROHN-HITE 3750 LP/HP/BP/BR Filter, ... $600.00
0.02 Hz-20 kHz, 6/12/18/24 dB/oct.
KROHN-HITE DCA-10R 10 Watt Amplifier, ... $450.00
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ROCKLAND 852 Dual Highpass/ ... $900.00
Lowpass Filter, 0.1 Hz-111 kHz
TEK AM502 Differential Amplifier, ... $475.00
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HP 11970K WR42 Harmonic Mixer, 18.0-26.5 GHz ... $1,100.00
HP 11970Q WR22 Harmonic Mixer, 33-50 GHz ... $1,400.00
HP 3585A Spectrum Analyzer, ... $4,500.00
20 Hz-40 MHz, 3 Hz min. res. bw.
HP 8559A/853A-001 Spectrum An., ... $3,750.00
0.01-21 GHz, 1 kHz res.,w/rackmount frame
HP 8565A-100 Spectrum Analyzer, ... $3,500.00
10 MHz-22 GHz, 100 Hz min. res.
HP 8569B Spectrum Analyzer, ... $7,500.00
10 MHz-22 GHz, 100 Hz min.res.bw.
TEK TR502 Tracking Generator, ... $950.00
0.1-1800 MHz, for 7L13/7L14
TEK WM782V WR15 Harmonic Mixer, 50-75 GHz ... $1,500.00

NETWORK ANALYZERS

HP 11650A Network Analyzer Accessory Kit, APC7 ... $600.00
HP 35676A Reflection/Transmission ... $1,000.00
Test Kit, 5 Hz-200 MHz
HP 8405A Vector Voltmeter, 1-1000 MHz ... $450.00
HP 85020A Directional Bridge, ... $650.00
10-4300 MHz, N(f) test port
HP 85027C Directional Bridge, ... $1,750.00
0.01-18 GHz, N(f) test port
HP 85044A Reflection/Transmission ... $1,500.00
Test Set, 300 kHz-3 GHz
HP 8753A/85046A Network Analyzer, ... $9,500.00
300 kHz-3 GHz, w/S-Parameter Test Set
HP 8756A Scalar Network Analyzer ... $2,500.00
HP R85026A WR28 Detector, ... $1,200.00
26.5-40 GHz, for HP 8757 series
WILTRON 560-98KF50 SWR Autotester, ... $1,800.00
10 MHz-40 GHz, for Wiltron 560 series

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FLUKE 6060A Synthesized Signal Gen., ... $1,900.00
0.1-1050 MHz, 10 Hz res., GPIB
FLUKE 6060A/AN Synthesized Signal ... $1,500.00
Gen.,10 kHz-520 MHz, 10 Hz res.,GPIB
FLUKE 6060B/AK Synthesized Signal ... $2,250.00
Gen., 0.1-1050 MHz, 10 Hz res.
GIGATRONICS 1018 Synthesized Signal ... $4,500.00
Gen., 50 MHz-18 GHz, 1 MHz res.
GIGATRONICS 600/6-12 Synthesized ... $2,500.00
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GIGATRONICS 840-18 Freq. Multiplier, ... $2,750.00
18-26 & 26-40 GHz outputs 0 dBm
GIGATRONICS 875/50 Levelled ... $2,500.00
Multiplier, x4, 50.0-75.0 GHz output, -3 dBm
GIGATRONICS 875/86 Levelled ... $3,750.00
Multiplier, 26.5-40.0 & 50.0-75.0 GHz outputs
GIGATRONICS 900/2-8 Synthesized ... $2,500.00
Signal/Sweep Gen., 2-8 GHz, 1 MHz res.,GPIB
HP 11720A Pulse Modulator, 2-18 GHz, 80 dB on/off ratio ... $450.00
HP 3335A Synthesizer / Level Generator, 200 Hz-81 MHz ... $4,500.00
HP 85100V Frequency Mult., ... $3,750.00
10-15 GHz in / 50-75 GHz out >0 dBm
HP 8640B Signal Generator, ... $1,000.00
0.5-512 MHz, AM, FM, pulse modulation
HP 8656B-001 Synth. Signal Gen., ... $2,500.00
0.1-990 MHz, 10 Hz res., OCXO ref.
HP 8657A-002 Signal Generator, ... $3,250.00
0.1-1040 MHz, 10 Hz res., HPIB
HP 8660C/86602B-002 Synth. ... $2,750.00
Sig. Gen., 1-1300 MHz, FM / Phase mod. w/86635A
HP 8660C/86603A Synthesizer, ... $3,250.00
1-2600 MHz, AM / FM, w/86633B
HP 8672A Synthesized Signal ... $6,000.00
Generator, 2-18 GHz, +3 dBm output
HP 8673D-H16 Synth. CW Signal ... $16,000.00
Generator, 50 MHz-26 GHz, +8 dBm out
HP 8673E Synthesized Signal Generator, ... $9,500.00
2-18 GHz, +8 dBm output
HP 8673G-004,008 Synth. CW Signal ... $12,500.00
Generator, 2-26 GHz, >+8 dBm output
HP 8684B Signal Generator, ... $3,500.00
5.4-12.5 GHz, AM/ WBFM/ Pulse

SWEEP GENERATORS

HP 8350A/83545A-002 Sweep Oscillator, ... $4,000.00
5.9-12.4 GHz, 70 dB step attenuator
HP 8350A/83570A Sweep Oscillator, ... $5,500.00
18.0-26.5 GHz, +10 dBm levelled
HP 8601A Generator/Sweeper, ... $400.00
0.1-110 MHz, +20 dBm levelled
HP 8620C Sweep Oscillator Frame ... $550.00
HP 86222B-002 RF Plug-in, ... $1,250.00
10-2400 MHz, +13 dBm levelled, 70 dB atten.
HP 86230B RF Plug-in, ... $375.00
1.8-4.2 GHz, +10 dBm unlevelled
HP 86240C RF Plug-in, 3.6-8.6 GHz, +16 dBm levelled ... $700.00
HP 86241A-001 RF Plug-in, ... $300.00
3.2-6.5 GHz, +8 dBm levelled
HP 86242D-004,008 RF Plug-in, ... $300.00
5.9-9.0 GHz, +10 dBm levelled
HP 86245A-001 RF Plug-in, 5.9-12.4 GHz, +17 dBm levelled ... $600.00
HP 86250D RF Plug-in, 8.0-12.4 GHz, +10 dBm levelled ... $500.00
HP 86260A RF Plug-in, 12.0-18.0 GHz, +10 dBm unlevelled ... $500.00
HP 86260A-H04 RF Plug-in, ... $500.00
10.0-15.0 GHz, +10 dBm unlevelled
HP 86290A-004 RF Plug-in, ... $1,750.00
2.0-18.0 GHz, +7 dBm levelled, rear output
HP 86290B-004 RF Plug-in, 2.0-18.6 GHz, ... $1,850.00
+10 dBm levelled, rear output
WAVETEK 962 Sweep Generator, ... $1,250.00
1.0-4.0 GHz, markers, +12 dBm unlvld.
WILTRON 6647M Sweep Generator, ... $4,500.00
10 MHz-20 GHz, +10 dBm levelled

POWER METERS

ANRITSU MP-81B/ML-83A Power Meter, ... $2,500.00
75-110 GHz (WR10), -20 to +20 dBm
BOONTON 4200-01A,03/&-4A x2 Dual ... $950.00
Channel Microwattmeter, w/(2) 1 MHz-7 GHz sensors
BOONTON 42B/41-4B Analog Power ... $375.00
Meter, with 1 MHz-12 GHz sensor
BOONTON 42B/41-4E Analog ... $500.00
Power Meter, with 1 MHz-18 GHz sensor
GENERAL MICROWAVE 476/4240A ... $300.00
Power Meter & Sensor, 0.01-18 GHz, -35 to +10 dBm
HP 435B/8481A Power Meter, ... $900.00
-30 to +20 dBm, 10 MHz-18 GHz
HP 435B/8482H Power Meter, ... $900.00
-10 to +34 dBm, 100 kHz-4.2 GHz
HP 436A/8481A Power Meter, ... $1,400.00
-30 to +20 dBm, 10 MHz-18 GHz
HP 8477A Power Meter Calibrator, for HP 432 series ... $500.00
HP K486A WR42 Thermistor Mount, ... $350.00
18.0-26.5 GHz, for 432 series
HP Q8486A Power Sensor, ... $1,500.00
33.0-50.0 GHz, WR22, for 435/6/7/8
HP R486A WR28 Thermistor Mount, ... $350.00
26.5-40 GHz, for 432 series
HP R8486A WR28 Power Sensor, ... $1,500.00
26.5-40 GHz, for HP 435/6/7/8

RF MILLIVOLTMETERS

BOONTON 92B-opt.05 RF Millivoltmeter, ... $500.00
10 kHz-1.2 GHz, 75 Ohms scale
RACAL 9303 TRMS Level Meter, ... $875.00
10 kHz-2 GHz, -77 to +23 dBm, GPIB

AMPLIFIERS, MISCELLANEOUS

AMPLIFIER RES. 1W1000 Amplifier, ... $650.00
30 dB gain, 1-1000 MHz, 1 Watt output
BOONTON 82AD-opt.01A Modulation ... $750.00
Meter, AM, FM, 10-1200 MHz, GPIB
HP 415E SWR Meter ... $200.00
HP 465A Amplifier, 20/40 dB, ... $125.00
5 Hz-1 MHz, 1/2 Watt/50 Ohms
HP 8447A Amplifier, 20 dB, ... $375.00
0.1-400 MHz, 5 dB NF, +6 dBm output
HP 8447E Amplifier, 22 dB, 0.1-1300 MHz, +13 dBm output ... $750.00
HP 8901A Modulation Analyzer, 150 kHz-1300 MHz ... $2,500.00
HP 8901B-1,2,3 Modulation An., ... $3,000.00
0.15-1300 MHz, rear input, OCXO, ext.LO
HP 8970A Noise Figure Meter ... $4,000.00
HUGHES 1177H02F000 TWT Amplifier, ... $1,500.00
4.0-8.0 GHz, 10 Watts output
ROHDE & SCHWARTZ ESH2 ... $5,000.00
Test Receiver, 9 kHz-30 MHz

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AMERICAN NUCLEONICS AM-432 ... $95.00
Cavity Backed Spiral Antenna,LHC, 2-18 GHz,TNC(f) *NEW*
AVANTEK AMT-4000X2 WR28 Active ... $450.00
Doubler, 13-20 GHz +10 dBm in, +10 dBm out
BAYTRON 3-28-300/10 WR28 ... $300.00
Directional Coupler, 10 dB, 26.5-40 GHz
BIRD 4410A/4410-3 Wattmeter, ... $400.00
2-30 MHz, 10 W - 1 kW f.s., N(f/f)
BIRD 6735-300 1 kW Load, ... $650.00
25-1000 MHz, LC(f), with wattmeter
BIRD 8201 500 Watt Oil Cooled Load, DC-2.5 GHz, N(f) ... $350.00
CONTINENTAL MW. RAE28-K-M ... $225.00
WR28 x K(m) Endfire Adapter
FXR/MICROLAB S3-02N Triple ... $125.00
Stub Tuner, 200-1000 MHz, 100 Watts max., N(m/f)
GR 874-LTL Constant Impedance ... $400.00
Trombone Line, 0-44 cm, DC-2 GHz
HP 11590A-001 Bias Network, 1.0-18.0 GHz, APC7 ... $450.00
HP 11636A 2-Way Power Divider, DC-18 GHz, N(m/f/f) ... $300.00
HP 11692D Dual Directional Coupler, 22 dB, 2-18 GHz ... $800.00
HP 33321K Programmable Step Atten., ... $475.00
0-70 dB, DC-26.5 GHz, 3.5mm
HP 33327L-006 Programmable Step ... $1,200.00
Attenuator, 0-70 dB, DC-40 GHz, 2.9mm
HP 774D Dual Directional Coupler, ... $275.00
20 dB, 215-450 MHz
HP 777D Dual Directional Coupler, 20 dB, 1.9-4.1 GHz ... $275.00
HP 778D-011 Dual Dir. Coupler, ... $450.00
20 dB, 100-2000 MHz, APC7 test port
HP 8431A 2-4 GHz Band Pass Filter, N(m/f) ... $150.00
HP 8494G-002 Programmable ... $350.00
Step Attenuator, 0-11 dB, DC-4 GHz, SMA
HP 8495H-002 Programmable Step ... $400.00
Attenuator, 0-70 dB, DC-18 GHz, SMA
HP 8497K-004 Programmable ... $750.00
Step Attenuator, 0-90 dB, DC-26.5 GHz
HP K382A WR42 Direct Reading ... $2,900.00
Attenuator, 0-50 dB, 18-26.5 GHz
HP K422A WR42 Flat Broadband Detector, 18.0-26.5 GHz ... $350.00
HP K532A WR42 Frequency Meter, 18.0-26.5 GHz ... $450.00
HP K870A WR42 Slide Screw Tuner, 18.0-26.5 GHz ... $275.00
HP K914B WR42 Moving Load, 18.0-26.5 GHz ... $300.00
HP Q752D WR22 Directional Coupler, 20 dB, 33-50 GHz ... $650.00
HP R382A WR28 Direct Reading ... $2,000.00
Attenuator, 0-50 dB, 26.5-40 GHz
HP R422A WR28 Crystal Detector, 26.5-40 GHz ... $400.00
HP R532A WR28 Frequency Meter, 26.5-40 GHz ... $500.00
HP R752C WR28 Directional Coupler, 10 dB, 26.5-40 GHz ... $450.00
HP R752D WR28 Directional Coupler, 20 dB, 26.5-40 GHz ... $450.00
HP R914B WR28 Moving Load, 26.5-40 GHz ... $250.00
HP V365A WR15 Isolator, 25 dB, 50-75 GHz ... $750.00
HP V752D WR15 Directional Coupler, 20 dB, 50-75 GHz ... $650.00
HP X870A WR90 Slide Screw Tuner ... $150.00
HUGHES 45712H-1000 WR22 Frequency Meter, 33-50 GHz ... $900.00
HUGHES 45714H-1000 WR15 Frequency Meter, 50-75 GHz ... $900.00
HUGHES 45716H-1000 WR10 Frequency Meter, 75-110 GHz ... $900.00
HUGHES 45721H-1000 WR28 ... $900.00
Direct Reading Attenuator, 0-50 dB, 26.5-40 GHz
HUGHES 45724H-1000 WR15 Direct ... $1,000.00
Reading Attenuator, 0-50 dB, 50-75 GHz
HUGHES 45732H-1200 WR22 ... $250.00
Level Set Attenuator, 0-25 dB, 33-50 GHz
HUGHES 45772H-1100 WR22 ... $400.00
Thermistor Mount, -20 to +10 dBm, 33-50 GHz
HUGHES 45775H-1100 WR12 ... $800.00
Thermistor Mount, -20 to +10 dBm, 60-90 GHz
HUGHES 47316H-1111 WR10 ... $600.00
Tuneable Detector, 75-110 GHz, positive polarity
HUGHES 47741H-2310 WR28 ... $2,000.00
Phase Locked Gunn Osc., 32.000 GHz, +18 dBm
HUGHES 47742H-1210 WR22 ... $2,750.00
Phase Locked Gunn Osc., 42.000 GHz, +18 dBm
HUGHES 47974H-1000 WR15 ... $375.00
SPST PIN Switch, 250 MHz speed, 60-62 GHz response
KRYTAR 2616S Directional ... $200.00
Detector, 1.7-26.5 GHz, K(f/m)/SMC
M/A-COM 3-19-300/10 WR19 ... $450.00
Directional Coupler, 10 dB, 40-60 GHz
MICA C-121S06 Circulator, 17.5-24.5 GHz, SMA(f/m/m) ... $75.00
MIDWEST MICROWAVE ... $40.00
3537 DC Block, 0.1-12.4 GHz, SMA(m/f) *NEW*
MINI-CIRCUITS ZFDC-20-4 ... $25.00
Directional Coupler, 19.5 dB, 1-1000 MHz, SMA(f)
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 368BNM Coaxial High Power ... $500.00
Load, 500 Watts, 2.0-18 GHz, N(m)
NARDA 3752 Coaxial Phase Shifter, ... $1,000.00
0-180 deg./GHz, 1-5 GHz
NARDA 3753B Coaxial Phase ... $1,000.00
Shifter, 0-55 deg./GHz, 3.5-12.4 GHz
NARDA 4000-SERIES SMA Miniature Directional Couplers ... $75.00
NARDA 4226-10 Directional Coupler, ... $275.00
10 dB, 0.5-18.0 GHz, SMA(f)
NARDA 4227-16 Directional Coupler, ... $325.00
16 dB, 1.7-26.5 GHz, 3.5mm(f)
NARDA 4242-20 Directional Coupler, ... $100.00
20 dB, 0.5-2.0 GHz, SMA(f)
NARDA 4247-20 Directional Coupler, ... $200.00
20 dB, 6.0-26.5 GHz, 3.5mm(f)
NARDA 4247B-10 Directional ... $200.00
Coupler, 10 dB, 6.0-26.5 GHz, 3.5mm(f)
NARDA 4799 Level Set Attenuator, 0-15 dB, 4-18 GHz, SMA(f) ... $135.00
NARDA 5070-SERIES Precision Reflectometer Couplers ... $300.00
NARDA 562 DC Block, ... $65.00
10 MHz-12.4 GHz, 100 V max., N(m/f)
NARDA 765-10 10 dB Attenuator, ... $165.00
50 Watts, DC-5 GHz, N(m/f)
NARDA 768-10,-20 10 dB or 20 dB Attenuator, ... $120.00
20 Watts, DC-11 GHz, N(m/f)
NARDA 792FF Variable Attenuator, 0-20 dB, 2.0-12.4 GHz ... $375.00
NARDA 794FM Direct Reading Variable ... $375.00
Attenuator, 0-40 dB, 4-8 GHz
OMNI-SPECTRA 2085-6010-00 Crystal ... $50.00
Detector, 1-18 GHz, negative polarity, SMA(m/f)
PAMTECH KYG1014 WR42 Junction ... $250.00
Circulator, 18.0-26.5 GHz
SONOMA SCIENTIFIC 21A3 WR42 ... $75.00
Circulator, 20 dB, 20.6-24.8 GHz
TRG B510 WR22 Direct Reading ... $1,000.00
Attenuator, 0-50 dB, 33-50 GHz
TRG B528 WR22 Direct Reading ... $1,250.00
Phase Shifter, 0-360 deg.,33-50 GHz
TRG V551 WR15 Frequency Meter, 50-75 GHz ... $600.00
TRG W551 WR10 Frequency Meter, 75-110 GHz ... $750.00
WAVELINE 100060 WR28 Terminated ... $200.00
Crossguide Coupler, 30 dB
WEINSCHEL DS109 Double ... $150.00
Stub Tuner, 1-13 GHz, N(m/f)
WEINSCHEL DS109LL Double ... $150.00
Stub Tuner, 0.2-2.0 GHz, N(m/f)

COMMUNICATIONS

HP 4935A-001 Transmission Test ... $700.00
Set, 20 Hz-110 kHz, battery option
HP 59401A HPIB Bus Analyzer ... $700.00
TEK 1410R NTSC Gen., w/SPG2 ... $800.00
sync. generator, TSG7 color bars
TEK 1411R PAL Gen.,w/SPG12 sync; ... $750.00
TSG11 color bars;TSG13 linearity
TEK 1411R PAL Test Gen., ... $1,000.00
w/SPG12,TSG11,TSG13,TSG15,TSG16
TEK 1411R PAL Test Gen., ... $1,100.00
w/SPG12,TSG11,TSG12,TSG13,TSG15,TSG16
TEK 1411R-opt.04 PAL Test Gen.,w/
SPG12,TSG11,TSP11,TSG13,TSG15,TSG16 ... $1,400.00
TEK 147A NTSC Test Signal Generator, ... $800.00
with noise test signal
TEK 148 PAL Insertion Test Signal Generator ... $700.00
TEK 520A NTSC Vectorscope ... $750.00
TEK 521A PAL Vectorscope ... $750.00

MISCELLANEOUS

FLUKE 2180A RTD Digital Thermometer ... $500.00
HP 7090A Measurement Plotting System ... $1,500.00
P.A.R. 5206-95,98 Two-Phase ... $1,500.00
Lock-in Amp., 2 Hz-100 kHz, GPIB
TEK TM5006 5000-series 6-slot ... $600.00
Programmable Power Module
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

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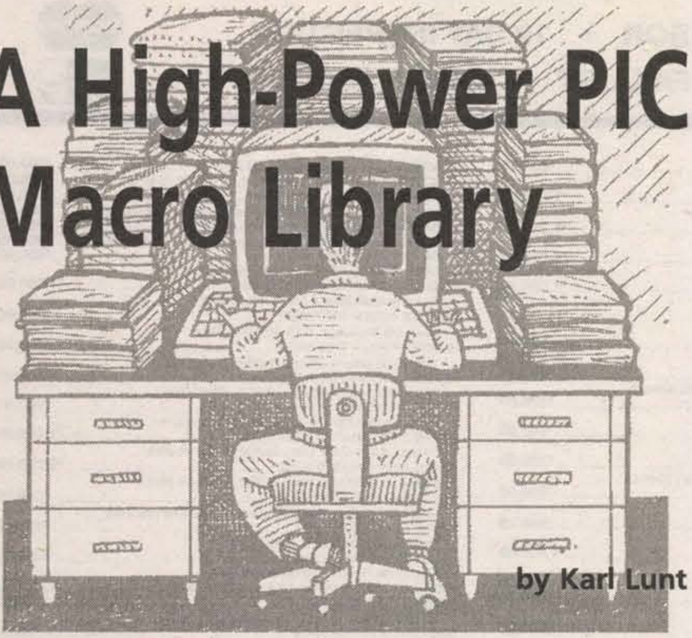
A High-Power PIC Macro Library



by Karl Lunt

The PIC microcontrollers pack a lot of power and speed in a tiny, inexpensive package, but the hobbyist is somewhat limited when it comes to writing software for them. The BASIC interpreter built into the Stamps is slow, the few high-level compilers can be expensive if you're on your own dime, and I've always found the assembler too weird to use.

But PIC assembly language runs so fast, and can be so small, that I wasn't willing to give up on using it. This article describes an extensive library of PIC macros that you can add to your own assembly language projects. Including this library with your PIC source file gives you the power of programming structures such as FOR-NEXT loops and greatly simplifies your code, all with minimal code bloat. Best of all, the library works with the standard Microchip MPASM assembler.

Using the library

You can find the library file — macros.asm — on my web site at www.seanet.com/~karllunt. I've included comments in the file to describe how to invoke each of the many macros. I also describe one or two problems that you'll need to watch for on the older PICs, such as the PIC 16c54.

Just copy the file into your working PIC directory. Next, edit your assembly language source file and add the following line somewhere near the top of the file:

```
include ".\macros.asm"
```

The best place to put this line is immediately following the statement where you include the equates specific to the PIC chip you're using. For example, if your assembly source file targets the PIC 12c508, the first few lines of your source file might look like:

```
include ".\p12c508.inc"
include ".\macros.asm"
```

Note that the macro library assumes that you are using the Microchip equates file for your target MCU, and relies on some common register definitions. If you don't use the Microchip equates file, you will need to provide the required register definitions yourself.

With this change made, you can now invoke any of the supplied macros. Let's take a look at what is available in the macro library.

BEQ and BNE

These are simple, and I use them virtually everywhere. As implemented in the macro library, they check the state of the Z bit in the status register and branch accordingly. You use them immediately after performing some operation that alters the Z bit.

The BEQ macro is of the form:

```
beq     foo     ; if Z is set, branch
                ; to foo
```

where foo is a label somewhere in your source file. If the Z bit is set when this macro is executed, control jumps to label foo. Otherwise, control continues with the next instruction in line.

The BNE macro is nearly identical:

```
bne     foo     ; if Z is clear, branch
                ; to foo
```

where foo is a label somewhere in your source file. If the Z bit is clear when this macro is executed, control jumps to label foo. Otherwise, control continues with the next instruction in line.

FOR-NEXT

The FOR-NEXT family of macros provides an iterated looping structure. This structure gives you a simple way to perform a task a given number of times. The basic form of the FOR macro is:

```
for     var, begl, endl
```

where var is a variable you've chosen to use as the index, begl is a literal for the starting value of the index, and endl is a literal for the ending value of the index.

When the FOR macro first executes, it writes the literal value begl to the index variable var. At the top of the FOR loop, the macro tests the current value in var against the literal value endl; if they match, control exits the looping structure at the associated NEXT macro. If they don't match, control continues with the next statement in sequence. This macro makes it easy to write counted loops. If you need to issue a certain amount of pulses, you could use code such as:

Note that the macro library assumes that you are using the Microchip equates file for your target MCU, and relies on some common register definitions.

```
for   n, 0, 60      ; need to issue 60
                    ; pulses
bsf   portb,1       ; raise a line
bcf   portb,1       ; drop a line
next  n             ; end of loop
```

Note that FOR-NEXT structures — like all of the macro structures in this library — can be nested as deep as you like. This allows you to do some fancy loops:

```
for    x, 0, 10     ; do 10 times
for    y, 30, 50    ; step across y
bsf    portb,3      ; raise a line
bcf    portb,3      ; drop a line
next   y            ; end of y loop
movlw  100          ; need to delay
                    ; now
call   delay        ; do the delay
next   x            ; end of x loop
```

As you can see, the macros save you from having to muck about with the W register and the flag bits. They also take care of all the labels and goto opcodes used in such operations. Thus, you get to focus more on what you want the program to do, and spend less time on how it gets done.

The FOR macro uses a pair of literals; one for the starting value of the index and one for the ending value. Sometimes, however, you need to use a variable to hold the ending value. In such cases, you can use the FORF (for-flag) version of this macro:

```
forf    var, begl, endf
```

where var is a variable you've chosen to use as the index, begl is a literal for the starting value of the index, and endf is a variable that holds the ending value of the index.

This macro works just like the basic FOR macro above, with one important difference. When this macro tests the index variable to see if the loop should end, it uses the value in the variable endf. This means your code could modify the endf variable, resulting in a FOR-NEXT loop that runs a variable number of iterations.

A typical use of this structure might be:

```
forf  n, 0, steps  ; need to issue
                   ; some pulses
bsf   portb,1      ; raise a line
bcf   portb,1      ; drop a line
next  n            ; end of loop
```

where the actual number of pulses to issue isn't known when you write the assembler source, but is held in the variable steps when the program runs.

Both versions of the FOR macro above end with a NEXT macro that refers to the same variable name. The basic NEXT macro looks like this:

```
next     var
```

where var is the same index variable used in the matching FOR or FORF macro.

It is important that you match the FOR or FORF index variable with the corresponding NEXT index variable. The NEXT macro adds one to the index variable and loops back to the matching FOR macro so the variable can be tested. If the variables don't match, the FOR index variable will never change and the loop will never end.

In some cases, you need to add more than one to the index variable at the NEXT macro. This is similar to BASIC's FOR-NEXT-STEP structure. I've included the NEXTL macro to provide that capability. This macro looks like:

```
nextl    var, incl
```

where var is the same index variable used in the matching FOR or FORF macro, and incl is a literal that is added to the index variable. For example, the following loop steps through several odd integers:

```
for      n, 1, 31 ; start of loop,
                  ; n = 1
nextl    n, 2     ; end of loop, add
                  ; 2 to n each time
```

NOTE: The NEXTL macro contains an addlw instruction, one of the newer PIC opcodes. Thus, older devices – such as the 16c54 – cannot execute this macro. If you assemble a source file for the 16c54 or similar processors, and the assembler detects this instruction, it will issue an assembler error.

To complete the package, the NEXTF macro works just like the NEXTL macro, but it instead adds the value in a variable to the index variable:

```
nextf    var, incf
```

where var is the same index variable used in the matching FOR or FORF macro, and incf is a variable whose contents are added to the index variable. This lets you create loops that execute a variable number of times:

```
for      n, 1, 31  ; start of loop,
                   ;n = 1
nextf    n, steps  ; end of loop, add
                   ; steps to n each
                   ; time
```

REPEAT structures

In some cases, you need to create a conditional loop. That is, you need a structure that loops until a specific condition exists or ceases to exist. For that, I've built the REPEAT series of structures. The REPEAT macro marks the beginning of the structure, and is of the form:

```
repeat
```

Exactly what type of structure you create depends on what macro you use to match up with this REPEAT macro. The simplest such structure is the unconditional loop, built from the REPEAT and ALWAYS macros. Here, control endlessly executes the code between the REPEAT and its matching ALWAYS macro. For example:

```
repeat              ; start an endless
                    ; loop
bsf     portb,1     ; raise a line
bcf     portb,1     ; drop a line
always              ; do forever
```

You can build a conditional loop using the UNTILEQ macro with the REPEAT macro. This combination yields:

```
repeat
untileq
```

Now control executes the code between the REPEAT and UNTILEQ macros until the Z bit in the status register is set when the UNTILEQ macro executes. The instructions just prior to the UNTILEQ should perform some operation to test for the ending condition, with the ending condition signaled by setting the Z bit. For example:

```
repeat              ; start a loop
movfw   portb       ; read a port
andlw   0x20        ; leave only bit 5
untileq             ; loop until bit 5 is
                    ;low
```

Here, the Z bit will be set when the W register is 0 after executing the AND operation; that is, when bit 5 of portb is 0.

Exactly what type of structure you create depends on what macro you use to match up with this REPEAT macro.

The macro library provides the matching and opposite function with the UNTILNE macro. It works just like the UNTILEQ macro, except that control loops until the Z bit is cleared when the UNTILNE macro executes. The above example could be rewritten as:

```
repeat              ; start a loop
movfw   portb       ; read a port
andlw   0x20        ; leave only bit 5
untilne             ; loop until bit 5 is
                    ; high
```

Now the loop repeats until bit 5 of portb goes high. This condition leaves the Z bit cleared when the UNTILNE macro executes, and control leaves the loop.

SELECT-CASE structures

The SELECT-CASE structure acts as a large switch table, allowing your code to take one of several paths, based on the value of a selector variable. The general format of a SELECT-CASE structure looks like this:

```
select
case
 .
 .
endcase
case
 .
 .
endcase
 .
endselect
```

This general description shows how a SELECT statement marks the beginning of the structure. If the selector variable holds the value called for in the first CASE statement, then code between that CASE statement and its matching ENDCASE statement is executed. If not, then the selector variable is tested against each successive CASE value in turn.

If the selector variable does not match any CASE value, the code immediately following the last ENDCASE statement, if any, is executed as a default. After executing any CASE block of code, control passes immediately to the matching ENDSELECT statement, skipping over any intervening CASE blocks.

This creates a very powerful structure, ideally suited for many robotic applications, where functions to be performed depend on the value in some global state variable. As implemented in the macro library, the SELECT macro is simply:

```
select    var
```

where var is the selector variable. When the SELECT macro executes, the underlying code copies the value in variable var into the PIC's W register.

The CASE macro actually tests the contents of the W register; the macro looks like this:

```
case          lit
```

where lit is a literal value used for testing. When the CASE macro executes, it compares the literal value lit against the contents of the W register. If they match, the code immediately following the CASE statement is executed. If, however, they don't match, control passes to just below the matching ENDCASE statement.

This macro library makes heavy use of the powerful macro operators built into the Microchip MPASM assembler.

Note that regardless of whether the test passes or not, the contents of the W register are preserved. Thus, code following the CASE statement may rely on the W register containing the literal value called out in the CASE statement.

The ENDCASE macro marks the end of a CASE-ENDCASE structure. This macro looks like:

```
endcase
```

There must be a matching ENDCASE macro for each and every CASE macro. When code inside a CASE-ENDCASE block hits the ENDCASE macro, control passes immediately to the ENDSELECT macro that closes out the current SELECT-ENDSELECT structure. The ENDSELECT macro marks the end of a SELECT-ENDSELECT structure. This macro looks like:

```
endselect
```

There must be a matching ENDSELECT macro for each and every SELECT macro. If any code exists between the final ENDCASE macro and an ENDSELECT macro, that code is treated as a default case. This means that any time a selector value fails all CASE tests, the code after the final ENDCASE is executed.

An example should make all of this clearer:

```
select    foo        ; use foo as the
                     ; selector variable
case      5          ; if foo = 5...
bsf       portb, 1   ; raise a line
endcase              ; all done
case      8          ; if foo = 8...
bcf       portb, 1   ; drop the line
endcase              ; all done
incf      count      ; default, not 5 or
                     ; 8, count it
endselect            ; end of select
                     ; structure
```

Here, I've used the variable foo as the selector value. The SELECT macro copies foo into the W register. The first CASE statement compares W to the literal 5. If they match, the code sets bit 1 of portb, then jumps to the ENDSELECT macro. If they don't match, the second CASE statement compares W to the literal 8. If they match, the code clears bit 1 of portb, then jumps to the ENDSELECT macro. If they don't match, then foo contained neither 5 nor 8.

In this case, the default code following the last ENDCASE is executed, incrementing the variable count. Finally, control falls through to the ENDSELECT macro.

The macro library contains an alternate form of the CASE macro, useful when you need to test the selector value against another variable, rather than a literal. The CASEF macro looks like:

```
casef    var
```

where var is a variable whose contents are compared against the W register. This means you can write CASE structures such that the test values aren't known at assembly time, but are created in the code at run time.

WAITWHILE and WAITUNTIL

These macros create very small, very fast loops that block, or wait, until a specific condition exists or ceases to exist. They are ideal for monitoring one or more I/O lines for an input condition. The WAITWHILE macro looks like:

```
waitwhile          addr, andl, xorl
```

where addr is the port register to monitor, andl is a literal value used as an AND mask, and xorl is a literal value used as an exclusive-or (XOR) mask.

This macro creates a small loop that reads the value in the port register at address addr, ANDs that value with the literal andl, then XORs the result with the literal xorl. This sequence of operations repeats for so long as the final result is non-zero. Control does not leave the WAITWHILE macro until the final result is zero. At that time, control passes to the statement following the WAITWHILE macro.

The use of the andl as an AND mask should seem obvious. It isolates only those bits in the port register value that match bits in the andl literal. A mask value of $0f, for example, lets your code test the lower four bits of an address without caring what happens to the upper four bits.

The XOR mask may not seem so obvious. This effectively inverts the state of selected bits, allowing your code to test for active-low inputs. For example, suppose bit 2 of the port is active-low, and your code needs to wait while that bit is 0. Using an XOR mask with bit 2 set ($04) inverts that bit, yielding a logic 1 when the input is a logic 0. An example might help:

```
waitwhile          portb, 0x02, 0x02
```

This WAITWHILE macro reads the value in register portb, ANDs that value with $02 to leave only bit 1 intact, then XORs that value with $02 to invert the state of bit 1. If the resulting value is non-zero, control repeats the WAITWHILE macro. Otherwise, control falls through to the statement following the WAITWHILE.

The opposite of WAITWHILE is WAITUNTIL, which loops until a certain condition is non-zero. The WAITUNTIL macro looks like:

```
waituntil          addr, andl, xorl
```

This macro creates a small loop that reads the value in the port register at address addr, ANDs that value with the literal andl, then XORs the result with the literal xorl. This sequence of operations repeats until the final result is non-zero. Control does not leave the WAITUNTIL macro until the final result is non-zero. At that time, control passes to the statement following the WAITUNTIL macro.

Note that if you use a value of 0 for the xorl literal in either of the above macros, the macro does not generate any PIC code for the XOR operation. XORing a value with 0 leaves that value unchanged, so there is no point in generating code for that operation.

POLL and ENDPOLL

The WAITWHILE and WAITUNTIL macros create fast blocking loops, but your code cannot perform any operations inside the loops. The POLL-ENDPOLL structure lets you perform functions inside an I/O polling loop. The POLL macro looks like:

```
poll      port, andl, xorl
```

where port is the address of a port register to monitor, andl is a literal value used as an AND mask, and xorl is a literal value used as an XOR mask.

This macro acts just like the front end of the WAITWHILE or WAITUNTIL macros. It reads the value at the address port, ANDs that value with the literal andl, then XORs the result with the literal xorl. If the resulting value is true (non-zero), control falls through to the next instruction in sequence. If, however, the resulting value is false (zero), control jumps to just below the matching ENDPOLL macro.

Each POLL macro must be paired with an ENDPOLL macro. The END-

POLL macro looks like:

```
endpoll
```

When control reaches the ENDPOLL macro, it returns automatically to the previous matching POLL macro.

Thus, the POLL-ENDPOLL structure lets your code monitor, or poll, a set of I/O lines for a specific condition. If that condition occurs, your code can take appropriate action, as defined inside the POLL-ENDPOLL structure. For example:

```
poll     portb, 0x80, 0x80
incf     count
endpoll
```

Here, the POLL macro tests for a low on bit 7 of portb. If that bit is low, then the variable count is incremented. If, however, that bit is high, control passes directly to the ENDPOLL macro and count is not incremented.

Under the hood

This macro library makes heavy use of the powerful macro operators built into the Microchip MPASM assembler. The following paragraphs will walk you through the design of one of the macros, so you can see

The use of the andl as an AND mask should seem obvious.

how I built it. You can then apply these techniques to create your own macros.

Here is the code specific to the FOR macro. I have added line numbers for reference only; they do not appear in the macro source file:

```
1.        variable _forknt=0
2.        variable _nxtknt=0

3. for    macro    var,begl,endl
4.        movlw    begl
5.        movwf    var
6. _for#v(_forknt)
7.        movlw    endl
8.        subwf    var,w
9.        beq      _next#v(_forknt)
10. _forknt  set  _forknt+1
11. _nxtknt  set  _forknt
12. endm
```

Lines 1 and 2 define two assembler variables that will be used by both the FOR and NEXT macros. Note that these are NOT variables used by your PIC program when it runs. These variables exist only while MPASM assembles your source, and they will only be used by MPASM. I intentionally use a leading underscore on all of my MPASM variable names, to avoid conflicts with PIC variables that you might declare in your program.

Line 3 declares the format of the FOR macro, as required by MPASM. Here you can see that the FOR macro requires three arguments, and you can see the names that they will be given throughout the FOR macro. MPASM is smart enough to know that a macro argument, such as begl, is different from a variable or equate that you have declared elsewhere in your source file.

Lines 4 and 5 copy begl, the literal value used as a starting index, to the index variable var. This code is executed once, when control enters the FOR macro at run-time.

Line 6 shows one of the powerful features of the MPASM macro operators. This line creates an assembler label composed of the characters "_for" followed by the characters for the current value of the assembler variable _forknt. Thus, if _forknt holds the value 3, line 6 will assemble as:

```
_for3
```

Note how the #v() macro operator reads the value of an assembler variable and adds that value to the end of a label. For more details on using the #v() macro operator, consult the MPASM Assembler User's Guide from Microchip.

Lines 7 through 9 test the current value of var against the ending literal value endl. If var matches endl, then the PIC's Z-bit will be set. The beq macro at line 9 will either pass control outside the FOR-NEXT loop if the Z-bit is set, or allow control to fall through to the next line of code if the Z-bit is clear. Note how line 9 again uses the #v() macro operator to build up the label used for the beq target. Here, the label consists of the string "_next" followed by the value in the assembler variable _forknt. Thus, if _forknt holds the value 4, then line 9 will assemble as:

```
beq      _next4
```

Line 10 increments the value in assembler variable _forknt, so the labels created at the next use of the FOR macro will differ from those just created. This ability to modify the values in the assembler variables is another powerful feature in the MPASM macro utility, and is essential to the proper functioning of this library.

Similarly, line 11 changes the value in assembler variable _nxtknt. The FOR macro doesn't use this variable in creating any labels, but it must perform the bookkeeping so the matching NEXT macro does create the correct label. Remember that the NEXT macro must generate a branch back to the top of the FOR macro, at the label in line 6. This adjustment of the assembler variable _nxtknt ensures that the correct branch label will be created.

Finally, line 12 contains the endm psuedo-op, used to indicate the end of a macro definition. This explanation is still pretty theoretical. It may not be clear yet how all of this comes together when the assembler actually processes a FOR macro. Let's finish up with a specific example. Assume that at some point in the assembly of your program, assembler variables _forknt and _nxtknt both hold the value 3. Your program now contains the FOR macro:

```
for      foo, 4, 20
```

Given the above, MPASM will create the following assembler source lines for your macro:

```
4.        movlw   4
5.        movwf   foo
6. _for3
7.        movlw   20
8.        subwf   foo,w
9.        beq     _next3
10. _forknt  set  _forknt+1
11. _nxtknt  set  _forknt
```

I have eliminated all the setup lines from the above FOR macro explanation, leaving only those actually used by MPASM when it processes your FOR macro. Note that the beq opcode in line 9 is itself a macro, so MPASM will expand it as well. I have left the beq unexpanded for clarity.

I've presented a suite of powerful PIC macros that you can add to your own assembler source files.

This example should make clear the power behind the MPASM macro utilities and this macro library. You don't need to match up the labels in the FOR macro with the labels in the corresponding NEXT macro. You don't have to worry that you might have used the ending literal in the FOR initialization, rather than the starting literal. All you have to do is write the FOR macro and match it up with a NEXT macro, and you're done.

That's a wrap

I've presented a suite of powerful PIC macros that you can add to your own assembler source files. These macros provide most of the common programming structures, such as FOR-NEXT and REPEAT-ALWAYS. Additionally, I've added structures such as WAITWHILE and POLL-ENDPOLL that simplify writing embedded control code, where monitoring I/O lines occurs frequently.

I hope you'll look on these macros as a beginning, not an end. Feel free to expand what I've done here. By studying my use of the assembler variables and the #v() macro operator, you should be able to create complex macros of your own. And, as your use of control structure macros increases, writing PIC assembly language programs should become simpler and less frustrating. **NV**

Open Channel

by Joseph J. Carr

Notes on Vibration Detectors and Seismographs — Part I

A number of scientific and engineering instruments measure vibration signals. For example, civil and mechanical engineers can characterize a metal plate or beam by placing a vibration sensor on it, and then giving it an impact.

The idea behind any sensor is to find some "transducible property" that responds to the event being measured.

I've seen one case where students placed strain gauge sensors on a metal beam (Figure 1) and then whacked the other end with a "dead blow" hammer (i.e., a hard rubber hollow mallet filled with B-B shot). The idea behind using the "dead blow" hammer is to prevent bouncing of the hammer from creating more than one blow – it's kinda like "switch contact bounce" with an attitude.

In another case, sensors were placed at critical points on a bridge, and then a small explosive charge was ignited at the other end. The charge was on the order of a cherry bomb (it's called an "M-80") so caused no damage (of course, it's dangerous to use). In both cases, the idea was to cause a single impact, and then record the vibrations in the structure that resulted from it.

If you saw the movie Jurassic Park, then you saw another use of vibration sensors. Early in the movie, before the team was recruited, the paleontologist was researching dinos, presumably in the Rocky Mountains. A shotgun shell blank was held in a rig against the ground and exploded. The seismic waves were recorded on a laptop computer and processed to show the all-too-realistic image of a raptor skeleton (real images are not that good!).

Oil exploration is done the same way. An explosion is set off at a site, and a cluster of vibration sensors around a perimeter are used to sense the vibrations. From their data, the geologists can construct an image of the underlying structure, and from it predict where oil might be found. A friend of mine designed and built a number of systems like this for oil geologists at the University of Texas ... until a drunk driver got him one rainy night near Austin.

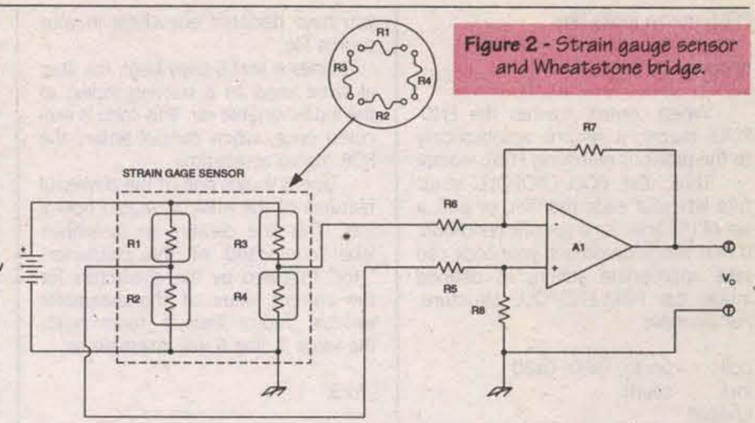


Figure 2 - Strain gauge sensor and Wheatstone bridge.

In other cases, a repetitive blow is delivered to the object under test. The idea is to set the thing into motion, and see what happens. Presumably, standing waves will arise in some cases. It was this type of experiment that led engineers to a better understanding of chaos in mechanical systems. It seems that resonance isn't the only way to destroy a metal beam or plate!

The idea behind any sensor is to find some "transducible property" that responds to the event being measured. A number of things can be used. For example, the strain gauge consists of a thin resistive wire stretched across a membrane or diaphragm (Figure 2). When the wire is deformed, its dimensions change, so its resistance will also change. This phenomenon is called piezoresistivity. When the strain gauge resistor is used in a Wheatstone bridge, then a sensitive measure of the deformation caused by vibration can be obtained. The circuit in Figure 2 is used for a lot of strain gauge sensors. The output of the Wheatstone bridge is fed to a differential amplifier (A1), where it is boosted to a usable level.

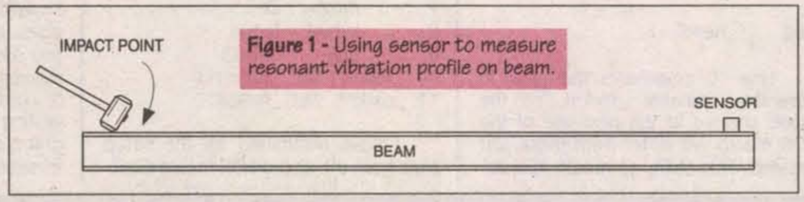


Figure 1 - Using sensor to measure resonant vibration profile on beam.

Another transducible property for vibrations is the inductance of a coil, as shown in Figure 3A. The inductance of the coil of wire is determined by the number of turns, diameter of the coil, the length of the coil, and the nature and position of the core. If a ferrite or powdered iron core is used, then a large increase of inductance occurs when the core is slipped into the coil form. "Slug-tuned" inductors are used in radio circuits. A threaded core is adjusted to be more or less inside the coil, depending on the value of inductance required. Vibration sensors can be made by placing the core on a spring, pendulum, or some other means of translating the motion caused by vibration into motion of the core ... and therefore a change of inductance.

In Figure 3B, a pendulum is used to move the core in and out of the coil form. This only works, however, if the coil form is arced to accept the

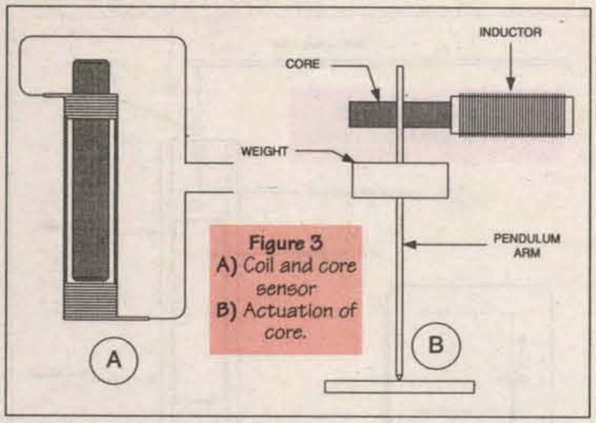


Figure 3
A) Coil and core sensor
B) Actuation of core.

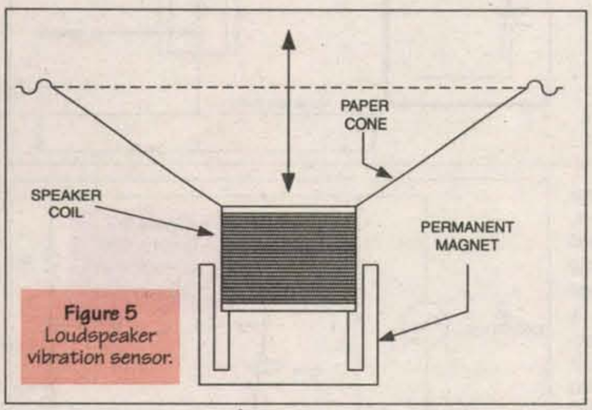


Figure 5
Loudspeaker vibration sensor.

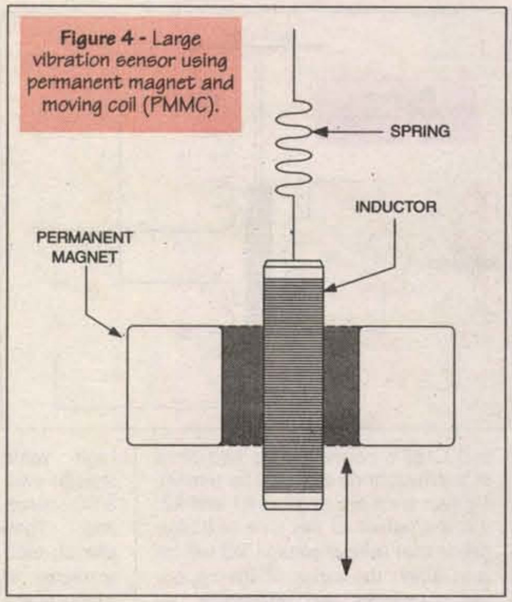


Figure 4 - Large vibration sensor using permanent magnet and moving coil (PMMC).

pendulum swing, or if there is mechanical linkage to translate the arced motion of the pendulum to the linear motion of the core.

There is a class of motion sensors that depends on the fact that a magnetic field and coil in motion relative to each other causes a current to be induced into the coil. It doesn't matter whether the coil moves or the magnet moves, so long as there is relative motion.

Figure 4 shows a crude form of a permanent magnet moving coil (PMMC) vibration sensor. A horseshoe magnet is positioned such that an inductor can move inside of its field. The coil, which may have many, many turns, is connected to a spring. When vibration is sensed, the coil moves up and down against the spring, causing a current to be induced because of the magnetic field.

A more familiar example is something that you might not at first see as a vibration sensor. The ordinary radio or television loudspeaker (Figure 5) will do this neat trick. The PMMC loudspeaker consists of a fixed permanent magnet (usually made of Alnico), and a lightweight moving coil that is attached to the paper speaker cone. When an electrical current from the radio output stage flows in the coil, it will produce a magnetic field that either attracts or repels the permanent magnet's field, depending on the polarity of the audio signal. Thus, as the polarity of the audio signal switches back and forth, the coil and cone move in and out.

The same loudspeaker that can be used as a radio output device can also be used as a microphone. Intercom sets that allow talk-back use this phenomenon. When sound vibrations impinge the cone, it will move the coil relative to the magnet causing a current to be induced into the coil. This tiny current can be amplified and used as an audio signal.

Note that word in the previous paragraph: vibration. I judge science fairs, and once saw a kid use a six-inch loudspeaker as a clever vibration sensor. If the vibrations being measured can be coupled to the speaker cone, then the speaker will act as a vibration sensor. I've seen speakers placed flat against metal plates for the purpose of recording vibrations. The science fair student cemented a plastic drinking straw against the bottom of the speaker cone, and used it to couple to the vibration source. Essentially, the kid made a large-scale "spike microphone."

Linear Differential Voltage Transformers (LDVT)

Figure 6 shows a special form of large vibration or displacement sensor called a linear differential voltage transformer (LDVT). It consists of three inductors (L1 through L3). Inductor L1 is excited by an AC signal, which is magnetically coupled to secondary coils L2 and L3. When the core is exactly midway between L2 and L3, the currents flowing in them will be identical. The dots indicate the phasing of the two secondary coils. Because of the connection of L2 and L3, the currents are in series opposing. Thus, when the core is midway, the currents are equal and opposite, so null to zero. But when the core is offset in one direction or another, then one of the coil currents will predominate.

The amplitude of the output signal (expressed as a voltage) gives us an indication of the magnitude of the core shift, while the polarity tells us the direction. When the core is coupled to something like a pendulum or diaphragm, then the vibrations received will move the core in and out of the coil-pair ... causing an AC output signal to appear.

Differential Capacitor Sensors

Capacitance exists whenever two metallic objects are in close proximity to each other, and are separated by an insulating material (i.e., "dielectric"). Such a device is called a capacitor. Capacitance is a measure of the capacitor's ability to store an electrical charge in an electrical field set up between the plates. The value of capacitance is proportional to the area of the metal surfaces and a property of the dielectric called the dielectric constant ($\varepsilon = 1$ for dry air), and inversely proportional to the distance between the metal surfaces (in other words, the closer together they are, the higher the capacitance).

Capacitors are used in a variety of electronic applications. But in this particular case, we are interested in a class of capacitors that are variable, and can be made to vary under the influence of vibration.

Differential Capacitors. This class of variable capacitor actually consists of two variable capacitors actuated by the same shaft or other mechanical device. They are configured such that one capacitance increases its capacitance while the other decreases its capacitance in the same manner. If you were to measure the total capacitance across the two capacitors, then you would find that the net capacitance does not change even though the values of the two capacitor sections does.

Figure 7 shows a large vibration sensor that works on the differential capacitance phenomenon. The two capacitors are formed by two metal cylinders (C1 and C2), separated by a small dielectric gap of air or other material. These cylinders share a metal plunger that is inside and axially concentric with them. An insulating sleeve prevents the plunger (the "common plate" of the differential capacitor) from shorting out against either cylinder. When the plunger is equally inside both cylinders, favoring neither, then their respective capacitances are equal. But if the actuating arm moves, then the plunger will move more deeply into one cylinder and out of the other. As a result, the ratio of the two capacitances changes.

The inset in Figure 7 shows the equivalent circuit schematic for the differential capacitor vibration and displacement sensor.

A circuit for using a differential capacitance sensor is shown in Figure 8. The differential capacitor (C1A and C1B) is connected as two arms of a Wheatstone bridge. The remaining two arms are resistors R1 and R2. It is the nature of this type of bridge circuit that output voltage VO will be zero when the ratios of the capacitive reactances and resistances are equal:

$$\frac{X_{C1A}}{X_{C1B}} = \frac{R1}{R2} \quad V_O = 0$$

If R1 = R2, the output voltage will be zero when the differential capacitor is balanced, i.e., C1A = C1B. When vibration or other motion displaces the plunger, however, C1A ≠ C1B, so the bridge is unbalanced and V_O is non-zero. The amplitude of V_O depends on the amplitude of the mechanical displacement of the plunger.

Other forms of circuit can be used with a differential capacitive sensor. For example, the two capacitors (C1A and C1B) can be used to control the frequency of radio frequency oscillators. When C1A = C1B, then the two frequencies would be equal, but a change in that equality will force the frequencies apart. One frequency will rise, while the other will fall. If the two frequencies are combined in a non-linear mixer, then the resultant heterodyne beat note will be proportional to the deflection of the plunger. A frequency-to-voltage (F/V) converter or other form of circuit can be used to produce the analog waveform.

Another approach is shown in Figure 9. It is derived from a sensor called the Shackleford-Gunderson seismometer. In this type of sensor circuit, the common plate of the capacitor is excited by a 4 to 6 MHz RF signal, and the other two are used as "receive antennas." When the detected and integrated outputs of these receive antennas are combined, the resultant signal is proportional to the vibration.

Still another approach is to charge the capacitors through a high value resistor with a DC source, and then use an electrometer to measure the voltage across the capacitors. The voltage will be proportional to the charge which, in turn, is set by the capacitance. The result is that the two DC voltages will vary according to the position of the plunger. Note: "Electrometers" are amplifiers with extremely high input impedances, so can be used to measure the charge developed across small value capacitors.

Another form of differential capacitor vibration sensor uses a pendulum (Figure 10) to move a metal disk between two sections of the capacitor. One inset shows the schematic symbols for C1A/C1B, while the other shows a top view of the capacitor/pendulum. The stator plates of C1A and C1B are made with bits of sheet metal, or blank unetched printed circuit board stock (which might be easier to work).

Two sets of plates are used for each capacitor, and they are connected together. As the pendulum bob swings back and forth, it will "shade" more or less of each set of stator plates depending on the amplitude and direction of the swing. Similar circuit strategies as above will also work for this sensor. **NV**

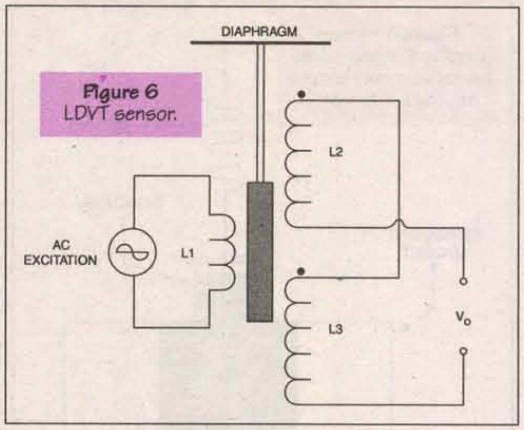


Figure 6 LDVT sensor.

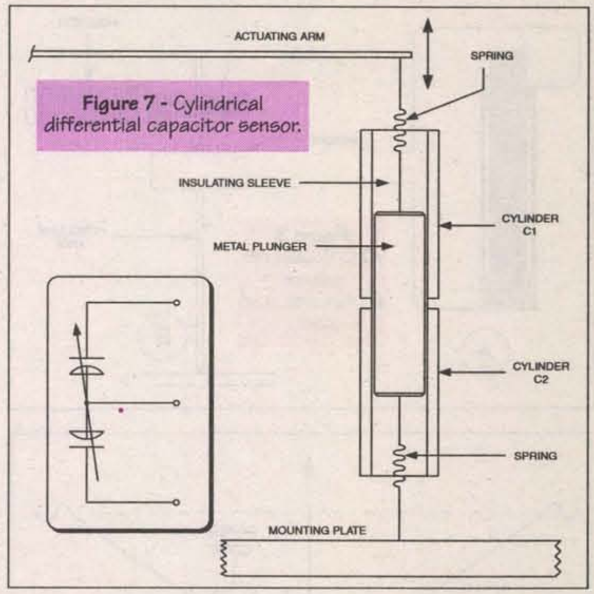


Figure 7 - Cylindrical differential capacitor sensor.

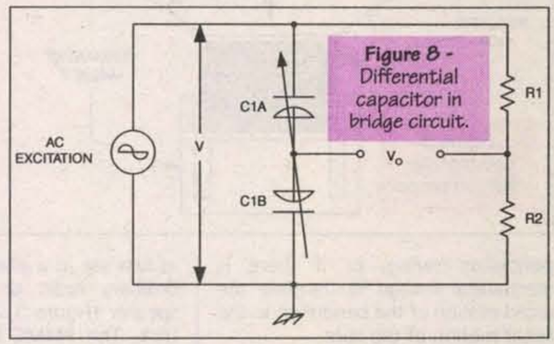


Figure 8 - Differential capacitor in bridge circuit.

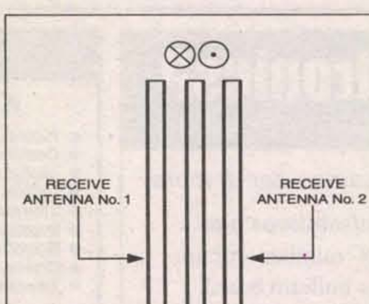


Figure 9 - Differential receive antenna capacitive sensor.

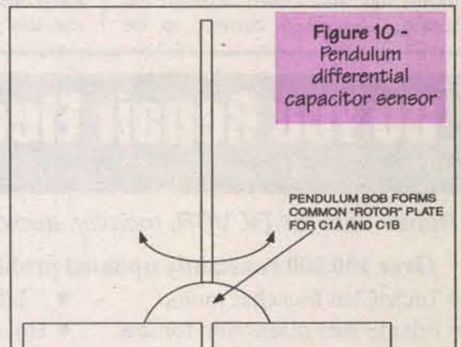


Figure 10 - Pendulum differential capacitor sensor

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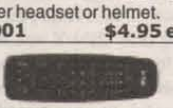

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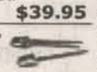

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MUS3C $7.95 each

TELEPHONE SPEECH NETWORK

With Dialer Interface
Telephone line powered. Adjustable gain. Works with electret mike and receiver or earphone. Impedance 150 Ohms or higher. Provides regulated voltage for external CMOS dialer. With docs.
97V005 $4.95 each

100 FEET RG/58U CABLE

With BNC male connectors.
97W028 $19.95 each

12VAC 1A WALL WART

Input 120VAC, 60Hz, 16W. Phone plug. 3.5mm plug size.
98E001 $4.95 each

14-DAY PROGRAMMABLE TIMER

Originally used to control a satellite receiver through its IR port. Time on/off for eight distinct events. Modify it for your needs or dismantle it for its parts. Programmable with a 2732 EPROM in a removable "personality" module, the unit may be modified to control any IR device through its IR port. Contains Z80 CPU, clock display and associated parts. Operates from 9VDC 500mA wall transformer which is included.
92V014 $9.95 each

NEC AMPLIFIED SPEAKERS

Use to amplify output of tape or portable radio, or as multimedia speakers. Excellent sound quality for their size. Approx. 30 watts, line out for recording, and earphone jacks. Simple schematics to build your own power supply included. ±15VDC @ 1A. Approximate size: 11"H x 5"W x 5"D.
98V013 $9.95/pr.

NEC SPEAKERS with POWER SUPPLY SEMI KIT

These speakers have crisp quality and deep bass. The kit provides the transformer, rectifier, and cable; everything needed to power our NEC speakers (98V013).
98V015 $14.95

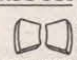
NEC SPEAKERS with POWER SUPPLY

This includes a pair of amplified NEC speakers, factory power supply, and cables.
98V015 $19.95

"FLUKE TYPE" METER PROBE KIT

Shrouded type banana plugs fit Fluke and other popular DMMs.
97Z017 $4.95 set

NEODYMIUM MAGNETS



100+ Gauss each. Size approx 0.5" sq. x 0.125".
92N003 6 for $9.95

VIDEO SWITCHING CENTER

This switch box has four inputs and three outputs. Console-mounted switches and instructions allow you to switch between a wide choice of video sources.
95V020 $9.95 each

TV INTERNAL A-B SWITCH

12VDC @ 15mA controls relay. Non-latching. Remotely switches between two signals. Specs included.
98G001 $7.95 each

ELECTRONIC COMPASS KIT

A Global Positioning System receiver may be the ultimate location finder device, but for casual hiking, biking or camping this amazing digital electronic compass is an economical alternative. The compass kit uses an advanced Hall-effect sensor to detect the earth's magnetic field and converts te information into a directional display. Runs on 9V battery.
97K001 $32.00 each

60 MHz SCOPE PROBE

Attenuation: X1 @ 15 MHz, 60 pF or X10 @ 60 MHz, 12 pF. Working voltage: 600VDC (including AC peak). Working temperature range: -13 deg. F (-25 deg. C) to 158 deg. F (70 deg. C). Compensation range: 15pF to 50pF. American-made.
94Z001 $19.50 each

100 MHz SCOPE PROBE

Attenuation: X1 @ 10 MHz, 75pF, X10 @ 100 MHz, 11pF. Working voltage: 600 VDC (including AC peak). Compensation range: 15-50 pF. Include 6" ground lead, spring hook, BNC adapter, I.C. tip, insulating tip, and trimmer tool. American-made.
94Z002 $24.50 each

SURFACE MOUNT TOOL

The Handi-Vac® is used to remove/replace surface mount components. Vacuum to lift the part is generated by the squeeze bulb. Four suction cups complete the ensemble for handling all types of delicate components. Of course, everything is anti-static.
HV-Kit $9.95 each

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1KHz-1MHz frequency range. Material 33. Approx. 150nH/T² for short coils centered on the rod. Approx. 50nH/T² for windings covering the full length of the rod. 5.875" long by 0.5" dia. Docs included.
98P005 $4.95 each

RS232 CABLE

25-ft, DB25-M to DB25-F.
97W019 $9.95 each

REMOVABLE HARD DRIVE

Syquest SO555 44MB removable SCSI cartridge hard drive. (Removed during upgrade)
97C024 $9.95 each

MINIATURE FOLDED HORN SPEAKER

8 Ohms impedance. Frequency response ±6dB, 120 Hz to 14 KHz. Use two in parallel for sound enhancement. Applications include multimedia (connects into sound card), ham radio (visor mount), etc. Measures only 3½" x 4½" x 1½". Incredibly good sound for such a small speaker!
95V017 $1.49 each

24V DIAPHRAGM AIR PUMP

24VDC @ 400mA (max.), Free air 0.3 CFM. Max. pressure approx. 11 lbs. Max. vacuum approx. 28"Hg. Dimensions 4"W x 4½"L x 3½"L.
99U002 $19.95 each

30V POWER SUPPLY

This desktop power supply is 30V @ 400mA. Center negative. 3mm X 6.5mm plug size.
99E005 $7.95

COMBO PACKAGE

This includes everything you need to hook up our 24V air pump (99U002) and our 30V power supply (99E005).
99U005 $24.95

24VDC @ 25A LAMBDA SWITCHING POWER SUPPLY

24VDC @ 25A (up to 40°C). Input 187-250 VAC, 790W, 0.7pF (260-350 VDC). Size 4.5" x 5" x 13". Weight approx. 9.5 lb.
98E027 $74.95

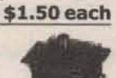
LAPLINK CABLE

Six-ft. "competition yellow" DB-25M to DB-25M cable. Works with LapLink, pcAnyWhere, or Win95/98 Direct Cable Connection and similar programs.
98W005 $5.95 each

PLANO-CONVEX LENS

21mm (5/8") dia. Focal length 25mm (approx. 1").
97L018 $1.50 each

STEPPER MOTOR



400 step/rev. (0.9°/step). NEMA 17 size, 2.5 cm deep, ball bearing, 5mm dia. shaft front and rear. Front shaft has a sleeve pinned to it to make it 7mm dia. by 1.5cm long. Bipolar 70 Ohm coils. Menebea (Japan) P/N 16PY-Q203-01.
96M005 $4.95 each

BIPOLAR STEPPER MOTOR DRIVER IC

600mA output current capability per channel. 1.2A peak output current (non-repetitive) per channel. Enable facility. Temperature protection. Logical "0" input voltage up to 1.5V (high noise immunity). Internal clamp diodes. With documentation.
L293D $3.00 each

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ELECTRONICS Q & A

With TJ Byers

In this column, I answer questions about all aspects of electronics, including computer hardware, software, circuits, electronic theory, troubleshooting, and anything else of interest to the hobbyist. Feel free to participate with your questions, as well as comments and suggestions. You can reach me at:

TJBYERS@aol.com
TJBYERS@juno.com
or by snail mail at Nuts & Volts Magazine, 430 Princeland Ct., Corona, CA 91719.

What's Up:

• EL lamp circuits galore! *See the companion article on page 82.* • Other laptop display problems. • More DSS solutions, and simplification of two previous answers: • a remote thermometer and • garage trigger device. • Two gel-cell chargers, and • a great IC find for zero-crossing, • noise-free dimmer circuits, plus • some computer music. Finally, • feedback from our readers that add a honing edge to previous answers. Enjoy!

More PC Screen Problems

Q. Recently, a friend was given an AT&T Safari computer, a circa 1993 Intel-based 386 notebook. She's not a computer person, but would like to use it with Microsoft Word and likes the small footprint. The problem is that the LCD display backlight doesn't work, and the display is virtually impossible to read without the backlight. There's an external monitor port which works fine, so the problem has to be in the LCD display. I would like to fix the backlight, if possible, but I've been unable to find any info from either AT&T or NCR. The light does flash at power down, which makes me suspect it's trying to work. Would you have any ideas or info?

Andy
via Internet

A. The backlight is a Cold Cathode Fluorescent Tube (CCFT). The lamp life of a CCFT is defined as the time when either of the following conditions occurs in continuous operation:

- The brightness becomes 50 percent of the original value.
- The kick-off voltage exceeds the maximum value.

Most of today's CCFT backlights are rated for 10,000 hours of operation. Depending on the display, you may be able to replace the backlight yourself. However, I don't recommend doing this unless you've cracked open a laptop computer before. There's a lot more to break under the display just by removing a couple of screws. Call your local PC repair shops and see if it's worth it (these old lamps aren't cheap, and I recently bought a refurbished IBM 486 notebook for less than $500.00).

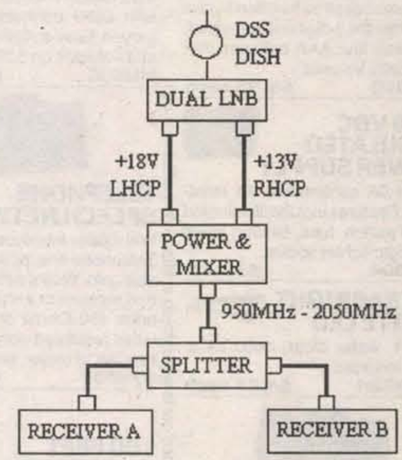
DSS Signal Splitting?

Q. The conventional wisdom within the Direct Satellite Systems (DSS) community is that the signal cannot be split at the Low Noise Blockdown (LNB) amplifier. If you want two set-top Integrated Receiver Decoders (IRDs), you need a dual LNB with two coaxial downlinks. Why can't I simply put a splitter at the LNB and run a coax cable from each side of the splitter (two total) to each of two receivers, like I do with my cable TV? The clerks at RadioShack, Circuit City, and Best Buy (etc.) have no idea, of course. (Their stock answer is, "Uhh, that's just the way it is, man ...") So do you know why? Is the signal too weak, cross-modulated, or maybe there's a power supply conflict? Am I oversimplifying things?

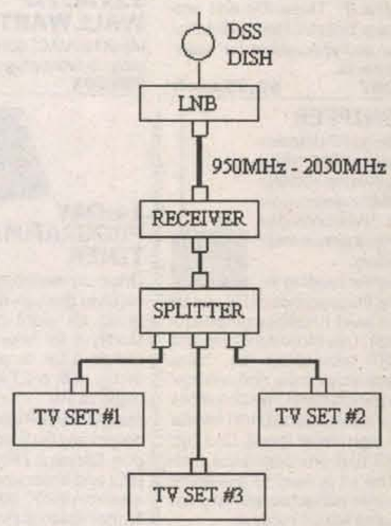
Mike Quinn
via Internet

A. Actually, it's a combination of factors, but here's the bottom line. In order to cram more signals into a very sharply focused beam from outer space, the DSS signals are polarized into right-handed circular polarization (RHCP), dubbed vertical, and left-handed circular polarization, called horizontal. The polarization selection of the desired signal is done at the dish by the LNB via a voltage applied to the downlink coax: +13 volts will select vertical (RHCP) signals, whereas +18 volts will select horizontal (LHCP) signals. Different channels can appear on different transponders, which get sorted out by cross polarization. The receiver knows what channels are on which transponders, and thus when you select a particular channel, it knows what voltage to send to the LNB for the appropriate polarization.

This scheme works great for a single receiver, but what happens when you have two receivers in parallel, each trying to control the polarization of the amplifier? My guess is that the receiver with the higher output voltage wins, which means you'll only get half the channels. In a properly-designed dual LNB setup, you have two receivers, each controlling one LBN. If you want to reduce that to just one main feed line with all the channels, one LNB is fixed to receive RHCP signals and the other LHCP signals. These signals are now mixed in a diplexer (or similar mixing device), amplified, and distributed to as many receivers as you can afford. Here's a simplified diagram.



Now if you're comfortable with having a single channel that's distributed to more than one TV set in the house, here's how it's done.



Notice that the split isn't done at the LNB, but after it goes through the receiver where the frequencies are lower and the insertion and cable losses are less.

Hard Boiled Batteries

Q. I recently acquired quite a few 12-volt, 6 AH sealed lead-acid batteries. Unfortunately, most of the batteries were completely discharged upon arrival. I tried to charge them using a plain old variable voltage power supply, using an external amp meter to monitor the charging current manually. I usually charge them at 14 to 16 volts, at around 2 amps. However, when I connected one and put juice to it, it wouldn't draw any amperage. After a while of this, it started to draw about 100 mA, but would not hold the charge. After several attempts to charge them, I gave up. I was wondering if you know of a way to charge a dead lead-acid battery, or how to modify my method. I know I'm using a very crude method to charge them, and probably overcharge them, but it is the only way I know of because I'm not old enough to take any high school courses on electronics.

Tyler Graff
via Internet

A. You don't need a high school education to have fun with electronics — you can start at any age. For example, you'll find a wealth of information in the pages of this magazine. Even if you don't build the project, just reading about how it works and why it works helps a lot. Then there are books, like *Getting Started In Electronics* by Forrest Mims ($4.99) and *Basic Electronics* by McWhorter & Evans ($9.99), both are available from RadioShack. As to why your batteries are dead, I think they have been "boiled" to death in a former life. Typically, a gel-cell (sealed lead-acid battery) shouldn't be charged faster than 200 mA per amp-hour (AH). In your case, that's 1.2 amps (2 amps is acceptable for a short time). After the battery is nearly fully charged, though, the charging current has to be reduced or it will start to "boil," that is, venting hydrogen gas. In most cases, the maintenance current is about 20 mA per 1 AH — 120 mA for a 6 AH battery. To prevent further damage to the remaining good batteries, I'd use the battery charger circuit described in the next question, "Gel-Cell Standby Charger." Sorry, but I don't know of a way to bring a dead gel-cell back to life.

Gel-Cell Standby Charger

Q. I'm trying to duplicate an old but reliable 12-volt gel-cell charger that calls for an Motorola HEPR0170 diode, for which I can't find a cross-reference. I have tried substituting various diodes, but none

Digital Thermometer Takes Bite Out Of Frost

Q. How does one go from an LM334 (temperature sensor) to a 74192 (up/down counter) to construct a seven-segment LED readout thermometer? If it's not easily done can you suggest alternative ICs? If there's a version that goes to -30°C it would really be nice. (It's a real pain to step outside this "igloo" just to check the thermometer.)

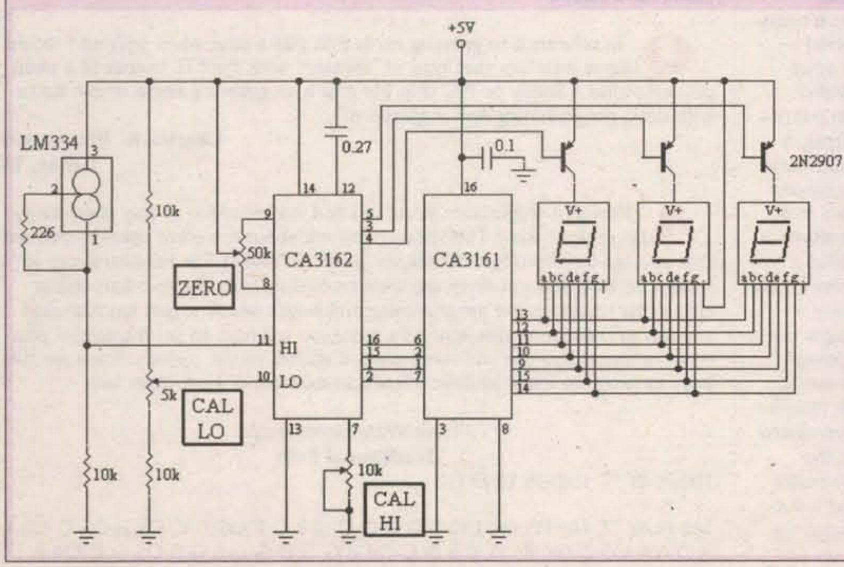
Ken Schultis
Salmon Arm, BC, Canada

Q. I've "inherited" the responsibility for maintenance of a digital temperature readout on a piece of commercial gear on a mountain top. The problem is that the sensor part of the circuit was fried by a lightning strike. The unit uses a very large seven-segment, common-anode LED display, which survived the attack. While it's hard to tell from the char, it appears the temperature sensor was a series of diodes. I suspect the other chips are configured as a DVM that senses the current flow through the diodes and converts it into a readout of 0 to 100 Celsius. We don't have a big budget here, and I have several modules to replace, so what I need is a very simple circuit to replace that which has gone bye-bye.

John White, WB6BLV
Porterville, CA

A. Although I answered a question similar to this in an earlier column, it took an alert reader, Dick Lynas, to remind me that Harris still makes the venerable CA3162 A/D Converter for 3-Digit Display. (I thought it was long extinct!) Originally invented by RCA, this chip converts a -99 mV to +999 mV input into BCD code. When paired with the companion CA3161 chip, a BCD to 7-segment LED decoder, you have a complete DVM with just four external parts (not including the LEDs). Both chips are available from Jameco (TK) and JDR (TK). The sensor is an LM334 current source and temperature sensor, which is available from the same sources. Total cost is about $10.00.

The LM334 sensor has a linear temperature coefficient of exactly 10 mV per Kelvin when configured as shown. In case you don't know what a Kelvin is, it's the same measurement as Centigrade, except that the scale starts at absolute zero instead of the freezing point of water (0 °C) — minus 273.1 °C, to be exact. At 25 °C (68 °F), this translates into 2.981 volts. At 125 °C, the voltage across the 10k resistor becomes 4 volts. So far so good; 100 degrees Centigrade for a 1-volt span — just what the CA3162 needs. However, the display won't read right. At 25 °C, the display will read EEE — an error message sent by the CA6231 to indicate that the input voltage has exceeded 999 mV. Fortunately, the input to this chip is differential; that is, similar to an op amp. So if we raise the input voltage of the LO pin to 2.73 volts, the equivalent of 0 °C, the display will read 250 mV at 25 °C. As the temperature inches its way up, so will the display voltage. At 90 °C, the display will read 900 mV. With the simple insertion of a decimal point, we have a digital thermometer that measures from -75 °C to 99.9 °C — a range from the Antartic to a boiling cauldron.

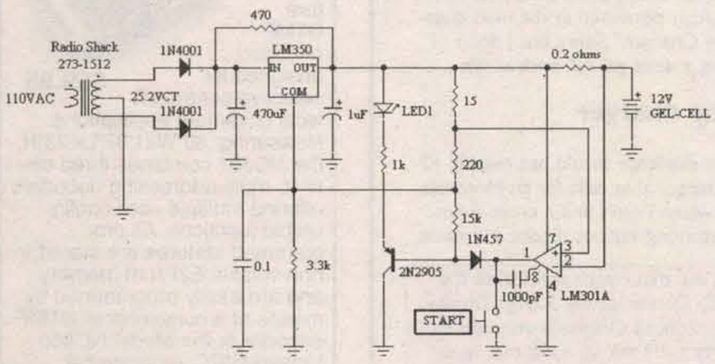


To calibrate the instrument, short pins 10 and 11 and adjust ZERO for zero out. Next, submerge the sensor in an ice-water bath and adjust the CAL LO for zero out. Finally, place the sensor in a pot of boiling water and adjust CAL HI for 99.9 (subtract about 1 °C for each 1000 feet above sea level). That's it! Again, my thanks to reader Dick Lynas for letting me know these chips are still alive and well — and cheap.

permit a charging current to flow through the battery, even though the LED lights. If I boost the charging voltage to 18 volts, I get a slight "boiling" condition in the battery. Do you have a good circuit to use instead as a standby charger for an alarm power pack?

Michael I. Herman
New York, NY

A- The circuit you sent is old and reliable — for its day. Fortunately, technology has advanced since then, and there are more sophisticated designs available at lower cost. Here's the circuit I recommend. It's simple, inexpensive, and easy to use.

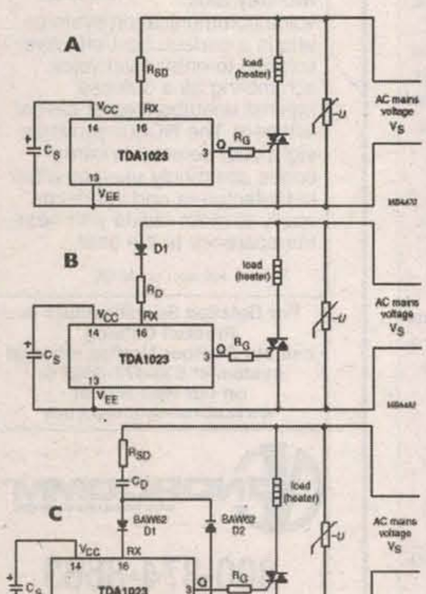


When the START button is pressed, the output voltage of the charger goes to 14.5 volts, which provides a quick-charge current of about 2 amps to the gel-cell. When the battery reaches full charge, the charging voltage is reduced to 12.5 volts and the battery is placed on a "float" current charge — about 125 mA. At this point, the transistor lights the LED to indicate a fully-charged battery. Of course, you'll have to press the START button again when the alarm goes off and power is taken from the battery, but I suspect you have to press a RESET button on the alarm anyway, so just add this step to your alarm-reset checklist. (By the way, the HEPR0170 is an ordinary silicon diode rated at 2.5 amps and 1000 volts.)

Zero-Crossing Triac Controller

Q- Could you help me design, or indicate if it exists already, a circuit to control average current to a resistive load of 20 amps at 230VAC using a triac and zero voltage firing? What I'm looking for is not your typical slice-the-sinewave cycle you so often see in light dimmers. What I envision is a timing cycle where you have three cycles on and three cycles off to produce a 50% duty cycle, all done at zero switching to eliminate RF interference, to control a heater or other resistive device. The control element will be a potentiometer or similar dialing device.

Victor Gladysz
Montreal, Canada



Alternative supply arrangements.

A- Sure, it's a common practice. After wadding through my catalogs, I came up with the TDA1023 from Philips Semiconductor. It's just what the doctor ordered — including a low $2.25 price tag! Order it from **http://www.questlink.com.** Here's a typical application straight from the TDA1023 data sheet.

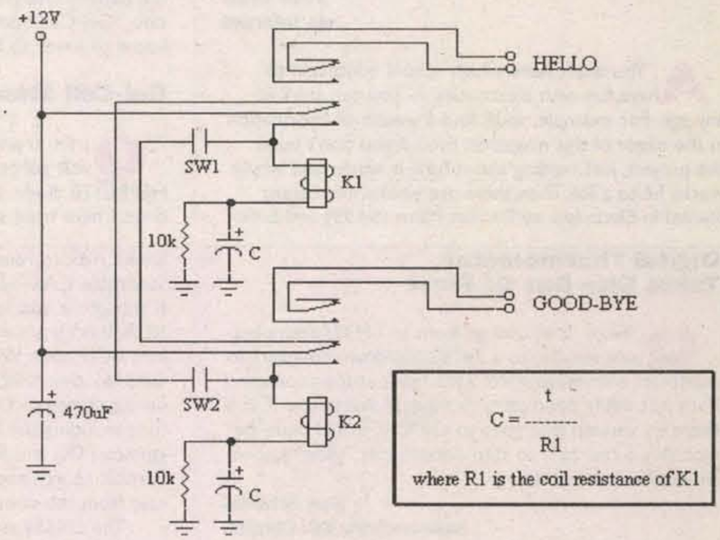
The TDA1023 is a bipolar IC for controlling triacs in a zero-switching proportional manner, commonly called a burst firing mode. A few cycles here, and a couple more there. Overall, it averages out to be a steady-state power output. Just be aware that it can only be used with resistive loads, typically a heater, where the load averages out the bursts. Use of this controller with a motor or other inductive device could damage the appliance.

Driveway In/Out Update

Q- I need information on how to install an inexpensive driveway enter/exit detector. I'm certain I can make one for less than the $200.00+ they're asking!

Mac Mars
Sorrento, FL

A- I answered a question similar to this last month in the Jun. '99 column. The original circuit used six relays plus a couple of hefty capacitors, at a cost of about $7.00 each — not cheap. Since then, I've had time to reflect on the circuit and one restless night dreamed up this simpler design.



It uses just two relays and a couple of capacitors. The relays are triggered by a pressure switch that's laid across the traffic lanes of your driveway. They're labeled SW1 and SW2, and can be any kind of pressure activated NO (normally-open) switch. Check your local auto supply store; I know Grand Auto and Pep Boys (Indy 500 sponsor) sell them. Place the strips about 4 feet apart. When the front wheels of the car run across SW1, let's call it "Welcome," K1 engages and removes power to K2, preventing it from engaging. At this point, capacitor C starts charging, which holds relay K1 closed even after the strip switch opens. The amount of time the relay remains closed is determined by the formula $t = 1.4\,RC$ where R is the DC resistance of the relay coil — typically 480 ohms. A 10,000 uF capacitor will hold the relay in for about a second. Fortunately, low-voltage, high-value capacitors are cheap, about the same price of the relay. **Digi-Key (1-800-344-4539; http://www.digikey.com)** lists a 33,000 uF cap for under $7.00. This should be enough time for all four tires to cross the switches before the circuit resets itself. The 10k resistor discharges the capacitor between cars. Going the other direction K2 turns on first and prevents K1 from engaging ("Goodbye"). This lets you know whether the car is coming or going.

BASIC Music

Q- In reference to greeting cards that play a tune when opened, I would like to interface that type of "speaker" with the TTL output of a small processor, like a Stamp or PIC chip. My goal is to generate some simple tunes with Basic programming. Any suggestions?

Charles W. Blumentritt
Dallas, TX

A- Plenty of suggestions, because I find it a lot of fun to play rinky-dinky piano using Basic. The speaker you ask about is a piezo speaker element that you can buy from RadioShack for $2.49 (273-091). The hardware part is simple, because you can drive the speaker directly from the microprocessor chip. What's tricky is the programming, and here's where it gets fun. Although you can only generate one note at a time, you still have to set the tempo, plus if you're clever, you can add some discord sounds to the melody. There are two ways to program music in Basic. Here's an example of each. Have fun!

'Irish Washerwoman'
Traditional Folk

```
100 PLAY "T 160 O5 L2 D C"

110 PLAY "T 160 MS O4 L12 B G G D G G B G B O5 D C O4 B O5 C O4 A
A D A A O5 C O4 B O5 C E D C O4 B G G D G G B G B O5 D C O4 B
```

```
O5 C O4 B O5 C O4 A O5 D C O4 B G G L8 G L24  O5 D C"

120 PLAY "T 160 MS O4 L12 B G G D G G B G B O5 D C O4 B O5 C O4 A
A D A A O5 C O4 B O5 C E D C O4 B G G D G G B G B O5 D C O4 B
O5 C O4 B O5 C O4 A O5 D C O4 B G G L8 G L24 G A"

130 PLAY "T 160 MS O4 L12 B G G D G G B G B B A G A F+ F+ D F+ F+ A
F+ A A G F+ E G G D G G C G G O3 B O4 G G O5 C O4 B O5 C O4 A
O5 D C O4 B G G L8 G L24 GA"

140 PLAY "T 160 MS O4 L12 B G G D G G B G B B A G A F+ F+ D F+ F+ A
F+ A A G F+ E G G D G G C G G O3 B O4 G G O5 C O4 B O5 C O4 A
O5 D C O4 B G G L8 G"
```

'Stars & Stripes Forever'
John Phillip Sousa

```
a$ = "<g6>d6<b6>d6<g6>d6<b6>d6<g6>d6<b6>d6<g3p20"
b$ = ">d4d4c6<b6b4a#6b6b2p20a#6b6b4a#6b6>d4<b6>d6c2<a3p20"
c$ = "a4a4g#6a6a4g#6a6>c2<b6a6b6>d3e3e6<a2p20"
d$ = ">d4d4c6<b6b4a#6b6b2p20a#6b6b4a#6b6>c6<b6a6f6a2g3"
e$ = "g4g4f#6g6b-4a6g6>g2<g6a6b>d6<g6a6b6>d6<d6e6b6a2g3"
PLAY a$
PLAY b$
PLAY c$
PLAY d$
PLAY e$
```

Commodore Cornicupia

Q - Do you know the name of the square power supply connector that's used on Commodore C128 computers, or a source for them? The C64 uses a common DIN plug, but the only way I can get a C128 connector is from a dead C128 power supply.

Frank Nally
via Internet

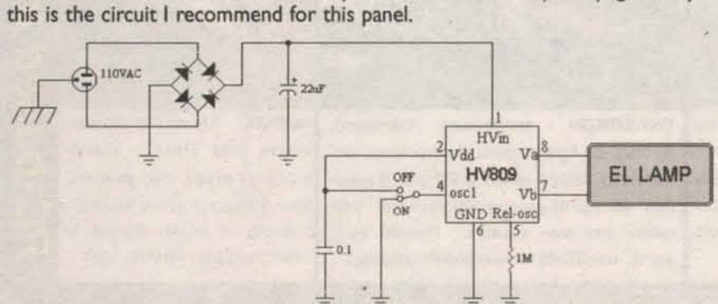
A - No I don't know its name, but I can tell you where to buy one — and a lot more. So listen up all you Commodore aficionados, because have I found a Commodore one-stop gold mine. **Creative Micro Design (http://www.cmdweb.com/chome.phtml)** has a list of Commodore peripherials, accessories, and replacement parts that'll send you reeling. They sell everything from complete systems, to disk drives, to nuts and bolts. They even have a wide selection of software titles and a long list of JiffyDOS chips. Some prices are bargains, others seem a bit steep; it all depends on what you're looking for. The part you're looking for is part number CN128, and it sells for $12.00.

Practical EL Lamps

Q - I scrapped out an old Tandy 1400 laptop and now own (among other things) an electroluminescent LCD backlight panel. Do you know what voltage (and frequency) is required to make the panel glow?

John McMichael
via Internet

A - EL lamps are usually rated at 115 volts AC, 400 Hz. This operating parameter comes about because it's the typical power available in the cockpit of an aircraft, where EL found it's initial application. Check out the companion article "EL Light: Playing In The Dark" on page 82 to find a bevy of circuits that'll make it work. In a hurry, and don't want to flip the page? Okay, this is the circuit I recommend for this panel.

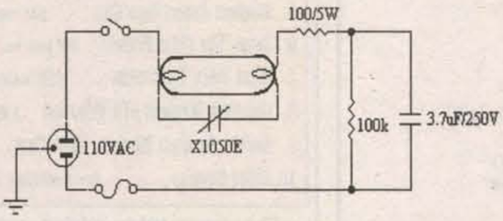


Still gotta flip the page to find where to buy the IC, though. Naw, just kidding. You can get it from a number of jobbers, including Nu Horizon and others. Check out the http://www.supertex.com web site for a supplier in your neighborhood.

MAILBAG

Dear TJ:

Regarding the letter from Mr. Chris in the Jan. '98 issue concerning the capacitor in his fluorescent shop lamp: Yes, Virginia, ballastless fluorescent lamps have been on the market for some time now (although 1985 seems a bit early). It appears there are two types: those that use a high-frequency, high-voltage inverter and those that use a capacitor only (which Mr. Chris probably has). Here is an example of the capacitor-only lamp circuit that comes from a SNAPIT Model 07006 lighted power strip.



It uses a 3.7uF capacitor to light a 5-inch long fluorescent lamp. However, I KNOW this circuit WON'T light a 4-foot F40 bulb — I tried it. I imagine it would take a larger capacitor, but I haven't had time to play with it.

Unsigned

Dear TJ:

In the May '99 issue, there was a question from Mr. Bill Pippin in Dallas, TX about his need to power a 12-volt fan from a 36-volt forklift battery. I had a similar problem with a 24-volt system. I solved my needs by connecting two, identically matched 12-volt fans in series. By connecting three fans in series, Mr. Pippin could move a considerable amount of air for a low price.

John
via Internet

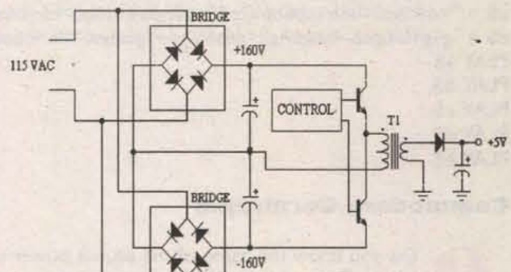
Dear TJ:

There seems to be an error in the switching power supply shown on page 77 of the Apr. '99 issue. The AC to one of the bridges is a short circuit.

Luisnan
via Internet

Response:

It's not a short circuit, because it won't do any damage, but it's certainly a misplaced wire. Here's a corrected schematic. My apologies and thanks for your alertness.



TJ Byers
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The Q & A column generally offers a quicker response from noted electronics author TJ Byers. Follow-up or spin-off questions and/or discussions might also appear in this column.

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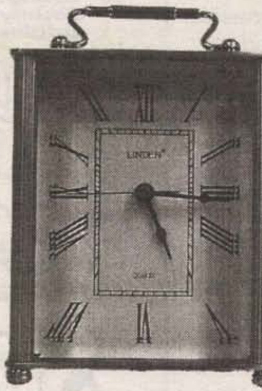

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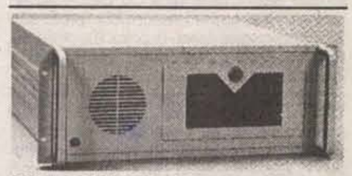

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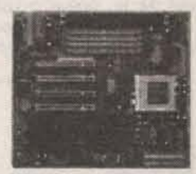

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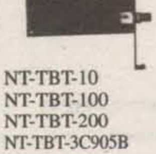

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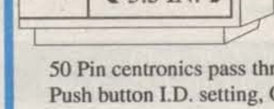

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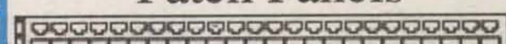

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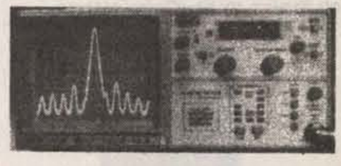

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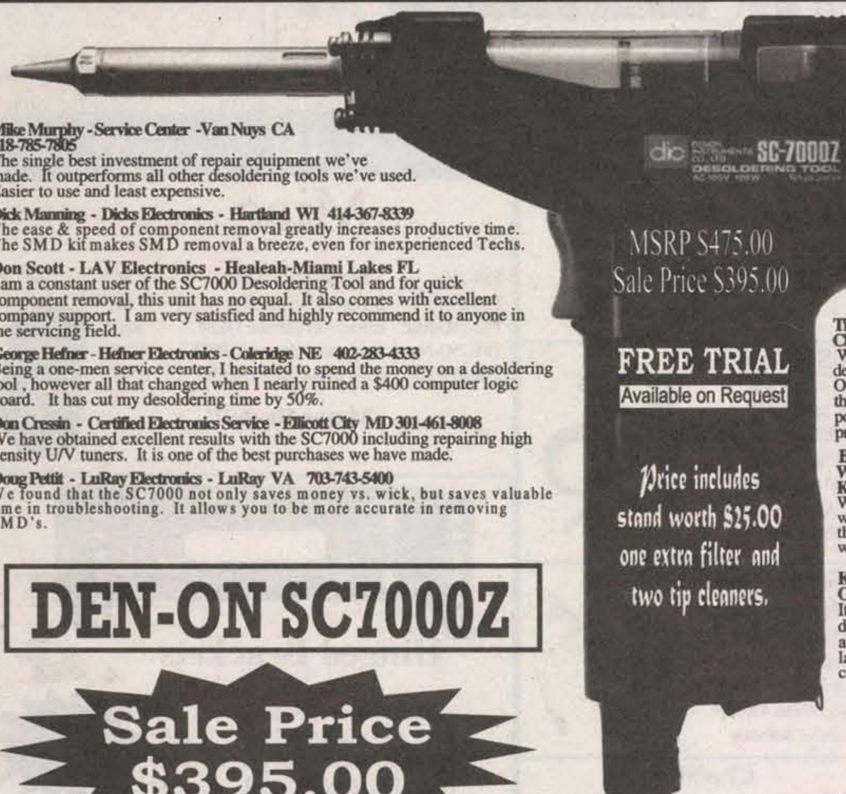

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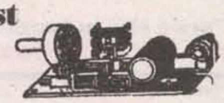

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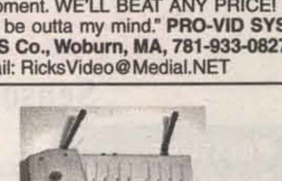

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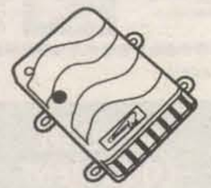

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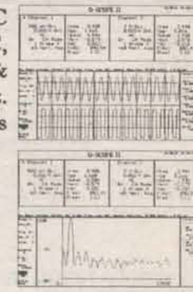

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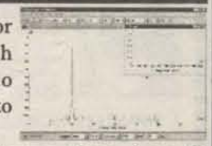

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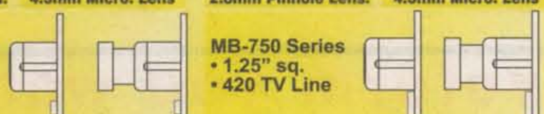

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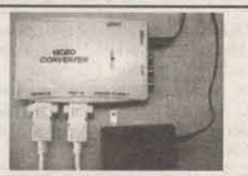

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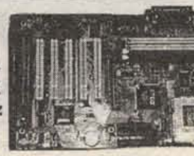

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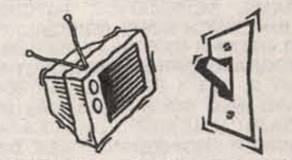

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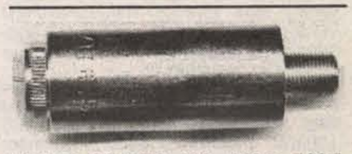

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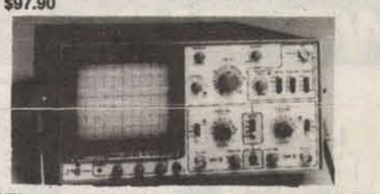

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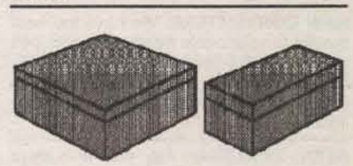

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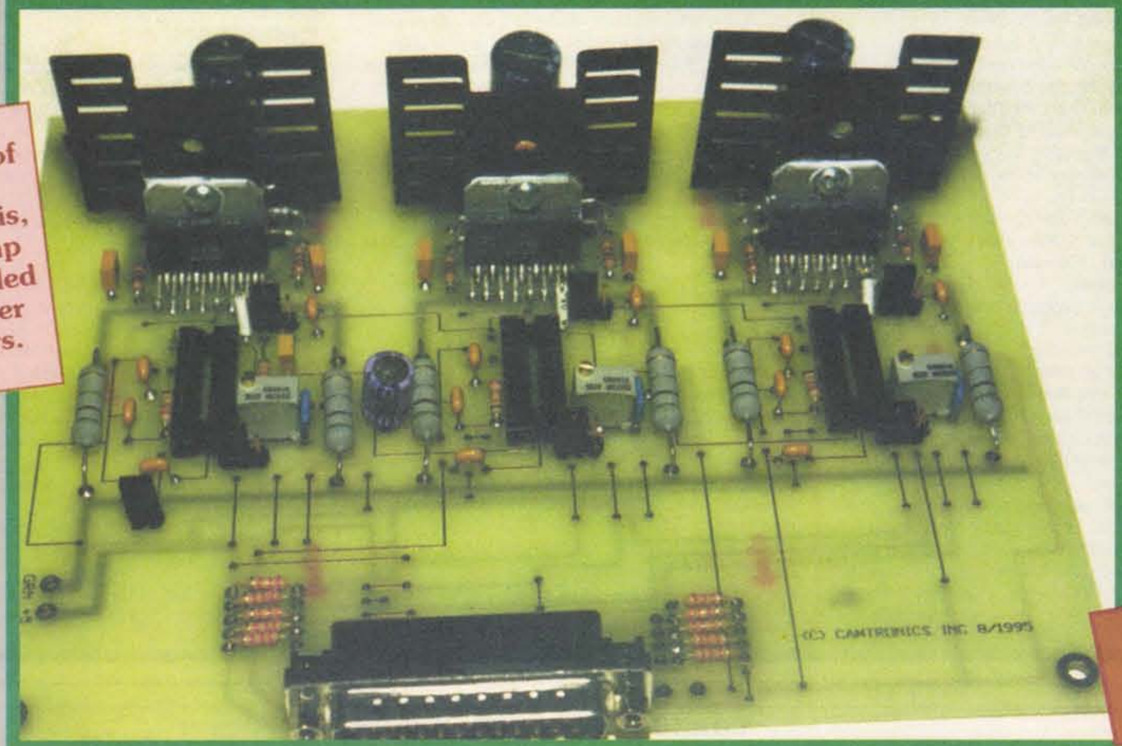
Continued on page 58

Three-Axis Chopper, Step Motor Controller for Computer Numerical Control (CNC) Applications

Part 3

In this article, we will configure, connect, adjust, and test the three-axis chopper driver built in last month's article.

by Dan Mauch



Picture of the three-axis, two-amp assembled chopper drivers.

For testing, we will use Dancam, a shareware program available on the Internet at various sites. You can download it at www.metalworking.com in the shareware file area. We will use this program only to checkout the controller. In the next article, we will use a G code interpreter program called DeskNC. DeskNC will be used for all G code tool paths files, but Dancam does have some good applications and is available free for the downloading.

Cautions

Since the controller does not use optoisolators on the inputs, there is a remote possibility that something could go wrong and cause damage to your parallel port or computer. The purpose of the warning is that the author cannot control how each reader will build, connect, or use their controller thus, this possibility should be considered before connecting your computer.

Never connect or disconnect a stepper motor cable with Vm power on. It will cause an inductive spike that may damage the L298 driver chips. **Never probe connections with power on**. You may short out the L298 and burn out an H-bridge.

Never boot up a computer with the controller connected to the power supply that is turned on. As the computer boots, solid-state relays, if installed, may inadvertently activate spindle motors or stepper motors may move the mechanism in an uncontrolled manner. Read the cautions in the DANCAM document file before use.

Configuring the Software

1. Make sure the Vref voltage was adjusted as described in the previous article.

2. Connect a DB25 male to DB25 female cable with all pins wired straight through between the DOS-based computer and the controller's DB25 connectors.

3. Connect the 5V and 12VDC leads to the proper terminals for the X-Y-Z-axis. Use the pictorial for correct connections of the motor and logic sections of the controller. Do not use the power supply in your computer. Use a separate power supply. Remove the jumper from J-7 (All Windings Off) if installed.

4. Load the Dancam.exe program. (Use the DOS mode of your PC if you have Windows.)

5. From the main menu, select #4 and hit Enter. The program will ask: "Change the Dancam.cfg configuration file to adjust how the motors move."

6. Next, from the Installation menu, select #1. A new menu will pop up.

7. From the parallel port menu enter the motor drive board type. The default is "0." Press Enter.

8. On this same menu after the "0" is typed, it will ask you to enter the parallel port to use. Normally, you would enter LPT1. If the controller board doesn't work with this setting, you have the wrong port address. You may have to buy a $20.00 parallel port board configured to run on hex address 378. LPT2 or LPT3 may be used if supported by your hardware.

9. Enter the number of pulses per motor request. This is always 1. Press Enter.

10. The main installation menu will now appear. Select #2. "Motor pulse width factor test and install commands."

11. A new menu will pop up. With the parallel port cable connected to the three-axis controller, and three stepper motors connected to the controller, and 12VDC power supplied to the controller, press 1.

12. An installation instruction will ask what motor axis to test (X, Y, or Z). Select X. Then press Enter.

13. Another instruction will pop up and will request the PULSE WIDTH FACTOR. A table is provided on screen to give help. The default is 600. When you press ENTER, the X axis stepper motor will run forward and backward. If the motor seems weak or just chatters, press S to slow it down until it runs strongly (about 1900 pwf on a 386-25). If it is slow but strong, then try speeding it up by pressing the F button on the keyboard. Press Control X when satisfied.

14. If you get a "SERVO MOTOR ERROR," or "LIMIT SWITCH IS OPEN" message, make sure that the out-of-range switch is in the correct position or jumper the yellow and white wires at the connector.

15. Set the PULSE WIDTH FACTOR for the Y and Z-axis similarly.

16. Press the Escape key until you are back at the main menu. The program will record the current configuration every time it goes to the main menu. If you make any temporary changes, make sure you change the values back to the original. Better yet, make a copy of the DANCAM.CFG file and store it separately for use if the installed copy is corrupted.

17. A tool path data file is included in the Dancam archive files downloaded from www.metalworking.com. At the main menu, enter 1 to select a Dancam file to be read. A new screen will pop up. Enter the path and file name. The program will try to home up the motors if the home setup menu was set to ON. If you don't have home switches, go back and shut the feature OFF for now. Rerun the test tool path file and you should see the three motors moving to the instructions of the data file.

18. Always shut off the controller when not in operation.

19. Read the DANPLOT.DOC file in the DANCAM ZIP files for many other features and a detailed explanation of other uses for Dancam/Danplot program. Be sure to read the safety warnings and conditions for use of the program. Once you get up and operating, you will find that Dancam is a superb program.

Troubleshooting

If the motors don't run properly, here are some procedures for locating the problem.

1. Load Dancam onto the computer you intend to use for running the controller. Run Dancam in the "Move Motor Manually" mode without a stepper connected to the defective axis. Connect a voltmeter to phase A-a leads of the controller axis motor connector to be tested.

2. A voltage of 12VDC ± 2V should be observed on the meter. Pulse the appropriate direction arrow one pulse at a time. After several pulses, it will change from +12 volts to a -12VDC. Check phase B-b similarly. If no voltage is present, check that the power is properly connected and, with the power off, check all solder joints and connections of the L298 and diodes. Correct as needed. If there is voltage on one phase but not on the other, a short circuit may have occurred and burnt out the L298. Replace if bad. A poor solder joint on the two-watt Rs sense resistors or the L298 leads can also cause improper voltages to be read at the motor connector.

3. DANCAM will give an error if the OUT OF RANGE switch is open or not connected. If this feature is not to be used at this time, then it will be necessary to jumper the yellow and white wires on the range limit switch connector. The error message provided by DANCAM will now disappear.

Suggestions

MONITOR the temperature of the L298 H-Bridge while testing the three-axis controller. With various stepper motors, the temperature of the L298 will vary. The L298s will run cooler while the motor is running than stopped. It is imperative that you monitor the temperature of the L298s while the motor is stopped using a low cost digital thermometer. They sell for about $15.00 in an electronic supply store. Keep the L298 with heatsink below 125F. Always use a cooling fan. Make sure on higher amperage motors that you use a good fan across the heatsinks of the L298. Be sure to use a larger heatsink if you are running the L298 at the full two amps rating.

If the temperature exceeds 125F, then you must reduce the current to a level below that value. You'll be amazed that the motor will perform nearly as well at 1.5A as it does with two amps, but you may see a temperature drop of 15F. Alternatively, you can reduce the voltage motor supply voltage. The controller was designed to be used with a 12V computer power supply, but you can run it 18-24VDC. If the motor is designed to run on two amps, you will get excellent performance and higher speed using 24V at a current of 750mA.

Ground Noise

The three-axis controller was designed to run off a separate computer power supply. The logic ground and the motor ground are common. In applications where a higher Vm is required, this ground is not adequate. Thus, the X-axis will have more power than the Y or Z-axis. There is an easy solution. Solder a piece of 18 AWG (total of six) insulated wire from the ground side of each sense resistor (R4, R6, R18, R19, R10 and R11) to its motor supply ground connection (the black wire near the 470uF electrolytic capacitor). This will reduce/eliminate the noise causing false triggering of the sense lines and will allow you to use higher voltage power supplies.

Three-axis controller complete kit $145.00 plus $9.00 s/h
Three-axis PCB with plans $25.00 plus $4.00 s/h
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Y-Z Axis Lack of Power

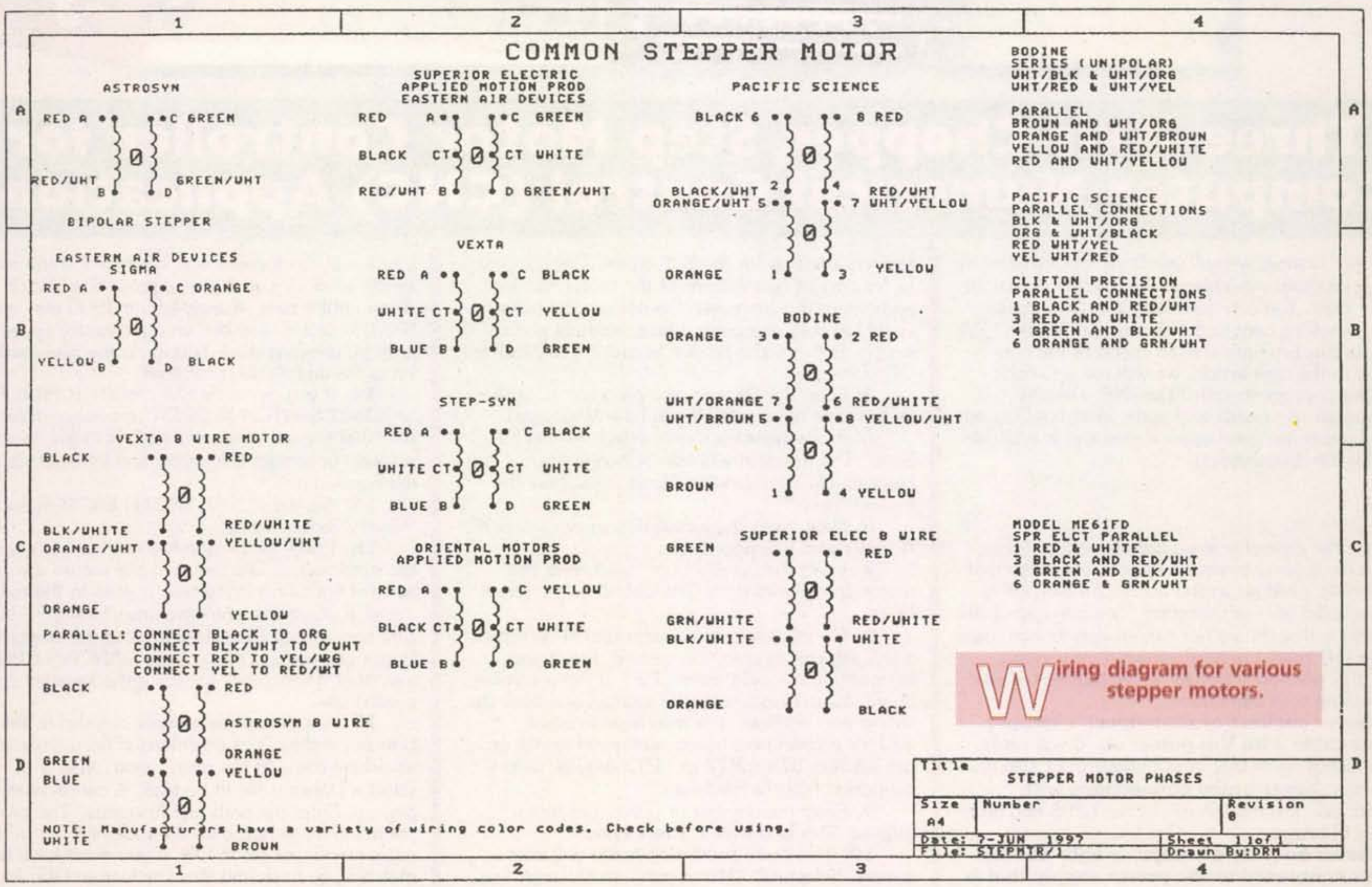
The lack of power on the Y and Z-axis, if noted, is attributed to one of three problems: a poor solder joint on the motor supply connections or a bad solder joint on the L298 to PC board. The last problem is that ground noise will cause the chopper to false trigger at a lower rating than planned. Correct by adding additional ground wires as described in the above paragraph.

Stepper Motors

A schematic of many surplus stepper motors that I have seen in the past — and figured out what color wire did what — has been included in this article. Notice the extra black dot near the motor connection for some of the phases. These indicate the correct phasing for the stepper motor. Be aware that manufacturers of stepper motors often change the colors of wires for special orders. Use the schematic as a guide and always check before connecting to a controller.

Here are some general observations of stepper motors that I have made over the years:

* Low inductance stepper motors (<3 ohms per phase) ran faster on the same voltage power



Wiring diagram for various stepper motors.

supplies than high inductance stepper motors.

* A four-wire stepper motor of the same voltage and current rating will run faster than a six-wire motor used in the bipolar series configuration.

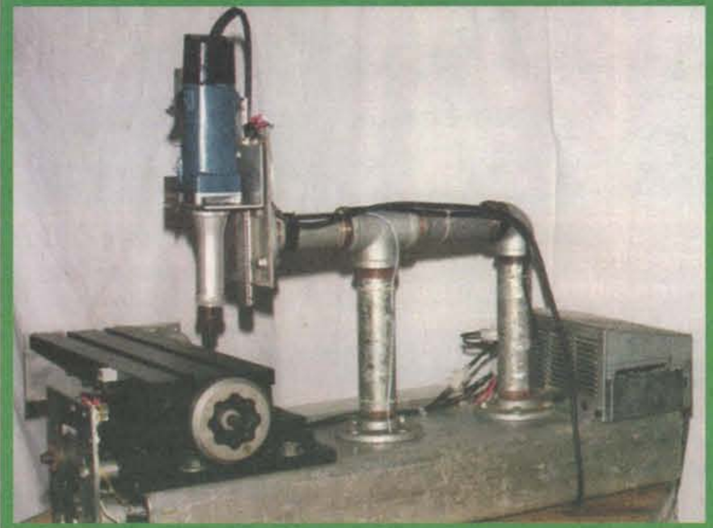
* The higher the motor power supply voltage, the faster the motor will run at higher pulse rates. Doubling the motor supply voltage will increase the maximum speed by about 50%.

* The higher the inductance rating of the motor, the slower its maximum speed will be with a given power supply. For example, a five-volt, one-amp stepper motor will not run as fast as a one-volt, five-amp motor.

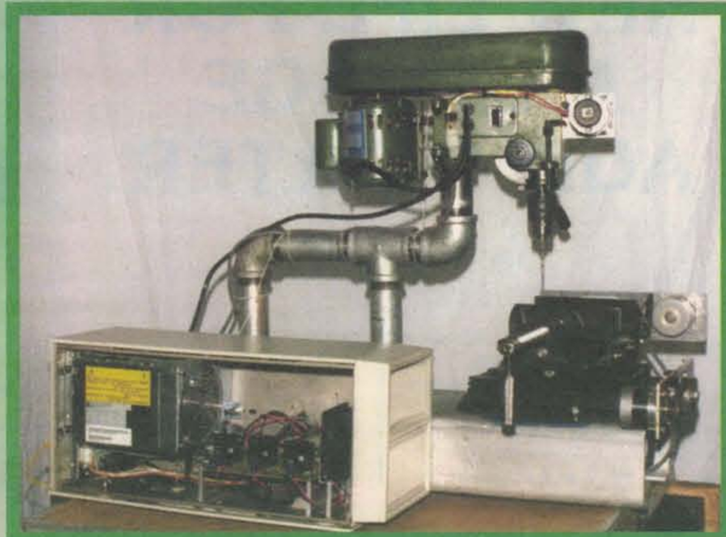
* A six-wire unipolar stepper motor connected in the bipolar series configuration will have more power at low speeds, but will have less power at high speeds.

* A stepper motor only requires 75%-80% of the rated current. Stepper motors only draw full current when they are stopped or running very slowly. As the pulse rate increases, the coils can't charge fast enough therefore, they don't draw as much current as when they are stopped. I often use a three-amp motor on my two-amp drivers with good results.

The next article will describe how to convert a low-cost desktop milling machine to CNC using the controller that was built in the last article. Until then, enjoy your three-axis controller. **NV**



Here is another three-axis chopper driver mounted in an old computer power supply case. This CNC controller runs a modified X-Y table used for routing/engraving. The power head is a 1/4hp 25,000 RPM ball bearing die grinder.



Picture of one of my first CNC projects that modified a low-cost bench drill press to CNC using the three-axis, two-amp drivers mounted in a surplus disk drive case. Notice the dual action of the fans for cooling.

NEW LIFE FOR A VINTAGE AUDIO FILTER

by Ron Tipton

Not long ago, I was in a local surplus electronics shop and I came across several Spencer-Kennedy model 302 tunable audio filters at a giveaway price. The model 302 has two independent filter sections, and either section can be used as a lowpass or highpass. Both sections are continuously and independently tunable from 20 Hz to 200 kHz. By cascading the sections, you can either increase the lowpass or highpass roll-off rate or get a bandpass response.

The converted filter dissipates much less heat, is lighter in weight and should be good for another 40 years service! Besides that, I think you'll find the conversion very easy.

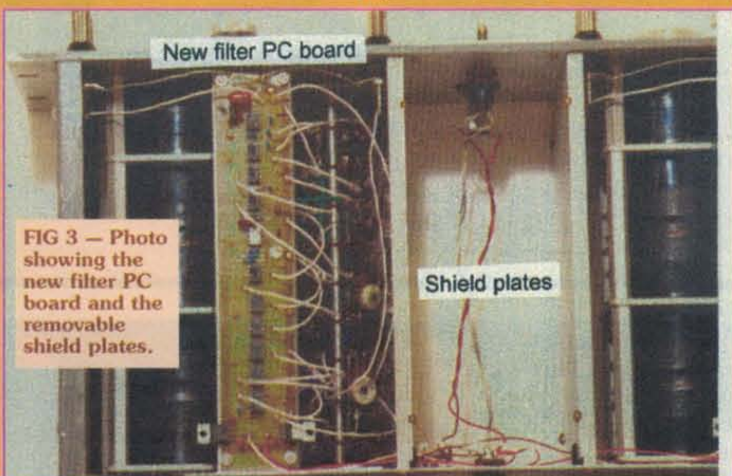


FIG 3 — Photo showing the new filter PC board and the removable shield plates.

These were manufactured during the 1950s and 60s and, of course, they use vacuum tubes. I have a copy of the original Operation and Maintenance Manual, so I quickly determined that two of the triode stages in each filter section were amplifiers and the other eight were cathode followers. This instrument would be ideal to "redesign" using integrated circuit opamps. I went back to the shop, bought two of them and got to work on the conversion.

A triode amplifier has a very high input impedance and a moderately high plate output impedance. The cathode followers also have a very high input impedance, an output impedance of about 300 ohms, and a voltage gain of about +0.9. Contrast this with modern high-gain opamps and you see how satisfying it is to have nearly "ideal" circuit building-blocks!

For example, the LM310 voltage followers I used in this conversion have a minimum voltage gain of +.999 and a minimum input resistance of 10,000 megohms.

Three of the stages in each filter are simple RC (resistance-capacitance) filters in cascade with cathode followers (now IC voltage followers) to isolate each one from the next in line. The fourth stage is an RC "T" in a feedback amplifier, and this circuit took most of the redesign effort; I'll have more to say about this in the next section. All the frequency determining components — the Rs and Cs — were used intact; the redesign was in replacing the vacuum tubes.

The final PC board for each filter measures 1.5 by 8 inches, and consumes less than two watts. This is about the same amount of power used by just one tube heater in the original instrument. The converted filter dissipates much less heat, is lighter in weight and should be good for another 40 years service! Besides that, I think you'll find the conversion very easy.

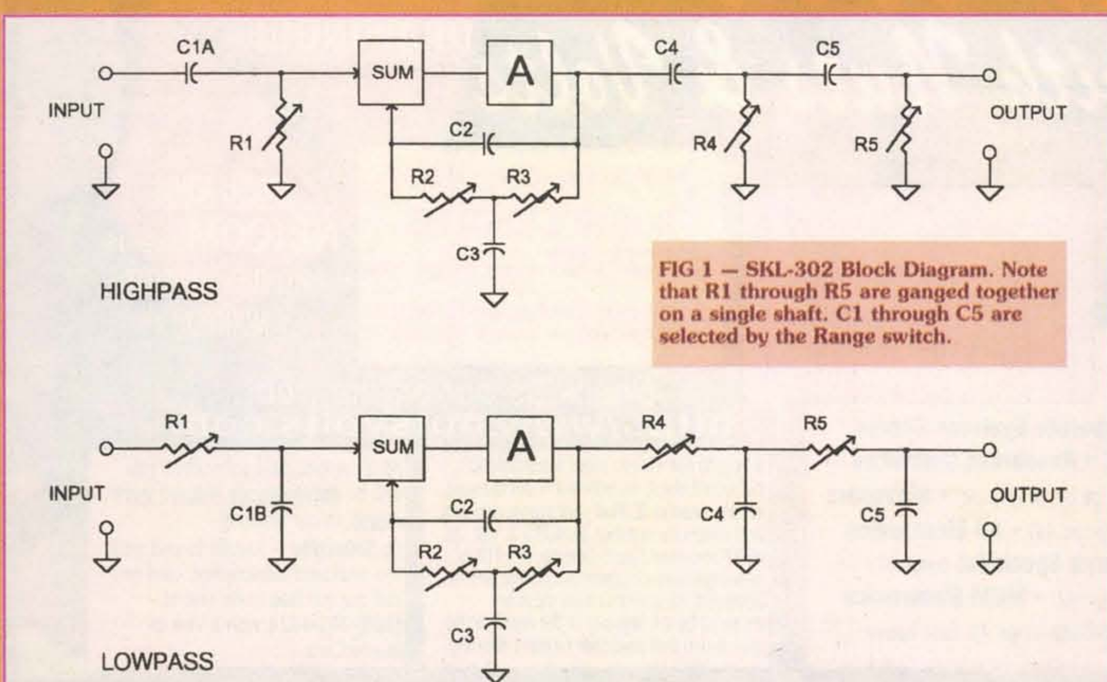


FIG 1 — SKL-302 Block Diagram. Note that R1 through R5 are ganged together on a single shaft. C1 through C5 are selected by the Range switch.

A BIT OF THEORY

Figure 1 shows the filter block diagram simplified by leaving out the input amplifier, the interstage voltage followers, and the output voltage follower. In lowpass mode, we have three passive sections (series Rs and shunt Cs) in series with the feedback amplifier section. In highpass mode, the passive sections become series Cs and shunt Rs but the feedback amplifier remains unchanged. We can see why this works by looking at its voltage transfer function. When normalized with respect to the cutoff frequency — f_o — it is approximately:

$$\frac{e_{out}}{e_{in}} = \frac{\left[1+j\frac{\sqrt{2}f}{f_o}\right]\left[1+j\frac{f}{\sqrt{2}f_o}\right]}{\left[-\left(\frac{f}{f_o}\right)^2+\frac{jf}{\sqrt{2}f_o}+1\right]}$$

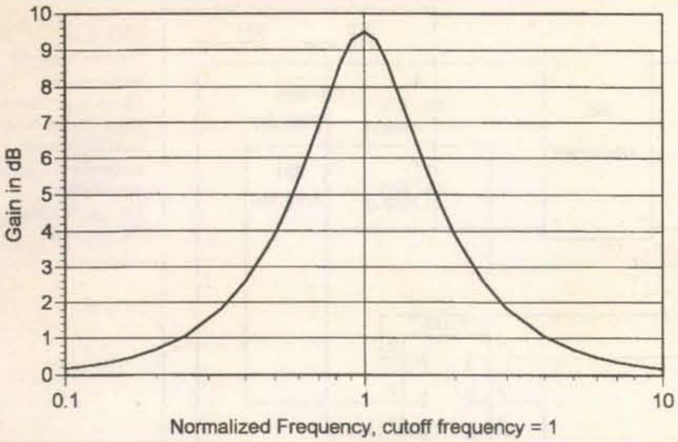


FIG 2 —Feedback amplifier response. Gain is 3 (about 9.5 dB) at cutoff frequency.

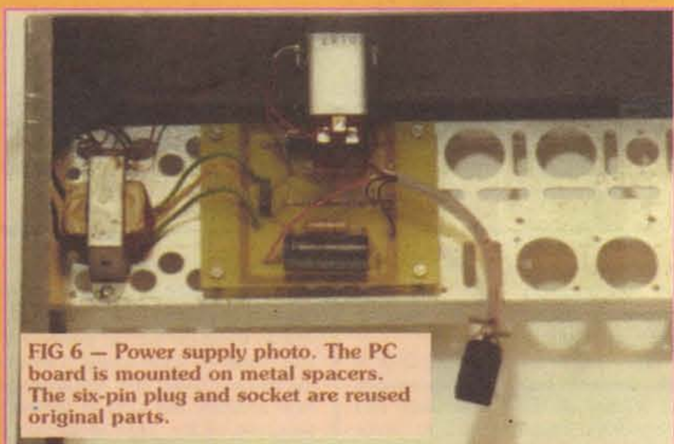


FIG 6 — Power supply photo. The PC board is mounted on metal spacers. The six-pin plug and socket are reused original parts.

Now, this looks a whole lot worse than it really is! By letting f0 = 1, and then letting the f/f0 ratio vary from 0.1 to 10, we get the curve shown in Figure 2. All the "j" operators drop out so the calculations can easily be done with paper and pencil or one of the many commercial or shareware math programs.

The curve in Figure 2 is very interesting because it's symmetrical about the cutoff frequency (when frequency is plotted on a logarithmic scale). This symmetry means that its response has the same effect in both the lowpass and highpass modes. This peaked gain at the filter's cutoff frequency flattens the passband and increases the attenuation slope past cutoff. Clever design!

R13 and R15 are adjusted for unity low frequency gain (in lowpass mode) and then R14 is adjusted for a gain of 3 (about 9.5 dB) at the cutoff frequency. One percent resistors are needed here and I laid out the PC board so two resistors can be used in series for each of these to make it easier to get the right value without a complete resistor stock.

I reused the original "V" (vacuum tube) numbers to identify the opamps. This made it easier to keep track of where I was when I was in the middle of the conversion.

V1A1 — one half of the LM6218 — is connected as a voltage follower. The input is capacitively coupled through C6 (1 uF) for good low frequency response. The LM6218 has a low DC offset voltage (typically three millivolts), but the input bias current flows through input resistor R6. Since this current can be as large as 0.5 microampere, I set R6 to 100,000 ohms to minimize the offset from this source (100,000 ohms x 0.5 microampere = 50 millivolts). In lowpass mode, the filter — including the output voltage follower — is DC coupled so all offsets appear at the output.

V1A2 — the other half of the LM6218 — is connected as an amplifier. It has unity gain except when the Range switch is set to HIGHPASS X10K. Then R11 (8250 ohms) is connected in series with R10 (10K ohms), increasing the gain to about 1.8 to make up for high frequency losses in the range switch and tuning potentiometer wiring. (This was done in the original circuit, too. The plate load resistor and cathode resistor were changed.)

Okay, enough theory. Let's get on with the conversion.

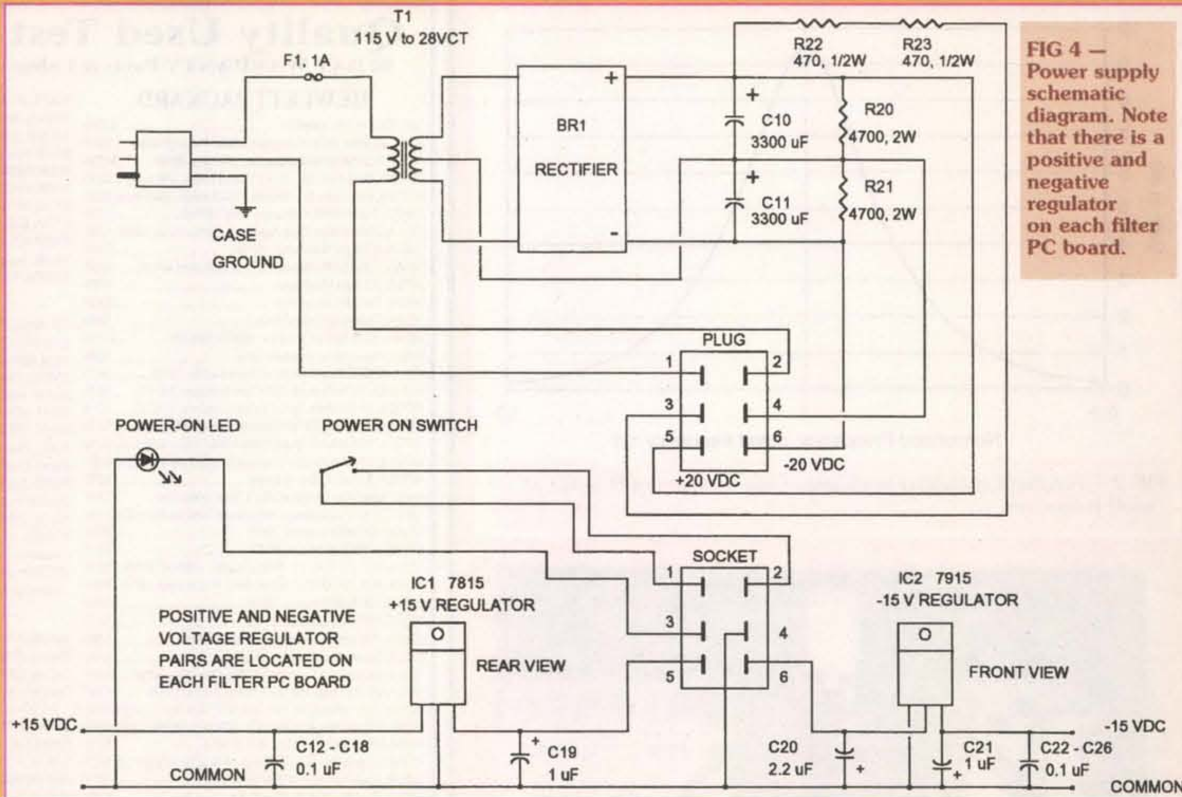


FIG 4 — Power supply schematic diagram. Note that there is a positive and negative regulator on each filter PC board.

DISASSEMBLY

This first step is dismantling the unit and stripping out the unneeded parts. I'll pretty much walk you through this step-by-step as it's easier and less frustrating to do it right the first time. But before we start, I'm going to list the special tools you will need so take a look at Table 1.

First, remove the top and bottom cover plates by removing the six screws fastening the covers to the rear panel. The cover plates now slide out towards the rear — but they may not slide easily. The flanges on the side panels may be bent or dinged up enough to bind one or both covers. Work patiently and they will come out. A little bit of oil may help a lot.

Next, remove the four screws on each side panel that are closest to the front panel. The side panels, rear panel, and power supply are now free from the front panel filter section. Disconnect the six-pin power plug and set the power supply assembly aside for now.

We'll work on the front panel filter section first, so remove and discard the tube shields and vacuum tubes. Remove and save the two shield plates identified in the photo in Figure 3. This will give you a bit more working room. Clip the power supply wires to each filter at the screw terminal block. Remove and save the two screws at each end of both vacuum tube subchassis and start to clip the wires connecting the subchassis to the long rotary switches.

Although most of the wires will be replaced anyway, try to clip close to the subchassis as this seems to make wire identification easier later on. Remove and discard the wires from the input and output binding posts.

We need to reuse the 1-1/2 by 8 inch aluminum subchassis, so remove and discard all the components and tube sockets. They may be a bit grimy, so a good wash with soap, water, and a scrub brush may be in order.

You can remove and discard the power supply terminal block as we won't reuse it. But the six-pin connector will be reused, so take your soldering iron and clean up its terminals, as well as those on the AC power switch and power-on lamp socket. I removed the bayonet-based bulb and soldered a high intensity red LED to the socket terminals so the LED sticks into the front panel jewel.

Using a couple of wooden blocks or such to clear the six-pin connector, position the filter section on your

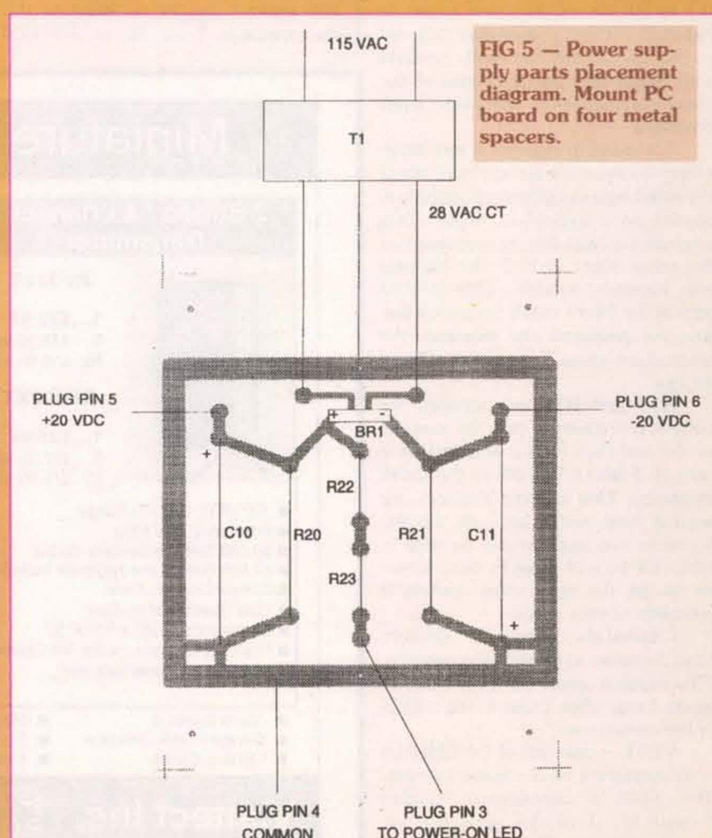


FIG 5 — Power supply parts placement diagram. Mount PC board on four metal spacers.

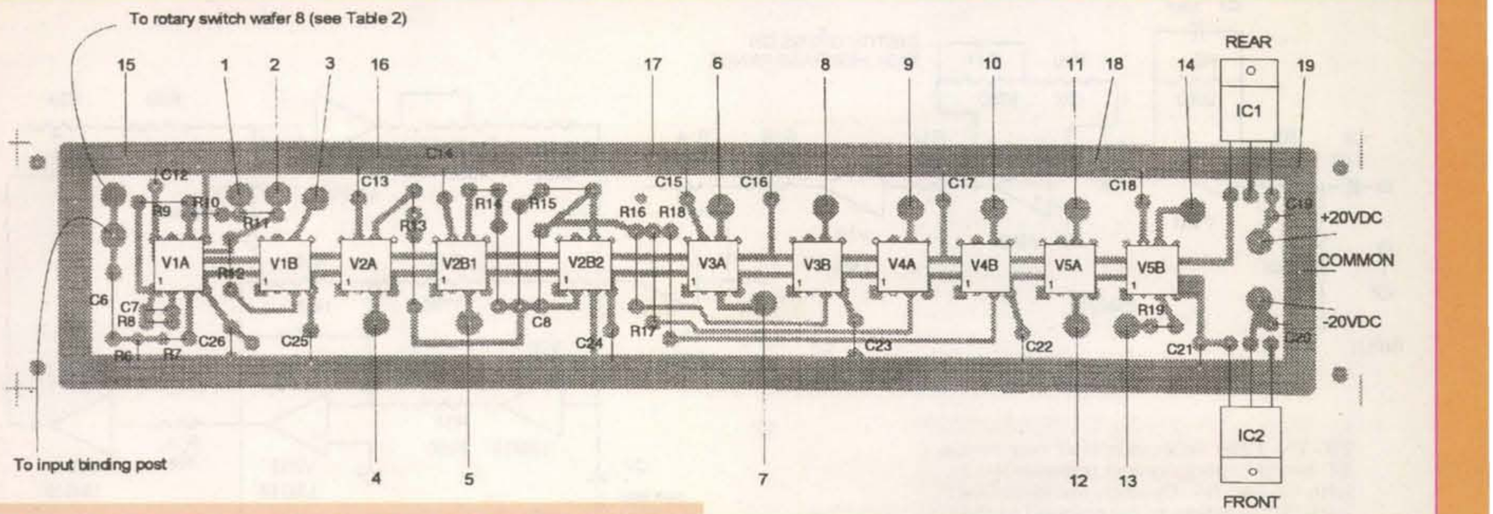


FIG 8 — Filter parts placement diagram. Off-card numbers are Range switch connections; see Table 2.

bench with the front panel up. Tune both filter frequency dials to "2" and then carefully remove and save the two plastic hairlines over the tuning dials.

Insert your flat 3/8-inch open end wrench between the front panel and the vernier tuning mechanism to hold it still while you remove its retaining nut. (Yes, it does take a fairly thin wrench.) During this, and the next few steps, be careful not to move the tuning dial or potentiometer position.

Using your 1/16-inch Allen wrench, carefully loosen the two set screws on each tuning dial and remove the dials. Then remove the range selector knobs with a 5/64-inch Allen wrench. Remove the retaining nut from the range selector switch bushing. Now the front panel can be removed by taking out the six large oval or binder head screws and the screws that go into the 1/4 by 1/4 inch support bars.

As soon as the front panel is off, replace both tuning dials. Even though the hairline isn't there, try to align the dial with the "2" under where the hairline would be. It may help to look at the set screw marks on the potentiometer shaft.

Spread a fairly thick layer of newspaper on your bench or table and carefully lay the filter section on it. Using a pair of needlenose pliers, unhook the springs that hold the three protective covers on each potentiometer. Remove the covers. Take a can of spray contact cleaner and apply a generous amount to the inside of each pot section and both range switches. Move the tuning dial through its range and the rotary switch to all its positions. All these contacts have been around a long time and probably need a good cleaning! Now would be a good time to refresh the front panel too with soap, water, and your scrub brush.

When the contact cleaner has mostly evaporated, replace the potentiometer covers by hooking the spring ends into the eyelets with your needlenose pliers. Carefully set the unit back on its blocks so the front is again up and adjust the tuning dials so the "2" would again be under the hairline.

Remove the tuning dials and replace the front panel and its hardware — don't forget the nuts on the range switches. Use your 3/8-inch open end wrench to adjust and then hold the vernier mechanism while you tighten its retaining nut. The thin plate behind the tuning dial should extend about 1/16 inch into the vernier. Well, that's it for now. Set this unit aside while we rebuild the power supply.

POWER SUPPLY

Remove and save the two screws on each side that hold the power supply chassis to the side panels. Remove and discard everything on the power supply chassis — the new power supply is almost trivial compared to this original maze of components! The bare chassis can probably use a scrub up before you mount the new parts.

Assemble the power supply PC

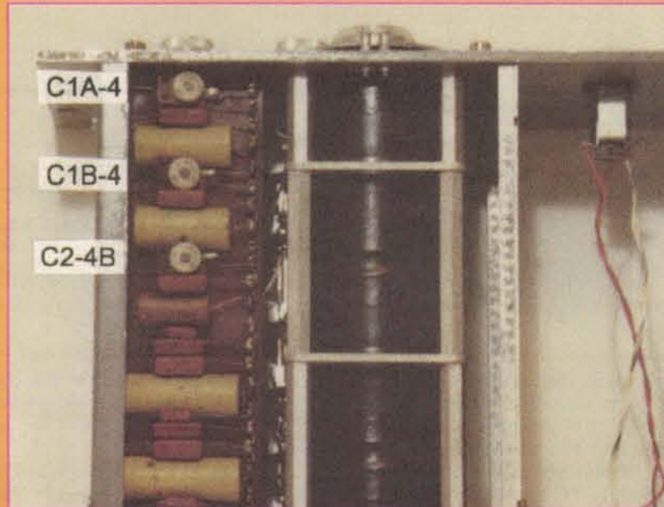


FIG 11 — Trimmer capacitor identification for Range X10K adjustments. Top of photo is the filter front panel.

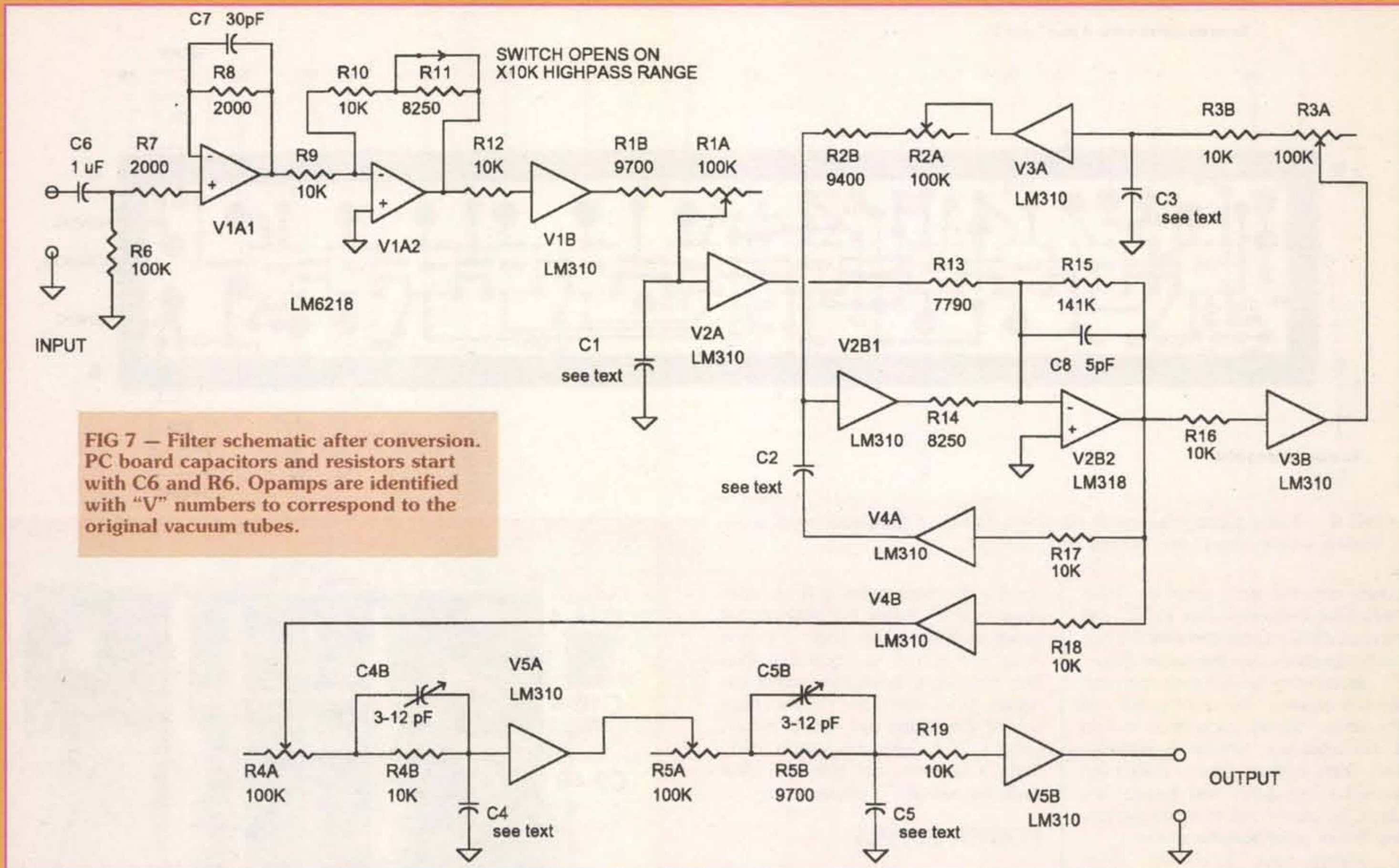


FIG 7 — Filter schematic after conversion. PC board capacitors and resistors start with C6 and R6. Opamps are identified with "V" numbers to correspond to the original vacuum tubes.

board using the schematic (Figure 4) and parts placement diagram (Figure 5). Note the polarity of the diode bridge and filter capacitors C10 and C11. Mount the power transformer, T1, and the PC board as shown in the Figure 6 photo. The PC board is mounted on 3/8- or 1/2-inch metal spacers.

I replaced the power cord and fuse holders with an IEC-type power connector (with built-in fuse) for compatibility with the rest of my test equipment. If you prefer a built-in line cord, I suggest you replace the old one as it is sure to have had a lot of use and abuse.

The wire lengths to the female six-pin connector aren't critical. You'll want the connector body about four inches from the front edge of the PC board.

This would be a good time to rewire the AC power switch and power-on LED so you can test the power supply. The LED should light and the unloaded DC voltages (which will go to the filter PC board regulators) should measure about ±21 volts.

FILTER REASSEMBLY

Assemble the two filter PC boards using both schematics (Figures 4 and 7) and the parts placement diagram (Figure 8). Insert the voltage regulators so about 1/8 inch of lead is on the foil side and solder. Bend the leads away from the PC board and dress both regulators parallel to the board so the regulator bodies will clear the bottom cover plate when it is replaced. Pay special attention to the orientation of the regulators and the polarities of the tantalum capacitors, C19, C20, and C21. I suggest installing the regulators, tantalum capacitors, and 0.1 uF bypass capacitors, and then checking for ±15 volts on each board. You can temporarily connect the filter board to the power supply to verify you have the correct voltages before installing the remaining components.

The PC board is laid out with enough clearance so you can use IC sockets if you prefer. Stray capacitance is already so large in the existing potentiometer and rotary switch wiring that any added by the sockets is negligible. I used 1/16-inch eyelets for all off-card connections, but stake-in terminals would work, too.

After you have completed the boards, clean off the solder flux and carefully inspect for cold solder joints and bridges. These are much easier to find and fix now before you install the boards.

The completed filter board is used as a drilling template. Orient a 1-1/2 by 8 inch subchassis so the bent lip with the 45-degree bevel is facing up and to your left. Place the PC board on the subchassis with the components up and the voltage regulators closest to you. Now mark through the five mounting holes. Carefully center punch and drill each hole with an 1/8-inch drill. Deburr the holes and place a 4-40 x 5/8 inch machine screw in each hole pointing up. Secure it with a 1/4-inch long threaded spacer. Place the PC board on the protruding screws

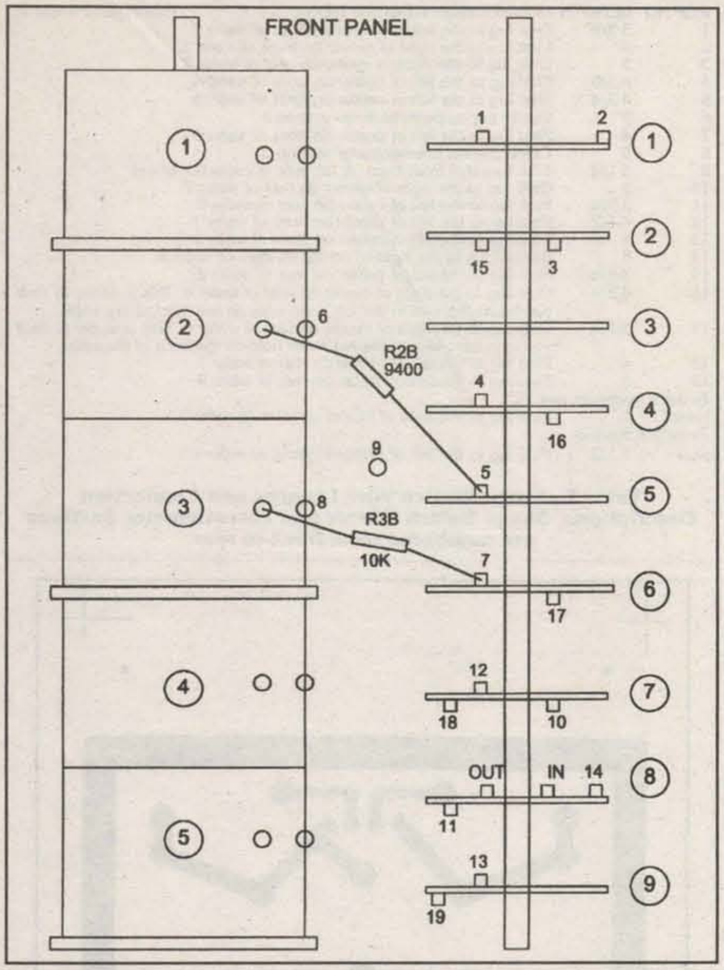


FIG 9 — Range switch and potentiometer wiring detail. Use this drawing with Table 2 for wire lengths and connection descriptions.

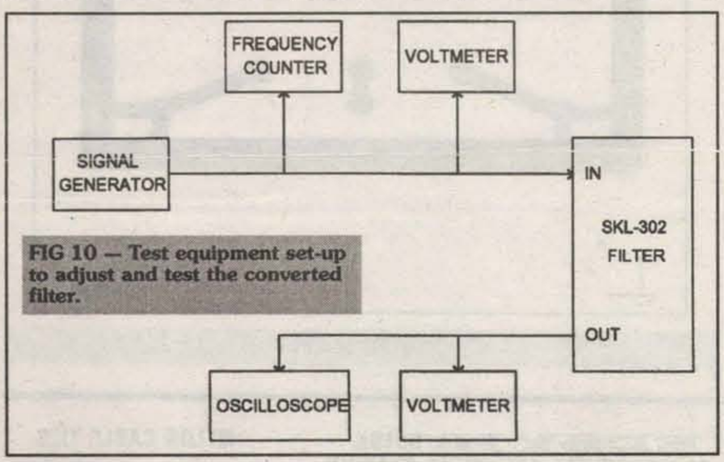


FIG 10 — Test equipment set-up to adjust and test the converted filter.

until later to mount the board assemblies gives you more working room.)

I found it easier to cut and solder the new interconnecting wires to the potentiometers and range switches before installing the PC boards. The drawing in Figure 9 along with Table 2 gives the wire lengths and connecting points. I used AWG 22 stranded wire which worked fine.

Resistors R1B, R4B, and R5B are already soldered to the range switch. I soldered R2B (9400 ohms) between the upper lug of potentiometer section 2 to range switch point 5 (see Table 2), and R3B (10,000 ohms) between the upper lug of potentiometer section 3 and range switch point 7. ("Upper" here means the lug closest to you when you are making these connections.) These are the only two components not on the new PC board that you have to reconnect.

When all the wires are in place, fasten each filter subchassis to the front and rear panels with a 6-32 machine screw, lock washer, and nut. Use the lower hole (of the two original holes) in the panels and the right side subchassis hole. This is easier to do if you orient the subchassis vertically to get the nuts started. Then position the subchassis horizontally (component side up) and tighten the screws. The subchassis is so light in weight that one screw at each end works okay.

Remove the PC board retaining nut on the right side at the front panel.

PARTS LIST

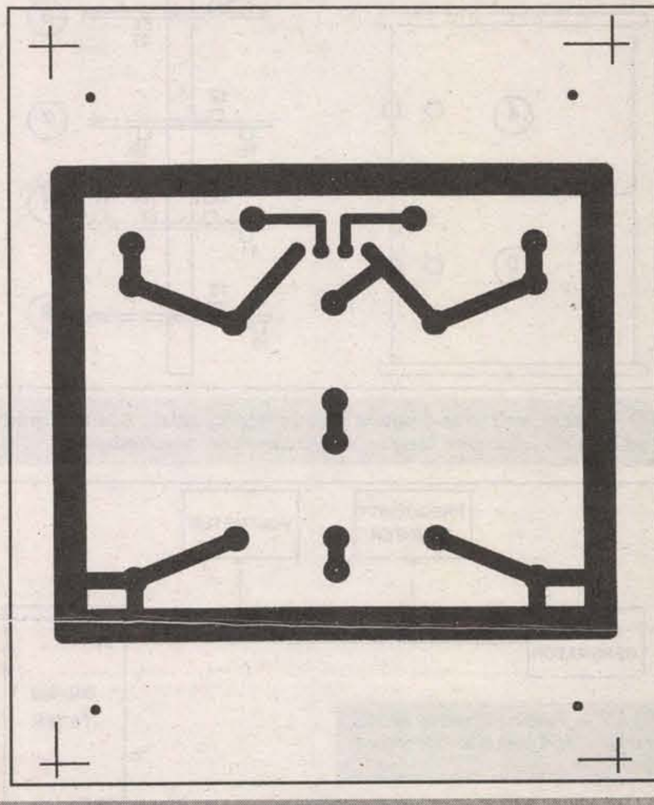
(These resistors are reused from the original circuit.)		
R1A, R2A, R3A,		
R4A, R5A	Variable resistor, 5-gang, each section 100K ohms	
R1B, R5B	9700 ohms, 1%, carbon film or metal film	
R2B	9400 ohms, 1%, carbon film or metal film	
R3B, R4B	10K ohms, 1%, carbon film or metal film	
(These resistor are on the new filter PC board.)		
R6	100K ohms, 1%, 1/4 watt, metal film	
R7, R8	2K, 1%, 1/4 watt, metal film	
R9, R10, R12, R16,		
R17, R18, R19	10K ohms, 1%, 1/4 watt, metal film	
R13	7790 ohms, 1%, 1/4 watt, metal film	
R11, R14	8250 ohms, 1%, 1/4 watt, metal film	
R15	141K ohms, 1%, 1/4 watt, metal film	
R20, R21	4700 ohms, 5%, 2 watt, carbon film	
R22, R23	470 ohms, 5%, 1/2 watt, carbon film	
CAPACITORS		
(These capacitors are reused from the original circuit.)		
C1A-1, C1B-1	0.0536 uF, 1%, paper	Range X10
C1A-2, C1B-2	5350 pF, 1%, mica	Range X100
C1A-3, C1B-3	505 pF, 1%, mica	Range X1K
C1A-4, C1B-4	47 pF, 1%, mica in parallel with 5-25 pF ceramic trimmer	Range X10K
C2-1	0.0493 uF, 1%, paper	Range X10
C2-2	4930 pF, 1%, mica	Range X100
C2-3	493 pF, 1%, mica	Range X1K
C2-4	20 pF, 1%, mica in parallel with 5-25 pF ceramic trimmer	Range X10K
C3-1	0.117 uF, 1%, paper	Range X10
C3-2	0.0117 uF, 1%, mica	Range X100
C3-3	1150 pF, 1%, mica	Range X1K
C3-4	115 pF, 1%, mica	Range X10K
C4-1	0.117 uF, 1%, paper	Range X10
C4-2	0.0117 uF, 1%, mica	Range X100
C4-3	1150 pF, 1%, mica	Range X1K
C4-4	104 pF, 1%, mica	Range X10K
C5-1	0.0493 uF, 1%, paper	Range X10
C5-2	4930 pF, 1%, mica	Range X100
C5-3	493 pF, 1%, mica	Range X1K
C5-4	36.5 pF, 1%, mica	Range X10K
(These capacitors are on a new PC board.)		
C6	1 uF, 10%, polyester	
C7	30 pF, 5%, mica or COG ceramic	
C8	5 pF, 5%, mica or COG ceramic	
C9	not used	
C10, C11	3300 uF, 35 volts, axial lead electrolytic	
C12 - C18	0.1 uF, 25 volts, ceramic	
C19, C21	1 uF, 35 volts, tantalum electrolytic	
C20	2.2 uF, 25 volts, tantalum electrolytic	
C22 - C26	0.1 uF, 25 volts, ceramic	
SEMICONDUCTORS		
LED	High-brightness red LED power-on indicator	
BR1	Diode bridge, 2A, 50 volts	
IC1	LM7815 +15 volt regulator	
IC2	LM7915 -15 volt regulator	
V1A	LM6218 opamp	
V1B, V2A, V2B1,		
V3A, V3B, V4A,		
V4B, V5A, V5B	LM310 voltage follower	
V2B2	LM318 opamp	
MISCELLANEOUS		
T1	Power transformer, 115 VAC primary to 28 VAC center-tapped secondary, 300 mA Stancor P-8602 or equal.	

IEC-type AC power connector with fuse or new built-in line cord
PC boards, hardware, wire, and solder.

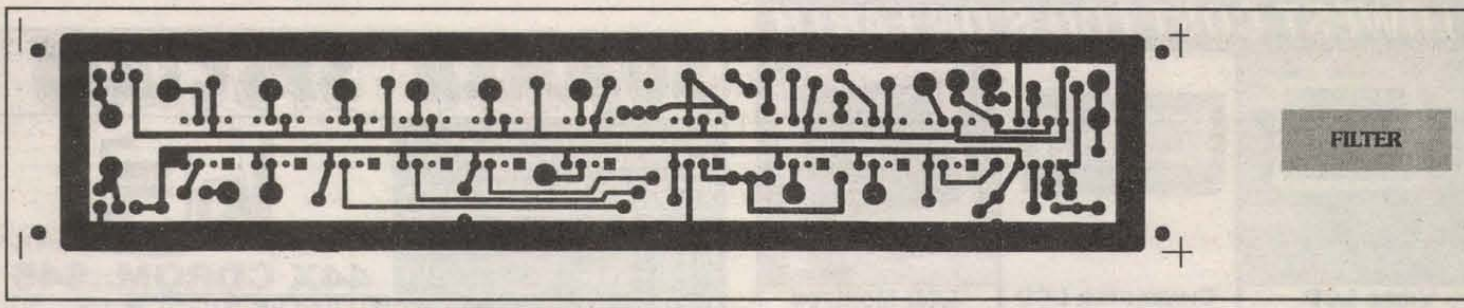
The following items are available from **TDL Electronics, 5260 Cochise Trail, Las Cruces, NM 88012. 505-382-8175, FAX 505-382-8810.** Set of three PC boards (two filter boards and one power supply board), $23.00 postpaid in the US and Canada.

REF NO	LENGTH	CONNECTION DESCRIPTION (see Figures 8 and 9)
1	3-3/8"	First lug to the left of center on front of wafer 1
2	4	First lug to the right of center on front of wafer 1
3	5	Only lug to the right of center on rear of wafer 2
4	4-3/8	First lug to the left of center on front of wafer 4
5	4-3/4	First lug to the left of center on front of wafer 5
6	5	Center lug on potentiometer section 2
7	4	First lug to the left of center on front of wafer 6
8	5	Center lug on potentiometer section 3
9	5-1/4	12th terminal from front on left side of capacitor board
10	5	Only lug to the right of center on rear of wafer 7
11	3-3/4	First lug to the left of center on rear of wafer 8
12	4-1/2	First lug to the left of center on front of wafer 7
13	4	First lug to the left of center on front of wafer 9
14	5	Second lug to the right of center on front of wafer 8
15	3-5/8	First lug to the left of center on rear of wafer 2
16	4-3/4	Only lug to the right of center on rear of wafer 4. This is easier to do if you insert the wire in the lug stake hole on the front of the wafer.
17	3-1/4	Only lug to the right of center on rear of wafer 6. This is easier to do if you insert the wire in the lug stake hole on the front of the wafer.
18	4	First lug to the left of center on rear of wafer 7
19	5	First lug to the left of center on rear of wafer 9
To input eyelet on new PC board	9	First lug to the right of center on front of wafer 8
To output binding post	7-1/2	First lug to the left of center on front of wafer 8

Table 2 - Range Switch Wire Lengths and Connection Descriptions. Range Switch Wafers and Potentiometer Sections are numbered from front to rear.



POWER SUPPLY



Place a solder lug on the screw and replace the nut. Run a length of AWG 20 solid bus bar from the input common binding post through the solder lug to the output common binding post.

Connect a short piece of hookup wire (about an inch) between the solder lug and one of the common PC board eyelets or terminals. Solder all these connections. Now connect all the free wire ends to the PC board (see Figure 8).

Finally, there are a few components attached to the Range switch which should be clipped out: both 5-25 pF trimmer capacitors connected between wafers 1 and 2; the 56K, 1/2 watt resistor on wafer 1; the 100K, 1/2 watt resistor connected between wafers 8 and 9; and the 47K, 1/2 watt resistor connected between wafers 4 and 6.

This completes the wiring, so you can replace any missing hardware and reconnect the power supply to the filter section. But leave the top and bottom covers off for now.

ADJUSTMENT

Adjustment affects only the high range (X10K), so if you are going to use the filter for just audio frequencies (less than 20 kHz), you are done! To calibrate the X10K range, set up the equipment shown in Figure 10. Set the filter range switch to HIGHPASS X10K and the frequency tuning dial to "4." Set your signal generator to 40 kHz, 2 to 3 volts RMS output.

Now adjust C2-4B (see Figure 11) for maximum output. Then adjust C1A-4 for an output of about -3 dB below the input level.

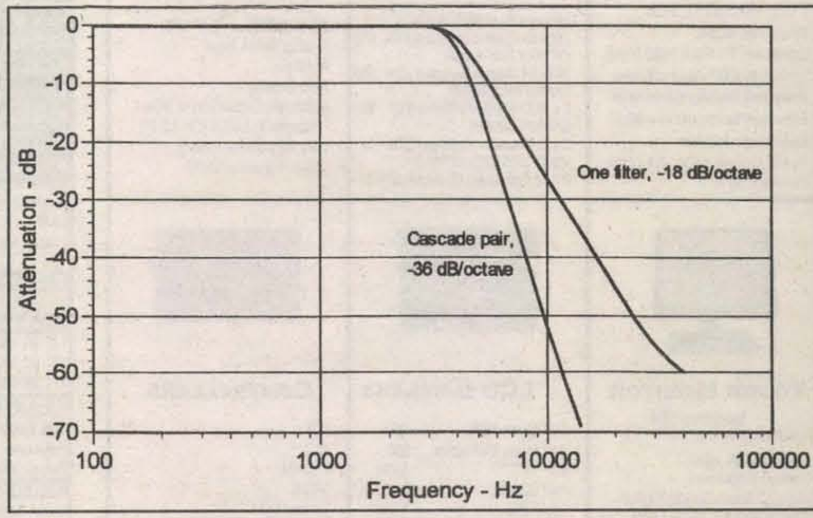
The passband response on the high range won't be quite flat, but this adjustment is about the best you can do. Now set the filter range switch to LOWPASS X10K and adjust C1B-4 for an output about -1.75 dB below the input.

PERFORMANCE

The converted filter pretty well meets or exceeds the original specifications. Because of the shielding provided by the original mechanical layout coupled with my use of separate voltage regulators on each filter board, the signal coupling between filters is lower than the noise level. Each filter can be used independently. Broadband output noise with the input open is about 500 microvolts RMS.

A measured lowpass response for a single filter and a cascade pair is graphed in Figure 12. (To cascade the filters, simply connect Output 1 to Input 2 and set the Range and Tuning the same.) The maximum attenuation you can measure is limited by the filter's noise level and the spectral purity of your signal generator. Harmonic distortion on the input signal will show up as reduced filter performance. This is especially true when you are trying to make measurements less than 60 dB or more below the input level.

FIG 12 — Lowpass response for one filter and cascade filter pair; cutoff frequency = 4,000 Hz.



Output impedance is typically less than one ohm over the audio frequency range and the output can be shorted without damage. The filter will drive a moderate capacitive load; I haven't had any problems driving small diameter coaxial test cables. A long cable run at high frequencies might be a problem but you can put a 50- to 100-ohm resistor in series with the center conductor to settle it down.

You can also use the cascaded pair as a bandpass filter. For example, to get a passband centered at 1000 Hz, set Filter 1 to HIGHPASS X100 and Filter 2 to LOWPASS X100.

If you set both Tuning dials to "10," you will get a narrow passband but the gain at 1000 Hz will be down -4 to -5 dB. Tuning Filter 1 (the highpass) to a lower frequency and Filter 2 (the lowpass) to a higher frequency will increase the center frequency gain at the expense of a wider passband.

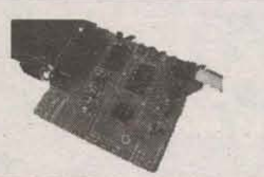
Overall, I'm very satisfied with the converted filter's performance and I think you will be too! **NV**

1. Thin, flat, 3/8 inch open end wrench for frequency dial vernier mechanism.
2. 1/16 (0.0625) inch Allen (hex) wrench for frequency dial.
3. 5/64 (0.078) inch Allen (hex) wrench for range selector knob.
4. Can of spray contact cleaner.

Table 1 - Special Tools Needed to Perform the Filter Conversion

Continued from page 46

MICROCONTROLLERS



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68HC11, 80C552 and 8031 microcontroller boards. Uploader, assembler and compiler software included. See our products at: www.tecel.com

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SELL PICSTART 16B1 and 16C programmers, complete. Both for $50 postpaid in US. Ron, 505-382-3173, www.zianet.com/tdl

ANTIQUE ELECTRONICS

WANTED: FOR historical museum, pre-1980 microcomputers, magazines, and sales literature. Floyd, VA 24091-0341 (540-763-3311/540-382-2935).

CRYSTAL SETS. Parts, plans, books, kits. Largest source in the world. Catalog $2. MIDCO, PO Box 222288, Hollywood, FL 33022.

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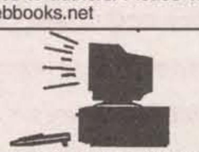

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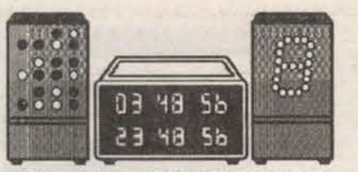

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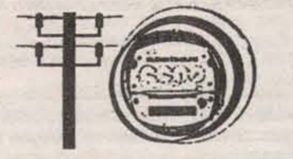

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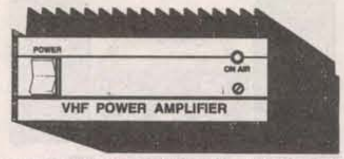

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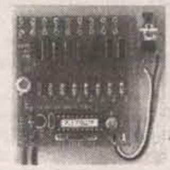

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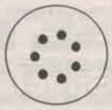

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Are you being bugged? Curious about the RF near your radios? Ever wonder how much wave you get from your microwave? This little unit illuminates into blinking mode when near any RF. Cell phones, PCS phones, cordless phones, hand held transceivers -- they all activate the detection disk. (Don't worry, your unit in standby mode won't activate the disk -- transmissions and incoming calls cause it to blink!) Compact RF disk can be worn on a neck chain, attached to your key ring, hung from your rear view mirror, or shoved in your pocket until you want to use it! Detects RF 1 Mhz to 2.5 Ghz, and is only activated at close range. Uses a CR-2032 battery -- yes, it is included! (Light may be hard to see in bright areas.)

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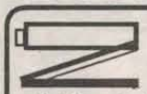

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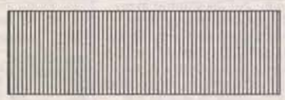

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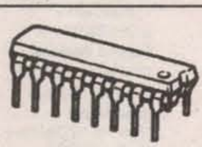

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1209 E. Golf Rd.
Schaumburg 60173

INDIANA
Harbourtown Sales
108 Park 32 W. Dr.
Noblesville 46060

KANSAS
Hollywood At Home
9063 Metcalf Ave.
Overland Park 66212

Lloyd's Radio & Electronic, Inc.
220 W. Harry St.
Wichita 67213

LOUISIANA
Lakeside News
3323 Severn Ave.
Metairie 70002

MARYLAND
Silicon Valley Electronics
2014-A Industrial Dr.
Annapolis 21401

Tower Records/Video
2566 Solomons Island Rd.
Annapolis 21401

1601 Rockville Pike #210
Rockville 20852

MASSACHUSETTS
Newsbreak, Inc.
579 G.A.R. Hwy. Rt. 6
Swansea 02777

Tower Records #172
360 Newbury St.
Boston 02115

MICHIGAN
Little Professors Book Center
22174 Michigan Ave.
Dearborn 48124

Purchase Radio Supply, Inc.
327 E. Hoover Ave.
Ann Arbor 48104

Tower Records
1214 S. University Ave.
Ann Arbor 48104

MINNESOTA
Radio City, Inc.
2633 County Road 1
Mounds View 55112

MISSOURI
Accurate Instruments
11201 E. 24 Hwy.
Independence 64054

Electronics Exchange
8644 St. Charles Rock Rd.
St. Louis 63114

NEVADA
Amateur Electronic Supply
1072 N. Rancho Dr.
Las Vegas 89106

Less Buster's Electronics
2930 N. Las Vegas Blvd.
VSTG-22
North Las Vegas 89030

Radio World
1656 Nevada Hwy.
Boulder City 89005

Tower Records/Video
4580 W. Sahara Ave.
Las Vegas 89102

6450 S. Virginia
Reno 89511

NEW JERSEY
Tech-Systems Electronics, Inc.
1309 Hwy. 71
Belmar 07719

NEW YORK
All Phase Video Security, Inc.
70 Cain Dr.
Brentwood 11717

Genosha Minicade
3413 Ave J
Brooklyn 11210

Ham Central
3 Neptune Rd.
Poughkeepsie 12601

Hirsch Sales Corporation
219 California Dr.
Williamsville 14221

Tower Records/Video
105 Old Country Rd.
Carle Place 11514

350-370 Route 110
Huntington 11746

1961 Broadway
New York 10023

383 Lafayette St.
New York 10003

OHIO
Compustuff
241 Great Oaks Trl.
Wadsworth 44281

Digital One
7603 Mentor Ave.
Mentor 44060

Footsteps
4925 Jackman Rd. Store #58
Toledo 43613

Hosfelt Electronics, Inc.
2700 Sunset Blvd.
Steubenville 43952

Keyways, Inc.
204 S. 3rd St.
Miamisburg 45342

Leo's Book Shop
333 N. Superior St.
Toledo 43604

Powermaxx, Inc.
1587 U.S. Route 68 N.
Xenia 45385

OKLAHOMA
Steve's Books & Magazines
2612 S. Harvard
Tulsa 74114

Taylor News & Books
133 W. Main, Ste. 102
Oklahoma City 73102

OREGON
News & Smokes
2295 W. Main St.
Medford 97501

News & Smokes #8
259-C Barnett Rd.
Medford 97501

Norvac Electronics
7940 S.W. Nimbus Ave. Bldg. 8
Beaverton 97005

960 Conger
Eugene 97402

1545 N. Commercial N.E.
Salem 97303

Powell's Technical Bookstore
33 N.W. Park
Portland 97209

Tower Books
1307 N.E. 102nd Ave.
Portland 97220

PENNSYLVANIA
Bedford St. News
308 Bedford St.
Johnstown 15901

Genes Books, Inc.
King of Prussia Plaza
King of Prussia 19406

Lehman Scientific
85 Surrey Dr.
Wrightsville 17368

Tower Books
425 South St.
Philadelphia 19147

Tower Records
340 W. Dekalb Pike
King of Prussia 19406

SOUTH CAROLINA
555 Electronics
5646 Farrow Rd.
Columbia 29203

TENNESSEE
Tower Books
2404 W. End Ave.
Nashville 37203

TEXAS
BDL News, Inc.
809 Pierce
Houston 77002

Electronic Parts Outlet
3753-B Fondren Rd.
Houston 77063

Mouser Electronics
958 N. Main St.
Mansfield 76063

Tanner Electronics
1301 W. Beltline #105
Carrollton 75006

Tower Records
2403 Guadalupe St.
Austin 78705

VIRGINIA
American Computer Clearance
1609 Rhoadmiller St.
Richmond 23220

Tower Records/Video/Books
4110 W. Ox Rd. #12124
Fairfax 22033

1601 Willow Lawn Dr.
Richmond 23230

8389 E. Leesburg Pike
Vienna 22182

WASHINGTON
A-B-C Communications, Inc.
17541 15th Ave. N.E.
Seattle 98155

Bohica Concepts
214 2nd St.
Morton 98356

Cody Books Ltd.
1125 Fir Ave.
Blaine 98230

Service Request
3304 W. Rowan Ave.
Spokane 99205

Supertronix
16550 W. Valley Hwy.
Seattle 98188

Tower Books
10635 N.E. 8th St.
Bellevue 98004

20 Mercer St.
Seattle 98109

WISCONSIN
Amateur Electronic Supply, Inc.
5710 W. Good Hope Rd.
Milwaukee 53223

Greenfield News & Hobby
6815 W. Layton Ave.
Greenfield 53220

Cudahy News & Hobby Ctr.
4758 Packard Ave.
Cudahy 53110

WYOMING
Western Test Systems
2701 Westland Ct. #B
Cheyenne 82001

Events CALENDAR

The Events Calendar is a free service for publicizing electronic events such as amateur radio hamfests, flea markets, etc. If your organization is sponsoring an event and would like a free listing, contact us at least 60 days in advance. 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

JULY 1999

JULY 3

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

KY - TOMPKINSVILLE - Hamfest. The National Guard Armory, Hwy. 163 N. Talk-in: 146.775 repeater. Monroe County ARC, David Welch K4PL, 502-678-5784. J. Bunch, 502-678-5784. E-Mail: dwelch@glasgow-ky.com Web: http://monroearc.hypermart.net

NC - SALISBURY - Hamfest. Firecracker Hamfest. Civic Center. Rowan ARS, Ralph Brown WB4AQK, 704-636-5902. E-Mail: rbrown@salisbury.net Web: http://home.interpath.net/kk4lh/hamfest

PA - LEHMAN - Wilkes-Barre Hamfest. Luzerne County Fairgrounds, Rte. 118 (I-81 Exit 47B to Rt. 309 to Rt. 415 to Rt. 118). 8am. FCC Exams. Talk-in: 146.52 & 146.61. Murgas ARC, Stan Perry KE3TC, 570-735-2385; E-Mail: slperry@epix.net Bob N3FA, 570-288-3532

JULY 4

PA - BRESSLER - Firecracker Hamfest. Emerick Cibort Park, Penn St. 8am. VE Exams. Talk-in: 146.16/76 & 146.52 simplex. Harrisburg RAC, Richard Bordner W3NJB, 717-939-4825. E-Mail: n3njb@aol.com

JULY 9-10-11

CANADA - MANITOBA - BRANDON - Hamfest. International Peace Garden, Dave Snydal VE4XN, 204-728-2463. E-Mail: dsnydal@mb.sympatico.ca

JULY 10

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

CANADA - ONTARIO - MILTON - Hamfest. Burlington ARC, Alan Montgomery VE3FCJ, 905-332-5282. E-Mail: ontariohamfest@canada.com Web: http://www.bigwave.ca/~ve3coj/barc/flyer

GA - GAINESVILLE - Hamfest. Lanierland ARC, Ken Parrish KN4UO, 770-867-9833. E-Mail: kn4uo@mindspring.com Web: http://www.qsl.net/kc4oxp/index.htm

IN - INDIANAPOLIS - ARRL Central Division Convention, Rick Ogan N9LRR, 317-251-4407. E-Mail: oganr@in.net Web: http://www.indyhamfest.com

MD - BRUNSWICK - Hamfest. Mid-Atlantic DX & Repeater Assn., Roy Bates N2CSQ, 301-834-9351. E-Mail: MADRA@qsl.net

ME - UNION - Hamfest. Fairgrounds. Pen-Bay ARC, Will Chadwick WC1W, 207-785-2739. E-Mail: wilchad@tidewater.net

MI - PETOSKEY - Swap & Shop. Emmet County Fairgrounds, US 31, 2 blks W of 131. 8am-1pm. VE Exams. Talk-in: 146.68 (-). Straits Area ARC, Tom W8IZS, 616-539-8459; Dirk KG8JK, 616-348-5043. E-Mail: kg8jk@qsl.net

MO - KANSAS CITY - Midwest Division Convention, Bob Roske WA0CLR, 816-436-0069. E-Mail: wa0clr@worldnet.att.net Web: http://members.tripod.com/~PHDARA/

NY - BATAVIA - Hamfest. Genesee fairgrounds. 6am-3pm. Talk-in: W2RCX 147.285+, "Gram," Harold Hay, 716-343-2844. E-Mail: wa2abq@aol.com

TX - TEXAS CITY - Hamfest. Tidelands ARS, Joe Wileman AA5OP, 409-945-6794

WI - EAU CLAIRE - Hamfest. Eau Claire ARC, Jim Staatz KG9MV, 715-838-9108. E-Mail: kg9mv@arrl.net Web: http://www.ecarc.org

WI - OAK CREEK - Swapfest. American Legion Post 434, 9327 S. Shepard Ave. 6:30am-2pm+ CDT. Talk-in: 146.52 (WA9TXE). South Milwaukee ARC, Inc., 414-762-3235

JULY 11

IL - PEOTONE - Hamfest. Will County Fairgrounds. Talk-in: 146.94. Kankakee Area Radio Society, Billie Kerouac KF9IF, 815-939-7548. E-Mail: dkbk@megsinet.net Web: http://www.geocities.com/capecanaveral/hanger/5711

NY - PATCHOGUE - Hamfest. 9am-2pm. VE Exams 12pm. Talk-in: K2TFC (East) 447.025 repeater (PL 91.5). Mid-Island ARC, Mike Grant N2OX, 516-736-9126. E-Mail: globalcm@erols.com Web: http://www.qsl.net/mid-islandarc/hamfest.html

OH - BOWLING GREEN - Hamfest. County Fairgrounds. 8am-1pm. VE Exams 9am. Talk-in: 147.18+ or 444.475 PL 77.0 Hz. Wood County ARC, Bob Boughton N1RB, 419-354-1811. E-Mail: boughton@bgnet.bgsu.edu Web: http://bravais.bgsu.edu/~boughton/wcarc.html

PA - KIMBERTON - Valley Forge Hamfest. Fire Co. Fairgrounds, Rt. 113 (S of Rt. 23). 8am. Mid-Atlantic ARC, Bill Owen W3KRB, 610-325-3995. E-Mail: hamfest-info@marc-radio.org Web: http://www.marc-radio.org/hamfest.html

PA - PITTSBURGH - Hamfest. Northland Public Library, 300 Cumberland Rd. 8am-3pm. Talk-in: 149.09 W3EXW. North Hills ARC, H. Rey Whanger W3BIS, 412-828-3694 (ph & fax). E-Mail: w3bis@freewwweb.com Web: http://nharc.pgh.pa.us/

JULY 16-17-18

MT - EAST GLACIER - Montana State Convention, Darrell Thomas N7KOR, 406-453-8574. E-Mail: n7kor@mcn.net Web: http://www.tlatech.com/hamfest/

JULY 17

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

CO - LOVELAND - Superfest. Larimer County Fairgrounds, 700 Railroad Ave. 8am-2pm. Talk-in: 145.115- or 146.85-. Northern CO ARC, 970-352-5304

LA - SLIDELL - Hamfest. Ozone ARC, Ronald Riviere WB5CXJ, 504-882-5067

NC - CARY - Mid-Summer Swapfest. Cary Community Center, 404 Academy St., Chapel Hill Rd. & Academy St. VE Testing. Talk-in: 147.15+.6. Cary ARC, POB 53, Cary, NC 27512; include SASE.

NY - FRANKFORT - Hamfest. Utica ARC, Bob Decker AA2CU, 315-797-6614. E-Mail: ktrnd@borg.com

OH - WELLINGTON - Hamfest. Lorain County Fairgrounds. 8am-2pm. VE Exams. Talk-in: 146.10/70. Northern Ohio ARS, John Shaaf KC8AOX, 216-696-5709. E-Mail: kc8aox@qsl.net

PA - SALEM TOWNSHIP - Hamfest. Beach Haven Carnival Grounds (I-80 Exit 36 or 38 N to US-11). 8am. VE Exams. Talk-in: 145.130 (PL 77.0) & 146.52 simplex. Jonestown Mountain Repeater Assn, Charlie Hooker AD3L, 570-864-2571 or fax 717-864-2377; Rich N3YGL, 570-784-0488; Mike K3EVQ, 570-752-1334; Walter N3UAU, 570-822-0180. E-Mail: chooker@epix.net

TX - DENISON - North Texas Hamfest '99, Wilmer O. Kinsey WB5DCU, 903-893-5872. E-Mail: wb5dcu@gte.net Web: http://home1.gte.net/wb5dcu/nortex99.html

JULY 18

IL - SUGAR GROVE - Hamfest. Waubonsee Community College, Rt. 47 at Harter Rd. (5 mi NW of Aurora). 8am. VE Exams. Talk-in: W9CEQ - 147.210 (+) PL 103.5/107.2 - AFAR repeater. Fox River Radio League, James Von Olnhausen N9UZC, 630-879-3042. E-Mail: n9uzc@amsat.org Web: http://www.frrl.org/hamfest.html

MA - CAMBRIDGE - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: http://web.mit.edu/w1mx/www/swapfest.html

MO - WASHINGTON - Hamfest. Zero Beaters ARC, Dave Neal N0PNG, 314-532-2477 days, 314-458-3254 eves. E-Mail: Dave Neal@msn.com Web: http://zbarc.usmo.com/

NJ - AUGUSTA - Hamfest. Sussex County ARC, Dan Carter N2ERH, 973-948-6999. E-Mail: n2erh@email.com Web: http://www.scarcnj.org

OH - VAN WERT - Hamfest. Van Wert County Fairgrounds, US Rt. 127 S. 8am-3pm. VE Exams. Talk-in: 146.85 (-). Van Wert ARC, Bob Barnes WD8LPY, 419-238-1877, Bob KA8IAF, 419-795-5763. E-Mail: barnesrl@bright.net Web: http://www.bright.net/~barnesrl/w8fy.html

JULY 22-23-24-25

IA - CEDAR RAPIDS - Central States VHF Society Conference. Sheraton Four Points Hotel. Al Groff K0VM, E-Mail: K0VM@rf.org Web: http://www.csvhfs.org

JULY 23-24

FL - MILTON - Hamfest. Milton ARC, Dean Clark WB6UKF, 850-626-9752. E-Mail: acordc@worldnet.att.net

OK - OKLAHOMA CITY - Ham Holiday '99. Oklahoma State Fair Park (Hobbies, Arts & Crafts Bldg.), intersection I-40 & I-44. 5-8pm Fri., 8am-5pm Sat. Talk-in: 146.82. Central Oklahoma Radio Amateurs, Thomas Webb WA9AFM. E-Mail: n1pn@swbell.net or tmwebb@telepath.net Web: http://www.geocities.com/heartland/7332

JULY 23-24-25

AZ - FLAGSTAFF - Hamfest & ARRL AZ State Convention. Norm Martin KC7FNK, 520-297-9562. E-Mail: arcathill@aol.com Web: http://www.hamsrus.com

JULY 24

FL - LANTANA - Flea Market. Next to Pizza Hut, 6170 S. Congress Ave. 7am-12pm. Talk-in: 147.045. The Major Armstrong FM Assn., Jeff Beals WA4AW, 561-586-5120. Al West W4SDC, 561-641-8244

NH - NASHUA - Hamfest. Res Ctr Church. NE Antique RC 617-923-2665

OH - CINCINNATI - Hamfest. Diamond Oaks Career Dev. Campus, 6375 Harrison Ave. VE Exams. Talk-in: 146.67- & 146.925-. OH-KY-IN ARS, Dana Laurie WA8M, 513-761-7388. E-Mail: wa8m@arrl.net Web: http://www.qsl.net/k8sch

JULY 24-25

SD - CLEAR LAKE - Hamfest. Deuel County ARC, Don Clifford N7AXW, 605-876-2671. E-Mail: drc@itctel.com

JULY 25

CA - SANTA ANA - Swapmeet. ACP parking lot. Mary Russo 714-558-8813

MD - TIMONIUM - Hamfest. Timonium Fairgrounds, York Rd. off I-695, I-83. 8am. VE Exams. Talk-in: 147.030 (+) & 224.960 (-) & 448.325 (-). Baltimore Radio Amateur TV Society, 410-461-0086. E-Mail: brats@smart.net Web: http://www.smart.net/~brats

OH - HAMDEN - Hamfest. 8am-2pm. Firefighters Bldg., East Railroad St. VE Exams 10am. Talk-in: 147.105. Vinton County ARC, Chuck Boyer 740-384-5238. E-Mail: cboyer@zoomnet.net or Gary Bowden 740-384-3213.

JULY 30-31-AUGUST 1

OR - PORTLAND - Pacific Northwest DX Convention. Willamette Valley DX Club, Al Rovner K7AR, 360-256-7437 E-Mail: alanr@pacifier.com Web: http://www.qsl.net/wvdxc

JULY 31

IN - HUNTINGTON - Hamfest. Huntington County 440 Repeater Group, Ray Tackett KC9DZ, 219-786-0029 or 219-786-0057. E-Mail: rtackett@ctlnet.com

KY - BOWLING GREEN - Hamfest. American Legion Post 23, 208 Dishman Ln. VE Exams. Talk-in: K4LOL 147.33. Kentucky Colonels ARC, Fred Painter, KA4CFW, 502-842-3193. E-Mail: ka4cfw@mindspring.com Web: http://kcarc.premiernet.net

NC - WAYNESVILLE - Hamfest. Haywood County Fairground. Western Carolina ARS, Carl Smith N4AA, 828-683-4251. E-Mail: wcars@dxpub.com

NV - RENO - Hamfest. Sierra Nevada ARS, Bill Massie K7NHP, 775-246-3756. E-Mail: macm.yncsmassie@juno.com

OR - BANDON - Hamfest. 9am-3pm. VEC Exams. Talk-in: K7CCH repeater, 146.610 MHz (-600 no PL). Coos County ARC, Brian Howard W7MLT, 541-572-5623. E-Mail: w7mlt@usa.net

AUGUST 1999

AUGUST 1

IN - ANGOLA - Hamfest. Land of Lakes ARC, Bill Brown WD9DSN, 219-475-5897. E-Mail: sharon.l.brown@gte.net

OH - RANDOLPH - Hamfest. Portage County Fairgrounds. 8am-4pm. VE Exams. Talk-in:

COMPUTER SHOWS

AGI Shows, 317-299-8827. E-Mail: info@agishows.com http://www.agishows.com

Blue Star Productions 612-788-1901 http://www.supercomputersale.com

Computers And You, 734-283-1754. www.a1-supercomputersales.com

Computer Central Shows 847-412-1900 & 1-888-296-6066. E-Mail: compcent@megsinet.net www.computercentralshows.com

Five Star Productions 810-890-0988 E-Mail: jeff@fivestar www.fivestarshows.com

Georgia Mountain Productions 706-838-4827. E-Mail: gamtnpro@blrg.tds.net georgiamountain.com

Gibraltar Trade Center, Inc. 734-287-2000. Taylor, MI.

Gibraltar Trade Center, Inc. 810-465-6440. Mt. Clemens, MI.

KGP Productions 1-800-631-0062, 732-297-2526. E-Mail: kgp@mail.com

MarketPro, Inc., 201-825-2229 http://www.marketpro.com

MarketPro, Inc., 301-984-0880. E-Mail: md@marketpro.com http://marketpro.com

Narisaam Computer Show 770-663-0983. E-Mail: narisaam@aol.com Web: http://www.shownsale.com

Northern Computer Shows 978-744-8440 E-Mail: inquiries@ncshows.com Web: ncshows.com

Peter Trapp Computer Shows, 603-272-5008. Web: www.petertrapp.com

145.39 600 MHz. Portage ARC, Joanne Solak KJ3O, 330-274-8240. E-Mail: ljsolak@apk.net Web: http://parc.portage.oh.us
VA - BERRYVILLE - Winchester Hamfest. Clarke County Ruritan Fairgrounds. 6am. VE Exams. Talk-in: 146.82 (-) W4RKC repeater. Shenandoah Valley ARC, Guy Avey W3INT, 540-678-9970; Jane Barb KD4IET, 540-955-1745. E-Mail: ibarb@visuallink.com Web: http://www.Vvalley.com/svarc/hamfest or http://www.visuallink.net/shenvalleyarc

AUGUST 6-7

TX - AUSTIN - Texas State ARRL Convention. Austin ARC, Austin Repeater Org & Texas VHF-FM Society, Joe Makeever W5HS, 512-345-0800. E-Mail: jomak@ibm.net Web: http://www.repeater.org/summerfest/

AUGUST 6-7-8

SD - WATERTOWN - Dakota Division Convention. Lake Area Radio Klub, Jerry Hegg N0JH, 605-886-7151. E-Mail: n0jh@dailypost.com

AUGUST 7

CA - CHICO - Hamfest. Golden Empire ARS, Muriel Pope K6GSK, 530-342-4765. E-Mail: k6gsk@w6rhc.org
CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
IL - CARLINVILLE - Hamfest. Macoupin County Fairgrounds, Rt. 4, I-55 exit 60. 7am-12pm. Talk-in: 146.82- or 443.400+ 103.5PL. Macoupin County ARC, Tim Jones 217-627-2355. KA9VIV E-Mail: jester25@ctnet.net. Jim Pitchford N9LQF, E-Mail: esda@ctnet.net
IL - QUINCY - Hamfest. Western Illinois ARC, Jim Funk N9JF, 217-336-4191. E-Mail: jfunk@adams.net Web: http://www.qsl.net/s9awe
ME - ST. ALBANS - Hamfest. Snow Mobile Club. Howard WA1SBI, 207-876-3702
MI - TAWAS - Hamfest. Iosco County AR Enthusiasts, John Hanley KA8AIP, 517-756-2845. E-Mail: ka8aip@centuryinter.net Web: http://www.oscoda.net/icare/
MO - SPRINGFIELD - Hamfest. Southwest Missouri ARC, Karen Thorpe N0TDW, 417-889-6775. E-Mail: n0tdw@juno.com
NY - PLATTSBURGH - Hamfest. Champlain Valley ARC, Bernard Jakobetz KC2ALG, 518-643-9657
NY - WEEDSPORT - Hamfest. Auburn ARA, Joe Kahler WA2NGX, 315-364-5135. E-Mail: htx@usa.net
OH - COLUMBUS - Hamfest. Aladdin Shrine Facility. 8am-3:30pm. VE Exams. Talk-in: 147.24 receive/147.84 transmit. Voice of Aladdin ARC, Jim Morton KB8KPJ, 614-846-7790
PA - MATAMORAS - Hamfest. Tri-State ARA, Dave W2DRH, 914-856-2529; Ray WY2D, 914-856-1733; Rich K3BBC, 570-559-7401

AUGUST 7-8

WA - SPOKANE - ARRL Eastern WA Section Convention. University High School, 10212 E. 9th Ave. Sat: 9am-5pm, Sun: 8am-12pm. VE Exams. Neil Gallup N7LVO, 509-928-7442. E-Mail: n7lvo@cet.com Betsy Ashleman N7WRQ, 509-448-5821. E-Mail: n7wrq@aol.com Web: http://www.iea.com/~n7utg

AUGUST 8

IA - AMANA - Hamfest. Cedar Valley ARC, Wayne Kolosik KI0FE, 319-393-4224. E-Mail: ki0fe@usa.net
IL - PEOTONE - Hamfesters Hamfest. Will County Fairgrounds. Tom Davis KB9NUQ, 708-210-9548; David Brasel NF9N, 708-448-0580. E-Mail: nf9n@aol.com or tdavis@internetplus.net
OH - LISBON - Hamfest. Triangle ARC, Mike Mays KB8JNM, 330-386-6021. E-Mail: mike.mays@usa.net Web: http://www.qsl.net/tarc
OH - MARTINS FERRY - Hamfest. Triple States RAC, Ralph McDonough K8AN, 740-546-3930. E-Mail: k8an@aol.com Web: http://www.qsl.net/tsrac

AUGUST 14

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves
NY - WESTMORELAND - Hamfest. Rome RC, Jack Roux KB2TXR, 315-336-1391
OH - NELSONVILLE - Hamfest. Sunday Creek AR Federation, Russell Ellis N8MWK, 740-767-2226. E-Mail: scarf@hocking.edu
WV - HUNTINGTON - Hamfest. Tri-State ARA, Dwight Smith WB8JPJ, 304-522-7865 eves; 304-523-6675 days. E-Mail: wb8jpj@arrl.net E-Mail: tara.amateur.radio@juno.com

AUGUST 15

CO - GOLDEN - ARRL Colorado State Convention. Jefferson County Fairgrounds, 15200 W. 6th Ave. (Indiana Exit). 8:30am-2pm. Denver Radio Club, Bob Lindell N0YIX, 303-422-0610. E-Mail: KB0QAB@arrl.net Web: http://users.ntr.net/~chastain/hamradio
IN - LAFAYETTE - Hamfest. Tippecanoe County Fairgrounds. Talk-in: W9REG 147.135/443.775.
KY - LEXINGTON - Hamfest. National Guard Armory. 8am-4pm. VE Exams. Talk-in: 146.760-. John Barnes KS4GL, 606-253-1178. E-Mail: KS4GL@juno.com Web: http://www.qsl.net/k4kjq/
MA - CAMBRIDGE - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: http://web.mit.edu/w1mx/www/swapfest.html
MI - JACKSON - Hamfest. Jackson Community College. VE Exams. Talk-in: 146.88 W8JXN. Cascades ARS, Dennis Byrne KC8IJZ, 517-522-4058. E-Mail: byrneda@voyager.net Web: http://www.qsl.net/cars-jxn/
NJ - BAYVILLE - Hamfest. Jersey Shore ARS, Bob Murdock WX2NJ, 732-269-6379. E-Mail: JARSFEST@aol.com Web: http://members.aol.com/jarsfest/jarsfest.html
NY - DEPEW - Hamfest. Hearthstone Manor, 333 Dick Rd. Lancaster ARC, Luke Calianno N2GDU, 716-634-4667. E-Mail: lcalianno@freewwweb.com Web: http://hamgatel.sunyerie.edu/~larc/GreaterBuffaloHamfest.ht
OH - WARREN - Hamfest. Trumbull County JVS School, Educational Hwy. Warren ARA, Frank Fitzhugh KD8KJ, 330-652-0452, E-Mail: kd8kj@onecom.com Ray Solinger N8HRZ, 330-652-5028, E-Mail: n8hrz@onecom.com
PA - YORK - Swapfest and Auction. York VO Tech School, Pauline Dr. (1 blk S of I-83 Exit 6, Rt 74S). Talk-in: 146.865. Swap Fest, John Salony (Ph) 717-741-1780; Greg Towson (fax) 717-741-0874. Gene Warner E-Mail: ad3e@arrl.net
WA - NORTH SEATTLE - Antique Radio Swap Meet. Shoreline Museum Parking Lot, N. 175th & Linden Ave. 9am-1pm. Puget Sound Antique Radio Assn., 425-747-1323 or 206-546-5495. Web: http://www.eskimo.com/~hhagen/psara.html

AUGUST 21

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
CANADA - MANITOBA - AUSTIN - MARM Hamfest. Dave Snydal VE4XN, 204-728-2463.

E-Mail: dsnydal@mb.sympatico.ca Web: http://WWW.MBNET.MB.CA/~donahue/a ustin.html
IN - WARSAW - Hamfest. Kosciusko County Fairgrounds. 8am-2pm. VE Exams. Hoosier Lakes Radio Club, Loren Melton WB9OST, 219-858-9374 eves. E-Mail: WB9OST@WAVEONE.NET
NJ - OAKLAND - Flea Market. American Legion Hall, 65 Oak St. 8am-Noon. Talk-in: 147.49 in/146.49 out & 441.175 in/446.175 out & 146.52 simplex. Ramapo Mountain ARC, Tony Cassera N2KDZ, 973-839-3564.
E-Mail: acassera@intac.com
NY - ITHACA - Hamfest. Tompkins County Airport. Talk-in: 146.97 (-600). Tompkins County ARC, David Flinn W2CFP, 607-533-4797.
E-Mail: dave@starflinn.com
Web: http://www.compcenter.com/~tcarc
VA - VINTON - Hamfest. William Byrd High School, Washington Ave. 9am-3pm. VE Exams. Roanoke Valley ARC, Mike Marsh KF4MUB, 540-389-3056. E-Mail: mikekf4mub@aol.com Web: http://ourworld.compuserve.com/homepages/fcu pp/rvarc.htm
WA - LONGVIEW - Hamfest. Cowlitz County Expo Center, Fairgrounds. 9am-1pm. Talk-in: 147.26+ K7ZVV repeater. Lower Columbia ARA, Bob Morehouse KB7ADO, 360-425-6076 (after 6pm wkdys). E-Mail: kb7ado@aolcom
Web: http://www.qsl.net/nc7p/

AUGUST 21-22

AL - HUNTSVILLE - Convention. Von Braun Center. Sat: 9am-4:30pm, Sun: 9am-2:30pm. Southeastern Division, Scotty Neustadter W4WW, 256-880-8004. E-Mail: scotty@hiwaay.net.
NM - ALBUQUERQUE - Duke City Hamfest. Marcus Lieberman KM5EH, 505-836-1724. Fax: 505-352-6154. E-Mail: buckml@lobo.net
Web: http://www.qsl.net/dchf

AUGUST 22

KS - SALINA - Hamfest. Central Kansas ARC. Ron Tremblay WA0PSF, 785-827-8149.
E-Mail: tremblay@midusa.net
MI - CORUNNA - Hamfest. Genessee County RC, Mid MI Wireless Assn., Lapeer ARC, Shiawassee ARA & Bay Area ARC. Rosemary Podsiadlik N8UHY, 517-288-4145
MO - ST. CHARLES - Hamfest. St. Charles ARC, Ken Fieser KB0VLN, 314-428-4383.
E-Mail: kfieser@aol.com
Web: http://www.qth.com/wb0hsi/
NE - OMAHA - Hamfest. AK-SAR-BEN ARC, Gerry Gross WA6POZ, 402-895-7267. E-Mail: wa6poz@aol.com Web: http://www.qsl.net/k0usa
NJ - MULLICA HILL - Hamfest. Gloucester County ARC, John Schumacher N2AWD, 215-238-4955. E-Mail: schumacher@kyw.com
Web: http://users.snip.net/~gradywhite
NY - YONKERS - Hamfest. Yonkers ARC, John Costa WB2AUL, 914-969-6548.
E-Mail: wb2aul@aol.com

AUGUST 27-28

LA - NEW ORLEANS - New Orleans International DX Convention, Don Boudreau W5FKX, 504-737-9733. E-Mail: dboudr@lsumc.edu
Web: http://www.gnofn.org/~w5ru/

AUGUST 27-28-29

CT - ENFIELD - Convention. Harley Hotel, 1 Bright Meadow Blvd. (off Rt. 5). Eastern VHF/UHF Society, Bruce Wood N2LIV, 516-265-1015.
E-Mail: wzlv@ntplx.net E-Mail: bdwood@erols.com
Web: http://uhavax.hartford.edu/~newsvhf

AUGUST 28

KS - CHANUTE - Hamfest. Chanute Area ARC, Charlie Ward WD0AKU, 316-431-6402
WV - WESTON - Convention. West Virginia State AR Council, Dick Fowler N8FMD, 304-623-9479.
E-Mail: n8fmd@neumedia.net

AUGUST 28-29

FL - SARASOTA - Computer Show. Municipal Auditorium. Frank Cox 941-954-0202

AUGUST 29

IL - WOODSTOCK - Hamfest. Tri-County Radio Group, Bob Grosse N9KXG, 708-944-0500.
E-Mail: N9KXG@quality-enterprises.com
Web: http://quality-enterprises.com/torg/
PA - NEW KENSINGTON - Swap/Flea Market. Skyview Radio Society Club House. Bob 724-727-2194
TN - LEBANON - Hamfest. Short Mountain Repeater Club, Patsy Pierce K3PAT, 615-395-4488.

SEPTEMBER 1999

SEPTEMBER 4

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
CANADA - ONTARIO - CARP - Hamfest. Ottawa ARC, Jim Cummings VE3XJ, 613-446-1225.
E-Mail: fleamarket@oarc.net
Web: http://oarc.net/fleamarket

SEPTEMBER 4-5

NC - SHELBY - Hamfest. Shelby ARC. John Ledford N4GOQ, 704-482-4507.
E-Mail: n4goq@shelby.net
Web: http://www.shelby.net/n4fan

SEPTEMBER 11

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves
DE - DOVER - Hamfest. Kent County ARC, Larry Roll K3LT, 302-678-4841. E-Mail: yodoc@aol.com or k3lt@magpage.com
IN - SPENCER - Hamfest. Owen County ARA, Kathryn Smith K9INU, 812-829-2140
ME - WINDSOR - Hamfest. Fairgrounds. AARA, Frank N1ITR, 207-623-9217
MO - COLUMBIA - Hamfest. Good Time Country, 5551 S. Hwy. 63. 8am-2pm. VE Exams. Central Missouri Radio Assn., Bruce Odle, 3315 Berrywood Dr., Ste. 101, Columbia, MO 65201
NY - BALLSTON SPA - Hamfest. County Fairgrounds. 7am-3pm. VEC Exams. Talk-in: WA2UMX 146.40/147.00 & 147.84/147.24. Saratoga County RACES Assn., Darlene Lake N2XQG, 518-587-2385 E-Mail: lake@capital.net
PA - ERIE - Hamfest. Franklin Twp. Firehall. VE Exams, 9am, Franklin Center Methodist Church, Rt. 98. Talk-in: 146.01/61. Radio Assn. of Erie, Dr. Tom McClain N3HPR, 814-833-1640.
E-Mail: TEM@ERIE.NET
Web: http://www.erie.net/~n3ntj/hamfest.htm
WA - GRAHAM - Tacoma Electronics Fleamarket. (Pierce County Fairgrounds), Frontier Park, 21718 Meridian Ave. E. 9am-3pm. Talk-in: 147.38+ PL 103.5, simplex 146.58. RCT, Roger 253-475-4293. E-Mail: rtwig@worldnet.att.net Web: www.mashell.com/~roblee/rct.htm

SEPTEMBER 11-12

FL - MELBOURNE - Hamfest. Auditorium. Platinum Coast ARC, Tim Madden KI4TG.
E-Mail: ki4tg@msn.com
KY - LOUISVILLE - ARRL KY State Convention. Bullit County Fairgrounds, I-65 (South 25 min.). Greater Louisville Hamfest Assn., Herbert Rowe W4WQD. 812-282-7007 or 812-948-0037 (commercial), 502-935-7197 or 606-284-9090 (FleaMkt/TailGate) E-Mail: wd4ixl@juno.com
Web: http://www.thepoint.net/~glha/

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AMATEUR ROBOTICS NOTEBOOK

by Robert Nansel

A problem robot builders always face is knowing when to say a robot is done. I've been working on Breadbot for over a year now, and every time I think I'm just about done with it, a new project idea comes along. That's how I got started with the wheel encoder project a couple months ago. All I wanted to do was to make Breadbot reliably go in a straight line so I could experiment with some simple obstacle avoidance algorithms, and now, three months later, I am still working on it.

Last month, I showed how to build the encoder boards, and this month, I had planned to do software for tracking the speed and direction of each wheel. In order to write the code, I first needed to allocate I/O bits for the four new inputs, A and B channels for both left and right wheels. The DT101 Breadbot already uses two outputs for the servos and three inputs for the bumper switches, leaving only three I/O lines free on port B. A problem.

Strapped for I/O

The easiest solution would have been to steal an I/O line or four from port A, but I didn't want to do that because port A is dedicated to RS-232 (asynchronous) and I2C (synchronous) serial communications on the SIMMStick. I'm not using them for anything yet, but I want to keep the option open.

The next idea I considered was to reduce from three to two the number of input lines used for the bumpers. One straightforward way to do this is to rewire the front bumper so that it uses the left and right inputs together to indicate a forward bump when both left and right inputs are switched low. This is the way the Parallax GrowBot does it, and it works fine. The left and right whiskers would still operate as before, but a leftward bump on the front bumper would read the same as a left whisker bump, and likewise for the right whisker. For obstacle avoidance, though, it's desirable to have more, not less, directions of touch sensitivity, so I scrapped that idea. Then, too, this method would have left no unassigned I/O bits for adding, say, a magnetic compass sensor; another project I'd like to do before I retire Breadbot.

I looked for ways to expand the number of I/O lines available. There are several ways to go about this. You can be tricky and make each I/O line do multiple duty by creating a scanning matrix. For instance, if you want 16 switch inputs (for a keypad, say), you can use eight I/O lines; four outputs and four inputs arranged in a 4x4 scan matrix that, with a little software, will scan and debounce the 16 switches. With a little more cleverness, you can also use such a matrix to do simultaneous keypad input and LED output (this is how calculators work). Scanning doesn't save any I/O lines for fewer than nine switch inputs, however, a 3x3 matrix gets you nine I/O and costs six, a 4x4 gets you 16 and costs eight, and a 5x5 gets you 25 and costs 10.

Another way to hang multiple switches on a single digital I/O is to create a simple A/D converter with a capacitor and various resistors – one resistor for each switch input. You periodically set the pin to be a

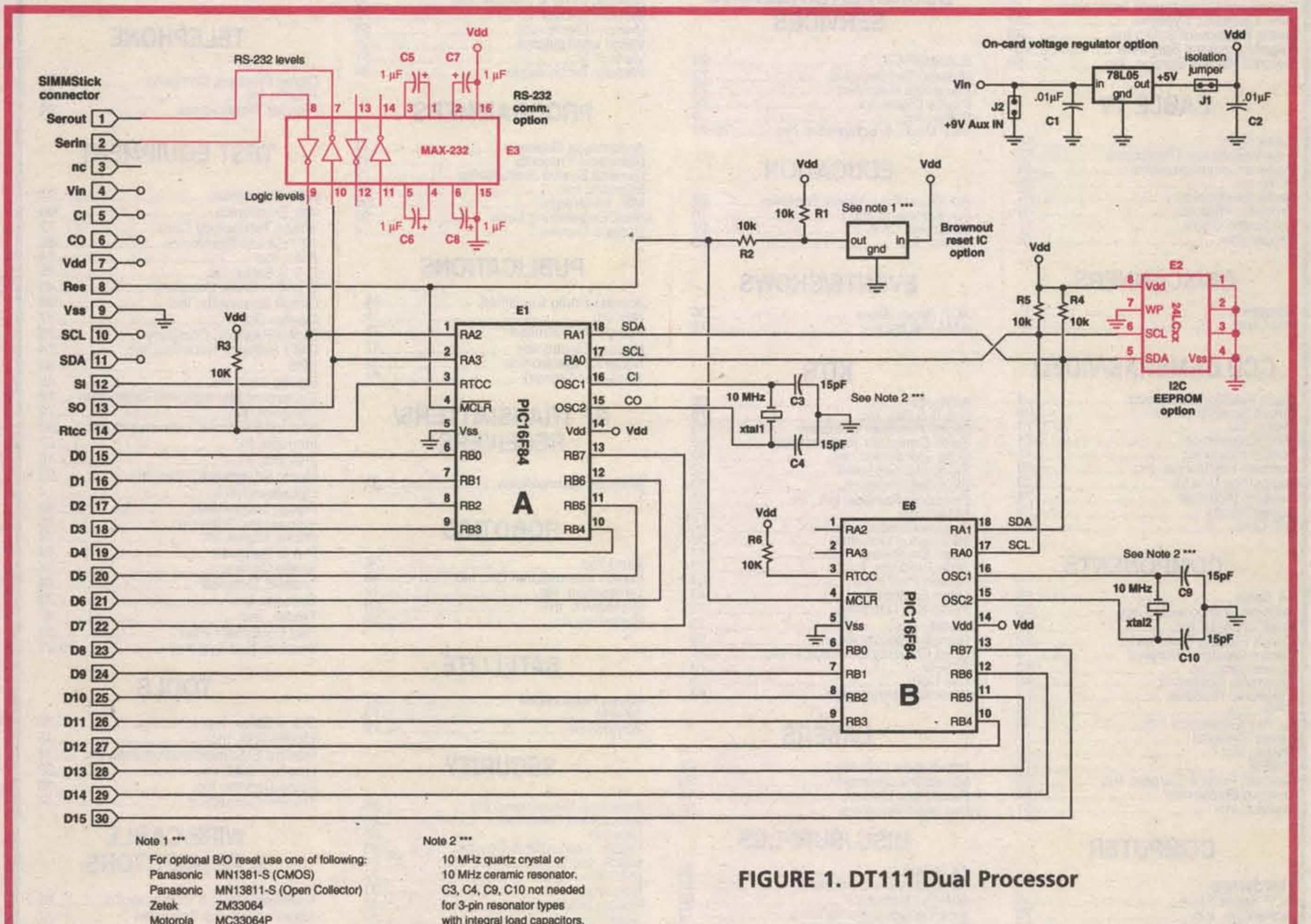


FIGURE 1. DT111 Dual Processor

momentary output LOW to dump the charge out of the timing capacitor, then revert to a high-impedance input. You then time how long it takes the capacitor to charge up to a logic-1 threshold. This time will vary depending on which resistors are switched out of the circuit. Using this method, you can get as many as four switch inputs on one digital I/O. An MCU with a built-in A/D converter will allow you to distinguish perhaps eight different switches on one analog input. These A/D methods aren't easy to apply and tend to be noise prone, but if you have only one free I/O pin it can be a lifesaver.

Corruption and Blue Smoke

Having eliminated the tricky ways to expand I/O without really expanding I/O, I then looked at the more traditional approach of adding extra hardware to create new I/O lines. There are two broad ways to do this, which I'll classify as the decoded register and shift register methods.

For the decoded register method, you set aside one group of I/O bits to act as a bus to which you wire the inputs of latches, the outputs of tri-state buffers, or the outputs of a multiplexer. Another group of bits is then used to select which register will latch the output data, or which data source – multiplexer or tri-state buffer – will be allowed to drive the bus with input data.

For example, with eight MCU pins allocated as a four-bit bus, three dedicated chip select lines, and a data strobe, you get three four-bit ports, 12 bits altogether – a gain of four bits. Your software has to ensure that only one of the chip select lines is ever active at one time or you'll wind up writing to more than one output port (which may or may not matter), or attempting to read from more than one input port (which does matter because when two or more buffers attempt to drive the same data line with different logic levels, the least that can happen is data corruption and the worst is blue smoke).

If you wire a 3-8 address decoder – a 74HC138, say – to the chip select lines, then you can access eight four-bit ports. For the cost of one chip, you eliminate the possibility of more than one port being selected at a time, and you more than double the potential number of I/O bits from 12 to 32 (though you still have to add enough latches or buffers to handle those extra bits). You can use this same idea when you have 12 MCU I/O lines available to give up to eight byte-wide ports – 64 bits total.

When you have less than eight MCU I/O lines, a bit-addressable latch can be a particularly elegant solution. A 74HC259 eight-bit addressable latch uses five output lines – one data, three select, and one strobe – to produce eight output bits.

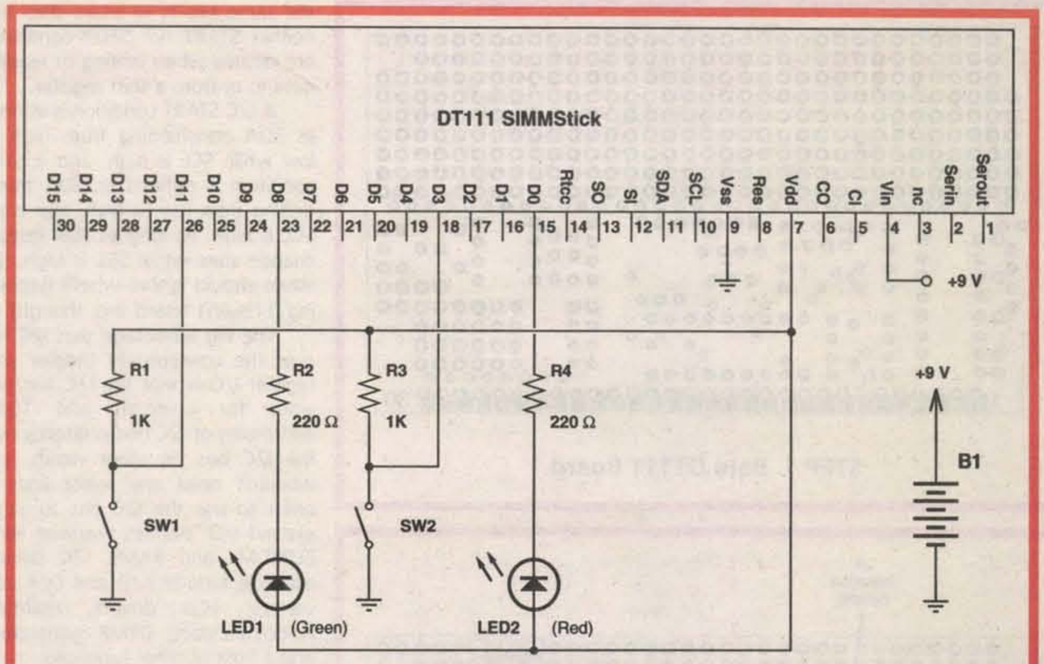


FIGURE 2. DT111 Dual Processor test circuit

Likewise, a 74HC251 – a tri-state data selector/multiplexer – gives the equivalent system for input; four MCU outputs drive the select lines and enable, and one input reads the data. You can dispense with the enable line provided: 1) You have only one HC251 connected to the input bit; and 2) You wait to read the input bit until after you've output the appropriate select code. In this last case, you get eight inputs from three outputs and one input line.

A Two-Bit Solution

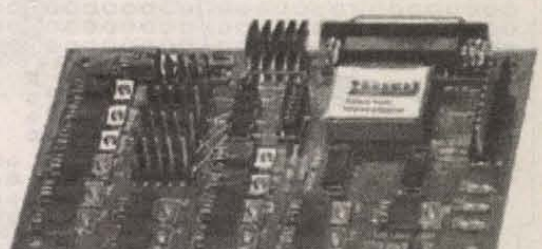
The above multiplexer scheme would have solved my immediate need for four more inputs and would have left me with one multiplexed input and two MCU I/O lines to spare. I didn't go this route, though, because it would have forced Breadbot's encoder inputs to share a port with the bumper sensors, and that means the software would have to be a little more complex to sort these separate functions out. This is a small detail, but I find it's easier to write software for systems where the hardware separates different I/O functions onto separate ports.

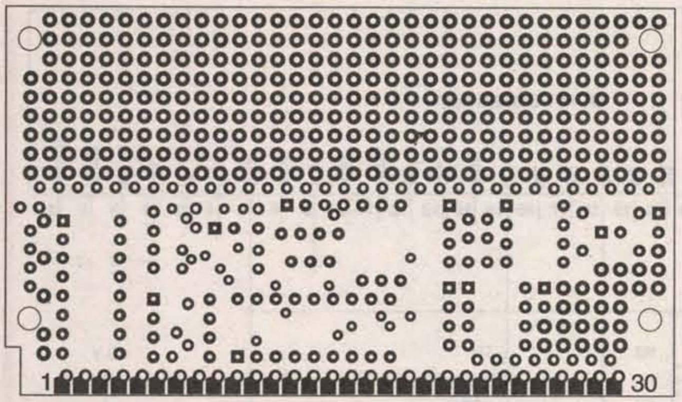
My ideal solution would give Breadbot eight or more new inputs while using no more than three MCU I/O lines in the process. This brings me to the other broad approach to I/O expansion: the shift register.

Shift registers can operate with as few as two I/O lines, serial data (SDA), and shift clock (SCL), though most applications will require a third line to latch the data into either the input or output register. I could have used a 74HC164 – a parallel-load eight-bit shift register – to get eight new inputs while leaving three lines free on port B.

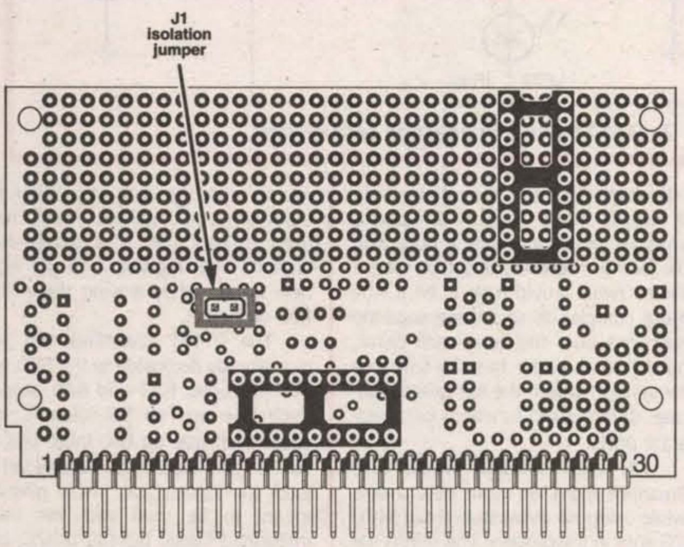
The DT101 SIMMStick has two pins already dedicated to the SDA and SCL functions, RA1 and RA0, respectively (see my Feb '99 column), so I could even free up two more bits on Port B (one would still be needed to latch the input data). These pins are meant to be used with the Inter-Integrated Circuit bus (IIC or I2C, pronounced "I-squared-C").

Using SDA and SCL with a shift register needn't mean sacrificing I2C functionality, however, all that is necessary for shift registers and I2C-compatible EEPROMs to coexist on

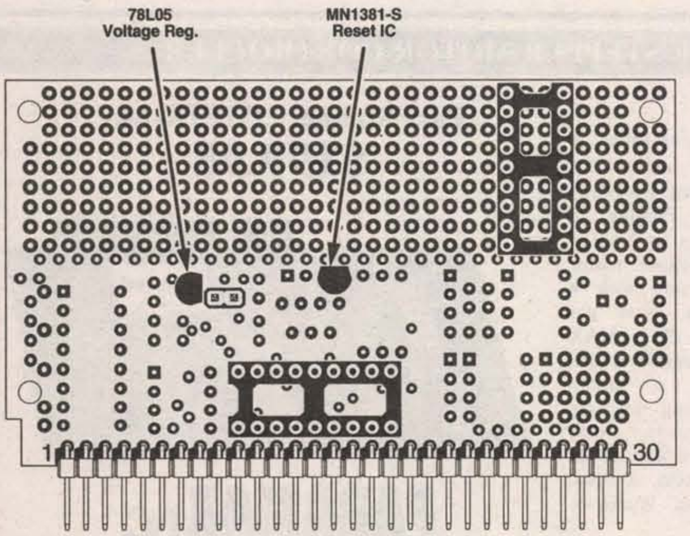




STEP 1. Bare DT111 Board.



STEP 2. Install headers and sockets.



STEP 3. Voltage regulator and Reset IC.

the same bus is to make sure that neither START nor STOP conditions are created when writing or reading data to or from a shift register.

A I2C START condition is defined as SDA transitioning from high to low while SCL is high, and a STOP condition is defined as SDA transitioning from low to high, also while SCL is high. As long as SDA doesn't change state while SCL is high, I2C slaves should ignore what's happening (I haven't tested this, though).

The big advantage that I2C has over the conceptually simpler shift register I/O is that the I2C bus provides for seven-bit and 10-bit addressing of I2C nodes directly over the I2C bus. In other words, you wouldn't need any select lines in order to use the I2C bus to vastly expand I/O. Besides two-wire serial EEPROMs and RAMs, I2C devices available include A/D and D/A converters, LCD drivers, real-time clock/calendars, DTMF generators, and a host of other functions.

An I2C part of particular interest here is the Philips PCD8584, which is a remote eight-bit I/O expander. It comes in a 20-pin package and provides an eight-bit bidirectional I/O port interfaced to the I2C bus. I have not yet used this part, but it looks like it would also do the job the plain shift register would do (and then some).

Biting the Bullet

After going through all of the above expansion options, I finally settled on a different approach altogether (of course). I chose to build a new dual-processor controller board for Breadbot. I did this for two reasons: First, the DT101 board doesn't have a prototyping area big enough to include even a 14-pin DIP, so I would have to add a whole other board or hack a daughter board onto the DT101. Second, I've been planning to offload sensor processing and path planning to its own MCU anyway.

Using two processors allows me to group the motor control and feedback functions in one MCU, and the bumper sensing and navigation functions in the other MCU. To keep things from getting out of hand, though, I decided to stay with the basic DT101 architecture. This is made trivial by using a DT111 – Don McKenzie's double-height version of his DT101. The DT111 is electrically identical to the DT101, the only difference being the addition of a generous one-inch prototyping area to the top of the board. This prototyping area is where the circuitry for a second PIC16F84 goes (see Steps 1 through 6).

Figure 1 is the schematic for this new dual-processor board. MCU A and MCU B share Vdd, Gnd, SDA, SCL, and Reset, but each has its own crystal oscillator circuitry and I/O pins. Port B of MCU A is already wired to D0 through D7 of the SS-Bus, and I wired port B of MCU B to the remaining I/O lines of the SIMMStick, D8 through D15.

I could have eliminated the second 10-MHz crystal and its associated capacitors by driving the OSC1 input of MCU B with OSC2 of MCU A (CO, "Clock Out", SS-bus pin 6), but I wanted to keep the processors as independent as possible. Using independent oscillator sections allows either processor to shut down without affecting the operation of the other.

The important thing to remember is that a dual processor project is not twice as difficult as a single processor; it's more like four times as hard – especially if you don't go into the project with ease-of-debugging in mind. Figure 2 is a simple test cir-

Item	Description	Vender	P/N
C1,C2	0.01 µF 50WV, 5%, polyester	Digi-Key	P4582-ND
C4,C5, C9,C10	15 pF 5% monolith ceramic cap	"	P4839-ND
C5*,C6*, C7*,C8*	1 µF, 16 V tantalum	"	P2105-ND
D1*,D2*	Schottky diodes (see DT111 docs)	"	11DQ03-ND
E1,E6	10 MHz PIC16F84 MCU	"	PIC16F84-10/P-ND
E2*	24LCXX I2C EEPROM		
E3*	RS-232 level converter	"	MAX232CPE-ND
E4*	Real Time Clock option (see DT111 docs)		
E5*	ADC/DAC option (see DT111 docs)		
J1,J2*, J5-J7*	2-pin single row straight pin header	"	929647-02-36-ND
J3*,J4*	4-pin single row straight pin header ¥ J1-J7 above are cut from 36-pin pin header	"	
J8	30-pin single row, RA pin header	"	S1111-30-ND
R1,R2,R3, R4,R5,R6	10k ohm, 1/4 W, 5%	"	10KQBK-ND
RVD	Reset Voltage Detector, 4.5V, CMOS	"	MN1381-S-ND
PCB	DT111 SIMMStick Wirz Elex DT111		
VR1	+5V positive regulator, 100 mA, TO-92	Digi-Key	NJM78L05A-ND
XTAL1, XTAL2	10 MHz crystal, HC49/US case	"	X422-ND
XTAL3	32.768 KHz (referred to as "XTAL2" in DT111 docs)		
Misc:			
	8-pin DIP IC sockets*	Digi-Key	ED3308-ND
	16-pin " " "	"	ED3316-ND
	18-pin " " "	"	ED3318-ND
	Shorting jumper (to isolate +5V from Vdd)	"	SPC02SYAN

* Optional components; see text & figures.

cuit, and the program listings testAB.asm, testA.asm, and testB.asm are the code I used to troubleshoot operation of the board.

Building the Board

Step 1: Familiarize yourself with the DT111. If you built the DT101 board (Amateur Robotics Notebook, Feb '99), then there's nothing new here except the "sea of pads" prototyping area. The diagram shows the location of all the pads. The rest of assembly proceeds in an order that allows you to do V.R.O.C. (Voltage + Reset + Oscillator + Com-munications) testing with a minimum of fuss. When doing continuity checks, it's a good idea to highlight each circuit node checked on a photocopy of the schematic.

Step 2: Solder in the 30-pin right-angle header (J8) and two 18-pin IC sockets. For now, the socket for MCU B should just be tacked in place by soldering the four corner pins since wire connections still need to be made to most of the pins.

Next, install a two-pin straight header (J1). After soldering J1, flip the board over and cut the trace between its pads with a hobby knife. This modification allows you to isolate the on-card voltage regulator from Vdd so there won't be a conflict if you use the DT001 SIMMStick programmer. Remove the jumper from J1 before you place the board in the programmer (and don't forget to replace it when you are testing your board).

Step 3: Install the voltage regulator and reset controller in the orientations shown. Test the regulator by apply +9V to Vin (SS-Bus pin 4) and ground to Vss (SS-Bus pin 9). You should measure +5V on Vdd (SS-bus pin 7) and pin 14 of MCU A.

Step 4: Install resistors. R1-R5 are simply soldered in place and their leads trimmed, but R6 requires a little more work. The top lead in the diagram should be bent over on the solder side of the board to contact pin 3 of MCU B's socket, then soldered and trimmed. The lower lead should be bent to hold it in place until it's wired in Step 5.

Install the capacitors. Solder C1-C4 and trim their leads. As seen from the wiring side (Step 5), bend the left-hand leads of C9 and C10 so they contact each other; solder and trim. Leave the right-hand leads free for now. Test the reset IC. With Vdd at +5V, you should see a voltage close to +5V on Res (SS-Bus pin 8) and pin 14 of MCU A. Now adjust Vin downward while observing the voltages on Vdd and Res. When Vin drops below about 7.5V, you'll see two things: First, Vdd will gradually begin to drop below +5V; Second, once Vdd reaches about 4.5V, Res will suddenly drop down close to 0V.

If you increase Vin at this point, Res will stay low at first, but once Vdd rises above the hysteresis threshold of the reset IC, Res will snap high again. If you don't observe this reset behavior, then try testing the voltage at the junction between R1 and R2 while you vary Vin. If you still don't see it, try probing the middle lead of the reset IC to make sure you see Vdd. Check your solder connections and that everything is installed properly. Only after exhausting all other possibilities should you conclude that the reset IC is malfunctioning.

Next, install the 10 MHz crystals. XTAL1 needs no special attention, but you'll need to insulate the bottom of XTAL2's case so it won't short to any of the pads it covers. I used a couple layers of cellophane tape. I poked two holes in each layer of tape with the leads of the crystal and stuck the tape strips to the bottom of the crystal case. Then I trimmed around the edge of the case to remove the excess tape.

Referring to the Step 5 diagram, install the crystal, then bend the free leads of C9 and C10 as shown. C9's free lead should contact both the upper lead of the crystal and pin 16 of MCU B. C10's free lead should contact the lower crystal lead and pin 15 of MCU B. Since you've insulated the crystal from the pads, you don't have to worry if you solder the leads to all the pads they cover, just as long as C9's leads don't short with C10's.

Step 5: Wire MCU B using 30-gauge wire wrap wire. First do ground, then Vdd. Check for continuity of Vdd and Vss to pins 14 and 5, respectively. Next, wire RB0-RB7 to the row of pads above SS_Bus pins 23-30. Finally, wire Res, SCL, and SDA as shown.

Everything Checks

TestAB.asm is the first testing program to use. Program two PIC16F84 chips with this code and plug them into their sockets. On a breadboard, wire up the switches and LEDs of the test circuit and plug the DT111 in. TestAB lights LED1 when you close SW1, and LED2 should light when you close SW2. LED1 and LED2 should be completely independent. If nothing works, try testing with only one MCU. If one section works but the other doesn't, try swapping MCUs. If swapping chips swaps which section works, then you may have an MCU that isn't programmed properly. Otherwise check voltage and reset;

As always, if you have suggestions for improving Breadbot, if you've built a Breadbot, or if you have questions or comments about amateur robotics topics, you can reach me at:

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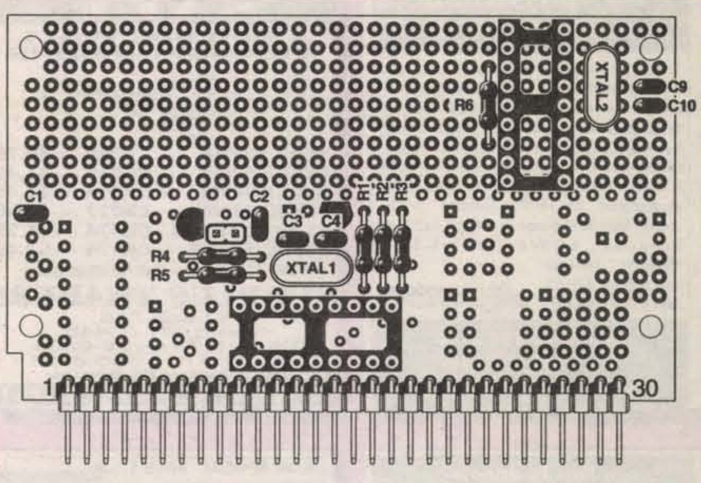
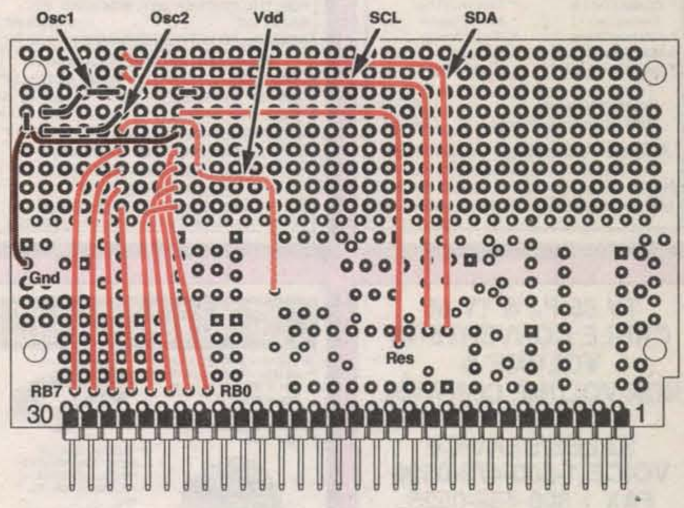
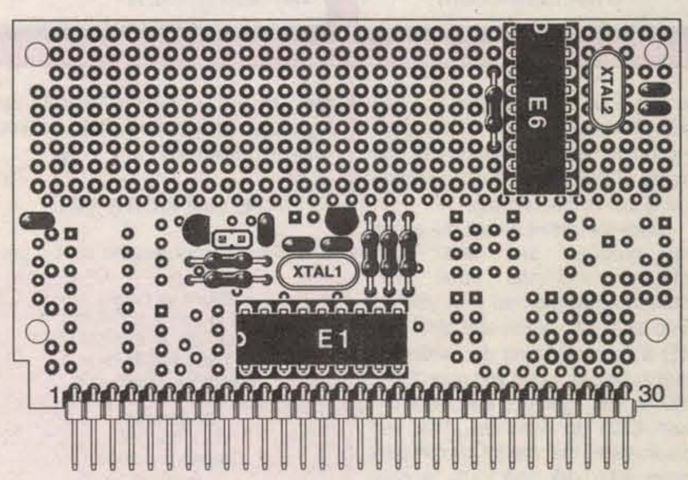


STEP 4. Discrete components.



STEP 5. Processor B wiring.



STEP 6. Install MCU A and MCU B.

you may have a wiring error or a bad solder joint somewhere in the non-functioning section. Also, check the polarity of the LED in the bad section (it may just be backwards).

Once the circuit passes the above test, program one MCU with testA.asm and the other with testB.asm. Plug the chip with testA in it into MCU A's socket, and testB into MCU B's socket. Using the same test setup as before, when you press SW1, LED2 should light up, and SW2 will cause LED1 to light up. This test demonstrates that the MCUs can pass simple data back and forth to each other. If the test fails, make sure you've programmed each MCU with the appropriate software, then check the SDA and SCL wiring. Measure the logic levels present on each line as you close and open SW1 and SW2.

Are we done yet?

Make no mistake, this is a big project, so it will take a couple months to present it all.

In the next couple months, I'll nail down the encoder code and show the details of I2C master/slave routines so the processors can talk to each other. Once the I2C routines are done, it will be easy to add additional I2C-networked processors as the need arises.

And there's even room for a few more MCUs on the board ... **NV**

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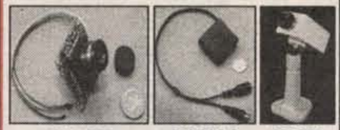

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SPDT	D129	6A/125V	Solder	.77	.67
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on-off-on		3A/250V	Solder		
DPDT	D133	6A/125V	Solder	.77	.67
DPDT	D135	6A/125V	Solder	.92	.82
on-off-on		3A/250V	Solder		
DPDT	D130	6A/125V	Solder	.92	.82
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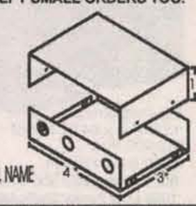

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Questions & Answers TECH FORUM

This is a READER TO READER Column. All questions AND answers will be provided by *Nuts & Volts readers* and are intended to promote the exchange of ideas and provide assistance for solving problems of a technical nature. All questions submitted are subject to editing and will be published on a space available basis if deemed suitable to the publisher. All answers are submitted by readers and *NO GUARANTEES WHATSOEVER* are made by the publisher. The implementation of any answer printed in this column may require varying degrees of technical experience and should only be attempted by qualified individuals. Always use common sense and good judgement!

Send all material to **Nuts & Volts Magazine**, 430 Princeland Court, Corona, CA 91719, OR fax to (909) 371-3052, OR E-Mail to **forum@nutsvolts.com**

QUESTIONS

Editor's Note - Please check our web site at www.nutsvolts.com for more questions that were not printed due to lack of space.

I need some information about speech recognition systems.

I have been thinking about designing one myself, but cannot come up with the circuitry or programming needed for a custom system. The specifications I'm looking for are speaker independence, large word memory, background noise filter, single or phrase-form commands, and easy to interface to a computer, BASIC Stamp, or standalone.

7991 **Kirk Olson**
via Internet

I need information on building a variable frequency drive for a single phase motor. I would like to build one to adjust the speed on a wood turning lathe.

7992 **W. Billett**
via Internet

I need a data sheet on the UM3750 IR encoder, decoder IC. The single-button transmitters are readily available, cheap and, I hear they can be converted to receivers, with minimal additional parts, a photo transistor, and buffer, etc.

Search of the net gets me a kit out of Australia, but no data sheet. The Taiwan manufacturer appears to be a chip foundry and has no data on their web site.

Electronic Goldmine, sells the transmitters for $2.00 each.

7993 **Brian Chesire**
Tucson, AZ

I am a novice wanting to set up a remote, wireless, CCD miniature video cam surveillance system for some remote property, about two blocks away, with some housing and other obstacles in the way.

Is there a manual I can buy, or site, where I can find instructions on doing so? Including the set up specific parts that would be needed, and an explanation of the various terms and jargon i.e., "410 lines CCD, 0.3 lux, AGC, 4mm 78 FOV lens" (taken randomly from *Nuts & Volts* ad).

Is there also a publication, etc. that rates these types of items for quality, compatibility, etc? I have tried comparing various items on my own, but find the great differences in ability, price, etc. overwhelming.

7994 **Dave Medina**
San Diego, CA

I just bought an NEC Silentwriter 97 printer at a garage sale, and I'm looking for a fuser lamp (stamped Minolta VK-1). Any ideas as to where I can get one? NEC only sells the complete fuser assembly (very expensive).

7995 **Larry Cowgill**
via Internet

I am interested in obtaining a Gauss meter to measure emissions of electric applicances, buildings, fields, etc. Can someone give me some sources?

7996 **Siegfried J. Hattler**
Pasadena, CA

I have an 800 number on which I would like to deliver an approximately three-minute message to callers, with a hang up or disconnect at the end of the message. The machine would not accept any incoming messages. Any ideas?

7997 **via Internet**

The HP Ergo 1024 (D2805A) color monitors have just a female DB-9 video connector on the rear apron. I need to know if these are standard SVGA monitors and, if so, the pinout data to make an adapter cable which will take the DB-9 socket to a standard HD-15 male SVGA connector.

7998 **Geoff Fors**
Monterey, CA

I changed out the video head on my VHS VCR. The picture had contained unremovable (by cleaning the head) horizontal noise lines. This resulted in a picture that was normal on the bottom third of the screen. The top two-thirds of the picture was half-washed, blurry, with about 20 snake-like waves moving up the screen.

What is the cause and remedy to this problem?

7999 **Frank Piernick**
via Internet

ANSWERS

ANSWER TO #5991 - MAY 1999

I have a 1/2 HP water pump 115V 12.4 amp start, 6.2 amp run. My 1850 watt generator will not start the pump.

I also have a small 800 watt generator that I would like to parallel to get more wattage. Coleman says it can't be done, is this true? Can anyone give me any way of doing it?

Synchronizing two generators, while not impossible, would be a large and tricky project.

The outputs would have to be in phase, and the smaller unit electronically governed to keep it's RPM in very close step with the larger unit. If one slipped out of phase, it would be bad.

All this trouble and risk of damaging both generators, and you wouldn't even be doubling the power available.

The initial surge for starting a 1/2 HP induction motor is short, but very large, on the order of tens of amps. This surge cannot be accurately measured with anything slower than an oscilloscope.

There are some things you can do that will give the 1850 watt generator a fighting chance to start your pump. The reason the generator won't start the pump is that the starting current is higher than the generator can supply. When the motor is switched on, it loads down the output of the generator. The output of the generator also is supplying the field winding, which draws at least 1/10 of the output power of the generator, and the power available for the field winding drops, which, in turn, further reduces the output voltage and also the field voltage ...

The heavy load also reduces the RPM of the engine, further lowering the output. All at the very time you would want the field voltage to increase, or at least stay the same. This effect can be reduced by adding a large capacitor across the field.

I have done this with a 3000 watt generator, and it helped make it possible to start my 1-1/2 HP air compressor.

The other key to that trick is an unloader valve, but with a water pump, you don't need to worry about that. The capacitor required is about 1/2 to one Farad.

A larger generator needs a larger capacitor, smaller could get by with less. The capacitor supplies the power to the field while the temporary overload keeps the field taps below the normal voltage.

A side benefit that I found, is that the capacitor also cleans up waveform of the output voltage. My generator has a 40-volt field. With a higher

ANSWER INFO

- Include the question number that appears directly below the question you are responding to.
- Payment of $25.00 will be sent if your answer is printed.
- In most cases, only one answer per question will be printed.
- Your name, city, state, and E-Mail address, (if submitted by E-Mail), will be printed in the magazine, unless you notify us otherwise with your submission.
- Due to space limitations, we can not reprint the original questions with the answer. The question number and the issue it appeared in are printed above the answer.
- Unanswered questions from a past issue may still be responded to.
- Comments regarding answers printed in this column may be printed in the Reader Feedback section if space allows.

QUESTION INFO

TO BE CONSIDERED FOR PUBLICATION

All questions should relate to one or more of the following:
1) Circuit Design 3) Problem Solving
2) Electronic Theory 4) Other Similar Topics

INFORMATION/RESTRICTIONS

- No questions will be accepted that offer equipment for sale or equipment wanted to buy.
- Selected questions will be printed one time on a space available basis.
- Questions may be subject to editing.

HELPFUL HINTS

- Be brief but include all pertinent information. If no one knows what you're asking, you won't get any response (and we probably won't print it either).
- Write legibly (or type). If we can't read it, we'll throw it away.
- Include your Name, Address and Phone Number. Only your name will be published with the question, but we may need to contact you.

field voltage, a smaller capacitor is required, with lower, a larger.

There is a voltage squared factor in the calculation for stored energy, so the capacitance required for the same effect depends highly on the voltage.

1 watt hour = 3,600 Joules. [1KW hour = 3,600,000 Joules]

V = volts

C = capacitance in Farads

J = Energy in Joules

Using the equation: J/[V * V] = C

For example, 40V with 1600 Joules:

1600/[40 * 40] = 1.0 Farad

If the field was 80V and you want to store 1600 J:

1600 / [80 * 80] = .25 Farad

If the field was 20V and you want to store 1600J: 1600/[20 * 20] = 4.0 Farad

The field winding is usually fed from a lower voltage tap in the output windings. The taps go to a rectifier to make DC for the field. The DC is usually fed to the rotating field by a pair of slip rings. If you put a voltmeter on the wires to the slip rings, you can measure the field voltage with no load and a near full load.

The voltage should be lower with the full load. The higher of these voltages is the working voltage required for the large capacitor.

You may notice the output of the generator will come up a little slower when started, due to having to charge the capacitor, but this should not a problem.

Another way to help the motor start is what is called reduced voltage starting. This is particularly helpful when the starting surge is seconds long. Instead of feeding 100% of the generator voltage to the pump motor, use a transformer or variac to get about 50-70% of the output voltage.

This reduces the overload so that the generator's field does not collapse, and actually gets more power to the motor. The transformer or variac should be rated to handle the running power of the motor, and will survive the short term starting overload.

After the motor is up to speed, a second switch, or time delay relay can transfer the motor to full voltage.

I use this setup to run a 12" radial arm saw [about seven-second spin-up time] off the same 3000 watt generator. Without this setup, my generator would loose RPM with the throttle full open, and the output would drop below 60V on the unloaded phase!

A final addition is to power factor correct the inductive load of the motor by paralleling AC rated motor run capacitors across the AC line to the motor. The lagging current drawn by a motor further multiplies the negative effect on the field of the generator.

PFC is the hardest to do, because you need a dual trace oscilloscope to monitor the voltage and current waveforms, and add capacitors to get the closest to unity power factor [current and voltage waveforms in phase] possible without causing harmonic distortion. The inputs to the scope require a step down transformer for the voltage, and a current transformer for the current.

Do not try to use the scope directly connected to the generator.

Of course, when trying to start these motors, nothing else should be drawing power from the generator. I have a current-sensing relay that shuts off all other loads automatically when one of the big motors is switched on, but this is strictly for convenience.

I have also recently acquired a Type 4 green plug from Electronic Goldmine, and it performs a soft start for motors up to 20 amps. I have not yet tried it with the generator, but it might just do the job, and for about $10.00, it might be worth a try. The down side is that the soft start ramp is fixed, and whether it works or not will depend on both the motor and the generator.

David Tiefenrbunn
via Internet

ANSWER TO #W69917 - JUNE 99

Where can I obtain the Motorola MC 34017 IC? Is it still produced?

The data sheet for the MC34017 can be found at Motorola's site at: http://www.mot-ps.com/books/dl136/pdf/mc34017rev0a.pdf

I did not find any discontinuation notices in my search of their site.

As of mid-June, the MC34017 is available from these two distributors [according to their web sites].

Union Electronic Distributors, 1-800-648-6657; www.unionel.com, $2.16 each. **America II**, 1-800-288-1187; http://www.americaii.com/a2i/a2ihome.html [no quote]

Tim Godfrey
Via Internet

ANSWER TO #6991 - JUNE 1999

I have three motion security lights outside. When I use my ham transmitter in the evening, it puts all *the lights on.*

Any ideas to prevent this?

You didn't specify what bands you are transmitting on, how much power you are transmitting, or the distance between the motion sensor lights and your antenna.

I can make some general recommendations, though.

First, I assume you have made sure your station is operating within the RF exposure guidelines from the FCC. If your radiation is exceeding the power density limits for maximum permissible exposure, it will be difficult to adequately shield the motion sensor lights.

You should re-check your grounding at the transmitter and the antenna. Re-check your SWR, since a high SWR can cause feedline radiation. If the feedline runs near the lights, try to move it away, especially if it is not coaxial.

If your power density is reasonable, and you are operating in the higher bands, you might try putting

ANSWERS TO #59910 - MAY 1999

I have an underground 110VAC line that has a cut and is causing the 15 amp breaker to trip every so often. How can I tell where the cable is cut and shorting out without digging up the 6" deep wire?

#1 Rent a TDR (time domain reflectometer). These devices are designed for such things. You might be able to detect it with a "Fox and Hound" locator device.

Breck Ricketts
via Internet

#2 Yes, it is possible to locate wire faults without digging up the whole cable.

A time domain reflectometer (TDR) will locate a serious fault as long as you know the propagation velocity of the cable. You probably don't have access to a TDR, but with a fast scope (100 MHz) and a fast pulse generator (5ns rise time), you can fake one that will locate a fault to a couple feet. I go into more detail, but there are other problems.

The first problem is the high impedance nature of the fault. If the fault is only 30K most of the time, there won't be a big reflection (less than 1%). You will have better luck with a solid short (that would trip the breaker). The AC impedance mismatch is probably larger, so a TDR might work.

The big problem is your installation violates the National Electrical Code (NEC). The wire should be buried 18 inches deep (not 6 inches). It's time to dig the cable up and replace it — since it is not deep enough, it probably isn't a suitable cable either. Use a trenching shovel (about 4 inches wide) instead of a regular (9 inch) shovel — it saves a lot of work and 18 inches is deep.

Although you can use a direct burial cable, I would use PVC conduit. Above ground boxes have special requirements for anchorage (e.g., two conduits must enter the box to prevent the box from spinning), and I think you must use metal conduit ground portion if the conduit holds the box up. Your library will have a copy of the NEC, but it is difficult to read.

Gerald Roylance
Mountain View, CA

#3 There are numerous manufacturers of cable fault equipment. The TDR (time domain reflectometer) is a favorite.

In an over-simplified example, it sends a pulse and measures the time it takes to return. The propagation characteristics of the cable must be known, and this the distance to the fault can be determined. It's expensive test equipment. And unless your buried cable is very expensive or very long, not worth it to even consider renting one. Your local power company probably has the right equipment to do this test.

Another approach worth a try, would be to apply voltage to the cable. Connect one lead of an AC reading DVM to a good ground. Attach the other lead to a probe and travel the length of the buried cable, inserting the probe periodically (taking care not to plunge it into the buried cable, of course).

If there is leakage due to the break in the cable (most likely a section of missing insulation as well), you may be able to detect a higher leakage voltage near the fault. Using two probes separated by some distance might work as well, if the length of your buried cable precludes easily grounding the meter.

Another approach would be to apply a good strong audio signal (tone for instance) to the cable and use sensitive high impedance headphones in place of the meter. The louder the tone, the closer you are to the "leak."

As a note, outdoor circuits should protect the user by a ground fault current interrupter (GFCI). It's designed to trip the circuit if excessive leakage current is detected to ground.

Rick Nelson
Newport News, VA

ferrite beads on the power lines going to the lights. They strongly absorb RF, with the frequency range depending on their size. Below 10 MHz, the size can get rather large, though.

All Electronics has a selection of snap-on ferrite beads that are easy to add to existing wires.

It is possible that the lights are just a bad design. It would be inconvenient, but you might consider trying a different brand. Higher quality devices might have better internal shielding.

Tim Godfrey
Via Internet

ANSWER TO #W69919 - JUNE 99

I would like to examine the proper use of the 8052 microcontroller, using the C language, not BASIC or assembly. Is there any such system available?

There are many companies that sell C compilers for the 8051 family which includes the 8052. This is a "legacy" eight-bit microcontroller that is still popular. There are many specialized variants available from several vendors.

Some of the leaders in the 8051 family C compiler market are: **Keil** www.keil.com, **Franklin Systems** www.fsinc.com, **Archimedes Software** www.archimedesinc.com, and **Avocet Systems** www.avocetsystems.com

If you are looking for something free, visit the SDCC site at www.geocities.com/ResearchTriangle/Forum/1353

You should also visit www.8052.com for more Internet resources on the 8052.

Tim Godfrey
Via Internet

ANSWER TO #59914 - MAY 1999

I need share-ware or free-ware to do:

1. Low end drafting (CAD).
2. Programming flow-charting.

There is a shareware program called PCDCAD which can perform the functions Mr. Cameron needs. I have a copy of it and since it is shareware, if Mr. Cameron supplies me with a disk and SASE, I would be happy to make a copy and send it to him.

I could also use a flow-charting program such as he describes and if he shoud find one, I would appreciate if he could send me a copy under the same conditions.

Howard Mark
Mark ELectronics
21 Terrace Avenue
Suffern, NY 10901
hlmark@j51.com

ANSWERS TO #4993 - APR. 1999

I have a 1 MHz oscillator. Can anyone come up with a circuit that will provide outputs at 100 KC, 200 KC, and 500 KC.

The circuit shown is a 4017 set- up to divide the input frequency depending on the switch setting. If the switch is set to Q2 (pin 4), the input is divided by two.

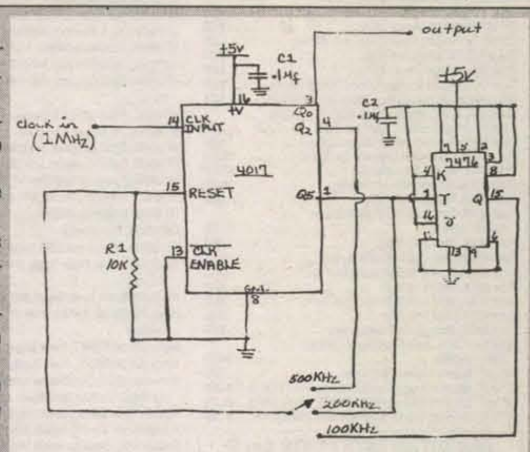
The JK flip-flop is one-half of a 7476 set-up to divide the 200 KHz output of the 4017 to give a 100 KHz output.

Resistor R1 holds the reset line low until it receives a logic high signal causing it to reset. You probably can build this circuit on perfboard. If you do, be careful with the layout.

Keep the wires as short as possible, keep your power supply wires separated, and use bypass capacitors C1 and C2 on the ICs.

The input and output connectors can be mounted on the front of the enclosure and the switch can to. The parts are easy to obtain and very inexpensive.

The circuit can be run off of a battery or a power supply. If the circuit is going to be used on a fairly consistent basis, you might be better off using a power supply.



Frequency Divider

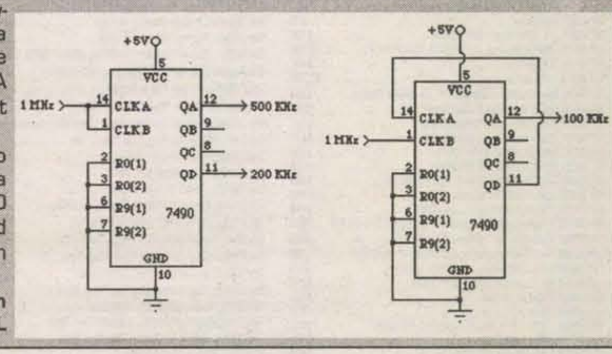
Dennis Gifford
Henagar, AL

ANSWERS TO #4993 - APR. 1999

Two 7490s can be used as illustrated, to divide a 1 MHz signal down to 500 KHz, 200 KHz, and 100 KHz.

The 7490 counter is actually a divide-by-two and a divide-by-five in the same package. Putting a 1 MHz signal into CLK A generates a 500 KHz signal at QA (divide-by-two). Putting a 1 MHz signal into CLK B generates a 200 KHz signal at QD (divide-by-five). Putting the 1MHz signal into CLK B and connecting QD to CLK A puts out a 100 KHz signal with a 50% duty cycle at QA.

(Going through CLK A first and connecting QA to CLK B will also produce a 100 KHz signal, but with a 20% duty cycle.) Be sure to ground the R0 (1), R0 (2), R9 (1), and R9 (2) pins. Watch out for power and ground as they are not in the usual TTL locations on the chip.



Ron Tinckham
Gainesville, FL

TECH FORUM

ANSWERS TO #6994 - JUNE 1999

When replacing the 6JS6C final tubes in the Model 101FT, Yaseu says they should be replaced with matched pairs. Does anyone know how to use unmatched pairs?

Years ago, Yaseu came out with a modification to do this.

#1 I believe you are mistaken about using unmatched pairs of tubes. What Yaesu said was that if

ANSWERS TO #5999 - MAY 1999

Am looking for a four pin 6 VDC logic buzzer that is controlled by a ca555 chip. The circuit is from an in-ground mole chaser that emits sequenced buzzing to annoy moles.

#1 A part number would have been helpful in finding a suitable substitute.

All Electronics Corp., P.O. Box 567, Van Nuys, CA 91408-0567; **http://www.allcorp.com** E-mail: all corp@allcorp.com has the following which may work in your application.

STAR #CMB-12 fits standard 14-pin DIP socket. CMOS compatible. Operates on 7-17 VDC has a trigger terminal that activates with a 1mA load and produces 70dB at 20cm. The catalog number is SBZ-7 and the price is $1.00. The dimensions are 0.9" x 0.62" x 0.67" and this is a square four-pin device. The minimum voltage listed is seven volts, but it may operate at six volts. I can't say for sure.

They have several other types of buzzers, as well as piezo and sound transducers that you may be able to adapt to your application. Their catalog is free, there is no minimum order and shipping is generally only $5.00. Give them a call at **818-904-0524** and request a catalog or visit their website.

Robert Turner
Via Internet

#2 International Components Corp., has four models available that are low- trigger current four-pin buzzers. Model BR2818L-06 has the following characteristics:

Voltage range: 4-8VDC (rated voltage 6VDC), maximum current: 30mA, sound output: 75dB at 100cm, frequency: 400 ±50 Hz.

International Components Corp., 105 Maxess Rd., Melville, NY 11747. Phone: **1-800-645-9154** fax: **516-293-4983.**

Dennis Gifford
Henagar, AL

ANSWERS TO #49915 - APR. 1999

Would it be possible to add a 3.5" disk drive to my old IBM 3270 PC, model 16 with 640 KB, It has a 5-1/4 disk drive that uses double density, double sided floppies.? What would I need in the way of hardware if it can be done?

#1 There is a combination internal disk drive that allows one to insert either 5-1/4" or 3-1/2" floppy diskettes.

The EPSON SD880 fits in the same slot as an ordinary 5-1/4" drive, is compatible with DOS 3.3 (or higher), and is very easy to install. Its JAMECO part number is 115810, and it costs $71.95 plus shipping and handling.

You can order from: Jameco Electronics, 1355 Shoreway Rd., Belmont, CA 94002-4100. Voice: 650-592-8097, fax: 650-592-2503.

Thomas Ng
San Jose, CA

#2 Of course, you can put a 3.5" drive in your older computer. But, depending on your computer, you might need equipment other than the drive itself. Unless your computer's case has a 3.5" drive bay, you will need a 3.5" Drive Mounting Kit. This is a fram that fits in a "half height" (5.25") drive bay and provides space for a 3.5" drive.

Now, to actually hook it up to the computer, the floppy cable needs a connector that fits the drive. If your cable has both a "card edge" type connector (the one your current floppy uses) and a small rectangular connector with two rows of small holes, (Molex type?) you're all set. But, if it only has the "card edge" connectors, you will need either a new cable (cheap, and widely available) which has both connectors, or an adapter that gives a 3.5" drive the "card edge" that the older connector can use.

This adapter is often included with the Drive Mounting Kit. (Hence the Kit in the name). A look through *Nuts & Volts* or the Internet will find each of these products from multiple vendors for no more than $5.00.

Amos Bieler
via Internet

#3 All you need is a new floppy controller board. Assuming your PC has ISA slots, JDR Microdevices (www.jdr.com) sells an eight-bit, four-drive "intelligent" floppy controller that can handle all PC floppy formats from 5.25" 360K to 3.5" 1.44M.

The board's JDR part number is MCT-FDC-HD4, has a price of $29.99, and comes complete with ribbon interface cables.

Just replace your existing floppy controller card with the new controller card, make sure your DOS version is 3.2 or higher, and you will be reading/writing 3.5" floppies in no time.

Ken Simmons
Auburn, WA

you wanted to use another brand of tubes, because of the different interelectrode conductance, you needed to change a capacitor affecting neutralizing of the radio.

If you try to use unmatched pairs, one of the tubes will pull more current than the other and if it exceeds the rating for that tube, it will fail early.

Vaughn Wilson
Atwater, CA

#2 NW2M has a Web page that looks to contain every piece of information you might ever want on the FT-101.

His section on the 6JS6C does not mention "matched pairs," but he does explain that tubes made by manufacturers other than the original manufacturer used by Yaesu [NEC], have slightly different specifications.

As a result, C125 should be changed from a 100pF 1000VDC mica capacitor to a 10pF 1000VDC mica capacitor, if you're using another brand.

The page goes on to describe the neutralization procedure and warns about the high voltages present on these parts. The URL for the page is http://www.qsl.net/nw2m/ft101.html#tubes

Tom Tillander
Bay Village, OH

Continued from page 61

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by TJ Byers

EL Light: *Playing In The Dark*

Last fall, Nokia ran a TV commercial where the stadium lights went dark just as the game-beginning football was kicked off, only to land who knows where. The spectators rose to the occasion by turning on their Nokia cell phones and pagers, causing their handheld screens to glow a soft blue-green. The combined light from thousands of these devices was enough for the game to proceed. A bit far-fetched? Sure, but it shows the widespread use of electroluminescent (EL) lamps.

Once a laboratory curosity, EL lamps have found their way into everything from wristwatches to cell phones to computers to flat-screen TVs. In fact, you'll find them just about anyplace where an evenly illuminated flat area is wanted, whether that area measures 1/4 or 100 square inches. Most often they're used to backlight an LCD (liquid-crystal display) screen — in other words, watches to computers.

In this application, the EL lamp is mounted directly behind the LCD display where the light makes its way through the display and is viewed from the front (Figure 1). The LCD structure has the ability to rotate polarized light as it passes through the molecular layers of the LCD material which, in turn, generates characters and images.

EL lamps are everywhere, from cell phones to laptops. Here's how they work, and how to make them work in your projects.

An EL provides the illumination needed to read that display in total darkness, aboard a plane, or in an office enviroment — at a considerable power savings over LED and other backlighting methods.

So, how do they work and how can they work for you? Read on.

EL Basics

EL lamps are based on research done by Prof. G. Destriau — a French physicist — in 1936. Destriau suspended a zinc-sulfide powder on an insulator (oil on ceramics) and, for other reasons, applied an AC voltage. To his amazement, the mixture glowed — as in it didn't blow up or create a bomb. He noted it. (Actually, it glows naturally in the dark if saturated with a heavy dose of sunlight. I know — had a jug of it that I used as a night light as a kid.) But that's where his discovery stayed, in the lab notes, until the late '50s, when research on the effect was revived and magazines like *Popular Science* forecast it to be the "light" of the future wherein large EL panels would light hallways and kitchens. While rooms with lighted walls that change color at the flick of a switch (as it did in the movie *Forbidden Planet*) never came to pass, the EL lamp did.

Today's EL panels have two conductive electrode layers: a clear top layer (typically of tin oxide) and a bottom opaque layer (often aluminum). Sandwiched in between the top and bottom conducting layers is phosphorus (Figure 2).

When an alternating voltage is applied across the electrodes, the electrons of the phosphor absorb energy as the electric field intensifies (goes from zero volts to +V). This increase in field intensity kicks the phosphor's electrons from their resting valence band into a higher conduction-energy band. As the electric field decreases (the voltage goes from +V to zero volts), the energy states relax, and the electrons fall back to the valence band, giving up their absorbed energy as a photon. During the downward transitions, the EL lamp gives off light.

By using different phosphors, the energy-band levels can be

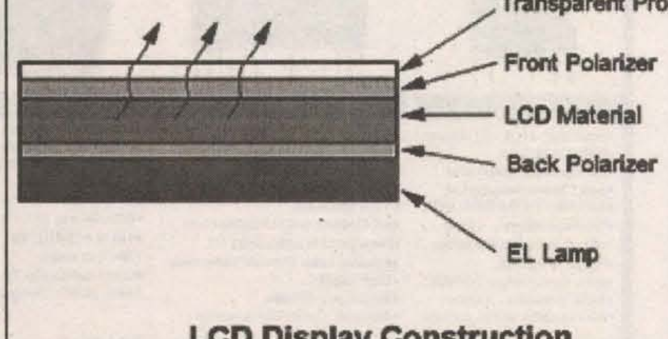
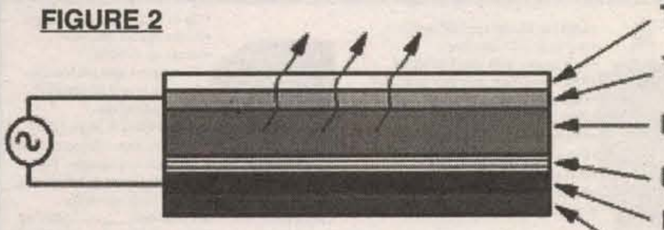


FIGURE 1

Because of the even illumination over a wide area, EL lamps are perfectly suited for backlighting LCD displays.

FIGURE 2



Like the LCD, an EL lamp is a layered sandwich of metals and chemicals. When AC voltage is applied across the front and rear electrodes, the phosphor layer emits photons.

modified to change the color and brightness of the emitted light. Larger band gaps pump up the electrons more than lower band gaps. Electrons with higher energy levels lean toward the blue part of the spectrum, whereas lower energy electrons lean toward the red. Typical phosphor compounds include zinc sulfide, calcium sulfide, and strontium sulfide laced with magnesium, samarium, and europium.

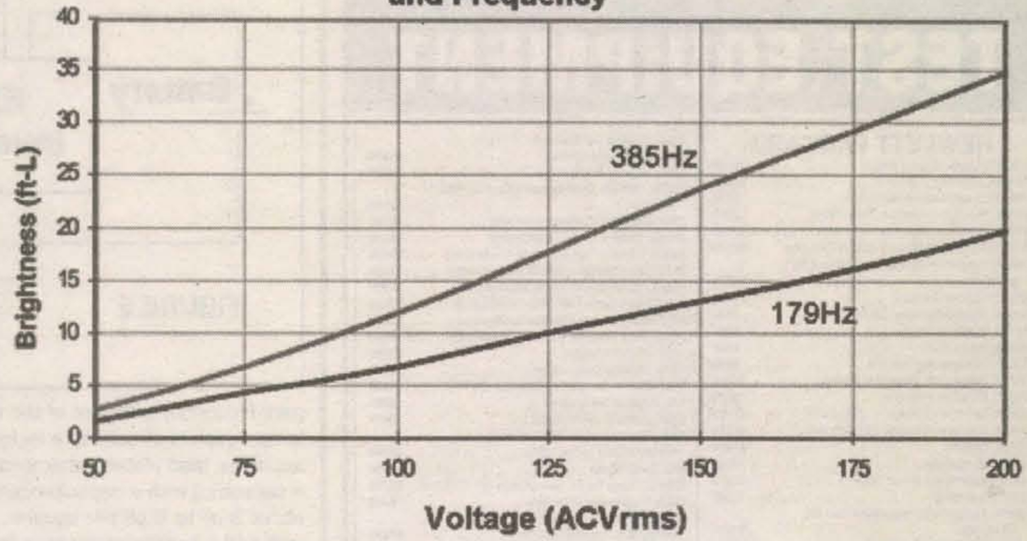
Powering An EL Lamp

EL lamps require a high voltage to knock those electrons around — a lot of voltage, in fact, generally in the range of 40 to 200 volts RMS. Ironically, the mass market for these lamps are battery-powered devices, like wristwatches and cell phones, which run off of 1.5- and 3-volt batteries. Generating these high AC-voltages from a battery is a design issue all by itself, and the meat and potatoes of this article.

The two biggest variables in EL light output are the applied peak-to-peak voltage and its frequency. The brightness of the lamp is directly proportional to both (Figure 3). As the output voltage and/or the frequency increases, the brightness of the lamp also increases. Typical LCD backlight EL lamps operate at 120VAC and 400 Hz.

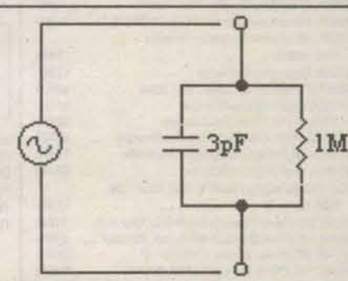
It takes a special type of voltage converter to provide this voltage. Until recently, it was done using a resonating-transformer inverter. Unfortunately, it's difficult to match the transformer's reso-

Brightness versus Voltage and Frequency — FIGURE 3



The brightness of the EL lamp is dependent on both the applied AC voltage and its frequency.

FIGURE 4



Electrically, an EL lamp is a leaky capacitor with a value of 3 pF to 6 pF per square inch.

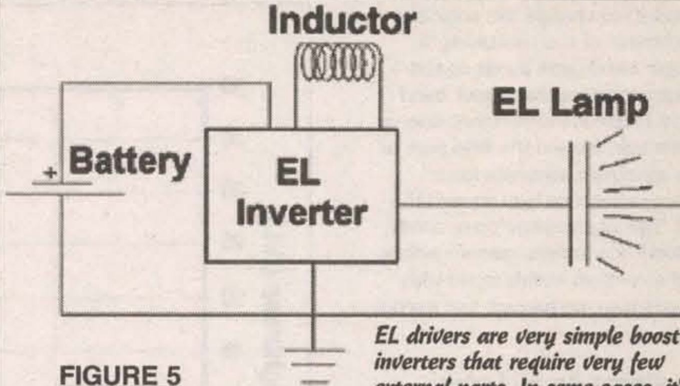


FIGURE 5

EL drivers are very simple boost inverters that require very few external parts. In some cases, it's nothing more than a battery and a coil.

nant frequency with that of the EL lamp, which is effectively a leaky capacitor (two plates separated by a dielectric) with a capacitance of about 3 pF to 6 pF per square inch and a parallel resistance that can range from 50k to 1.5M per square inch (Figure 4). Moreover, the part count was high, the transformer bulky, and the circuit less than reliable.

EL Driver ICs

Recognizing the need for a small, reliable inverter to power the burgeoning use of EL lighting in handheld devices, the semiconductor industry rushed in to fill the void. Today, the typical EL lamp inverter consists of a single IC chip — some as small as an apple seed — flanked by an inductor and a capacitor. As you can see in Figure 5, nothing could be simpler.

Most integrated circuit EL drivers are made up of three basic elements: an oscillator, an inductor, and a switched H-bridge. Here's a look inside a typical EL driver (Figure 6), the SP4422A from Sipex.

The oscillator controls the charge and discharge phases of the inductor and the EL lamp. An external capacitor connected between pins 7 and 8 sets the frequency of the oscillator, which is adjustable between 32 kHz and 400 kHz. The suggested frequency is 90 kHz — typically a 100 pF capacitor. Alternatively, the frequency can be set from an external source by removing the capacitor and applying a squarewave to pin 8. The oscillator frequency is then divided by flip-flops to generate two control signals.

One of the signals clocks a switch that applies voltage across the inductor. When the switch is closed, current flows through the inductor and builds up a magnetic field. The amount of current is determined by the inductance and DC resistance of the coil. It's important that the current never reaches saturation, which is set by the design and construction of the coil.

If the current exceeds inductor saturation, excess heat will be generated and the efficiency will decline. In general, smaller inductors that can handle more current are more desirable. As the value of the inductor increases (and the DC resistance decreases), the oscillator frequency should be increased to prevent saturation. In fact, the design of the inductor is so critical that the IC vendor often provides a list of acceptable devices (see Table 1).

When the switch is opened, the field collapses and the energy in the inductor is forced to flow through the H-bridge. In the case of the SP4422A, the H-bridge consists of a pair of SCRs that act as

Table 1. Recommended Coils For EL

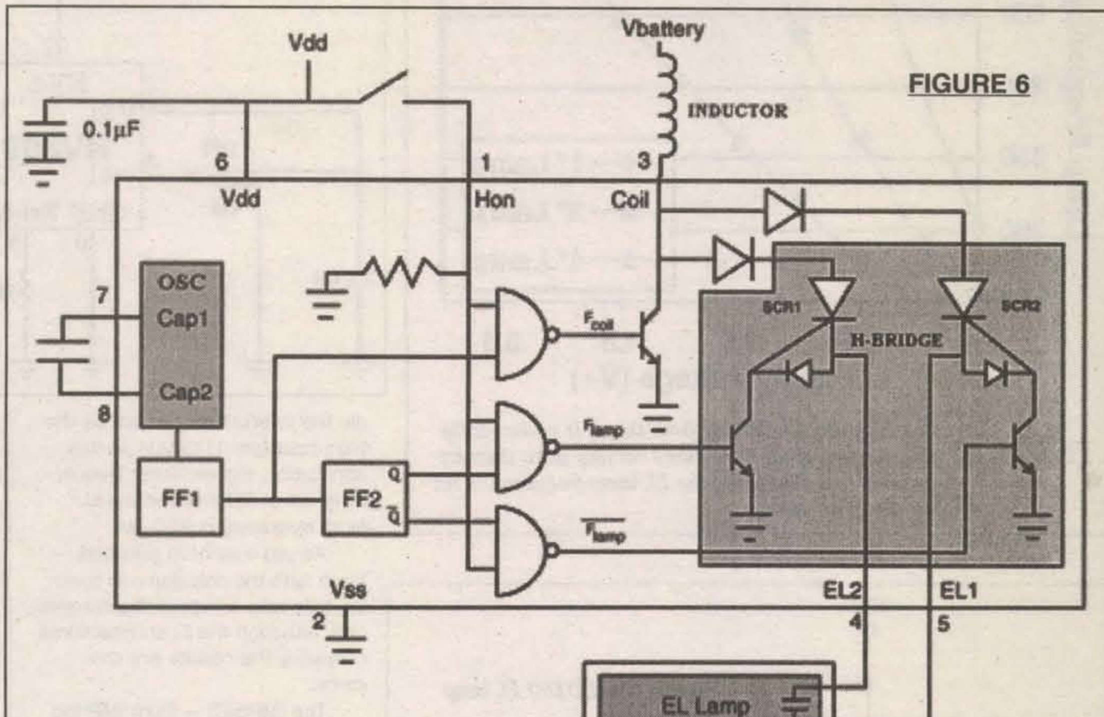
Inductor Value	DC Resistance	Mfg. Part Number	Manufacturer
20mH	65	CH5070AS-203K-006	CTC Coils
10mH	80	LQN6C103M04	muRata
10mH	32	DS1608C-106	Coilcraft
9mH	41	MD735L902B	Hitachi Metals
5mH	19.8	MD735L502A	Hitachi Metals
4.7mH	35	LQN6C472M04	muRata
4.7mH	13	667MA-472N	Toko
3.9mH	not available	CLS62-392K	Sumida
680uH	2.2	DSI608C-684	Coilcraft
560uH	14.5	LQH4N561K04	muRata
330uH	8.2	LQH4N331K04	muRata
220uH	5.4	LQH4N221	muRata

high-voltage switches. The SCRs are alternately turned on and off by the second clock signal, which is 1/32 the frequency of the inductor's switching frequency. While the SCR is conducting, a charge builds up across the EL lamp, as the inductor dumps charge after charge into the lamp. The resultant waveform is shown in Figure 7.

Like most EL inverters, the SP4422A also has an input (pin 1) for placing the chip in a standby mode. In this mode, the battery current drops to an infinitesimal 50 nA or less. This step is critical for handheld battery operation, where the inverter must be kept alive but not kill the battery (remember the Nokia commercial?). Typically, a logic high starts the oscillator and a logic low turns it off.

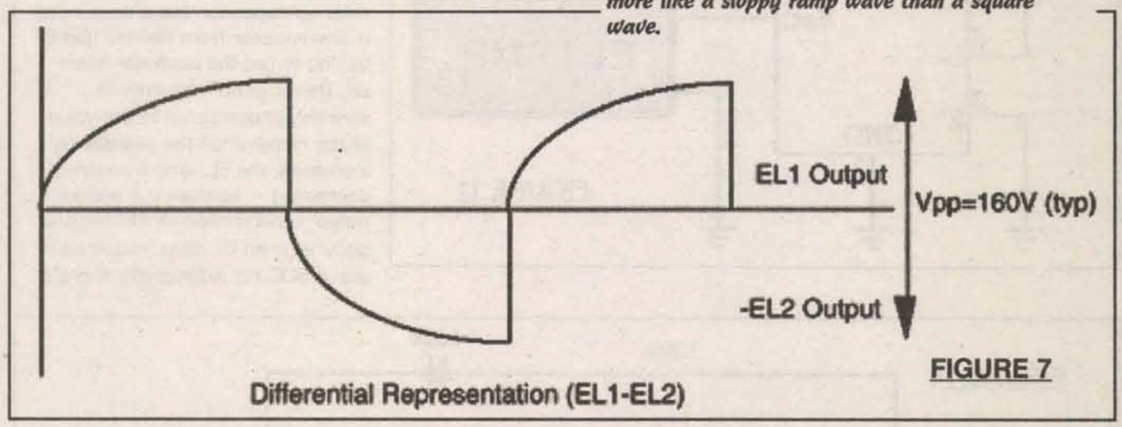
Practical EL Driver Applications

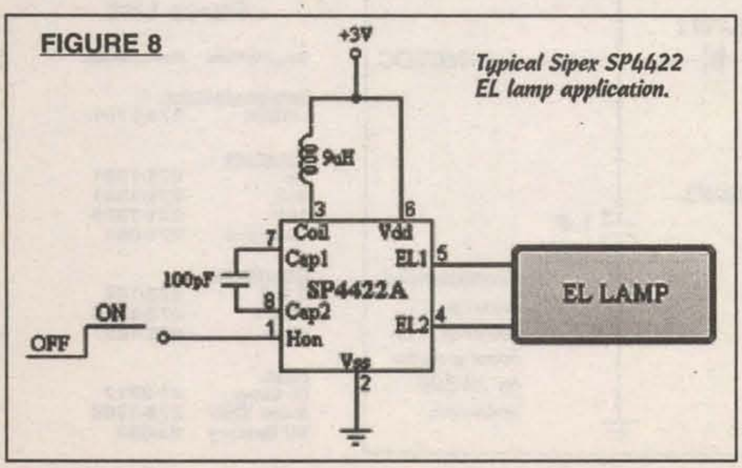
With that said, here's what a finished SP4422A design looks like (Figure 8). If you don't need to tog-



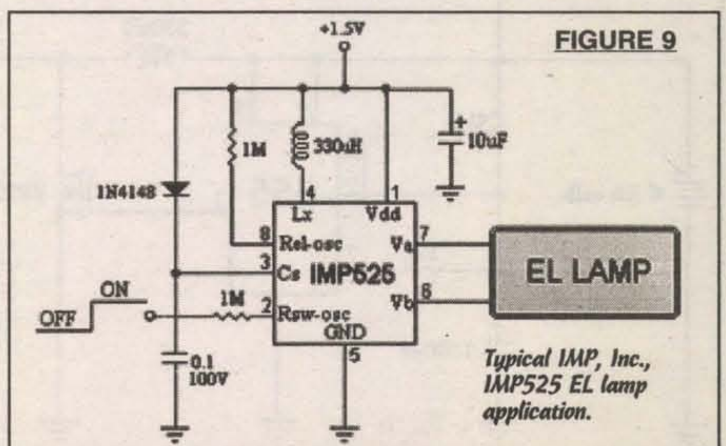
Most integrated circuit EL drivers are made up of three basic elements: an oscillator, an inductor, and a switched H-bridge. Here's a look inside the SP4422A from Sipex.

Generally, the switching frequency of the inductor is higher than that of the EL lamp. As a consequence, the waveform across the EL lamp looks more like a sloppy ramp wave than a square wave.





Typical Sipex SP4422 EL lamp application.



Typical IMP, Inc., IMP525 EL lamp application.

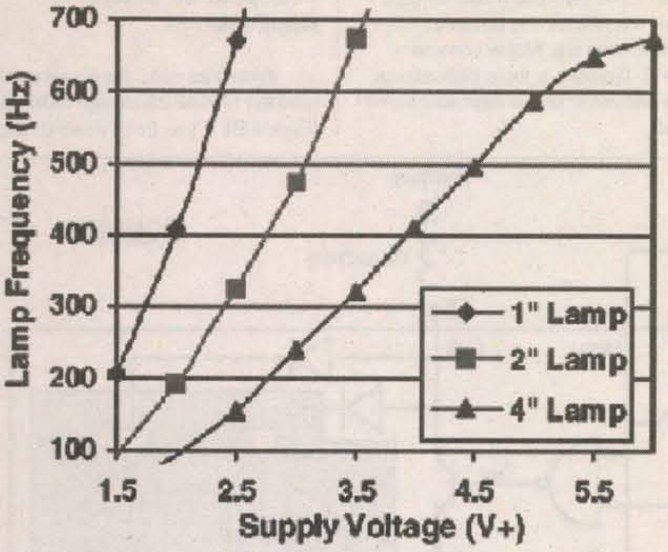
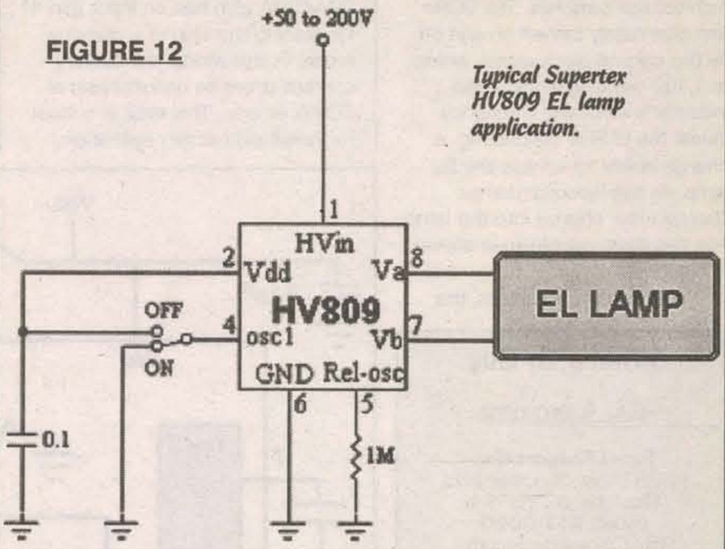
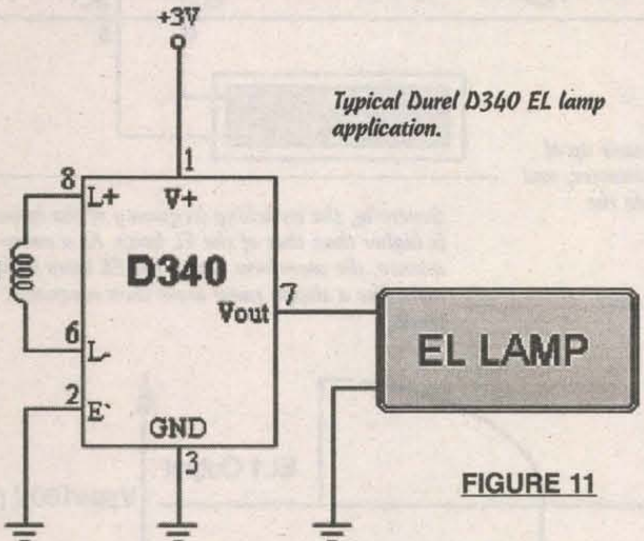


FIGURE 10 *The D340DG EL drivers, from Durel, is undoubtedly the simplest of all. It requires nothing more than an external coil. Basically, the EL lamp frequency is set by the input voltage.*

FIGURE 12



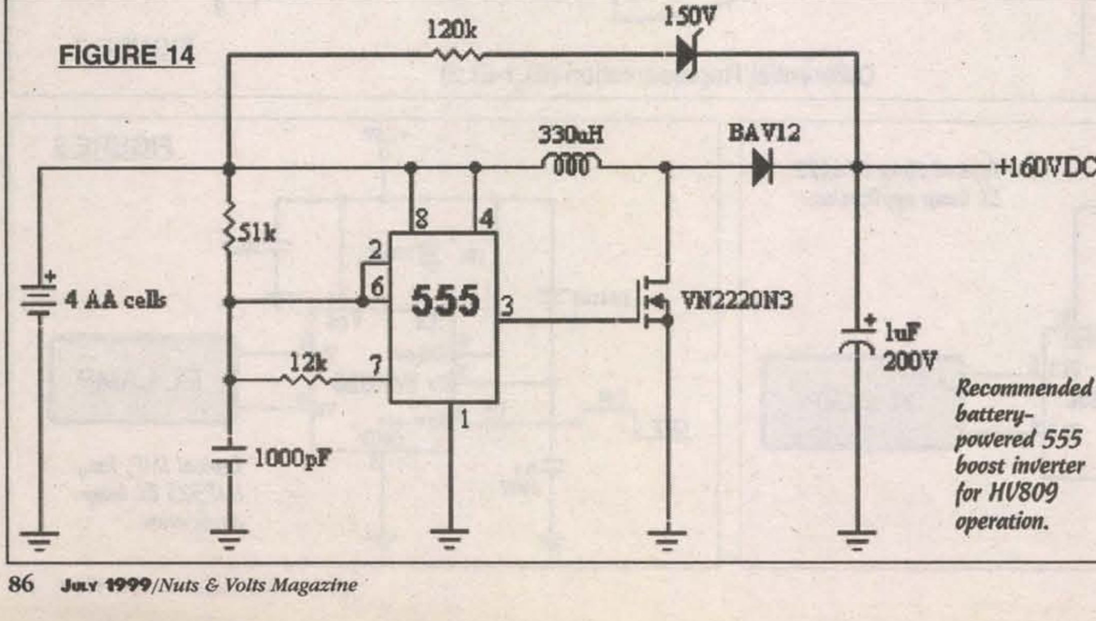
Typical Supertex HV809 EL lamp application.



Typical Durel D340 EL lamp application.

FIGURE 11

FIGURE 14



Recommended battery-powered 555 boost inverter for HV809 operation.

gle the inverter off and on, tie the Hon input (pin 1) to Vdd. In this application, the oscillator frequency is set at 90 kHz and the EL lamp frequency is 256 Hz.

As you may have guessed, Sipex isn't the only game in town. So, let's take a look at the competition. Although the IC architectures may vary, the results are the same.

The IMP525 — from IMP Inc. — is a popular EL inverter designed to operate off a single battery cell at voltages down to 0.9 volts. Figure 9 shows a typical IMP525 application.

This chip doesn't require an external capacitor, but it does need a bias resistor from Rel-osc (pin 8) to Vdd to get the oscillator started. The EL lamp frequency is inversely proportional to the value of the resistor; as the resistance increases, the EL lamp frequency decreases — as does the overall power consumption. A 1M resistor generates an EL lamp frequency of about 500 Hz. Additionally, there's a logic ON/OFF inout (pin 2) which puts the inverter into the standby mode (typically 1uA) when pulled low. This pin also sets the switching frequency for the inductor, when connected to Vdd, via a series resistor.

The switching frequency is inversely proportional to the value of the resistor, with 1M being the recommended value. Typical values for the inductor range from 330 uH (1.5V) to 680 uH (0.9V). See Table 1 for recommended coil manufacturers. Unlike the SP4422, the two switching frequencies aren't synchronized, but the resultant EL waveform is the same.

The D340DG and its family of switching mode EL drivers, from Durel, is undoubtedly the simplest of all. It requires nothing more than an external coil — no resistors, no capacitors. Of course, that gives you less control over the EL lamp frequency and inductor switching frequency, but if your EL panel size falls within its parameters, it doesn't matter.

Basically, the EL lamp frequency is set by the input voltage (Figure 10). The lamp voltage of

Parts List

Description	RadioShack
Semiconductors	
LM386	276-1731
Resistors	
1k	271-1321
33k	271-1341
10k	271-1335
100k pot	271-092
Capacitors	
0.1uF	272-135
10uF	272-1025
50uF	272-1027
Misc.	
EL Lamp	61-2717
Audio Xfmr	273-1380
9V Battery	23-553

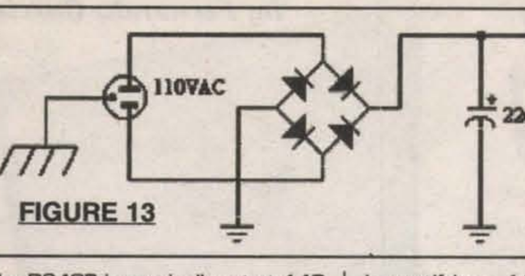


FIGURE 13 *Recommended off-line power supply for HV809 operation.*

the D340B is nominally set at 140 volts peak-to-peak; in each case a 3.9uH Sumida inductor was used. A typical D340B circuit is shown in Figure 11.

The Supertex HV809 addresses a totally different area of EL illumination — literally. This chip is capable of powering EL lamps up to 100 square inches. That's the equivalent of a 14-inch (diagonal) panel. Unlike the previous examples, the HV809 requires a high-voltage input in the range of 50 to 200 volts DC, typically supplied by a boost inverter if you're working from batteries. Consequently, the HV809 itself needs no inductor. Essentially, an on-board oscillator drives an H-bridge which powers the EL lamp. Let's first look at an HV809 application (Figure 12) and then the recommended boost inverter (Figure 14).

The Rel-osc resistor sets the switching frequency of the EL lamp, which is inversely proportional to the value of the resistor — the higher the resistance, the lower the frequency. A 1M resistor generates 400 Hz. The output voltage is typically 340 volts RMS when the input voltage is 170 volts DC, which is easily obtained by rectifying a 110-volt AC line via a full-wave bridge rectifier (RadioShack 276-1161) and a small 22uF filter capacitor (Figure 13).

Pulling OSC1 low (GND) starts the oscillator; forcing it high (Vdd) stops the oscillator. Like I said, the HV809 requires a high-voltage input. When working from batteries, this voltage has to be generated by a separate boost inverter. Supertex recommends using a 555 chip (Figure 14), but any boost regulator that generates 50 to 200 volts will work.

In the 555 version, the chip generates a pulse that charges the 330uH inductor which, in turn, kicks up the six-volt input (four AA batteries) to 160 volts. A 150-volt zener is placed from the output to the input to regulate the width of the pulse, thus keeping the output voltage more or less constant.

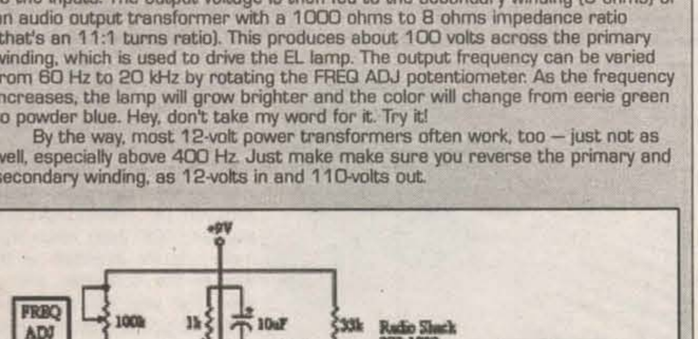
That's Light

Well that's EL light, and how versatile it can be. Now that you know how to make it work, take advantage of this low-power light source to illuminate your next genius project. **NV**

The AC voltage applied to the EL lamp has another component to it. In addition to increasing brightness as the voltage increases, higher AC frequencies produce a slight but noticeable shift in the color of the EL panel. Here's a simple experiment that lets you have fun with the effect. First, hoof it over to your local RadioShack, buy the listed parts, and then wire them accordingly.

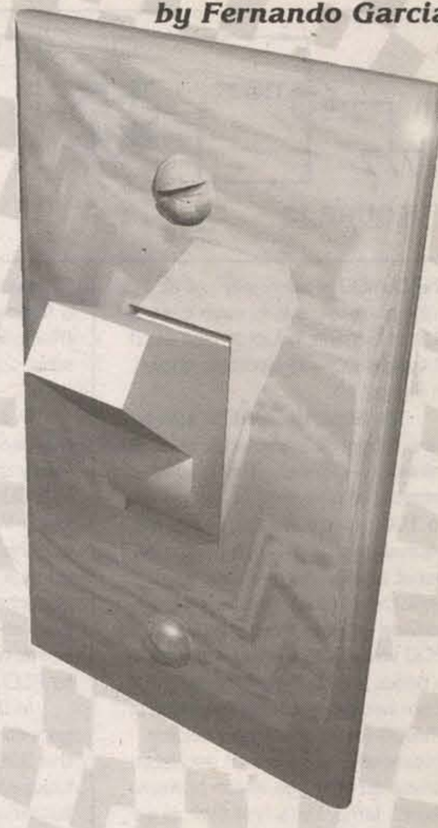
This is a simple audio amplifier that's configured as a squarewave oscillator. A portion of the amplifier's output is fed to its non-inverting input at pin 3. This voltage serves as a reference for the 0.1uF capacitor, which is connected to the inverting input at pin 2. The capacitor continually charges and discharges around the reference voltage as the IC's output voltage jumps up and down in response to the inputs. The output voltage is then fed to the secondary winding (8 ohms) of an audio output transformer with a 1000 ohms to 8 ohms impedance ratio (that's an 11:1 turns ratio). This produces about 100 volts across the primary winding, which is used to drive the EL lamp. The output frequency can be varied from 60 Hz to 20 kHz by rotating the FREQ ADJ potentiometer. As the frequency increases, the lamp will grow brighter and the color will change from eerie green to powder blue. Hey, don't take my word for it. Try it!

By the way, most 12-volt power transformers often work, too — just not as well, especially above 400 Hz. Just make make sure you reverse the primary and secondary winding, as 12-volts in and 110-volts out.



Low Loss Electronic Switch

by Fernando Garcia



Apparently, there are quite a few hobbyists who are interested in battery-powered portable electronics. However, can portable also be stationary? Read on ...

The battery-powered SEPIC regulator article (April '99 issue of *Nuts and Volts*) generated a considerable amount of interest and lots of questions. Apparently, there are quite a few hobbyists who are interested in battery-powered portable electronics. But one of the most frequent queries centered upon the fact that portable electronics may also be stationary. This means that the device will be hooked, via a wall-wart transformer (a.k.a. battery eliminator), to the AC line for extended usage or while the batteries are being recharged. It may also mean that the portable electronics may be connected to an automobile's electrical system from a cigarette lighter to operate the circuit while travelling.

The question is: Will the regulator be able to handle the higher voltages provided by the transformer or vehicle? The short answer is yes, although simple modifications are required to accommodate the higher source voltages. The component substitutions are shown in Table 1. Please note that a nine-volt (nominal) battery eliminator may output as much as 10 volts, and a vehicle's alternator may output over 14 volts.

But other questions were involved with the fact that a seamless transfer from battery to AC power and back to the battery is sometimes required to avoid resetting our digital project. What happens if the portable device becomes accidentally unhooked from the wall or automobile? Also, many vehicles will only apply power to cigarette lighters if the ignition key is on, so what happens if the ignition key is turned off? How do you

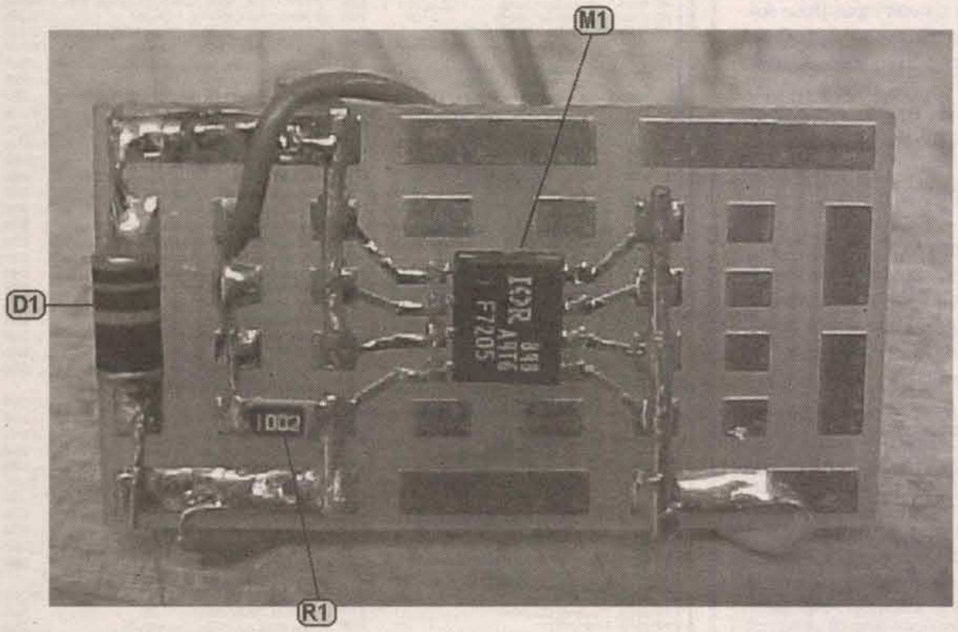


Figure 3: The ultra simple project may be implemented on a Surfboard®.

Parts List

D1: 1N4001 diode
R1: 10k, 5% SMT resistor
M1: IRF7205, logic level P-channel MOSFET.
D2: P6KE16A Transient suppressor diode (optional).

Misc.:
Model 9081 Surfboard®

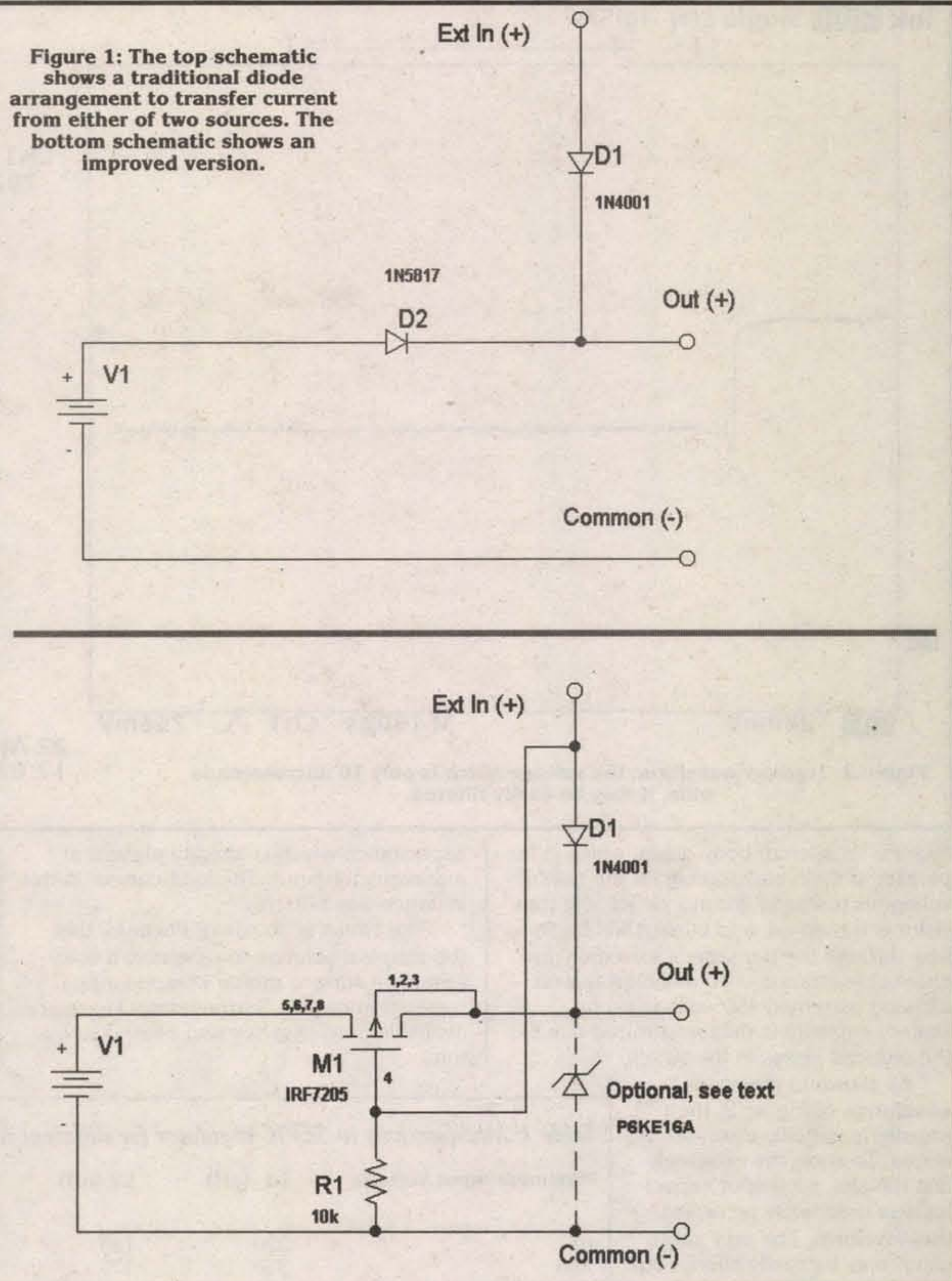


Figure 1: The top schematic shows a traditional diode arrangement to transfer current from either of two sources. The bottom schematic shows an improved version.

ensure continuous power to the load?

Again, a simple question apparently has a simple answer; that back-up current delivery will be required from the "AA" cells. In its simplest form, the transfer circuit only comprises two diodes, as shown in Figure 1 (top of figure). If the battery eliminator or vehicle's ignition are turned on, current is supplied to the load via D1, and D2 is reverse-biased. In the opposite case, D1 will be reverse-biased and load current will be supplied from the "AA" cells to the load via D2. Piece of cake, uh?

The only pitfall is that D2's forward voltage drop will subtract from the "AA" cell's voltage, and these precious tenths of a volt may well mean several minutes of usage time. Even with a Schottky diode, the voltage drop may be substantial when the device is operating close to its maximum ratings.

Fortunately, by spending just a little additional money, you can build a fully automatic transfer switch with (almost) negligible cell voltage loss. The improved circuit is shown in Figure 1 (bottom of figure). Diode D1 still carries the wall-wart's current when available, but diode D2 has been replaced by P-channel MOSFET M1. When the main external voltage is available, current will flow through D1, but most important, the MOSFET gate will be reverse-biased (remember, on a P-channel device, a positive gate voltage — with respect to source — will turn off the transistor). Since M1's gate voltage is taken from D1's anode, it will be about 0.7 volts positive with respect to the source. Thus, the cells are, for all practical purposes, disconnected from the circuit.

If the main supply voltage is lost, current will flow initially through the

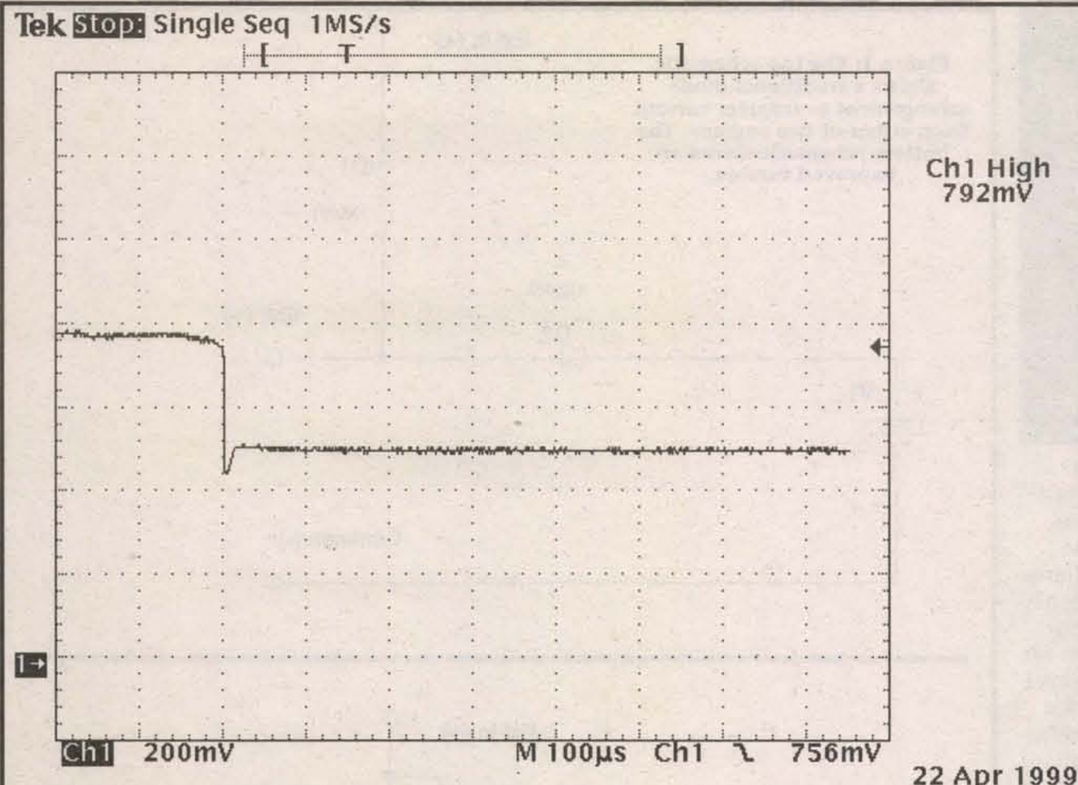


Figure 2: Transfer waveform; the voltage glitch is only 10 microseconds wide, it may be easily filtered.

MOSFET's internal body diode, which is in parallel to drain and source. As the gate's voltage is pulled to ground via R1, the transistor is turned on, and current will begin to flow through the transistor's extremely low channel resistance — 70 milliohm typical — allowing extremely low voltage drops. Battery capacity is thus maximized due to the reduced losses in the switch.

As shown in the scope waveforms of Figure 2, the transfer is virtually instantaneous. To show the extremely fast transfer, no output capacitor was used while recording the waveform. The very short glitch may be easily filtered out with the mandatory input capacitance which is already present at any regulator input. The load current in this instance was 600 mA.

The circuit is so straightforward, that the simplest solution to assemble it is to employ a surface mount breadboarding medium known as Surfboards®. These are available from Digi-Key and other distributors.

Table 1: Modifications to SEPIC regulator for different input voltages.

Maximum Input Voltage	L1 (µH)	L2 (µH)	C4, C5, C6 (µF/ volt)
10	220	120	4.7/ 10
14.5	330	120	6.8/ 16

As shown in Figure 3, the diode, resistor, and MOSFET chosen for this project are all SMD, which allows an ultra compact assembly, a mere 0.75 by 1.20 inches.

Figure 3 shows the location of the components in the assembled prototype board; you may use it as a guideline or feel free to make modifications. The numbers shown in the schematic close to the MOSFET symbol are the pin assignments for a SO-8 package device. The specified device not only is extremely compact, it has ultra low Rds(on) at low gate drive levels. Thus, if you decide to employ a substitute MOSFET, ensure that it is a logic-level device which will still maintain a very low Rds(on) at a low gate voltage drive.

Don't despair if you have never assembled SMD devices before. Surfboards® come with a little note, which has instructions on how to solder SMD components which may come in handy for the novice user. The only real tools required are a fine point soldering iron, tweezers, and — if you are eyesight-challenged like myself — a magnifying glass. I always like to rant that as I become older, devices are becoming smaller. And although you may have heard this warning a thousand times, here it goes again: **Always ensure ESD-safe handling for the MOSFETs.**

If operation from a vehicle is required, or if frequent connect/disconnect cycles are expected, it is strongly suggested that optional TRANZORB diode D3 is installed.

Surprisingly, large voltage transients in a vehicle's electrical system or during disconnects are generated, which could damage the switch and the regulator downstream. **NV**

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"Ready-to-Build Telephone Enhancements" *by D.T. Horn* **$17.95**

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Voice Changer

An electronic circuit that can shift the pitch of your voice is called a voice changer.

Thanks to Holtek, there's an easy, inexpensive way to build a voice changing circuit: Use the HT8950A.

by Jack Dennon

Voice changing is an interesting application of electronics and could even have some important applications if you need, for example, to answer the phone without having your voice be recognized.

Voice changer circuits can be based on the frequency-shifting characteristics of the double balanced mixer (see sidebar) or, nowadays, you can take advantage of digital signal processing (DSP) techniques. Either approach involves a fair amount of design work. But thanks to Holtek, there is now an easier way to build a voice changing circuit: use the HT8950A.

This is actually a DSP-type approach, but you don't have to do any programming. Just add an LM386 audio output amp, a few passive components, and a nine-volt battery, and you have a system capable of shifting your voice up to sound like a lady, or down to sound like a gruff old man. There are six frequency shifts available, plus normal (no shift).

About the HT8950A

This Holtek HT8950A chip appears to simulate the operation of an audio tape recorder. But since it uses digital techniques, it can pull some tricks that would not be possible with physical tape. Mind you, I'm not certain that the way I will describe its operation is in fact what the chip actually does; Holtek's data sheet doesn't tell you exactly what is going on inside this chip.

We are told that there is an analog-to-digital converter at the input, a digital memory, and then a digital-to-analog converter for output. The actual algorithm may be quite sophisticated, but what it simulates is a tape recorder with variable speed readout.

So you can visualize it as an endless loop of tape, or a magnetic drum, with a write head that moves at about 8000 samples per second, and a read head that moves a selectable fraction or multiple of that rate.

For shifting up, you can select 4/3, 8/5, or two times the write rate; for shifting down you have available 8/9, 4/5, or 2/3 the write rate.

The chip was designed to be used in a handheld device. It has four pins internally debounced for dedicated push-button inputs. One of these inputs punches the pitch up one step, one punches the pitch down one step, and the other two invoke special effects that are a robot-like voice, and vibrato.

The chip powers up in the robot voice mode. The stepping up and stepping down provided by the two push-button inputs are each actually performed in a circular fashion.

In other words, you can get to any frequency shift by just punching the up button or the down button because when you hit the end of the multiplier table, they just wrap around to the other end of the table and keep stepping; the only difference between the two buttons is the direction in which they step. One goes clockwise, the other goes counter-clockwise, so to speak.

About the Circuit

The HT8950A operates on 2.4 to 4.0 volts and draws less than 10 milliamps so, as shown in Figure 1, we use a simple zener regulator to drop the voltage from a nine-volt battery down to our operating level.

Zener diode D1 draws just the right current through resistor R1 to maintain Vdd at about 3.5 volts. Pin 11 of the HT8950A — the "lamp" pin — draws current through LED D2 proportional to the audio level, so they say, but if you install resistor R10, then mainly it just shows that the power is on.

Resistors R7 and R8 set the internal clock rate. Resistors R9 and R5 establish the gain of the audio input amplifier. Resistors R4 and R6, with the help of smoothing capacitor C3, provide the bias voltage that the electret microphone requires.

Coupling capacitor C4 isolates the microphone's DC bias voltage from the IC's audio input amplifier while passing the audio voice signal.

The frequency-shifted audio available at pin 12 is low-pass filtered by R2 and C5 and then applied via pot R3 to the input of the audio output amplifier U2. The audio output amplifier is configured for a voltage gain of 20; out-

PHOTO 1. A short length of 2x4 and a clothespin make a versatile jig that holds small parts for soldering.

Voice Changer

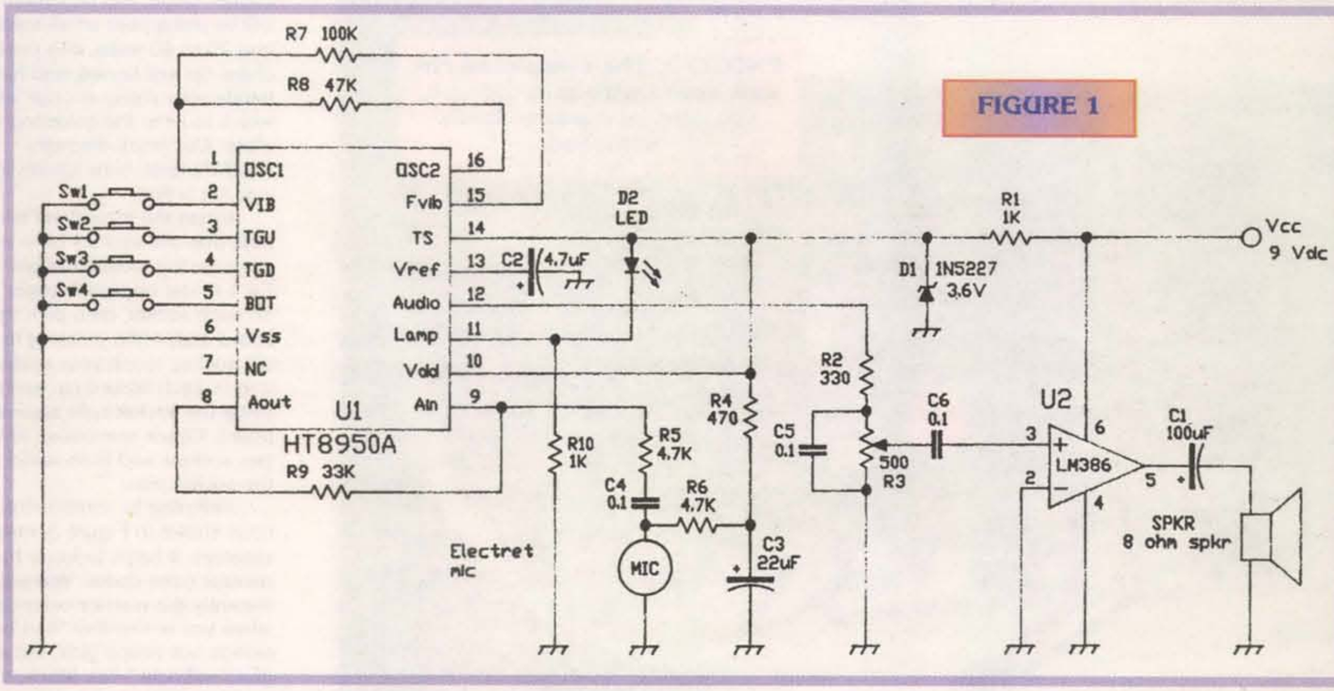


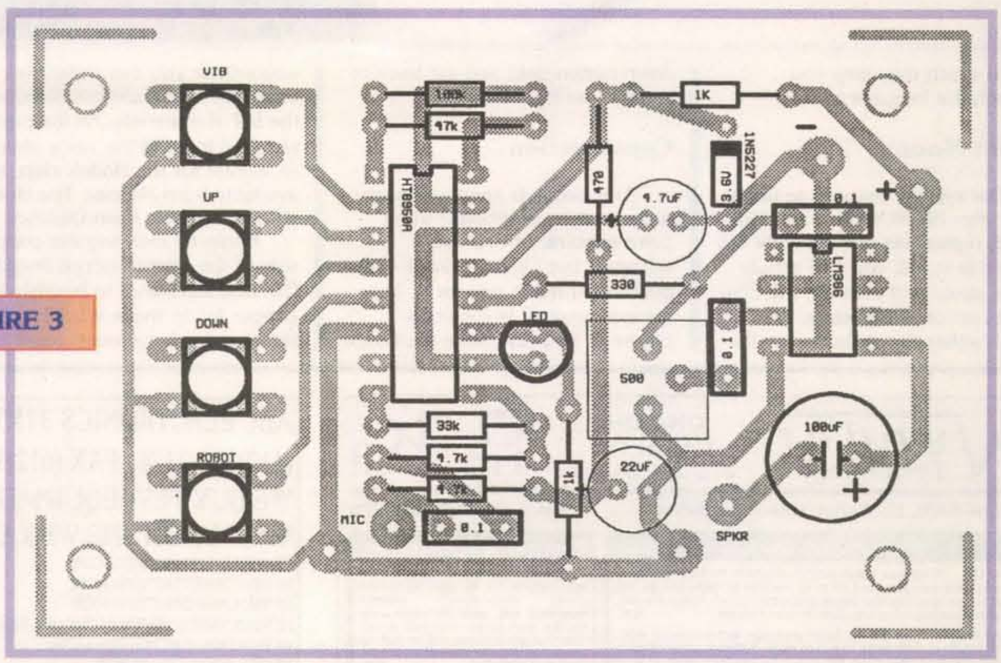
FIGURE 1

put volume is, of course, controlled by pot R3. The LM386 drives an eight-ohm speaker via coupling capacitor C1.

Vibrato

An output voice will be generated with a vibrato effect when the VIB pin is triggered, regardless of what state the system is in. The vibrato pin toggles the vibrato state. That is to say, when a voice output is playing with vibrato effect, this effect can be eliminated by retriggering the VIB input. The rate of vibrato effect can be changed by changing the value of resistor R7.

FIGURE 3



Voice Modulation

The HT8950A provides eight-bit analog-to-digital (A/D) and eight-bit digital-to-analog (D/A) converters with a sampling rate of 8 KHz, ensuring voice output of high quality with a high signal-to-noise (S/N) ratio. The large scale integrated (LSI) circuit includes seven steps to shift the frequency of the input signal. The frequency steps are illustrated in the following table:

0	Down3	2/3
1	Down2	4/5
2	Down1	8/9
3	Normal	1
4	Up1	4/3
5	Up2	8/5
6	Up3	2
7	Robot	

Power Up

The chip powers up in robot mode. The TGD (down) pin steps the frequency in the direction Down1, Down2, Down3. The TGU (up) pin steps the frequency in the direction Up1, Up2, Up3. So after power-up, if you assert the TGU (up) input by pressing the UP button, you step to Down3. Simple, huh?! The numbers listed in the far right column of the preceding table give you the "speed ratio" that indicates, for example, that Down3 provides an output frequency that is two-thirds of the input frequency.

Either input TGD or TGU can get you to any frequency setting. The only difference between "up" and "down" is the direc-

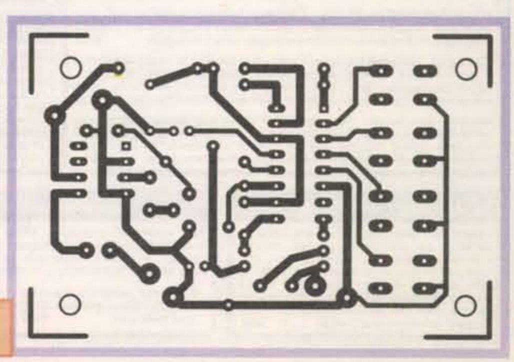


FIGURE 2

Voice Changer

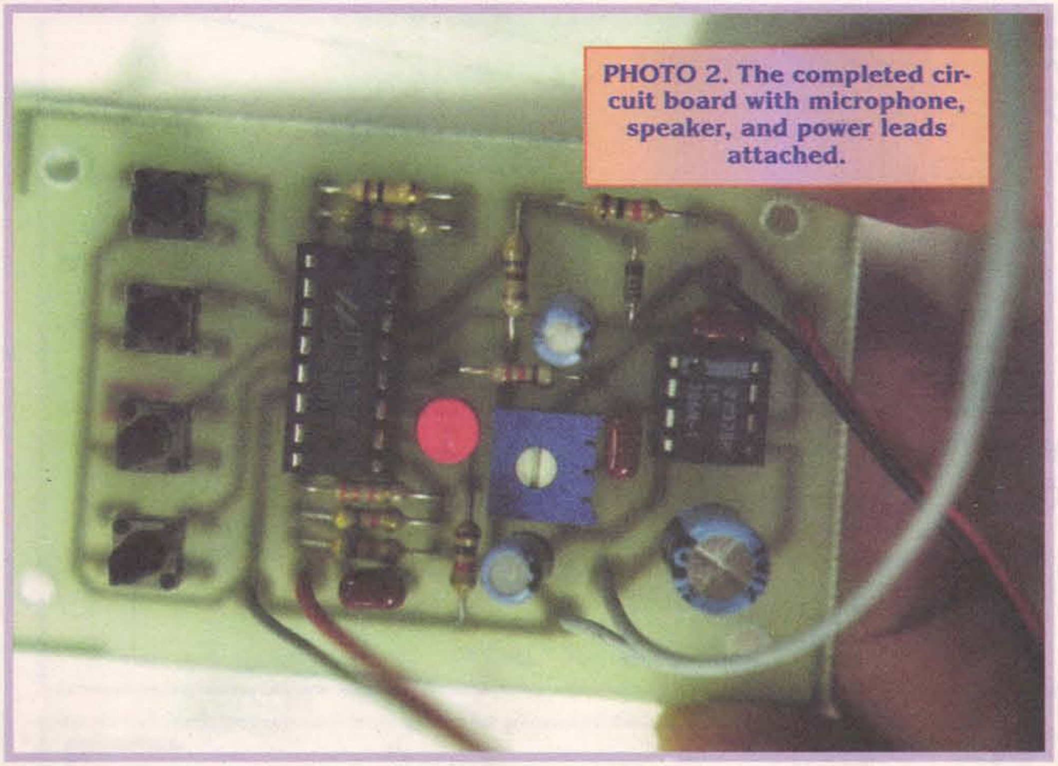


PHOTO 2. The completed circuit board with microphone, speaker, and power leads attached.

tion in which they step you through the frequency table.

Robot Mode

The system changes to Robot state after the ROBOT pin is triggered, regardless of what state the system is in. Or, you can simply power down and then up; the chip comes up on Robot state, or punch either the up button or the down button until you get back to state 7, the Robot state.

Construction

The circuit is simple enough to be built on perf-board wired point-to-point, or even wire-wrapped, but I like a printed circuit board, so I made one for it. The foil side artwork is shown in Figure 2. You can make the board yourself, or you can order the board from the address given with the bill of materials. All the parts required to build the voice changer, except for the Holtek chip, are available from Mouser. The Holtek chip is available from Digi-Key.

Begin by cleaning the copper side of the printed circuit board. Use fine steel wool to burnish the copper foil to make it bright and shiny and remove resist residue, copper oxide, etc. Of course you will be using your small soldering iron 25 to 40 watts with pencil or chisel tip well tinned, and have handy your damp sponge with which to keep the soldering tip clean. Use small diameter (0.031") rosin core solder; 60/40 lead/tin is fine.

Install the IC sockets taking note that the sockets have an indicator for the location of pin 1. Tack-solder opposite corner pins on each socket, then pick up the board and, while pressing in on the socket, touch your soldering iron to each tacked pin and thus press the socket tight against the board. Check orientation of the two sockets and then solder all of the socket pins.

Referring to component locations shown in Figure 3, install the resistors. It helps to know the resistor color codes. You will recall instantly the resistor color codes when you remember "bad boys ravage our young girls, but violet gives willingly." Yes, black, brown, red, orange, yellow, green, blue, violet, gray, white, for 0, 1, 2, 3, 4, 5, 6, 7, 8, 9. (They're not allowed to teach stuff like that anymore, so be thankful that there are still some of us old timers around to pass along important electronic lore of the past.) All resistors are mounted on 0.5" centers, so you can use your bending tool (Jameco part number 106884) to form the leads.

It is good practice to insert the resistors such that the color codes read consistently such as left-to-

Voice Changer

Analog voice changers

Analog voice scramblers and voice changers are based on the same building blocks, mixers, and local oscillators. A voice scrambler and a voice changer are diagrammed side-by-side in Figure 4 to show how similar they are. Each system has a microphone, two mixers, two local oscillators, a transmission line, and a speaker.

In the voice scrambler, the local oscillators are at separate ends of the line; one in the transmitter and one in the receiver, and they oscillate at the same frequency. In the voice changer, both local oscillators are in the transmitter and they operate at different frequencies; the difference being the amount by which voices are to be shifted.

The device that audio engineers call their "mixer" is not the device we are dealing with here. The audio engineer's mixer is really an adder. The mixer we need here is the kind used by radio engineers; it is really a multiplier.

If you add signal s1 = cos f1 to signal s2 = cos f2, you just get cos f1 + cos f2. The signals remain intact and, in fact, you can isolate and extract either signal with a bandpass filter. But if you multiply cos f1 times cos f2, you create an entirely different signal. In your trigonometry textbook, you will find the following two identities (they are called identities because they hold for all values of A and B):

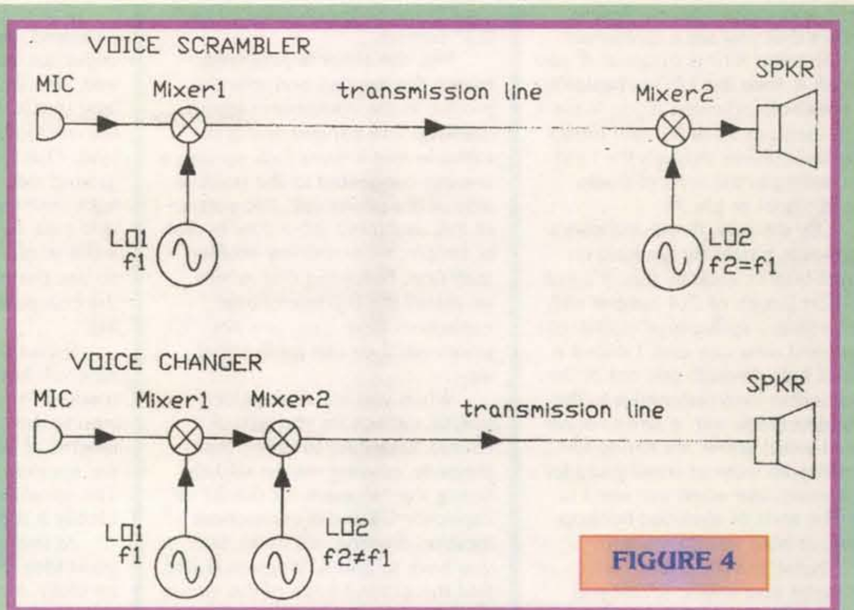


FIGURE 4

$$\cos(A+B) = \cos A \cos B - \sin A \sin B$$
$$\cos A \cos B + \sin A \sin B$$

If we add these two identities together, we get

$$\cos(A+B) + \cos(A-B) = 2 \cos A \cos B$$

or

$$\cos A \cos B = 0.5 \cos(A+B) + 0.5 \cos(A-B)$$

Applying this result to our case, we get:

$$\cos f1 \cos f2 = 0.5 \cos(f1+f2) + 0.5 \cos(f1-f2)$$

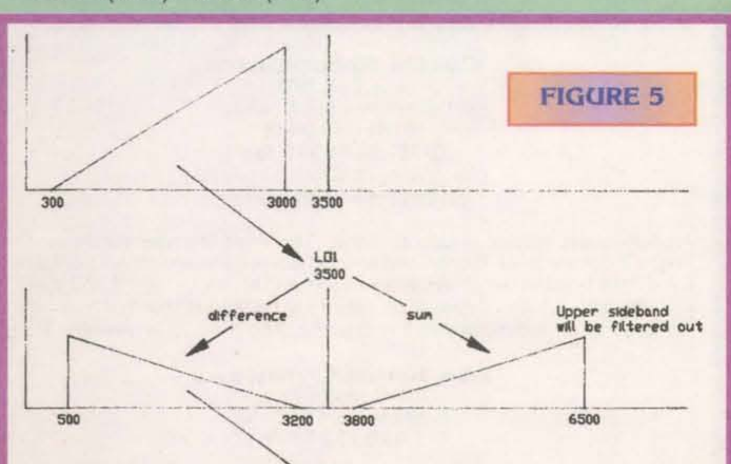


FIGURE 5

In other words, when you multiply signal s1 by signal s2, what you get are two new signals: one oscillating at the sum of the original frequencies, and the other oscillating at the difference of the two original frequencies; with amplitude reduced to half its original value.

In this ideal mixer, the two original frequencies disappear entirely. In a real mixer, of course, things are not quite this tidy.

But this mixer is doing something else that does not at first meet the eye; it is inverting the spectrum of the input signal. If we use a low-pass filter to save only the lower sideband of what comes out of the mixer, we will find that what goes in low comes out high, and vice versa.

To understand this "sideband" lingo, it is advisable to draw a diagram of what is actually going on here. In Figure 5, we have plotted a band of audio input frequencies extending from 300 Hz up to 3000 Hz. The amplitudes are not important; we show a linear spread of frequencies just to help see which end of the spectrum is which. We set up our local oscillator to run at say, 3500 Hz. What comes out of the mixer is a lower sideband containing all of the difference frequencies (f1-f2), and an upper sideband containing all of the summation frequencies (f1+f2).

On the lower sideband, what goes in at 300 Hz comes out at 3200 Hz; what goes in at 3000 Hz comes out at 500 Hz. In other words, the spectrum has been inverted; what was low is now high, what was high is now low. The frequency inversion is what scrambles your voice. We put the output of the mixer through a low-pass filter to save only this lower sideband and, in this way, we have turned the spectrum end-for-end. Garbled indeed.

To recover the original voice at the receiver, we run the garbled signal through another mixer identical to the first one; with its local oscillator set to the same 3500 Hz frequency. Again we save only the lower sideband. What now goes in at 3200 Hz comes out at 300 Hz, and what goes in at 500 Hz comes out at 3000 Hz. In other words, we have inverted the inverted spectrum and everything is back to normal.

What will happen if you run the second local oscillator at a frequency different from the first local oscillator? What will happen is, you will have invented the voice changer. Suppose we run the second local oscillator at 3600 Hz, or 100 Hz above the frequency of the first local oscillator. What goes in now at 3200 Hz will come out at 400 Hz, and what goes in at 500 Hz will come out at 3100 Hz. But the 3200 Hz signal is really our original 300 Hz signal in disguise, so what we have done is shifted the original 300 Hz signal up to 400 Hz.

Similarly, the 500 Hz signal is our original 3000 Hz in disguise, so overall what we have is our original spectrum shifted up in frequency by 100 Hz; we have a voice changer.

The second mixer inverts the inverted spectrum output from the first mixer, so your voice in no longer garbled, it is just shifted up in frequency. The diagram in Figure 5 shows the amplitude dropping by one half at each mixer in accordance with our earlier mathematical analysis but, in an actual system, one or more amplifiers — probably integrated into the low-pass filters — would be used to maintain signal volume.

right and top-to-bottom. Well, it shows that you are a craftsman.

Resistor R10 is optional. If you install it, then the LED is basically a power-on indicator. If you leave it out, then pin 11 of IC1 will modulate the current through the LED according to the level of audio input signal at pin 9.

By the way, Photo 1 shows a jig that is handy for working on small boards such as this. It's just a short length of 2x4 lumber with an ordinary spring-type clothespin fastened near one end. I drilled a small hole through one ear of the clothespin then fastened it to the wooden block with a small round-head wood screw. It's handy for holding all sorts of small parts for soldering, like when you need to tin the ends of stranded hookup wire, or hold this little board.

Install the trimmer potentiometer and solder. When you bend the leads of the zener diode, hold the lead with your needlenose pliers, grabbing the lead between the glass package and the bending place. That way you won't crack the glass. But you have to hold really close to the case because the diode goes in on 0.3" centers.

Yes, the zener is polarized; match the banded end with the picture in the component layout drawing. The banded end is the cathode and it must look up into a resistor connected to the positive side of the power rail. The pattern of this assembly procedure is pretty simple: we install low profile stuff first. Following that advice, we install the 0.1 microFarad capacitors next. They are not polarized; they can go in either way.

When you install the electrolytic capacitors you will, of course, take care to orient them properly, cussing me for slightly hiding the "+" mark for the 22 uF capacitor C3 in the component location drawing. It's there, but you have to find it. When in doubt, find the ground trace of the circuit board and put the "-" lead there.

The push-button switches will fit down against the board if you push them in. If you don't want to push that hard, then you may want to open up the mounting holes slightly.

The electret microphone is polarized, like an electrolytic capacitor, but it isn't marked as well, so look it over carefully. The lead that is attached to the case of the microphone is the negative lead. That lead attaches to the ground side of your circuit. The light emitting diode also is a polarized part. Its cathode is marked by a flat portion of the plastic case, so use the orientation shown in the component placement drawing.

Solder the red lead of the nine-volt battery clip to the pad marked "+" and solder the black lead to the "-" pad. Use two lengths of hookup wire to connect the speaker to the "SPKR" pads. The speaker is not polarized; electrically it is just a coil of wire.

At this point, it would be a good idea to look your work over carefully. Measure the resistance across the nine-volt battery clip. No, it should not be zero. The assembled circuit in Photo 2 measured just a little over 6000 ohms across the battery clip.

If you have a small resistance, or no resistance, something is upsidedown, like maybe the zener, or you've got a solder bridge somewhere.

If things look okay, install the two ICs following the orientation indicated in the component placement drawing. Both are installed with pin 1 toward the top of the board. Well, now you're ready to connect a nine-volt battery and "tune for smoke," zero smoke being the preferred value.

Options

As we indicated earlier, you don't really need four push buttons to step through the available modulations. A single push-on push-off power switch and one momentary push button connected to the TGU pin, for example, would allow you to get to any modulation the HT8950A provides. To get to robot mode, power down and then up; the circuit powers up in robot mode. Punching the up-button can then step you in circular fashion through all the other modulations. So, depending on how you decide to package your voice changer, you may find it easier to provide just a power switch and one push button connected to either TGU or TGD.

In place of the eight-ohm speaker, you may want to install a phone jack so that you can connect the audio output to headphones. The 32-ohm headphones that I tried worked fine. **NV**

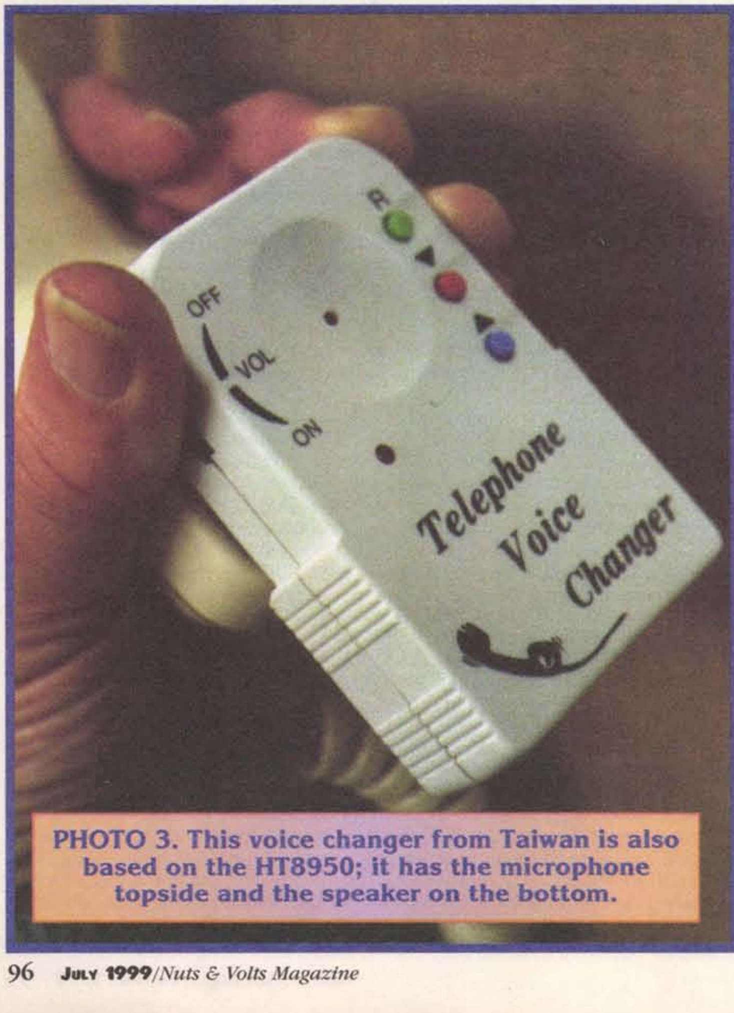


PHOTO 3. This voice changer from Taiwan is also based on the HT8950; it has the microphone topside and the speaker on the bottom.

You Have Alternatives ...

After designing my own board for this kit, I got on the Internet and discovered an almost identical kit imported from Taiwan; available from Carl's Electronics. Sharp-eyed readers may notice that the circuit board being worked on in Photo 1 is the PC board from the Taiwan kit.

Carl's Electronics
P.O. Box 722
Leominster, MA 01453
(978) 840-8834
(978) 840-6172 fax
http://www.electronickits.com
carlton@mail.ultranet.com

A ready-made version is also available. The voice changer shown in Photo 3 comes from Taiwan and is built around a bare HT8950 unpackaged chip bonded out directly onto pads on the circuit board and then covered with a blob of epoxy; an assembly technique that really carries surface mount technology to the extreme. The product is available from:

The Edge Company
P.O. Box 826
Brattleboro, VT 05302
1-800-732-9976

Alas, there's more. From China, an AK-700 style telephone (available from **C & S Sales, Inc.; see their ad on page 75**) with built-in HT8950 voice changer chip is available from:

Deer Creek Products
3038 N.W. 25th Avenue
Pompano Beach, FL 33069
(954) 978-0597

New Product News

DFA 5 DIFFERENTIAL AMPLIFIER

Allison Technology Corp. announces the release of its new DFA 5, a low-voltage differential amplifier for test and measurement applications.

The unit is small, lightweight, and low cost. It can run for days on its internal battery or be powered from an external power source.

DFA 5 provides gain settings from 1x to 1000x and may be used as either a differential mode or a single-ended mode amplifier. With common mode noise rejection that exceeds 100 dB, DFA 5 makes low-voltage measurements straightforward. The unit is suitable for use with oscilloscopes and other common test equipment.

DFA 5 is designed to amplify differential signals ranging from several volts down to microvolts. Gains of 1x, 10x, 100x, and 1000x are switch selected with a gain accuracy of 1%. Maximum frequency depends on the gain setting ranging from 20 KHz at a gain of 1000x to over 1 MHz at unity gain. The unit allows for both AC and DC coupling with the AC mode low-frequency cutoff being 10 Hz using non-attenuating probes.

DFA 5 is available for $129.00.

For more information, contact:

ALLISON TECHNOLOGY CORP.
2006 FINNEY VALLET, DEPT. NV
ROSENBERG, TX 77471
1-800-980-9806
281-239-8500 FAX: 281-239-8006
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REVISED RING-IT!

Digital Products Company announces the release of their newly revised Ring-It!, a popular microprocessor-controlled telephone-line simulator.

Ring-It! acts like a phone company central office and it is used to test and demonstrate telephones, answering machines, fax units, voice mail systems, or modems.

Its recently updated design now supports E-911 training and Caller-ID signalling. A convenient external audio jack has been added for call monitoring applications.

Telephone equipment connected to the simulator behaves as if it were connected to a real analog telephone line. For example, a connected telephone produces an authentic sounding dial tone. Dialing a 7- or 11-digit phone number with a touchtone phone rings the device plugged into the test line. Busy signals and reorder tones are also heard as with a standard phone line.

The Caller-ID feature provides number only or name/number messages. Five different test modes offer standard telephone-line emulation or special repetitive cycle testing, including automatic ring-up. An LED digital readout displays the DTMF digits that are dialed to verify operation of touchtone phones.

Ring-It can be purchased factory assembled or as a kit. The kit comes with a high-quality printed circuit board, all electronic components, and a technical manual.

Factory assembled units (#RI-001F) are $325.00. The deluxe kit (#RI-001D) is $205.00 and it includes the Caller-ID option and custom enclosure. Non-Caller-ID kit versions (#RI-001) are available starting at $149.00.

For more information, contact:

DIGITAL PRODUCTS COMPANY
134 WINDSTAR CIRCLE, DEPT. NV
FOLSOM, CA 95630
916-985-7219 FAX: 916-985-8460
http://www.digitalproductsco.com
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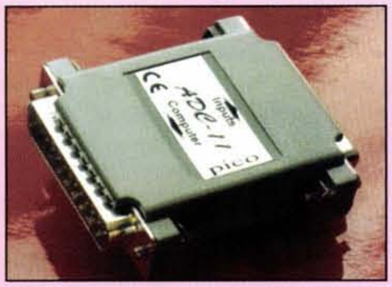
ADC-11



ADC-11 is a versatile matchbox-size unit that turns a PC's parallel port into an 11-channel, 10-bit datalogger for recording analog signals up to 5 kHz. A digital output is also provided, which can be used for control or preset alarm functions. This output can also be used to power sensors such as thermistors. An optional screw terminal board makes it easy to connect 0V to 2.5V signals to the 10 kHz sampling rate ADC-11.

Supplied Picolog software is a powerful but flexible datalogging package for collecting, analyzing, and displaying data from the converter.

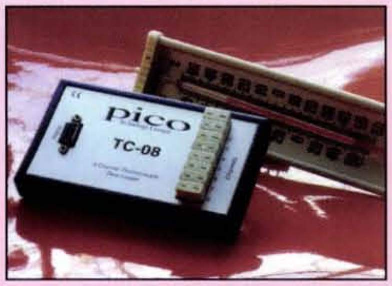
Picolog software can collect data at rates from once per second to once per hour. Data can be displayed in both graphical or spreadsheet format, both during and after data collection.

The software is easy to set-up and use with on-line help, and features time data collection, analysis, and display on the large screen of a PC.

Data can be exported to spreadsheets and databases, and multiple loggers may be used on the same PC. Waveforms can be saved, printed, faxed, or E-Mailed from your PC.

ADC-11 comes complete with PicoScope and Picolog software for only $155.00.

TC-08 THERMOCOUPLE CONVERTER



TC-08 is an easy-to-use eight-channel thermocouple-to-PC interface which works with all popular thermocouple types to measure temperatures from -270°C to +1800°C.

Just plug TC-08 into the serial port of your computer, connect a thermocouple and you are ready to measure temperatures with 0.1°C or 0.025°C resolution depending on sensor type, at ±4% accuracy.

TC-08 software provides all of the calculations necessary for cold junction compensation. DOS drivers with program examples in C, Pascal, and Win 3.1/95/NT drivers with examples for C, Visual Basic, and LabView are also provided.

For 16 channels of temperature measurement, two TC-08s may be installed in a PC with a dual serial port card.

TC-08 comes complete with manual and Picolog software for $325.00.

For more information, contact:

SAELIG COMPANY
1193 MOSELEY RD., DEPT. NV
VICTOR, NY 14564
716-425-3753 FAX: 716-425-3835
E-MAIL: saelig@aol.com
WEB: www.saelig.com

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A new high-efficiency gallium nitride (GaNi) green 530 nm LED (IF-E93) is the latest addition to Industrial Fiber Optics.

The green 530 nm light produced by this device is ideally positioned to take advantage of the low attenuation window of PMMA plastic optical fiber.

The many applications for this LED include: water turbidity sensors, plant sensors, long distance communications over plastic fiber, optical wavelength multiplexing, medical electronics, and displays.

Some key features of the line are: no optical design required; mates with standard, 1000 mm core, jacketed plastic fiber cable; internal micro-lens for efficient coupling; inexpensive plastic connector housing; excellent linearity; and visible light output.

The cost-per-unit ranges from $5-$9.

For more information, contact:

INDUSTRIAL FIBER OPTICS
627 S. 48TH ST., STE. 100, DEPT. NV
TEMPE, AZ 85281
480-804-1227 FAX: 480-804-1229

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